

# **IBM** Field Engineering Maintenance Manual

**29** Card Punch

## Preface

This publication provides information for the maintenance of the IBM 29 Card Punch. The manual is written with presupposition that the reader has a working knowledge of the machine. As much applicable information as possible is in each section of this manual. The sections are numbered for easy reference. The sections are presented in a sequence similar to the card path through the machine.

Timing adjustments for some units may vary among machines due to features and engineering changes; refer to the individual machine wiring diagram for accurate timing.

Special features are treated individually in a separate manual, *Field Engineering Theory – Maintenance, IBM 29 Card Punch Features, IBM 29 Interpreting Card Punch, Model C*, S223-2926.

Other related manuals are:

Field Engineering Theory of Operation, *IBM 29 Card Punch*, S225-3358

Illustrated Parts Catalog, *IBM 29 Card Punch*, S124-0085

Reference Manual, *IBM 29 Card Punch*, GA24-3332

Field Engineering Maintenance Manual, *Motors, Generators, Relays, Circuit Breakers, Test Instruments, Miscellaneous Components*, S225-3422

### *Fourth Edition (April 1969)*

This a major revision of, and obsoletes, Form 225-3357-2, FE Supplement Form S23-4035, and all earlier editions. Significant changes have been made throughout this manual, including: new diagnostic flowcharts, Chapter 1; a new chapter, Chapter 2; new lubricant specifications, Chapter 3; revised starwheel adjustments and revised print suppress adjustments, Chapter 4. This manual should be reviewed in its entirety. Changes are periodically made to the specifications herein; any such changes will be reported in subsequent revisions or FE Supplements.

This manual has been prepared by the IBM Systems Development Division, Product Publications, Dept B96, PO Box 390, Poughkeepsie, N.Y. 12602. A form for readers' comments is provided at the back of this publication. If the form has been removed, comments may be sent to the above address.

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**Abbreviations**

A	ampere
alpha	alphabetic
AMP	amphenol pin
auto	automatic
CB	circuit breaker
CE	customer engineer
CEM	Customer Engineering Memorandum
CF	card feed
char	character
ckt	circuit
col, cols	column, columns
ctrl	control
dc	direct current
def	definition
dup	duplicate
FC	friction clutch
HSS	high-speed skip
Hz	Hertz (cycles per second)

IBC	interposer bail contact
intlk	interlock
LZ	left zero
max	maximum
ms	millisecond
MULT PCH	multipunch
NC	normally closed
NO	normally open
No.	number
num	numeric
PCC	program cam contact
PM	preventive maintenance
prgm	program
sec	second
SMS	Standard Modular System
V	volt

## Safety Procedures

Safety cannot be overemphasized. To ensure personal safety and the safety of co-workers, each CE should make it an everyday practice to observe safety precautions at all times. All CEs should be familiar with the general safety practices and procedures for performing artificial respiration that are outlined in *CE Safety Practices*, S229-1264. For convenience, the -1 printing of this form has been reproduced.

Always use a reliable voltmeter to verify that power is actually off after using power-off switches. Although all power supplies are provided with bleeder resistors to drain off capacitor charges when power is dropped, it is wise to check all capacitors with a meter before attempting maintenance. A defective bleeder resistor could create an unexpected hazard.

Anyone working near electrical circuits may accidentally come in contact with live voltage.

Round off sharp edges on plastic guides; replace broken guides.

Check that all applicable safety devices are on the machine.

Check all safety devices for proper operation.

Do not permit machines to be run unattended with covers open or removed.

Leave the escapement gearing cover in place at all times when the machine is running.

Turn off power when tilting the base.

Use only IBM approved products. Read the labels. As a general rule, cleaning fluids should be used only in an open area. Breathing the concentrated vapors, even for a short time, may cause immediate reactions.

Review Customer Engineering Memorandums (CEMs) for current safety practices.

### CE SAFETY PRACTICES

All Customer Engineers are expected to take every safety precaution possible and observe the following safety practices while maintaining IBM equipment:

1. You should not work alone under hazardous conditions or around equipment with dangerous voltage. Always advise your manager if you MUST work alone.
2. Remove all power AC and DC when removing or assembling major components, working in immediate area of power supplies, performing mechanical inspection of power supplies and installing changes in machine circuitry.
3. Wall box power switch when turned off should be locked or tagged in off position. "Do not Operate" tags, form 229-1266, affixed when applicable. Pull power supply cord whenever possible.
4. When it is absolutely necessary to work on equipment having exposed operating mechanical parts or exposed live electrical circuitry anywhere in the machine, the following precautions must be followed:
  - a. Another person familiar with power off controls must be in immediate vicinity.
  - b. Rings, wrist watches, bracelets, metal cuff links, shall not be worn.
  - c. Only insulated pliers and screwdrivers shall be used.
  - d. Keep one hand in pocket.
  - e. When using test instruments be certain controls are set correctly and proper capacity, insulated probes are used.
  - f. Avoid contacting ground potential (metal floor strips, machine frames, etc. — use suitable rubber mats purchased locally if necessary).
5. Safety Glasses must be worn when:
  - a. Using a hammer to drive pins, riveting, staking, etc.
  - b. Power hand drilling, reaming, grinding, etc.
  - c. Using spring hooks, attaching springs.
  - d. Soldering, wire cutting, removing steel bands.
  - e. Parts cleaning, using solvents, sprays, cleaners, chemicals, etc.
  - f. All other conditions that may be hazardous to your eyes. REMEMBER, THEY ARE YOUR EYES.
6. Special safety instructions such as handling Cathode Ray Tubes and extreme high voltages, must be followed as outlined in CEM's and Safety Section of the Maintenance Manuals.
7. Do not use solvents, chemicals, greases or oils that have not been approved by IBM.
8. Avoid using tools or test equipment that have not been approved by IBM.
9. Replace worn or broken tools and test equipment.
10. Lift by standing or pushing up with stronger leg muscles — this takes strain off back muscles. Do not lift any equipment or parts weighing over 60 pounds.
11. All safety devices such as guards, shields, signs, ground wires, etc. shall be restored after maintenance.

KNOWING SAFETY RULES IS NOT ENOUGH  
AN UNSAFE ACT WILL INEVITABLY LEAD TO AN ACCIDENT  
USE GOOD JUDGMENT — ELIMINATE UNSAFE ACTS

S229-1264-1

12. Each Customer Engineer is responsible to be certain that no action on his part renders product unsafe or exposes hazards to customer personnel.
13. Place removed machine covers in a safe out-of-the-way place where no one can trip over them.
14. All machine covers must be in place before machine is returned to customer.
15. Always place CE tool kit away from walk areas where no one can trip over it (i.e., under desk or table).
16. Avoid touching mechanical moving parts (i.e., when lubricating, checking for play, etc.).
17. When using stroboscope — do not touch ANYTHING — it may be moving.
18. Avoid wearing loose clothing that may be caught in machinery. Shirt sleeves must be left buttoned or rolled above the elbow.
19. Ties must be tucked in shirt or have a tie clasp (preferably nonconductive) approximately 3 inches from end. Tie chains are not recommended.
20. Before starting equipment, make certain fellow CE's and customer personnel are not in a hazardous position.
21. Maintain good housekeeping in area of machines while performing and after completing maintenance.

- Rescue Breathing for Adults**  
Victim on His Back Immediately
1. Clear throat of water, food, or foreign matter.
  2. Tilt head back to open air passage.
  3. Lift jaw up to keep tongue out of air passage.
  4. Pinch nostrils to prevent air leakage when you blow.
  5. Blow until you see chest rise.
  6. Remove your lips and allow lungs to empty.
  7. Listen for snoring and gurglings, signs of throat obstruction.
  8. Repeat mouth to mouth breathings 10-20 times a minute.
- Continue rescue breathing until he breathes for himself.



### Artificial Respiration

#### GENERAL CONSIDERATIONS

1. Start Immediately, Seconds Count — Do not move victim unless absolutely necessary to remove from danger. Do not wait or look for help or stop to loosen clothing, warm the victim or apply stimulants.
2. Check Mouth for Obstructions — Remove foreign objects — Pull tongue forward.
3. Loosen Clothing — Keep Warm — Take care of these items after victim is breathing by himself or when help is available.
4. Remain in Position — After victim revives, be ready to resume respiration if necessary.
5. Call a Doctor — Have someone summon medical aid.
6. Don't Give Up — Continue without interruption until victim is breathing without help or is certainly dead.

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**Section 1. Reference Data**

Figure 1-1 shows machine characteristics for the IBM 29 Card Punch.

**1.1 OPERATIONS**

The 29 Card Punch operations may be divided, as shown in Figure 1-2, for troubleshooting. These operations are:

1. *Start and Run:* Establishment of power (electrical and mechanical) necessary for machine operations. This includes the operation of the card feed and the pick-and-hold of the card lever relay.
2. *Interposer Selection:* Engagement of an interposer or interposers with the punch bail in preparation for punching.
3. *Escapement:* Advancement of the program drum and of the escapement-driven feed wheels.

Characteristics	Description
Speed:	<u>Without Print</u> <u>With Print</u>
Manual punching	20 col/sec      18 col/sec
Manual duplication	10 col/sec      9 col/sec
Automatic duplication	20 col/sec      18 col/sec
Skipping	80 col/sec
Releasing	80 col/sec
Feed from pre-register to detail station	0.250 sec
Hopper	500 cards
Stacker	500 cards

Figure 1-1. Characteristics

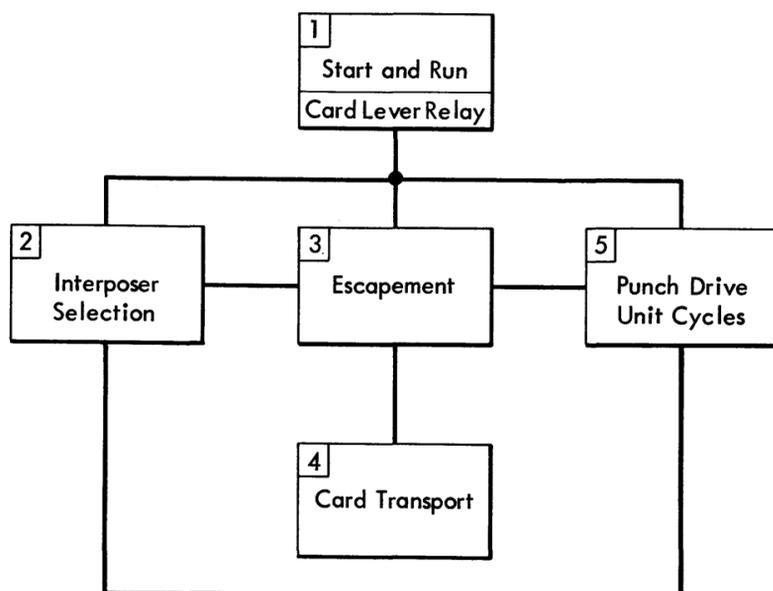


Figure 1-2. Operations

4. *Card Transport:* Mechanical control of the movement of the card through the machine.
5. *Punch Drive Cycle:* Controlled rotation of the punch drive unit index shaft. According to the function, this is required to punch a hole in the card at the punch station or to read a hole in the card at the pin-sense station.

**1.2 SEQUENCE OF OPERATIONS**

It is essential that the customer engineer be aware of the correct sequence of operations as they are used in any machine function.

**1.2.1 Functions**

When the function is to punch a character from the keyboard, the sequence of operations is:

1. Start and run
2. Interposer selection
3. Escapement
4. Card transport
5. Punch drive cycle

Using the numbers only, the sequence is:

- 1
- 2
- 3-4
- 5

Showing escapement and card transport (3-4) side by side indicates that while 3 causes 4, they occur at the same time. Using this notation, the sequence of these operations for all of the functions of the 29 Card Punch is shown in Figure 1-3.

The functions shown in Figure 1-3 are the responses of the machine to the inputs shown here:

- |                               |   |
|-------------------------------|---|
| Key Punch                     | Press any character.  |
| Multiple Punch                | Press the multiple punch key and any numeric key.   |
| Key Skip                      | Press the skip key in numeric or alphabetic shift.  |
| Manual Duplicate              | Press the duplicate key for one or more columns with no programming.  |
| Blank Column Manual Duplicate | Press the duplicate key for one or more blank columns with no programming and with the machine in alphabetic shift.                   |
| Auto Duplicate                | Pressing the duplicate key or the reading of a "0" in the program card in a column followed by "12's" in the program card.            |
| Blank Column Auto Duplicate   | Same as "Auto Duplicate" but for blank columns with the machine in alphabetic shift.  |
| Skip: Release, Auto, Drum     | Press release key if starwheels are up or if they are down in a column programmed "12". An "11" in a program card. Card-to-card skip. |
| Release, Auto Space           | Press release key in a nonprogrammed field but with the starwheels down.  |

Function	Key Punch	Mult Punch	Skip Key	Manual Dup	Blank Column Manual Dup	Auto Dup	Blank Column Auto Dup	Skip: Release, Auto, Drum	Release Auto Space
First Col	1 2 3-4 5	1 2 3-4 5	1 3 4-5	1 5-2 3-4 5	1 5 3-4 5	1 5-2 3-4 5	1 5 3-4 5	1 3-4	1 3-4 5
Second and Other Cols	Repeat for All Cols	2-5 Repeat for All Cycles	3-4 Repeat for Field Def	Repeat for All Cols	Repeat for All Cols	3-4 5-2 Repeat for Field Def	3-4 5-2 Repeat for Field Def	Repeat for All Cols	Repeat for All Cols
						3-4 5 Last Col			

Figure 1-3. Sequence of Operations

## Section 2. Diagnostic Techniques

### 1.3 INITIAL APPROACH

The first step in troubleshooting is to reduce the possible trouble sources to one of the five operations. Locate the operation that breaks the correct sequence for the failing function.

The second step is to vary the machine function to one in which the failing operation occurs in another sequence. This tests the same operation with a different input. For example, interposer selection is faulty during keypunching (2, 3-4, 5). Varying the function to manual duplication (5-2, 3-4, 5) allows interposer selection from the pin-sense input instead of the key input. The cause of the failure, if in a particular input path, can be discovered in this way. If the same operation fails, regardless of the input path used, the failure is common to all paths.

Enough information may be gained in this way to find the cause of the failure by using the wiring diagram and the test probe.

For those troubles that cannot be found by using this approach, refer to the appropriate section in Chapter 4.

Diagnosis of the complete failure of all machine operations should be preceded by a continuity check of the fuses. If attempted punching fails to occur after a card has been registered at the punch station, the card lever relay should be checked first. Consistent blowing of fuses indicates a short or a ground on the machine. Line terminals and/or cam contacts can be checked, one at a time, to locate this type of failure. Some common possible sources of grounds are the starwheel contact and the latch magnet contact.

### 1.4 DIAGNOSTIC FLOWCHARTS

Figure 1-4 defines the symbols used in the diagnostic flowcharts (Figures 1-5 through 1-10). These flowcharts aid in locating the trouble area when diagnosing fairly consistent failures.

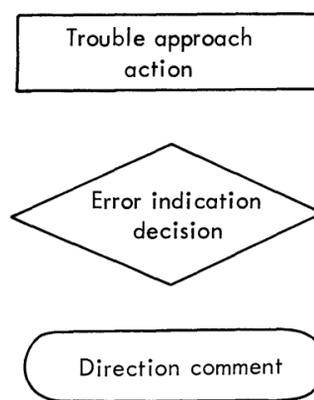


Figure 1-4. Diagnostic Flowchart Symbols

#### 1.4.1 Start and Run Failures

To locate start and run failures (Figure 1-5), the starwheels must be raised and blank cards must be used.

#### 1.4.2 Card Transport Failures

Diagnosis of the failure causing incorrect card movement should include an initial visual check to confirm that the components of the card transport mechanisms are operating. When card transport failure occurs, any mark or nick on the card will help to indicate the source of trouble (Figure 1-6).

A change in registration during the duplication of one punched card can be a false indication of card transport failure. If the escapement moves while the sensing pins are still up through the holes in the card, the card will be retarded. The sensing pins usually leave marks on the card. (See 1.4.4.)

Improperly inserting cards into the pin-sense station can cause trouble. The card to be duplicated should not be forced into the pin-sense station before registering the card.

#### 1.4.3 Interposer Selection Failures

Interposer selection may be incorrect from either the keyboard or pin-sense units, or both. If either unit operates correctly, the circuits and components of the other unit must be considered as a source of the trouble. If both units fail, the trouble is assumed to be in the interposer magnets and associated circuitry or in the interposer mechanism (Figure 1-7).

Note that when the interposers have been tripped for any reason, they must be restored by a drive-unit cycle.

To avoid confusion in diagnosis, the starwheels must be raised to locate interposer selection failures.

#### 1.4.4 Escapement Failures

Faulty escapement is defined as: escaping too far, not far enough, not at all, or at the wrong time.

Program control is used with Figure 1-8 to locate escapement failures. The program card should be punched for alternate three-column duplications and two-column

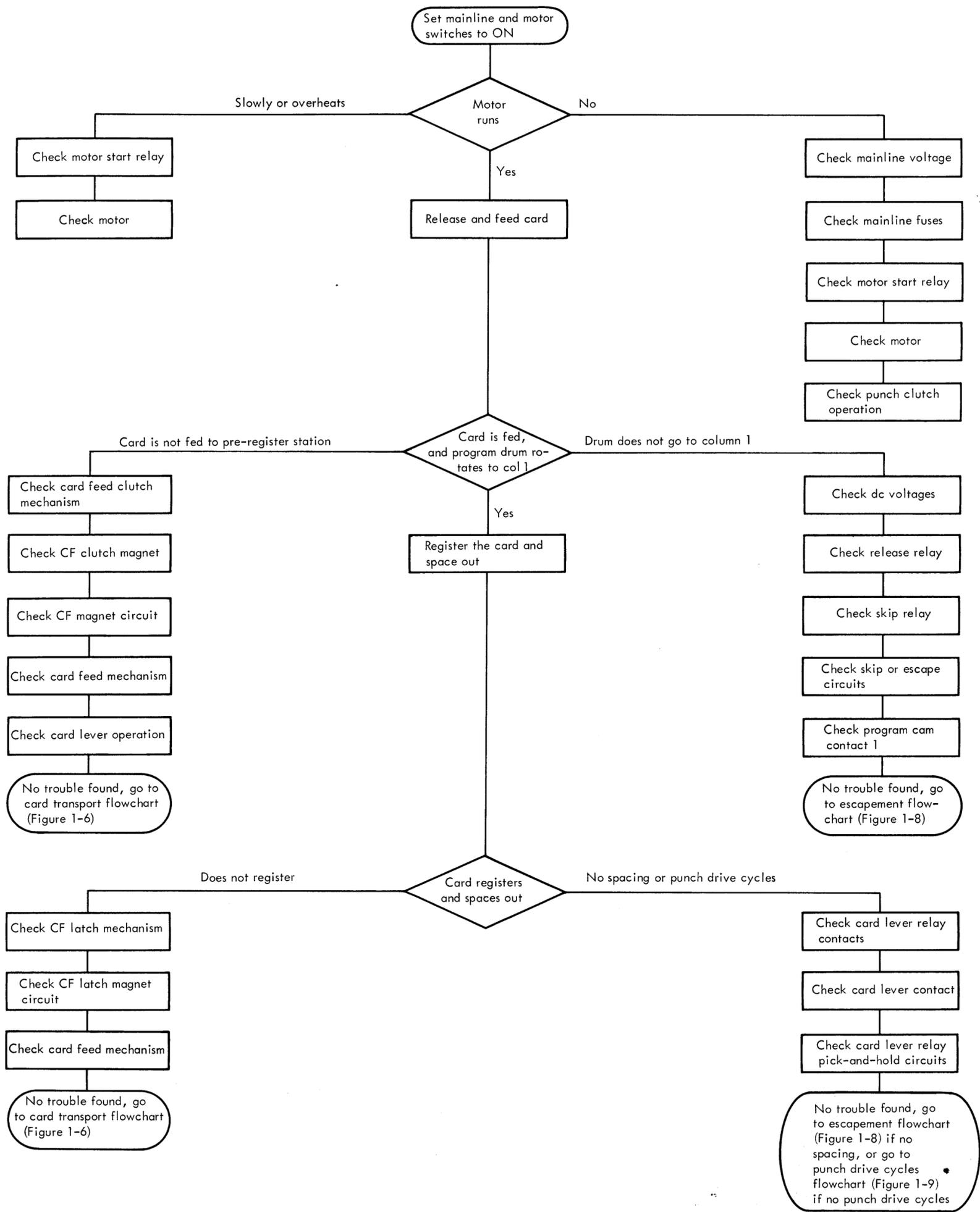


Figure 1-5. Start and Run Failures

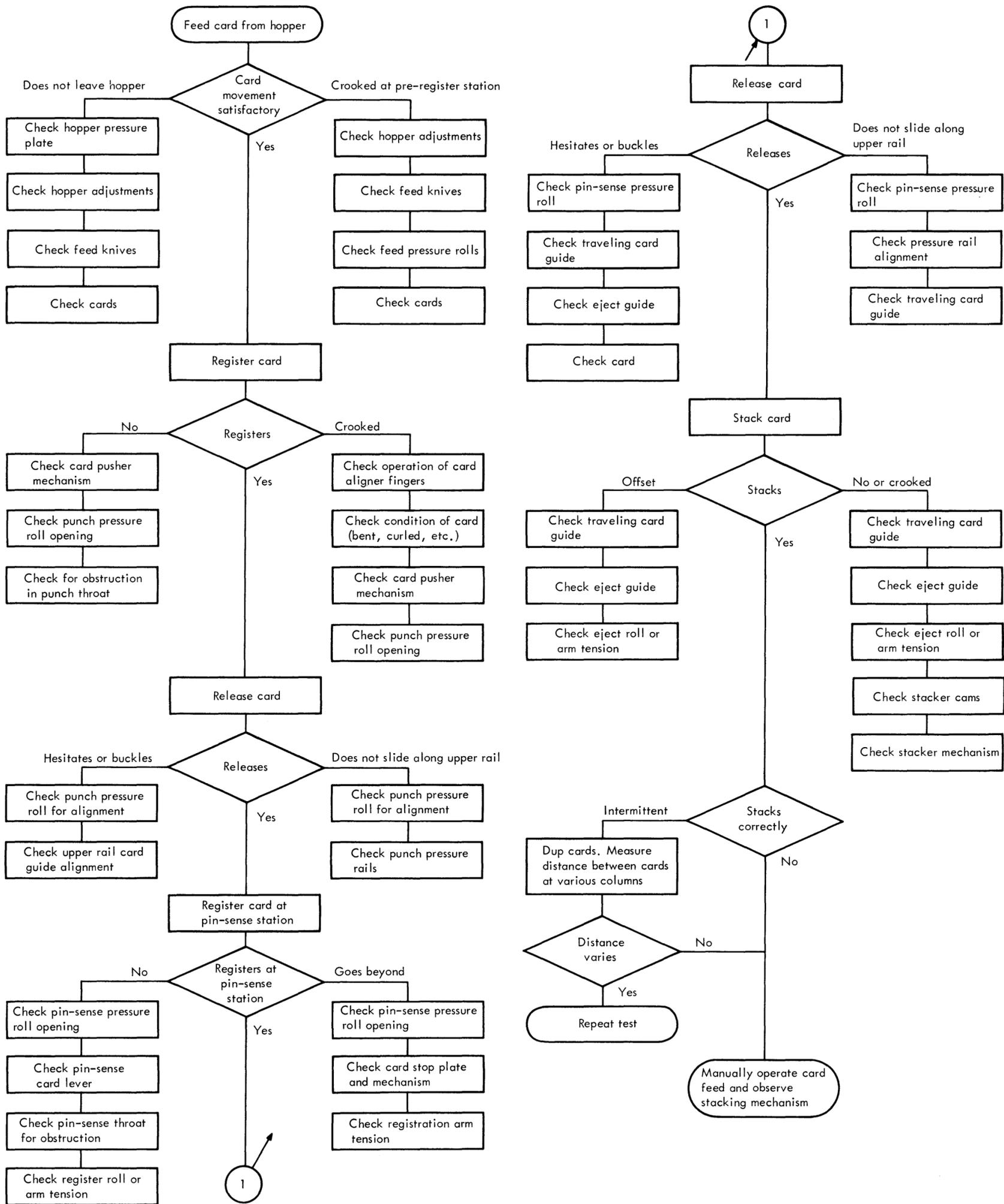


Figure 1-6. Card Transport Failures

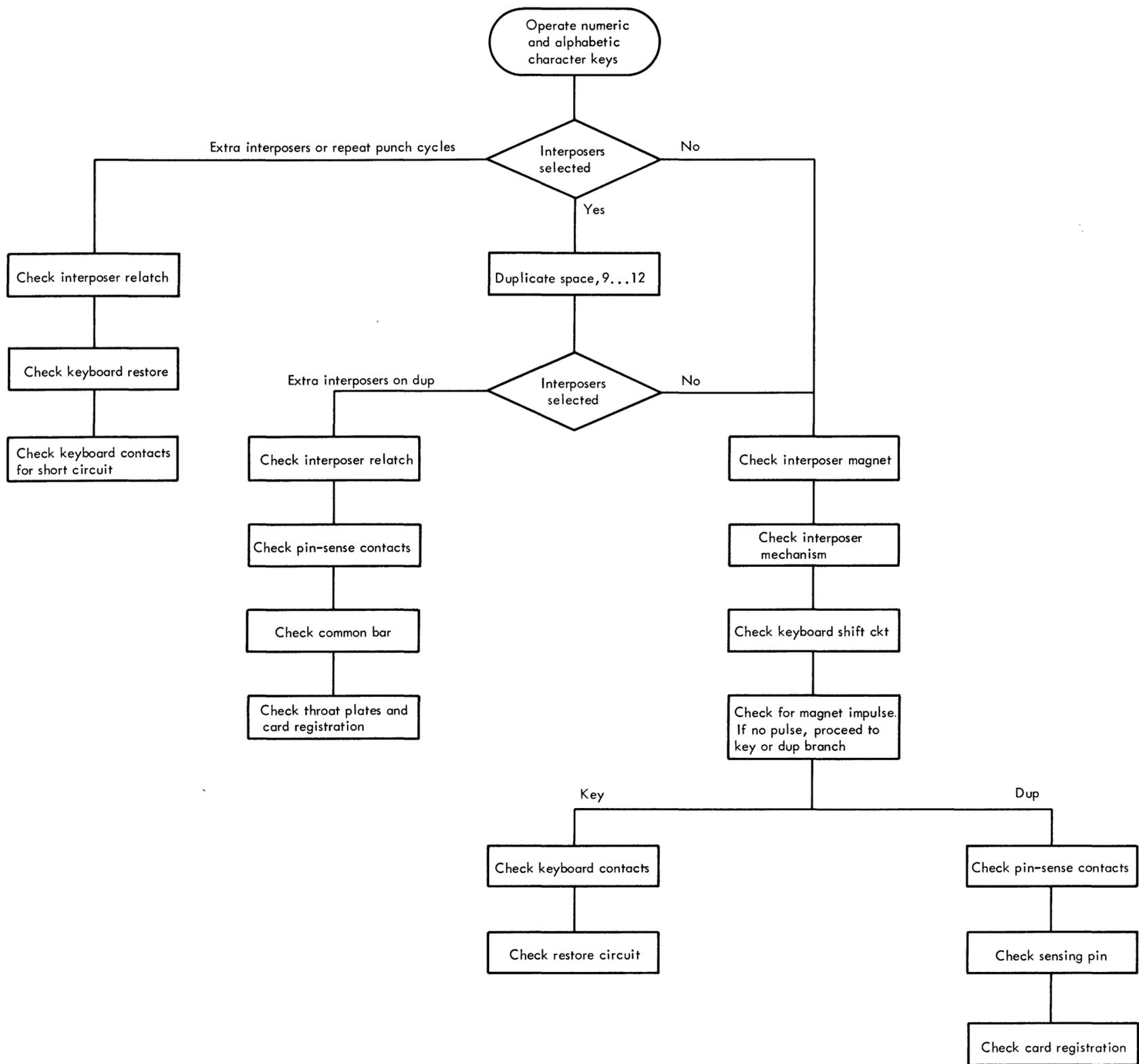
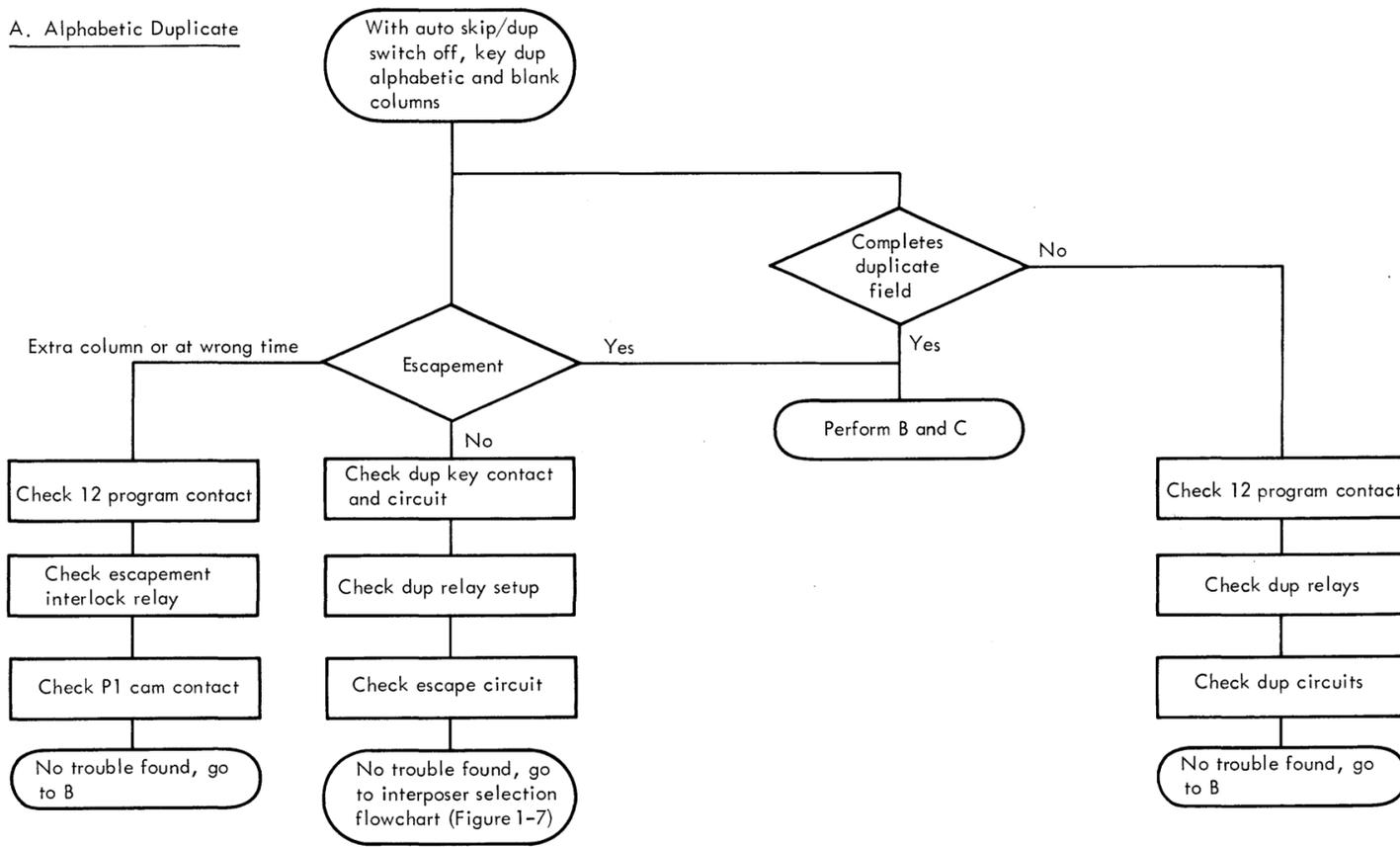


Figure 1-7. Interposer Selection Failures

A. Alphabetic Duplicate



B. Numeric Duplicate and Skip

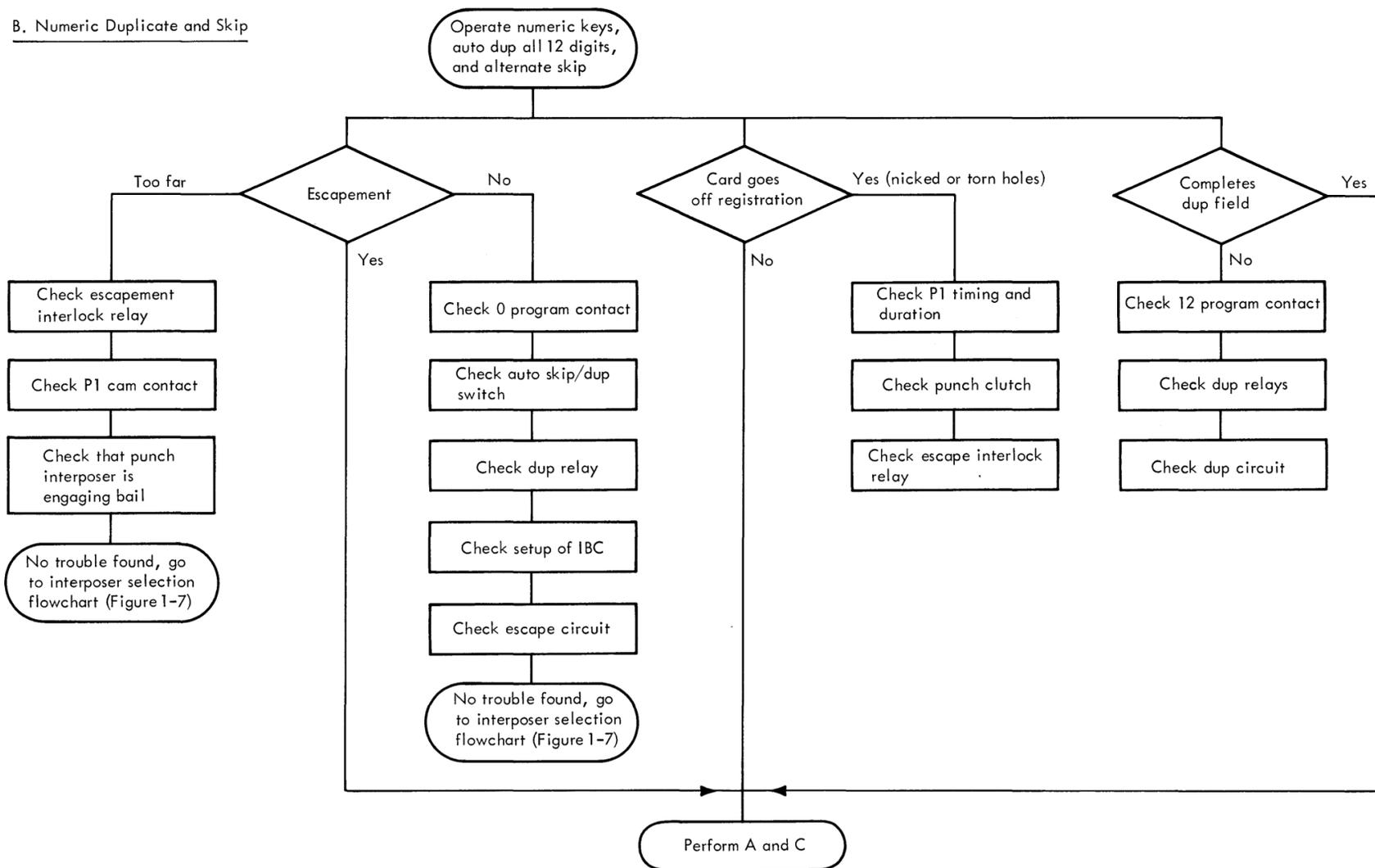


Figure 1-8. Escapement Failures (Part 1 of 2)

### C. Key Punch

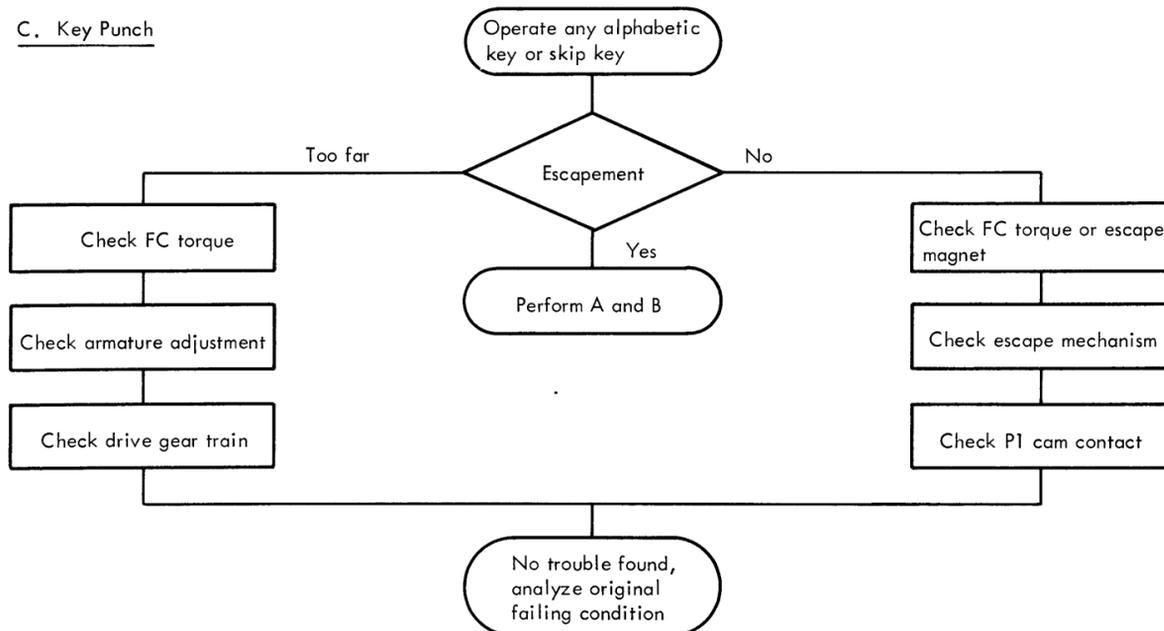


Figure 1-8. Escapement (Part 2 of 2)

skips through column 38. This is followed by a 25-column skip (ending in column 63), an 11-column alphabetic duplication, a 5-column skip, and duplication of column 80.

#### 1.4.5 Punch Drive Cycle Failures

Locate punch drive cycle failures with the starwheels raised (Figure 1-9). Diagnosis of clutch failures should include an initial manual cycle of the punch drive unit. Incorrect clutch overthrow or a defective detent can be found while performing this operation.

#### 1.4.6 Printing Control Failures

The program card used for locating escapement failures can be used for locating programmed printing failures. Diagnostic flowchart is Figure 1-10.

### 1.5 MACHINE SERVICE FEATURES

The 29 Card Punch has two diagnostic features that have been incorporated to aid the customer engineer. These are:

- Motor switch
- Test probe

#### 1.5.1 Motor Switch

The motor switch turns the motor off and allows other areas of the machine to remain energized. It is useful when manually cycling the machine. Some adjustments are made with the motor stopped.

#### 1.5.2 Test Probe

The test probe (Figure 1-11) contains a neon indicator in series with a resistor. One lead of the indicator is connected

to the power supply. The other lead is used to trace circuits leading to coils or magnets. A jack is provided on the power supply chassis.

#### CAUTION

Care must be used when probing relay points because the point of the probe might spread the pin connectors and cause the reed switch to make poor contact or break the pin. Be careful in the use of the test probe; an accidental short could tack several relay points. The probe should not be used to estimate circuit voltages. Use the meter for voltage measurements.

Reed relays should be probed through the top of the bobbin because the vertical rows of holes on the land pattern for a particular relay position do not, in all cases, connect to the relay connector.

*Note:* When probing P3, a false indication may occur; P3 appears not to make. This is due to the timing relationship between the short duration of P3 (7 ms) and the 60-Hz negative line pulse used to bias the probe.

### 1.6 SERVICING TECHNIQUES

#### 1.6.1 Forcing

Extra pressure can be applied to various components to simulate malfunction. For example, the friction drive can be forced or retarded manually at the top of the program drum, or finger pressure can be applied to the escape magnet armature to help or hinder its operation. Magnetism of the escape magnet can be detected, and its strength estimated with any lightweight steel blade (screwdriver or burnishing tool).

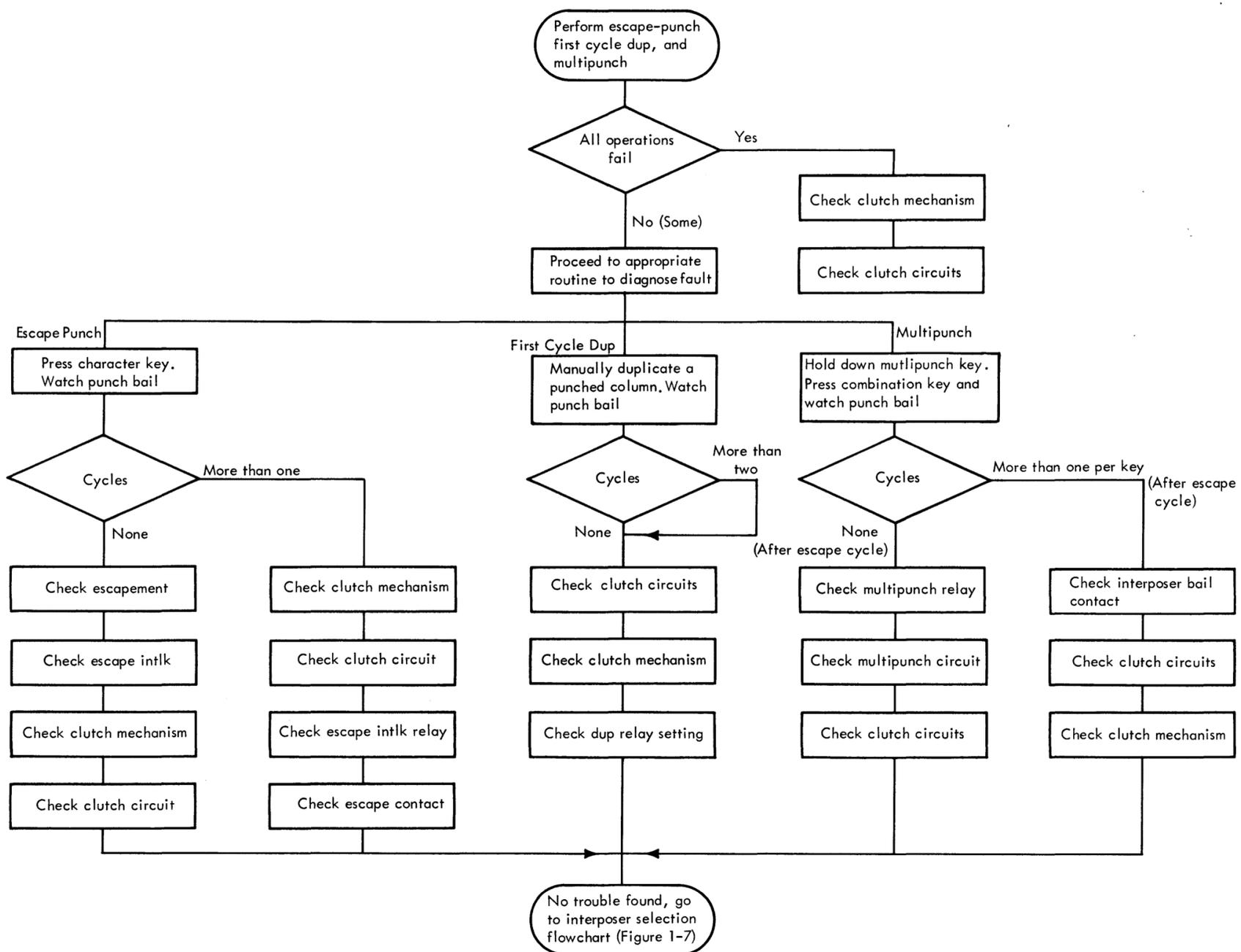


Figure 1-9. Punch Drive Cycle

### 1.6.2 Interrupting Machine Operation

The sequence of machine operation can be interrupted and controlled by removing a lead from the controlling magnets. For example, a lead can be removed from the escape magnet or from the punch clutch magnet. Operation can then be controlled by retouching the lead long enough for one operation to occur.

#### CAUTION

The machine should not be left static in the middle of an operating sequence for a long period of time.

The source of undesired operations can often be located by removing leads along the undesired circuit until the source is found. *This should not be done in reed-relay circuits with power on.*

### 1.6.3 Jumpering

Portions of circuitry suspected of being open can be jumpered to determine whether they are open. It is also useful to jumper the desired voltage into a circuit, to determine how much of the circuit operates correctly.

*Circuit Card Tab Connections:* Individual wires are easily removed from the connectors to facilitate circuit diagnosis or component isolation. To remove wires from Amphenol connectors, use AMP\* disconnect tool (part 452815).

### 1.6.4 Measuring

A voltmeter can be used while the machine is static to measure the magnitude of a voltage. Manual operation may

\*Trademark of Amp, Incorporated

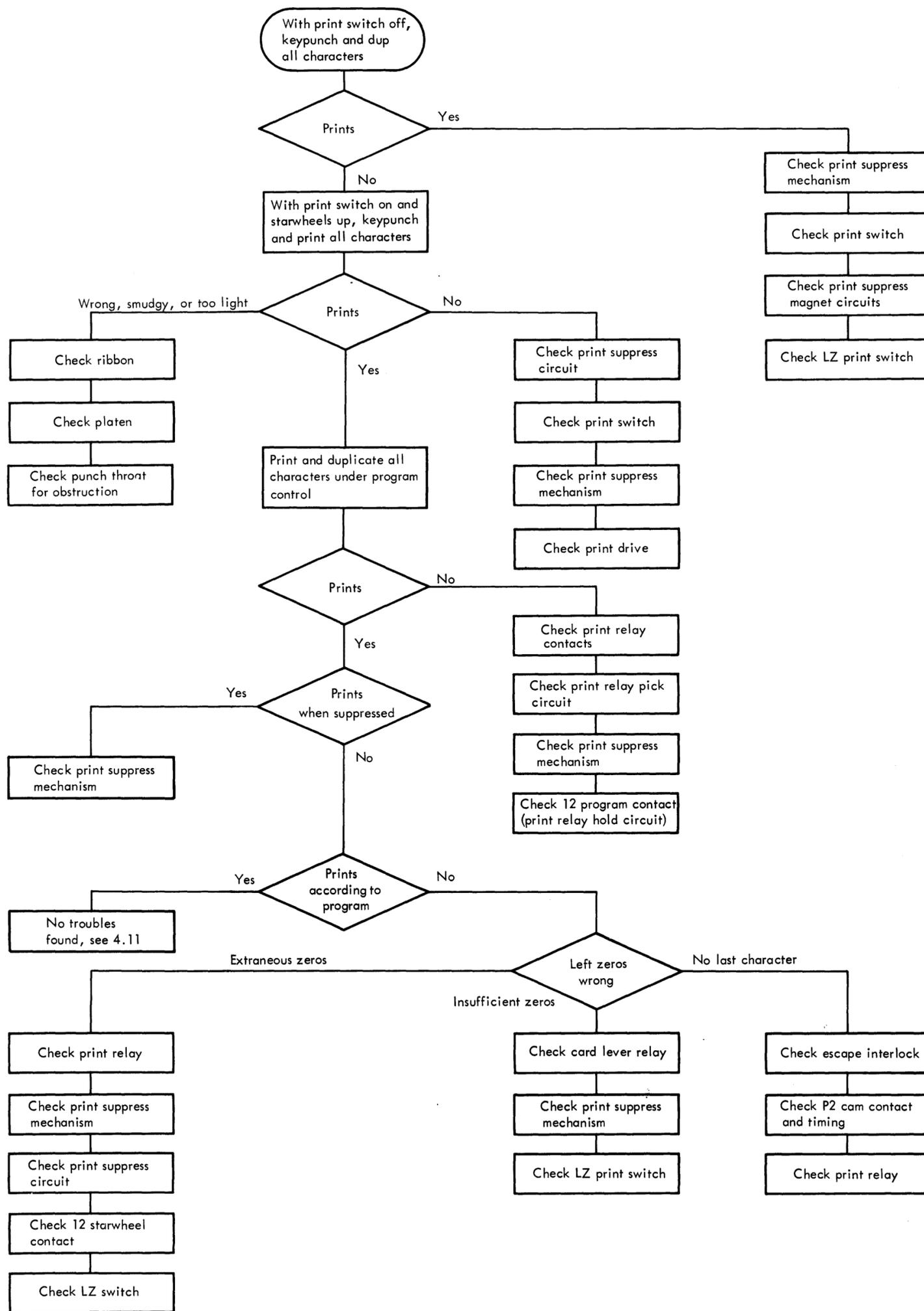


Figure 1-10. Print Control Failures



Figure 1-11. Test Probe

be performed to determine the timing of circuit breakers. The voltmeter can also be used while the machine is operating, to detect the presence and relative magnitude of the voltage. Remember, when measuring power supplies with no secondary fuse, a short in the secondary indicates little or no voltage. A secondary short may not blow the primary fuse.

### 1.6.5 Cycling Manually

Turn the motor switch off. Observe machine functions while manually operating the escapement gear train and the punch clutch. This allows voltages to be checked at any time during the machine cycle.

### 1.6.6 Interchanging Units

Keyboards, relay boards, or relay gates may be interchanged with other machines of the same type and feature configuration. This can help isolate suspected units when diagnosing intermittent troubles.

#### 1.6.6.1 Relay Gate

The relay gate in either type of machine is easily removable. In the reed-relay machine, slide the relay gate out of the guide tracks through the slots provided. In the wire-contact relay machine, first slide one tab out of the slot, then slide the other tab out.

#### 1.6.6.2 Arc Suppression

Arc suppression is necessary for the proper operation and longevity of the reed-relay switches. If trouble is suspected in an arc suppression network, it *must* be substituted with another.

#### CAUTION

Removal of arc suppression for diagnosis can cause considerable damage as well as faulty operation.

#### 1.6.6.3 Reed Relays

When inserting reed relays on the circuit board, care must be exercised not to exert pressure on the coil portion of the relay. Pressure exerted on the coil can cause the relay to flex, and breakage of the glass reed switch may occur. To prevent this breakage, the relay must be positioned and pressed on the card with equal pressure exerted on each of the plastic ends of the relay (Figure 1-12).

A short caused by a defective part or a slip of the hand while troubleshooting could damage several relays. All relays in the circuit between the short and the line should be checked because the sudden surge of current could cause the interceding relay points to weld or develop a tacking condition. *Do not remove or replace relays during a machine cycle.*

If tacking is suspected, do not jar the machine because the tacking problem may disappear temporarily. *Do not interchange relays or relay types.* If the relay used does not have a hold coil, do not put one that has a hold coil in its place. *Do not interchange relay reeds.* The individual relay reeds are matched and should not be interchanged by disassembly or use of ones from other relays.

Repeated relay insertions and removals can cause the glass envelope to break; Berg connectors may lose tension and cause intermittent failures. Check connector alignment with a 0.010-inch feeler gage, aligning it with adjacent connector.

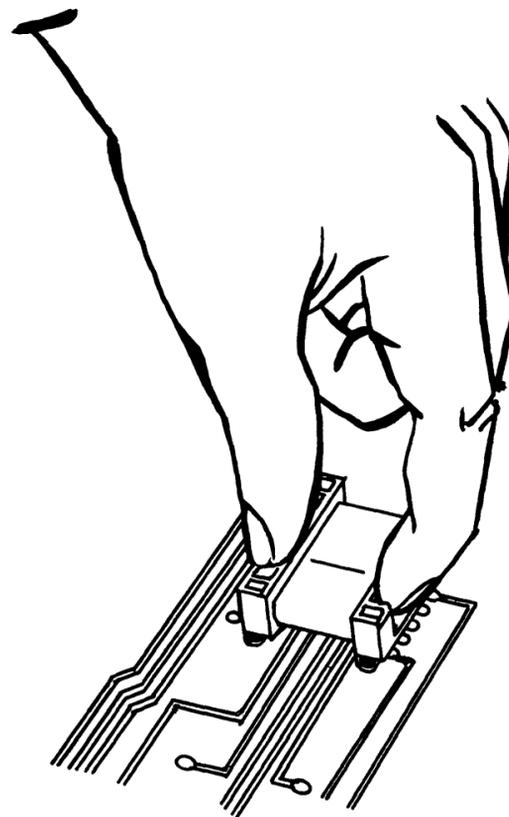


Figure 1-12. Reed Relay Insertion

## 1.7 DIFFICULT-TO-ANALYZE AND INTERMITTENT FAILURES

There are some sources of trouble in the 29 Card Punch that cause varying results and are difficult to diagnose. Among these are:

1. Friction drive torque (too much, too little, or erratic)

2. Punch clutch spring (broken, dry or gummy, or loss of tension)
3. Punch clutch armature (broken or worn)
4. Punch clutch detent pivot stud (worn or loose)
5. Punch clutch overthrow (too much or too little)
6. Relays (high resistance shorts or hold points burned or welded)
7. High-speed cam contacts (binding roller, strap tension, or loose contact pile-up)
8. Interposer bail contacts (strap tension, air gap, or contact condition).

An intermittently failing machine should not be returned to the customer without investigating every suspected cause of the failure.

### 1.7.1 Left-Zero Feature

#### 1.7.1.1 Left-Zero Overflow/Incorrect Punchout

Incorrect punchout of left-zero information occurs if the operator keys-in more digits than the field can contain. Reed-relay machines continue shifting the bits in the registers; the first digits keyed-in are lost. Wire-contact relay machines accumulate the overflow of bits in the first register.

*Examples:* In a reed-relay machine with a five-position field programmed, the operator keys-in 1, 2, 3, 4, 5, 6. The machine punches out 2, 3, 4, 5, 6 when the left-zero key is pressed. In a wire-contact relay machine with a five-position field programmed, the operator keys-in 1, 2, 3, 4, 5, 6. The machine punches 3, 3, 4, 5, 6 when the left-zero key is pressed.

#### 1.7.1.2 Intermittent Loss of Bits

Common causes for loss of information during read-in or read-out operations are:

1. Keyboard latch or bail contact adjustments
2. Keyboard restore bail contact adjustment
3. Error reset contact or backspace switch intermittently breaking contact
4. Loose slip-on connectors to punch interposer magnet unit
5. Loose connectors in 0-volt or 48-volt net to LZ relays
6. Punch CBs out of adjustment.

### 1.7.2 Diagnosis of "Heavy" or Stiff Keyboards

To isolate the source of trouble when a keyboard feels "heavy" or stiff, make the following checks.

#### 1.7.2.1 Key Pressure

Key pressure can be affected by lubrication, by interference between the keystem and the cover, or by sluggish interlock disks.

*Lubrication:* Check to be sure that the proper lubricant is used in the correct places. Refer to "Chapter 3."

*Interference:* Check to be sure that the keybuttons are centered within the holes in the cover face.

*Interlock Disks:* Check for dirty, magnetized, or oily interlock disks.

1. With the machine on, press the P-key.
2. Using a gram gage, operate the P-key; 55 to 65 grams should be read. Note the actual pressure required to operate the key.
3. Press the Q-key.
4. Using the gram gage, operate the P-key again. The pressure required should not exceed 10 grams more than the reading noted in step 2.
5. If step 4 failed to meet the requirements specified, remove the interlock disks.
  - a. Wash the disks and the race in IBM cleaning fluid to remove all traces of oil or dirt.
  - b. Test for magnetism by sliding the disks down an inclined steel surface; replace all sticking disks.

#### 1.7.2.2 Keyboard Cycle Time

To check for slow keyboard restore:

1. Open keyboard base and place machine in numeric shift by inserting a card between the numeric keystem contacts.
2. Feed a card to column 1.
3. Short latch contact 6 and time the punching of 80 columns. Timing should be approximately 4.5 seconds.
4. If the time exceeds 7 seconds, repeat the punching operation with one thickness of card inserted between the keyboard restore magnet armature and the core.
5. If an increase in speed of the punching operation occurs, adjust the armature-to-core clearance to 0.005 inch. (No increase in speed indicates a slow machine cycle.)

*Note:* Keyboard restore magnet coils are connected in parallel. A short or open in either coil upsets the balance of the circuit. Symptoms include slow keyboard cycles, double punching, or extra spaces.

#### 1.7.2.3 Machine Cycle Time

To check machine cycle timing:

1. Install an 80-column auto-dup program card on the program drum.
2. With the machine in alphabetic shift, time the automatic duplication of 80 columns (using *blank* cards). Timing should be 4 to 4.5 seconds.
3. If timing exceeds the limit, slow action is due to the punch clutch, the friction clutch, or the escapement mechanisms.

4. Place the machine in numeric shift and time the automatic duplication of 80 columns (using *punched* cards). Timing should be 4 to 4.5 seconds.
5. If timing exceeds the limit, slow action is due to the interposer magnet assembly:
  - a. Excessive magnet-to-armature air gap.
  - b. Interposer bail contacts.

### **1.7.3 Stacker**

The base should not be raised or lowered by using the stacker plate as a handle; relative position of the stacker plate to the stacker assembly may be changed and may require readjustment. Improper adjustment of the traveling card guide can cause difficulties in reading the end portion of a card.

### **1.7.4 Starwheel Adjustment**

The 29 Card Punch is designed so that the starwheel duration is about 9 ms. One tooth on the escapement wheel equals 12 ms. This timing is critical because too much or too little duration could cause relay points to arc. This could be compounded if the relays develop a tacking condition.

### Section 1. Basic Unit

#### 2.1 INSTALLATION PROCEDURES

##### 2.1.1 Shipping Material

1. Visually check for any machine damage before signing the bill of lading. If machine is severely damaged, notify your branch office before continuing the installation procedure.
2. Using packing/unpacking instructions (part 7331107), locate and remove spacers, washers, and screws on base rubber mounts. Also, remove the two screws in the base pivot brackets to allow tilting of the base for servicing.
3. Check for loose cables, connectors, and components.
4. Adjust line cord to keep excess cord off the floor.
5. For Model C machines, refer to Field Engineering Theory—Maintenance, *IBM 29 Card Punch Features/29 Interpreting Card Punch, Model C*, Form 223-2926.

##### 2.1.2 Power

1. Compare voltage requirements with those supplied. Chapter 5 shows power and receptacle requirements.
2. Turn power on and observe the punch drive for smooth operation.

##### 2.1.3 Keyboard Operations

1. Set the following switches:
  - a. Starwheels raised.
  - b. Punch/interpret – PUNCH (Model C).
  - c. Auto skip/dup – OFF.
  - d. Auto feed – OFF.
  - e. Print – OFF.
  - f. Left-zero print – OFF.
2. Put cards in the hopper.
3. Press release key:
  - a. Column indicator revolves 80 columns and returns to column 1.
  - b. No cards feed from the hopper.
4. Press register key. Card feed cycle occurs, but no cards feed from the hopper.
5. Press and hold feed key. Two cards feed from the hopper.
6. Press A through Z and 0 through 9 keys.
  - a. Press each key twice to detect binding keystems.
  - b. Hold numeric key while keying numbers.
7. Release and register second card.
8. Set print switch to on position and press all special character keys.
9. Operate the clear switch. Both cards should feed to the stacker. No cards feed from the hopper.

10. Compare holes in the cards:
  - a. Holes in the cards should compare with the keys pressed in steps 6 through 8.
  - b. Machine with print feature prints special characters in corresponding columns.
11. Check registration by using a card gage.

##### 2.1.4 Program and Function (Model A)

1. Set the following switches:
  - a. Auto skip/dup – OFF.
  - b. Program select – ONE.
  - c. Auto feed – ON.
  - d. Print – ON.
  - e. Left-zero print – ON.
2. Install Model A program card (Figure 2-1) on drum, install drum in machine, and lower the starwheels.
3. Feed two cards from the hopper.

###### 2.1.4.1 First Card

1. Press 0 through 9 keys.
2. Press skip key. The cards move to column 34.
3. Backspace to column 14 to check that registration is maintained for 20 columns of backspacing.
4. Press dash key. If machine has X-skip feature, program drum skips to column 34; if not, press skip key and program skips to column 34.
5. Press all alphabetic character keys (A through Z).
6. Press skip key. Program drum should be at column 80.
7. Multipunch 0 through 9 in column 80. Multipunch key must be pressed and held while keying-in 0 through 9.

###### 2.1.4.2 Second through Fifth Cards

1. Set auto skip/dup switch to on position.
2. Set left-zero print switch to off position. A “0” should be punched but not printed in column 1.
3. Press dup key. Machine duplicates card and program drum skips to column 80.
4. Press space key.

###### 2.1.4.3 Sixth Card

1. Set auto skip/dup switch to off position.
2. Set program select switch to TWO.
3. Press program two key.
4. Press dup key (duplicate to column 11).
5. Press skip key (skip to column 34).
6. Press dup key (duplicate to column 60).
7. Press skip key (skip to column 78).
8. Press and hold alpha key; press Z, A, and Q keys.

2.1.4.4 Seventh through Tenth Cards

1. Set auto skip/dup switch to on position.
2. Press dup key. Machine duplicates and skips the entire card. Dup key is pressed once for each card.

2.1.4.5 Eleventh Card

1. Press program one key.
2. Press dup key. Machine duplicates card and program drum skips to column 80.
3. Operate clear switch. The three remaining cards should feed to the stacker.

2.1.5 Program and Function (Model B)

1. Set the following switches:
  - a. Auto skip/dup – OFF.
  - b. Program select – ONE.
  - c. Auto feed – ON.
  - d. Print – ON.
  - e. Left-zero print – OFF.
2. Install Model B program card (Figure 2-2) on drum, install drum in machine, and lower starwheels.
3. Press release key to seat starwheels, and feed one card from the hopper.
4. Press feed key to feed second card from the hopper.

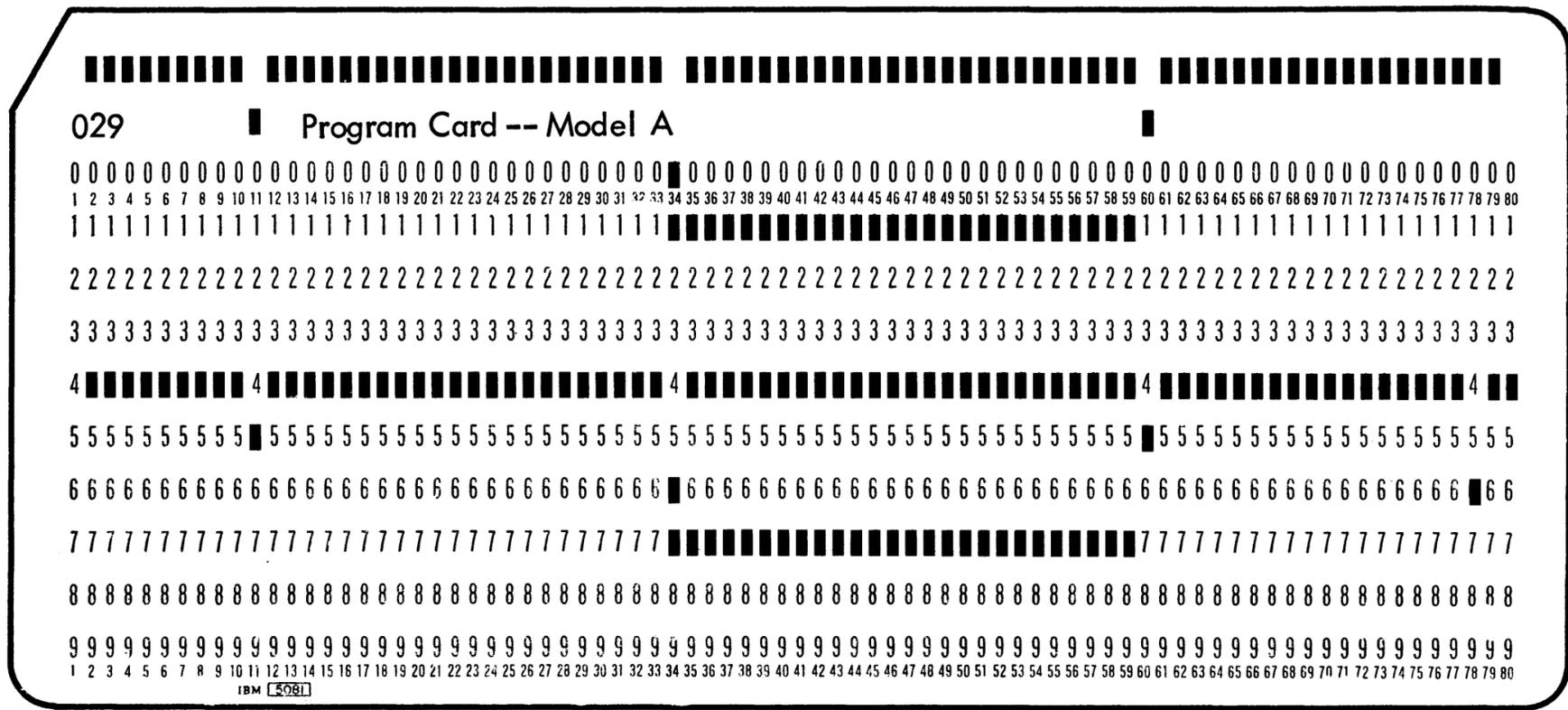


Figure 2-1. Program Card--Model A

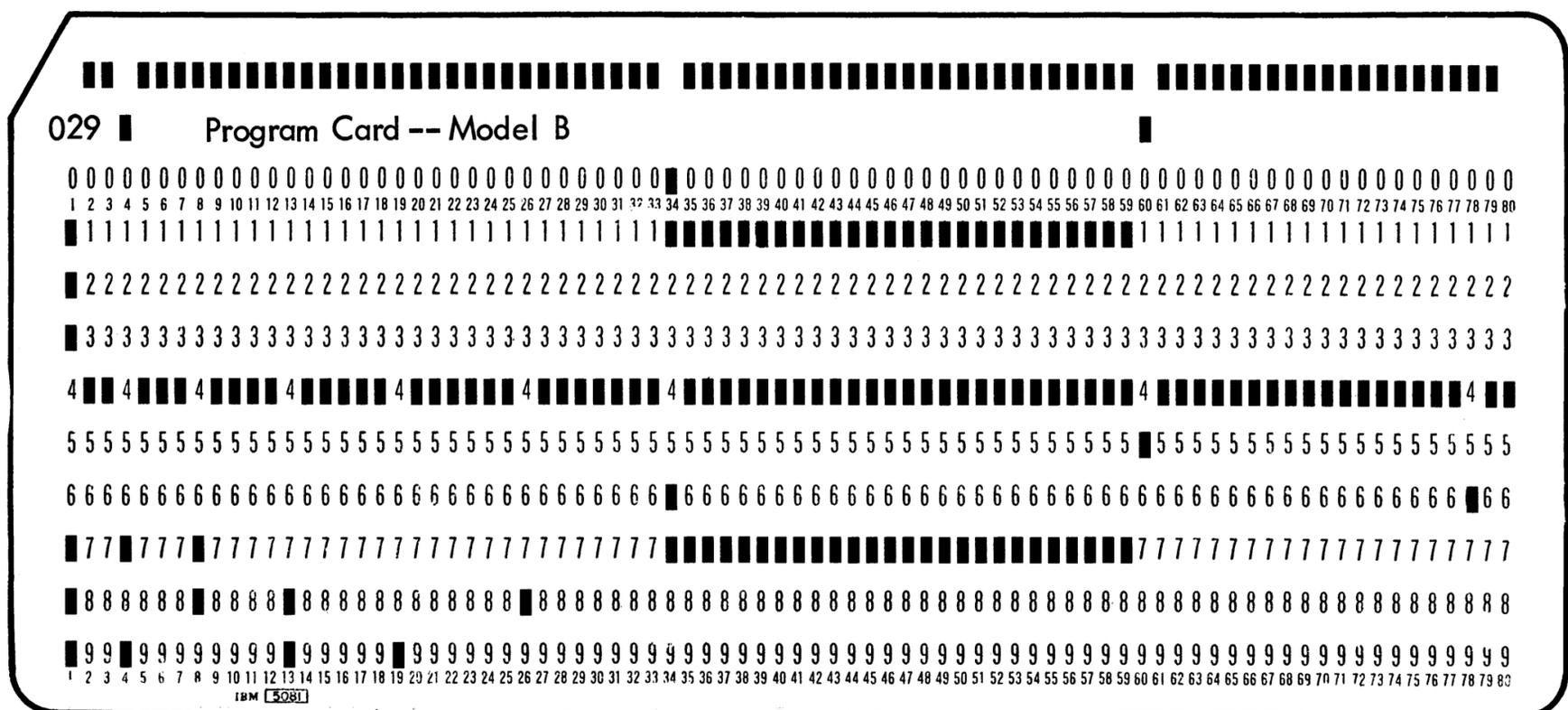


Figure 2-2. Program Card--Model B

#### 2.1.5.1 First Card

1. Press 1, 2, and 3 keys. Machine performs punch cycles but does not escape from column 1.
2. Press error reset key.
3. Press left-zero key. Three zeros are punched, but only the last one is printed.
4. Press skip key. Cards skip to column 34.
5. Backspace to column 14 to check that registration is maintained for 20 columns of backspacing.
6. Press dash key. If machine has X-skip feature, program drum skips to column 34; if not, press skip key and program drum skips to column 34.
7. Press A through Z keys.
8. Press skip key to move card to column 80.
9. Multipunch 0 through 9. Multipunch key must be pressed and held while keying-in 0 through 9.

#### 2.1.5.2 Second through Fifth Cards

1. Set auto skip/dup switch to on position.
2. Set left-zero print switch to on position.
3. Press 7 and 9 keys.
4. Press left-zero key. The 0, 7, and 9 are punched and printed, and machine skips and duplicates to column 80.
5. Press space key.

#### 2.1.5.3 Sixth Card

1. Set auto skip/dup switch to off position.
2. Set program select switch to TWO.
3. Press program two key.
4. Press 1, 2, 3, and dash keys.
  - a. A 1 and 2 are punched and printed in columns 1 and 2.
  - b. A 3 and dash are punched and printed in column 3 (a dash is an 11-hole).
5. Press 1, 2, 3, 4, and left-zero keys. A 1, 2, 3, and 4 are punched and printed.
6. Press 1, 2, 3, 4, 5, and left-zero keys.
7. Press 1 through 6 and left-zero keys.
8. Press 1 through 7 and left-zero keys.
9. Press 1 through 8 and left-zero keys.
10. Press dup key. Machine duplicates to column 60.

11. Press skip key. Program drum skips to column 78.
12. Hold alpha key and press Z, A, and Q keys.

#### 2.1.5.4 Seventh Card

1. Set auto skip/dup switch to on position.
2. Repeat steps 4 through 9 of 2.1.5.3. Machine automatically duplicates and skips the remainder of the card.

#### 2.1.5.5 Eighth Card

1. Press program one key.
2. Press 7, 9, and left-zero keys. The 0, 7, and 9 are punched and the machine duplicates and skips to column 80.
3. Operate clear switch. The three remaining cards should feed to the stacker.

#### 2.1.6 Final Checkout

Operator should set up and test machine using a practical application.

## Section 2. Features

### 2.2 INSTALLATION PROCEDURES

#### 2.2.1 Feature Checkout

Refer to Field Engineering Theory—Maintenance, *IBM 29 Card Punch Features/29 Interpreting Card Punch, Model C*, S223-2926. Set up and check out the special features according to the feature description.

*Note:* Perform the installation procedure for the basic unit model before checking the features. For Model C machines, use procedure for Model A machines.

#### 2.2.2 Final Checkout

Operator should set up and test machine using a practical application.

## Chapter 3. Preventive Maintenance

### Section 1. Basic Unit

The customer engineer's approach to preventive maintenance is important to machine performance and customer satisfaction. Effective scheduled maintenance is essential for good machine performance. Time spent systematically on scheduled maintenance results in complete inspection of major machine units. Figure 3-1 is a suggested guide for maintaining a standard machine if normal usage is 40 hours per week. Refer to Field Engineering Maintenance Manual, *Motors, Generators, Relays, Circuit Breakers, Test Instruments, Miscellaneous Components*, S225-3422, for additional scheduled maintenance information.

#### 3.1 CLEANING

A clean machine is important to good performance. While cleaning a machine, observe the bearings, cams, linkages, and other moving parts for rust accumulation. Rust accumulation indicates wear. Reduction of corrective maintenance is the goal of scheduled maintenance.

#### 3.2 ADJUSTMENT

A properly adjusted machine is more reliable than one that has had compensating adjustments made for wear or malfunction in some other area. As part of a PM routine, check the following adjustments regardless of operating conditions. A quick check of the same areas is also recommended at the time of each maintenance call. The adjustments for these areas are in Chapter 4.

- Friction clutch
- Escapement
- Feed throat
- Punch clutch
- CBs
- Program unit

#### 3.3 SAFETY

Preventive maintenance also implies the prevention of accidents to operating and maintenance personnel and concern for their health and well-being.

#### DANGER

Do not permit machines to be run unattended with covers open or removed.

#### 3.3.1 Safety Devices

Check that all applicable safety devices are on the machine. If they are operating devices, check them every time you perform a routine PM. Refer to CEMs for current safety information.

#### 3.3.2 Electrical Hazards

#### DANGER

Anyone working near electrical circuits may accidentally come in contact with live voltage. *Be alert and careful.*  
*Note:* Immediate mouth-to-mouth resuscitation is imperative for unconscious victims of electrical shock.  
*Always disconnect voltage.*

#### 3.3.3 Chemical Hazards

#### DANGER

Use only IBM-approved products. *Read the labels.* As a general rule, cleaning fluids should be used only in an open area. Breathing the concentrated vapors, even for a short time, may cause immediate reactions.

#### 3.4 LUBRICATION

Lubrication points are shown in Figures 3-2 through 3-7. Frequency of keyboard lubrication depends on machine usage and local conditions.

Applicable IBM lubricant part numbers are:

<i>Lubricant</i>	<i>Quantity</i>	<i>Part Number</i>
IBM #6	4 ounces	460052
IBM #6	1 pint	223980
IBM #23	1/2 ounce	1280441
IBM #23	1 pound	1280442
Silicone grease		341016

Preventive Maintenance Routine Chart							
Code		Location	Frequency (Months)	Required Maintenance	Observe	Lubrication Figure Reference	Adjustment Section
U	R						
		Punch Clutch	Each service call	Lubricate grease fitting.	Check overthrow and outer sleeve lead.	3-4 3-6	4.6.8
1		Feed	12	Clean dirt from moving parts. Lubricate gears, cams, and pivots.	Check card feeding and stacking.	3-2	4.5 4.9
2		Print		Lubricate gears, grease fitting, and oil wicks.	Check printing.	---	4.11
3		CB		Clean contacts. Lubricate cams and rollers.	Check for contact wear and pits.	3-6	4.5.14 4.6.10
4		Punch		Lubricate oil wicks, cams, and pivots.	Check for worn cams, bearings, and linkage.	3-6	4.6
		Drive		Lubricate motor bearings.	Check for worn belts.	---	4.2
5		Friction Drive		Lubricate clutch with silicone grease.	Check torque.	3-3	4.3
		General		Clean dirt from moving parts and base.	Check for loose wires, terminals, and grounds.	---	---

● Figure 3-1. Preventive Maintenance Routines

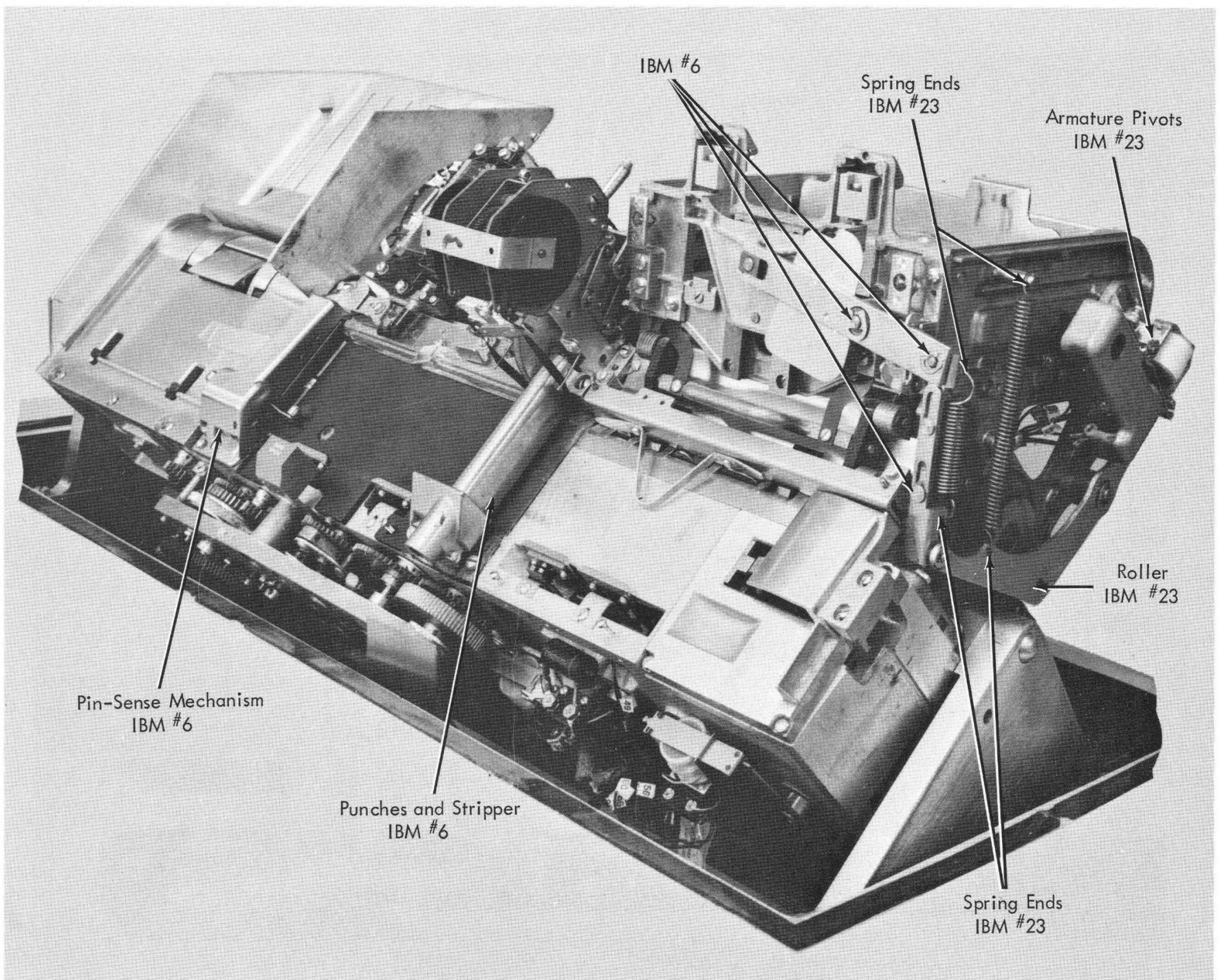


Figure 3-2. Lubrication – Right Front

*Lubrication Hints:*

1. Die and punches may be lubricated by saturating a blank card with IBM #6 oil and punching all columns of the card.
2. Pin-sense unit may be lubricated by applying two or three drops of IBM #6 oil to the wicks through the two holes in the pin-sense casting. Do not overlubricate.

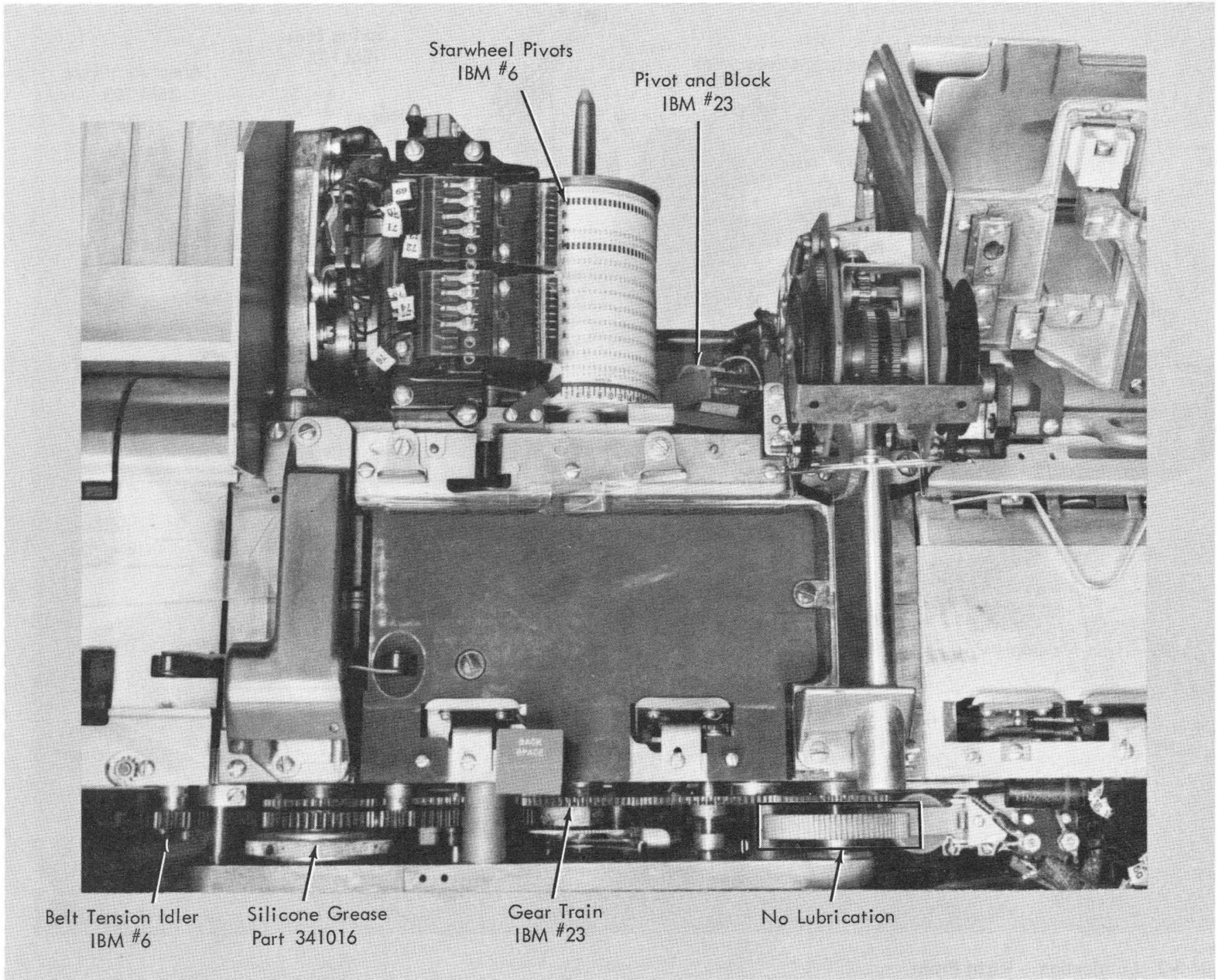
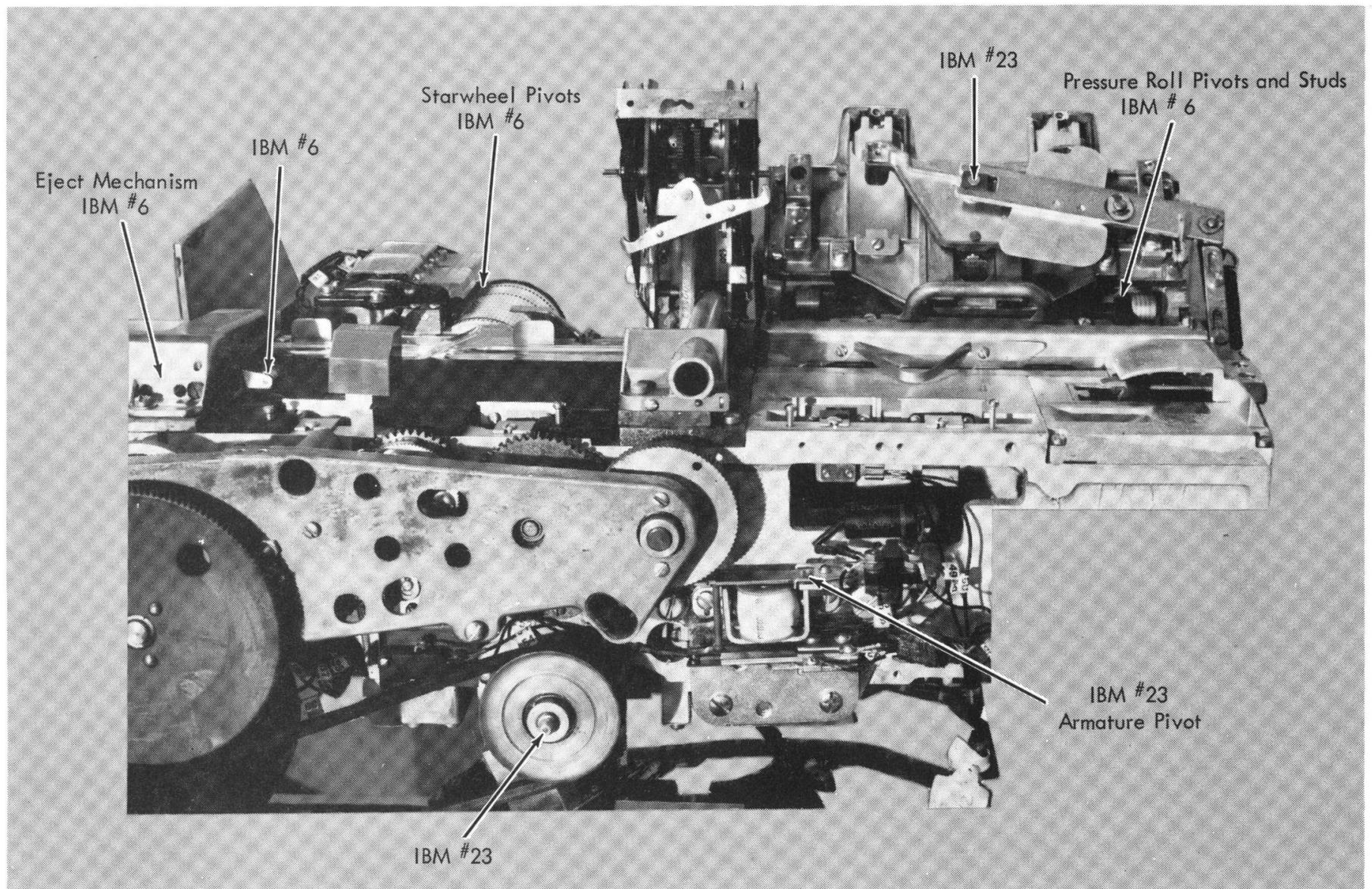


Figure 3-3. Lubrication – Front

*Lubrication Hint:* To prevent grease migration to the escapement wheel and the friction clutch, apply IBM # 23 grease sparingly to the escapement gear train. To prevent print suppress armature from sticking, apply IBM # 23 grease sparingly to pivot and block.



● Figure 3-4. Lubrication – Front (Machine Bed Tilted)

*Lubrication Hint:* After greasing the punch clutch, remove excess grease from the sleeves and collar. This prevents grease from splashing onto the armature and magnet.

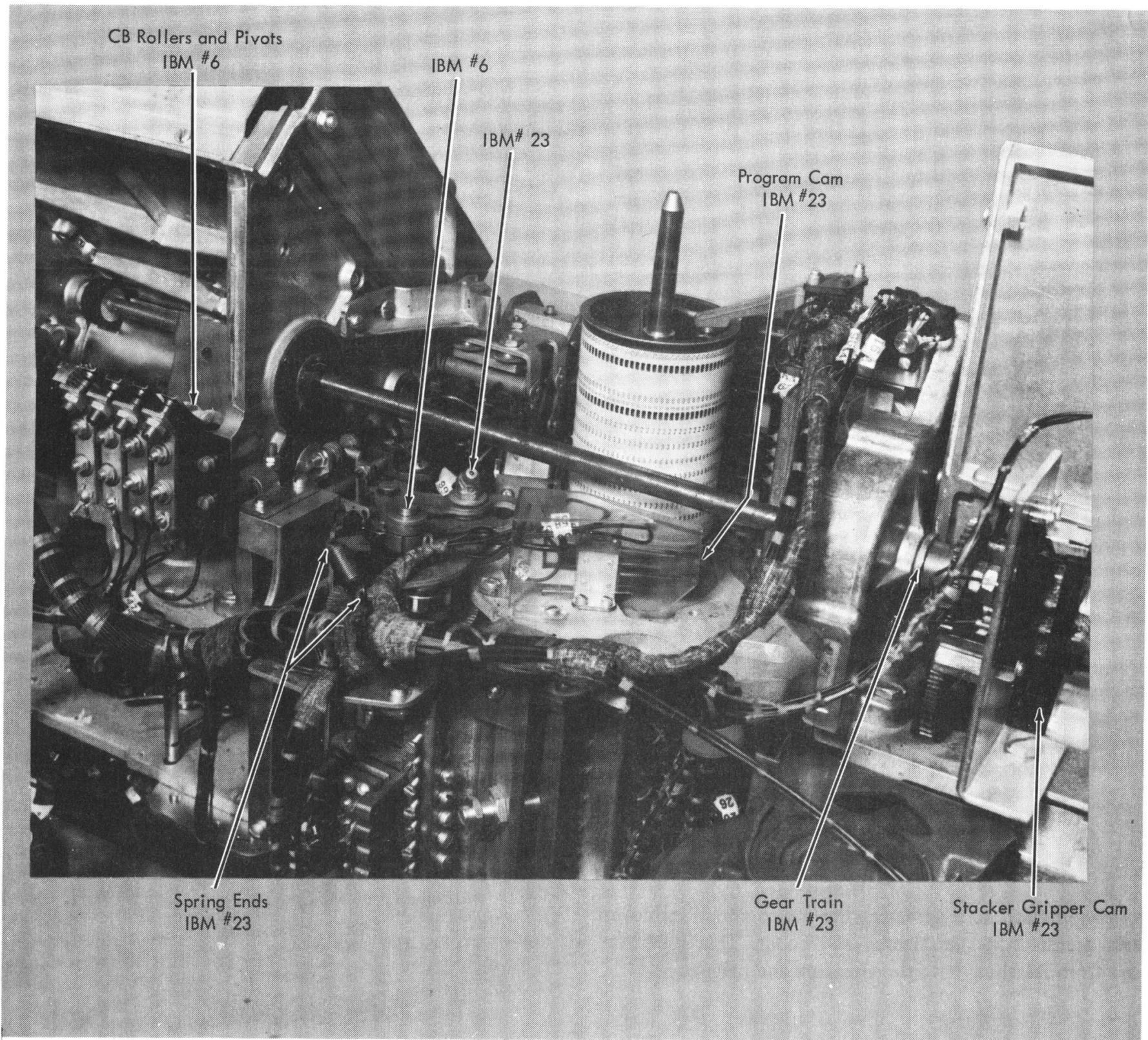


Figure 3-5. Lubrication – Rear

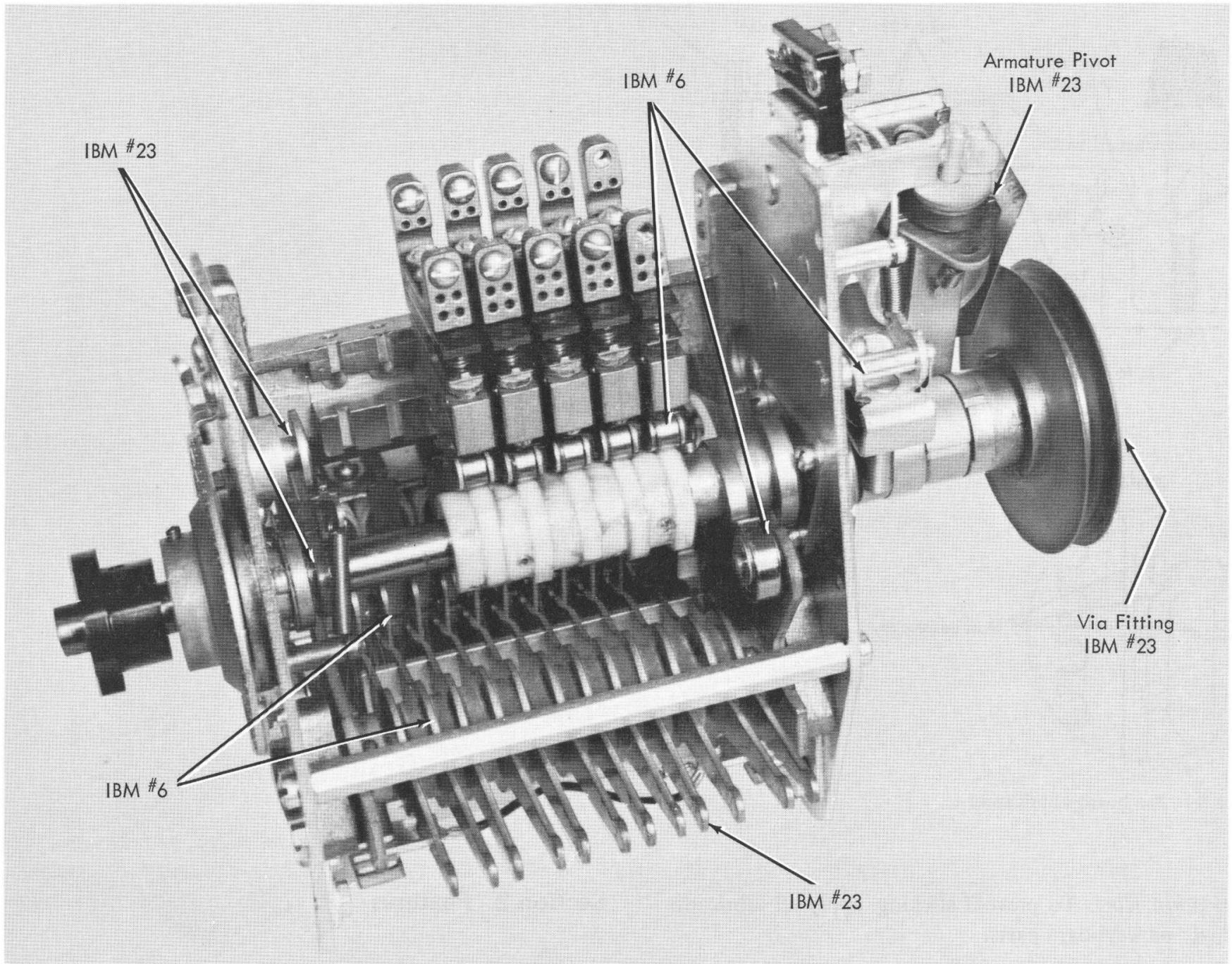


Figure 3-6. Punch Unit Lubrication

*Lubrication Hint:* Do not oversaturate the felt wicks that separate the punch drive arms. The oil will run down onto the CBs.

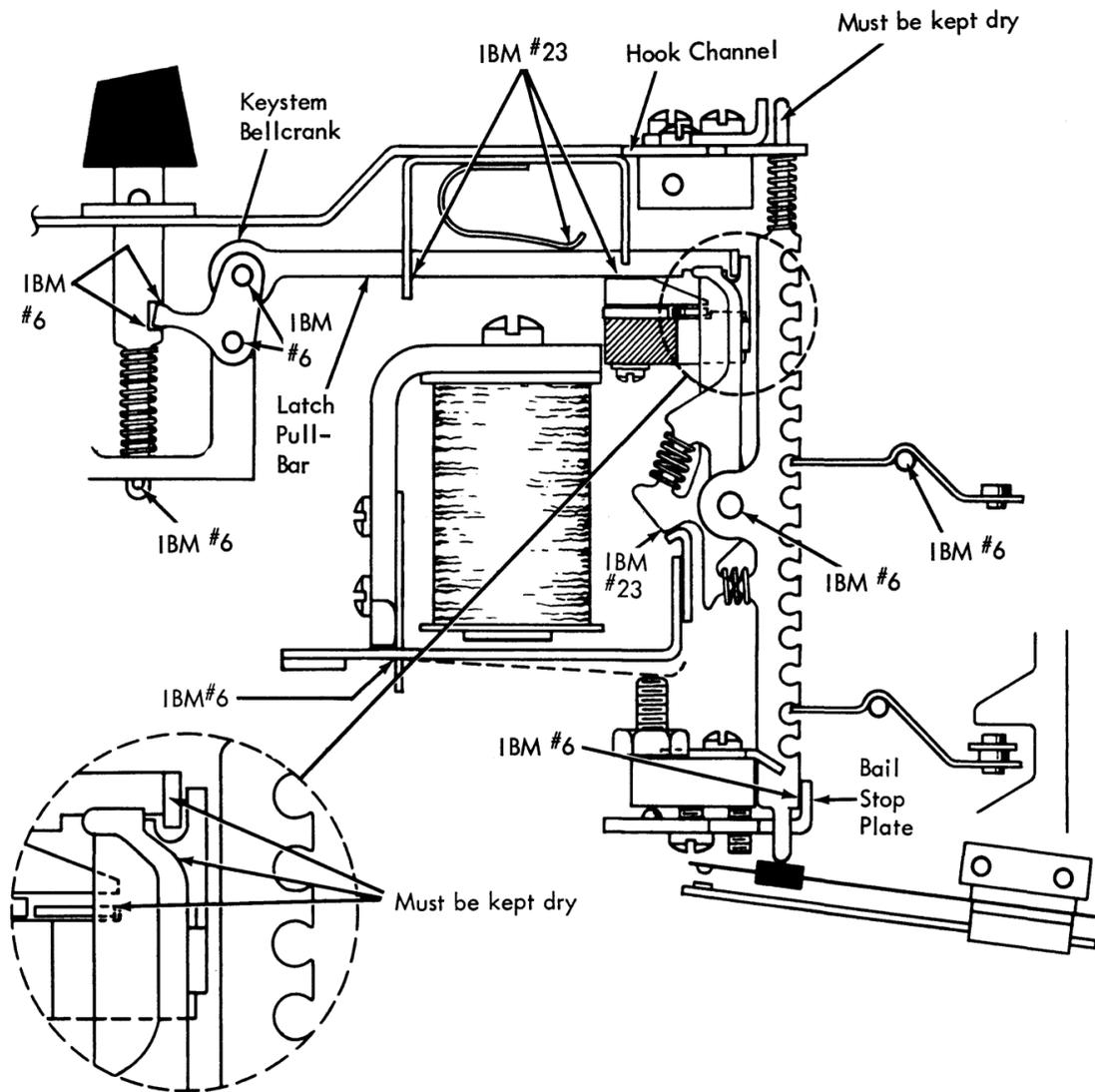


Figure 3-7. Keyboard Lubrication

*Lubrication Hint:* To prevent sticking, apply all lubricants sparingly on keyboard parts.

## Section 2. Features

Lubrication of features should be performed at the discretion of the customer engineer, using the guidelines in Field Engineering Theory—Maintenance, *IBM 29 Card Punch Features/29 Interpreting Card Punch, Model C*, Form 223-2926.

## Section 1. Basic Unit

Procedures outlined for removal and adjustment of the machine units are intended as guides. Adjustments should be kept close to the specification, but the procedures preferred may vary among experienced customer engineers.

### 4.1 BASE

#### 4.1.1 Diodes

Check diodes for shorts or opens by using an ohmmeter.

#### 4.1.2 Arc Suppressors

Check the arc suppression RC units by substitution, never by running the machine with the arc suppressors removed. The RC units are highly efficient at reducing destructive arc.

#### CAUTION

Operation of the machine without arc suppressors may cause considerable damage.

### 4.2 DRIVE

#### 4.2.1 Drive Motor

Factory lubrication of the motor should last one year, if normal usage is 40 hours per week. Oil sparingly.

#### 4.2.2 Drive Motor Belt Adjustments

##### 4.2.2.1 Belt Tension

Elongated motor-mounting holes permit adjustment of belt tension for 1/4-inch deflection midway between pulleys.

##### 4.2.2.2 Belt Size

Check part number of belt. A different size belt is used when machine has print feature.

#### 4.2.3 Backspace Mechanism Service Check

Check that 20 consecutive columns of backspacing does not affect card registration. The actuating arm should be straight and free of binds so that its spring can return it to normal position.

To ensure proper backspacing, check escapement armature adjustments (4.4.1).

#### 4.2.4 Backspace Mechanism Adjustment

1. Position backspace ratchet with its three screws to cause a card to backspace into column 1 and not into column

88 of program drum. Each backspace should cause escapement wheel teeth to move 1-1/4 teeth past end of armature.

2. Position backspace switch to operate with 1/16-inch depression of the actuating arm.

### 4.3 FRICTION DRIVE

#### 4.3.1 Friction Drive Service Check

The friction clutch should provide sufficient torque to deflect gram gage 275 to 325 grams when measured in the following manner. Manually escape the machine until the hole in the escapement wheel is straight up. Use the 10X blade in the gram gage. Hold the gram gage in the left hand (Figure 4-1) and engage the escapement wheel.

#### DANGER

Make sure the starwheels are up when checking torque if high-speed skip feature is installed.

Press the release key and place right index finger on the 10X blade. Gradually release the pressure of the left hand until only the blade prevents turning of the wheel. Read the gram gage.

Gram tension should be measured and adjusted after the machine has warmed up.

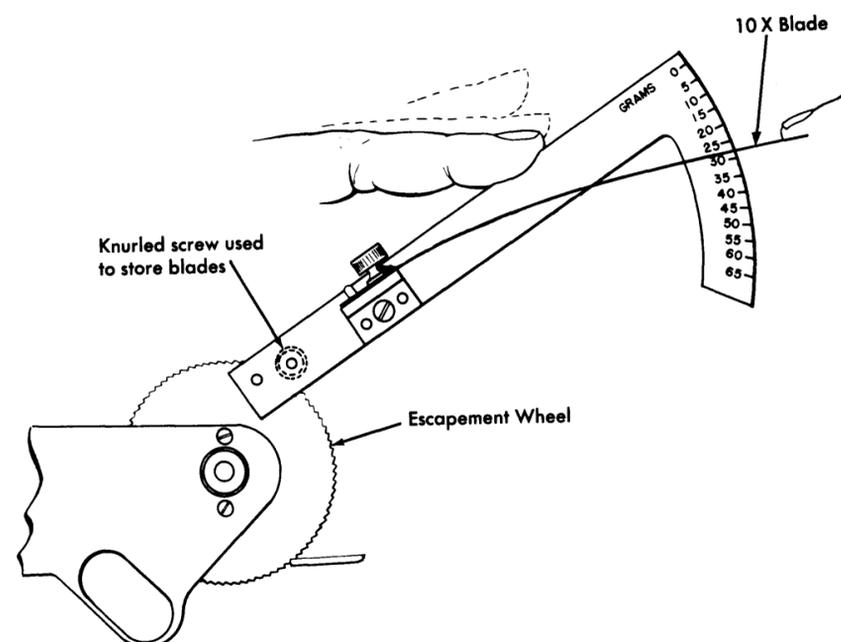


Figure 4-1. Friction Drive Adjustment

### 4.3.2 Friction Drive Torque Adjustment

1. Manually escape the machine until adjusting screw is at the top.
2. Turn power off and manually turn belt until hole at top of housing is aligned with adjusting screw.
3. Adjust screw for required torque. (4.3.1). Turn screw clockwise to increase torque; a half-turn changes reading about 60 grams.

### 4.3.3 Friction Clutch Removal

1. Remove escapement gearing bracket and friction clutch adjusting screw.
2. Drive out spring pin holding clutch assembly on shaft. Remove clutch and separate hub assembly from housing.
3. Remove nylon friction ring.
4. Remove friction clutch spring.

5. Reverse removal procedure for reassembly. Make sure hub assembly is clean and free of dried grease and oil.

## 4.4 ESCAPEMENT UNIT

### 4.4.1 Escapement Unit Service Check

Check the residual on the left yoke end for wear; clean dirty points and lubricate armature pivot. Clean oil and dirt from escapement wheel. Too much torque on the friction drive may make action of escapement armature sluggish. The escapement wheel must be free of lubricants. Incorrect strap tension or improper make-time of the escape armature contact may cause double spacing or erratic escapement.

The contact operating pin should be free enough to allow pin to be rotated between the finger tips. A binding or canted operating pin usually indicates poor adjustment of the unit.

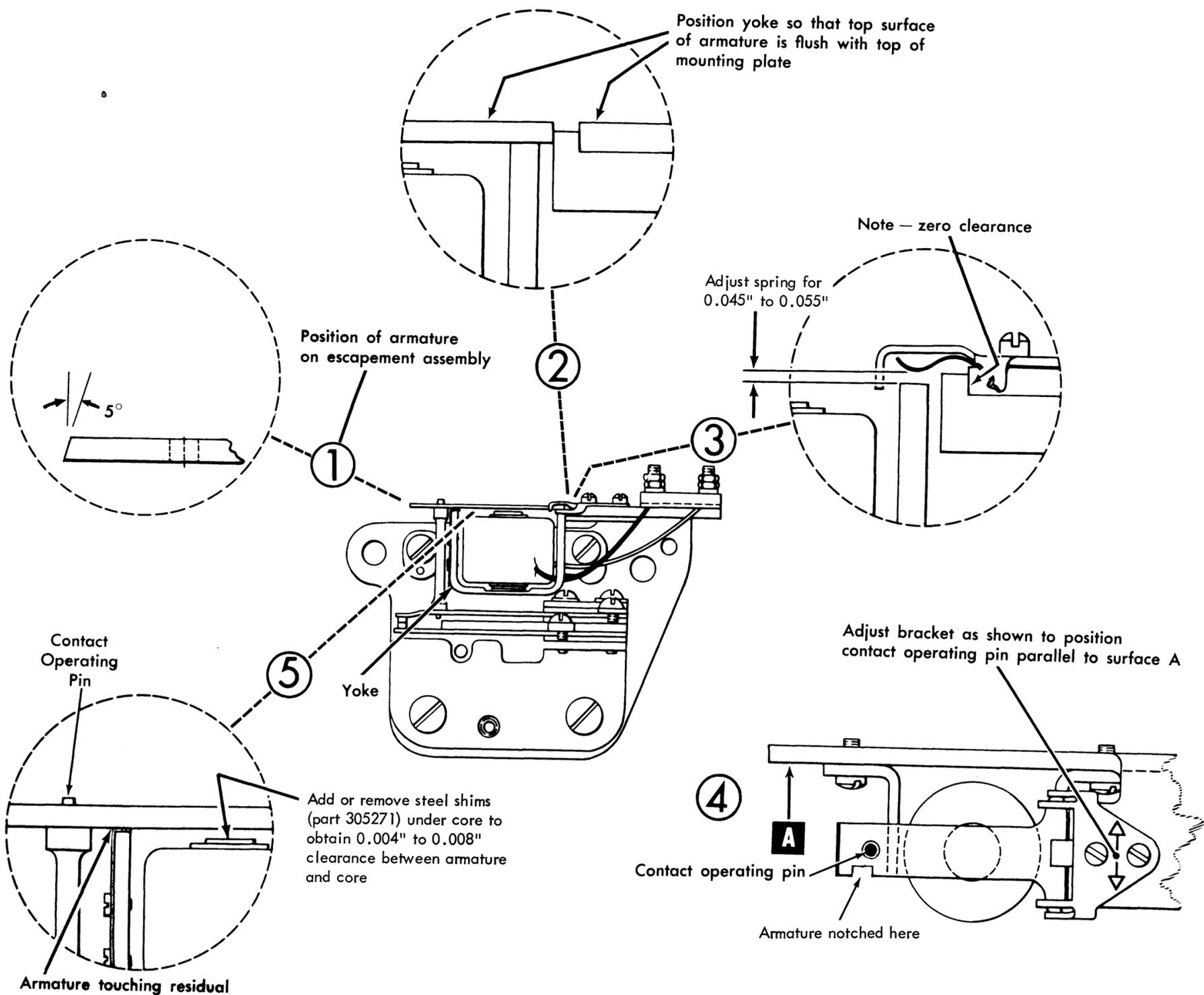


Figure 4-2. Escapement Adjustment (Part 1 of 2)

Wipe off excess lubricant around escapement armature pivot. Grease at this point picks up dirt and card chips, and may cause escapement failures. Observe the armature while backspacing. If the armature drags with the movement of the escapement wheel, the armature pivot spring requires adjustment.

#### 4.4.2 Escapement Unit Adjustments

1. Remove escapement magnet unit from machine.
2. Make adjustments 1 through 7 in Figure 4-2.

3. Replace magnet unit.
4. Make adjustments 8 and 9 in Figure 4-2 (Part 2).

The escapement armature pivot spring must hold the escapement armature against the yoke at the pivot point as shown at 2, Figure 4-2. Avoid putting sharp bends in spring straps while forming them. The outboard edge of the armature is notched at a point near the hole for the operating pin; the end is ground at a 5-degree angle. The armature must be upright for proper operation.

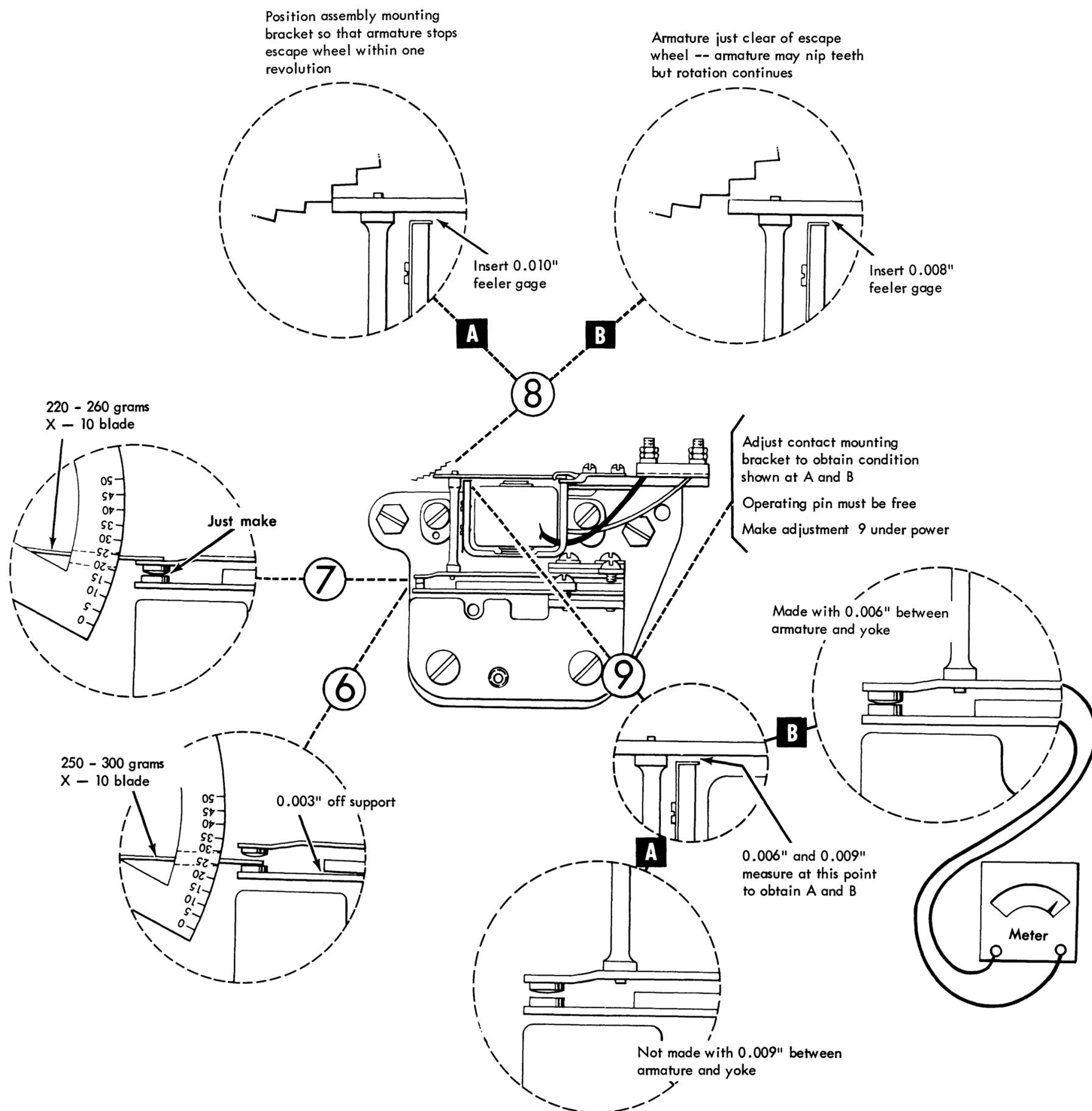


Figure 4-2. Escapement Adjustment (Part 2 of 2)

**Escapement Gearing:** Keep escapement gear train lubricated on machines that use the drum-type friction clutch. Keep card chips and other foreign matter out of escapement gears and friction drive. Faulty escapement may be caused by incorrect torque at the friction drive. All gear shafts protruding through bearing support must be pulled to the extreme forward position before tightening collars. Be sure unsealed bearings are capped.

## 4.5 CARD FEED

### 4.5.1 Hopper Adjustments

#### 4.5.1.1 Magazine Springs

Form magazine springs to touch feed bed (1, Figure 4-3).

#### 4.5.1.2 Feed Knives

Check card feed latch magnet adjustment. When card feed latch magnet adjustment is correct, manually cycle the card feed mechanism. With CF latch armature engaged with CF cam follower arm, adjust both feed knives evenly to give minimum clearance of 0.015 inch (0.040 inch maximum) from feed knives to top edge of cards in hopper (2, Figure 4-3).

#### 4.5.1.3 Throat

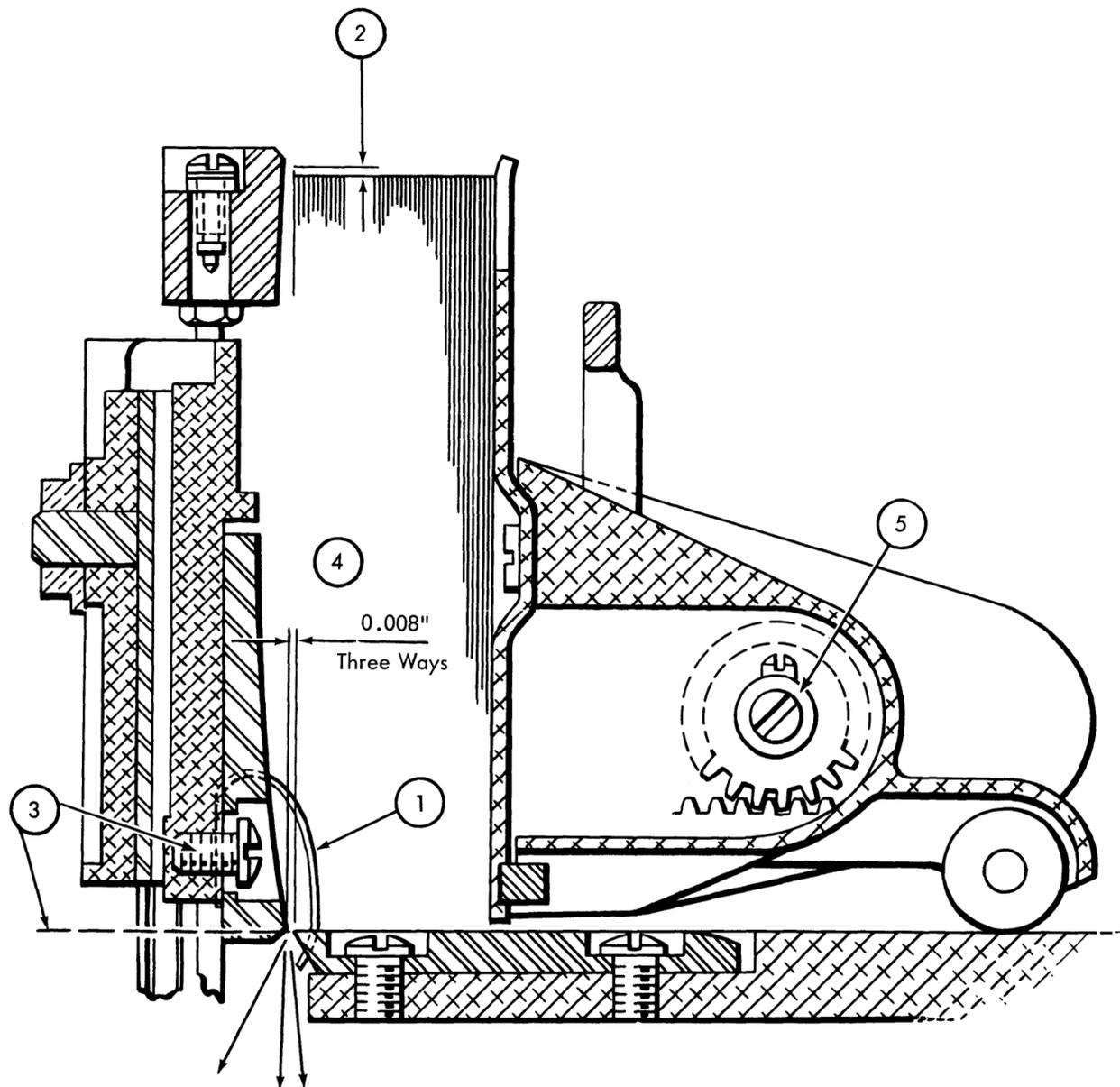
Adjust throat block (3, Figure 4-3) to place crown in direct line with top edge of throat knife. Adjust throat knife (4, Figure 4-3) for an opening of 0.008 to 0.010 inch. If throat is properly adjusted, a 0.008-inch gage should freely pass in three directions (Figure 4-3) but a 0.010-inch gage should not.

#### 4.5.1.4 Pusher Plate

The card-feed pusher-plate spring (5, Figure 4-3) is adjusted to have 450-gram tension when one card is in the hopper.

### 4.5.2 Feed Clutch Adjustment

1. Adjust magnet yoke adjusting screws (Figure 4-4) for 0.032-inch to 0.036-inch clearance between armature and yoke at the operating end.
2. Form armature spring to exert tension of 100 to 120 grams in direction of A (Figure 4-4) and 230 to 250 grams in direction of B (Figure 4-4).
3. Position CF magnet unit to obtain 0.010-inch to 0.014-inch unlatching clearance between armature and CF dog when armature is attracted (Figure 4-5).



● Figure 4-3. Hopper Adjustment

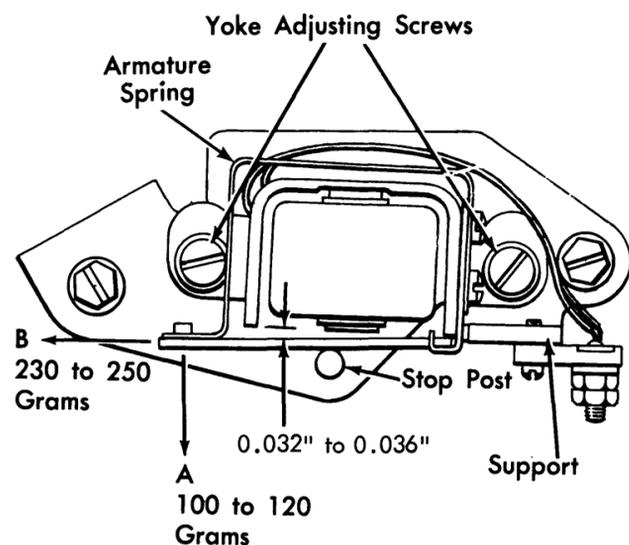
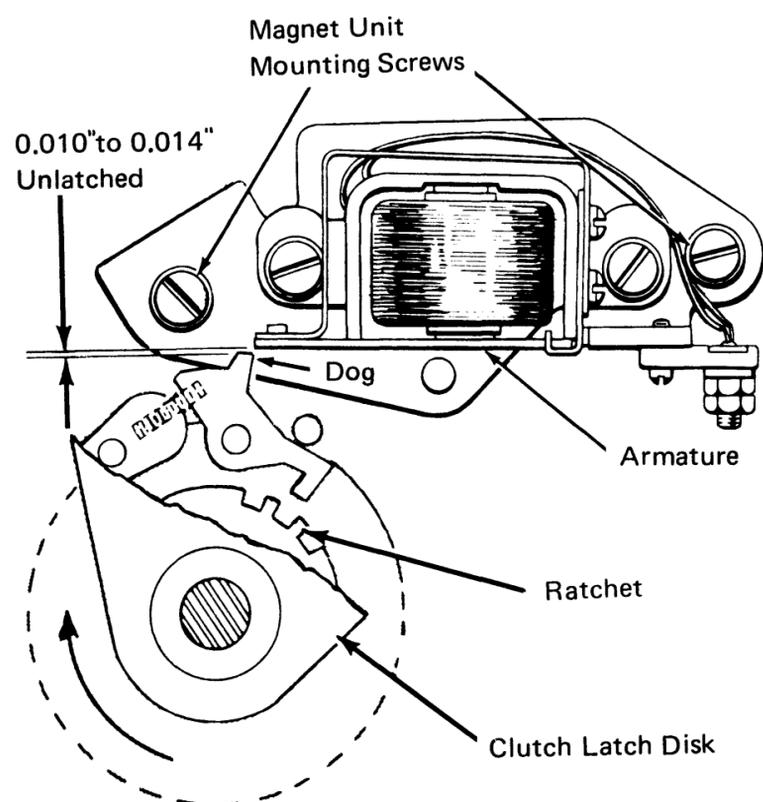


Figure 4-4. CF Clutch Magnet Adjustment



● Figure 4-5. CF Clutch Adjustment

4. Adjust the two jam nuts on the stacker end of the CF shaft for 0.003-inch to 0.011-inch endplay.
5. When previous adjustments are correct, clearance between ratchet and latched dog will be at least 0.005 inch. If clutch nipping or clutch chatter persists, recheck spring tension as in item 2, then check timing of card stop cam shaft. (See 4.5.9).

*Note:* When the cam follower is rising on the cam after latch-up, the cam shaft and card feed shaft are pushed backward which allows the clutch dog to drop against the ratchet.

#### 4.5.3 Card Feed Latch Magnet Adjustments

##### 4.5.3.1 Yoke and Armature

1. With contacts aligned against contact supports, turn armature backstop screw until stationary contacts rise

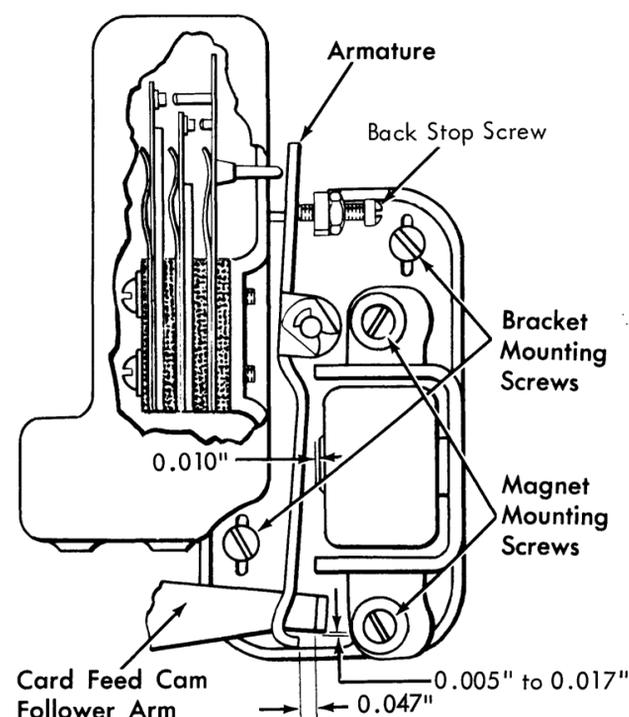


Figure 4-6. CF Latch Magnet Adjustment

1. Turn backstop screw 1/32-inch off their supports (Figure 4-6).
2. Position magnet yoke so that lower arm of yoke strikes armature with a 0.010-inch gage between armature and magnet core. Tighten screws.
3. Turn backstop screw two full turns counterclockwise and lock.

*Note:* Check feed knife adjustment after adjusting latch magnet.

##### 4.5.3.2 Mounting Plate Assembly

1. Provide 3/64-inch (0.047-inch) clearance from latch magnet armature to ear on CF cam follower arm (Figure 4-6).
2. At same time, position assembly vertically to provide 0.005-inch to 0.017-inch latching clearance from cam follower arm to armature tip when armature is attracted.

#### 4.5.4 Hopper-to-Prepunch Bed Service Checks

##### 4.5.4.1 Card Feed Pressure Roll Service Check

Check for even drag on a card inserted lengthwise down either side. Rollers should be free of binds, and the two flat springs should be straight when removed from machine. Misalignment or uneven tension on pressure roll bar may cause uneven feeding of cards.

##### 4.5.4.2 Aligner Finger Service Check

Factory adjustment for the card aligner fingers is 0.035-inch to 0.055-inch movement ahead of top card rail. The card must snap off the card aligner fingers and drop into position along the top rail before registration. Otherwise, the first 15 columns may be in-registration and the rest of the card may be off-registration to the left.

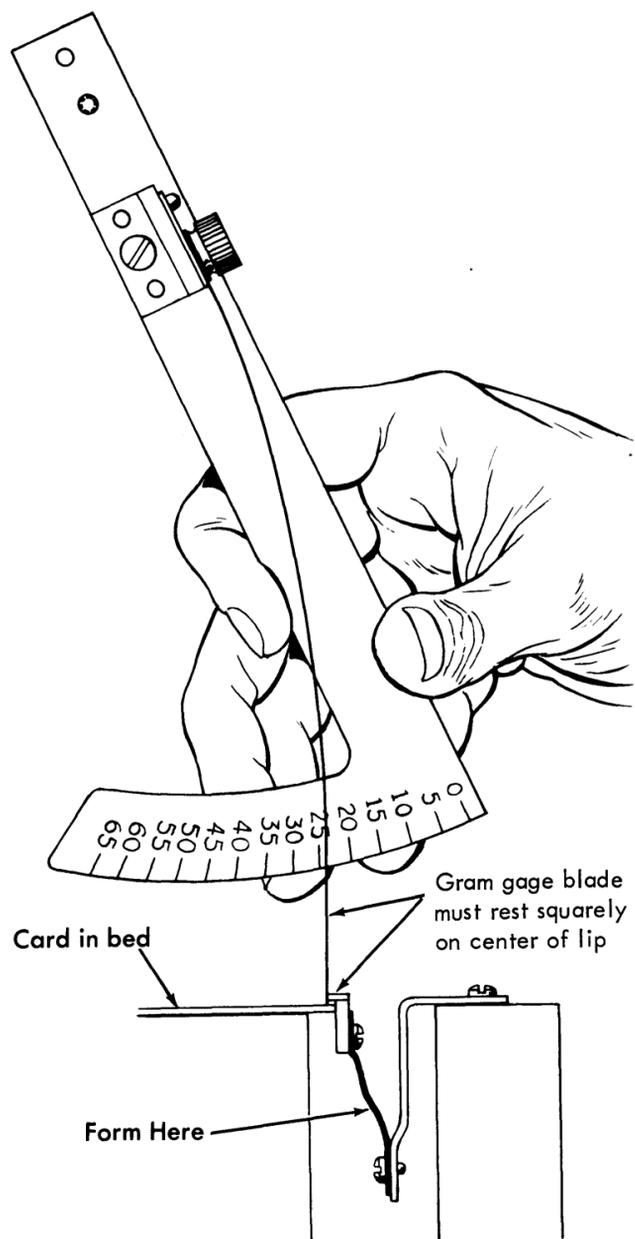


Figure 4-7. Pressure Rail Adjustment

#### 4.5.5 Pressure Rail Adjustments

When making the following adjustments, hold the gram gage as shown in Figure 4-7. In this position, gram gage reading and pressure rail movement can be simultaneously observed.

##### 4.5.5.1 Pressure Rail Without Contact

Form pressure rail spring in detail station to exert 23-gram to 31-gram (12-gram to 20-gram for master station) pressure on a registered card. Check tension necessary to move rail away from card evenly.

##### 4.5.5.2 Pressure Rail With Strap Contact

1. Remove card lever contact assembly from machine and straighten stationary strap.
2. Hold assembly at the same angle it has in the machine (45 degrees) and form operating strap to a contact air gap of 0.015 inch to 0.020 inch (Figure 4-8).
3. Form stationary strap for minimum contact rise of 0.025 inch with 23-gram to 31-gram (27-gram to 35-gram for master station) pressure applied at center of lip on rail.

4. Install assembly in machine and recheck adjustment by registering a card.

##### 4.5.5.3 Pressure Rail With Microswitch

Microswitch card levers in the detail station right-hand pressure rail position and the master station left-hand pressure rail position are adjusted at the factory to transfer within the correct gram tension range. Replacement of the entire pressure rail and switch assembly is recommended when any part is faulty. To install the microswitch assembly:

1. Position the assembly vertically to provide 23-gram to 31-gram (27-gram to 35-gram for master station) pressure against the card. The contact should be transferred.
2. Remove the card and check that the contact returns to its normal position.

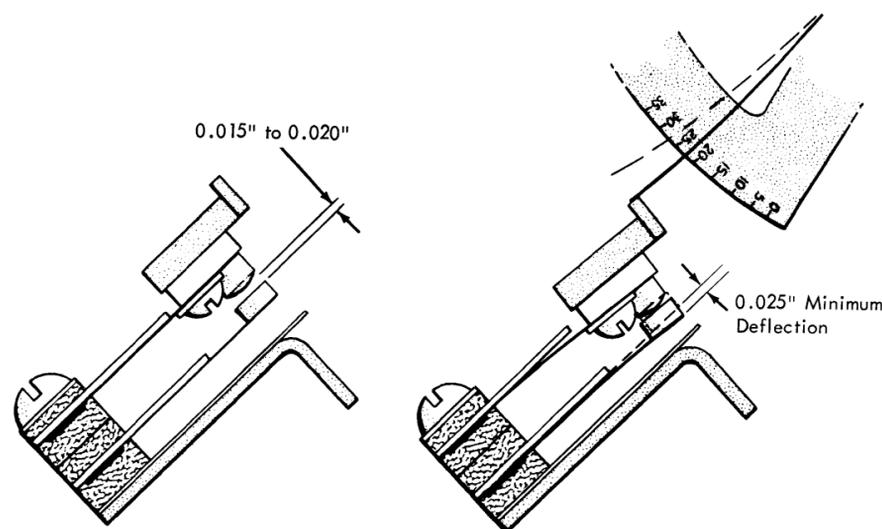
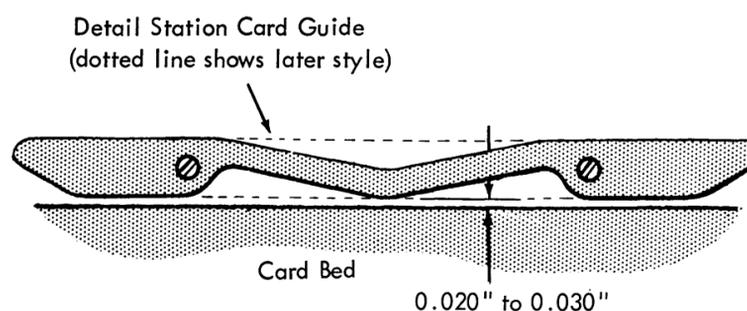


Figure 4-8. Pressure Rail - Card-Lever Contact

#### 4.5.6 Card Guide Adjustments

##### 4.5.6.1 Detail Station

Loosen card guide holding screws and position card guide for 0.020-inch to 0.030-inch clearance to detail card bed (Figure 4-9).



● Figure 4-9. Card Guide - Detail Station

#### 4.5.6.2 Master Station

Position master station card guide to obtain 0.013-inch to 0.017-inch clearance to center bed plate at point closest to eject unit (Figure 4-10).

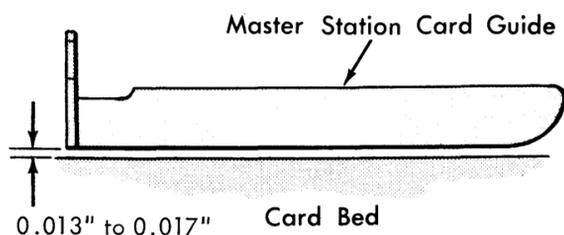


Figure 4-10. Card Guide – Master Station

#### 4.5.7 Card Registration Service Check

Card registration should be checked every time the machine is serviced. To improve operation of the register and eject arms, lubricate the roller pivots with IBM # 6.

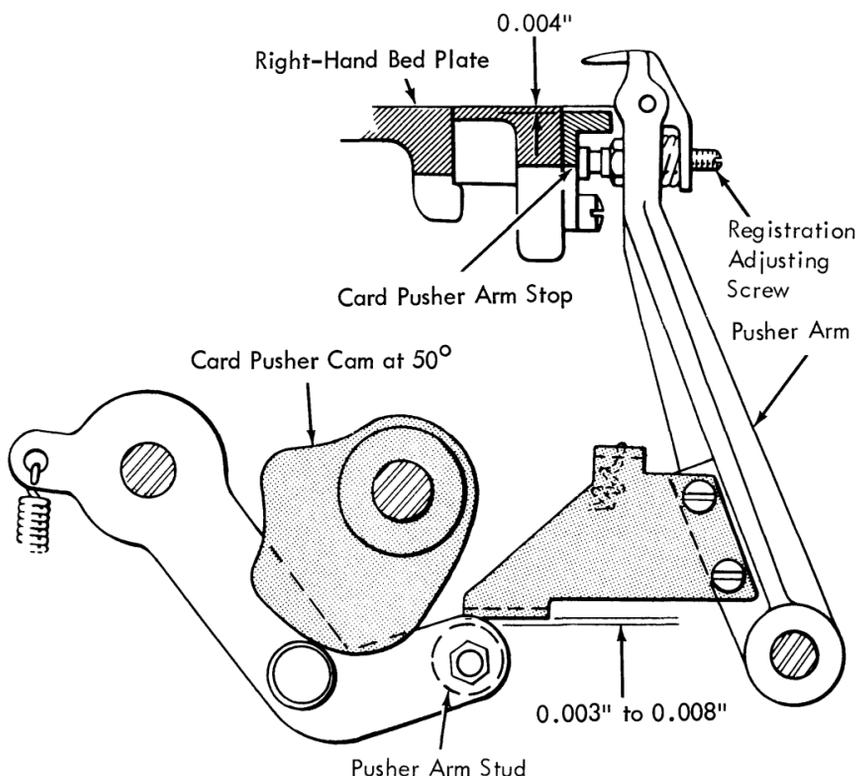


Figure 4-11. Detail Card Registration

#### 4.5.8 Pusher Arm Adjustment

1. Position card pusher arm stop to 0.004 inch below upper edge of right bed plate (Figure 4-11).
2. Pull back pusher arm stud to be sure it does not interfere with registration.
3. Set registration adjusting screw for best punching registration.

*Note:* This adjustment is easier if a 1/4-inch socket is used to loosen and tighten the adjusting screw lock nut.

4. Set card feed index at 50 degrees and adjust pusher arm stud for 0.003-inch to 0.008-inch clearance to pusher arm.

#### 4.5.9 Card Stop Cam Adjustment

1. Loosen setscrews on index shaft bevel gear.
2. With the CF clutch latched, rotate card stop cam to a point where cam follower is at the approach but is not up on rise of cam.
3. With some wink at the meshpoint of the bevel gears, tighten the setscrews.
4. Check timing by watching eject and register arms to be sure that they do not start down again at the end of the CF cycle. The beveled gears are spot-marked at the factory so that this timing can be regained after removal of the feed by simply aligning the marks.

#### 4.5.10 Pressure Roll Service Check

After a card is registered, turn power off. With the power off, manually engage card feed clutch and turn the card feed mechanism. Check to see that the card is released by 10 degrees and gripped again at 60 degrees.

#### 4.5.11 Pressure Roll Adjustments

##### 4.5.11.1 Punch Station

1. Turn card stop cam until cam follower is on high dwell of cam (index at 22 degrees to 45 degrees).
2. Adjust eccentric on stop lever cam arm for 0.023-inch to 0.032-inch opening between detail station pressure roll and large feed roll (1, Figure 4-12).

##### 4.5.11.2 Read Station

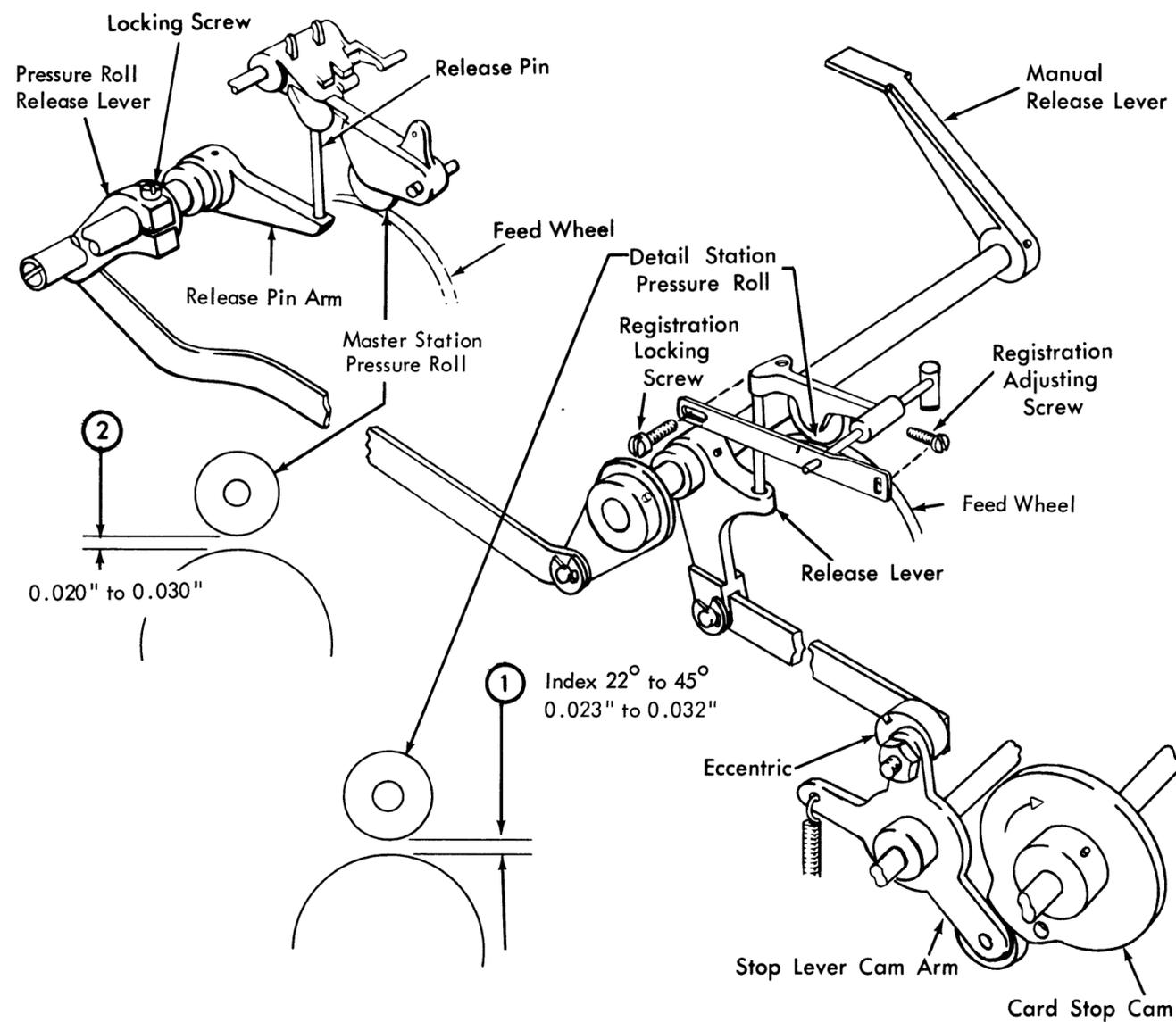
1. Turn card stop cam until cam follower is on high dwell of cam (Figure 4-12).
2. Loosen locking screw in pressure roll release lever (Figure 4-12).
3. Twist release pin arm shaft until 0.020-inch to 0.030-inch clearance is between read station pressure roll and large feed roll (2, Figure 4-12).
4. Tighten locking screw.

#### 4.5.12 Registration Adjustments

##### 4.5.12.1 Detail Station

Check pressure rail tension before making this adjustment.

1. Loosen registration locking screw (Figure 4-12).
2. Adjust lateral position of detail pressure roll with the registration adjusting screw so that card rides against the guide bar while manual duplication is performed.
3. Tighten registration locking screw.
4. Adjust upper rail (detail station) to eliminate any vertical registration skew caused by nonparallelism between the die and stripper assembly and the detail punch bed.



● Figure 4-12. Pressure Roll Adjustment

**Note:** Nonparallelism exceeding 0.025 inch must be corrected at the factory.

#### 4.5.12.2 Master Station

The master pressure roll lever pivot is an eccentric.

1. Loosen setscrew (Figure 4-13) and rotate pressure roll lever shaft until card does not pull away from upper rail when spacing is performed.
2. Tighten locking setscrew.
3. Multipunch a card with 12 through 9 in column 40. Check the card length and registration on a card gage. Register the card in the read station and space to column 40. While holding the card stationary, remove the eject unit and check that both sensing pins are visible in each hole.
4. Adjust the two setscrews in the eject throat plate to obtain the correct registration.

**Note:** In addition to normal eject wear and malfunction, the following conditions may cause the preceding adjustment to vary for successive cards:

- Alternating long and short cards
- Loose pins in escapement gear train
- Bent idler gear shafts in escapement gear train
- Improper friction clutch torque

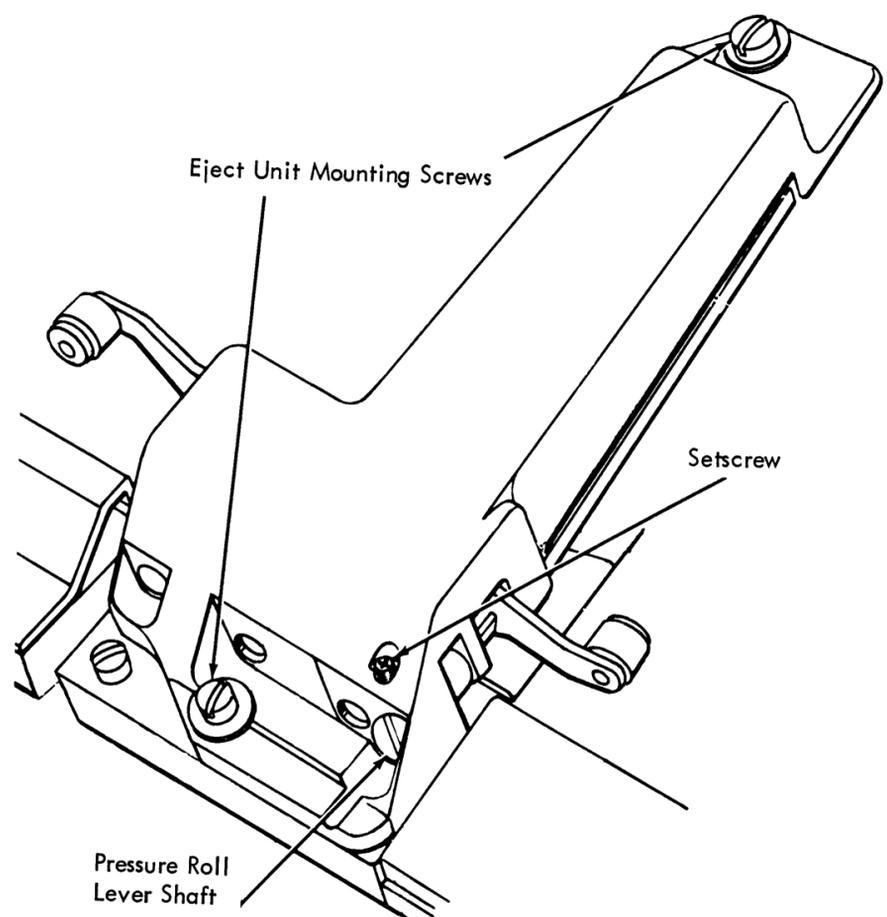


Figure 4-13. Master Station Registration Adjustment

#### 4.5.13 Feed Wheel Removal and Replacement

##### 4.5.13.1 Detail Station

On machines with print feature, remove chip tube, print head, plastic bed plate, and die and stripper; then proceed with steps 1 through 5. On machines without print feature, separate feed wheel and shaft using procedure listed in 4.5.13.2, step 3; then remove die and stripper and proceed with steps 1 through 5.

1. Drive taper pins out of escapement wheel and space gear.
2. Remove collar from escapement wheel shaft.
3. Slide shaft toward rear of machine and slip off escapement wheel and gear.
4. Slide shaft back far enough to manually insert, one taper pin. Use this pin to force ball bearing out of the base casting.
5. Pull pin and bearing free of the shaft and slip shaft through to the inside base and out the top.

When replacing these assemblies, pull escapement wheel shaft toward the bearing in the space gearing bracket and lock the collar. There should be little or no endplay of the escapement wheel shaft.

*Note:* Check timing of program cam and sensing contacts, and check adjustment of backspacer. Check printing and adjust if necessary.

##### 4.5.13.2 Master Station

The feed wheel is pressed on as well as pinned to the shaft.

1. Remove eject unit and stacker plate. (Check adjustment of traveling card guide so that stacker plate can be replaced in the same position.)
2. Remove pin-sensing unit.
3. Withdraw the taper pin that holds space gear to feed wheel shaft but do not remove it from the feed wheel.
4. Remove the three collars and outboard bearing plate.
5. Remove friction drive (the pins will push out).
6. Remove clip from read-pressure-roll release arm and turn arm so that feed wheel shaft assembly can be pulled to front of machine for removing bearing and bearing adapter.
7. Pull out feed wheel shaft assembly from the rear.

To reassemble, reverse the removal procedure. Readjust stacker plate and pin bail drive link. Remove endplay from each shaft before tightening the three collars.

##### 4.5.14 Card Feed Circuit Breaker Service Check

Replace badly pitted or worn points. Check for worn operating arm rollers.

##### 4.5.15 Card Feed Circuit Breaker Adjustment

1. Align points to make sides and faces of contacts parallel.
2. Adjust stationary contact for 0.020-inch to 0.025-inch air gap on high dwell of cam.

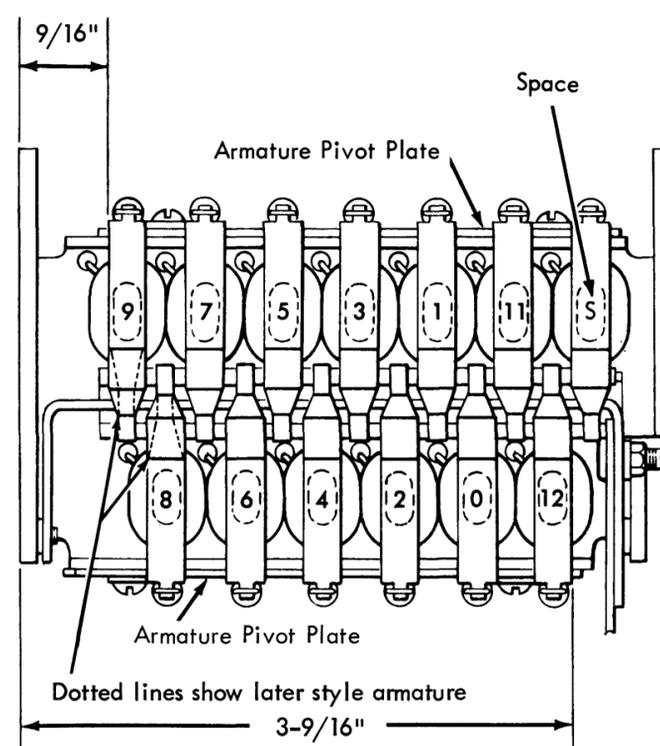


Figure 4-14. Armature Pivot Adjustment

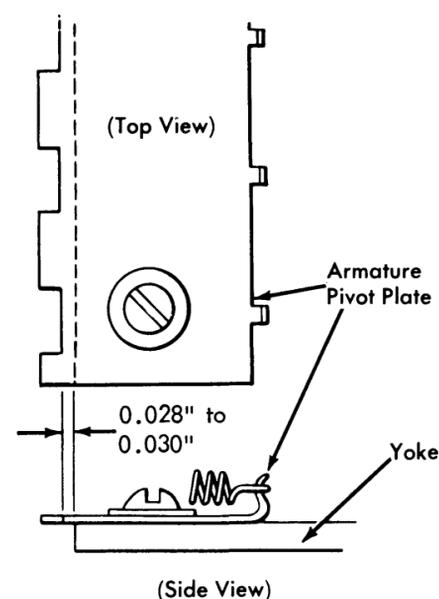


Figure 4-15. Armature Pivot Adjustment - Side View

#### 4.6 PUNCH DRIVE

##### 4.6.1 Index Pointer Adjustment

With clutch detent back against clutch latch, set index pointer to 345 degrees. Be sure that pointer clears index wheel.

##### 4.6.2 Interposer Magnet Adjustment

1. Position armature pivot plate as shown in Figures 4-14 and 4-15.
2. Form armature pivot by lifting tip of the armature until there is at least 1/8-inch free movement to the operating end (Figure 4-16).

##### 4.6.3 Guide Comb and Bumper Adjustment

With clutch latched, adjust guide comb and bumper so that bumper portion holds punch operating arms down against punch bail. When interposers are hooked under the bail,

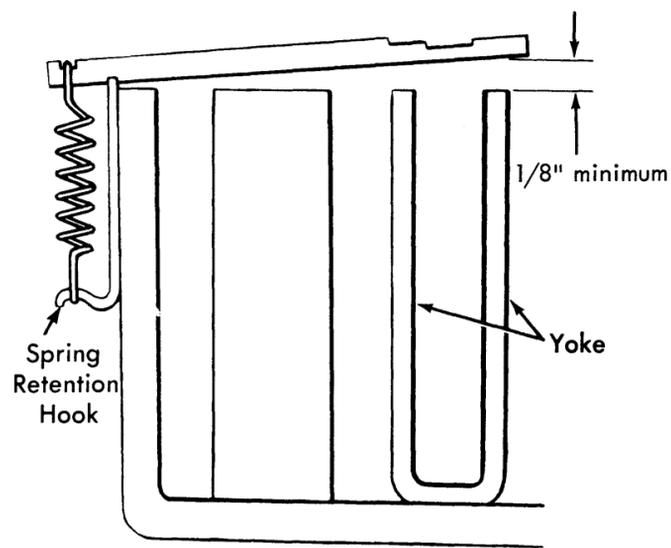


Figure 4-16. Armature Adjustment

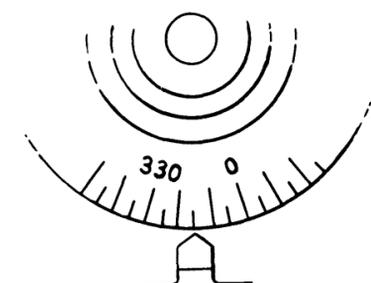
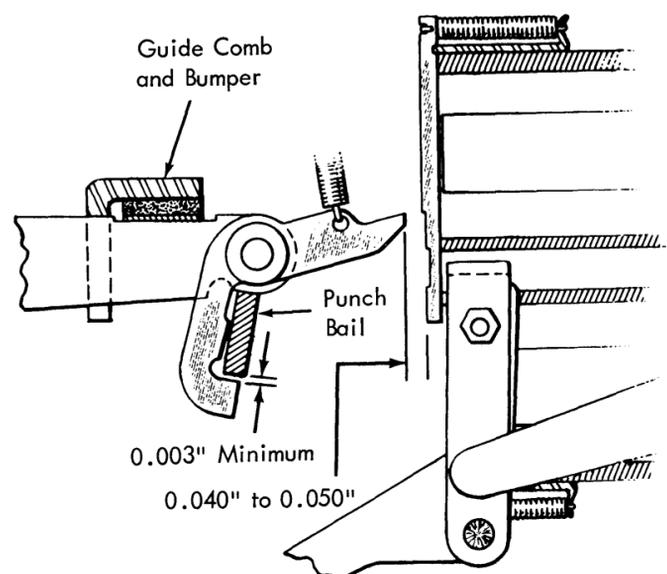


Figure 4-17. Interposer Unlatching Clearance

there should be 0.003-inch minimum clearance between bottom of bail and interposers (Figure 4-17). Check adjustment by placing the hand on the punch arms to take up any clearance between top of bail and punch arms; then trip all interposer armatures. All positions should latch under the bail.

#### 4.6.4 Punch Interposer Magnet Assembly Adjustment

The position of the magnet unit affects three interrelated adjustments: unlatching clearances, relatching of interposers in their armature notches, and knockoff bail.

1. Install magnet unit with reasonable unlatching clearance as a preliminary step. Do not overtighten screws because magnet unit will be readjusted in step 2. Restore all but four interposers across the unit. While manually rotating index clockwise, position magnet unit so that the unlatched interposers in their downward motion start to

enter their armature notches at 92 degrees and so that all are in the notches at 100 degrees. Space interposer movement varies from that of the other interposers, but the interposer should be in its armature notch at 100 degrees (Figure 4-18).

2. The heel of the latching end of the interposers has been rounded to avoid contact with the opposite side of the notch in the armatures. Shift the magnet unit toward or away from the interposers to obtain 0.040-inch to 0.050-inch clearance (Figure 4-17).

The preceding adjustment should result in minimum unlatching clearance of 0.008 inch for each interposer, except the space interposer, which can have a minimum unlatching clearance of 0.005-inch (Figure 4-19).

3. Adjust eccentric screw on knockoff bail (Figure 4-18) to cause bail to contact an attracted armature at both ends of unit between 13 degrees and 20 degrees. If the eccentricity is insufficient, inspect cam follower for wear. It may be necessary to pivot entire magnet unit around armature latching point to bring bail closer to armatures.

4. Momentarily attract each armature electrically. The spring should cause the armature to fall away from the core. If the armatures hang up when the pick circuit is broken, they should be replaced; the residual magnetism causes excessive wear on the knockoff bail.

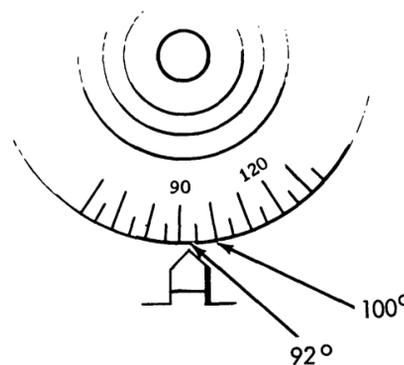
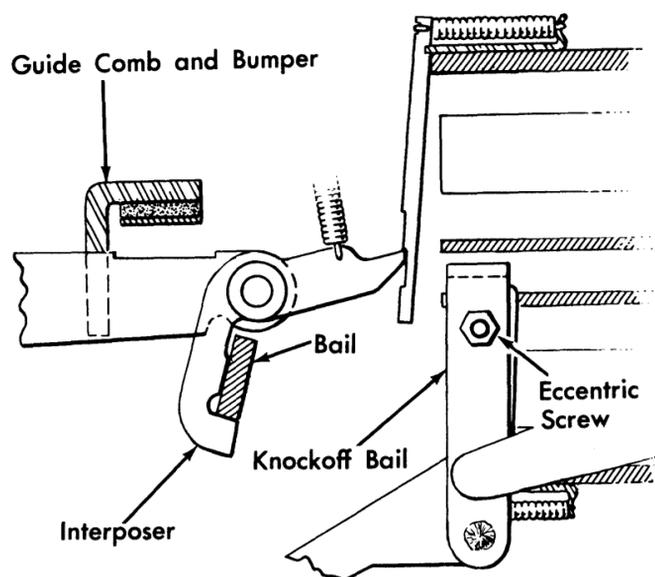
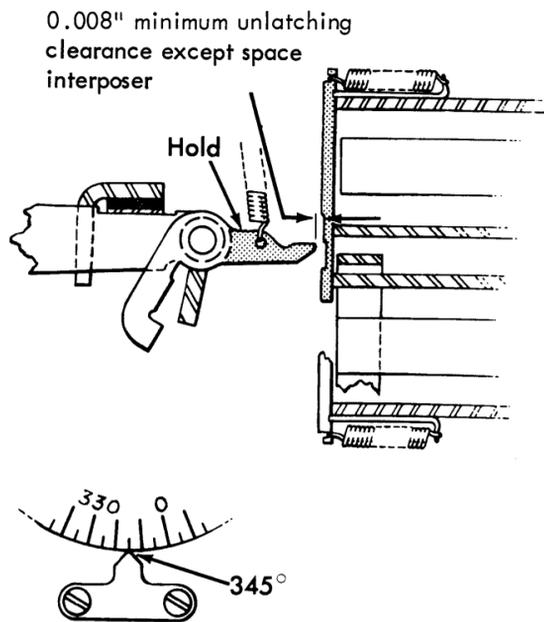


Figure 4-18. Interposer Relatching Adjustment



● Figure 4-19. Armature Unlatching Clearance

#### 4.6.5 Interposer Bail Contact Assembly Adjustment

Bail-contact assemblies may be removed after removing the master bed plate or punch drive unit.

- Both contact assemblies must have equal tension. Form stationary contact strap to require 30 to 35 grams to raise it off its support. Forming should be within the area of the support strap to reflect a true condition. One method of forming the contact strap is to insert a straightened paper clip between the strap and its support. Form contact strap to obtain a point-to-point contact at outer tip of support strap. When strap is properly adjusted, a crack of light will appear at tip of support strap during measurement.
- With contact assemblies removed, form operating strap near the mounting to require 20 to 25 grams to close contacts (Figure 4-20). Place gram gage finger under phenolic pad with 1/4-inch overlap when checking adjustment; 50 to 60 grams should then be required to close contact and to raise stationary contact off support strap (Figure 4-21).
- Reinstall the contact assemblies and adjust their mounting brackets for 0.017-inch contact gap with all armatures restored.

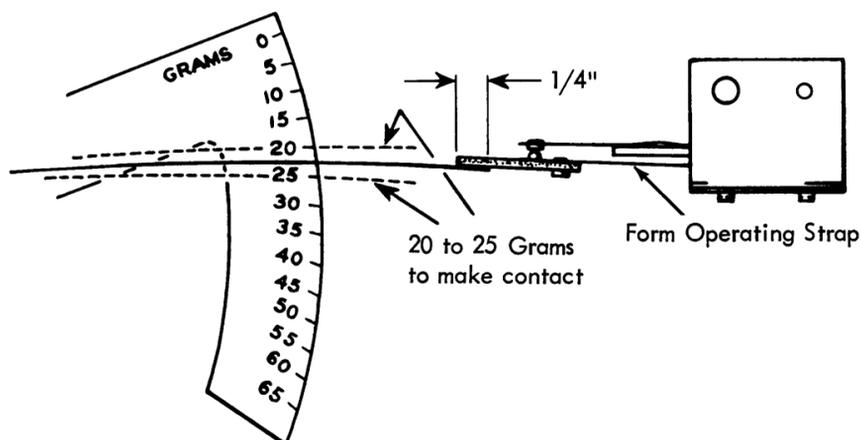


Figure 4-20. Interposer Bail Contact Adjustment

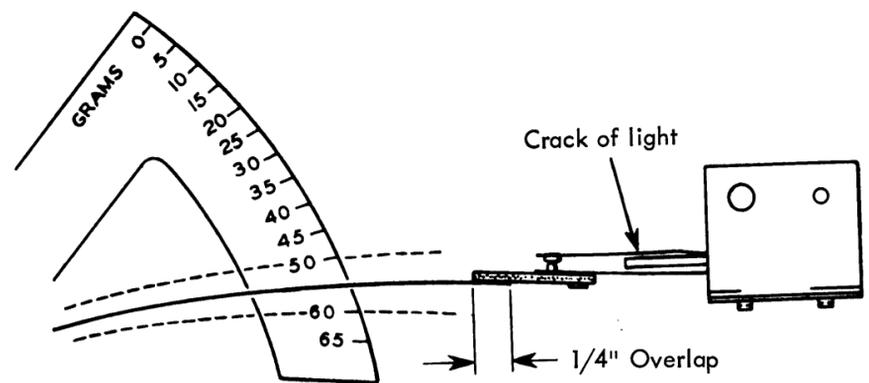


Figure 4-21. Interposer Bail Contact Rise Adjustment

#### 4.6.6 Punch Drive Removal and Replacement

##### 4.6.6.1 With Print Feature

- Remove:
  - Belt guard and punch drive belt.
  - Auxiliary duplicating feature (if installed).
  - Wires to punch drive unit.
  - Two screws in pin-sensing bail drive link.
  - Flexible shaft (if installed).
- Unhook print drive spring (Figure 4-22) and trip punch clutch armature to prevent damage to it. Hold index and remove screw with left-hand threads from end of punch shaft. Unscrew grease fitting from mounting plug.

*Note:* The next step requires realigning the code plate when reassembling. Refer to 4.11.2.3.

- Loosen knurled thumb screw or remove slotted clip on vertical drive rod to relieve tension and remove vertical drive rod guide plate. Disengage the print rod from the print arm (Figure 4-22) by applying slight pressure on drive rod at lower end.
- Lift print drive mechanism from rear mounting plug.
- Remove two screws from each end of drive-unit anchor bar.
- Loosen screws in front mounting plug enough to permit disengaging the plug. Remove rear mounting plug screws.
- Shake drive unit up and down (bed in vertical position) to free mounting plugs.
- Turn drive unit clockwise and remove from base.

Before reinstalling drive unit, manually push punch extensions in as far as possible. Reverse procedure to install punch unit. Align groove in eccentric bearing to mark on print cam (Figure 4-22). Check printing.

##### 4.6.6.2 Without Print Feature

- Remove belt guard and punch drive belt.
- Loosen setscrew in reduction housing gear hub and pull out flexible drive shaft. Use unused position of cable clamp to hold cable out of the way.

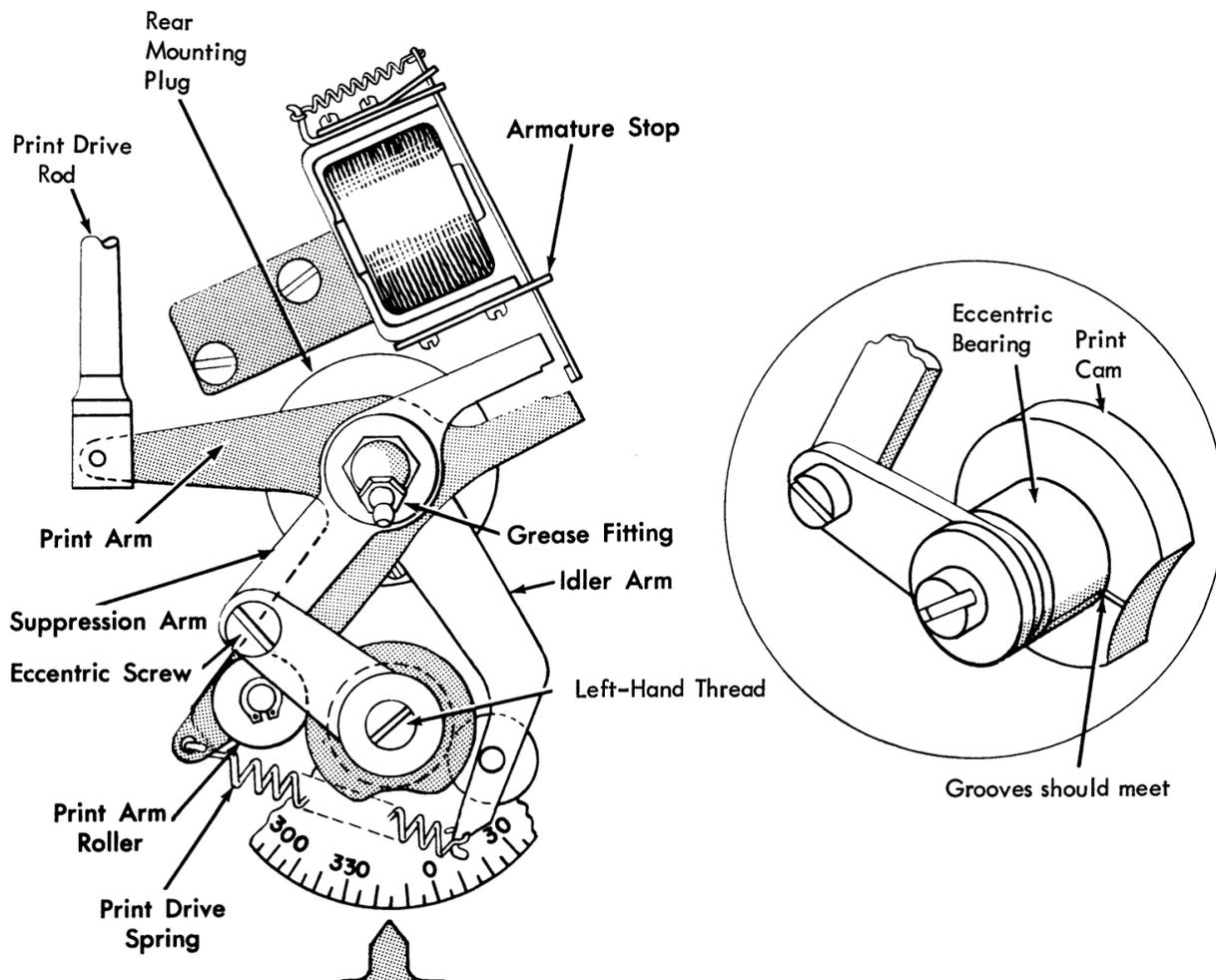


Figure 4-22. Print Drive Unit Cam Timing

3. Remove the wires from punch clutch magnet and punch circuit breakers. Remove the slip-connectors from the interposer magnets.
4. Remove the two screws in pin-sensing bail drive link. On reassembly, tighten these screws after punch drive unit is fastened into position with links extended.
5. Remove the two screws from each end of drive-unit anchor bar.
6. Loosen the screws in front mounting plug enough to permit disengaging the plug. Remove rear mounting plug screws.
7. Shake drive unit up and down (bed in vertical position) to free mounting plugs.
8. Turn drive unit clockwise and remove from base.

Before replacing the unit, be sure all punch interposers are resting in the center of the armature slots. It is easier to re-engage the punch operating arms with the punch extensions if they are pushed in flush with the lower guide plate.

#### 4.6.7 Clutch Magnet Adjustment

1. Position the core with shims (part 305271) for 0.006-inch to 0.012-inch clearance between armature and core with armature attracted (Figure 4-23).
2. Attract the armature and pivot magnet assembly around its support bracket to obtain 0.003-inch to 0.005-inch unlatching clearance to the step on the sleeve.

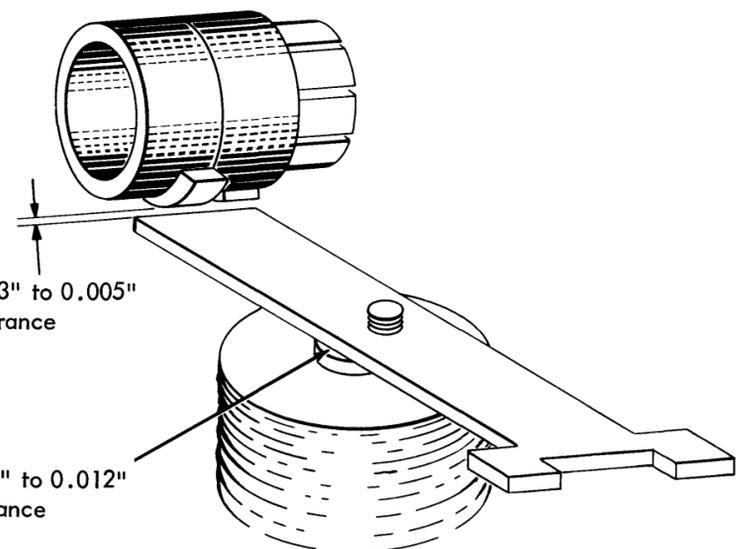


Figure 4-23. Punch Clutch Magnet

#### 4.6.8 Punch Clutch Service Check

##### *Sleeve Latching Surface Lead Distance:*

1. Trip the armature and check the outer-sleeve lead distance; it should be 1/8 inch to 3/16 inch. Punch clutch lockup is possible if 3/16-inch outer-sleeve lead distance is exceeded.
2. While the clutch is unlatched, turn the drive pulley forward (do not use the index wheel) until the outer sleeve hits the armature and the index stops. This should be 325 degrees  $\pm$  10 degrees.

**Overthrow:** Check for 1-degree to 3-degree overthrow with the clutch latched. The clamp should be replaced if the clamp faces contact when tightened. The clutch spring should be replaced if it becomes distorted.

#### 4.6.9 Punch Clutch Adjustments

##### 4.6.9.1 Standard Method

**Sleeve Latching Surface Lead Distance:** This adjustment establishes the correct relationship between the clutch spring and the outer and inner sleeves (Figures 4-24 and 4-25).

1. Loosen the clamping screw. The clamping collar is a separate part and can be moved independently of the inner sleeve.
2. Trip the clutch armature and turn the index wheel (not the drive pulley) forward until the inner- and outer-sleeve latching surfaces can be observed.
3. Move the clamping screw to an accessible position while holding the two sleeves with their latching surfaces visible.
4. Turn the outer sleeve clockwise against the spring (Figure 4-25). The sleeve moves very easily in a counterclockwise direction. Therefore, keep the outer-sleeve protrusion snug against the end of the spring to avoid a false indication of the latching surface distances.
5. Position the inner-sleeve latching surface behind the outer-sleeve latching surface as shown in Figure 4-25, and keep the clamping screw accessible.
6. Tighten the clamping screw. While tightening this screw, press the clamping collar and inner sleeve toward the machine base, and keep the outer-sleeve protrusion against the spring.

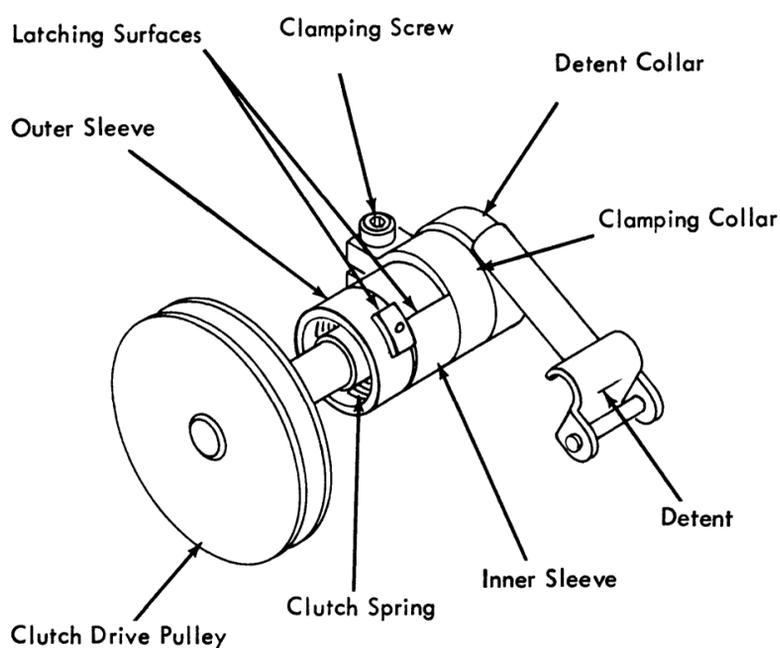


Figure 4-24. Punch Clutch Components

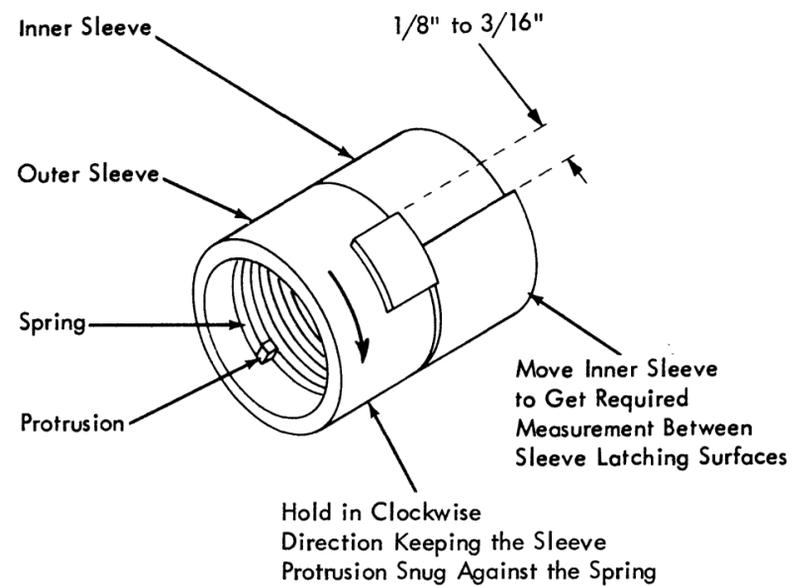


Figure 4-25. Punch Clutch Adjustment

**Overthrow:** This adjustment times the clutch to the index. The clamping screw must be loosened so that the shaft can be turned without disturbing the previously established relationship between the spring and the inner and outer sleeves.

1. Loosen the clamping screw approximately 1/4 turn. Allow the shaft to be turned inside the spring with some resistance, but not so loose that the spring will move inside the inner sleeve.
2. Turn the index wheel forward until the inner- and outer-sleeve latching surfaces are driven against the armature. (If you cannot turn the index beyond this point, the clamp is too tight; and it is necessary to loosen the clamp more.)
3. Continue turning the index wheel forward to 347 degrees, 2 degrees beyond the point where the detent drops into place. While turning the index wheel, hold the inner sleeve against the armature to overcome the tendency of the sleeve to move backward.
4. Tighten the clamping screw securely.
5. Check the clutch adjustment (use 4.6.8) and repeat if necessary.

##### 4.6.9.2 Alternate Method

The abbreviated method can be used to make the adjustment after becoming more familiar with the operation of the clutch.

1. Loosen the clamping screw and use the index wheel to position the sleeve and collar to an accessible location.
2. Hold the outer sleeve against the spring tip, and set the inner sleeve for the correct lead.
3. Tighten the collar so that the index can be turned with some resistance after the sleeves are stopped by the armature.
4. Turn the index wheel to 347 degrees and tighten the clamp securely.
5. Check the clutch adjustment (use 4.6.8) and repeat if necessary.

#### 4.6.10 High-Speed CB Assembly Service Check

1. Check for loose pile-up screws.
2. Check for binds in rollers, operating pins, and plungers. Inspect cam surfaces for irregularities due to wear or dirt. Wipe cam surfaces clean before adding new lubricant. If an abrasive tool is used in removing burned spots, check the contact make-and-break timing.

#### 4.6.11 High-Speed CB Assembly Adjustment

1. Remove the CB assembly from the machine. Shim for 0.027-inch to 0.032-inch contact air gap with plunger seated against the frame (Figure 4-26).
2. Form operating strap to require 100 to 150 grams of pressure, at tip of strap, to close contact.
3. Form cam-follower spring to require 475 to 550 grams of pressure to close contacts with 0.020-inch to 0.030-inch overtravel of cam follower.
4. Install CB assembly in machine but do not completely tighten the holding screw. Turn CB to low dwell and turn adjusting screw to obtain 0.017-inch to 0.023-inch contact air gap.

#### 4.6.12 High-Speed Cam Removal

1. Remove print cam if machine has print feature.
2. Remove pin from index and slip it off shaft.
3. Unhook knockoff-bail arm and pin drive link springs.
4. Drive taper pins from the two mechanical cam assemblies.
5. Loosen setscrews in all circuit breaker cams.
6. Slide shaft toward clutch end until end of shaft clears rear bearing. It may be necessary to shift clutch magnet assembly to allow clutch collar to pass clutch magnet armature. Remove desired cam.

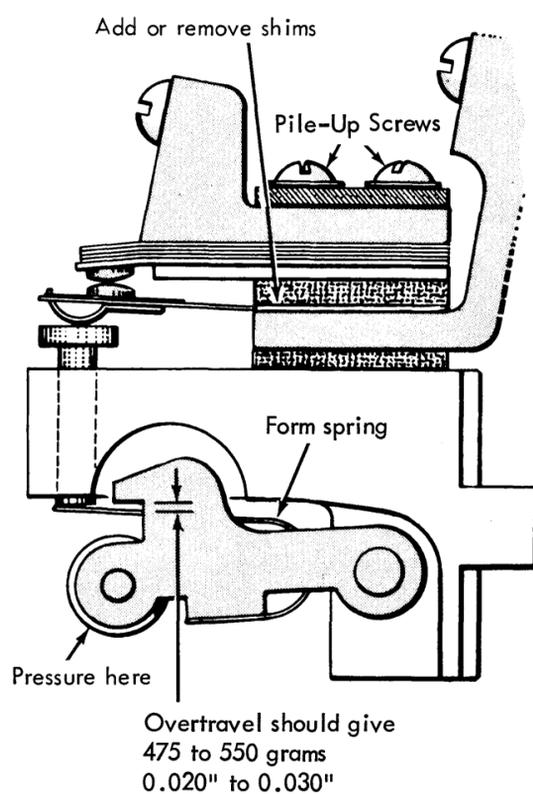


Figure 4-26. High-Speed Circuit Breaker

#### 4.6.13 Die and Stripper Service Check

A crayon or pencil deposit sometimes forms on the underside of the die and can cause drag on the card, resulting in off-registration punching. These deposits can be removed with a feeler gage.

A convenient method of lubricating the porous bronze punch guides is to multipunch several columns of an oiled blank card.

#### 4.6.14 Die and Stripper Adjustment

Die and stripper clearance is set at 0.020 inch to 0.026 inch on machines without print feature. On machines with print feature, clearance should be 0.012 inch to 0.017 inch.

#### 4.6.15 Die and Stripper Removal and Replacement (With Print Feature)

To remove die and stripper:

1. Remove:
  - a. Printing head.
  - b. Chip tube by taking out two screws (Figure 4-27). Be careful not to lose the pressure roll spring.
  - c. Front rails.
  - d. Plastic bed plate.
  - e. Punch extension cover, nuts, and springs.

#### CAUTION

On reassembly, do not force the nuts tightly against the shoulder; this can cause the extension to break off.

- f. Horizontal shift spring.
  - g. Three mounting screws.
2. Pull print interposer assembly from punch extensions.

#### CAUTION

Keep horizontal shift slide compressed.

3. Remove bottom punch extension guide plate. Lift each punch extension over punch arm and push it into the die.
4. Remove the two die mounting screws.
5. With left hand on punch extensions, remove unit from base.

#### 4.6.16 Die and Stripper Removal and Replacement (Without Print Feature)

Remove die and stripper. With punch drive unit in machine:

1. Remove lower punch extension guide. With two or three 2-inch pieces of card between die and stripper, push punches into the die.
2. Remove chip tube by taking out two screws (Figure 4-27). Be careful not to lose the pressure roll spring.
3. Lift out release pin from die.
4. Remove front pressure rail covers at punch and read stations (Figure 4-27).

5. Remove plastic guide from top of rear rail. The guide is flexible enough to be removed without pulling pins, if care is used.
6. Remove space gearing cover.
7. Remove the two bed plate screws in master station bed plate and lift plate out to the right.
8. Back out the two holding screws and lift out die and stripper assembly. Be careful not to pull punches out as the extensions are pulled past interposer arms.

Do not separate die and stripper unnecessarily. Clear all card chips away from these assemblies when replacing assemblies on the machine.

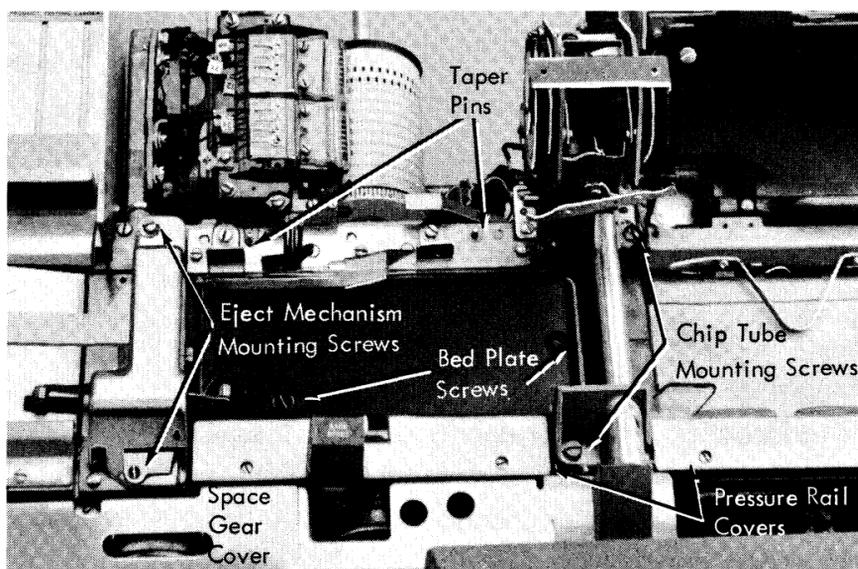


Figure 4-27. Punch Bed – Front View

#### 4.6.17 Punch Penetration Adjustments

##### 4.6.17.1 With Print Feature

Satisfactory punching should result from the print drive and yoke adjustment in 4.11.2.1. The punch and extension retaining pin must be moved, if additional penetration is needed. Die and stripper clearance is set at 0.012 inch to 0.017 inch. Current machines use the number-1 hole as a starting point. As the retaining pin is moved to the next higher-number hole, 0.010 inch more punch penetration is obtained.

*Note:* Always insert the retaining pin in identically numbered holes in both the extension and punch (Figure 4-28).

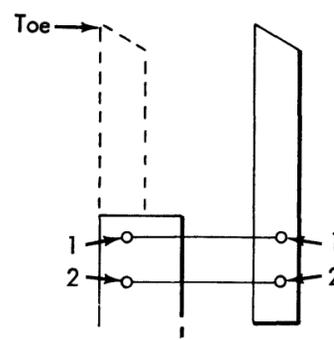


Figure 4-28. Punch and Extension

##### 4.6.17.2 Without Print Feature

The following adjustment eliminates partially punched holes during the setup process. The heel of the lowest punch must enter 0.015 inch to 0.020 inch into the die. Refer to Figure 4-29.

1. Loosen:
  - a. Support screws in anchor bar.
  - b. Holding screws in pin bail links.
  - c. Drive-unit adjusting-screw lock nut.
  - d. Holding screw.
2. At 345 degrees (punch index), trip all punch interposer armatures. To trip armatures electrically:
  - a. Disconnect escape magnet to prevent spacing when interposers are tripped.
  - b. Operate detail station card lever.
  - c. With an interposer bail contact lead, energize each magnet.
3. With index turned to 126 degrees (punches up), turn the drive-unit adjusting screw in until a 0.010-inch gage passes between lowest punch and the die. The punch adjustment holding screw must be tightened after each trial.
4. Remove feeler gage and back off two turns on adjusting screw. Tighten lock nut.
5. Turn the two support screws until they rest against drive unit side frames; tighten lock nuts.
6. With the punch clutch latched, extend the pin bail drive links.
 

Additional travel, when needed, should not exceed 1/8 turn (0.003 inch) of the adjusting screw per step.

#### 4.6.18 Punch Removal and Replacement

##### 4.6.18.1 With Print Feature

###### *Removal:*

1. Remove punch extension covers, nuts, and springs.
2. Loosen knurled thumb screw on vertical drive rod; then unhook horizontal shift spring.
3. Remove the three mounting screws and pull print interposer assembly from the punch extensions.

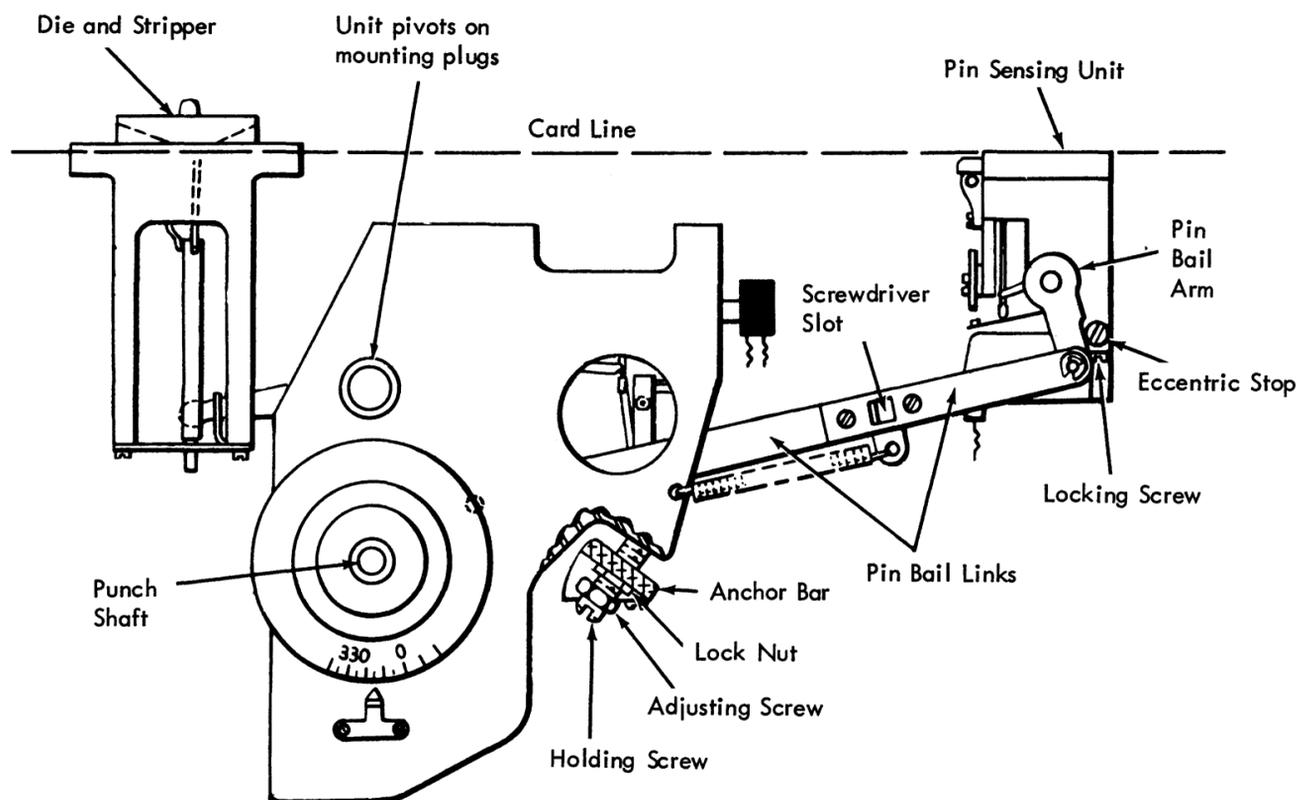


Figure 4-29. Punch Penetration Adjustment

**CAUTION**

Keep the horizontal shift slide compressed.

4. Remove punch extension lower guide. Punches may be pulled out by lifting each extension over its operating arm.

*Replacement:* To reinstall the assemblies, slip extension guide plate off print interposer unit and place it over the extensions first. The extensions will then be equally spaced, and the yokes will locate themselves freely to the extension. When the interposer unit is being replaced on the extension, the yokes should be in their lowest operating position and held there by spring or finger pressure on the slides.

Note that the toe of the punch is toward the front of the machine. Be sure that the retaining pin head is on the same side as the pin retaining plate. Support the punch and extension on a 6-inch scale to aid in reassembly.

**CAUTION**

When removing the interposer unit, note that the screw over the 9-punch drive is shorter than the other screws. Be sure to reinstall the short screw in the same position. Placing one of the longer screws in this position will bind the drive unit.

**4.6.18.2 Without Print Feature**

*Removal:*

1. Tilt punch bed to vertical position and remove the three screws holding punch-extension lower-guide plate.

2. Slide plate off its guide pins and punch extensions. Any punch is accessible by lifting the extension over the associated punch operating arm, and pulling it straight out.

*Replacement:* When replacing the punch assembly, check to see that retaining pin head is on same side as pin retaining plate. Toe of punch should be toward front of machine. Inserting punch into stripper is easier if it is supported on a 6-inch scale, (hold with a rubber band).

**4.6.19 Pin Bail Drive Link Adjustment**

1. Loosen the two holding screws in pin bail drive link.
2. Insert screwdriver blade in square hole between holding screws. After punch clutch is latched at 345 degrees, extend the pin operating arm until it rests against its stop screw.
3. Tighten holding screws while holding link extended.

**4.7 PIN-SENSE UNIT**

**4.7.1 Pin-Sensing Unit Service Checks**

Improper insertion of master cards by the operator can cause incorrect reading. If the card is pushed in so far that it is pressed against the feed and idler rolls and, at the same time, is pulled away from the top guide rail, it will stay in this position after being registered. Most punching in the first third of the card will fail to read, and some punching in the rest of the card may also be left out.

#### 4.7.1.1 Card Sensing Contacts

Inspect contacts for burning. Remove card particles and lint. One broken contact in a pair causes intermittent read failures.

#### 4.7.1.2 Sensing Pins

Check that sensing pins operate separately. Pins sticking together cause reading failures by forcing both pins to enter the hole at the same time.

#### 4.7.1.3 Pin Bail, Drive Link, and Arm Assembly

Inspect guide stud in the rear frame for wear. Adjust link and lubricate stud if necessary. Check for rust accumulation or wear.

#### 4.7.1.4 Card Lever

Remove any accumulation of card dust around the card lever.

### 4.7.2 Pin-Sensing Unit Adjustments

Contact pressure, throat gap, and contact gap adjustments are made with unit removed from base.

#### 4.7.2.1 Contact Pressure

Before installing a new contact molding, pre-form contact straps (Figure 4-30). A reading board is helpful in forming contacts evenly.

1. Form contacts as shown in Figure 4-30.
2. Install contacts on pin-sensing unit.
3. Adjust contact pressure by forming the strap near the molding to require 20 to 30 grams to move the contact from the common bar.

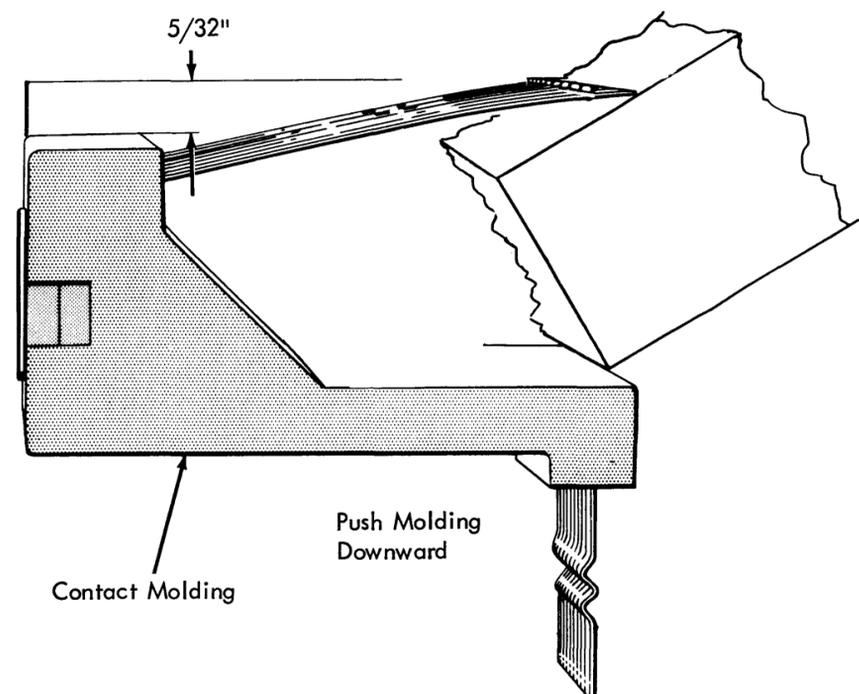


Figure 4-30. Sensing Pin Contact Adjustment

#### 4.7.2.2 Throat Gap

1. Place eject unit in normal operating position on pin-sensing assembly. Hold together with screws if necessary.
2. Shim throat plate (bottom of eject unit) to adjust throat gap for 0.012-inch to 0.021-inch clearance (Figure 4-31). Check 0.012-inch clearance at closest point and 0.021-inch clearance at widest point. Replace throat plates worn beyond these dimensions. The 0.004-inch shim is part 121397, and the 0.010-inch shim is part 49901.

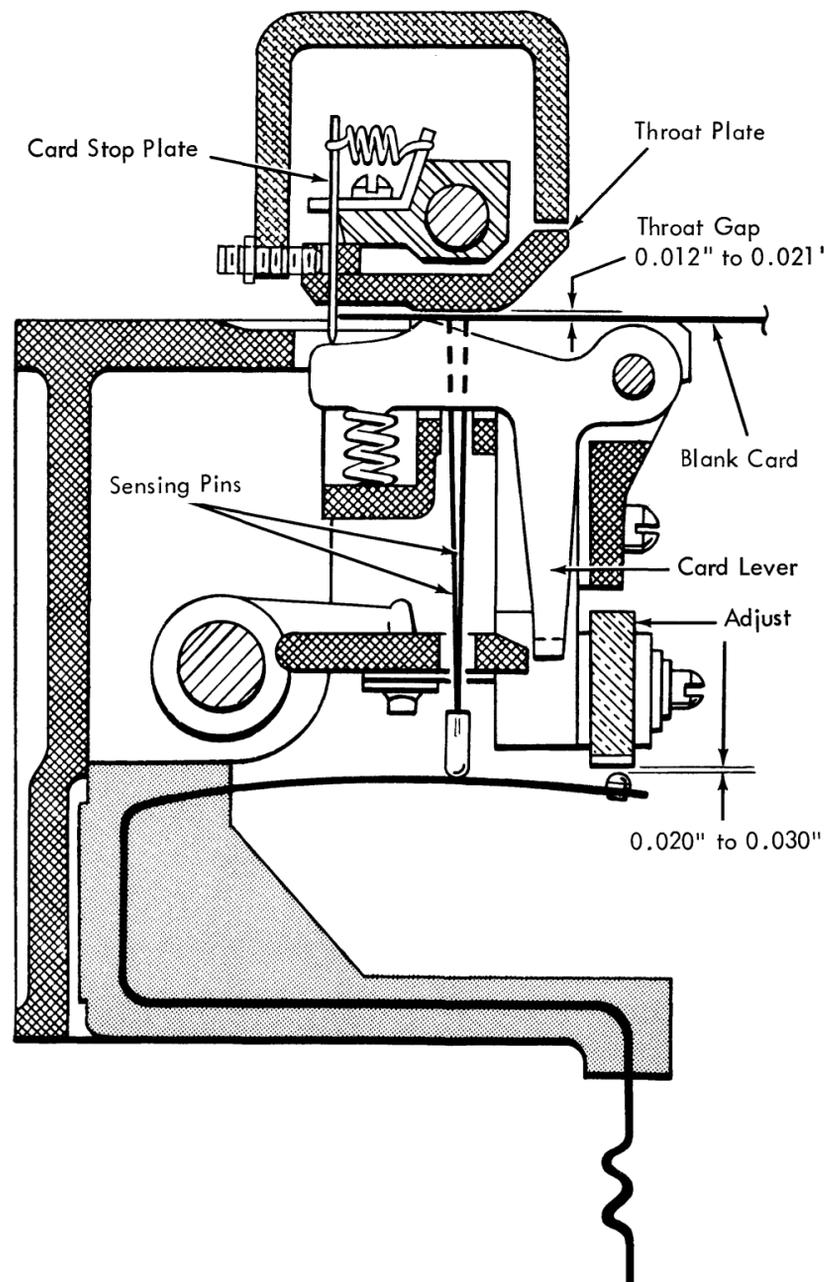
*Note:* Late production units do not use shims.

#### 4.7.2.3 Contact Gap

1. Insert blank card and let pins rest against it.
2. Remove contact cover and adjust common contact bar for minimum air gap of 0.020 inch and a maximum air gap of 0.030 inch (Figure 4-31).

#### 4.7.2.4 Pin Bail Arm Eccentric

Normally, it is unnecessary to alter factory adjustment on pin-bail-arm eccentric stop. If adjustment is necessary, loosen locking screw and adjust eccentric to stop pin-bail arm when sensing pins are retracted 0.010 inch to 0.015 inch below surface of separators. Tighten locking screws.



● Figure 4-31. Pin Sensing Adjustment

#### 4.7.2.5 Card Lever

With pin bail arm against its stop, position card lever to clear pin bail by 0.005 inch to 0.010 inch.

#### 4.7.3 Pin-Sensing Unit Removal and Replacement

1. Remove eject mechanism from top of pin-sensing unit. Remove release pin that operates eject mechanism.
2. Remove the three screws holding eject front rail, the two nuts beneath this rail, and the two nuts holding stacker plate to stacker assembly near stacker switch. The plate can now be removed. (When reassembling, check adjustment of traveling card guide before tightening nuts.)
3. Disconnect pin bail drive link at its coupling screws (Figure 4-29) through hole in rear of punch bed. Do not remove spring from link-to-drive-unit rear frame.
4. Remove the screw holding the sensing-pin cable clamp.
5. Remove the two screws in top of pin-sensing unit and lift out unit from top of base.
6. With long-nose pliers, pull out common wire to sensing contact strip; then slip off connections to individual terminals. Note that cable is fanned out so that it can be easily reinstalled.
7. Reinstall unit in machine with punch index at 345 degrees. Extend pin bail link to bring pin bail arm up against the stop.

#### CAUTION

Do not overextend pin bail link because punch drive can be damaged.

8. Check to see that P5 makes *after* and breaks *before* pin contacts. Be careful that plastic dust cover does not bind the 9-sensing contact.

#### 4.7.4 Sensing Pin Removal

1. Remove pin-sensing unit from machine.
2. Trip card lever and place pin-sensing unit upside down.
3. Remove plastic dust cover for sensing pin contacts.
4. Remove the two screws holding contact assembly to frame and lift it off. This exposes operating ends of sensing pins. Use care to avoid moving contact bail because it is possible to lift all sensing pins out of the separator; considerable time is needed to replace them.

### 4.8 EJECT UNIT

#### 4.8.1 Eject Unit Adjustments

##### 4.8.1.1 Pressure Roll Registration

Adjust pressure roll lever shaft to align pressure roll with feed roll and cause proper feeding through read station (4.5.11.2 and 4.5.12.2).

##### 4.8.1.2 Pressure Roll Opening

For adjustment of pressure roll opening, see 4.5.11.2.

##### 4.8.1.3 Throat

Add or remove shims for a throat clearance of 0.012 inch to 0.021 inch. (See 4.7.2.2.) Late production units do not use shims. Replace throat plate when gap is not within tolerance.

##### 4.8.1.4 Register Arm Tension

1. Tip bed to vertical position and turn CF index to 30 degrees.
2. Insert strip of card between rolls.
3. Form paper clip to hook under arm just inside roller, and hook other end in hole of 10X blade.
4. Form long end of spring to require 200 to 275 grams to free the card.

##### 4.8.1.5 Eject Arm Tension

Use the procedure under 4.8.1.4.

##### 4.8.1.6 Eject Card Guide

The plastic guide should clear the stacker plate by at least 0.016 inch. It can be raised by filing the eject casting slightly or by shimming the right end of the guide. Forming the plastic is unsatisfactory because, even if heat is used, the plastic returns to original condition.

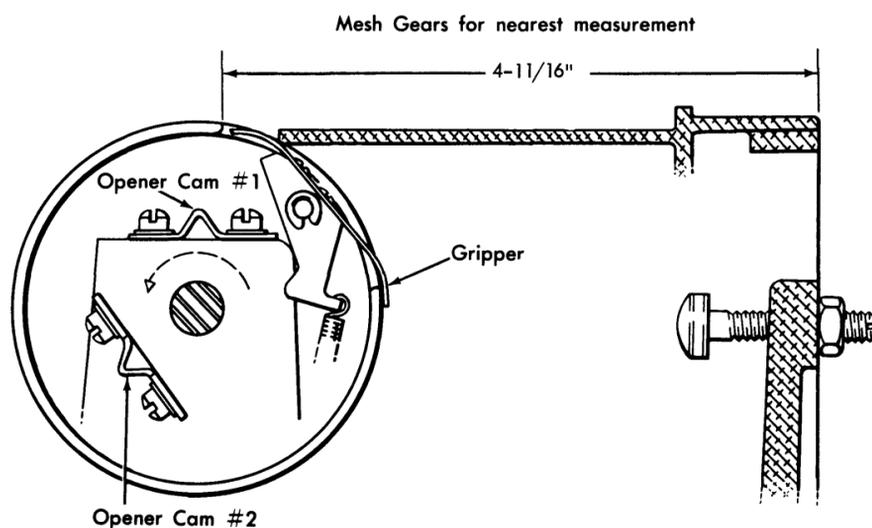
### 4.9 STACKER UNIT

#### 4.9.1 Stacker Unit Adjustments

*Note:* Check wiring diagram for exact timings on machines with special features such as variable card length feed.

##### 4.9.1.1 Stacker Timing

With card feed index at 0 degree, time stacker with teeth that provide the closest measurement to 4-11/16 inches from upper cut in stacker drum to front edge of base. This



● Figure 4-32. Stacker Timing

distance should be measured before removal of unit to prevent changing other adjustments that might be affected because of a change in timing. Be sure to measure distance to edge of base and not to stacker bed plate (Figure 4-32).

#### 4.9.1.2 Card Pusher Cam

The cam is mounted by screws in elongated holes on the stacker drive gear. Position cam so that gripper fingers grip  $3/16$  inch of the card. Check adjustment with power on (Figure 4-33).

#### 4.9.1.3 Number-1 Opener Cams

With stacker plate removed, adjust front opener cams so that gripper fingers just start to open at 73 degrees.

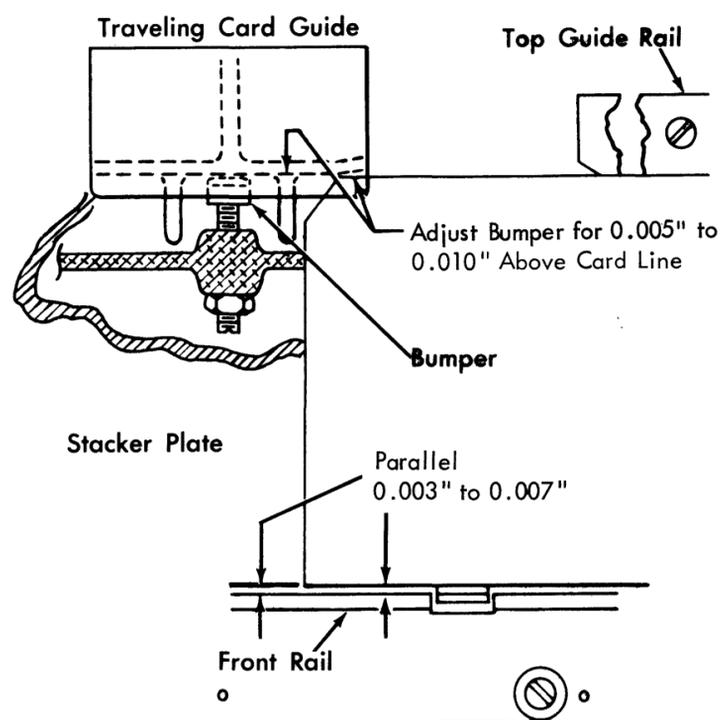
#### 4.9.1.4 Number-2 Opener Cams

The rear opener cams are positioned so that card is released when fully stacked but before it is damaged. Check adjustment with power on.

#### 4.9.1.5 Stacker Bed Plate (Figure 4-34)

*Note:* For stacker plates mounted directly to casting (no rubber acoustic isolators), omit steps 1 through 3.

1. Loosen the two hex-head screws securing the stacker plate mounting bracket to the base. (The bracket, below



● Figure 4-34. Traveling Card Guide

the stacker, with the wire-contact relay and arc suppression mounted on it.)

2. Adjust the stacker plate mounting bracket so that the stacker plate is flush to 0.050 inch below the stacker drum at the card line (top of the card).
3. Tighten the mounting bracket screws.
4. Insert a card halfway through the eject station and against the master station upper guide rail.

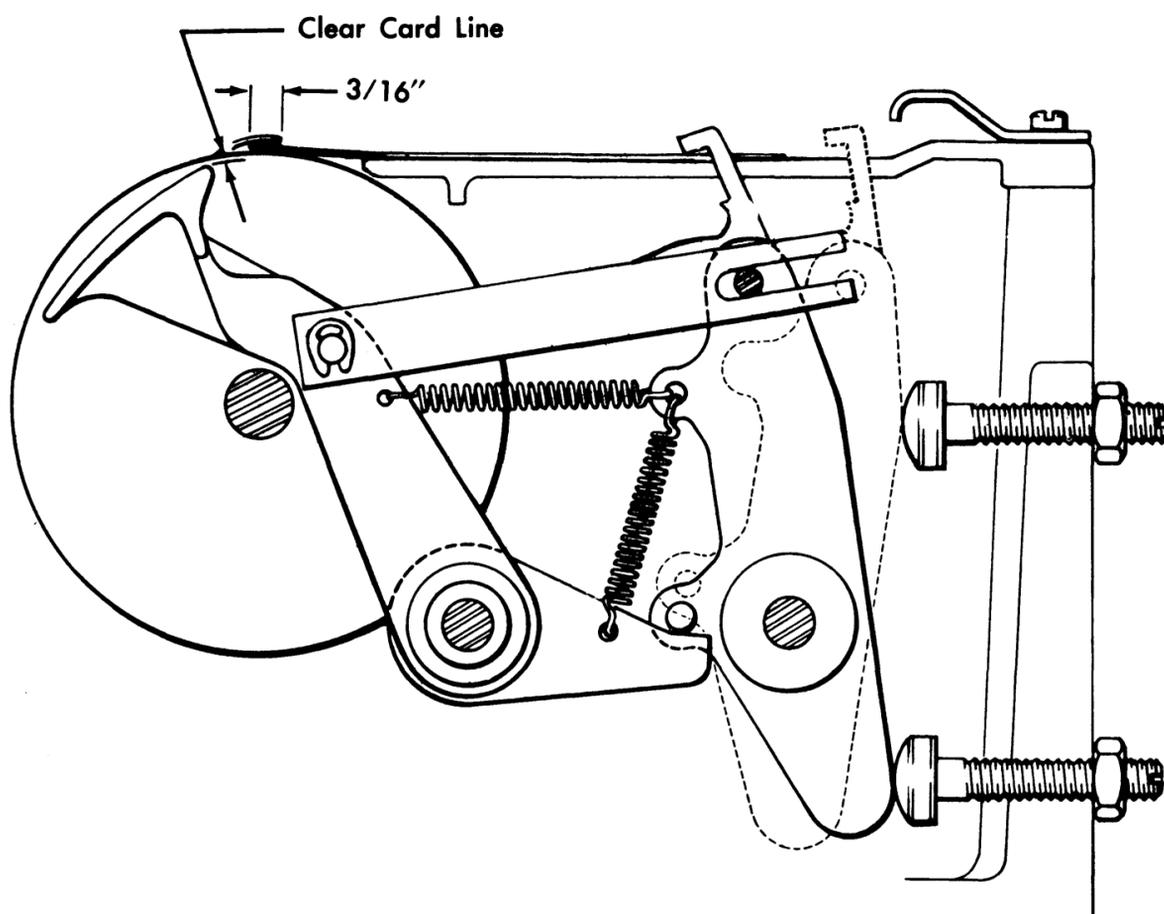


Figure 4-33. Stacker Adjustment

5. Loosen acoustic isolators or mounting screws.
6. Remove the lower stacker card guide.
7. Position the stacker plate parallel to and with 0.003-inch to 0.007-inch clearance between the bottom of the card and the lower stacker rail (use the support bumpers to the rear and below the stacker when stacker support bracket is on the machine).
8. Tighten the isolators and replace the card guide.
9. Adjust the traveling card guide bumpers to allow 0.005-inch to 0.010-inch clearance between the traveling card guide and the card when the feed clutch is latched and a minimum of 0.001-inch clearance when the card is stacking. When properly adjusted, the operating noise is reduced by the rubber bumpers.

## 4.10 PROGRAM DRUM UNIT

### 4.10.1 Sensing Assembly Service Check

#### 4.10.1.1 Card Life

The program card should be changed daily when usage is heavy. The sensing wheels, in correct adjustment, should graze the surface of the program card. Improper tension on the program sensing arms shortens life of the program card. Worn program cards may cause elusive failures.

#### 4.10.1.2 Drum Interchangeability

Determine interchangeability by checking all drums against a master drum. Replace worn gripper cam shafts.

#### 4.10.1.3 Drum Eccentricity

1. Mount a program card with 4's punched at about 15-column intervals.
2. Space to the columns preceding the punched ones and observe the distance from the starwheel to the hole. Variation in the starwheel-to-hole distance is an indication of drum eccentricity and should not exceed 0.003 inch.

#### 4.10.1.4 Sensing Wheels

Wheels must pivot freely. Check for oxide deposit on pivots, and for proper lubrication. Sensing arm lever must move freely on its pivot shaft.

#### 4.10.1.5 Sensing Contacts

Contacts should seldom require adjustment. When trouble is suspected in this area, remember that there are several possible sources of trouble inside and outside the sensing unit that may make this adjustment erratic and unstable. Check the following points before adjusting the sensing contacts; it may save a callback.

1. Inspect straps and contact screw heads for pits and nodes.

2. Make certain that program drum shaft adjustable yoke is not loose.
3. Check for wear between end of shaft in program drum and hole in column indicator wheel that locates and seats drum.
4. Check for excessive play in the escapement gear train, while power is off.
5. Test friction drive torque.
6. Be sure that the plastic safety cover is installed over the terminals.

Service time on these contacts is greatly reduced if the method outlined in 4.10.2 is closely followed.

### 4.10.2 Sensing Assembly Adjustments

With the escapement armature stopping the escapement ratchet tooth and machine power on, a zero reference point is established at any single column of the program unit by using the timing tool, part 453160 (Figure 4-35). The use of millisecond (ms) notation instead of 1/12 of an escapement tooth is to aid in determining relationships of the program unit timing to the escapement during a skip operation and does not imply using an oscilloscope.

Perform operations in the order shown:

1. Set the starwheel tension when the contacts are changed.
2. Set the starwheel duration.
3. Use only a starwheel with the correct duration to set the forked arm/starwheel timing.

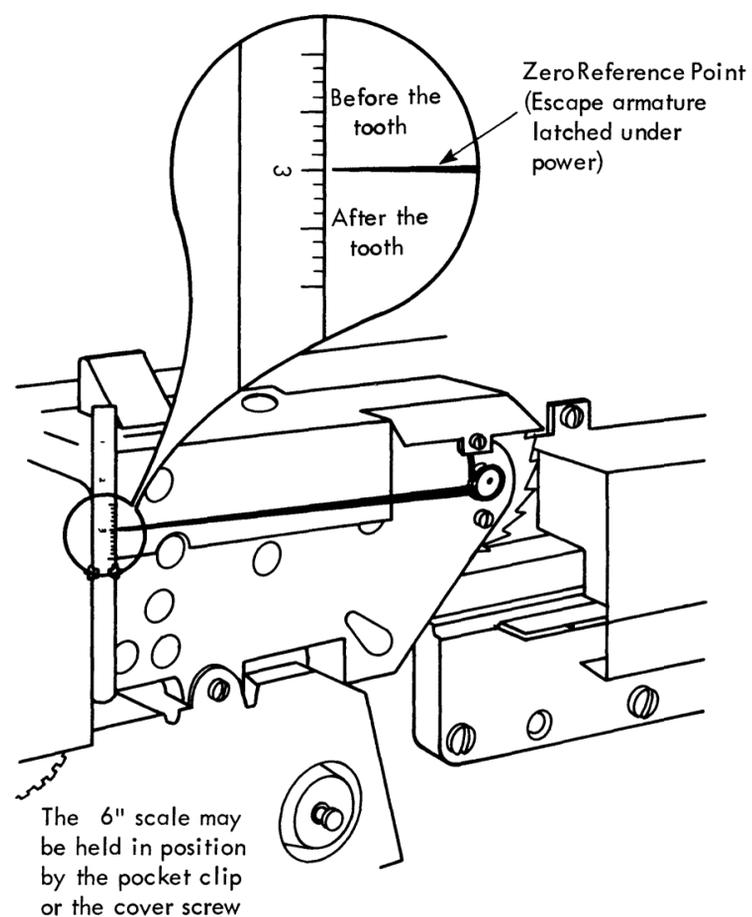


Figure 4-35. Timing Tool

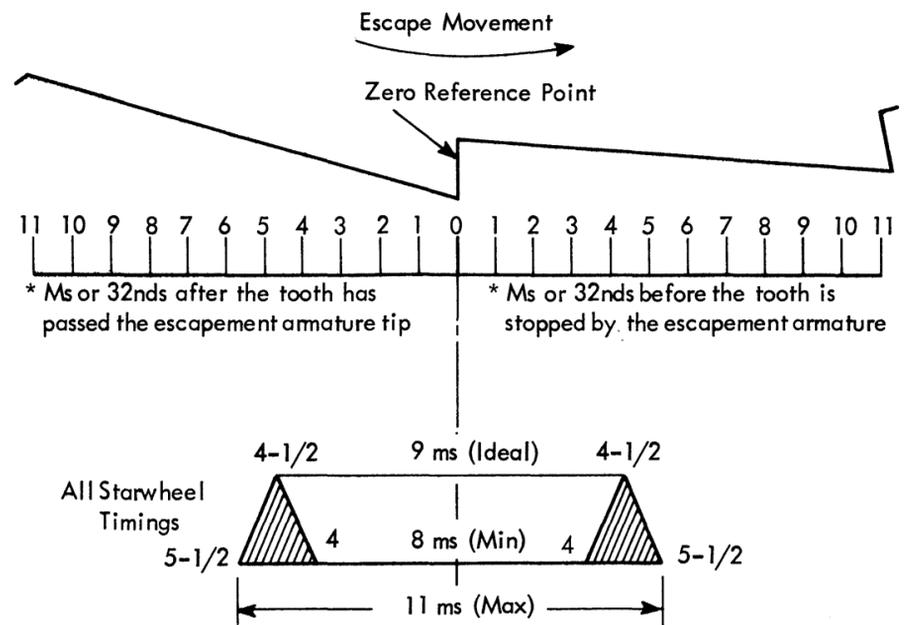
#### 4.10.2.1 Starwheel Tension

1. Adjust flat-tip strap type contacts for 50-gram to 60-gram contact pressure, measured at the starwheel hub, to lift each starwheel off the program card.
2. Adjust barrel-tip strap type contacts for 35-gram to 45-gram pressure measured in the same manner as the flat-tip strap type.

#### 4.10.2.2 Starwheel Duration

Prepare a program card with each digit punched in every other column. Check registration with a card gage.

1. Remove common wire and all starwheel wires (12 through 9).
2. Using R x 10 scale, connect an ohmmeter between starwheel common and 11-starwheel contact.
3. Set timing tool and 6-inch scale as shown in Figure 4-35.
4. With the 11-starwheel fully seated in a hole near column 40 of the program card, rotate the escapement wheel in both directions. Adjust the 11-starwheel contact for 9-ms duration as shown in Figure 4-36. (This is a dynamic adjustment requiring motor drive.) Figure 4-37 is a guide for holding the escapement wheel while making this adjustment.
5. The remaining starwheels are adjusted to a meter reading. To calibrate the meter, remove the fiber



\* Use timing tool, part 453160

Figure 4-36. Program Unit Timing Chart

escapement armature return pin and note the meter reading. Adjust the duration of the remaining starwheels to match the meter reading of the 11-starwheel contact. Replace the fiber escapement armature return pin when adjustments are complete.

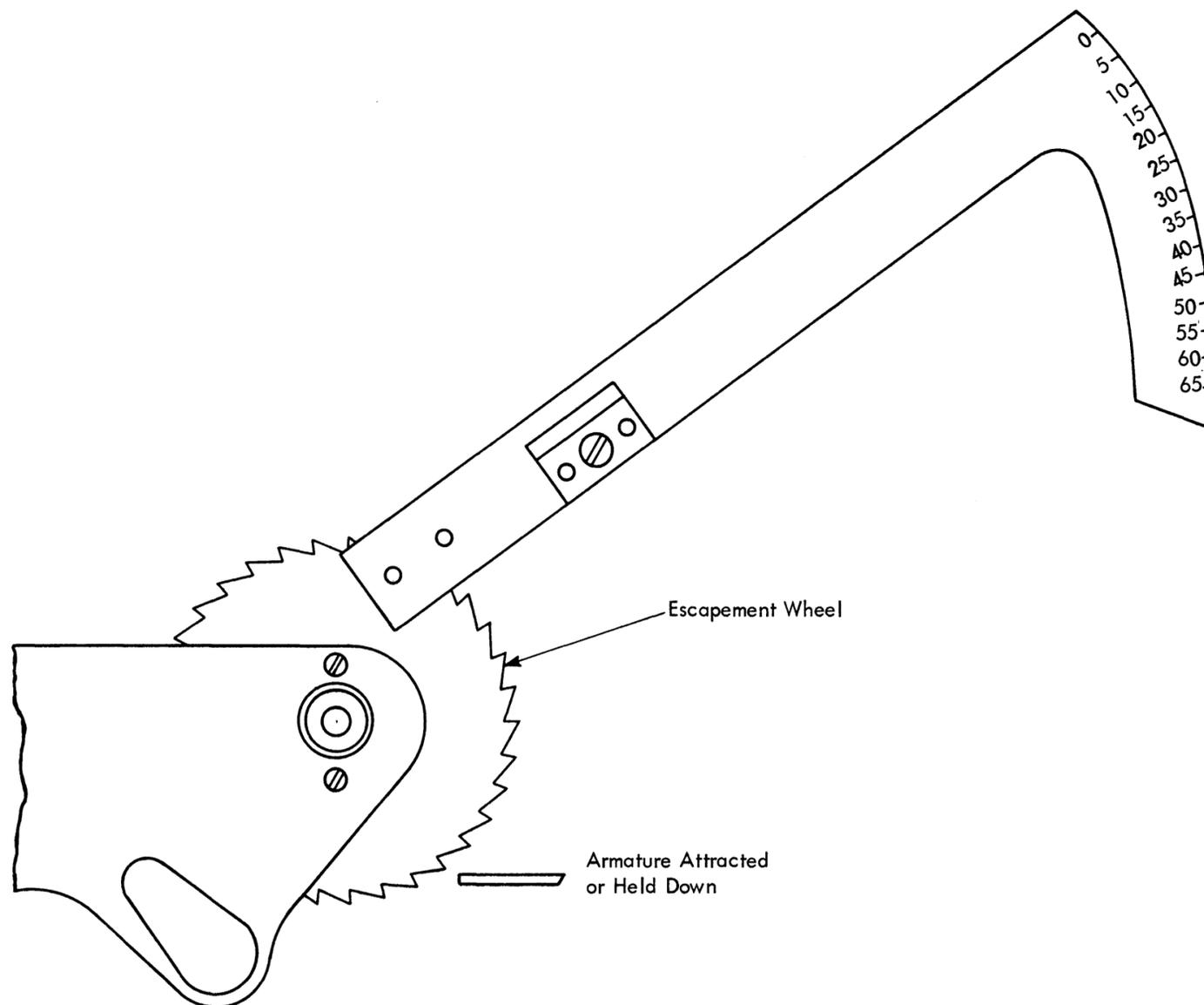


Figure 4-37. Method of Holding Escapement Wheel

#### **4.10.2.3 Starwheel Timing**

Using the same program card as that used in adjusting starwheel duration, locate an 11-hole near column 40. Center the 11-starwheel timing by adjusting the forked arm for 4.5-ms duration on both sides of the escapement wheel tooth as shown in Figures 4-35 and 4-36. (This is a dynamic adjustment requiring motor drive.) Figure 4-37 is a guide for holding the escapement wheel while making the adjustment. Timing the 11-starwheel automatically times the remaining starwheels.

#### **4.10.3 Sensing Assembly Removal and Replacement**

##### **4.10.3.1 Program Sensing Unit**

Remove program sensing unit as an assembly by taking out the two screws holding unit to base casting. On machines where plastic top plate that supports sensing wheel arms is not pinned, scribe a line along its left edge to ensure proper relocation; contact duration and timing are easily lost by removing the top plate. When assembly is reinstalled on base, the shoulder on sensing unit should seat firmly on base; a locator pin ensures proper lateral placement. Check timing of contacts after reinstalling unit.

##### **4.10.3.2 Sensing Contact Straps**

Loosen the common plate screws so that tension is taken off contacts. Be careful not to bend contacts while removing or installing.

##### **4.10.3.3 Program Shaft Assembly**

No timing need be observed when installing a program shaft assembly. When installing auxiliary duplicate assembly, it must be timed to the program index. Punch a card in column 1 and place it on the auxiliary drum. With program index at column 1, install unit with starwheels reading column 1.

#### **4.10.4 Program Cam Contacts Service Check**

With power on and the program drum in column 1, use feeler gages and place 0.070 inch between the escape-armature tip and the escape-wheel tooth. The contact should be made. Place 0.042 inch between the armature tip and escape-wheel tooth; the contact should be open.

*Note:* To allow reverse drum motion, hold contact operating arms clear of PCC cam.

#### **4.10.5 Program Cam Contacts Adjustment**

The contacts are to be timed according to the timing on the wiring diagram. Timing is set by the adjustable program cam (Figure 4-38).

#### **4.10.6 Program Drum Interlock Arm (Split Hub) Adjustment**

1. Raise starwheels.
2. Rotate interlock arm on serrated shaft to operate program handle switches with 0.002-inch to 0.005-inch travel remaining before switch plungers bottom.
3. Lower starwheels.
4. Position interlock arm along the serrated shaft for 0.015-inch to 0.020-inch clearance to the top of the program drum.

### **4.11 PRINT UNIT**

#### **4.11.1 Print Assembly Service Checks**

##### **4.11.1.1 Code Plate Lubrication**

Keep oil or grease away from back of code plate because they cause printing failures.

##### **4.11.1.2 Code Plate Projections**

Broken or missing projections can be determined easily for one specific character. A test of other characters will usually determine if it is a shifting error or a bind.

##### **4.11.1.3 Code Plate Return Springs**

If the machine is run without plunger, broken wires or code plate projections occur.

##### **4.11.1.4 Code Plate Shifting Test**

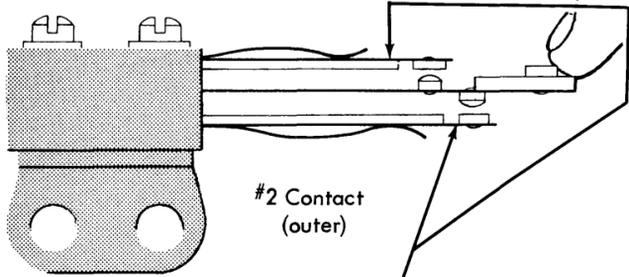
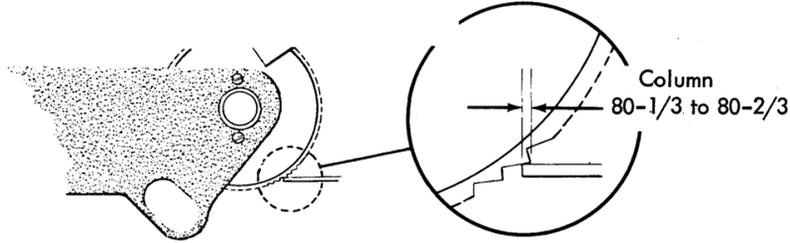
To determine which way the code plate should be shifted for correct printing, place overlay (Figure 4-39) over code plate chart Figure 4-40 and shift it for a particular character.

If printing troubles occur, this method may help determine whether the trouble is broken wires, damaged code plate, or improper code plate shifting.

①

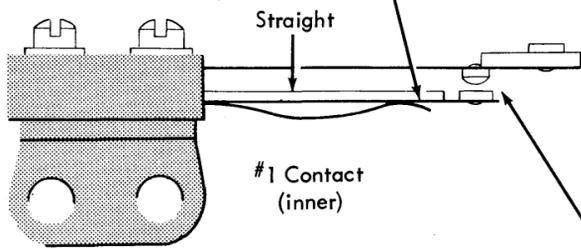
Register a card. Space to column 80. Hold escape wheel as below. Punch a key. Watch for the timing of the card to card skip as controlled by the #1 contact.

Refer to the machine wiring diagram to check or readjust the program cam contact timings.

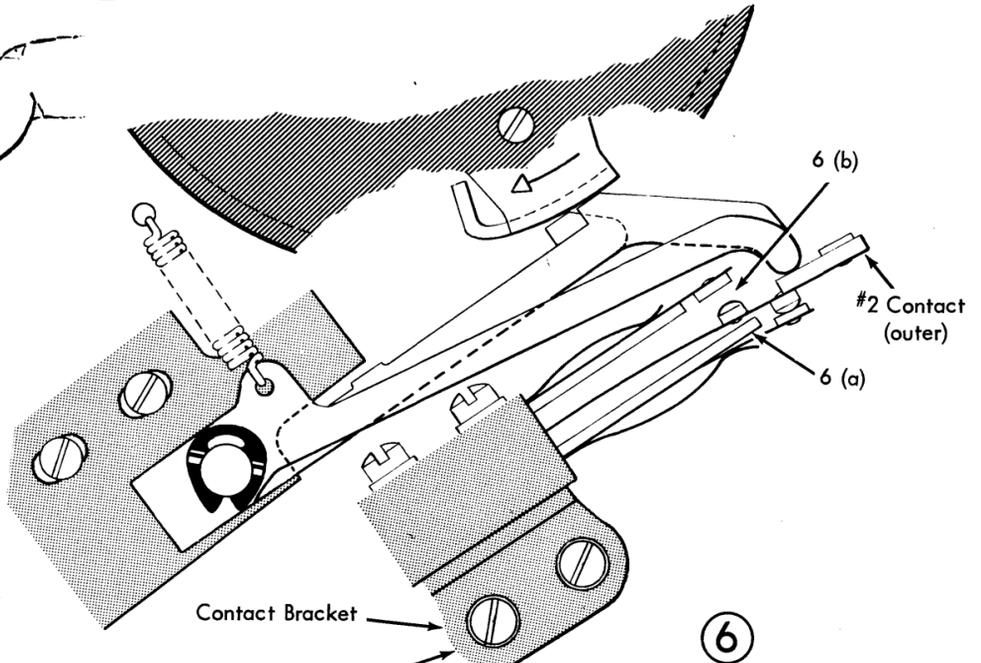


②

15 grams minimum towards support strap.



③ 0.035" to 0.055" air gap (#1 contact only). Form operating strap.



⑤

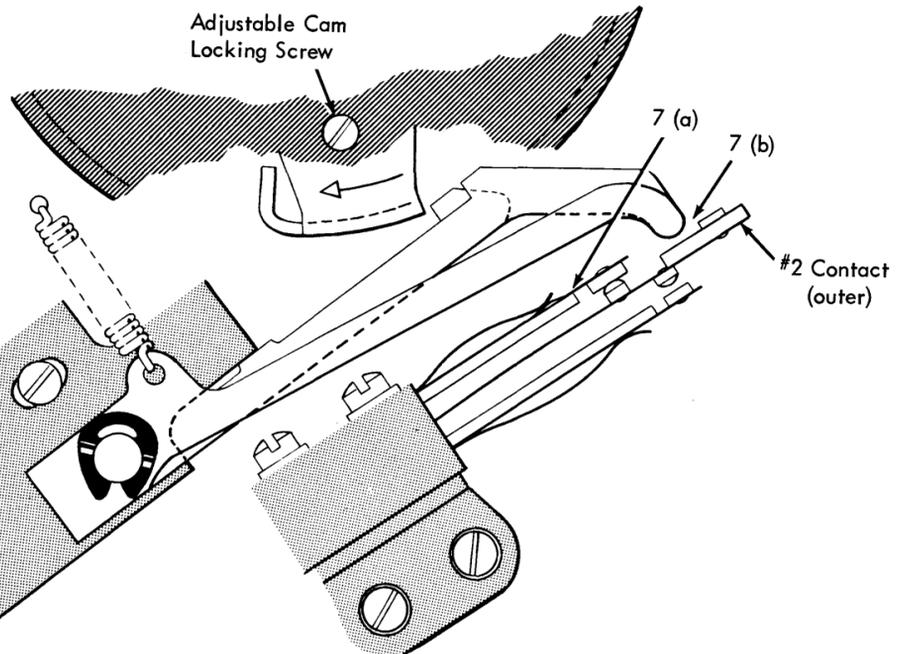
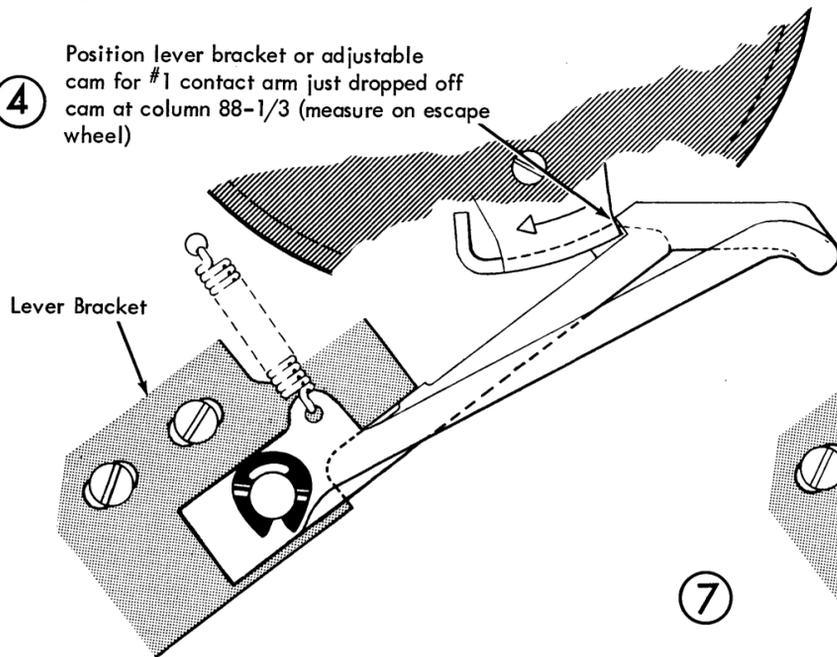
To obtain proper make time, position contact bracket with program index at column 86 for a 0.015" to 0.025" rise of #1 contact stationary strap from its support strap.

At column 86, form the support straps of the #2 contact for:  
(a) 0.015" to 0.025" rise of the NO contact from its support strap.  
(b) 0.020" minimum air gap of the NC contact.

This will result in the proper make timing of the #2 contact.

④

Position lever bracket or adjustable cam for #1 contact arm just dropped off cam at column 88-1/3 (measure on escape wheel)



⑦

At column 1:

- (a) Adjust the tension on #2 contact operated strap for 0.005" to 0.025" rise of the NC contact from its support.
- (b) Turn the lever bracket for 0.015" clearance (#2 contact only) of the arm to the contact pad.

Figure 4-38. Program Cam Contact Adjustment

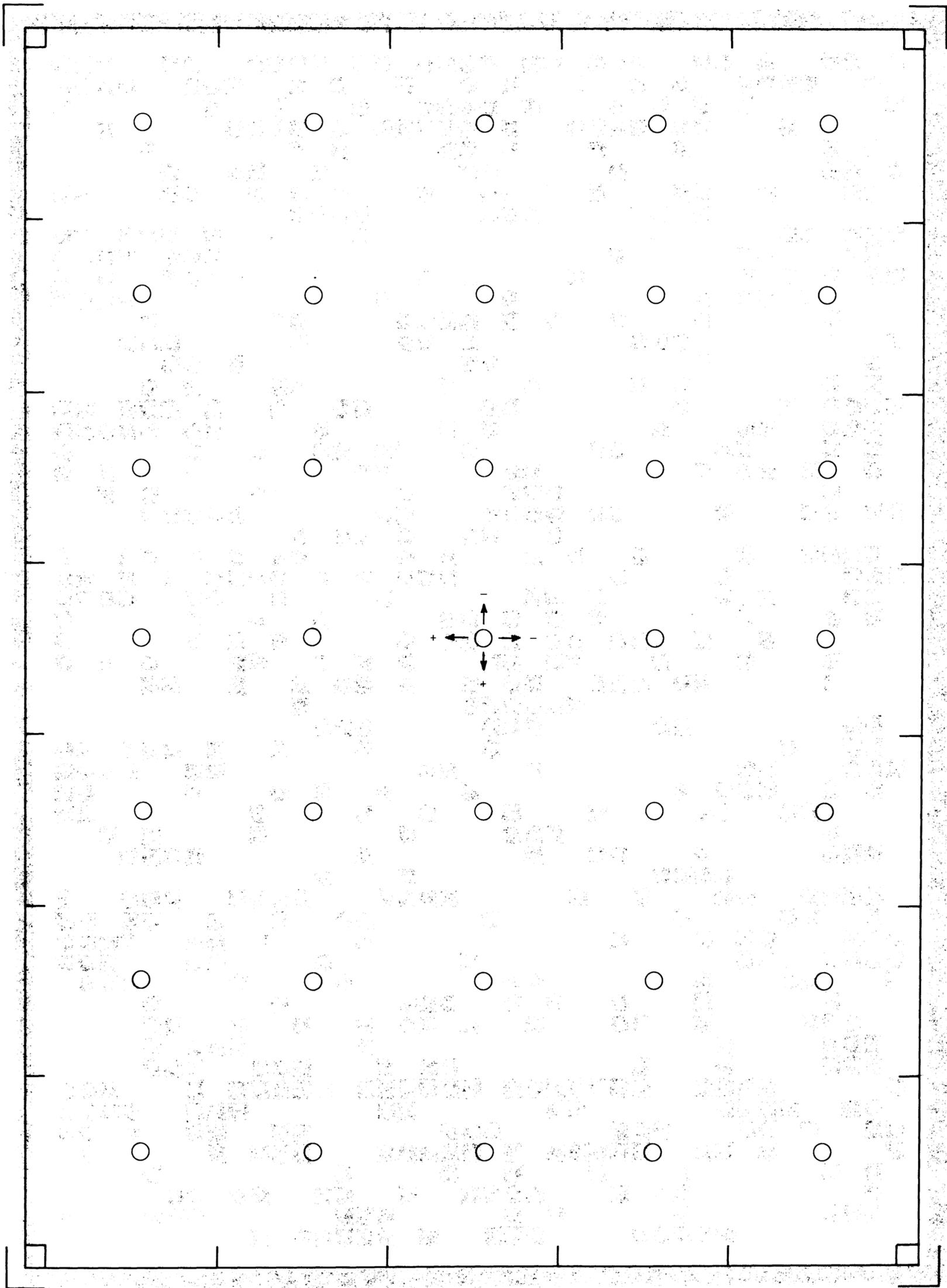
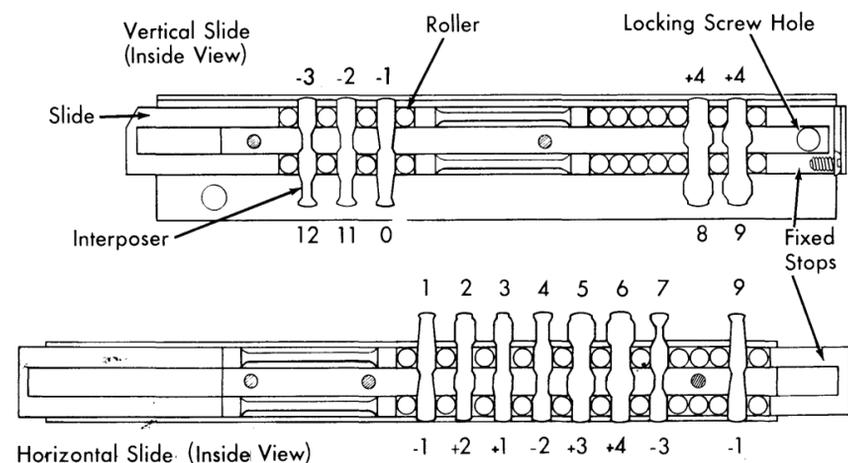


Figure 4-39. Overlay for Figure 4-40



#### 4.11.1.5 Printing Interposers

Figure 4-41 shows the location of the print interposers, rollers, and slides. Each unit of cam action equals 0.020-inch motion to its slide. A -1 cam has a 0.010-inch cut from both sides of the interposer, resulting in a 0.020-inch motion. A +4 interposer moves the slide 0.080 inch. Use Figure 4-41 as a guide to reassemble the print interposer assembly. The + or - values are etched on the interposer faces. (The ratio of motion of the slides to the code plate is 10 to 11.)



● Figure 4-41. Print Interposer Assembly

#### 4.11.2 Print Assembly Adjustments

Adjustment of one component unit often affects another unit. Units should be adjusted in the order in which they appear in the following text.

##### 4.11.2.1 Punch Drive and Print Yoke

Clearance between the yokes and guides should be 0.015 inch to 0.020 inch (Figure 4-42); it is obtained by adjusting the punch drive unit. This clearance causes rollers to contact print interposers a minimum of 0.015 inch above the start of cam action. Because the clearance cannot be measured, it is obtained as follows:

1. Oil (IBM # 6) the print interposers.
2. Remove belt guard and punch drive belt to remove tension on drive unit.
3. Loosen the two screws in the pin bail drive link.
4. Loosen the adjusting screw lock nut, holding screw, and two support screws in the drive anchor bar (Figure 4-29). Unhook the print drive spring.
5. Rotate the drive unit counterclockwise with the punch clutch latched until yokes can be felt to bottom on their inner guides. Turn the adjusting screw in until it touches the casting; back off 1 to 1-1/2 turns maximum and tighten the lock nut and holding screw. The two support screws should be turned in until they rest against side frames.
6. Reassemble the machine and test punch penetration with standard codes.

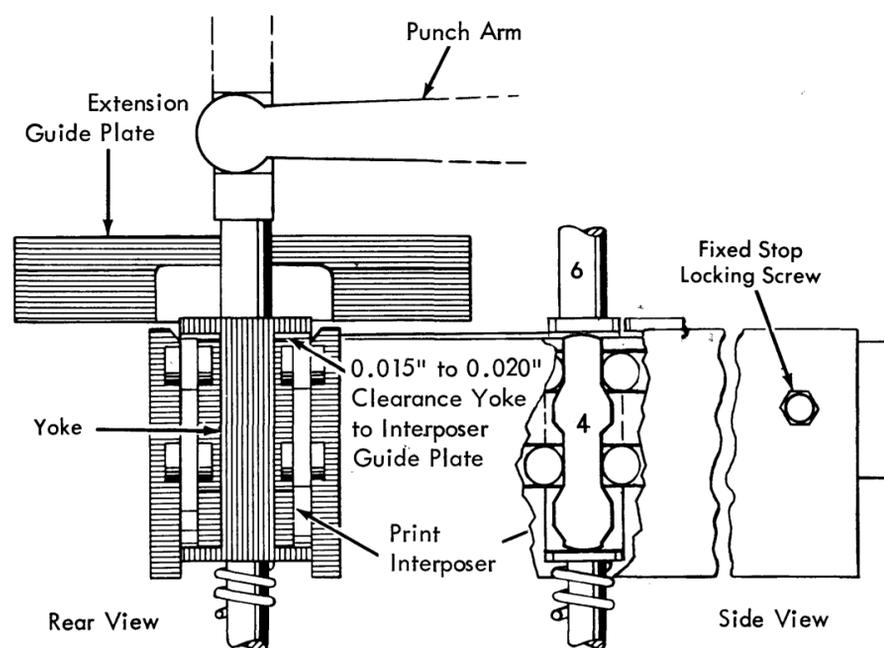


Figure 4-42. Punch Drive and Yoke Adjustment

*Note:* Extend and tighten the pin bail drive link during reassembly.

##### 4.11.2.2 Code Plate Clearance

1. Start with one 0.003-inch shim (part 305243) and two 0.007-inch shims (part 228296) between the pressure plate and the shim retaining plate (Figure 4-43).

*Note:* No oil or grease should be on the code plate or shim retaining plate because shifting troubles occur.

2. Turn the three large pressure plate adjusting nuts counterclockwise until snug (Figure 4-43). Lock them in this position.
3. Check for code plate clearance to wires of 0.028 inch to 0.030 inch. Add or remove code plate shims if necessary.

##### 4.11.2.3 Code Plate Alignment (Figures 4-44 through 4-47)

#### CAUTION

Failure to loosen locking screws during alignment may result in sheared adjustment screws.

1. Code plate is aligned with the punch clutch latched up. Loosen screws on the vertical drive rod guide plate (Figure 4-45).
2. Loosen stop-adjustment locking screws and back off horizontal and vertical stop-adjusting screws (Figure 4-44).
3. Unhook horizontal shift spring. Take tension off vertical shift spring by backing off knurled thumbscrew (Figure 4-45). Tighten the locking nut.
4. Insert code plate aligning tools.
5. Position both vertical drive studs within the code plate slots and tighten the locking screws of the vertical drive rod guide plate (Figure 4-45).

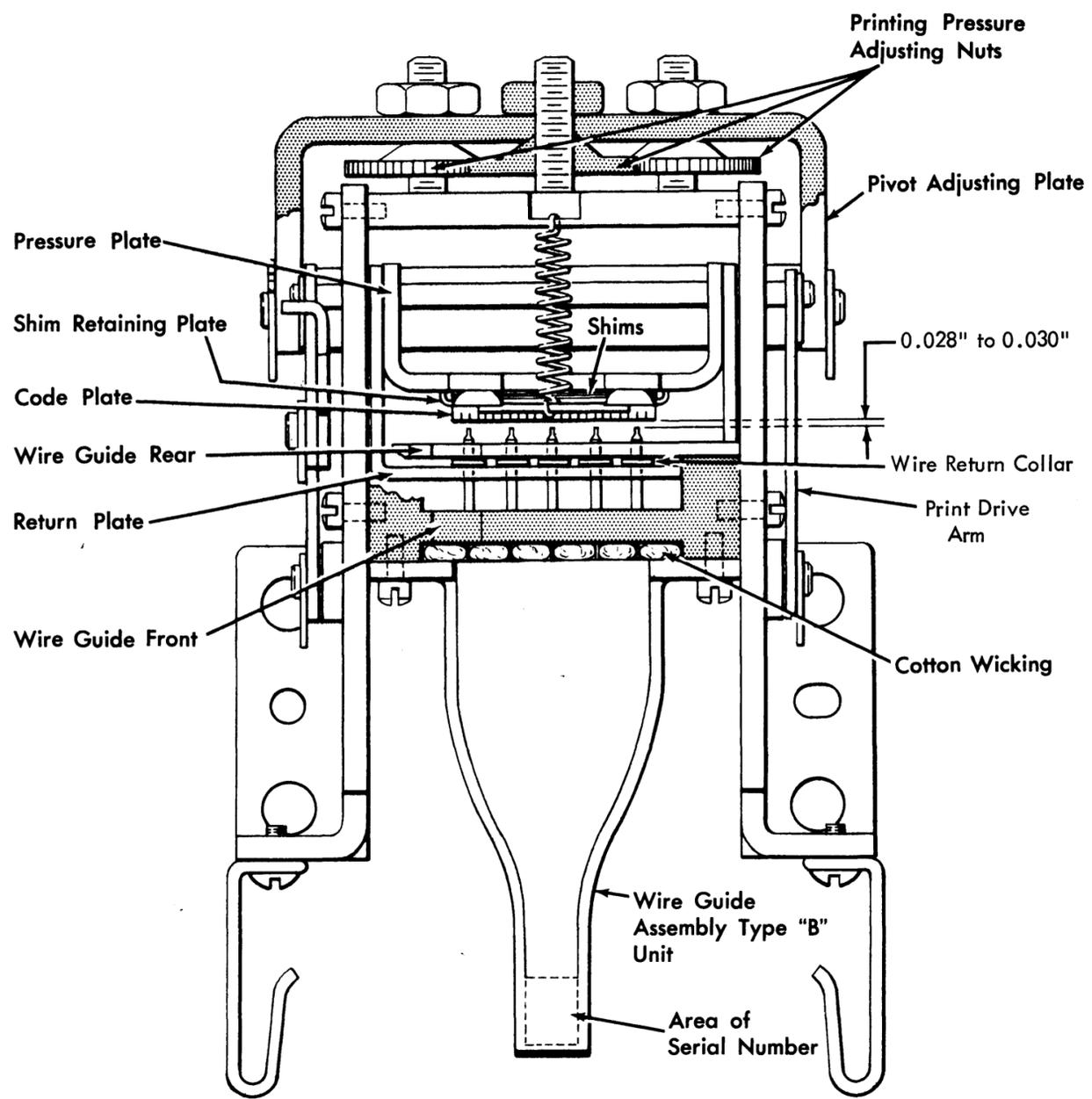


Figure 4-43. Printing Adjustment

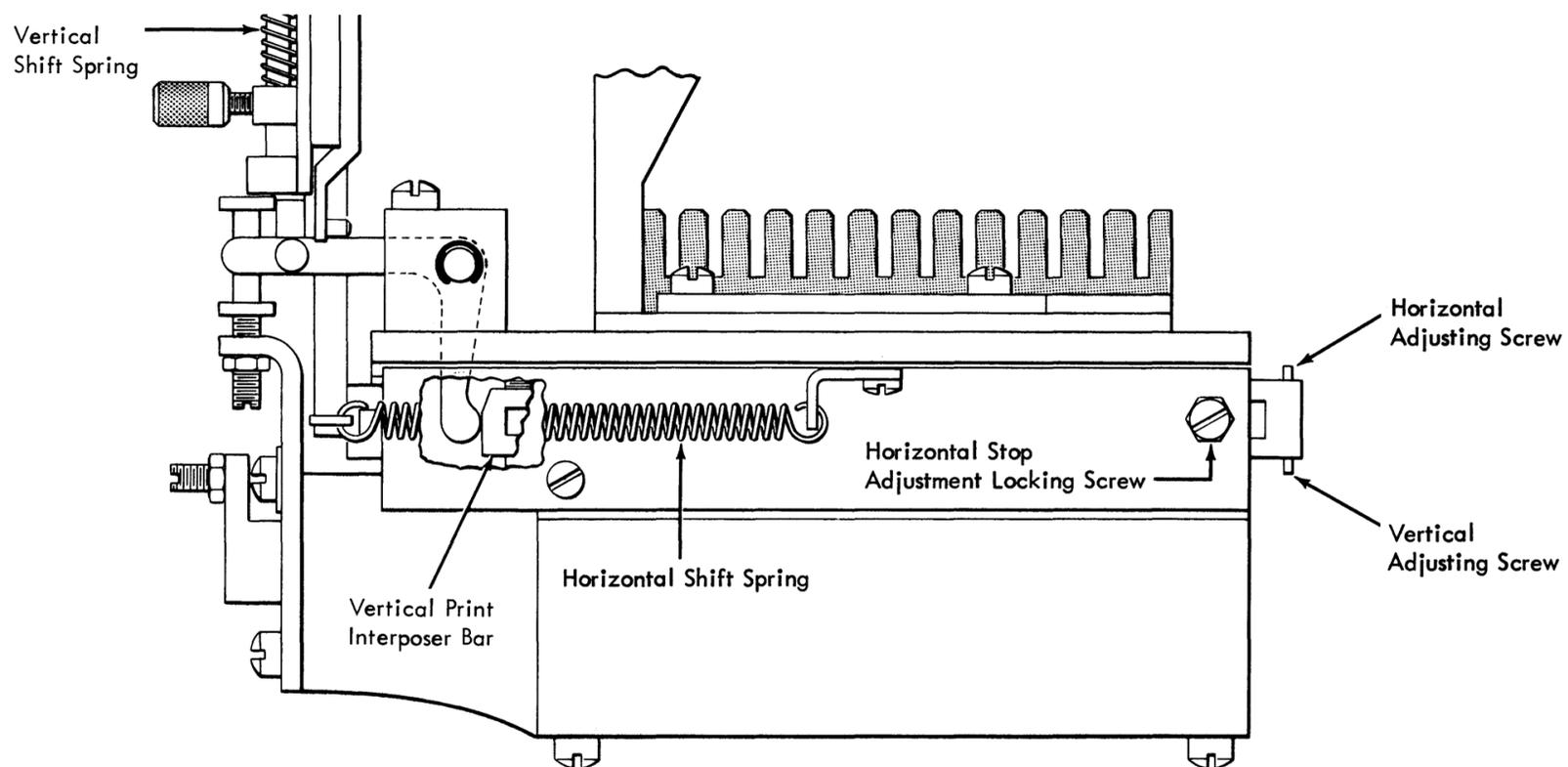
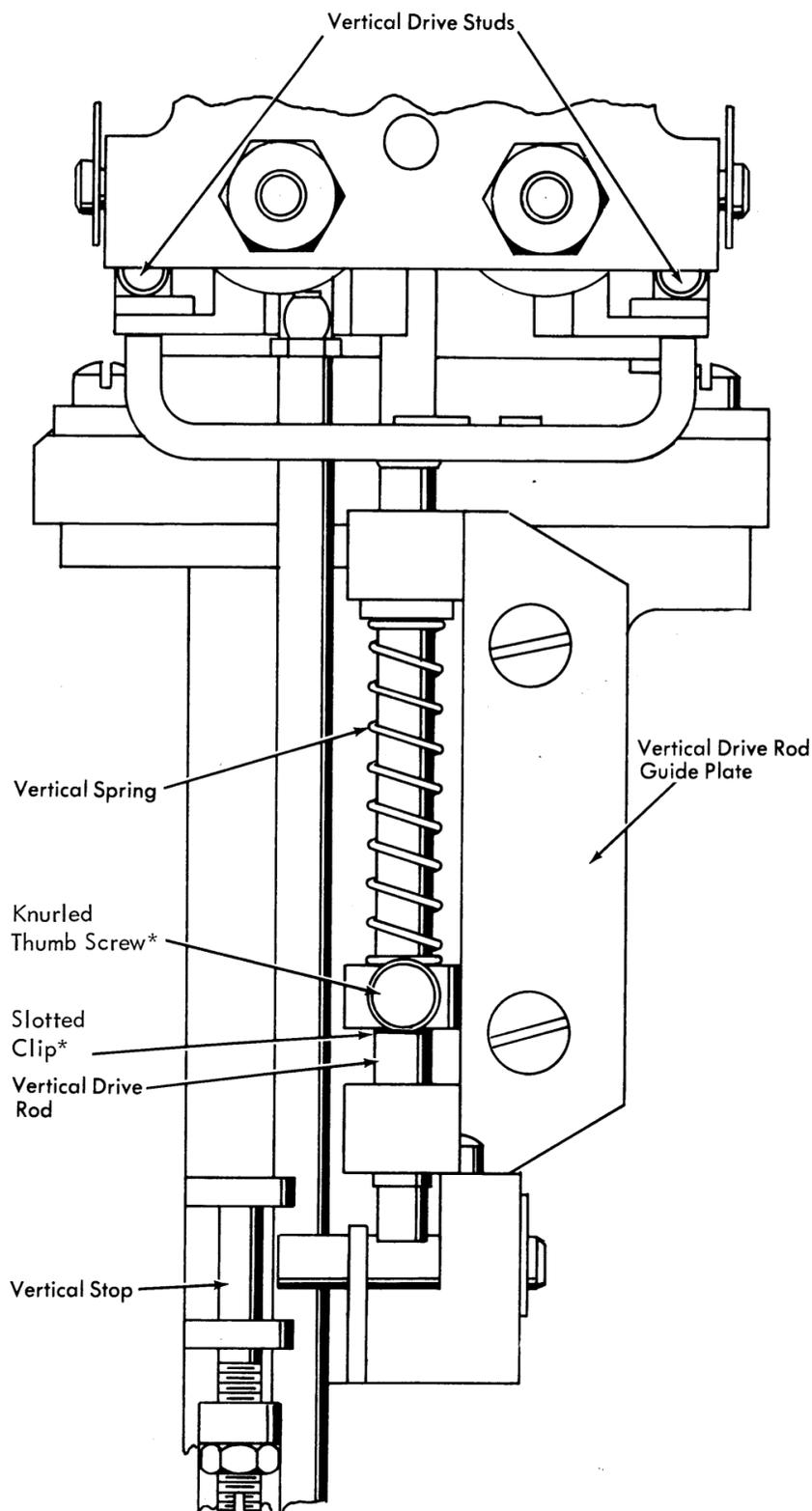


Figure 4-44. Print Interposer Assembly



\* Slotted clip replaces knurled thumb screw on later machines.

Figure 4-45. Vertical Drive Rod Assembly

6. Hook up the horizontal shift spring and turn the horizontal adjusting screw (on left from front of machine) until the code plate aligning rods are free.
7. Restore tension to the vertical shift spring and tighten the knurled screw into the groove in the vertical drive rod. Turn the vertical adjusting screw until the code plate aligning tools are free.
8. Remove the aligning tools.

Figures 4-46 and 4-47 show wires used for printing each character; they can be used to determine when extra wires are being picked up during printing. If extra wires are

printed, refine the code plate alignment (without code plate stops) as follows:

1. Position the code plate with the aligning tool, as done in preceding steps, and tighten the locking screws.
2. Adjust the vertical position of the code plate by printing an 8. Loosen the vertical locking screw, and turn the vertical adjusting screw clockwise until unwanted dots appear. Mark this position. Turn adjusting screw counterclockwise past a clear 8 until unwanted dots reappear. Mark this position. Turn adjusting screw to a point midway between these two positions and tighten the locking screw.
3. Adjust the horizontal position of the code plate by printing a 6. Loosen the horizontal locking screw and turn the horizontal adjusting screw clockwise until unwanted dots appear. Mark this position. Turn adjusting screw counterclockwise past a clear 6, until unwanted dots reappear. Mark this position. Turn the adjusting screw to a point midway between these two positions and tighten the locking screw.
4. Check to see that the code plate is in true alignment with the vertical rows of print wires. Loosen the horizontal locking screw. While printing a 3, slowly turn the adjusting screw counterclockwise. If alignment is true, all dots will disappear simultaneously because the code plate is being moved to its neutral position. If a corner of the number disappears first, readjust the vertical guide-plate bracket using the aligning tool. If this is done, it will be necessary to repeat steps 2 and 3.

#### 4.11.2.4 Code Plate Stops

1. Adjust the bracket so that the horizontal stop clears the stud on the horizontal shift lever, and the vertical stop is parallel to the end of the stud on the vertical shift lever. Tighten the screws.
2. Turn both adjustable stops to get clearance between stops and studs of 1/8 inch in the plus direction. The stud is then nearly centered between stops.
3. Unhook the heavy spring to the print cam follower. Set punch index at 133 degrees.
4. Remove the cover from punch extensions and manually push punch 6 to the extreme upward position. Turn the adjustable stop to just touch the horizontal shift lever stud. Tighten the locking nut.
5. To adjust the vertical stop, manually push punch 8 to the extreme upward position. Turn the adjustable stop to just touch the vertical shift lever stud. Tighten the locking nut.

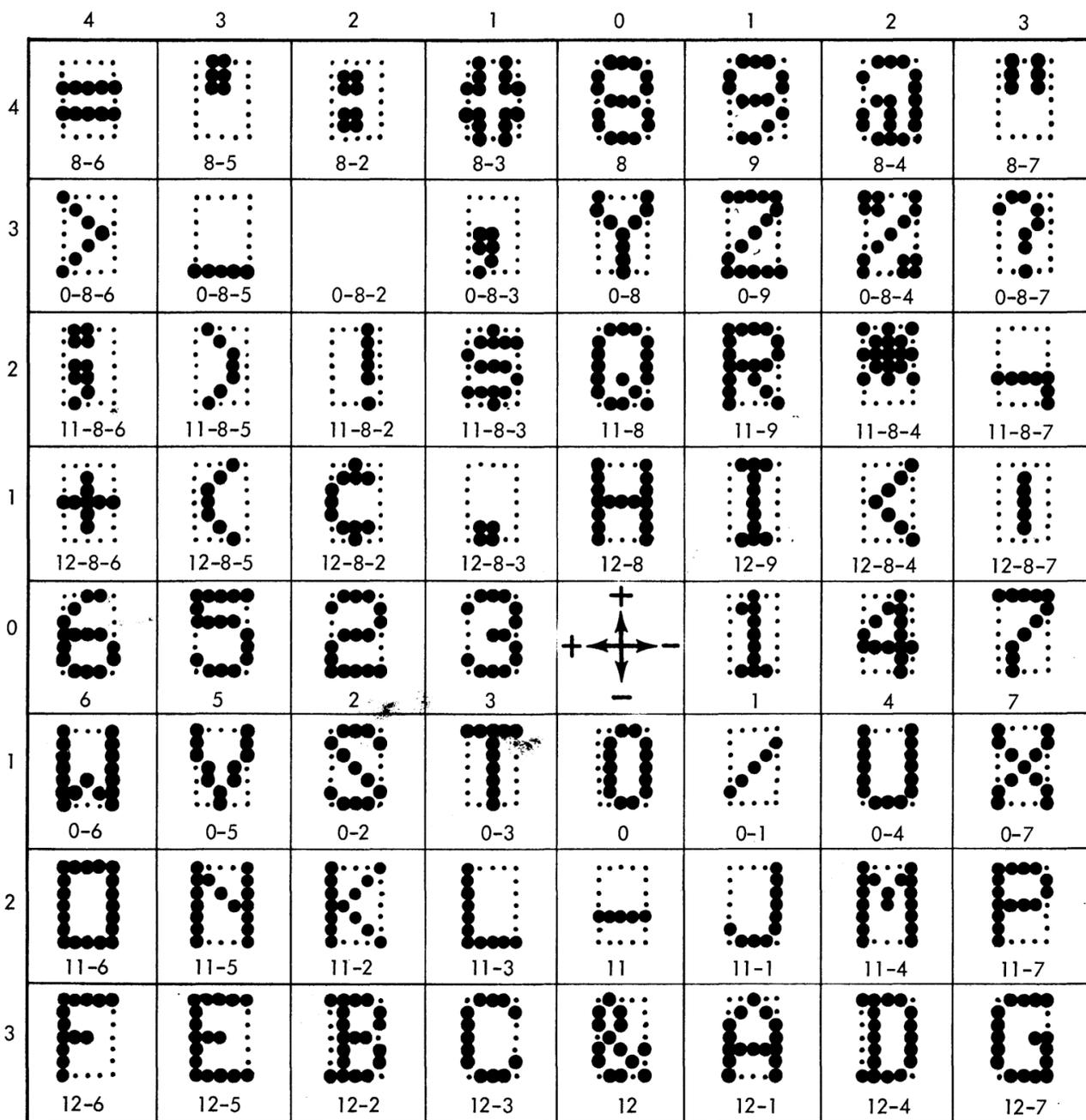


Figure 4-46. Character Patterns E'L'

	4	3	2	1	0	1	2	3
4	8-6	8-5	8-2	8-3	8	9	8-4	8-7
3	0-8-6	0-8-5	0-8-2	0-8-3	0-8	0-9	0-8-4	0-8-7
2	11-8-6	11-8-5	11-8-2	11-8-3	11-8	11-9	11-8-4	11-8-7
1	12-8-6	12-8-5	12-8-2	12-8-3	12-8	12-9	12-8-4	12-8-7
0	6	5	2	3	+ - +	1	4	7
1	0-6	0-5	0-2	0-3	0	0-1	0-4	0-7
2	11-6	11-5	11-2	11-3	11	11-1	11-4	11-7
3	12-6	12-5	12-2	12-3	12	12-1	12-4	12-7

Figure 4-47. Character Patterns E'A'

6. Check under power by duplicating punches shown in Figure 4-48. Correct setting of the code plate stops prints the characters shown.
7. Stops must be checked and readjusted each time the blank position of the code plate is altered.

#### 4.11.2.5 Printing Pressure

1. Turn in evenly on the three adjusting nuts (Figure 4-43), 1/4 turn at a time, until printing is obtained. Tighten lock nuts after each step and space before punching to prevent damage to wires. A practical test to show uneven printing can be obtained by disengaging the ribbon feed pawl and printing an H until the printing grows faint. Too much printing pressure will make the machine noisy and cause marks to appear when spacing.
2. Print arm roller (Figure 4-49) must be free to lift 0.010 inch off the cam during print suppression to reduce noise and wear on the cam. Check clearance with print drive spring removed. The lifting motion drives wire collars 0.005 inch closer to the wire guide plate than

their normal return after printing. If necessary, remove code plate shims and readjust printing pressure to maintain enough clearance to prevent wire return collars from striking wire-guide rear (Figure 4-43). Code-plate-to-wire clearance should now be 0.028 inch to 0.030 inch.

#### 4.11.3 Print Assembly Removal and Replacement

##### 4.11.3.1 Print Head

1. Remove the ribbon spools. Slip them together and tape them to the bed plate. Leave the ribbon under the die.
2. Unscrew the gear at the upper end of the flexible shaft (left-hand thread) if installed.
3. Pull the print drive rod (Figure 4-50) out of the print arm. (On some units, it may be easier to remove the right horseshoe clip and slide the drive rod over, instead of disconnecting the drive rod from the stud.) Remove the four screws holding the print head to the stripper; lift the print head off the guide pins and completely off the base.

Punches	Direction		Character
	Horizontal	Vertical	
6	+4		
8		+4	
7	-3		
12,0		-4	

Figure 4-48. Test Patterns

#### 4.11.3.2 Print Wire Unit

1. Pull the three clips (Figure 4-50) and withdraw the three shafts.
2. Note the position of the pressure plate for reassembly. The end with the wide cut-out portion goes toward the ribbon feed unit.
3. Remove the two screws (B, Figure 4-50) from each side. Note that the adjusting screw plate assembly will pivot slightly around its two dowel screws.
4. Remove the pressure plate operating linkage.
5. After reassembly, the impression may be lighter at one end of the character. To correct this condition, first try shifting the adjusting screw plate. If the condition is not corrected, repeat the adjustment procedure.

**Print Wire:** Single wires can be replaced. Be sure that the collar portion of the wire, which extends through the guide plate, is the same size as the one being replaced.

#### CAUTION

Do not disturb the cotton wicking around the print wires.

1. Remove the four holding screws and lift off the rear wire-guide plate (Figure 4-43).

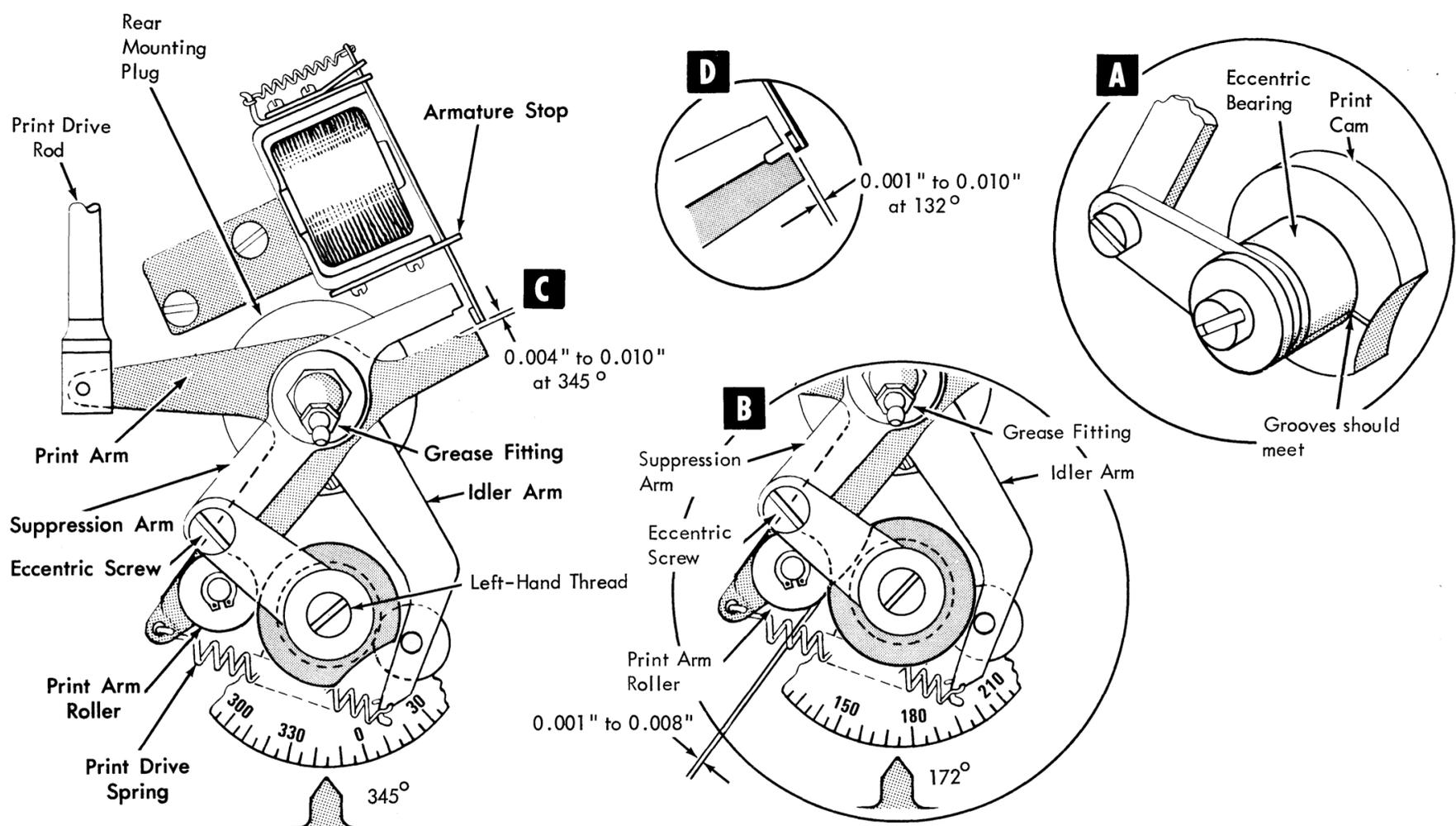
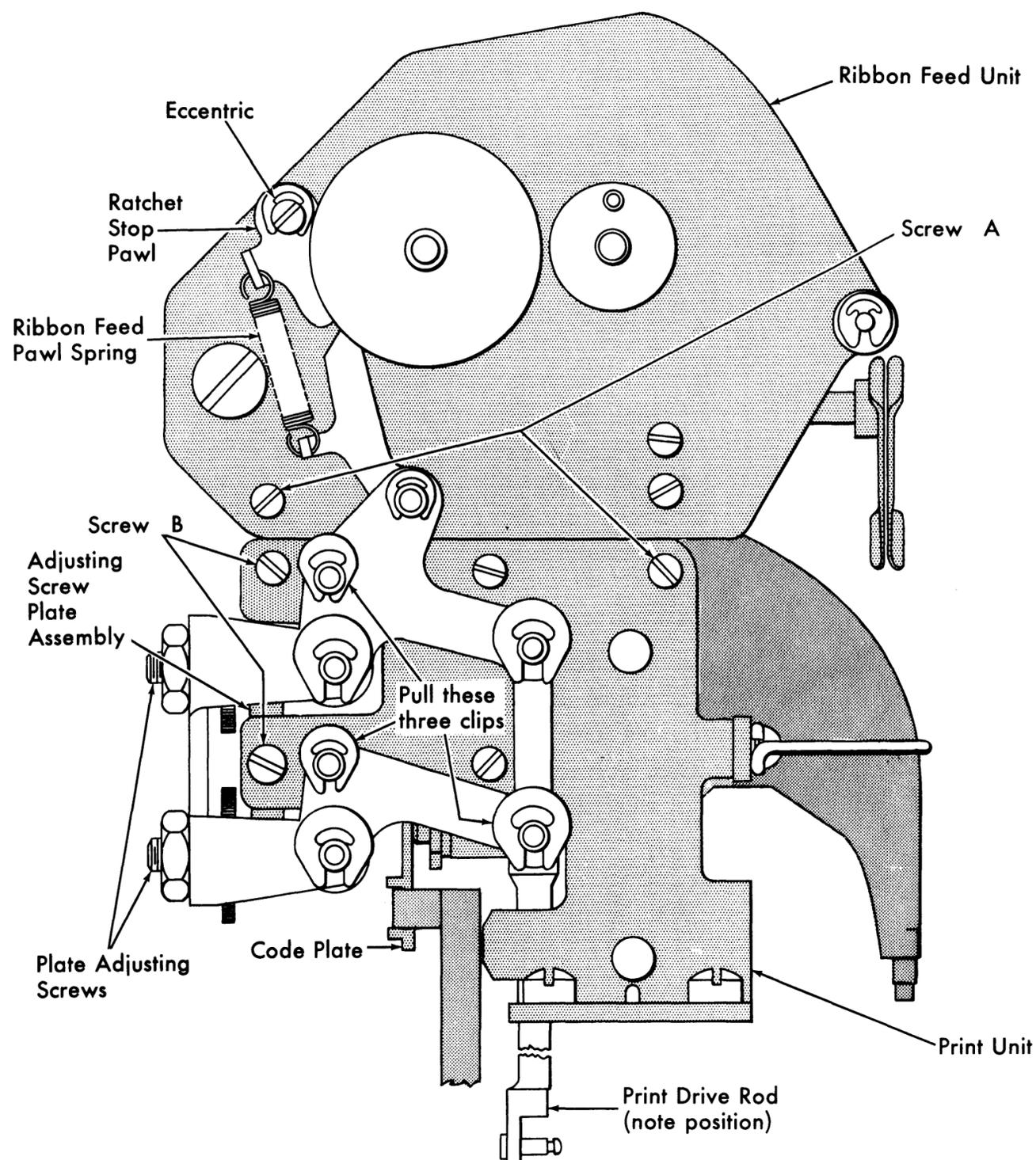


Figure 4-49. Print Drive Unit



● Figure 4-50. Print Head Removal

2. Pull out the desired wire for inspection. Be sure to replace it in the same position; all wires have a different length. If the print wire has been pulled out of its head, a new wire may be inserted from the front end and the old wire pushed up enough to pull it out.

*Note:* Apply IBM #6 oil to any print wire before installing it in the print unit. Usually a new wire can be installed without difficulty by inserting it in the hole from which the old wire was removed. Lightly stone the edge of the new wire to remove any burrs. Do not make the wire pointed. If trouble occurs, it is then necessary to insert another wire, used as a guide, from the front end. In this procedure, the end of the new wire should be pointed. (If a new wire is used as a guide, stone its end flat.) Then, using the first wire as a guide, push the new wire into the unit as shown in Figure 4-51. Reinstall the rear guide plate and pull all wires

back against it. Cut off the end of the wire as close as possible to the wire guide and carefully stone it even with the other wires. Oil the cotton wicking with IBM #6.

#### 4.11.3.3 Code Plate

1. Remove the print head from the machine.
2. Unhook the ribbon feed pawl spring. Remove the two screws (A, Figure 4-50) from each side.
3. Remove the ribbon feed unit by lifting it off the print unit.
4. Remove the two vertical shift plate guide studs and the vertical shift plate.
5. Set the print unit on the plate adjusting screws; this prevents the code plate shims from getting out of place.

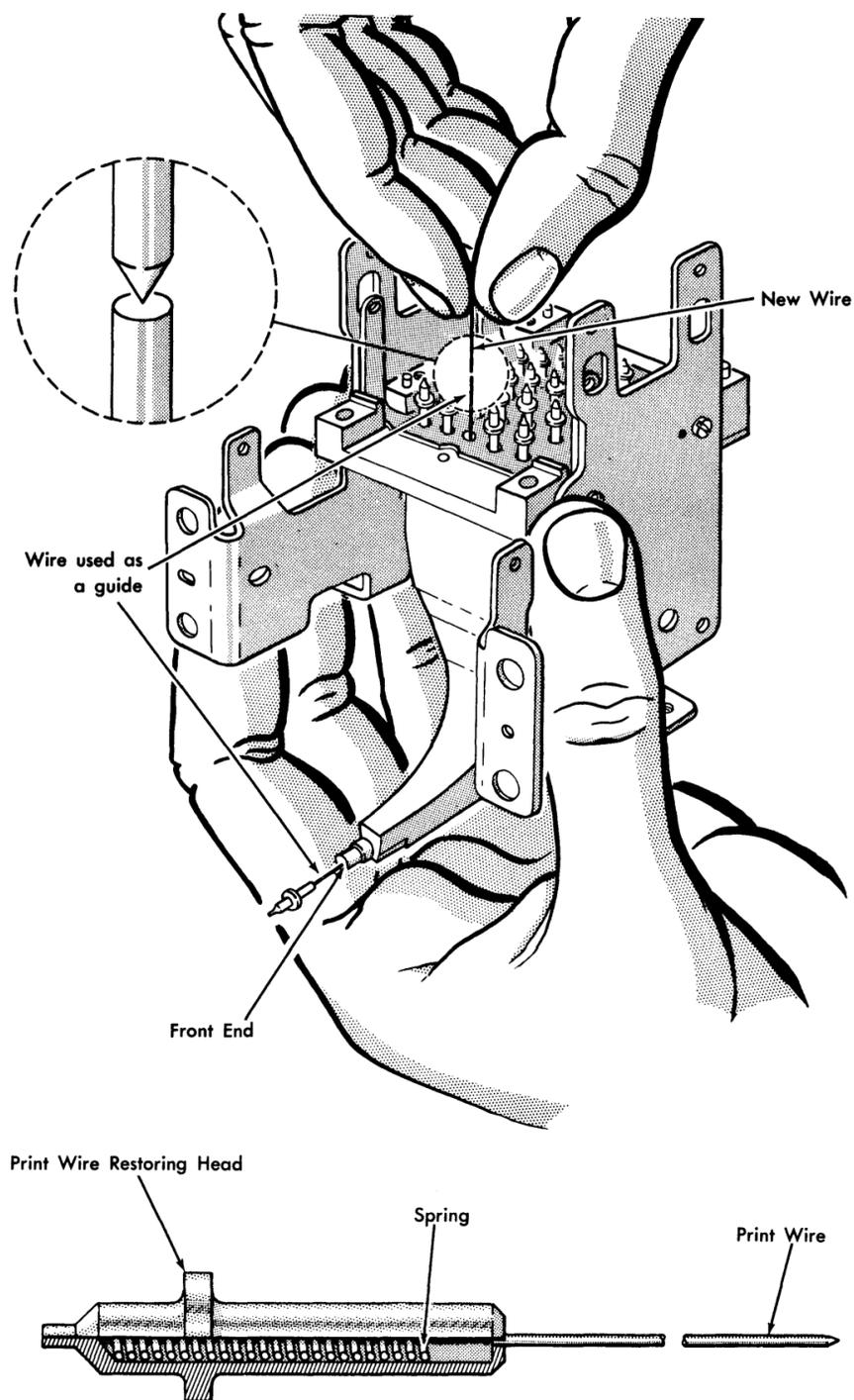


Figure 4-51. Print Wire Replacement

- Unhook the code plate return springs. To prevent damage to the print wires, move the pressure plate back away from them. The code plate may now be withdrawn.

**CAUTION**

When reinstalling the code plate, see that the shims do not get out of position. Keep oil and grease off the code plate back and shim-retaining plate to prevent shifting troubles. When replacing the code plate return plungers, replace the plungers in matched pairs only; they must be balanced within 10 grams of each other.

**4.11.4 Ribbon Feed Pawl Adjustment**

Adjust the ratchet stop pawl eccentric to cause ribbon feed pawl to feed one tooth per print cycle.

**4.11.5 Print Drive Adjustment**

- Loosen the left-hand thread screw (Figure 4-49) at the rear of the punch shaft and position the eccentric to align its groove with the mark on the print cam (A, Figure 4-49).
- Trip the punch clutch while holding the print suppression armature attracted and rotate the punch shaft to 172 degrees on the index. Adjust eccentric screw for 0.001-inch to 0.008-inch clearance between the print cam and the print arm roller (B, Figure 4-49). Rotate the punch shaft through the rest of the cycle and note that the print arm roller does not touch the print cam before 180 degrees on the index.
- Unhook the print spring and make sure that the print arm roller can be lifted 0.010 inch off the cam. If the clearance is unobtainable, check step 2 of 4.11.2.5.

**4.11.6 Print Suppress Magnet Adjustment**

- Armature should be flat within 0.005 inch (Figure 4-52).
- Adjust and form the ears of the armature pivot so that the armature lies flat against both yokes.
- Check for 0.006-inch to 0.008-inch air gap between the armature and the core when the armature is attracted. Shim the core, if necessary, using steel shims (part 305271).
- Form the ears of the armature return spring (flat spring) to require 15-gram to 30-gram pressure to move each ear from the armature; sides must be within 5 grams of each other. Improper adjustment causes print suppression trouble.

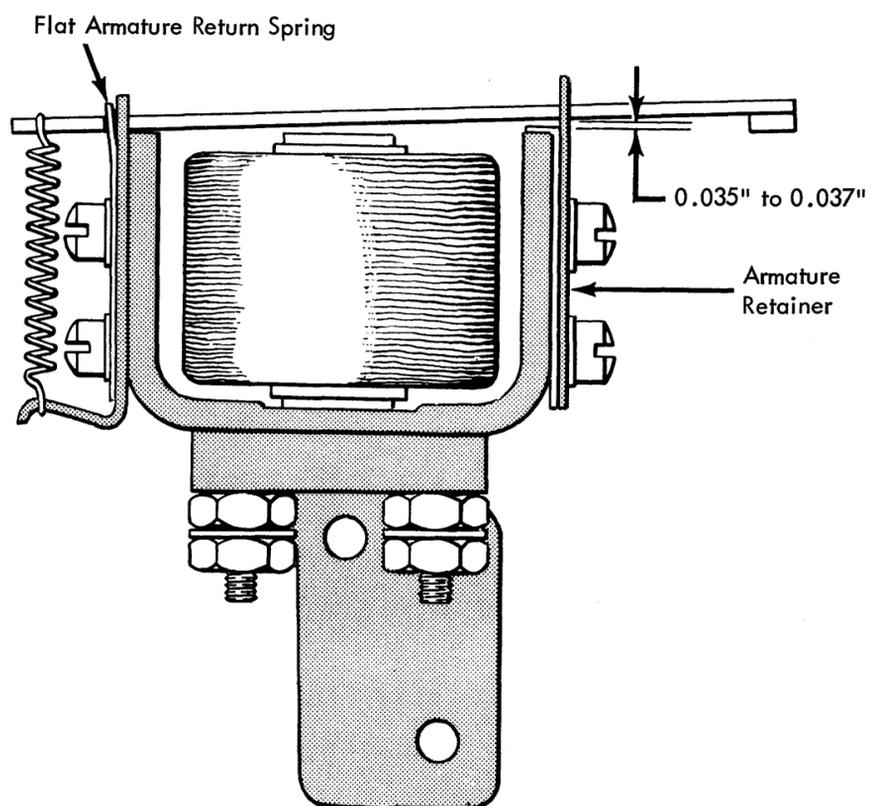


Figure 4-52. Print Suppression Magnet Adjustment

5. Adjust the armature retainer squarely for 0.035-inch to 0.037-inch air gap between armature and residual with magnet de-energized. Armature must not drag on the side of the retainer.
6. Attract the armature and position the magnet bracket so that the armature interposer block clears the side of the print arm by 0.004 inch to 0.010 inch (C, Figure 4-49).
7. When not attracted, the armature interposer block must clear both the print arm and suppression arm by 0.001 inch to 0.010 inch at 132 degrees on the index (D, Figure 4-49).

## 4.12 KEYBOARD

Remove the keyboard from the keyboard well by rotating the keyboard clockwise. Lift keyboard out of keyboard well.

### 4.12.1 Contact Adjustments

Keyboard contacts should be inspected for air gap, tension, and contact rise. Check contact surfaces for nodes and pits due to burning. Insufficient air gap of latch contacts can cause false error indications. Note the condition of these contacts, particularly if the keyboard has been jarred or dropped.

### 4.12.1.1 Bail Contacts

With bail contact assemblies out of the machine, form each contact strap to require a pressure of 9 to 11 grams to close points (measure at contact point). Position the contact plates for contact air gap of 0.015 inch to 0.025 inch with all latch assemblies restored (Figure 4-53).

#### CAUTION

When installing new assemblies, excessive heat (10-15 seconds) applied with soldering iron loosens contact points.

### 4.12.1.2 Latch Contacts

Form the operating strap to require 18-gram to 24-gram pressure to close contacts. Measure at contact pad. Pivot contact assembly mounting bar to obtain 0.015-inch to 0.025-inch contact air gap across the unit. Stationary contacts may be formed for individual air gap.

### 4.12.1.3 Restoring Bail Contacts

Form the operating strap to require 48-gram to 52-gram pressure to open the contacts. Position the contact bracket for 0.002-inch minimum to 0.010-inch maximum clearance between movable strap and operating insulator disk on restoring bail; it is very important to have clearance between the contact strap and the disk. When all restoring magnet adjustments are made correctly, restoring bail

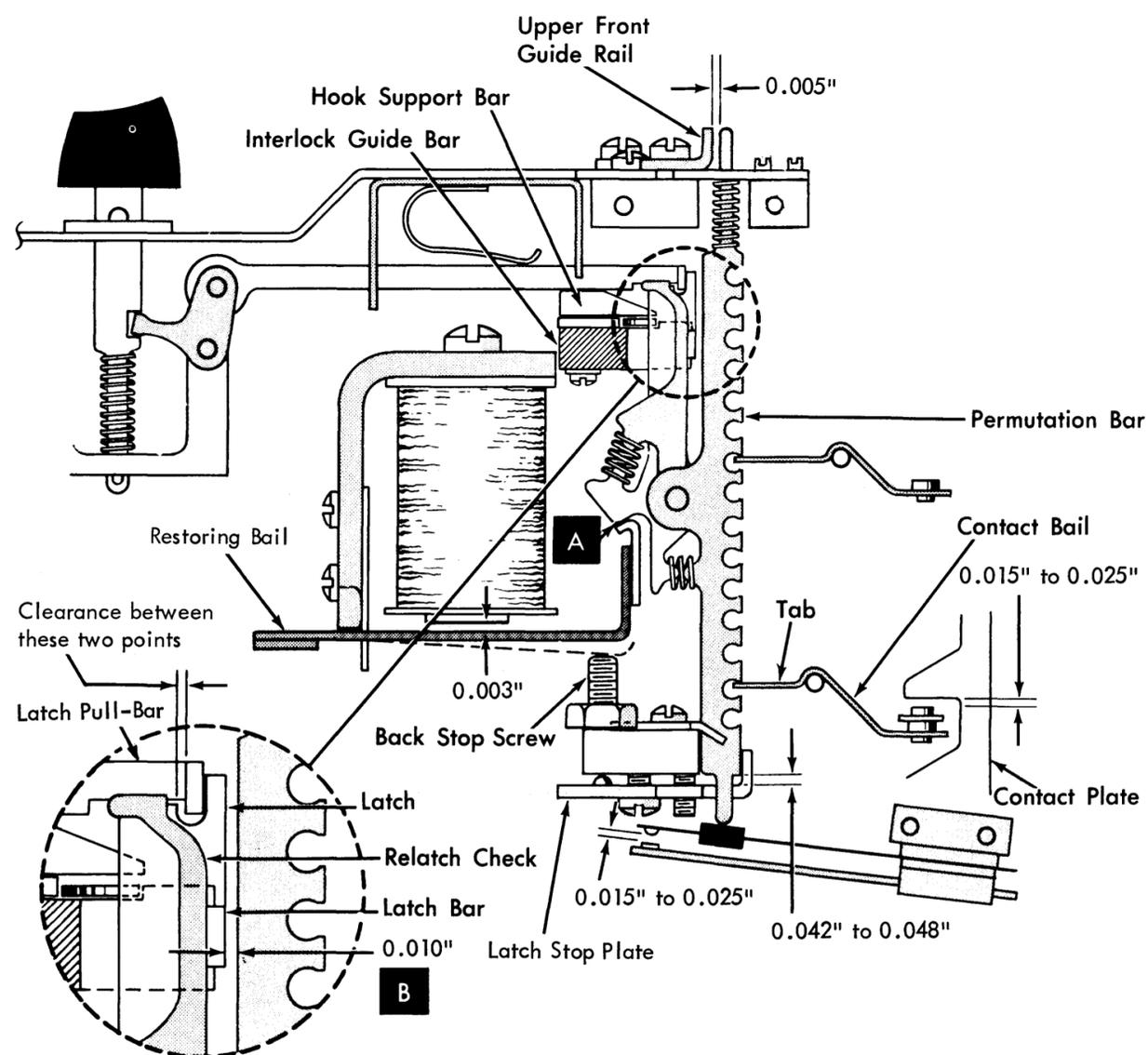


Figure 4-53. Keyboard Adjustment

contacts should have a minimum of 0.010-inch air gap when restoring magnets are energized.

*Note:* It is important that restoring bail contacts open before the latch or bail contacts.

#### 4.12.1.4 Keystem Contacts

*Strap Contacts:* The NO contacts should have a 1/32-inch minimum air gap. The NC contacts must open with the minimum pressure of 15 grams at the end of the strap and with minimum movement (1/64 inch) of stationary strap when contacts open.

1. When the MP key is pressed 3/32 inch  $\pm$  1/64 inch, the upper contact must break. Further depression of 1/32 inch causes the lower contact to make.
2. When the ALPHA and DUP keys are pressed 3/32 inch  $\pm$  1/32 inch, their contacts must close. If the operator's palm strikes the ALPHA key, increase the contact air gap.
3. When the NUMERIC key is pressed 3/32 inch  $\pm$  1/64 inch, the numeric contact must open.

*Microswitch Contacts:* Position single microswitches to transfer 0.015 to 0.060 inch prior to the downward limit of keystem travel. Position double microswitches to transfer the outboard switch 0.015 to 0.060 inch prior to the downward limit of keystem travel, and the inboard switch to transfer 0.010 to 0.045 inch prior to the outboard switch.

#### 4.12.1.5 Contact Bails

When a new bail (Figure 4-54) is installed, form all tabs on each bail for 0.000-inch to 0.005-inch clearance to associated operation ears on permutation bar, with latch assemblies in restored position. This may be checked on a keyboard with its covers removed. Check tension required to just open a closed bail contact for each key that operates that bail; tension should be at least 15 grams. Bail contact air gap and tension on operating strap affects this tension and should be checked before a measurement is attempted.

#### 4.12.2 Hook Support Bar Adjustment

Bar must be parallel with interlock guide bar, directly beneath it, along their longest edges, within 0.008 inch. This is to prevent binding of the latch.

#### 4.12.3 Permutation Bar Adjustment

Adjust the four setscrews that position the latch stop plate to allow bars to drop 0.042 to 0.048 inch. Measure a bar near each holding screw. To measure, lay a 6-inch rule across the top of the permutation bars. If the bar whose travel is to be measured is lower than the 6-inch rule, measure this amount and add it to the 0.042 to 0.048 inch given previously. Trip the latch and measure the distance from the top of this bar to the edge of the rule.

#### 4.12.4 Restoring Magnet Adjustment

1. With all latch assemblies restored, insert 0.005-inch gage between armature and magnet core and hold them sealed. Position magnet brackets evenly until restoring

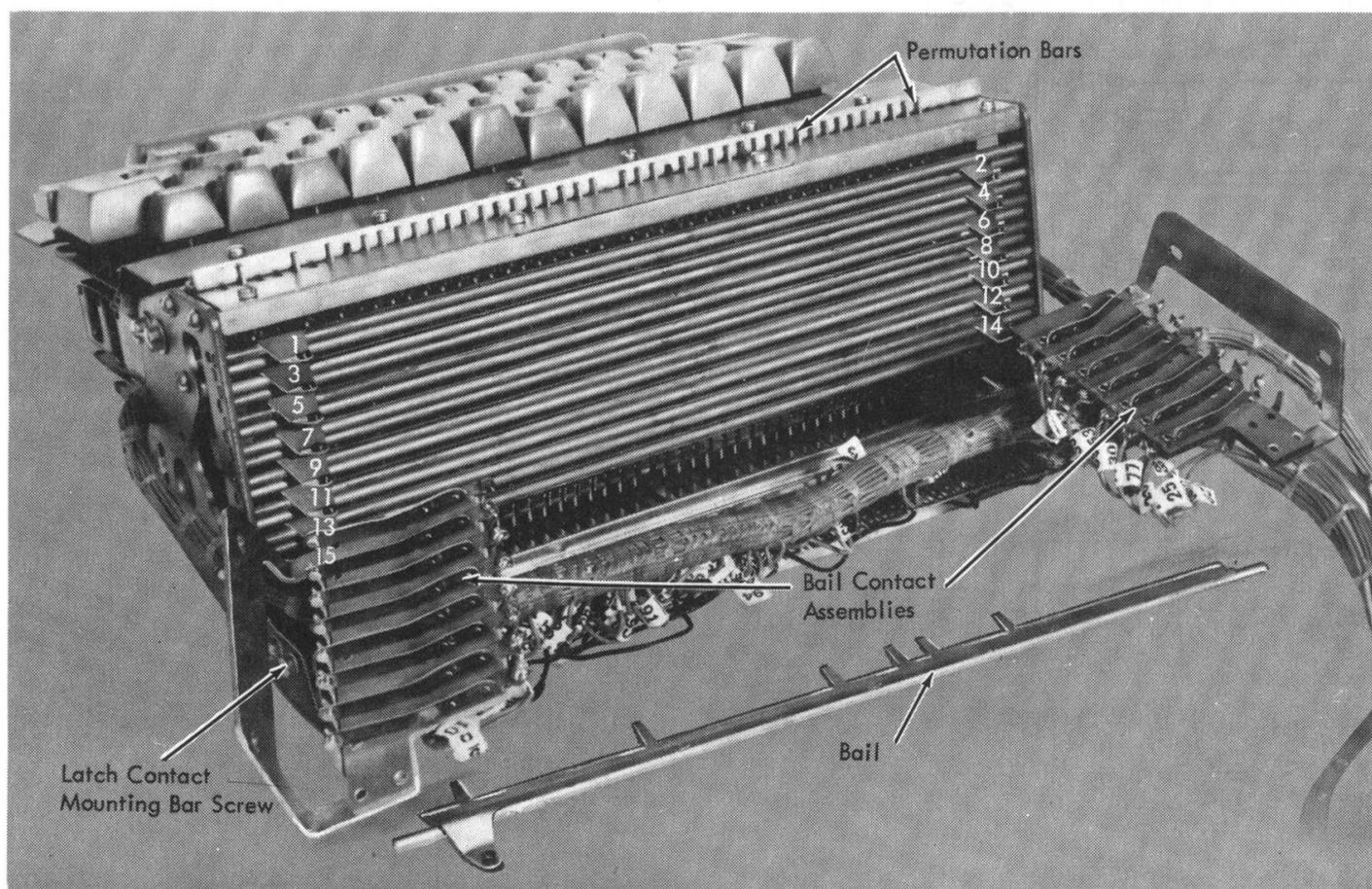


Figure 4-54. Keyboard Permutation Unit - Rear

bail contacts all latches at A, Figure 4-53. This should result in 0.010-inch maximum overtravel of latching point with gage removed.

2. With magnets de-energized, adjust the two backstop screws for clearance between each armature and its magnet core of 0.030 inch, measured at the center line of the core. (Use special 0.030-inch gage issued to measure clearance between feed and idler roll.)
3. Check adjustment of permutation bar travel and adjustments 1 and 2 by tripping, one at a time, several latches across the unit. Clearance between closest tripped latch and restoring bail should be at least 0.002 inch. Readjust if this condition is not present.
4. Adjust restoring bail pivots so that the restoring bail operates freely but has a minimum of clearance in the pivots.

#### 4.12.5 Upper Permutation Support Adjustment

1. Loosen the two end screws in the upper front guide rail and the four screws holding the plate comb.
2. Position the comb for 0.010-inch ( $\pm 0.005$ -inch) clearance between latch bar and permutation bars (B, Figure 4-53).
3. Position upper front guide rail evenly for 0.005-inch clearance to permutation bars.

#### 4.12.6 Key Unit Adjustment

1. Loosen the four screws (Figure 4-55) that hold the key unit to the permutation unit.

2. With key plate level, *and with no interlocks affected*, a 50-gram to 80-gram weight on any keytop (except ERROR RESET, FEED, PROG ONE, PROG TWO, LEFT ZERO, DUP, NUMERIC, MULT PCH, ALPHA, and the space bar) must be sufficient to trip its latch assembly. The key must return to its normal position with a 10-gram minimum weight resting on the keytop, when its latch assembly has been previously restored.
3. With key plate level, *and with no interlocks affected*, a 75-gram to 100-gram maximum weight on the space bar and left-zero key must be sufficient to trip its latch assembly. The bar must return to its original position with a 10-gram weight resting on it when its latch assembly has been previously restored.
4. With key plate level, *and with interlocks affected*, a 90-gram maximum weight on any keytop (except ERROR RESET, FEED, PROG ONE, PROG TWO, LEFT ZERO, DUP, NUMERIC, MULT PCH, ALPHA, and the space bar) must be sufficient to trip its latch assembly.
5. ERROR RESET, FEED, PROG ONE, PROG TWO, LEFT ZERO, DUP, NUMERIC, MULT PCH, and ALPHA keys must travel 0.125 inch with 50-gram to 80-gram key pressure.
6. With any latch assembly dropped, no hook should slip off its latch when its keytop is struck by a quick sharp blow with the finger. The exception to this is the release key latch assembly.

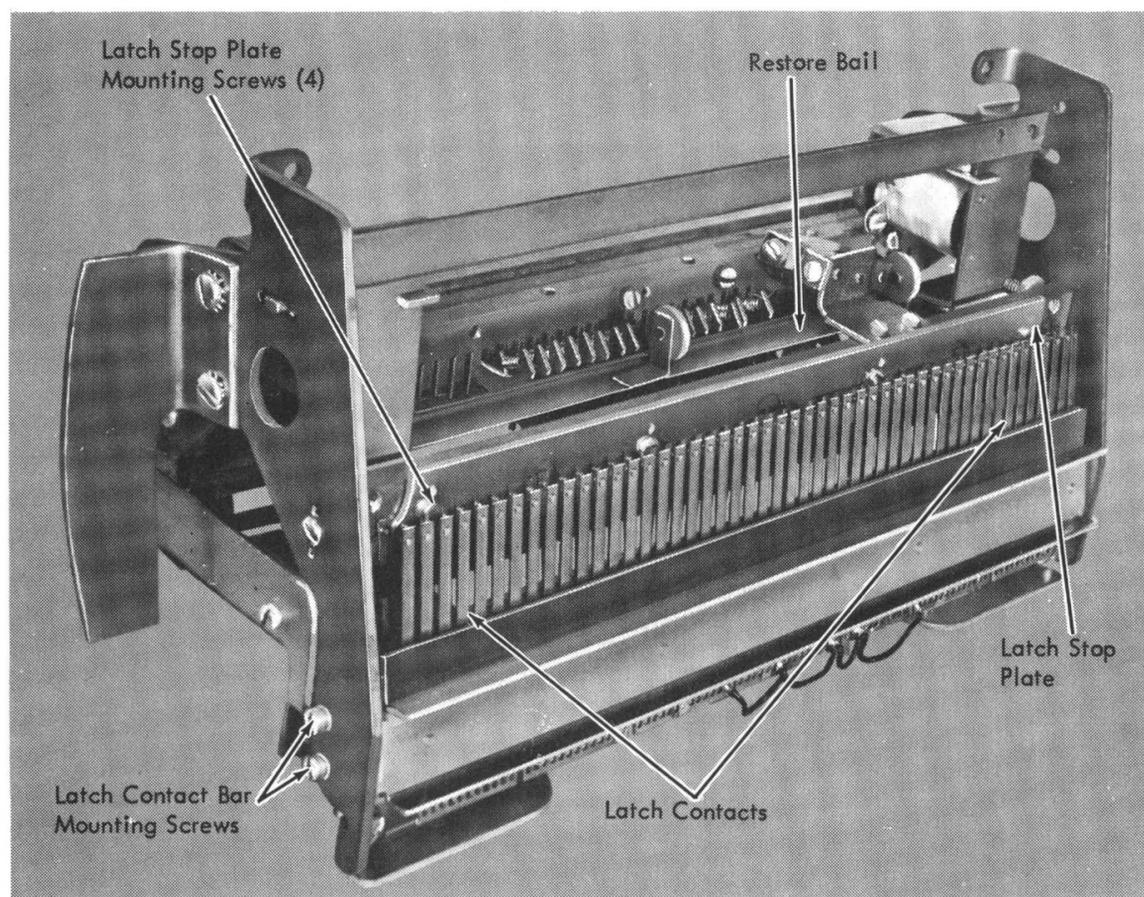


Figure 4-55. Keyboard Permutation Unit – Bottom

#### 4.12.7 Key Unit Removals

Separate the keyboard into its major units as shown in Figure 4-56. Be careful when sliding the key unit out of permutation unit: the Y-pull-bar may hook on the center support screw. It is not necessary to remove any wires if the removal is merely for inspection. Untie the nylon retaining wire at the end where it is fastened to the permutation unit.

*Note:* Do not oil or grease the hook ends of the latch pull-bars. On reassembly, check clearance of latch to pull-bar (Figure 4-53).

##### 4.12.7.1 Keytop

1. Remove keyboard cover.
2. Insert a straightened paper clip through slot in lower portion of keystem below lower guide plate. (This prevents the nylon retainer from being severed.)
3. Reset the keyboard in the reading table opening.
4. Grasp the keytop by the sides with the keybutton removal tool (part 9900373).
5. Remove keytop by pulling upward and working to the front and rear of keyboard. *Sideward motion may cause keystem breakage.*
6. To replace keytop, insert a follower rod (typewriter service tool, part 1012444) through the keystems above upper guide plate and rubber bumpers. (The straight portion of a wire coat hanger may be used as a follower rod.)
7. Press the new keytop onto the keystem until fully seated. The keytop will then be at the proper level in relation to the adjacent keytops.

##### 4.12.7.2 Keystem

1. Remove the nylon retaining wire to free the desired keystem. (Use a follower rod to aid reassembly.)
2. Lift the key from the unit while the end of the latch pull-rod is held up and clear of latch. Be careful that the keystem spring does not drop into the unit. Refer to Figure 4-53.
3. Reassemble the unit. Hold the latch pull-rod free of the latch and allow the keystem bellcrank to rotate into the keystem. Be sure the spring is assembled on the keystem.
4. Test the position for binds.

##### 4.12.7.3 Contact Bails

1. Remove the two bail contact assemblies shown in Figure 4-54. Each assembly is held by two screws and may be shimmed away from the side frame. Note the position of these shims.

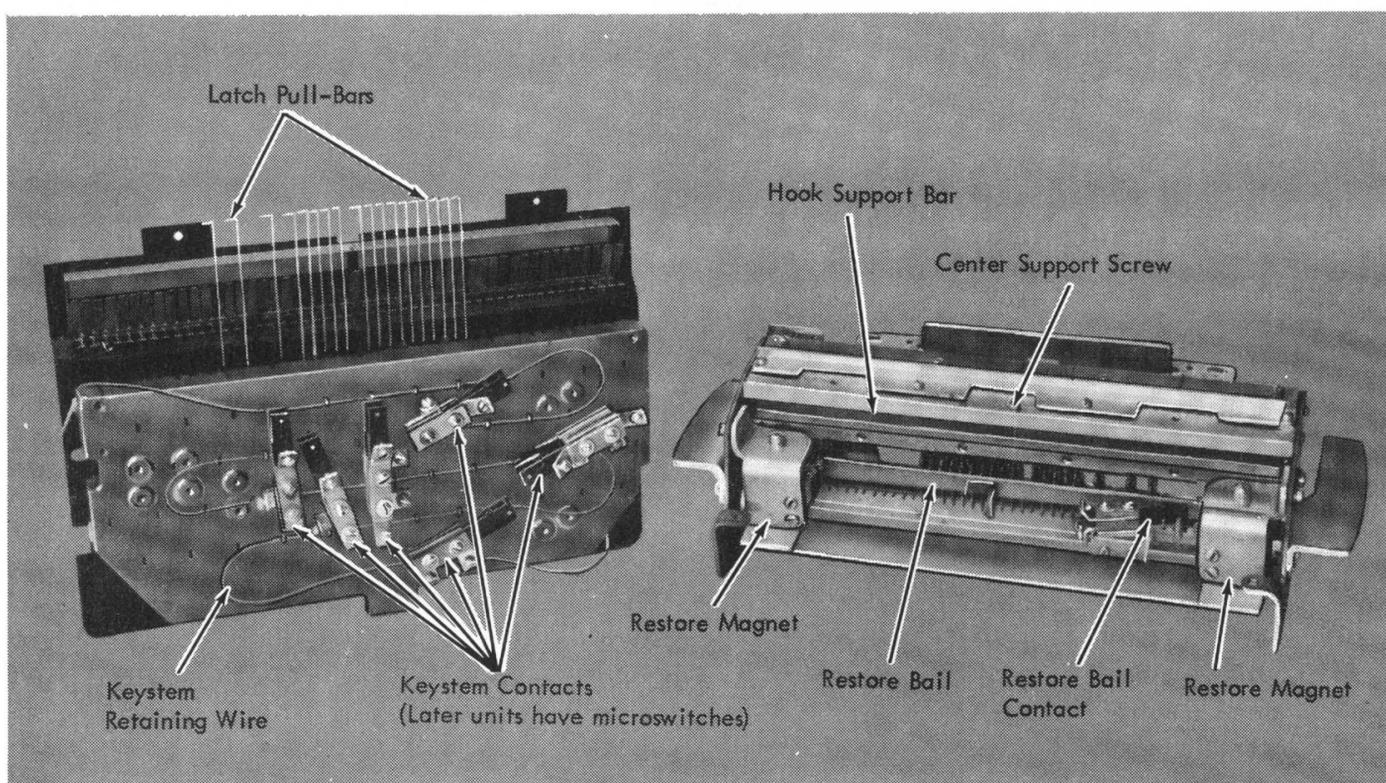
#### CAUTION

As each bail contact assembly is removed, cover pivot end of contact bails with cellulose acetate tape to keep bails from falling out.

2. Punch a hole in the tape and remove the desired contact bail.

##### 4.12.7.4 Latch Assembly

1. Separate the key and the permutation units.
2. Remove wires from all keystem contacts and the two restoring magnets (Figure 4-56).



● Figure 4-56. Keyboard Key Unit and Permutation Unit

3. Loosen the two mounting screws and remove the restoring bail contact assembly.
4. Remove restoring bail by taking out one screw from one of the pivots and turning pivot block away from the armature.
5. Remove the two bail contact assemblies shown in Figure 4-54.
6. Remove the contact bails; they are numbered 1 to 15, top to bottom (Figure 4-54).
7. Remove the latch contact mounting bar.
8. Remove the four screws from the latch stop plate (Figure 4-55).
9. Remove the two springs on the latch assembly to be taken out. The longer spring belongs between the latch and the relatch check lever.
10. Remove the center support screw from the upper latch assembly guide (Figure 4-56).
11. Set the unit on its back. Hold the hook support bar (Figure 4-56) while removing the three screws that hold it. Also, remove the pivot screw.
12. Holding the hook support bar, set the permutation unit upright.
13. Slide the hook support bar off, exposing the interlock disks.
14. Lift out the interlock disks adjacent to the latch assembly to be removed. Latch is free to come out of bottom. Note carefully the difference between the release key latch and other latch assemblies. The release key latch is cut away at the point where the latch would contact the interlock disks. The release key is not interlocked. Figure 4-57 shows the correct position of the 44 interlock disks for the alphabetic keyboard. A numeric keyboard has 20 interlock disks.

#### CAUTION

When an interlock is removed and a latch is tripped off, the latch bar can fly out. All parts in direct contact with interlocks, including latches that strike interlocks, must be free of oil or grease.

When reassembling, the center support screw should be tightened sufficiently to remove any downward bow in the brass latch support bar caused by the combined pressure of the latch springs. Sight check along one row of notches in the permutation bars and adjust until no curve is seen.

After reassembly, check all adjustments. When replacing contact bails, stand permutation unit on one end after covering pivot holes with tape to keep contact bails from falling out.

#### 4.12.7.5 Latch Pull-Bar

1. Separate the key and permutation units; see 4.12.7.
2. The defective pull-bar may be replaced by sliding out the bellcrank pivot rod (a follower rod will aid in reassembly) until the pivot rod disengages from the bellcrank.
3. Remove the defective latch pull-bar.
4. The new pull-bar may be inserted from the top, engaging the bellcrank with the keystem.
5. Reassemble keyboard. Check the clearance of the latch to the pull-bar (see Figure 4-53).

## Section 2. Features

Refer to Field Engineering Theory—Maintenance, *IBM 29 Card Punch Features/29 Interpreting Card Punch, Model C*, S223-2926, for feature adjustments.

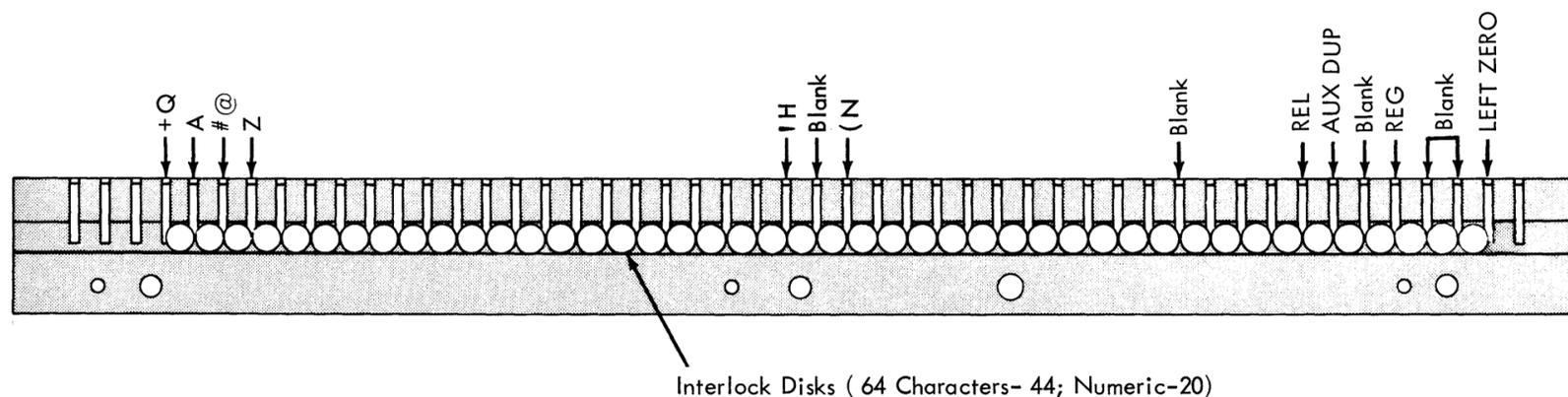


Figure 4-57. Keyboard Interlock Disks

### Section 1. Basic Unit

The IBM 29 Card Punch has a 48-volt power supply (Figure 5-1).

Refer to the machine wiring diagram for proper connections. Refer to Figure 5-2 for power and receptacle requirements.

The output of the 48-volt power supply can vary 10% and machine operation should be correct.

### Section 2. Features

Refer to Field Engineering Theory—Maintenance, *IBM 29 Card Punch Features/29 Interpreting Card Punch, Model C*, Form 223-2926, for feature power requirements.

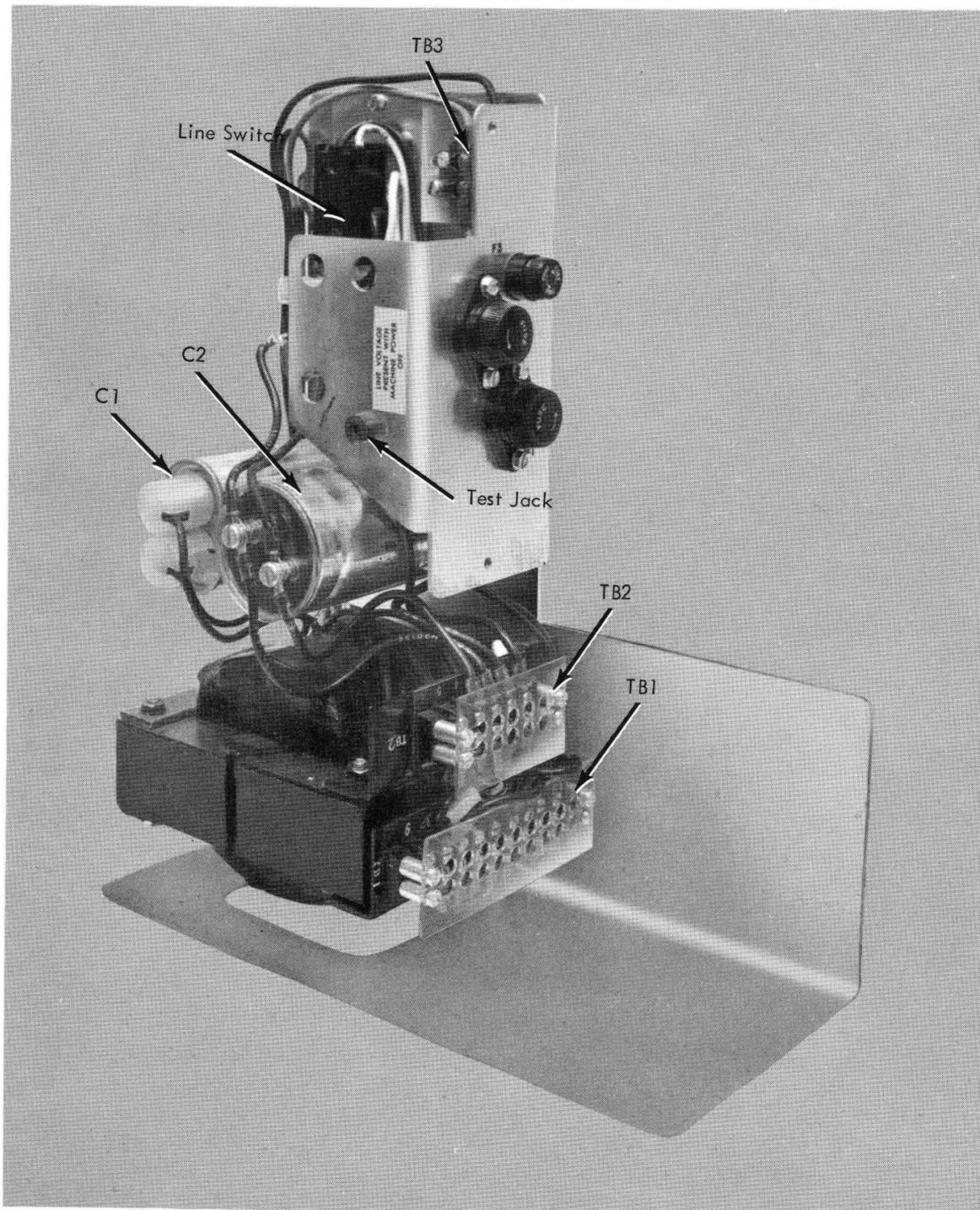


Figure 5-1. Power Supply

Description	Characteristics
Power	115V, single phase, 60 Hz, 3.0A (Models A and B) 208V, single phase, 60 Hz, 1.6A (Models A and B) 230V, single phase, 60 Hz, 1.5A (Models A and B)
Power Receptacle Requirements	B, H (115V) C, K (208/230V)

Figure 5-2. Power and Receptacle Requirements

### 6.1 KEYSTEM NUMBERING

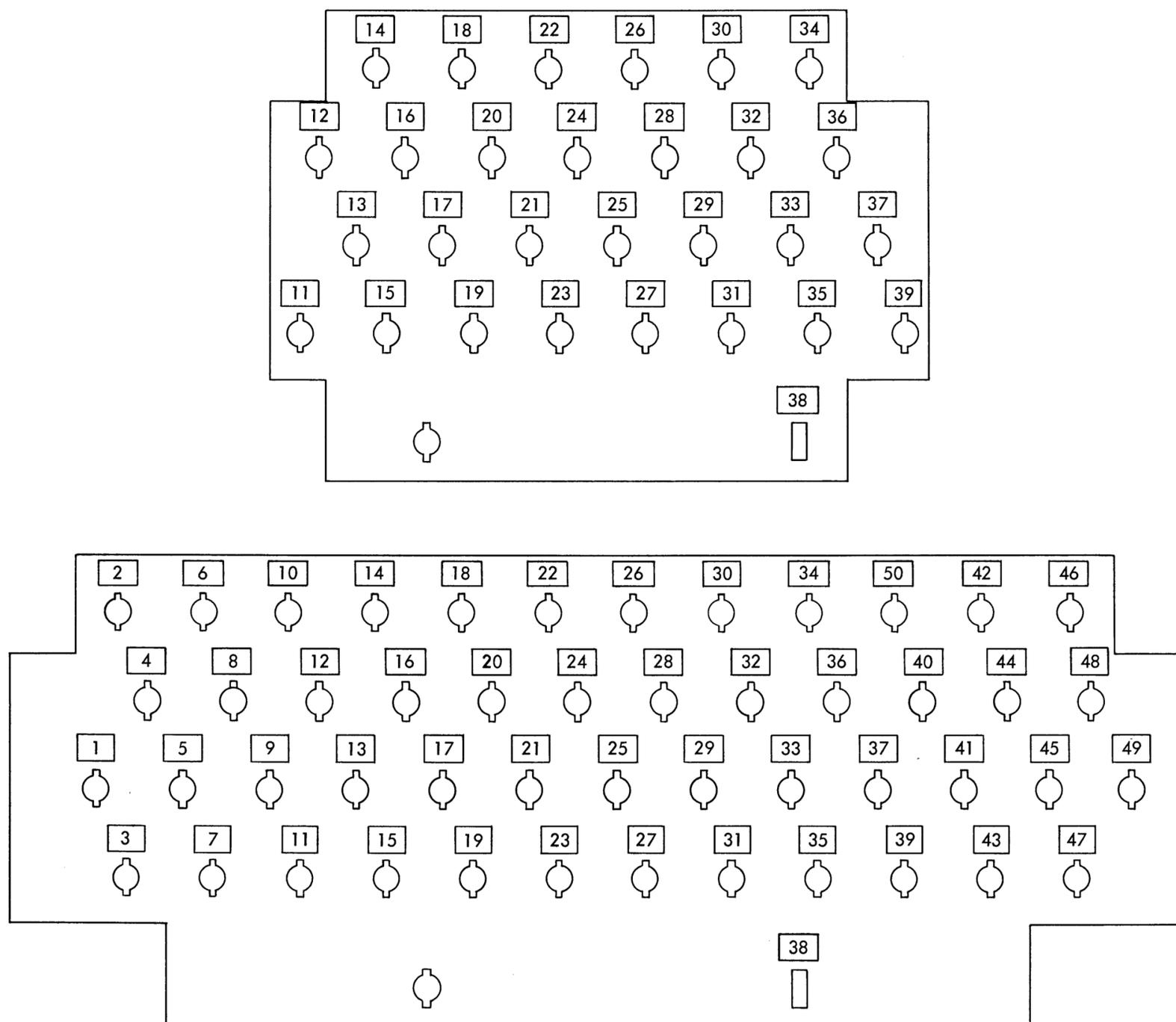
Figure 6-1 shows the numbers assigned to each keystem. Reference between these numbers and the numbers found in the keyboard location chart on the wiring diagram (00.29.10.0) identify the characters assigned to the keystem.

### 6.2 REED-RELAY CARD

The relay card is 9 inches by 20 inches. There are six connector tabs with 30 connections on each tab. The front of the card is the component side and this is divided into 36 blocks. Each block is capable of accommodating up to one 6-position reed relay or 10 components. The top of the card is the edge with the connector tabs (Figure 6-2, view A).

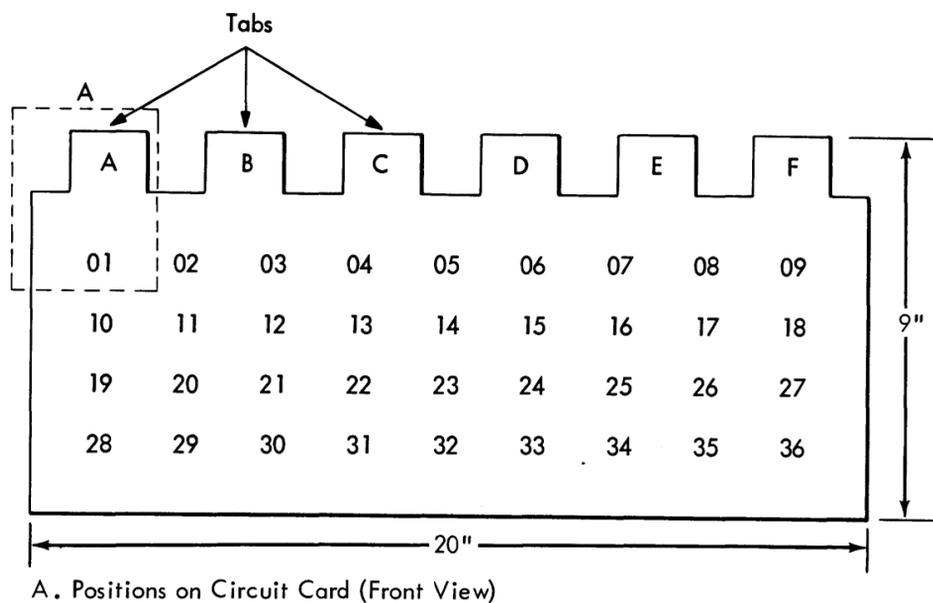
All references to the card are made while viewing the front of the card with the connector tabs up.

The connector tabs are labeled A through F, from left to right (Figure 6-2, view A). The 30 connections on each tab are separated into 15 connections on the front and 15 connections on the back. The front connections are labeled 1, 3, and 5 through 29 (odd numbers). The back connections are labeled 2, 4, and 6 through 30 (even numbers). A typical connection would be 1C07. This is card 1, connector tab C, and connection 07. The block is the main-component location factor. Blocks are labeled (left to right and top to bottom) with block 01 in the upper left-hand corner and block 36 in the lower right-hand corner (Figure 6-2, view A). The full designation of a block is 101, 102, etc. The high-order digit represents the card number; when two cards are in the machine, the block is

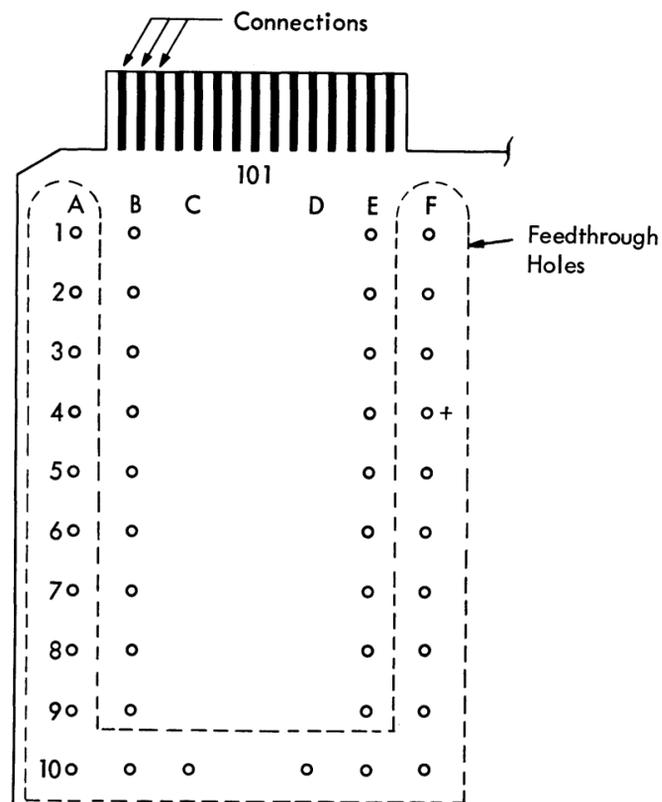


Refer to Wiring Diagram for Characters By Stems.

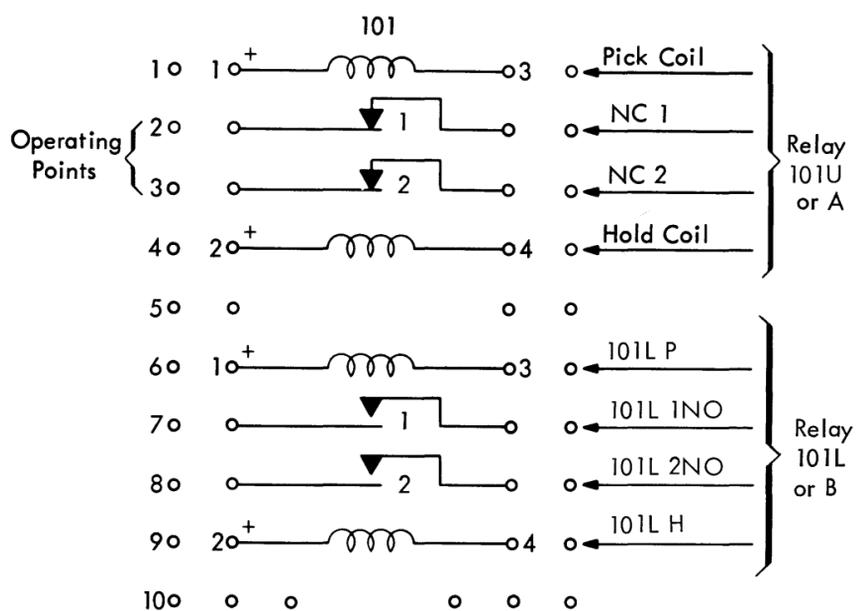
Figure 6-1. Combination and Numeric Keystem Numbering



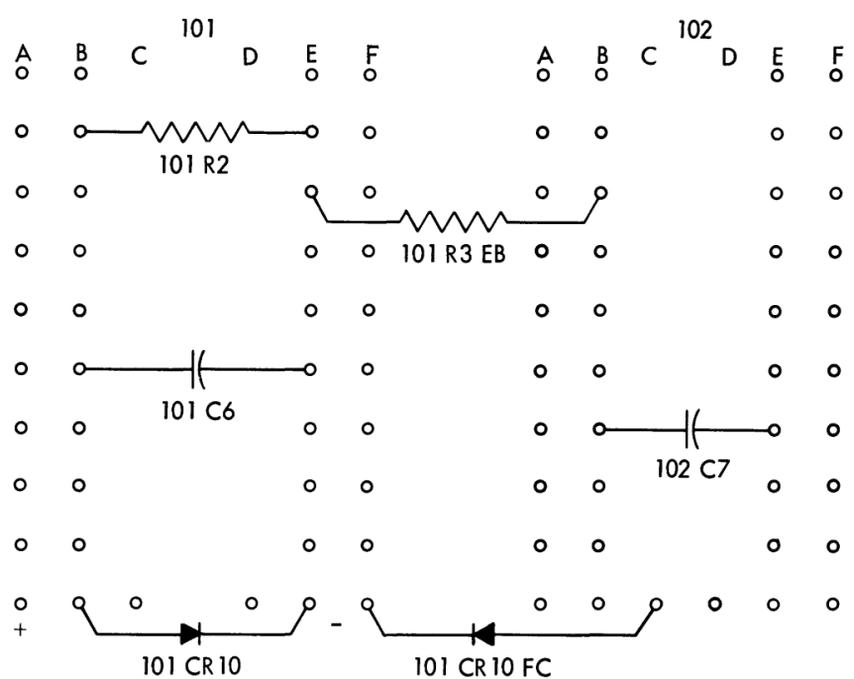
A. Positions on Circuit Card (Front View)



B. View A of A - 1 Block



C. Relay Numbering



D. Component Numbering

Figure 6-2. Locations-Relay Board and Relays

201, 202, etc. Each block consists of two columns of nine holes, defining the left edge and right edge of the blocks. The bottom of the block is defined by two groups of three holes each (Figure 6-2, view B). The number within the block is the same for each block. This enables each hole to be specified if necessary. In Figure 6-2, view B, the hole 101F4 has a + beside it.

Relays are placed on pins that are secured to the board. When more than one relay is in a block, the relay may be designated by U or A (upper), and L or B (lower). The U is the top relay, the one closest to the connector tabs. An example is 101U and 101L as shown in Figure 6-2, view C. There will be one space between the relays.

Components are located between the two columns within a block or between blocks (Figure 6-2, view D). The column rows are numbered from top to bottom within a block. A component within a block is designated by block, component type, and row numbers. A component between blocks is designated by the from-block, component, row, from-pin, and to-pin.

### 6.2.1 Reed Relays

As shown in Figure 6-2, view C, the reed-relay points and coil connections are numbered. The relay is *always* placed on the card so that the pick coil is at the top and the

operating straps are to the left side. The four outboard connections are numbered 1, 2, 3, and 4. The pick coil is located between 1 and 3, and the hold coil between 2 and 4. Connections 1 and 2 are connected to the positive side of the circuit. A locating pin is near the position-4 connector (minus side of hold coil). *Do not swap relay type.* If the relay used does not have a hold coil, do not put one that has a hold coil in its place. Do not remove or install reed relays during a machine cycle.

### 6.3 WIRE-CONTACT RELAYS

The wire-contact relays are located in the rear gate of the machine and are removable for inspection or replacement. For detailed information on wire-contact relays, refer to Field Engineering Maintenance Manual, *Motors, Generators, Relays, Circuit Breakers, Test Instruments, Miscellaneous Components*, Form 225-3422.

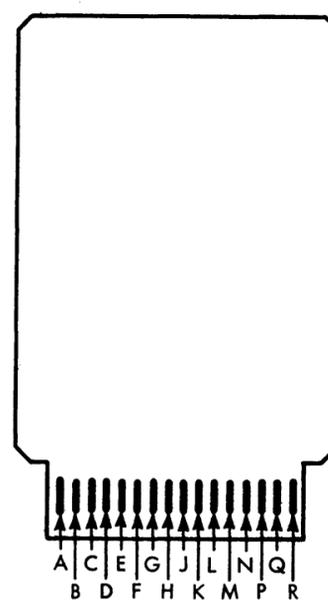
### 6.4 STANDARD MODULAR SYSTEM (SMS)

Standard printed wiring cards are used in the modular type of packaging. These SMS printed wiring cards facilitate the manufacturing process and permit standardization of circuits. The pluggable printed circuit cards contain all the components and printed wiring necessary for a particular electrical function or functions. Other printed wiring cards are used as cable connectors and back panel voltage distribution buses.

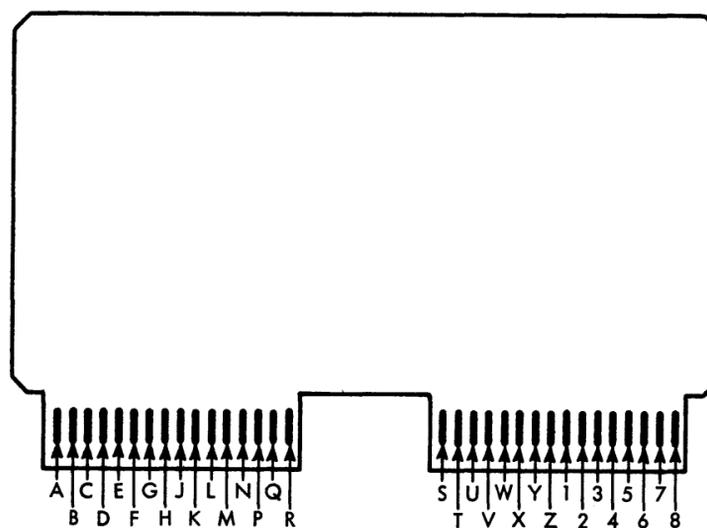
The SMS single card (Figure 6-3) is made of an epoxy paper laminate material and is 0.056-inch thick, 4-1/2 inches long and 2-1/2 inches wide. All of the electrical components are mounted on the front side of the standard SMS card form. Connections to the components are made on the back side of the SMS card form by printed wiring patterns that terminate at contacts at the bottom of the card. These contacts, labeled A through R, couple the signal and standard service voltages to the circuit components when the card is inserted in the SMS socket. The printed wiring (land pattern) depends on the circuit configuration of the card.

SMS twin cards (Figure 6-3) are made of the same material used in single cards. Twin cards are 5-1/4 inches wide; other dimensions are the same as for single cards. With twin cards, more circuitry can be packaged in a given space than with single cards.

The dual-density twin card (Figure 6-3) has electrical components mounted on the front side of the card. This card contains as many as 14 reed relays. Connections to components are on both sides of the card and are made by printed wiring patterns that terminate at 32 possible contacts on the back side of the card. These contacts, A through Z and 1 through 8, couple the signal and service voltages to the circuit components when the card is inserted into two vertically adjacent SMS card sockets (Figure 6-4).



A. Single Card



B. Twin Card

Figure 6-3. SMS Printed Wiring Cards

#### 6.4.1 SMS Card Receptacles

The pluggable printed circuit cards are inserted into SMS receptacles as shown in Figure 6-4. Although the contacts are all at one edge on the card insertion side of the SMS receptacle, they pass through the receptacle in a staggered arrangement as noted in the figure. This staggering allows additional room for wire-wrapping or soldering of signal and voltage wires to the terminal pins.

#### 6.4.2 SMS Locations and Pin Numbering

SMS locations are identified by:

- Row
- Column or card number
- Pin

Refer to Figure 6-4.

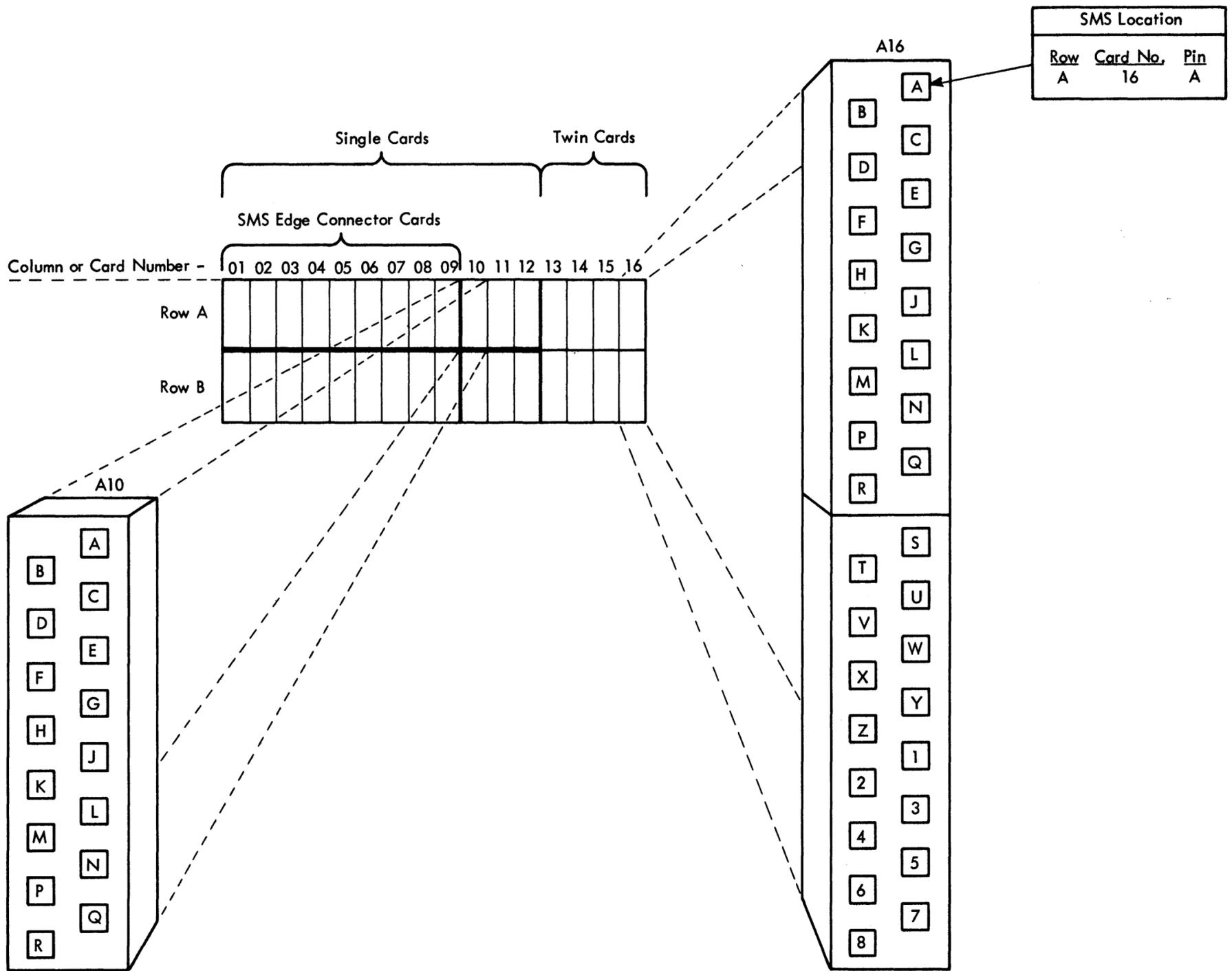


Figure 6-4. Wire-Contact Relay Machine Relay Gate-Card Side View

## 6.5 LOCATION FIGURES

Figures 6-5 through 6-9 show where certain items are located on the machine.

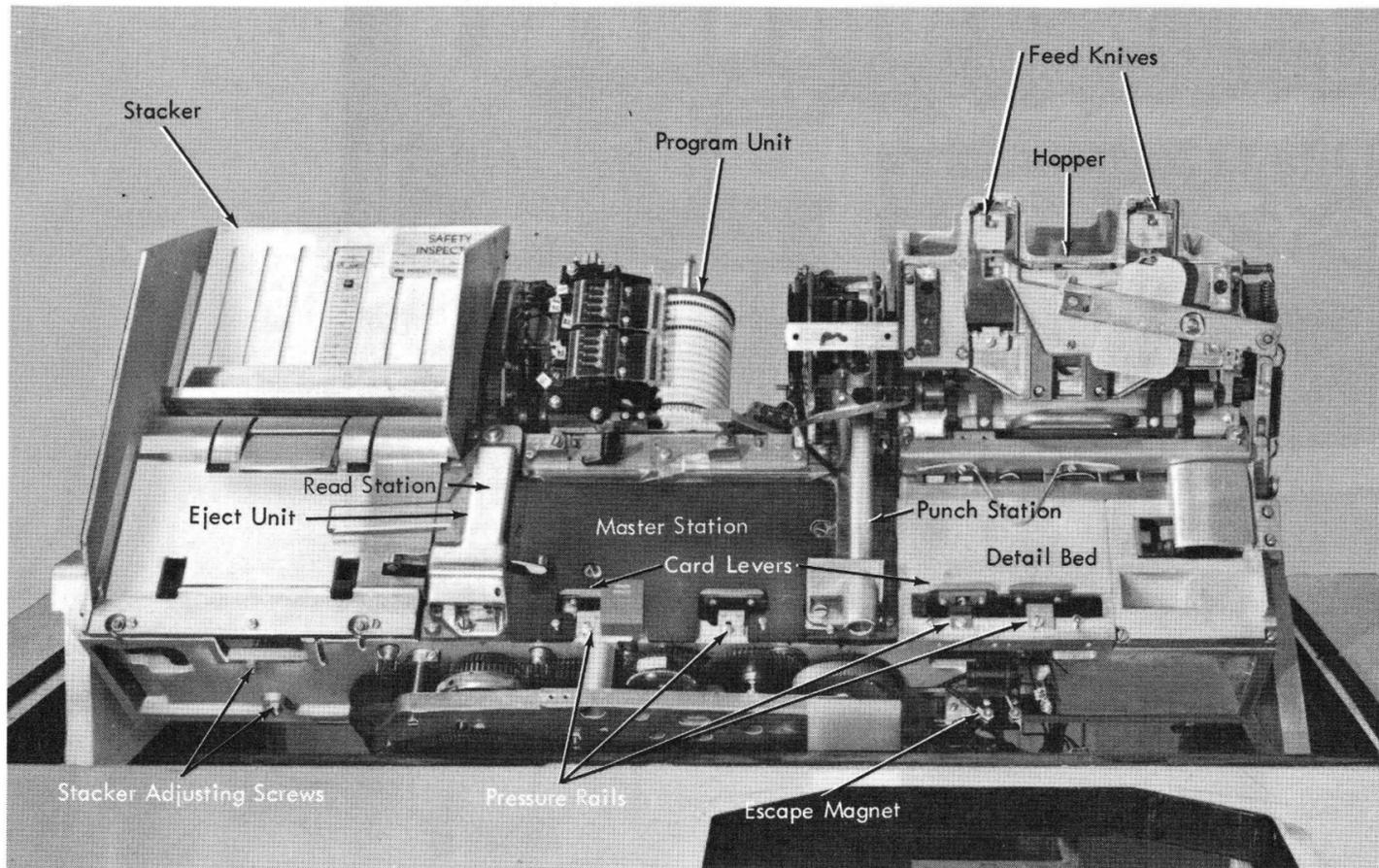


Figure 6-5. Locations—Front View

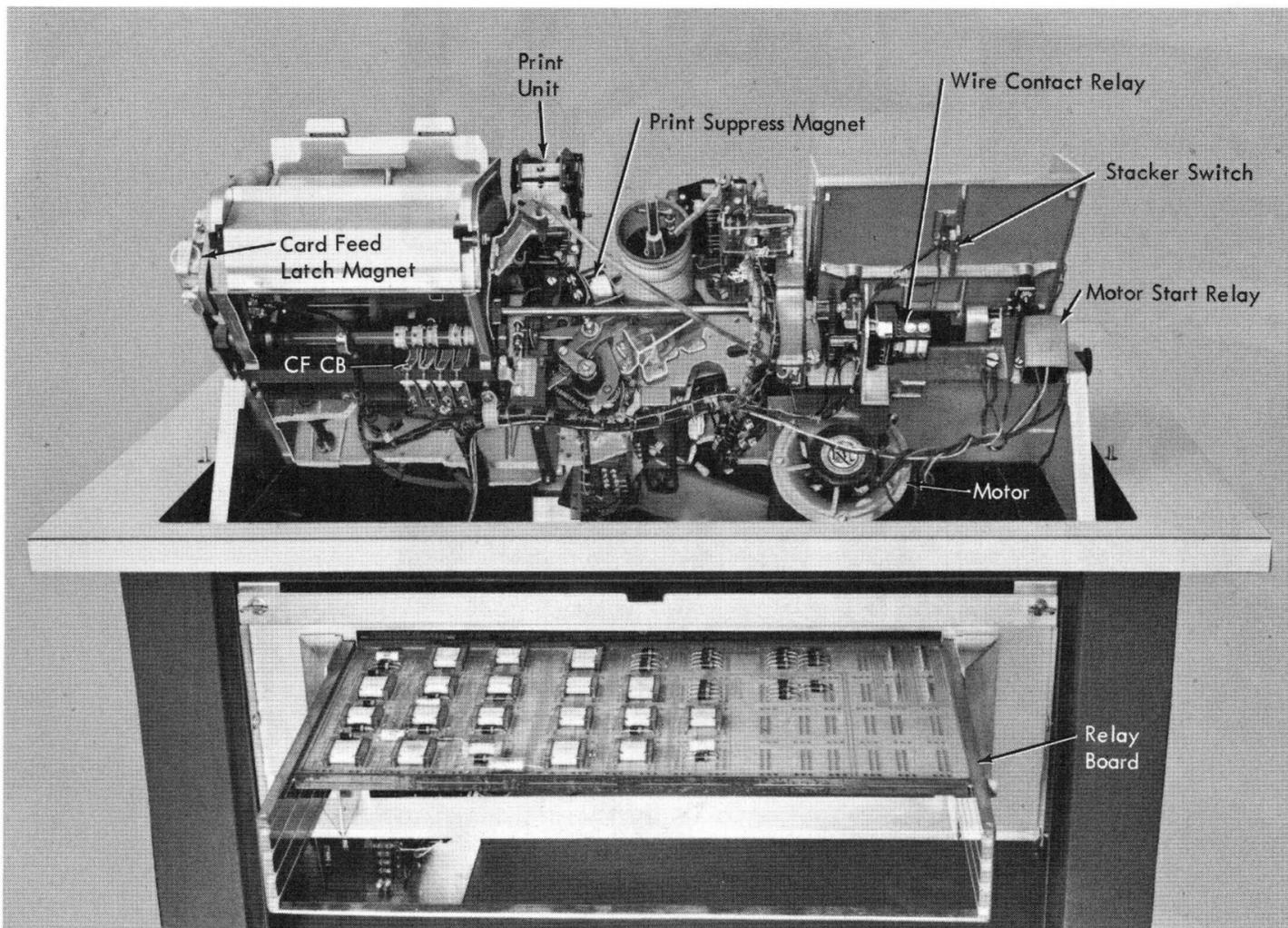


Figure 6-6. Locations—Rear View (Reed-Relay Machine)

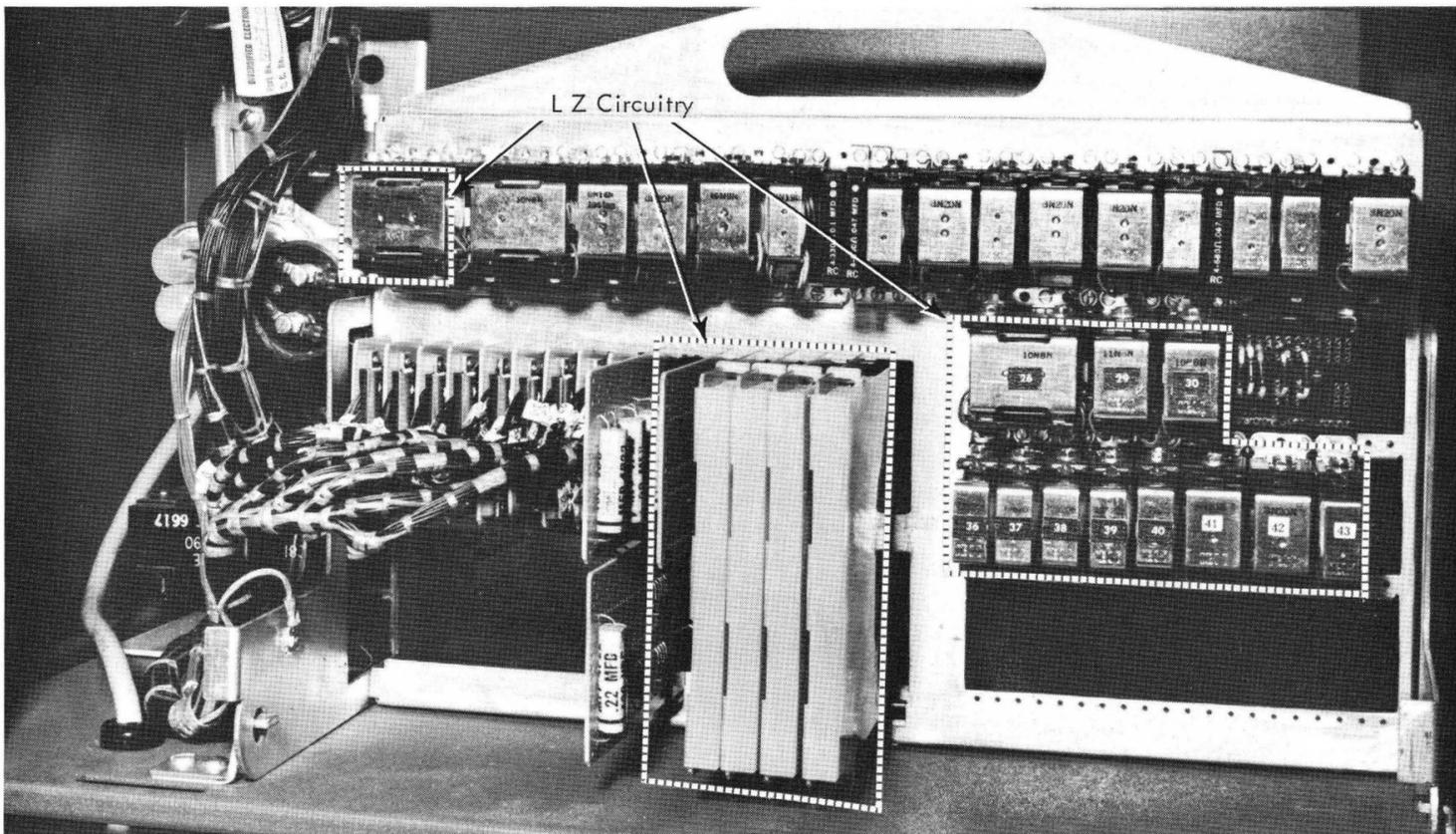


Figure 6-7. Locations-Rear View (Wire-Contact Relay Machine)

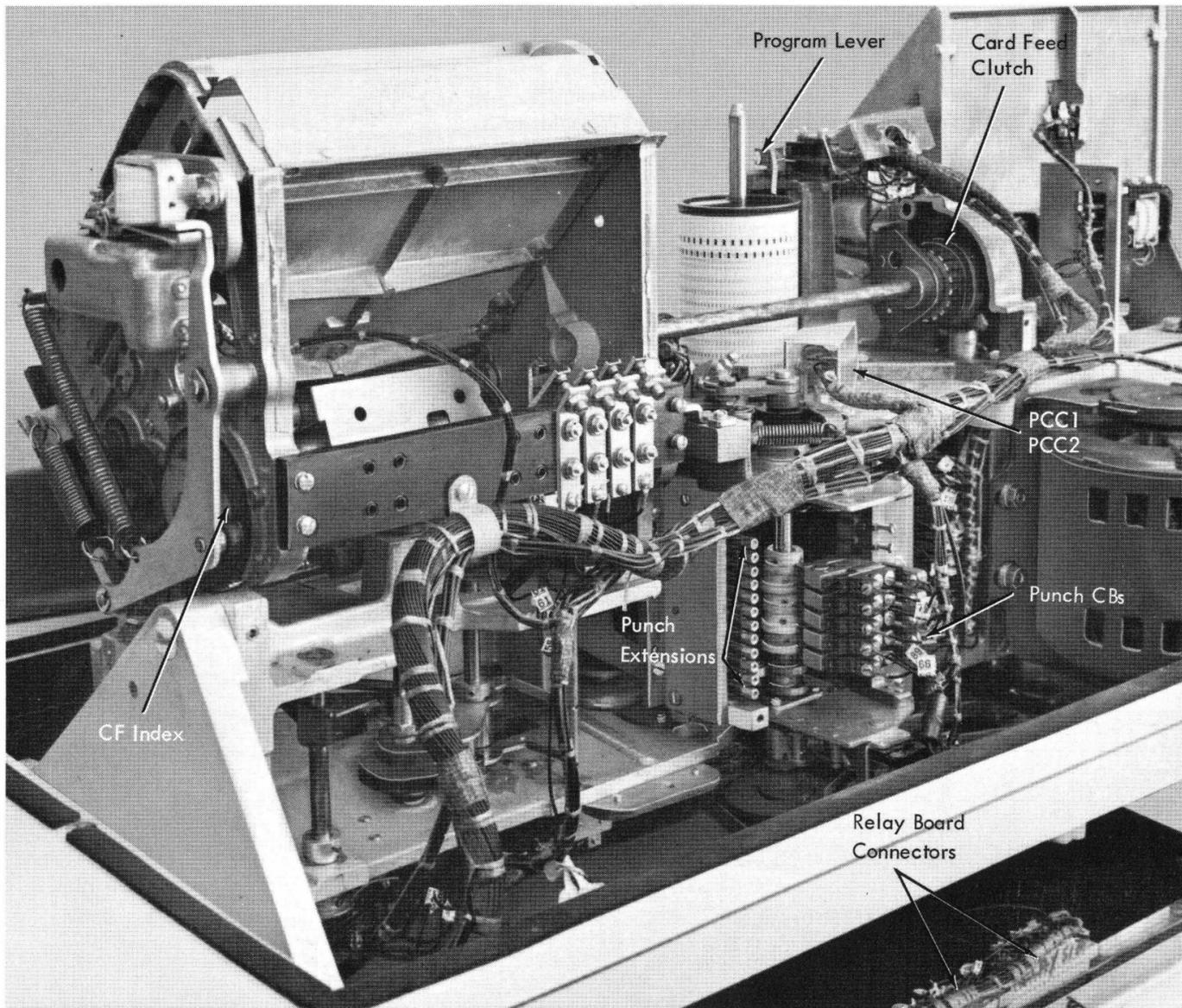


Figure 6-8. Locations-Rear

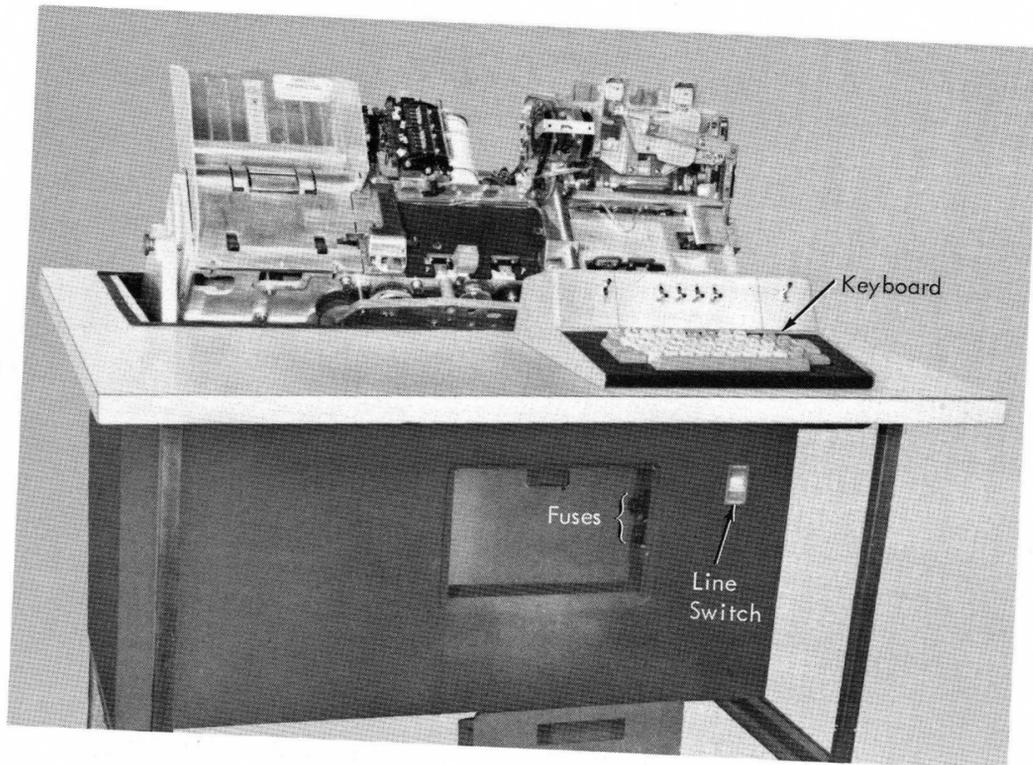


Figure 6-9. Locations-Front

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IBM 29 CARD PUNCH

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Pages to be inserted and/or removed are:

Title Page, Preface	4-1 through 4-12
iii through vi	4-17 through 4-22
1-9, 1-10	4-29, 4-30
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3-1, 3-2	X-1 through X-5, blank
3-5, 3-6	

A change to the text is indicated by a vertical line to the left of the change; a changed or added illustration is denoted by the symbol ● to the left of the caption.

Summary of Amendments

Maintenance Manual addition to list in Preface  
Additional troubleshooting aids in Chapter 1  
Lubrication changes in Chapter 3  
Checkout procedure change in Chapter 2  
Adjustment tolerance changes in Chapter 4  
Figure 4-41 changed to improve figure-to-component association

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