

PAT DEPT HISTORICAL

O.H. Osborne

FILE

To Mr. [unclear]

513

**IBM**  
E L E C T R I C P U N C H E D C A R D  
**ACCOUNTING MACHINES**  
CUSTOMER ENGINEERING MANUAL OF INSTRUCTION

**AUTOMATIC REPRODUCING PUNCH**

TYPE 513

**INTERNATIONAL BUSINESS MACHINES CORPORATION**  
NEW YORK, NEW YORK

6/13/54  
S. W. [unclear]

**IBM**  
E L E C T R I C P U N C H E D C A R D  
**ACCOUNTING MACHINES**

---

**CUSTOMER ENGINEERING MANUAL OF INSTRUCTION**

**AUTOMATIC REPRODUCING PUNCH**

TYPE 513

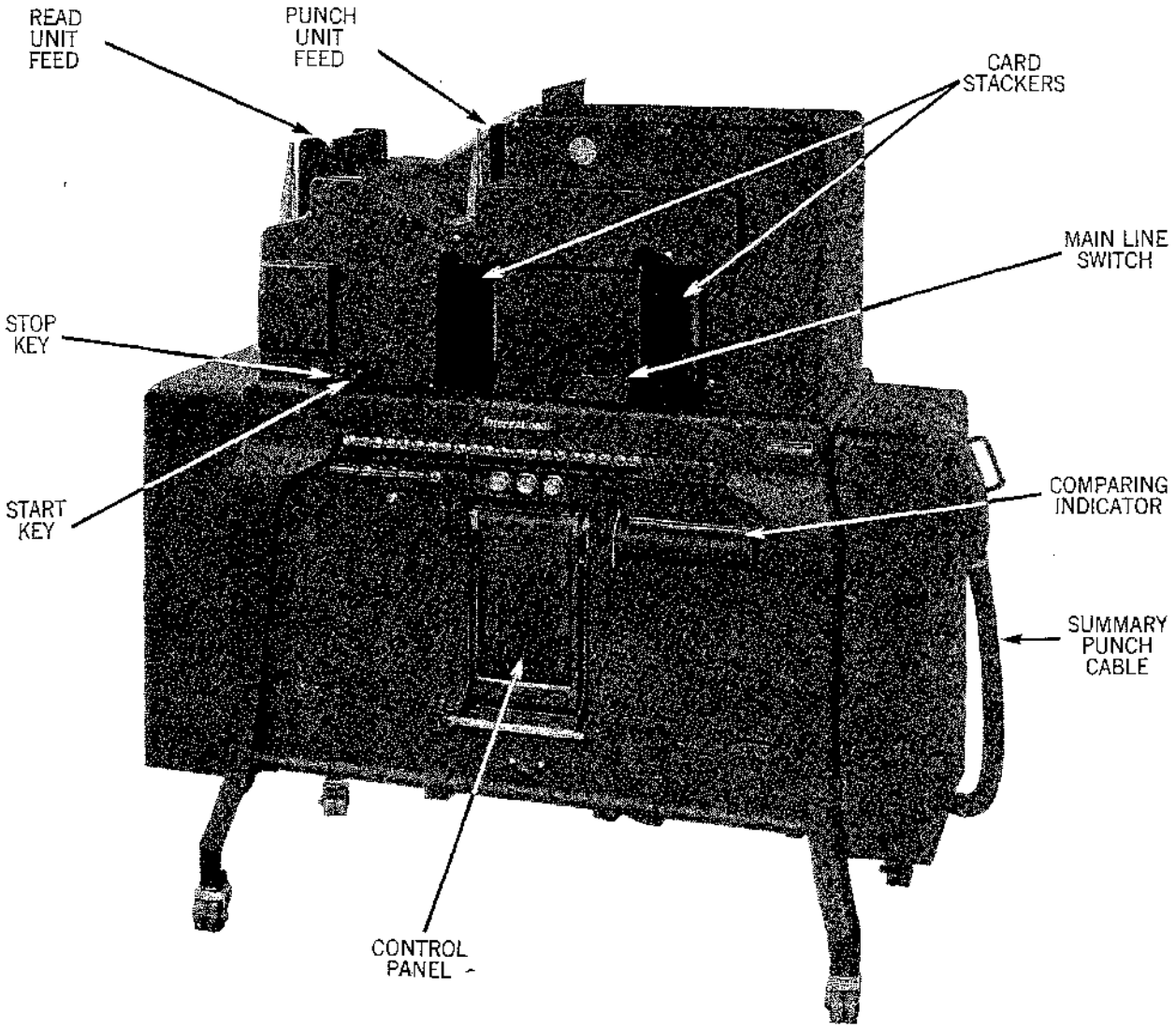
**INTERNATIONAL BUSINESS MACHINES CORPORATION**  
NEW YORK, NEW YORK

# CONTENTS

FUNCTIONAL PRINCIPLES .....	5	Single Revolution Timing Cam Bracket .....	44
FEATURES .....	6	Geneva Clutch .....	44
Models .....	6	<b>PUNCH UNIT</b> .....	44
Card Feeds .....	6	Belt Tension .....	44
Read Unit .....	6	Feed Roll Tension .....	45
Punch Unit .....	6	Feed Knife Guides .....	45
Stackers .....	7	Feed Knives .....	45
Speed .....	7	Throat .....	45
Alphabetic and Numerical Punching .....	8	Feed Roll Opening Device .....	46
Current .....	8	Die .....	46
Comparing Light and Indicator .....	8	Punch Bail Tongue .....	47
Control Panel .....	8	Interposer Spring Bail .....	47
Main Line Switch .....	10	Punch Bail Connecting Links .....	47
Reproducing Switch .....	10	Punch Magnet Armatures .....	48
Selective Reproducing and Gang Punch .....	10	Punch Magazine Side Plates .....	48
Comparing Switch .....	10	Punch Brush Lateral Alignment .....	49
Detail or Master Switch .....	10	Anchor Slide Adjustment .....	49
Comparing Indicator Handle .....	10	Punch Feed Knives—Lateral Adjustment to Obtain Brush Timing .....	49
<b>OPERATION</b> .....	11	X Brush Timing .....	49
Reproducing .....	11	Vertical Registration .....	50
Verifying Reproducing .....	11	Stacker Plate .....	51
Field Selected Reproducing .....	12	Stacker Timing .....	51
Selective Reproducing .....	14	<b>COMPARING UNIT</b> .....	51
Gang Punching, Column-for-Column with Single Master Card .....	14	<b>READ UNIT</b> .....	52
Gang Punching with Interspersed Masters .....	16	Read Magazine Side Plates .....	52
Offset Gang Punching .....	17	Reproducing and Comparing Brush Alignment .....	52
Combination Reproducing and Gang Punching .....	18	Reproducing Brush Timing .....	52
X Elimination or Transfer .....	19	Comparing Brush Timing .....	52
Summary Punching .....	19	Common Brushes .....	52
Summary Punching with a Numerical Accounting Machine .....	20	X Brush Timing .....	53
Summary Punching with a Net-Balance Alphabetical Accounting Machine .....	20	<b>CONTACTS</b> .....	53
Summary Punching with a Non-Net Balance Alphabetical Accounting Machine .....	21	Circuit Breakers .....	53
Combinational Reproducing, Gang Punching and Summary Punching .....	21	Cam Contacts .....	53
Card Comparing .....	23	Summary Punch Emitter .....	53
		Card Lever Contacts .....	53
		Stacker Roll Contact .....	55
		Start and Stop Keys .....	55
		<b>LUBRICATION</b> .....	56
		IBM 6 .....	56
		IBM 9 .....	56
		IBM 12 .....	57
		IBM 17 .....	57
		IBM 21 .....	57
		<b>CIRCUITS</b>	
		<b>REPRODUCING</b> .....	58
		Punch Hopper and Read Hopper Card Levers .....	59
		Circuit to Start Machine .....	59
		Motor Circuit Analysis .....	59
		Drive Motor Circuit .....	61
		Feed Clutch Circuits .....	61
		Motor Running Circuit .....	62
		Reproducing Circuit (Punch Magnet) .....	63
		Interlocking Circuits .....	63
		Feed Magazine Interlocks .....	63
		Read and Punch Station Interlocks .....	63
		Verifying Reproduced Information .....	64
		<b>GANG PUNCHING</b> .....	64
		Motor Circuits .....	64
		Motor Start Circuit .....	64
		Motor Running Circuit .....	65
		Punch Feed Clutch Circuit .....	65
		Punching Circuit .....	65
		Gang Punch Verification .....	65
		Interspersed Gang Punching .....	65
		Verifying Gang Punching with Interspersed Master Cards .....	66
		Motor Hold Circuit for Verifying Operation Only .....	67
		X Elimination .....	67
		Class Selection .....	67
		Class Selector Relay Circuit .....	68
		Verifying Class Selected Reproduced Data .....	68
		Offset Gang Punching .....	70
		Detail or Master Switch .....	70
<b>MECHANICAL PRINCIPLES</b>			
Location of Units and Parts .....	24		
Drive Mechanism .....	25		
Principle of Punching .....	27		
Geneva Mechanism .....	28		
Single Revolution Timing Cam .....	30		
Feed Knives .....	30		
Clutches .....	31		
Oil Pump .....	32		
C-Cams .....	32		
R-Cams .....	32		
P-Cams .....	33		
Comparing Unit .....	33		
<b>REMOVAL AND ASSEMBLY PROCEDURES</b>			
To Remove the Drive Housing .....	34		
To Replace the Drive Housing .....	35		
Removal and Assembly of Geneva Mechanism .....	36		
To Replace the Geneva Mechanism .....	36		
To Remove the Magnet Unit .....	38		
To Remove a Feed Roll .....	39		
To Remove the Feed Roll Opening Device .....	39		
To Remove a Punch .....	40		
To Remove a Die and Stripper .....	41		
To Install a New Die and Stripper Assembly .....	41		
To Remove a Magnet or Magnet Armature .....	42		
To Remove the Eccentric Shaft .....	42		
To Remove a Stacker .....	42		
To Remove a Contact Roll .....	42		
<b>ADJUSTMENTS</b>			
<b>CLUTCHES</b> .....	43		
Punch and Read Clutch .....	43		
<b>GENEVA MECHANISM</b> .....	44		
Single Revolution Timing Cam .....	44		

## CONTENTS (continued)

Combination Reproducing and Gang Punching with Master Cards Interspersed in the Punch Unit	70	Read Circuit	82
Selective Reproducing	70	Delay and Punch	82
0 and X Circuit	71	Mark X	83
Summary Punch Emitter	71	Circuit Grouping	83
Special Interlocking Features	71	Heater Open Circuit	83
		Heater Short Circuit	84
		Bias Voltage Tests	84
		Checking the Mark Sensing Device	84
		Meter Test	85
<b>MARK SENSING DEVICE</b>			
<b>OPERATION</b>	73	<b>SPECIAL DEVICES</b>	
Cards, Pencils and Leads	73	<b>DOUBLE PUNCH AND BLANK COLUMN DETECTION</b>	87
Control Panel	73	Circuits	87
Switches	74	<b>OFFSET STACKER</b>	88
Capacity	74	Mechanical Electrical Principles	88
Units	74	Adjustments	90
<b>MECHANICAL-ELECTRICAL PRINCIPLES</b>	75	<b>PURPOSES OF CAMS AND CONTACTS</b>	
Feed Rolls	75	<b>STANDARD MACHINE RELAYS</b>	93
Die Card Lever	76	<b>MARK SENSING RELAYS</b>	97
Mechanical Delay Unit	76	<b>OFFSET STACKER RELAYS</b>	97
Adjustments	76	<b>DOUBLE PUNCH AND BLANK COLUMN DETECTION RELAYS</b>	97
Mark Sensing Brushes	78	<b>C-CAMS</b>	97
Mark Sensing Brush Timing	78	<b>P-CAMS</b>	98
Heat Units	79	<b>R-CAMS</b>	98
<b>CIRCUITS</b>	79	<b>MECHANICAL REVIEW QUESTIONS</b>	99
Mark Sensing Switch Circuits	79	<b>ELECTRICAL REVIEW QUESTIONS</b>	100
Tube Types	80		
Polarity	80		
Operation of the Electronic Delay Unit (Using OA4G)	80		
Theoretical Tube Circuit 25L6	81		



AUTOMATIC REPRODUCING PUNCH

Type 513

# AUTOMATIC REPRODUCING PUNCH TYPE 513

## FUNCTIONAL PRINCIPLES

Among the marked advances made in the IBM Punched Card Accounting Machine method are the machines which can automatically transcribe repetitive data. Originally, the copying of punched holes had to be done by a manual or semi-automatic method. In the Type 513 Automatic Reproducing Punch is incorporated a punching mechanism which permits high speed automatic card punching and complete flexibility. The automatic punching of repetitive data means increased speed and accuracy in the accounting procedure. The Type 513 Automatic Reproducing Punch is a valuable unit in an accounting machine installation because it can perform the functions of reproducing, gang punching, and summary punching, thereby eliminating the necessity of having more than one machine to perform all three operations. In addition to copying information already recorded in the form of punched holes, the mark sensing device provides for automatic punching of data recorded on the original document, the IBM card, in the form of pencil marks.

### FUNCTIONAL PRINCIPLES

The functions of the Type 513 Automatic Reproducing Punch may be classed under five general headings.

Reproducing is the operation whereby all, or any part of the information which is punched in one set of cards can be punched into another set of cards. The information can be transcribed either in the original or in a different location on the card. At the same time that the reproducing operation takes place, the cards can be verified for accuracy of the reproduction. Any discrepancy between the punching of the original and new cards is indicated to the operator by a signal light and an indicator, which points out the column in which the discrepancy occurred, and an automatic machine stop.

Gang punching is the operation whereby identical information can be copied from a master card into a group of detail cards. Although the gang punching is usually column for column, with the use of a class selector information may be punched into columns other than those punched in the master card. Any number of master cards can be interspersed throughout the set of detail cards. The information which is to be punched will change automatically each time a new master card feeds into the machine.

Cards which have been gang punched can be verified for the accuracy of the punched data. It is also possible to verify that detail cards which are to be gang punched are associated with the correct master cards.

Summary punching is the operation whereby totals accumulated in an electric accounting machine, along with either alphabetic or numerical indicative information, may be automatically recorded in a punched card by the Type 513 Punch. The manual punching of summary cards from totals appearing in reports was formerly a time-consuming routine. Summary punches automatically prepare total or new balance cards simultaneously with the accumulation of totals and printing of reports. These summary or new balance cards are utilized to reduce the volume of cards in the current file in order to speed up the compilation of the accounting and statistical analysis. Debit or credit balances can be identified by an X punching in any desired column of the summary card.

Reproducing and gang punching can be performed at the same time as summary punching. During a non-listing operation, therefore, employees' earnings cards can be summary punched

with employee number, deductions, and earnings at the same time that employee name is reproduced from a corresponding master card in the reading unit, and as date is gang punched from the punch unit. One cycle later, employee number and name punched in the summary card are compared with the employee number and name punched in the master source card, thereby verifying both the correct association of employee number and name in the summary card and the accuracy of the reproduction of the name.

With the installation of the mark sensing feature on the Type 513 Punch, punched card accounting is made completely automatic because it is possible to punch information which is recorded on an IBM card in the form of pencil marks. These pencil marks may be transcribed into punched holes at the standard operating speed of 100 cards per minute. As applications frequently permit marking the source information directly on the card, the automatic punching of this information both simplifies and accelerates the accounting procedure.

#### FEATURES

##### Models

There are six models of the Type 513 Punch available. Basically, the machines all operate in the same manner, but there is a model to meet the needs of each user. These models are:

- Reproducing Punch.
- Reproducing Punch with 45 columns of comparing.
- Reproducing Punch with 80 columns of comparing.
- Reproducing Punch with 45 columns of comparing, and summary punching (Alphabetical or Numerical Accounting Machine).
- Reproducing Punch with 80 columns of comparing, and summary punching (Alphabetical or Numerical Accounting Machine).
- Reproducing Punch with mark sensing, with or without comparing and summary punching.

##### Card Feeds

There are two feed mechanisms, one in the read unit and one in the punch unit. For all operations, cards are placed in the feed hopper face down, 12 edge first. The feeds are electrically interlocked so that when both feeds are being used the machine will automatically stop if either hopper should become empty or if a card should fail to feed.

##### Read Unit — Figure 1

In its path through the read unit, the card passes first five read X brushes, second 80 reproducing brushes, and third 80 comparing brushes. The card then passes into the stacker. The five X brushes can be set to read an X punch in any five columns of the card provided they are separated by at least two columns. The 80 reproducing brushes read the information from the card to be reproduced and signal the punch unit to punch. The 80 comparing brushes provide a means of checking the accuracy of the reproduced or gang punched information. The stacker stacks the cards in the same order in which the cards were placed in the feed.

##### Punch Unit—Figure 1

In its path through the punch unit, the card passes first six punch X brushes, second the die and punch position, and third the 80 punch brushes. The card then passes into the stacker. The six punch X brushes can be set to read any six columns of the card provided they are separated by at least two columns. Between the punch X brushes and the die and punch position are the 27 mark sensing brushes, if the punch is equipped with the mark sensing device. In the die and punch position there are 80 punches, one for each column of the card. These punches are controlled by 80 magnets, one for each punch. Each card passes the punch die with its 12 edge first, so that the 12 position is first to be punched. There is a separate punch for each column of the card;

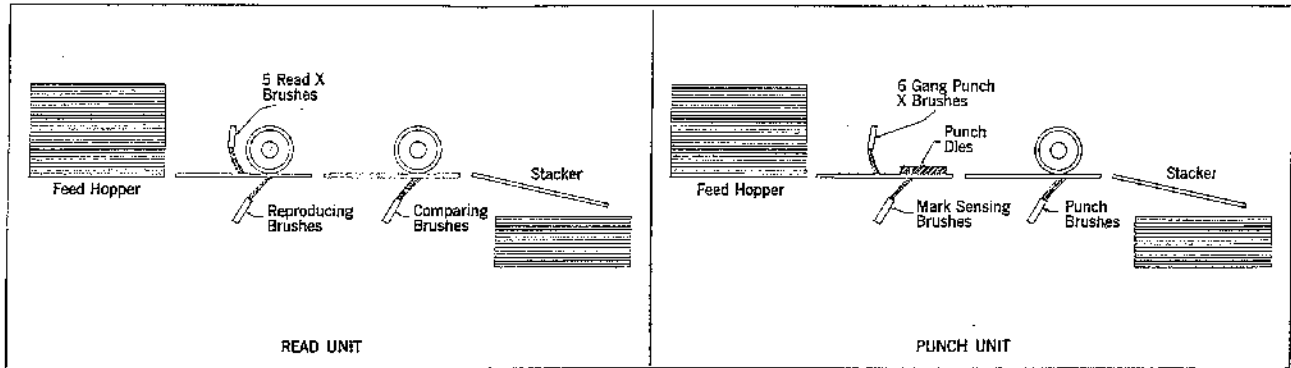


Figure 1. Schematic of feeds

therefore, every 12 position hole is punched at one time. The card advances to the 11 punching position and every 11 position hole is punched, etc., until all positions in the card have been punched, the last being the 9 position. Thus, the card is punched completely in twelve stations of the card cycle. The next card position is represented by the 80 punch brushes. The punch brushes in conjunction with the comparing brushes provide a means of comparing the information just punched with that of the card in the read unit from which the information was read. They are also used to signal the punch magnets to operate in a gang punching operation.

#### Stackers

There are two stackers, one for each unit, with a capacity of 1000 cards. If either stacker should be filled to capacity, the machine will be automatically stopped by the stacker stop switch (Figure 2).

#### Speed

Gang punching, reproducing, and mark sensing operations are performed at the rate of 100 cards per minute. Summary punching from the Alphabetical Accounting Machine requires 1.2 seconds per summary card. Summary punching from the

Numerical Accounting Machine requires .8 second per summary card. All speeds are constant, regardless of the number of columns to be punched. The time required for summary punching is in addition to the total print and reset time of the accounting machine involved.

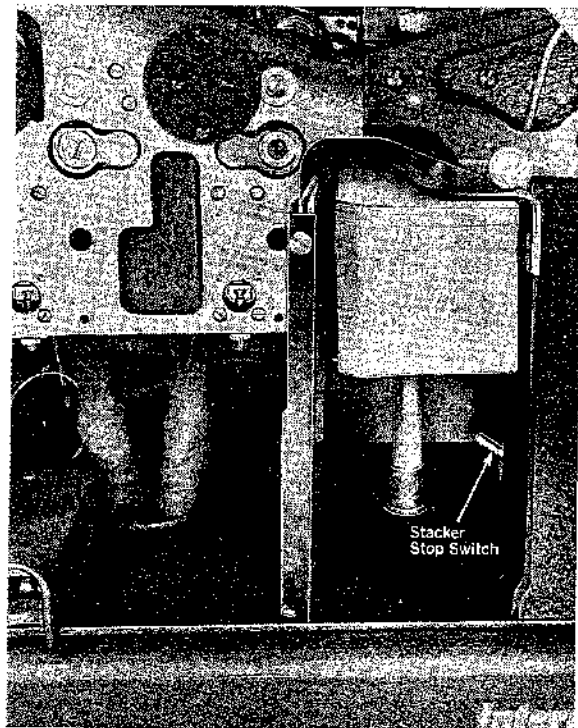


Figure 2. Stacker stop switch



### Alphabetic and Numerical Punching

Both alphabetic and numerical data can be punched. Columns which have more than one numerical position punched, as for digit selection, can also be reproduced or gang punched.

### Current

All machine circuits operate on 40 volt direct current obtained from either a dynamotor or motor-generator set which is a part of the machine. The machine may be connected to any commercial source of supply, either alternating or direct current, by changing the drive motor and dynamotor or motor generator for the proper supply. On alternating current operation, a motor generator is employed to supply the 40 volt direct current, whereas on direct current supply, a dynamotor is used. When the generator builds up to 40 volts, a green jewel light glows. A table of the start and running currents on 110 and 220 volts follows:

### COMPARING REPRODUCER (80 columns)

Volts	Start Amps	Run Amps
110 AC	35.0	9.2
110 DC	15.0	7.5
220 AC	17.0	4.6
220 DC	10.0	3.8

Weight 945 lbs. packed; weight 735 lbs. unpacked.  
Dimensions: Length 47", width 21", height 48".

### Comparing Light and Indicator — Figure 3

On machines equipped with the comparing feature, a red light signals a discrepancy in the verifying operation. In addition, the machine automatically stops and an indicator points out to the operator the positions in which the discrepancy occurred.

### Control Panel — Figure 4

The automatic control panel is the medium through which the punching and verifying operations of the reproducer are controlled.

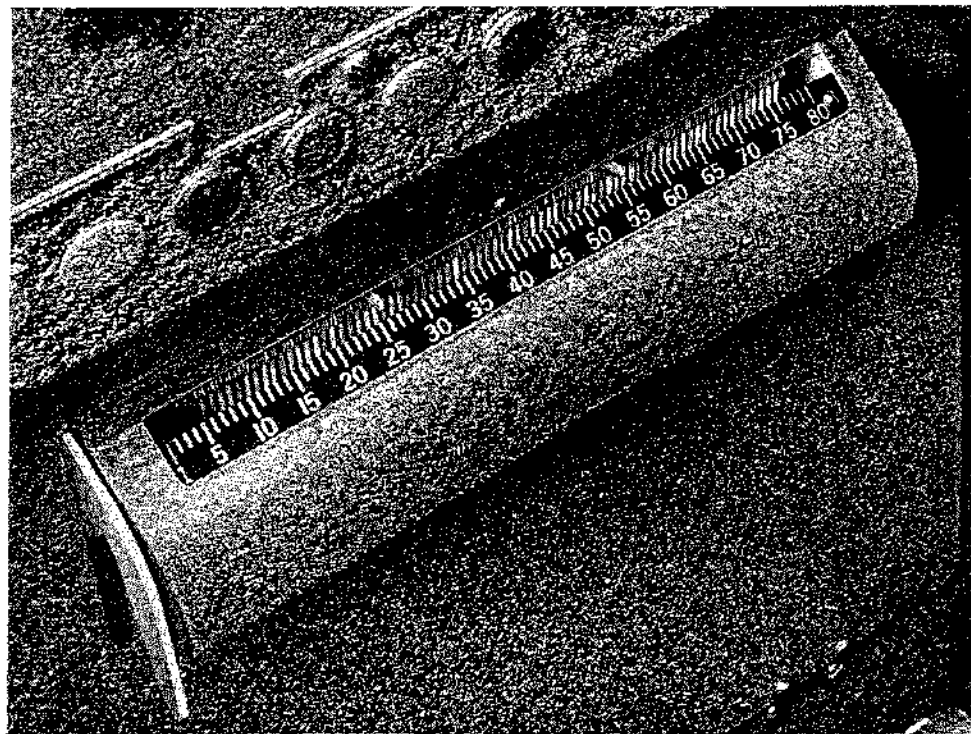


Figure 3. Comparing indicator

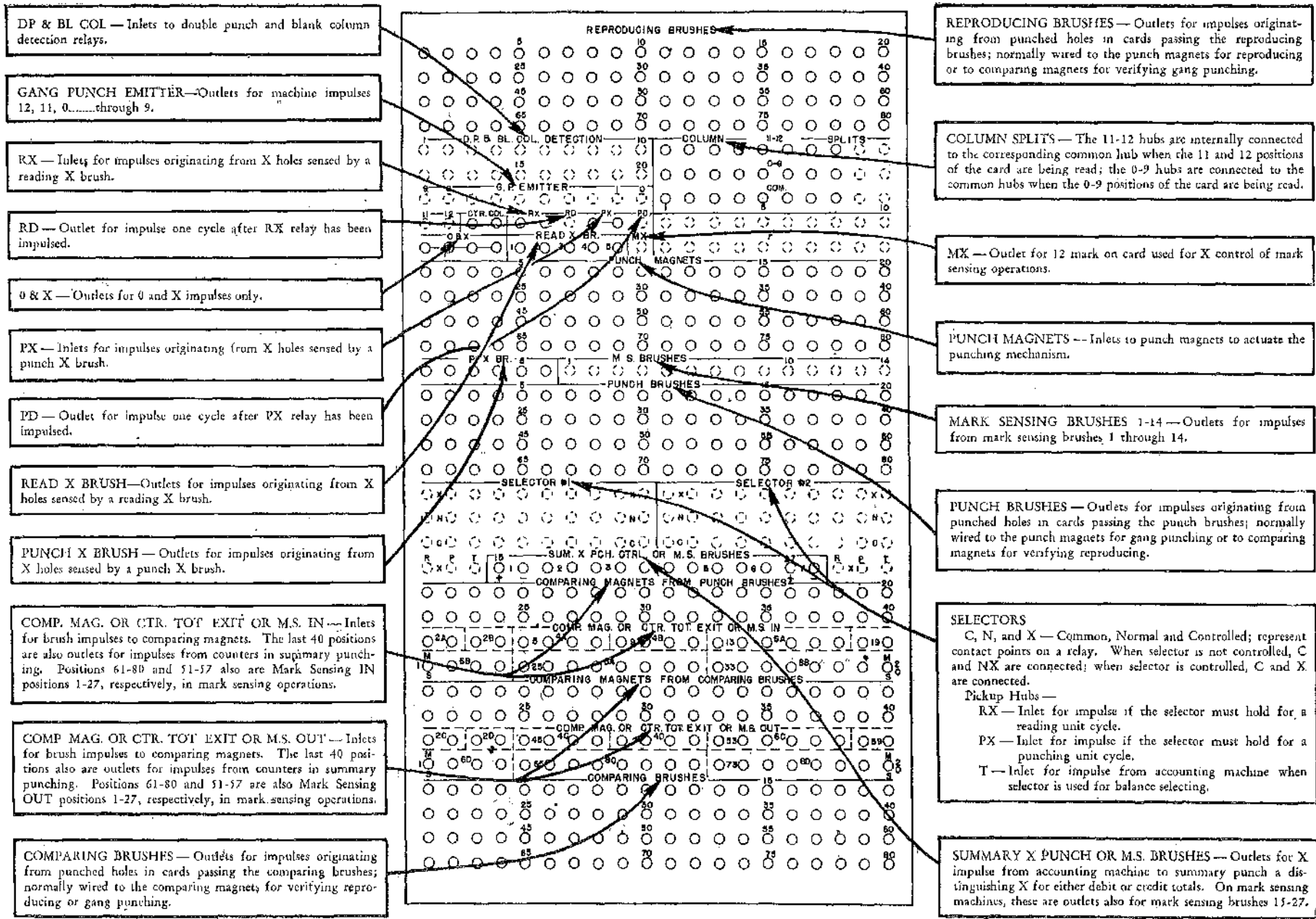


Figure 4. Control panel layout

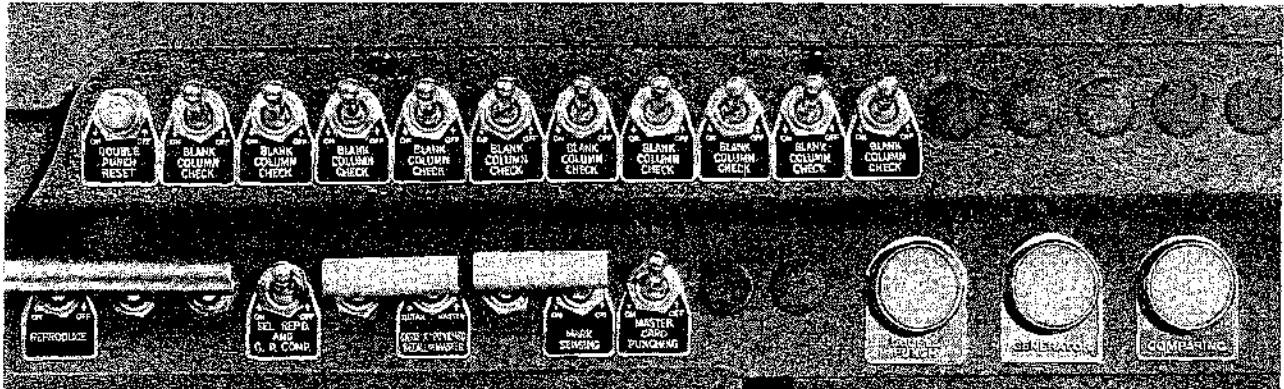


Figure 5. Switches

#### Main Line Switch — Figure 5

The main line switch controls the motor-generator, and must be ON for all machine operations. A green light labeled Generator indicates to the operator that the switch is turned ON.

#### Reproducing Switch — Figure 5

This switch, when ON, synchronizes the feeds of the read and punch units; if either hopper becomes empty, the machine will automatically stop. The reproducing switch must be ON for all reproducing operations. It must be OFF for any gang punching, summary punching, or mark sensing operation.

#### Selective Reproducing and Gang Punch Comparing Switch

This switch, when ON, allows continuous feeding in the read unit. If the switch is turned OFF, an impulse to the PX hub will cause the read unit to stop feeding for the following card cycle.

In selective reproducing or interspersed master card gang punching and verifying operations, the operation of the read unit should not be affected by an impulse to the PX hub. For either operation, therefore, the switch must be ON.

For any other operation, particularly in a combination reproducing and interspersed master gang punching operation, the switch must be OFF. In the latter case, it is necessary to stop feeding in the read unit for one card cycle while a gang punch master card is passing under the punches. If the read unit feed did not stop for one card cycle, a source card would not be reproduced whenever a gang punch master card passed through the punch unit.

#### Detail or Master Switch — Figure 5

This switch involves control X or No X punching. It should be set to MASTER, except when gang punching with interspersed master cards and the detail cards rather than the master cards have the control X punch, or when selective reproducing and the X punched source cards (rather than the No X source cards) are to be reproduced.

#### Comparing Indicator Handle — Figure 3

When an error is indicated during a verifying operation, the operator must reset the comparing magnet indicator to restore the unit and turn off the error light. This is done by raising the handle to the left of the indicator.

OPERATION

Reproducing

For reproducing operations, the read and punch units operate simultaneously. The original cards, called the source cards, are placed in the read unit feed. The cards to be punched are placed in the punch unit feed. As each card feeds in the read unit a corresponding card feeds in the punch unit. As the card in the read unit passes the reproducing brushes, the impulses originating from the brushes reading the holes in the card are transmitted to the punch magnets. These magnets actuate the punch interposers which are attached to the punch. The holes are therefore punched in the blank cards corresponding to the holes in the source cards in the read unit. The columns to be read and the positions to be punched are determined by proper control panel wiring between the reproducing brushes and the punch magnets as illustrated in Figure 6.

Switch settings are as follows: Reproducing switch ON, selective reproducing and gang punch comparing switch OFF, detail or master switch turned to MASTER.

Verifying Reproducing

If it were desired to determine that two cards contained the same information, one could read both cards visually and determine that they were alike or unlike. Similarly, the machine must read the information from two cards and compare it. This is accomplished one cycle after the punching operation, as shown in Figure 1. The source card will be read by the comparing brushes one cycle after it has been read by the reproducing brushes. The reproduced card will be read by the punch brushes one cycle after the punching has taken place. Thus, the information read from the source cards by the comparing brushes and the information read from the reproduced cards by the punch brushes may be compared. To verify reproduced information, the comparing brushes and the punch

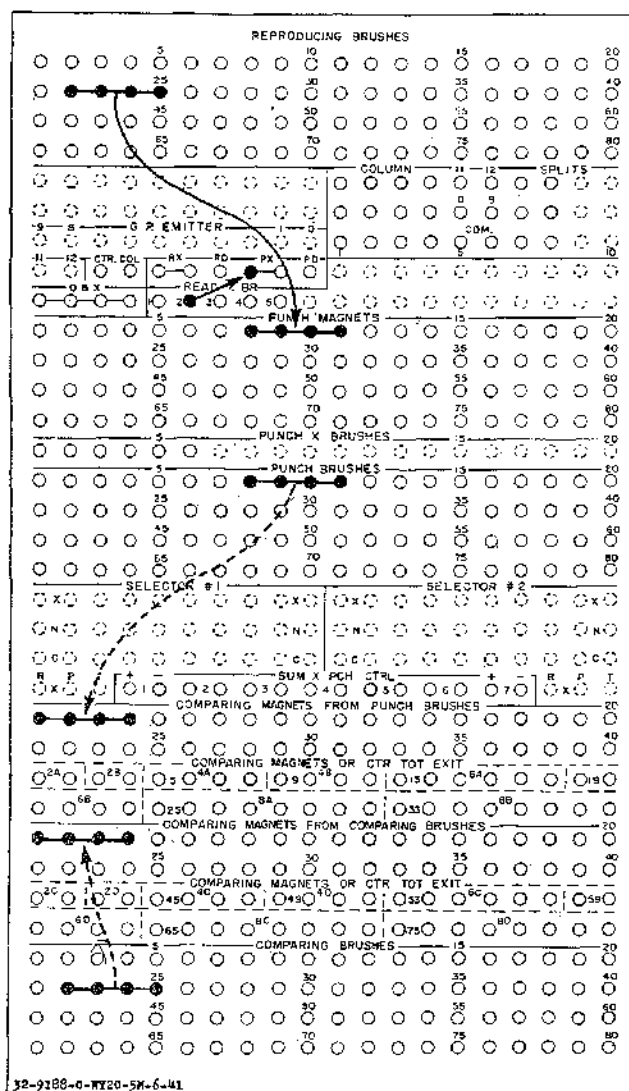


Figure 6. Reproducing and comparing

brushes should be wired to the comparing magnets (Figure 6). If the punched holes sensed by the comparing brushes are exactly the same as those sensed by the punch brushes, the card has been reproduced correctly and the machine continues to operate. If, however, any discrepancy exists between the holes sensed by the brushes, the card is in error and the machine is caused to stop automatically. This verifying operation may be performed concurrently with the reproducing operation.

ENTRY DATE		GROUP	SOURCE	INVOICE DATE			VENDOR NO.	PURCHASE ORDER NO.	CLASS	ACCOUNT	SEQUENCE	OFFICE OR DEPT. CHARGE	GROSS AMOUNT	DISCOUNT	NET AMOUNT	CHECK NO.	DATE PAID	
MO.	DAY			MO.	DAY	YR.											MO.	DAY
00	00	00	00	00	00	00	000000	00	0000000000	0000	0000	00000000	00000000	00000000	000000	00	00	
X-47																		
No X-47																		
00	00	00	00	00	00	00	000000	00	0000000000	0000	0000	00000000	00000000	00000000	000000	00	00	
CLASS		PART NO.		ACCOUNT		SEQUENCE		DEPT. CHARGE		PURCHASE ORDER NO.		VENDOR NO.		QUANTITY		UNIT		
WEEK ENDING	DAY	SOURCE	NO.	DAY	YR.	PURCHASE ORDER NO.	VENDOR NO.	CLASS	SYMBOL	ACCOUNT	SEQUENCE	OFFICE OR DEPT. CHARGE	AMOUNT	ITEM ANALYSIS	PURCHASE ANALYSIS & DISTRIBUTION			
00	00	00	00	00	00	000000	000000	00	00000000	00000000	0000	0000	00000000	00000000	000000	000000		
11	11	11	11	11	11	111111	111111	11	11111111	11111111	1111	1111	11111111	11111111	111111	111111		
22	22	22	22	22	22	222222	222222	22	22222222	22222222	2222	2222	22222222	22222222	222222	222222		
33	33	33	33	33	33	333333	333333	33	33333333	33333333	3333	3333	33333333	33333333	333333	333333		
44	44	44	44	44	44	444444	444444	44	44444444	44444444	4444	4444	44444444	44444444	444444	444444		
55	55	55	55	55	55	555555	555555	55	55555555	55555555	5555	5555	55555555	55555555	555555	555555		
66	66	66	66	66	66	666666	666666	66	66666666	66666666	6666	6666	66666666	66666666	666666	666666		
77	77	77	77	77	77	777777	777777	77	77777777	77777777	7777	7777	77777777	77777777	777777	777777		
88	88	88	88	88	88	888888	888888	88	88888888	88888888	8888	8888	88888888	88888888	888888	888888		
99	99	99	99	99	99	999999	999999	99	99999999	99999999	9999	9999	99999999	99999999	999999	999999		

Figure 7. Accounts payable and accounts payable distribution card

Field Selected Reproducing

Field selected reproducing is reproducing one field from one kind of source card and another field from another type of source card into a common field in the reproduced card.

In Figure 7, the accounts payable card may contain either the gross amount or both gross and net amounts. If no discount is allowed, only the gross amount is punched. If a discount is allowed, both gross and net amounts are punched in the card, and an X is punched in column 47. When the information in these cards is reproduced to accounts payable distribution cards, only the actual amount paid is required. Therefore, a selection must be made between columns 47-54 and 62-69 on the source card to determine which

columns are to be read from the source card and punched in columns 67-74 in the reproduced card. Since the information may be read from one of two sources, an automatic switching and signalling arrangement must be provided. Such a gang switch is provided by a device known as a class selector. The class selector provides for 10 positions of automatic switching from one source to another. The signalling is accomplished by an X in the accounts payable card. When an X appears in column 47 of this card, it indicates that a discount was allowed and that the net amount was actually the amount paid. Therefore, columns 62-69 should be reproduced into the accounts payable distribution card. When an X does not appear in column 47, no discount is allowed and the gross

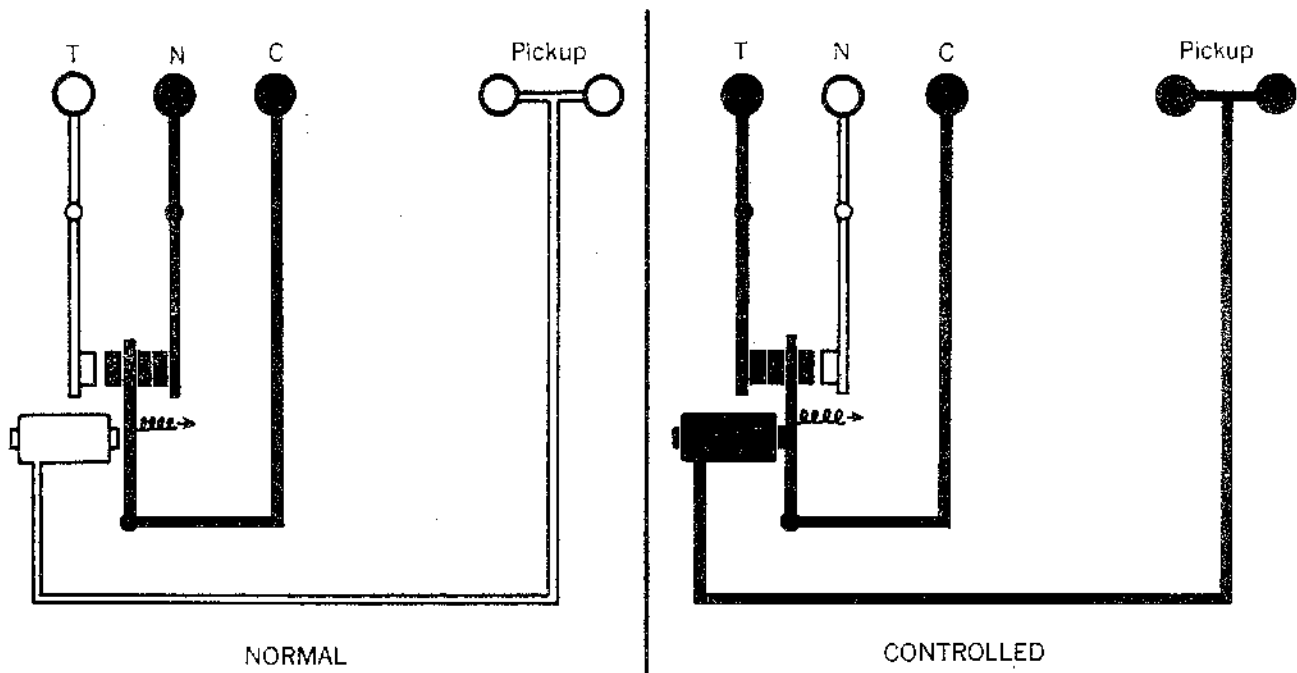


Figure 8. Operation of the class selector

amount appearing in columns 47-54 of the accounts payable card is the amount paid. In such a case no information will appear in columns 62-69 of the accounts payable card. Therefore, the information in columns 47-54 of the accounts payable card must be reproduced into columns 67-74 of the accounts payable distribution card. This operation is known as field selected reproducing.

The operation of the selector may be explained by the operation of one position or unit of the selector (Figure 8). In each unit of the selector, the C hub is normally connected internally to the No X hub; therefore, an impulse entered in the No X hub can come out of the C hub, or an impulse entered into the C hub can come out of the No X hub. This is called the normal connection. As long as no impulse enters the pickup hub of the selector, this connection between C and No X will exist in each of the 10 units of the selector. The pickup hub of the selector can be impulsed by an X punch read by either a PX or an RX brush. When the pickup hub is impulsed, the

normal connection in each of the ten units of the selector is broken for the next card cycle. Under this condition, the selector is said to be picked up or controlled, and the C hubs are connected internally to the X hubs. Therefore, an impulse brought in C can come out of X, or an impulse brought in X can come out of C. When a card is at the X brush station, it is read for an X control punch to determine whether the information in columns 47-54 or columns 62-69 of the source card is to be reproduced into columns 67-74 of the reproduced card. The control panel wiring for this operation is shown by solid lines in Figure 9. The field to be selected from the X punched cards is entered in the X or controlled row of hubs; the field to be selected from the No X cards is entered in the normal or No X row of hubs, and the common or C row of hubs is connected to the desired punch magnets. A reading X brush must be placed on the X control column and the proper reading X brush hub connected to the RX hub. The class selector is then impulsed by the second RX hub.

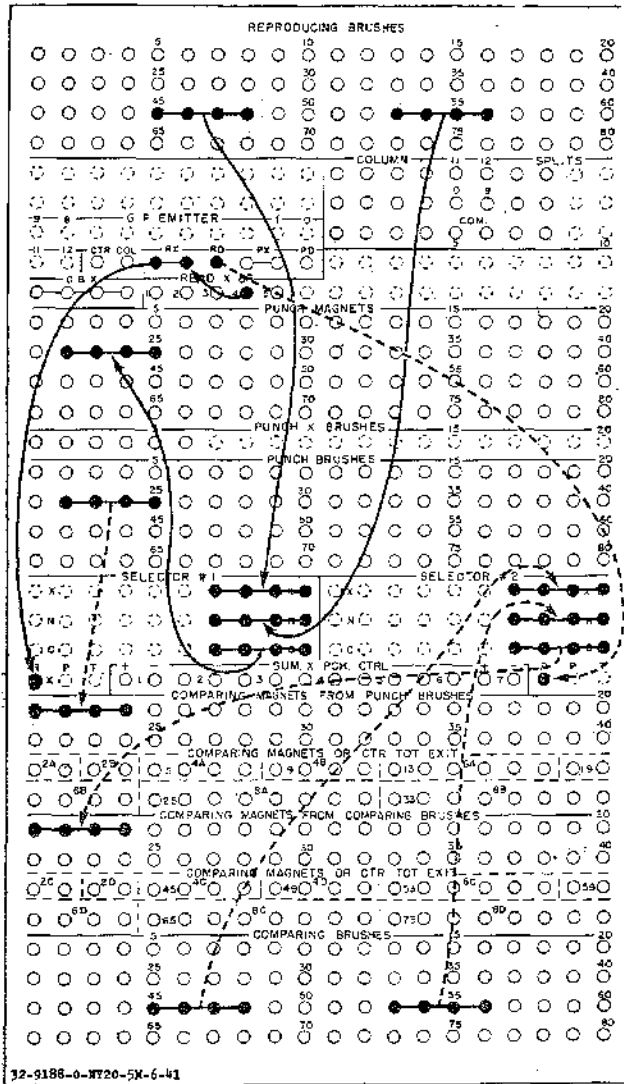


Figure 9. Field selected reproducing

X source cards are punched in columns 45-48; No X source cards are punched in columns 53-56; reproduced cards are to be punched in columns 22-25.

If this punching is to be verified, a second class selector must be used. The field of the X punched card picked up by the comparing brushes is entered in the controlled row of hubs; the No X card field picked up by the comparing brushes is entered in the normal row of hubs. The selector must be impulsed by an RD impulse, as the X impulse must be held until the X card has passed from the read

X brushes, to the comparing brushes. The common row of the class selector is taken to the comparing magnets, where it is compared with the field read by the punch brushes.

The wiring for verifying field selected reproducing is shown in dotted lines in Figure 9.

The switch settings are as follows: Reproducing switch ON, selective reproducing and gang punch comparing OFF, detail or master switch turned to MASTER.

### Selective Reproducing

Selective reproducing is the operation whereby any source card with a particular X (or No X) punch will not be reproduced. For each X (or No X) source card there will be a blank card in the reproduced deck. As in normal reproducing, the proper reproducing brushes are connected to the punch magnets. In addition, a read X brush must be placed on the column in which the X punch is located and the proper read X brush hub is connected to the PX hub, which, when impulsed, prevents the punch magnets from operating for the following card cycle. Therefore, a blank card will pass through the punch unit.

The verification of selective reproducing is the same as for straight reproducing. The comparing and punch brushes are wired to the comparing magnets. Control panel wiring is shown in Figure 10.

Switch settings are as follows: Reproducing switch ON; detail or master at MASTER if the No X cards are to be reproduced, or to DETAIL if the X source cards are to be reproduced; selective reproducing switch ON.

### Gang Punching, Column-for-Column with Single Master Card

Gang punching is a term applied to the operation of punching common data into a group of cards. This requires one card punched with the desired data, and the cards to be punched. This operation is frequently used for punching the date in a file of cards. The card, punched with

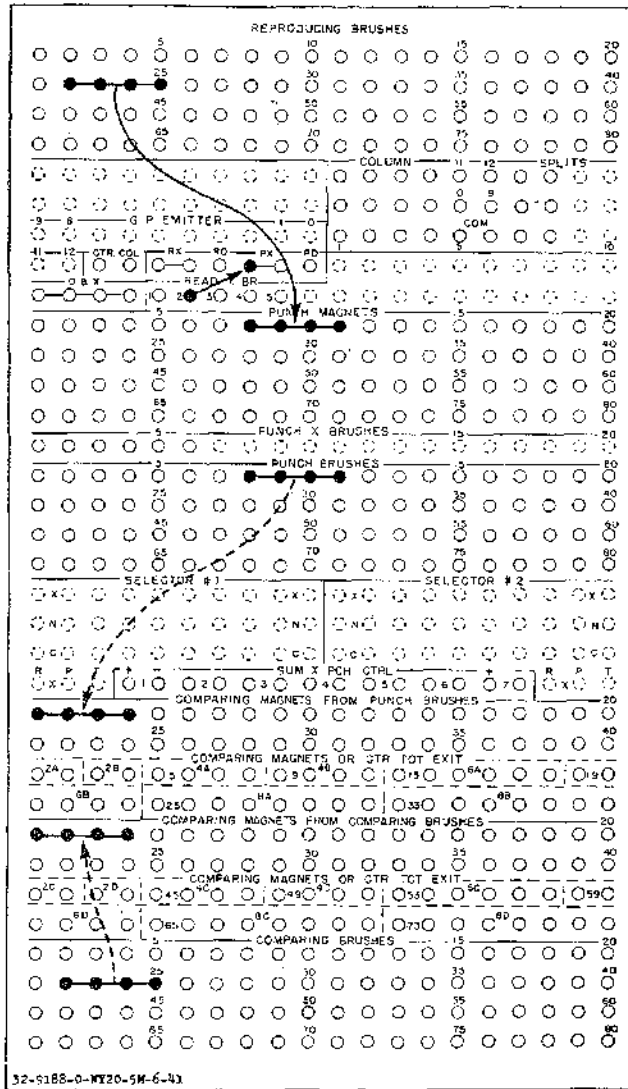


Figure 10. Selective reproducing  
Columns 22-25 into columns 8-11.

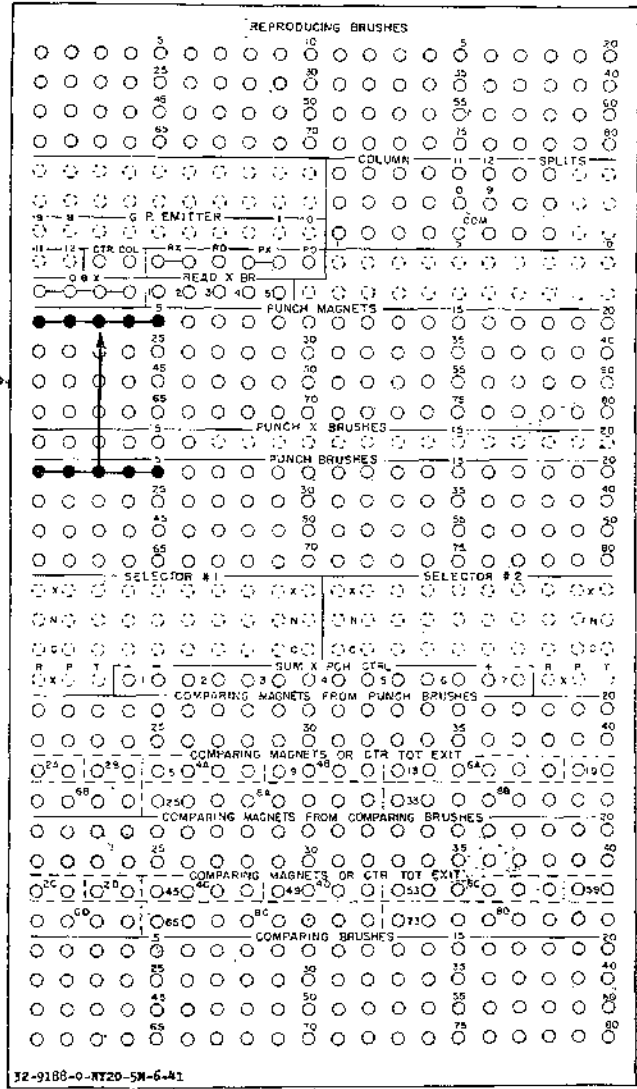


Figure 11. Single master card gang punching  
Columns 1-5 into columns 1-5.

the desired data is known as the master card and is placed in the magazine first. As the master card passes the punch brushes, the holes are read and the impulses are transmitted to the punch magnets (Figure 11) to cause holes to be punched in the detail card in the punching position. As this card advances to the punch brushes, it becomes the setup card for the following card. Each card in turn

acts as the setup card for the one which follows.

The quickest method of verifying this type of gang punching is to compare visually the master card with the last card punched.

Switch settings are as follows: Reproducing switch OFF, selective reproducing and gang punch comparing switch OFF, detail or master switch turned to MASTER.



### Gang Punching with Interspersed Masters

The gang punching operation previously described involves the use of only one master card. At times, however, it is desirable to intersperse master cards between the detail cards to be punched. The data punched in a given field of the master card is to be punched in a given field in all of the detail cards which follow. Since each card becomes the setup card for the card following, such an operation requires that no punching be performed when the last detail card of one group is passing the punch brushes and the master card of the next group is passing the die. On such a machine cycle, all punching must be suppressed to prevent the information from the last detail card of the previous group from being punched into the master card of the succeeding group. The machine must receive a signal to stop punching for the cycle during which the master card is passing the punching station, and this signal must come before the card enters the punching station. Reference to Figure 1 will indicate that the card passes beneath the punch X brush before it reaches the punching position and that the X brushes provide such a means of signalling at the proper time.

The master cards are inserted in front of the detail cards, and either the master or the detail cards must have a distinguishing X punch. For example, in a payroll application two things are usually required; paying the employee for work done, and charging the employee's earnings to the various jobs or departments for which the work was done. This latter phase is known as labor distribution. One labor distribution card is punched for each job done. This card will be punched with the job number, the time spent on the job, and the rate of the employee's pay. Before the cost of the various jobs can be computed, the hours must be multiplied by the employee's rate. Rate times the time equals the amount to charge. Where the time periods and the rates do not vary too much, this operation can be performed by a gang punching operation.

For each time period and rate, a master card is made. This master card is punched with specific hours, rate and the product of the hours times the rate. The master cards will be identified by an X punched in a predetermined column.

All of the master cards and detail cards are sorted together on both the hours field and the rate field. The master cards are placed in the sorter first, hence the cards will be arranged as follows:

	<u>Hours</u>	<u>Rate</u>	<u>Product</u>
X Master	.5	\$ .80	.40
Detail	.5	.80	
Detail	.5	.80	
Detail	.5	.80	
Detail	.5	.80	
X Master	1.0	.80	.80
Detail	1.0	.80	
Detail	1.0	.80	
Detail	1.0	.80	
X Master	1.5	.80	1.20
Detail	1.5	.80	
Detail	1.5	.80	

All cards for .5 hours at .80 per hour will fall behind the master card for .5 hours at .80 per hour when sorting. The product (.40) read from the first master card will be punched in the product field of the detail cards which follow. Each card will act as the setup card for the card following. However, when the last detail card of this group is passing the punch brushes, the master card for the second group will be passing the die. This master card is punched .80 in the products field and .80 should be punched in the products field of the cards following, etc.

Figure 12 shows the control panel wiring for such an operation. In addition to wiring from punch brushes to punch magnets, a punch X brush, placed on the column in which the control X is punched, should be connected to the PX hub; this wiring allows the master cards to pass the punching position without being punched with

information picked up from the preceding detail card.

In verifying gang punching with interspersed masters, the cards are taken from the punch unit stacker and placed in the read unit feed. The verification is accomplished by comparing the punched holes of the card at the comparing brush station with those of the card which is at the reproducing brush station. The relationship of cards for verification is similar to that of gang punching; the master card is compared with the first detail card and each subsequent detail card is compared with the card which immediately follows it. When a discrepancy occurs, the machine stops and the signal light glows. The cards in the stacker and the feed hopper should be removed and the indicator reset. When the start key is depressed, the second and third cards entering the stacker are the cards which were being compared when the discrepancy occurred.

In verifying gang punching with interspersed master cards, it is necessary to prevent comparison between the master card of one group and the last detail card of the previous group. This is accomplished by connecting the proper read X brush to the RX hub. The reproducing and comparing brushes should be connected to the comparing magnets (Figure 12).

Switch settings are as follows: Reproducing switch OFF, and selective reproducing and gang punch comparing switch ON (OFF if not verifying). The detail or master switch is turned to MASTER if the control X is in the master card, or to DETAIL if the X is in the detail cards.

**Offset Gang Punching**

In the preceding example of interspersed master card gang punching, the information in both the master card and the detail card was punched in the same field. If, however, some information is to be punched in the deduction cards in a different field from that punched in the master cards, a class selector must be used. The punch brushes cor-

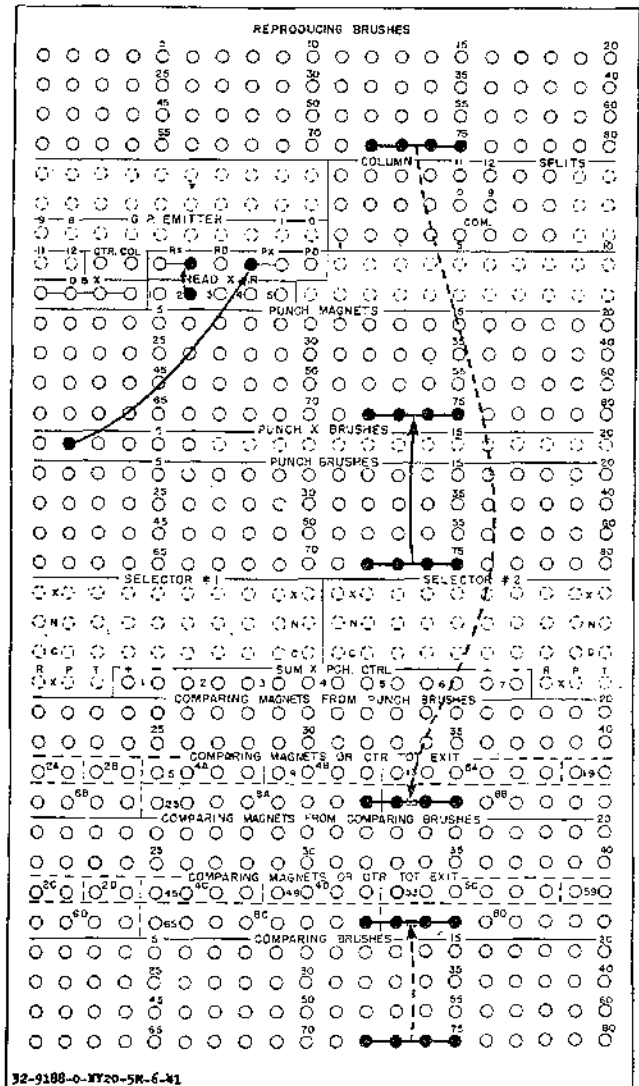


Figure 12. Interspersed master gang punching

Columns 72-75 into columns 72-75; X column 16 in Master Card; 2nd PX and RX brushes are set on column 16.

responding to the columns punched in the master cards are connected to the controlled hubs of a class selector; the punch brushes corresponding to the columns to be punched on the detail cards are connected to the normal row of hubs; the common hubs of the selector are connected to the punch magnets corresponding to the columns to be punched in the detail cards. The selector must then be controlled on a PD impulse in order to be operative when the X punched master card has

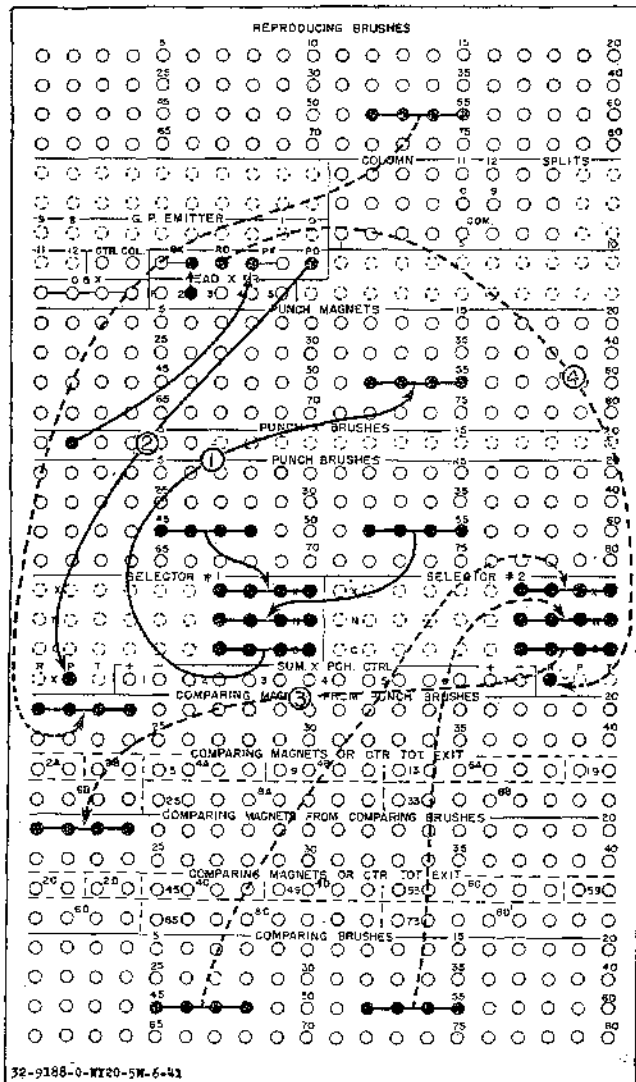


Figure 13. Offset gang punching

1. Detail cards are to be punched columns 52-55 from a master card punched columns 45-48.
2. Selector is controlled on a PD; there is a connection between C and X when the X punched master is at the punch brushes.
3. The comparing brushes read columns 45-48 in the master cards and columns 52-55 on the detail cards and are connected to the comparing magnets.
4. Selector is controlled on a RD; there is a connection between C and X when the X punched master is at the comparing brushes.

moved from the punch X brush past the die to the punch brushes (Figure 13).

The verification of offset gang punching requires another class selector. A read X brush is placed on

the proper column to read the master X punch and the brush outlet is connected to the RX hub. The comparing brushes corresponding to the columns punched in the master card are connected to the controlled hubs of the selector; the comparing brushes corresponding to the columns punched in the detail cards are connected to the normal hubs of the selector; and the common hubs of the selector are connected to the comparing magnets. The reproducing brushes corresponding to the columns punched in the detail card are wired to the comparing magnets. The selector is controlled by an RD (read delay) in order that it may be operative when the X punched card has moved from the read X brush station to the comparing brushes (Figure 13). In the offset gang punching operation the PX and RX hubs, when impulsed, perform their respective functions of preventing master cards from being punched and compared with the last detail card of the preceding group.

The switch settings should be set as follows: Reproducing switch OFF, selective reproducing and gang punch comparing switch ON (OFF if not verifying), detail or master switch turned to MASTER.

#### Combination Reproducing and Gang Punching

For all combined operations, the separate read and punch units operate in unison as described for reproducing. If it is desired to gang punch at the same time straight reproducing is being done, it is necessary only to place a card containing the information to be gang punched in the punch unit feed ahead of the blank cards. If the master card is to be used only as a setup card and is not X punched, it will be necessary to precede the cards in the read feed with a blank card. This is necessary to prevent the information from the first source card from being reproduced into the master setup card. If the master setup card is X punched, and the PX brush is wired to the PX pickup hub, it will not be necessary to place the blank card in the read feed.

X Elimination or Transfer

By wiring a brush column to the common hub of a column split, the numerical punches of that column can be taken out of the 0-9 hub to a punch magnet. The X or 12 punch of that column can be eliminated completely, or taken from the 11 and 12 hub of the same column split to a different punch magnet, as shown in Figure 14.

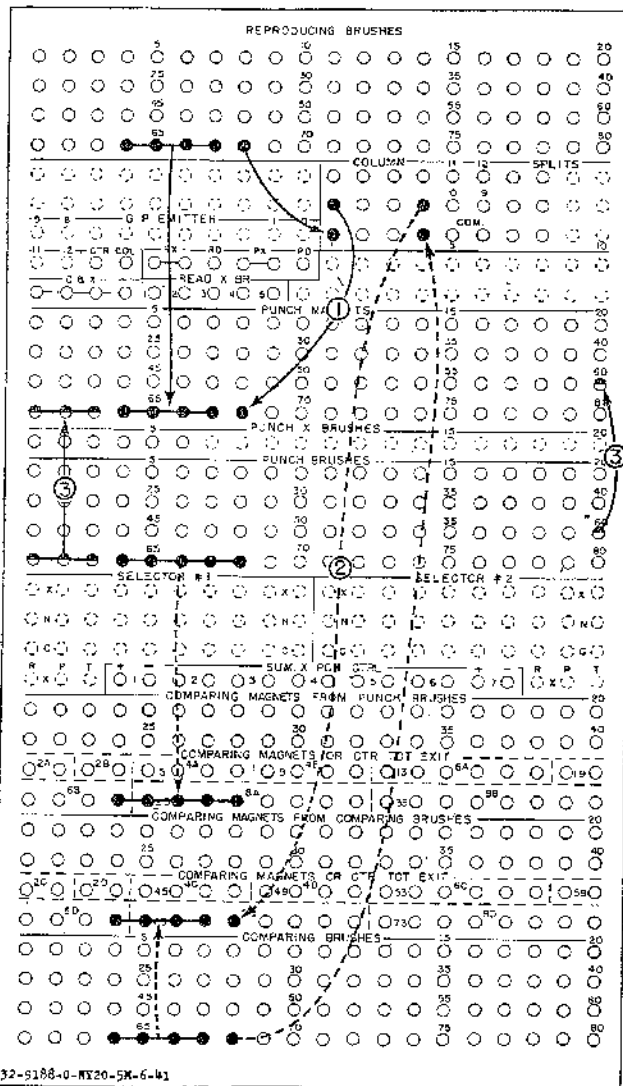


Figure 14. Reproducing with X-elimination and gang punching

1. X column 68 eliminated in reproducing columns 64-68.
2. X column 68 eliminated in verification of columns 64-68 punching.
3. Gang punching columns 60-63 into columns 60-63.

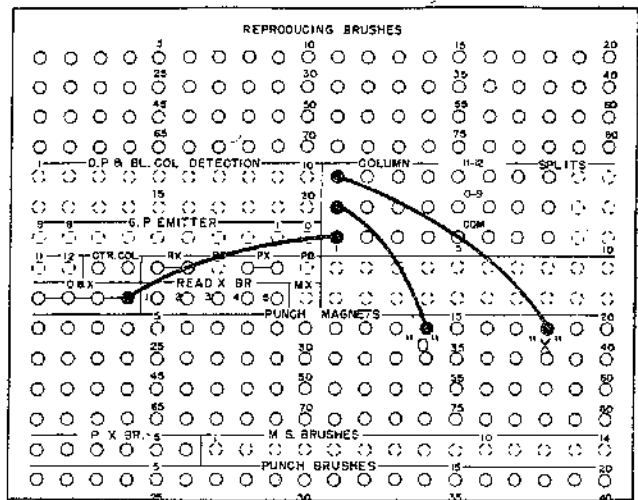


Figure 15. Use of 0 and X hubs

The 0 and X hubs emit both 0 and X impulses, and a column split may be used to punch a single 0 or X, as shown in Figure 15.

Summary Punching

Summary punching is an operation whereby totals are accumulated in counters in an accounting machine, then punched into a card by a Type 513 Reproducing Summary Punch. In this way the totals of amounts, hours, etc., from several cards may be punched in one card, thereby reducing the volume of cards in a file. This speeds up other operations because only a small number of cards need be used.

For the summary punching operation, the Type 513 Reproducing Punch is attached to the accounting machine by the connector cable. The accounting machine accumulates totals until a change occurs in the control from which the totals are to be punched. The accounting machine then stops, and does not print or reset until the punching of the summary card has been completed. The punch magnets in the Type 513 Reproducing Punch are actuated through the medium of an emitter, which reads the amounts standing in each counter and transmits the impulses to the punch magnets in the sequence determined by the wiring

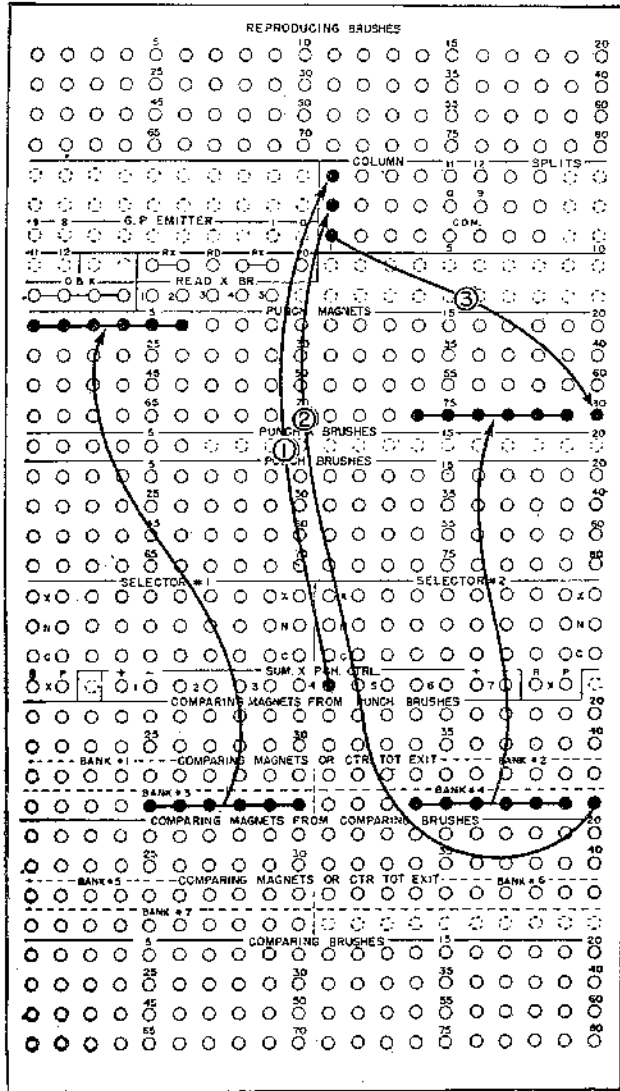


Figure 16. Summary punching with Numerical Accounting Machine

1. Credit X is wired to column split.
2. Units position of Amount field is wired to same columns split.
3. Units position of Amount field is punched, and if field is a credit amount, an X is also punched.

arrangement. The reset circuit of the accounting machine is made operative when the punching of the summary card has been completed. At this time the machine prints the total, resets the coun-

ters to zero and group indicates the next control group in the normal manner.

#### Summary Punching with a Numerical Accounting Machine

Summary punching with a numerical accounting machine can be done by wiring from the proper counter total exits to the punch magnets. If an X punch to distinguish a credit (or debit) total is needed, wire from the — (or +) hub of the summary X punch control unit corresponding to the number of the balance counter involved in the operation; that is, if the total of bank 4 is to be summary punched, the — (or +) hub of the 4th summary X punch control unit is used. To punch the X and a numerical punch in the same column the X is taken to the 11-12 hub of a column split, the numerical information to the 0-9 hub, and the C of the column split is connected to the punch magnets. Refer to Figure 16.

#### Summary Punching with a Net-Balance Alphabetical Accounting Machine

To summary punch from a net-balance accounting machine, the proper counter total exit hubs are wired to the punch magnets. An X punch to identify a credit (or debit) total may be obtained by wiring on the accounting machine control panel the proper counter summary — (or +) hub to a column split device. This column split hub is internally connected to the correspondingly numbered column split on the summary punch control panel. By wiring the C hub of the summary punch column split to a punch magnet, an X will be punched. If a numerical punch is to be in the same column as the X, the numerical impulse must be brought to the 0-9 hub of the column split and both impulses can be taken out of the C hub. Wiring is shown in Figure 17.

The reproducing switch should be OFF, the selective reproducing and gang punching comparing switch OFF, and the detail or master switch should be turned to MASTER.

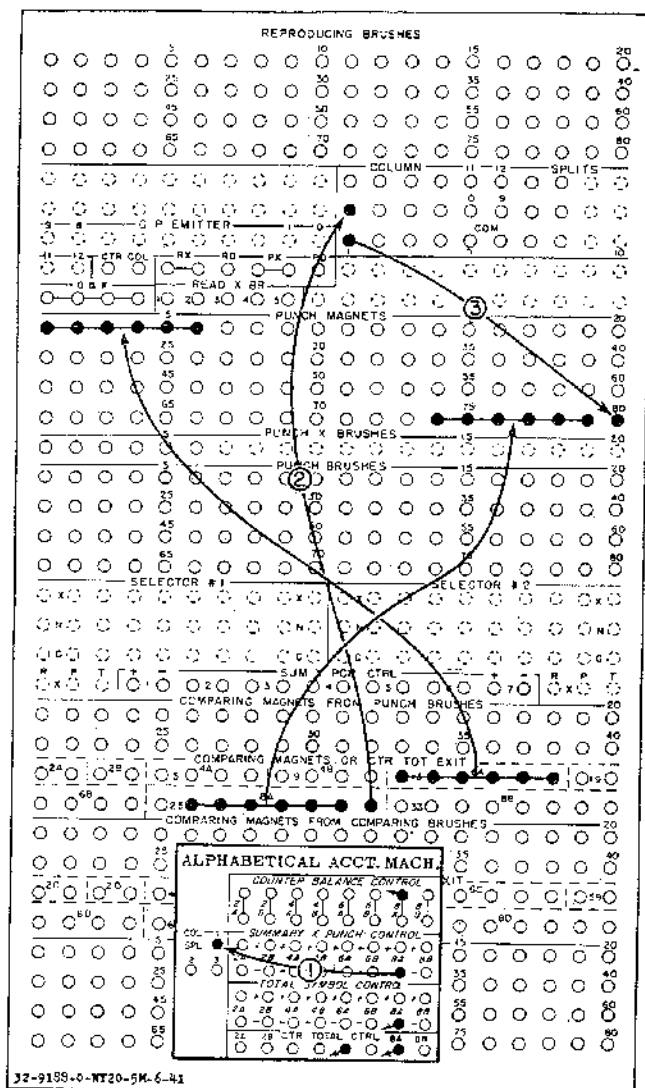


Figure 17. Summary punching with Alphabetical Net-Balance Accounting Machine

1. If counter 8A has gone through a conversion cycle indicating a credit balance, an X impulse is brought to column split.
2. Units position of Amount field is brought to same column split.
3. Units position of Amount field is punched and if field is a credit amount, an X is also punched.

**Summary Punching with a Non-Net Balance Alphabetical Accounting Machine**

To summary punch from a non-net balance accounting machine, the proper counter total exit hubs are wired to the punch magnets. If balance

selection is being performed on the accounting machine, it must be repeated on the Type 513 Reproducing Punch in order to punch a true figure. The total exit hubs of the accounting machine counter normally impulsed for addition and subtraction are wired to the normal hubs of a class selector on the Type 513 Reproducing Punch. The total exit hubs representing the counter which is impulsed in the reverse manner are wired to the controlled hubs of the selector. The common hubs of the selector are connected to the punch magnets. The selector is controlled by the extreme left position of the total exit hubs of the normal counter. Whenever a complement occurs, indicated by a 9 in this position, the selector is controlled and a true credit figure rather than the complement will be punched.

If an X is desired to identify a credit (or debit) total, wire from the proper summary X punch control — (or +) hub to the punch magnet. The proper summary X punch control unit is determined according to the class selector used on the Type 513 Punch. If selector 1 is used for the balance selecting, summary X punch control 1 must be used. If the X is to be punched into the same column as a numerical punch, a column split should be used.

The reproducing switch should be OFF, the selective reproducing and gang comparing switch OFF, and the detail or master switch at MASTER. Control panel wiring is shown in Figure 18.

**Combinational Reproducing, Gang Punching and Summary Punching**

All three operations of reproducing, gang punching, and summary punching can be performed at one time. The wiring is done in the normal manner for each operation. A control to be sure that the reproduced information has been punched in the right summary card can be obtained by wiring to the comparing magnets the punch and comparing brushes corresponding to a control field in the summary and source cards.

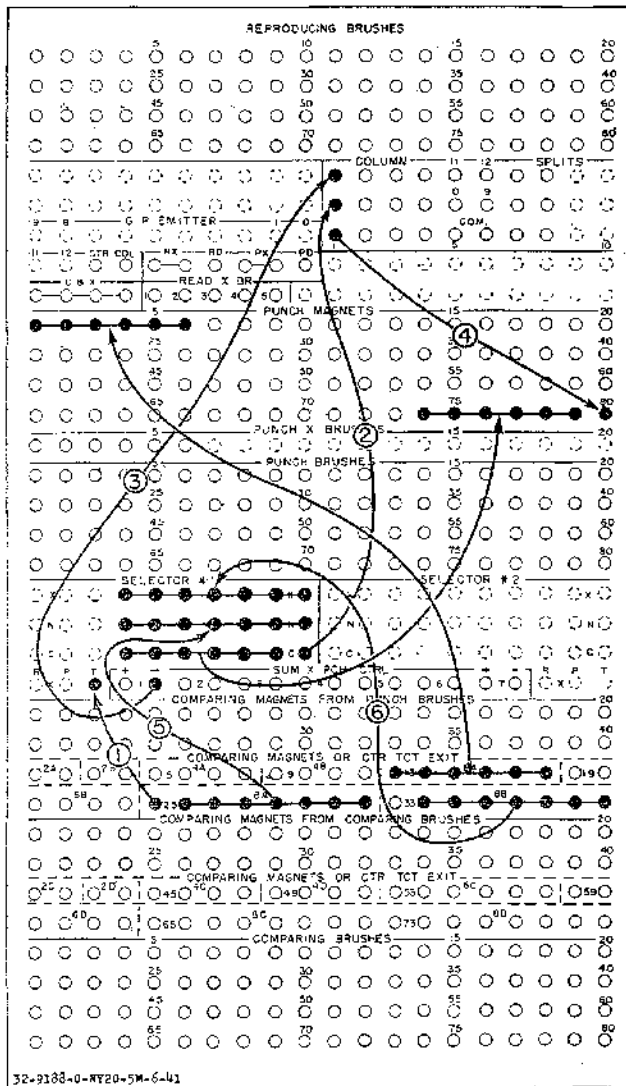


Figure 18. Summary punching with Alphabetical Non-Net Balance Accounting Machine

1. Selector is controlled by complement 9 of left-hand position of normal counter.
2. Units position of field is brought to 0-9 of column split.
3. Credit X impulse corresponding to selector used is wired to same column split.
4. Units position of Amount field is punched and if field is a zero or a credit amount, an X is also punched.
5. Counter normally impulsed is connected to normal hub of selector.
6. Counter impulsed in reversed manner is connected to controlled hubs of selector.

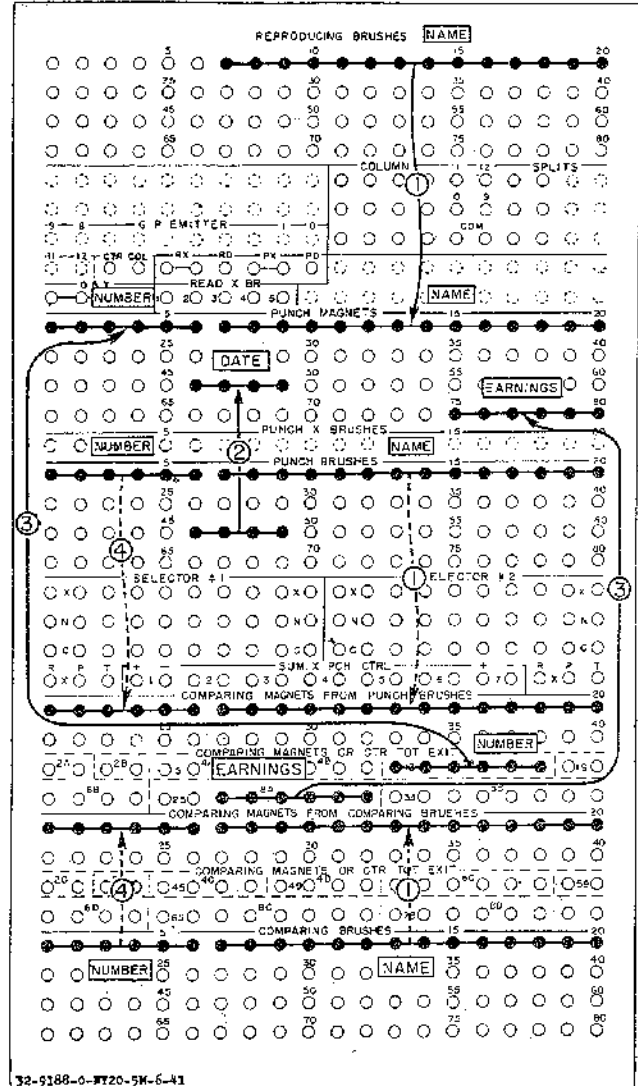


Figure 19. Summary punching with reproducing and gang punching

1. Name is reproduced, punching is verified.
2. Date is gang punched.
3. Earnings and Employee Number are summary punched.
4. Employee Number on summary card is compared with Employee Number in corresponding master source card.

The reproducing switch should be ON, the selective reproducing and gang punch comparing switch OFF, and the master or detail switch turned to MASTER. See Figure 19 for wiring.

**Card Comparing**

The fields on two sets of punched cards can be checked for agreement with each other. One set of cards is placed in the read unit feed and the other set is placed in the punch unit feed. The fields to be compared are connected from the punch and comparing brushes to the comparing magnets. When a discrepancy is detected between any two cards, the machine stops and the signal light glows. The cards in error are those about to enter the stackers. The cards in the feed hoppers and the correct cards already in the stackers should be removed, the signal light should be reset, and the machine started. The first card in each stacker may be compared visually to determine where the error occurred. Control panel wiring is shown in Figure 20.

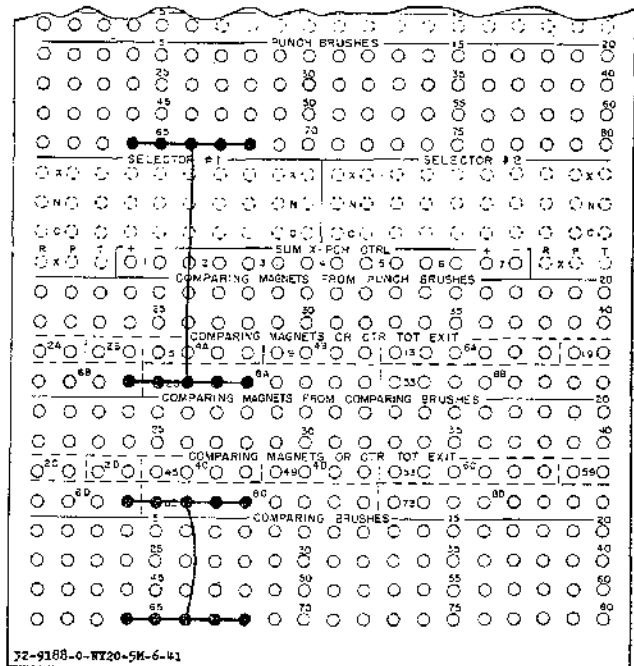


Figure 20. Card comparing

Columns 64-68 of corresponding cards in each set are compared.



## MECHANICAL PRINCIPLES

Before removing or dismantling any of the units on this machine, a study of its general construction should be made. By following the description and suggestions given, the customer engineer will obtain an understanding of the general machine operation which will be valuable to him in maintaining this equipment.

Remove covers from the upper base. (Be sure

the power cord has been removed from the source of current.)

### Location of Units and Parts

Note the position of the punch and read units, magnet unit, relay cabinet, comparing unit and indicator, fuse panel, main line switch, start and stop keys, summary punch emitter, mark sensing amplifier unit and C-cams, as shown in Figure 21.

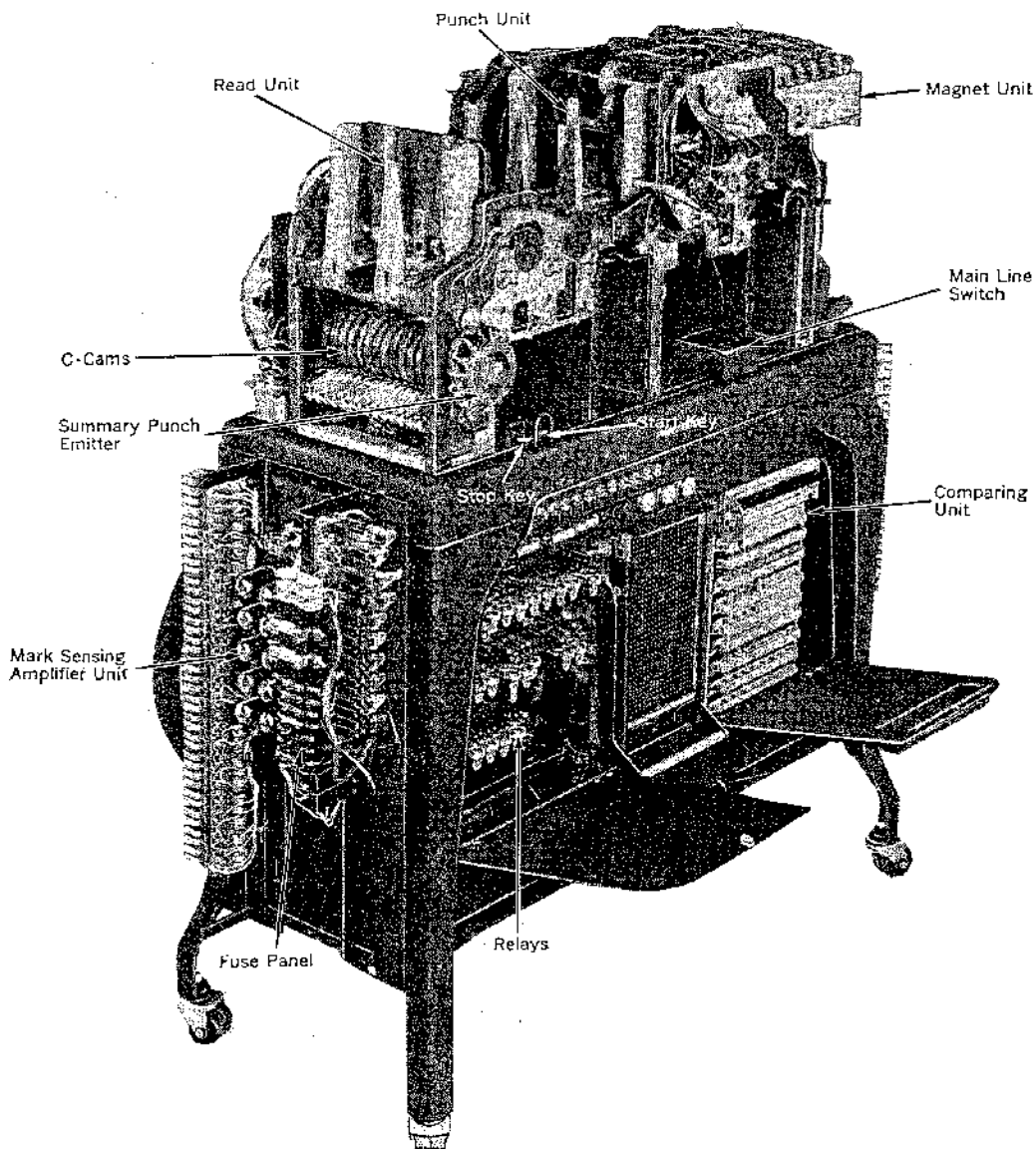


Figure 21. Front view showing units

Note the position of the drive housing, punch clutch, read clutch, P-cams, R-cams, mark sensing delay unit, drive motor and the motor-generator as shown in Figure 22.

Remove the top cover from the gear or drive housing. (Do not operate under power with this cover removed because oil will be thrown out of the gear housing.)

#### Drive Mechanism — Figure 23

Power to drive both the punch and read units of the machine is furnished by the drive motor. The drive motor transmits power to a gear housing through a V-belt and pulley. Since either feed may at times operate independently, there are two clutches to provide for independent operation of

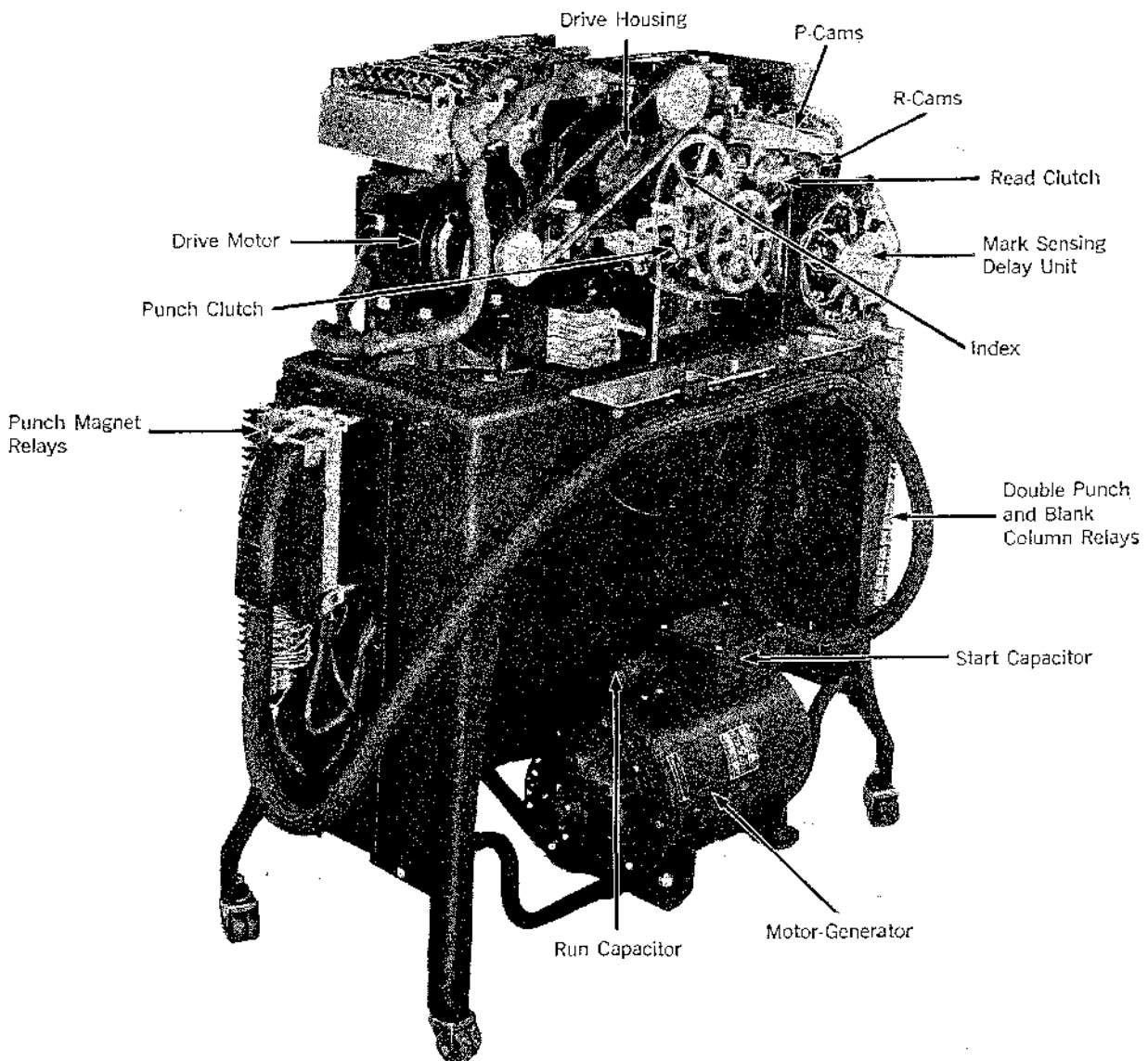


Figure 22. Rear view showing units

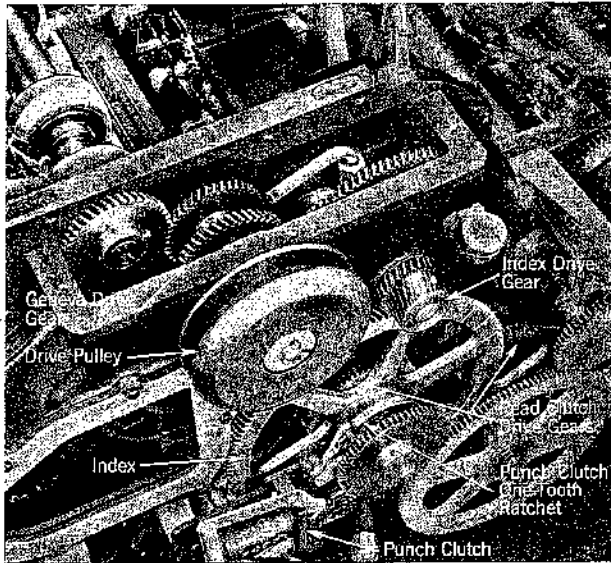


Figure 23. Drive mechanism

the read and punch units. These clutches, the punch clutch and the read clutch, are of the pawl and one-tooth ratchet type. The one-tooth ratchet of both clutches is driven by a train of gears from the drive housing. The drive housing and one-tooth ratchets operate continuously as long as the drive motor is running. This may be noted if the machine is cranked over by hand. (See that both the read unit and punch unit feed clutches are latched; that is, that the pawl is disengaged from the one-tooth ratchet and the clutch pawl arm is back of the keeper.) Follow the sequence of power transmitted through the gear train in the drive

housing. The pulley turns the pulley shaft to which are attached two gears. The gear toward the front of the machine drives the twin eccentric shaft. This will be discussed in detail later. The gear toward the rear of the machine drives a large gear to the right of itself (facing rear of machine). This gear (the punch clutch idler gear) transmits motion to all other continuously running parts, the punch clutch one-tooth ratchet, the read clutch one-tooth ratchet and the C-cam shaft.

The index drive gear, the small spur gear outside the drive housing, is pinned to the same shaft as the punch clutch idler gear and, therefore, turns with the idler gear. The index drive gear drives the large index gear. The hub of the index gear serves as the one-tooth ratchet for the punch clutch.

Attached to the index gear (punch clutch gear) by three screws is another smaller gear. This gear drives a train of gears which in turn operate the read clutch one-tooth ratchet gear. The P-cam contact drive gear is pinned to the index gear shaft, and drives a train of gears which operate the P-cams. The R-cams turn when the read clutch is engaged and are driven by the gear to which the read clutch pawl arm is attached.

When both clutches were disengaged and the crank was turned, it was noted that only the eccentric shaft, the punch and read clutch one-tooth ratchets and the C-cams turned.

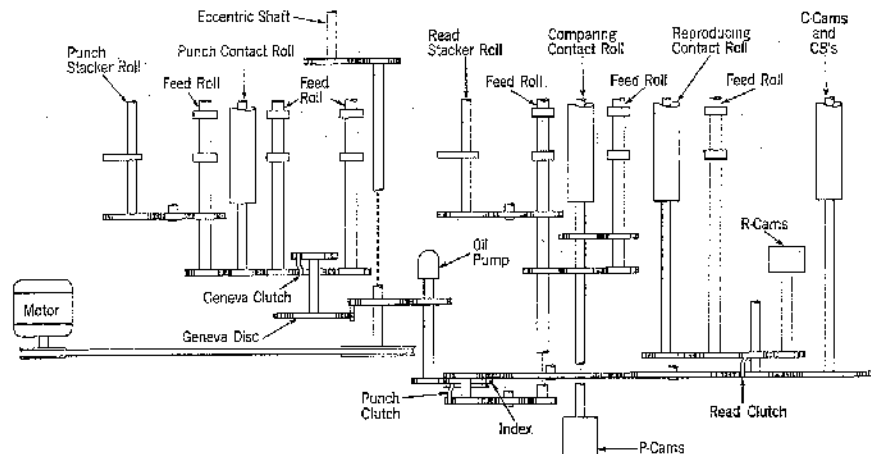


Figure 24. Schematic of clutch control of feed rolls

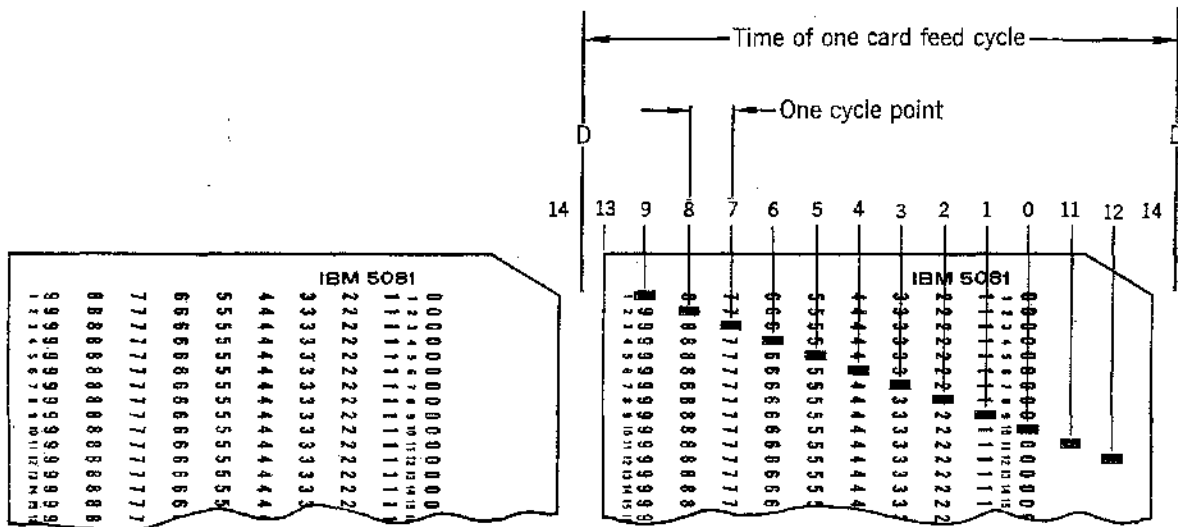


Figure 25. Card feed cycle

Engage the punch clutch and crank the machine by hand. Note that the feed knives, the first, second, and third pairs of feed rolls, the punch brush contact roll and the stacker roll in the punch unit operate. Also, the second and third sets of feed rolls, the comparing contact roll and the stacker roll of the read unit operate under the control of the punch clutch (Figure 24). It will be observed that the two pairs of feed rolls in the read unit turn smoothly while all the rolls in the punch unit turn intermittently. The intermittent movement is necessary to have the card stopped in punching position. This will be discussed in detail later. The P-cam contact unit also operates under the control of the punch clutch.

Engage the read unit clutch and crank the machine by hand. Note that the feed knives, the first pair of feed rolls and the reproducing contact roll in the read unit operate. Also, the R-contact cams operate under the control of the read clutch. It will be well to review the units which are controlled by the punch and read clutches to be certain that they are firmly fixed in mind.

#### Principle of Punching

As shown in Figure 25, there are 12 punching positions on the card.

The distance between any two of the twelve punching positions is  $\frac{1}{4}$ " and is called a cycle point. Therefore, for each cycle point the card has moved  $\frac{1}{4}$ " on its path through the machine. The card, being  $3\frac{1}{4}$ " wide, covers 13 cycle points and in the feed there is  $\frac{1}{4}$ " between each card and the next one. Therefore, the distance from the leading edge of one card to the leading edge of the following card is  $3\frac{1}{2}$ ". Since each  $\frac{1}{4}$ " equals a cycle point, each cycle of the reproducer is made up of fourteen cycle points and the machine index is divided into 14 divisions; therefore, this machine is known as a fourteen point cycle machine.

When the machine was cranked over by hand, the operation of the twin eccentric shaft was noted. Figure 26 shows the part the eccentric shaft plays in the punching operation. The circular motion of the gears and shaft is transformed into reciprocating (up and down) motion by the eccentric shaft. This up-and-down motion is imparted to the punch bail through the punch bail eccentric links. As shown in Figure 26A, when the magnet is de-energized, the punch bail may move up and down without contacting the interposer; therefore, no punching takes place. When the punch magnet is energized (Figure 26B), the armature is attracted, and through the magnet pull wire, pulls the punch interposer into engagement with the

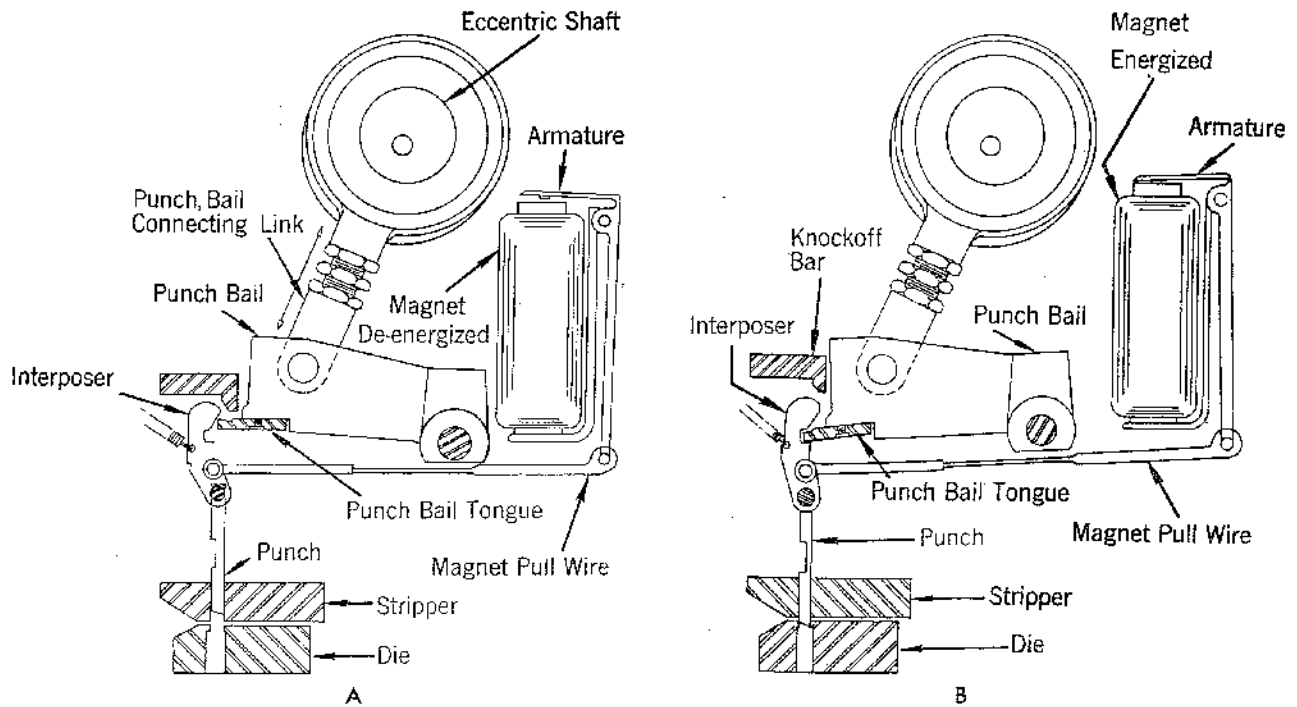


Figure 26. Principle of punching

punch bail tongue. Since the bail tongue operates up and down, it carries the punch interposer and the punch connected to it down through the card. On the return stroke, the punch is positively withdrawn from the card by the upward motion of the punch bail. As the interposer approaches its upward limit of travel, it contacts the knockoff bar which cams it away from the punch bail tongue.

Eighty punches are arranged in a row, each with its individual interposer and magnet. There is but one punch bail which spans the eighty punches. The punch bail operates up and down once for every punching position of a cycle. Any interposers which are pulled into engagement with the punch bail tongue will cause their respective punches to be driven down through the card. Thus, if eighty magnets are impulsed, all eighty interposers will be engaged with the punch bail and eighty holes will be punched.

Geneva Mechanism

The punch bail moves up and down once for

each cycle point to drive the punches through the card. While the punches are being driven through the card and withdrawn, the card must not be in motion. If the card were in motion, the holes would not be clean cut, but ragged and torn. Since the card must be stationary while it is being punched, and must then be moved to a new punching position fourteen times each cycle, the motion of the card must be intermittent. This

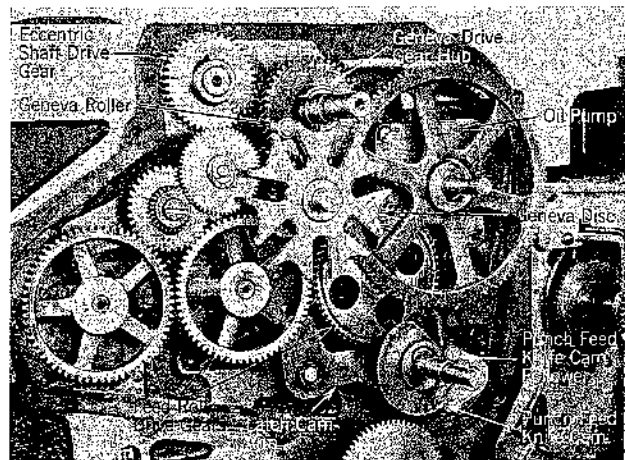


Figure 27. Geneva mechanism

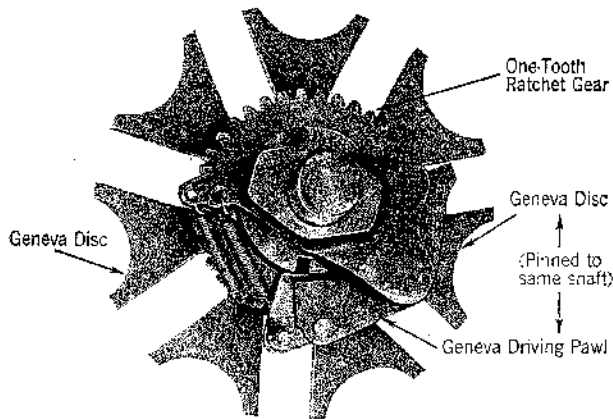


Figure 28. Geneva pawl and ratchet

intermittent motion is obtained by means of a Geneva mechanism.

The Geneva drive gear is located just inside the gear housing and pinned to the pulley shaft. It also drives the gear train which drives the CR cams and feed clutch one-tooth ratchets. A stud and roller fastened to this gear operates in the slots of the driven member of the Geneva gear (the Geneva disc, Figure 27).

The hub of the Geneva drive gear is a cam surface for approximately two-thirds of its periphery. This cam surface holds the feed rolls in a stationary position during punching time (Figure 27).

The Geneva disc has seven deep slots and seven shallow cuts in it. The roller of the drive gear operates in the deep cuts in the Geneva disc and the cam surface rides in the shallow cuts. As the drive roller leaves the deep cut of the Geneva disc, the cam surface turns into the low cut, thus stopping the Geneva disc from turning, and holding it still until the drive gear has rotated to a point where the drive roller enters the next deep slot of the Geneva disc and starts driving. Then the cam surface has turned to a point where it releases the disc and allows it to turn freely. The Geneva disc turns continuously as long as the drive motor runs. However, no motion is transmitted to the feed rolls until the Geneva pawl is engaged with its one-tooth ratchet gear. The one-tooth ratchet gear

is meshed with the feed roll drive gears. The Geneva pawl and the Geneva disc are pinned to the same shaft, which runs through the hub of the one-tooth ratchet. The one-tooth ratchet is free on the shaft and does not turn unless the Geneva pawl is engaged (Figure 28).

When the punch clutch is not engaged, the Geneva pawl rides on the surface of the one-tooth ratchet during the greater part of the cycle. When the pawl reaches a point opposite the single tooth, the tail of the pawl strikes the pawl disengaging roller and is cammed away from the ratchet until it has moved past the point where it may engage in the single tooth of the ratchet. Crank the machine by hand and note how the pawl disengaging roller prevents the Geneva pawl from engaging (Figure 29). From the above, it is evident that the operation of the Geneva pawl is controlled by the pawl disengaging roller. The pawl disengaging roller is mounted on a triangular plate which is free to pivot on the latch cam roller arm. The latch cam roller arm is operated by the feed knife and latch cam which turns only when the punch clutch is engaged. When the punch clutch is engaged, the latch cam turns, causing the latch cam arm to rotate in a counter clockwise direction. As the latch cam arm rotates, the upper end moves to the left and down, allowing the pawl disengaging roller to move past the single revolution timing cam, and

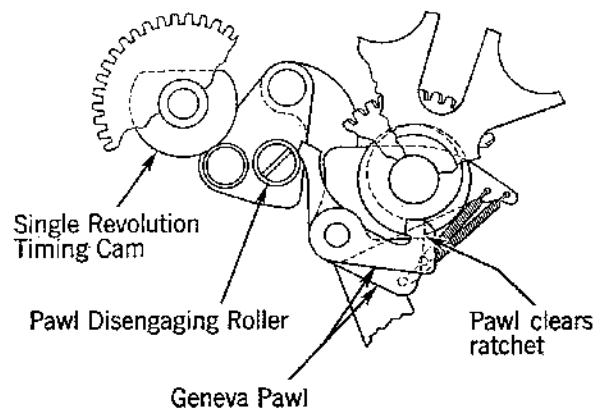


Figure 29. Pawl disengaging roller

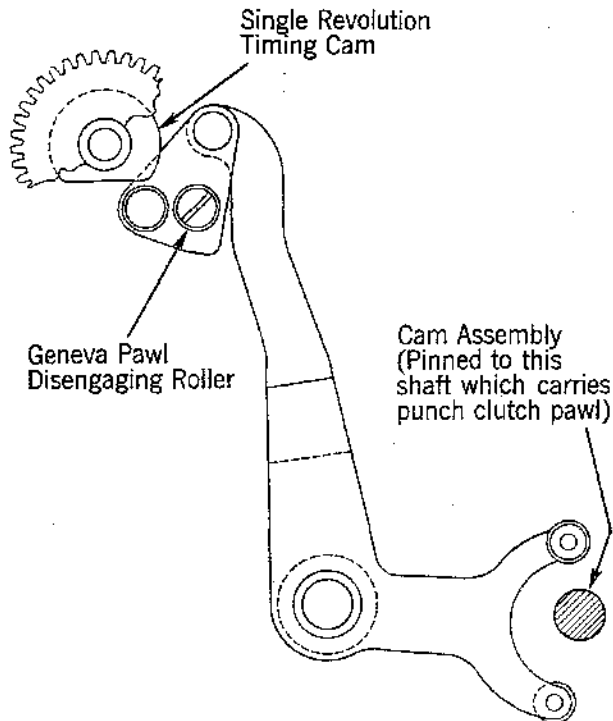


Figure 30. Single revolution timing cam

thus allowing the geneva pawl to engage in the one-tooth ratchet. As the cycle is completed, the latch cam causes the latch cam arm to rotate in a clockwise direction, carrying the pawl disengaging roller to the right. The roller strikes the tail of the geneva pawl and disengages the pawl from the one-tooth ratchet when the roller is backed by the single revolution timing cam.

#### Single Revolution Timing Cam

Since the geneva disc has 7 cuts in it and moves the card one cycle point for each cut and the machine is a 14 point cycle machine, the geneva disc must make two revolutions per machine cycle. Therefore, the geneva pawl will pass the pawl disengaging roller twice during each cycle. The purpose of the single revolution timing cam is precautionary. If the geneva pawl should fail to engage on the first revolution of the geneva disc, the single revolution timing cam will prevent it from engaging on the next revolution. Thus the geneva pawl may engage only at 14.1. At the end of the first

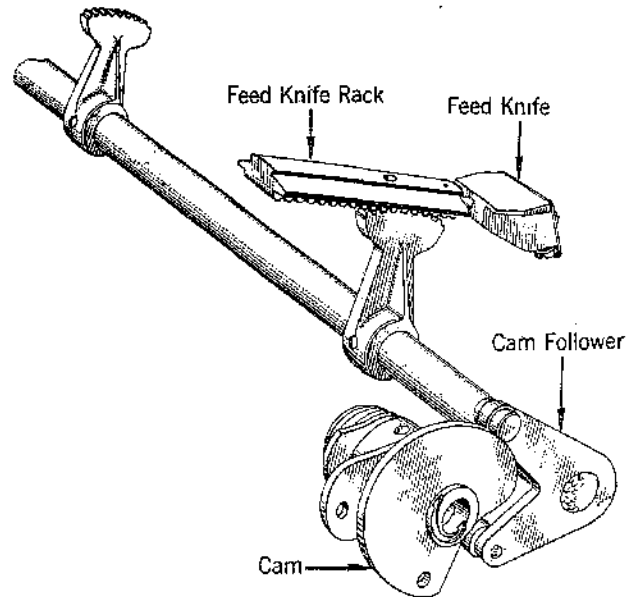


Figure 31. Punch feed knife drive

revolution of the geneva dog and intermittent disc, the flat side of the single revolution timing cam should be down (Figure 30). The pawl disengaging roller is free to swing away from the tail of the pawl. Therefore, if the geneva pawl should become disengaged from the one-tooth ratchet, possibly because of a jam, it would be free to drop into the one-tooth ratchet on the next revolution. This assures that the pawl will not be disengaged by the pawl disengaging roller until the punch unit mechanism has reached its proper latching position.

#### Feed Knives

The feed knives are designed to feed one card

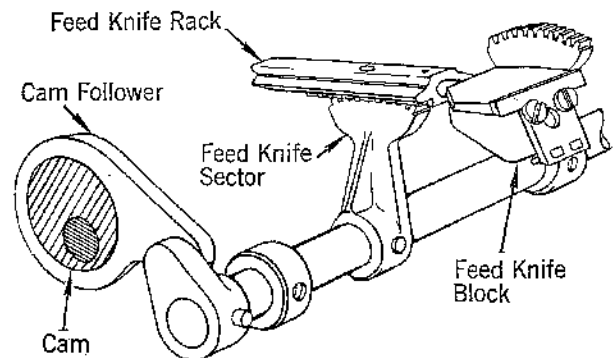


Figure 32. Read feed knife drive

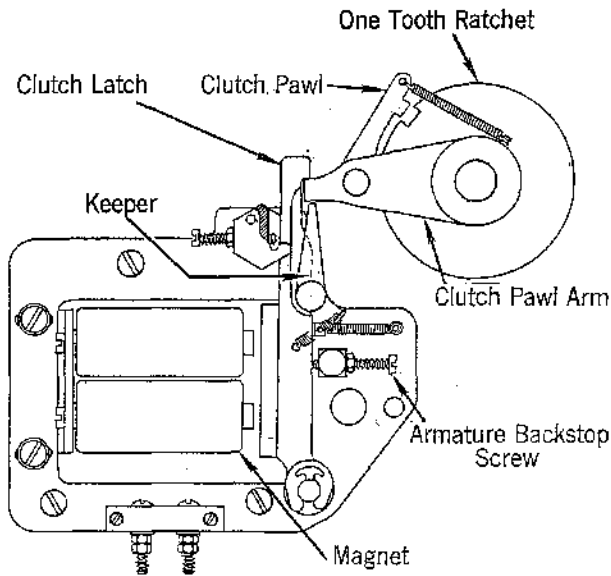


Figure 33. Clutch

into the throat at a time by a reciprocating motion. They are carried back and forth by a gear sector which meshes into the feed knife rack. The gear sector is pinned to a shaft which oscillates under the control of a cam and follower. Figure 31 shows the punch feed knife drive and Figure 32 shows the read feed knife drive.

#### Clutches

Both the punch clutch and the read clutch are of the one-tooth ratchet type (Figure 33). This is a common type on EAM equipment, and its operating principle should be firmly fixed in mind. The principal parts of the clutch are a continuously running one-tooth ratchet, a clutch pawl, a latching mechanism composed of a clutch latch arm and keeper, and a magnet. The magnet provides a means of electrically controlling the operation of the clutch. The clutch magnet armature serves as the latching mechanism. When the magnet is energized, the armature is attracted and allows the pawl to pivot in a clockwise direction by spring tension. The pawl drops into the continuously running one-tooth ratchet and turns with it. The pawl rotates about a stud on the clutch pawl arm and the clutch pawl arm is pinned

to a shaft; thus, when the pawl turns, the shaft to which the pawl arm is pinned must also turn. Since there is but one latching point, if the clutch latch is tripped, the pawl must make one complete revolution before it can be relatched. As the pawl reaches the end of the cycle, if the clutch magnet is de-energized, the armature will be pulled by spring tension to a point where its latching surface will engage the tail of the pawl and cam it out of the one-tooth ratchet. As the pawl is cammed out of the one-tooth ratchet, the keeper gets behind the clutch pawl arm. This prevents the shaft, to which the clutch pawl arm is attached, from turning backward. If the shaft were to turn backward, the pawl would drop against the one-tooth ratchet and nip. This nipping action may be noted if the clutch is tripped and the machine is cranked through a cycle by hand. Note that the keeper does not get behind the clutch pawl arm, and that every time the one-tooth ratchet comes around, the pawl catches in it, moves slightly, then is disengaged by the latch. This condition has a tendency to round off the edge of the one-tooth ratchet, as a result of which the pawl may pull out of the ratchet part way through a cycle and cause the mechanism operated by that clutch to lose a cycle.

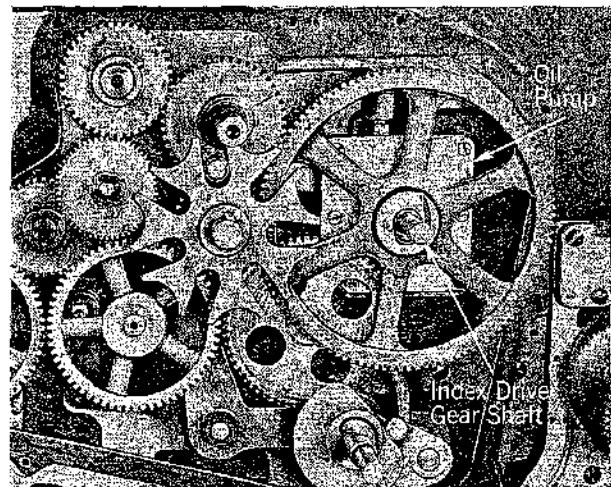


Figure 34. Oil pump mounted



### Oil Pump

The oil pump is a simple rotary-vane type pump. It is located inside the gear housing on the shaft of the small gear which drives the index (Figure 34). It pumps the oil from the bottom of the gear housing to the top where it is free to run down over the geneva and gears.

The rotor is pivoted off-center in the housing as shown in Figure 35. The expansion chamber at the inlet provides a vacuum and causes the oil to enter the pump from the well below. The compression chamber at the outlet causes oil to be forced out at the top.

### C-Cams

The C-cams are located in the read unit just

below the read magazine (Figure 21). There are four C-cams, 11, 12, 13, and 14, which supply timed impulses for each of the 12 punching positions of the card. The other C-cams, mounted on the C-cam shaft, supply timed machine impulses for various functions in the machine. The C-cam shaft rotates whenever the motor is running. The cams are numbered from front to back on the machine.

### R-Cams

The R-cams and contacts are located on the left rear of the machine and supply timed machine impulses only when the read clutch is engaged. They are numbered from front to back.

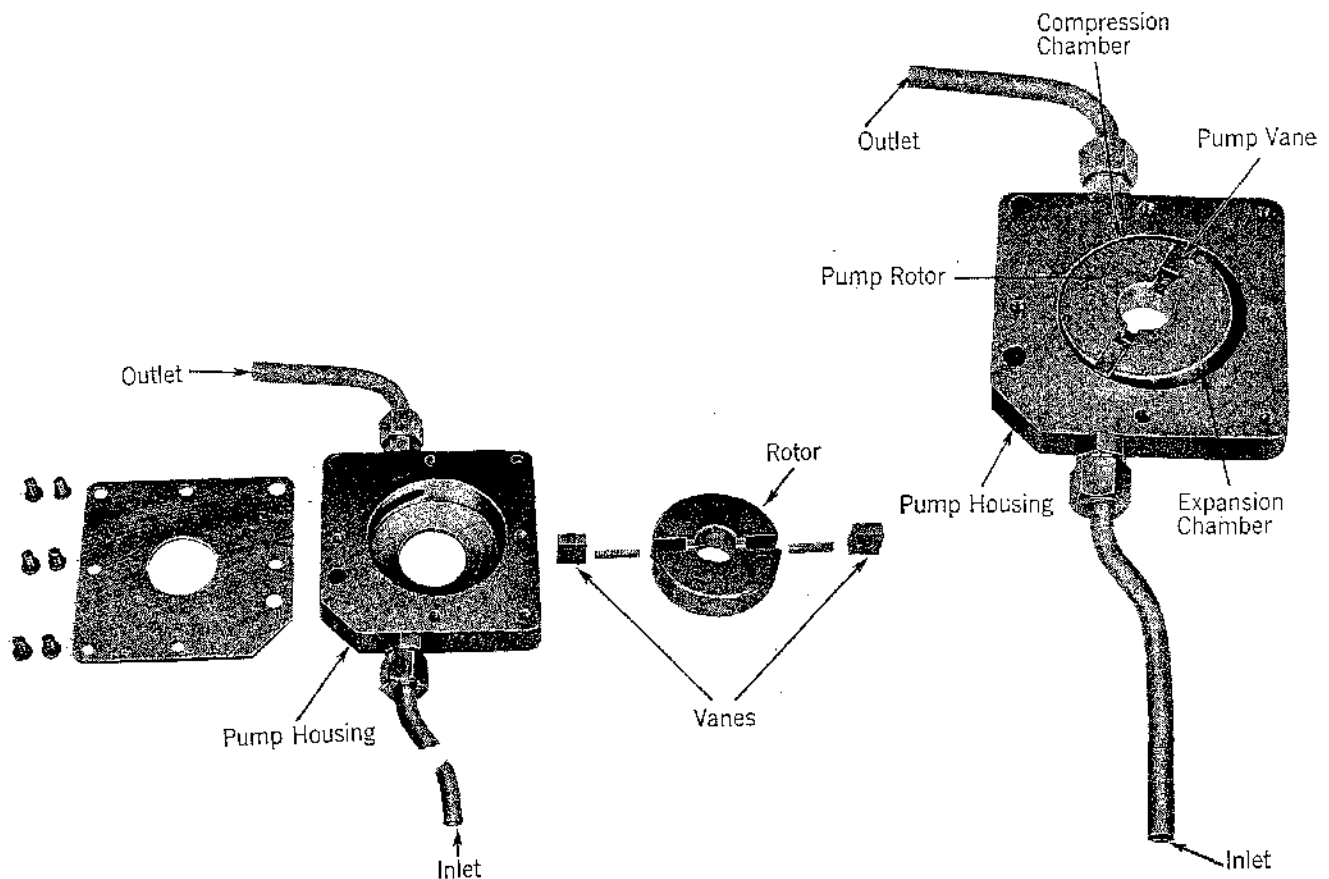


Figure 35. Oil pump dismantled

### P-Cams

The P-cams and contacts are located directly above the R-cams and supply timed impulses when the punch clutch is engaged. They are numbered from front to back.

### Comparing Unit

The comparing unit is located on the lower front right side of the machine. It consists of 80 magnets which control individual pawls. The magnets are the two-coil bucking type, which will cause a pawl to trip if a circuit is complete to one coil only. A circuit to both coils simultaneously will have a neutralizing effect and will not trip a pawl.

A tripped pawl will cause a bail to unlatch,

which will in turn operate a transfer contact. This contact serves two functions, namely, to open the circuit controlling the feed clutches and also to complete a circuit to the comparing signal light. The light is an indication to the operator that the cards do not agree. The pawl or pawls which are tripped remain in a tripped position and serve to indicate to the operator the exact positions in the comparing unit which did not agree. The indicator in this unit represents the comparing magnet being used. The control panel must be checked to determine which column in the card is wired to that comparing magnet.

It is necessary to manually relatch the tripped bail. The bail in turn relatches the pawls which may have been tripped and restores the comparing contact to normal.

## REMOVAL AND ASSEMBLY PROCEDURES

### To Remove the Drive Housing — Figure 36

1. Drain oil from the gear housing into a pan or bottle.
2. Remove the pivot screw from the punch clutch manual trip lever and remove manual trip lever.
3. Remove drive belt from pulley.
4. Remove the seven screws from drive housing top cover, and remove cover.
5. Remove crank stud and lock washer from drive pulley shaft and remove drive pulley.
6. Remove the drive pulley clutch from the drive shaft. The clutch is keyed to the shaft with a Woodruff key. Be sure to remove the key.
7. Remove the three screws from the punch clutch and remove the clutch. Note on the upper screw that there is a spacer between the clutch plate and the casting.

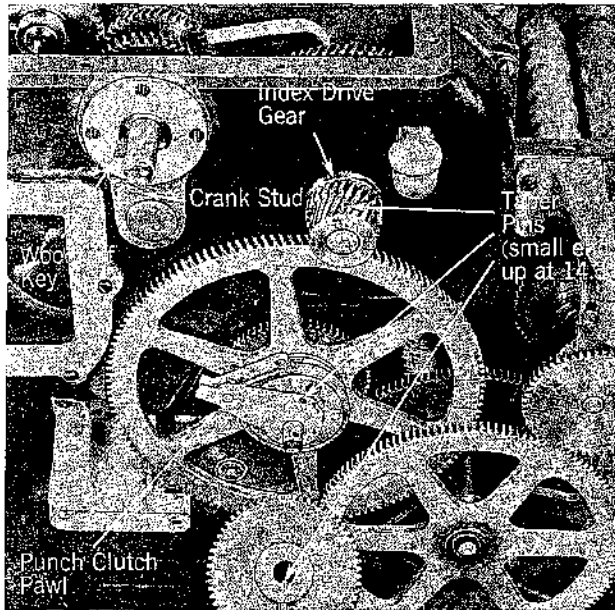


Figure 36. Drive housing

8. Remove blue steel clip from P-cam idler gear. Remove gear. Remove screw from safety cover. The cover may now be removed.

9. Engage the punch clutch. Turn the index to approximately three teeth past 14. This places the small end of all taper pins in position to be driven. Loosen the clutch pawl spring and drive the three pins shown in Figure 36.

10. The punch clutch pawl assembly may now be removed from the index shaft.

11. The index wheel may now be removed. There are 47 needle bearings in the hub of the index wheel. These bearings may easily drop out and be lost. Place a cloth beneath the hub of the gear so that when the gear is pulled off the shaft, the bearings may be caught in the cloth and will not be lost. An alternative method is to push the bearings toward the drive housing and slide the gear far enough off the shaft to expose about  $\frac{3}{8}$ " of the needle bearings, then tie a string or rubber band about the bearings to hold them to the shaft. The gear may then be removed. If care is taken, the housing may be removed without removing the index gear.

12. Remove the small gear (the punch index clutch driving gear) from its shaft.

13. Remove the R-cam idler gear.

14. Remove punch clutch mounting bracket.

15. Loosen two setscrews in rear feed roll opening cam and pull shaft toward rear of machine, far enough for drive housing to clear the feed roll opening device drive gear. On later machines the small jack shaft which carries the feed roll opener idler gear may be removed if the hex nut which holds the shaft in the casting is removed. On this style of machine it is not necessary to loosen either feed roll opening cam.

16. Remove the nine screws around the drive housing, and the drive housing may be pulled off. Should the housing stick to the base do not pry

at any point except the top, as a screwdriver inserted along the sides or bottom will cut the fiber gasket which seals the drive housing to the base. There are four shafts which pivot in the drive housing. Take care when working the housing off these shafts so that the timing relationship of the mechanism is not disturbed. It may not be necessary to remove the geneva mechanism each time the drive housing is removed.

#### To Replace the Drive Housing

1. Work the drive housing onto the picker knife cam shaft, the punch clutch idler gear shaft, the geneva disc shaft, and the pulley shaft.

2. Replace the nine screws which hold the casting to the side frame of the machine.

3. Replace the R-cam idler gear.

4. Move feed roll opening device cam shaft and gear back into place.

5. Replace punch clutch bracket.

6. Turn the crank until the four factory marks (scribed lines) on the eccentric shaft gear, the eccentric drive gear, the geneva disc gear, and the punch clutch idler gear inside the drive housing line up (Figure 37). Turn the index gear until the scribed line on the drive housing casting lines up with the first tooth past 14 (between 14 and 12).

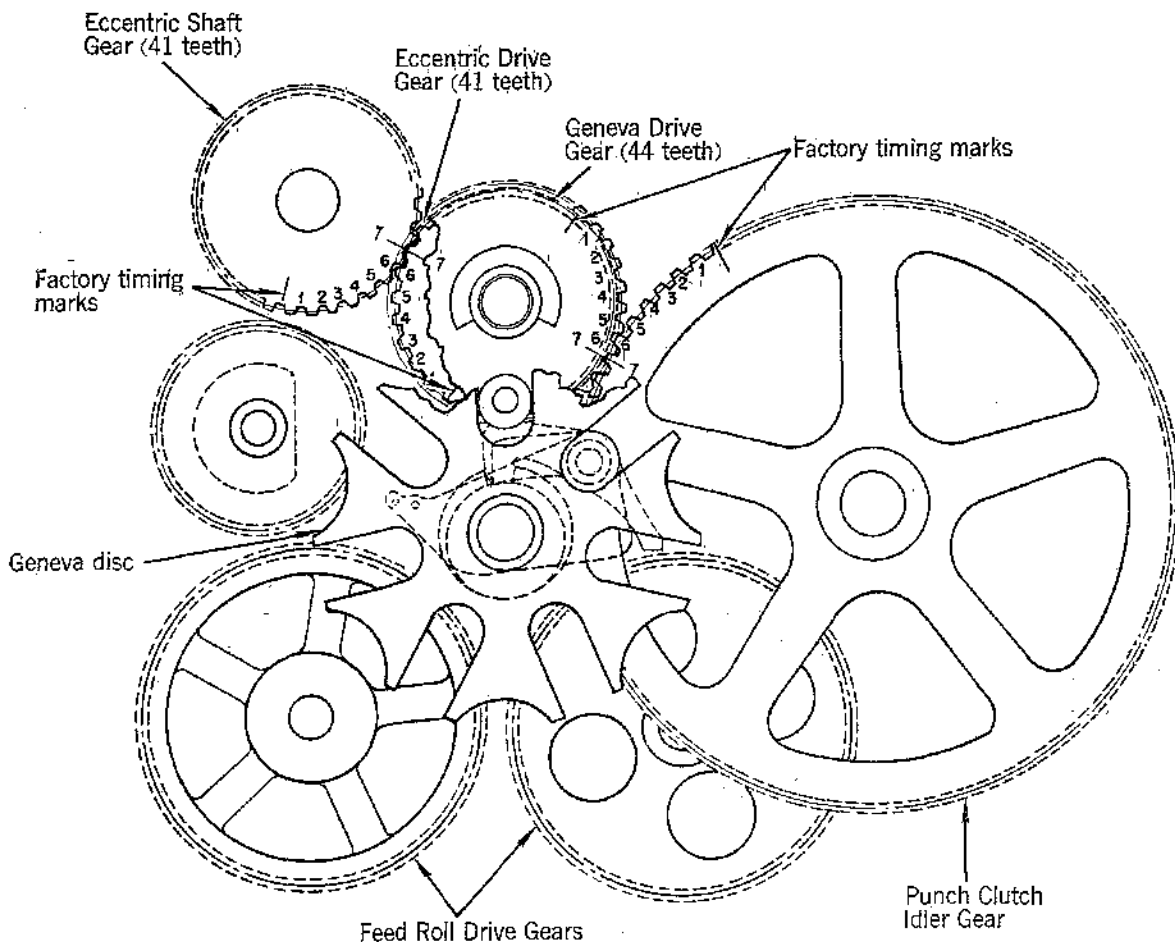


Figure 37. Timing the geneva mechanism

7. Replace the index drive gear so that the scribed line meshes with the line scribed on the index gear at two teeth past 7. This assures that the large end of the taper pin lines up with the hole in both the shaft and gear. This timing may again be checked by cranking the machine over until the index has made seven revolutions, at which time the scribed lines on the gears inside the gear housing should line up, the index should be at one tooth past 14, and the scribed line on the under side of the index drive gear should line up with the scribed line on the index gear at two teeth past 7.

8. Replace punch clutch pawl on shaft, and replace pin.

9. Replace P-cam drive gear on shaft, and replace pin.

10. When the drive mechanism is correctly timed and adjustments are completed, replace the oil in the housing. The proper amount may be determined from the meter rod. If the drive pulley oil seal is ever removed, be sure to replace the three fibre washers. The steel disc should be placed as shown in Figure 38 and the cap must be replaced with the oil well in the down position.

11. It will be necessary to retime the C-cams, P-cams and R-cams after the drive housing has been replaced. To retime the C-cam and R-cam shaft:

(a) Trip the read clutch latch and turn the crank until the pawl drops into the one-tooth ratchet. Be certain before tripping the latch that the pawl is fully latched so that the keeper is behind the pawl carrier arm.

(b) Unmesh the large idler gear and turn the crank until the index reads 14.1.

(c) Remesh idler gear.

(d) Check timing of C-cams and R3.

To Retime the P-cam shaft:

(a) Remove blue steel clip and idler gear. Turn the crank until the punch clutch pawl latches on the clutch latch. Be sure the keeper is behind the clutch pawl arm.

(b) Turn the P-cams shaft until P3 just drops off the sharp cut of the cam and opens.

(c) Replace the idler gear and blue steel clip.

(d) Check by engaging the punch clutch and turning the crank until the clutch pawl latches once more. P3 must be broken at D.

#### Removal and Assembly of Geneva Mechanism

This may be done only after the drive housing has been removed.

1. Turn the geneva mechanism to a point where the geneva clutch pawl will clear the two gears just below the shaft of the geneva disc (Figure 37).

2. Remove the pulley shaft and gear assembly, the geneva disc, and the P-clutch idler gear as an assembly.

#### To Replace the Geneva Mechanism

In order that the geneva clutch pawl may clear the two upper feed roll drive gears, it is necessary to turn the gears so that the factory-scribed marks do not line up. However, if the following reference marks are made, these may be lined up to assure that the geneva mechanism is properly timed when it is replaced in the machine (Figure 37).

1. On the eccentric shaft gear (41 teeth) pencil or spot mark the 7th tooth space, in a counter clockwise direction from the tooth space already marked.

2. Mark the 7th tooth in a clockwise direction from the present marked tooth of the eccentric drive gear (41 teeth). Also, mark the 7th tooth space in a clockwise direction from the present marked tooth space of the geneva disc drive gear (44 teeth). Both of these gears are pinned to the drive pulley shaft.

3. Mark the 7th tooth in a counter-clockwise direction from the present marked tooth of the punch clutch idler gear (110 teeth).

4. Turn the feed roll shafts until the flat side of the single revolution timing cam is on the right and in a vertical position.

5. Turn the eccentric shaft and the punch clutch idler shaft until the new marks point toward the drive pulley shaft center.

6. Turn the key slot in the oil pump so that it lines up with the key tongue on the hub of the punch clutch idler gear.

7. Be sure the geneva pawl is engaged in its ratchet.

8. Place the roller in the slot of the geneva drive gear that lines up with the one-tooth ratchet (the one to the left of the pawl pivot).

9. Work the three gears forward into position, at the same time matching the pencil marks, and position the three shafts into their respective bearings in the side frame. The punch clutch idler gear shaft, being the longest, should enter the hole in the rotor of the pump first. Then the geneva disc shaft should enter its bearing, then the pulley shaft bearing will enter its housing. After the punch clutch idler gear shaft is in the rotor of the pump, the shaft should be raised ver-

tically about  $\frac{1}{4}$ " so that it will then line up with the bearing in the side frame. If the geneva disc shaft seems to bind just after its shaft enters the bearing, check to see that it meshes properly with the two upper feed roll drive gears. It may be necessary to turn either one or both of these gears a part of a tooth to mesh with the gear on the shaft of the geneva disc. Note: it should not be necessary to hammer these shafts in place. Check to see that all gears are properly meshed, all shafts aligned with their bearings, and that the key is aligned with the oil pump rotor, if any of the mechanism does not properly seat.

10. Insert the crank stud and turn the machine over until the factory marks (scribed lines) line up. At this time the geneva drive gear roller should be half way out of its slot and the tail of the pawl should strike the pawl disengaging roller.

11. Replace drive housing.

12. Replace drive pulley oil seal as shown in Figure 38.

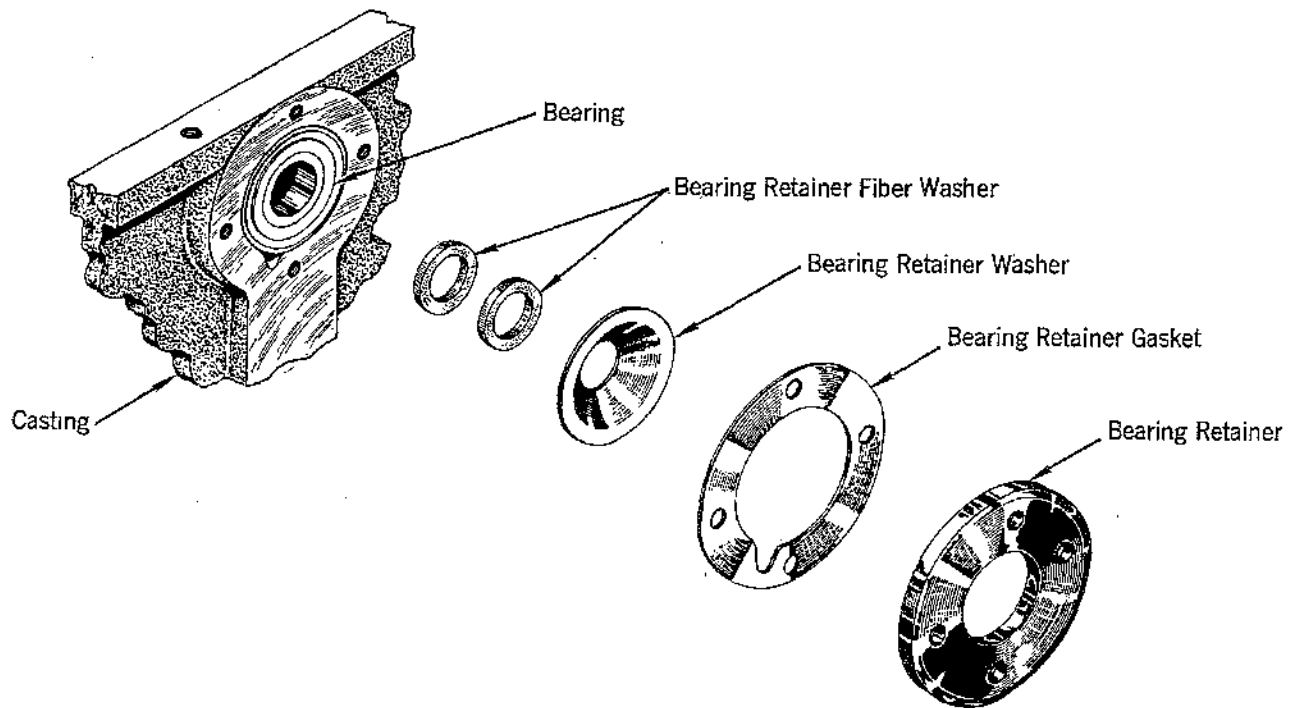


Figure 38. Exploded view of drive pulley oil seal

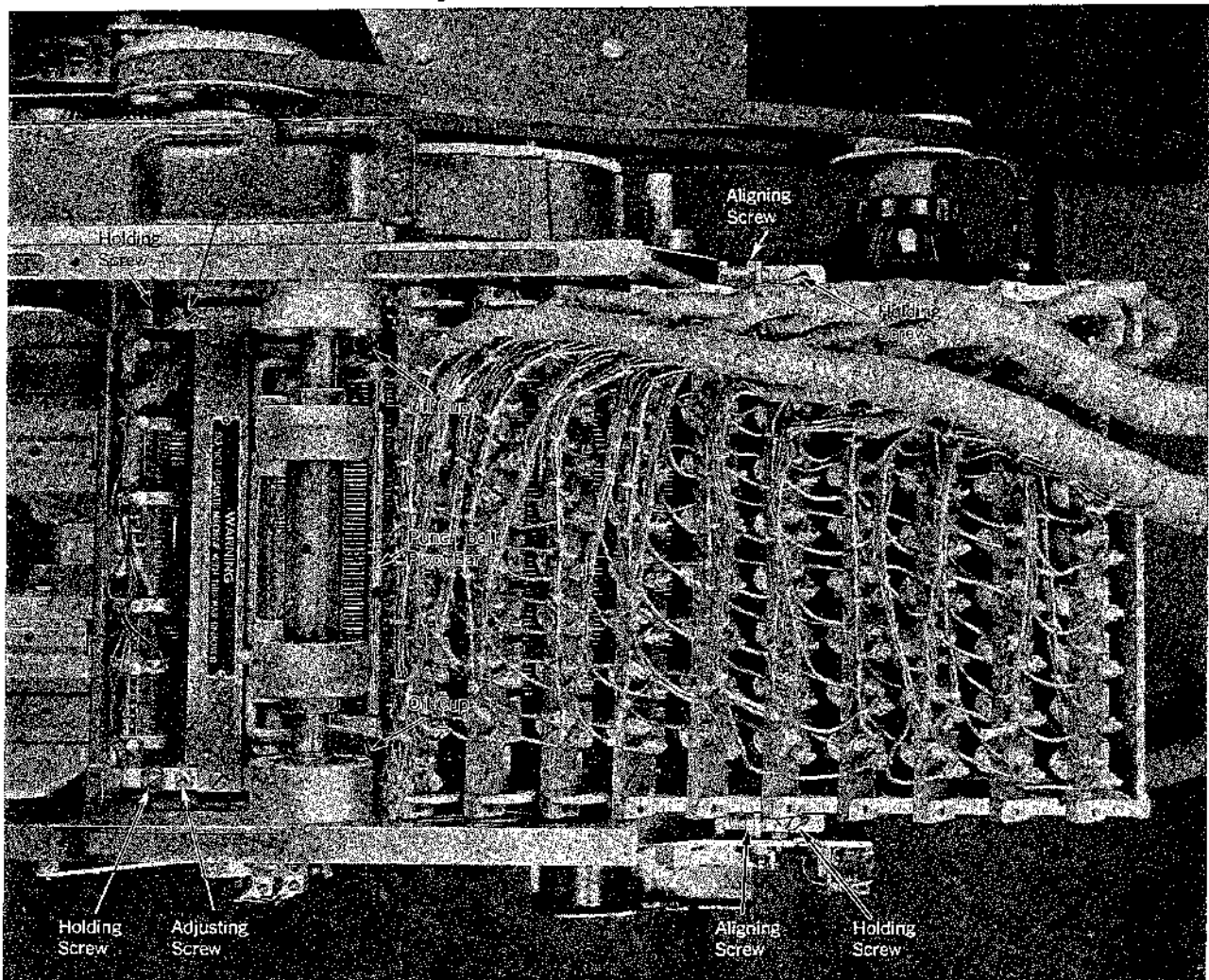


Figure 39. Magnet unit — top view

To Remove the Magnet Unit — Figure 39

1. Remove the chip box and take down the die.
2. Remove the four locking screws, 2 on left end and two toward right end.
3. Remove blue steel clips from the punch bail connecting pins.
4. Turn the high side of the twin eccentric shaft up and remove the two punch bail connecting pins.
5. Turn the eccentric links up.
6. Raise right end of magnet unit so that the pull wire guides clear the punch brush card lever contact, grasp left end by the binder post strip for

the first row of magnets, raise and move the magnet unit to the right and out of the machine.

7. If it is necessary to work on this unit, it may be placed on a stool or table near the end of the machine, or may be set across the top of the two side frames, in order to eliminate the necessity for removing the wires from the magnet unit. To replace the magnet unit, reverse the procedure. Be sure that the magnet unit is pushed to the left until the aligning screws are snugly against the casting before tightening the locking screws. However, in order that the same alignment may be maintained, it is advisable to place the die in position before the clamping screws are tightened.

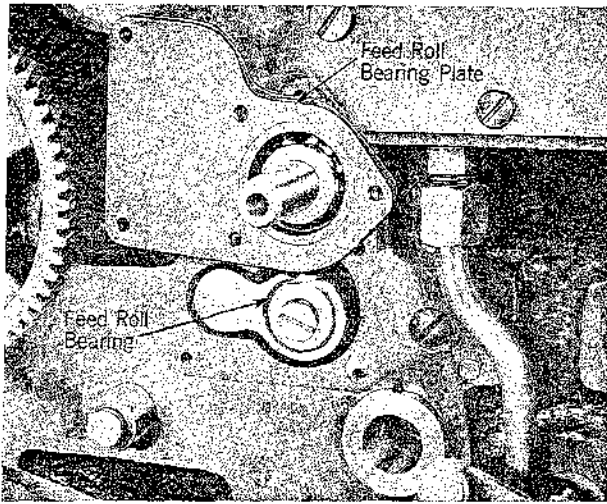


Figure 40. Feed roll bearing

#### To Remove a Feed Roll — Figure 40

The first upper roll will be considered, for it requires the most disassembly and care.

1. Remove the magnet unit.
2. Remove punch X brush mounting bar.
3. Remove drive housing and geneva mechanism.
4. Pull the picker knife cam shaft from the side frame.
5. Drive the taper pin from the feed roll rear drive gear and remove the gear from the shaft.
6. Remove the oil pump; two screws hold it.
7. Remove screws from bearing plate.
8. Remove dowel screws from punch feed back plate which support the punch X brushes and center bearing for the feed roll. There are two screws in front and two in back.
9. Drive pin from the front drive gear of the feed roll.
10. Relieve the pressure from the lower feed roll.
11. Tap the front end of the feed roll shaft to loosen the bearing housing. Use a hammer and brass rod. When the bearing housing is loose, it may be turned to clear the latch cam roller arm and the shaft may be removed from the machine. Take care in passing the feed roll through the hole in the

casting to prevent breaking out the grooves in the linen delecto feed roll.

The shaft of the first feed roll in the punch feed is heavier than the others. This is to prevent bowing when the feed roll opening device operates.

The feed roll pressure shoes for the first feed roll in the punch feed are cut with a greater radius because the diameter of this shaft is greater than the other feed rolls in the machine.

The feed roll pressure springs in the first and second feed roll pressure shoes are heavier than on the other feed rolls of the machine. Take care that these pressure shoes and springs are not interchanged if more than one feed roll is removed.

To replace the feed roll, reverse the above procedure.

#### To Remove the Feed Roll Opening Device

1. Remove the magnet unit.
2. Turn the machine until feed roll opening cams are on the high dwell. Place 5-40 screws in lower feed roll pressure bracket spring wells and tighten. Turn machine until feed roll opening cams are on low dwell. This will relieve the pressure from the lower feed roll. The pressure bracket may now be removed if the two mounting screws are removed.
3. Remove the drive housing and geneva mechanism. Refer to procedure on Page 34.
4. Remove the rear bearing cap and bearing from the first upper feed roll.
5. Drive the taper pin from the front of the lower feed roll drive gear and remove bearing.
6. Loosen setscrew in feed roll opener cams and pull the shaft out from the rear of the machine.
7. Remove screw from rear bearing and remove bearing (Figure 40).
8. With front and rear bearings removed from the lower feed roll, it is possible to shift the roll at an angle and remove it from the side frames, with the feed roll opening links attached.



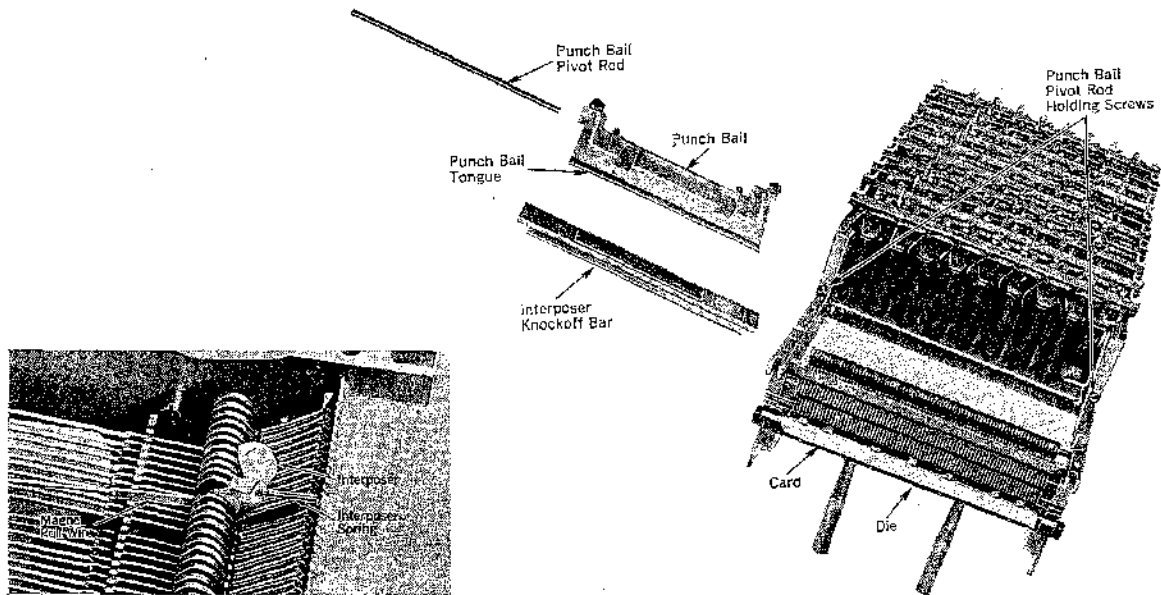


Figure 41. Magnet unit

#### To Remove a Punch — Figure 41

1. Remove the magnet unit from the machine.
2. Remove the interposer knockoff bar; two screws hold it.
3. Remove the punch bail assembly as follows: Loosen the two screws in the magnet unit side frame. Pull out the pivot rod. Lift punch bail from unit.
4. Hold the die against the bottom of the stripper with the locating studs in the holes in the stripper. This aligns the holes in the die with the punches.
5. Insert an IBM card between the die and stripper, the width of the stripper.
6. Still holding the die in place, tap the interposers lightly to drive all the punches through the card to the extreme limit. The card will hold the

punches in place. Pull up the interposer controlling the punch being replaced.

7. On machines not equipped with mark sensing, remove the four screws and remove the X-brush bar to expose the screws in the stripper which hold the punch stop bar. On machines equipped with mark sensing remove the die, taking care when separating the die and stripper that the plates are not damaged.

8. Remove two or three of the screws in the punch stop bar which also serves as the interposer pawl stop spring bar. This will allow the stop bar to be moved far enough to clear the notch in the punch so it can be removed. Four screws hold the punch stop bar; the two end ones are short and the two center ones are longer.

9. Remove the desired punch. There are three types of punch interposers. One type is used in the first column, another type is used in the 80th

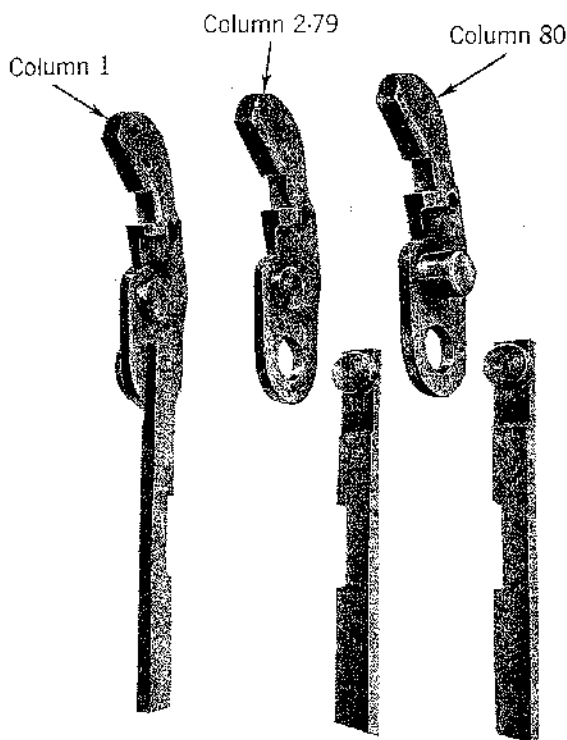


Figure 42. Three types of interposers

column and yet another is used in all columns from 2 to 79 inclusive. The interposer used in the 80th column is provided with a long stud for the eye of the magnet pull wire to prevent it from slipping off the stud. The interposer used in column 1 is attached to the punch to prevent the interposer from slipping off. The other interposers, being protected on both sides by other interposers, do not require any such precautionary design. The three types are shown in Figure 42. It can be seen that the interposers have been relieved to provide a space between them. This space prevents the interposers from sticking together and causing extra holes to be punched. The interposers should be kept free of foreign particles and gumming oil.

10. Restore all interposers to normal and remove card and die.

#### To Remove a Die and Stripper — Figure 41

The two parts are replaced as an assembly.

1. Remove the magnet unit from the machine.

2. Remove the punch interposer knockoff bar.

3. Remove the punch bail assembly. Replace the pivot bar and tighten screws to prevent spreading side frames.

4. Remove extreme left pull wire guide comb.

5. Unhook all magnet pull wires from the interposers.

6. Remove the four screws which hold the punch and stripper assembly to the magnet unit side frames.

7. Remove the punch and stripper assembly.

#### To Install a New Die and Stripper Assembly

1. Place punch and stripper assembly in position of magnet unit for assembling of magnet pull wires, but do not screw to unit. This permits more flexibility of the unit and the die and stripper when assembling pull wires.

2. Assemble pull wires to interposers. It is only necessary to move the interposers forward to assemble the wires. Check wire for proper fit to interposer stud.

3. Screw punch and stripper assembly to magnet unit.

4. Replace guide comb.

5. Check all interposers and pull wires for binds.

6. Assemble bail and tongue, and check for .015"-.020" movement of top of interposer when engaged and in its extreme lower position.

7. Assemble unit to machine and make all necessary adjustments.

8. Run in each punch five minutes without punching cards. This can be done by wiring twenty punch magnets to twenty punch unit brushes and shorting R7BU points. Hold start key down and allow machine to run five minutes. The first run may be punches 1-20, etc., and the second run should be punches 21-40, etc. Continue this until all 80 punches are run in. Running too many at a time, may cause the die plate to pull off the heads of the rivets.

#### To Remove a Magnet or Magnet Armature — Figure 41

It will be necessary to remove one row of magnets as an assembly if either a magnet or magnet armature is to be removed.

1. Remove the magnet unit from the machine.
2. Remove the magnet wires from the row of magnets involved.
3. Remove two screws, one on either side of the magnet unit, which clamp the magnet support bar.
4. Remove interposer pull wire guide comb from the position which corresponds to the row of magnets being removed.
5. Disconnect the pull wires from the bottom end of the magnet armatures.
6. Raise row of magnets as an assembly. Either a magnet or armature is now accessible for removal.

#### To Remove the Eccentric Shaft

1. Remove the magnet unit.
2. Remove the drive housing top cover.
3. Drive the taper pin from the eccentric shaft drive gear (Figure 23).
4. Remove the screws from the front and back bearings. There are three screws in each bearing.
5. Raise front bearing until it projects slightly above the side frame. With hammer and brass rod, drive the bearing toward the rear of the machine until the eccentric shaft may be lifted from the machine.

#### To Remove a Stacker — Figure 43

1. Remove the magnet unit.
2. Remove the cam for the stacker contact.

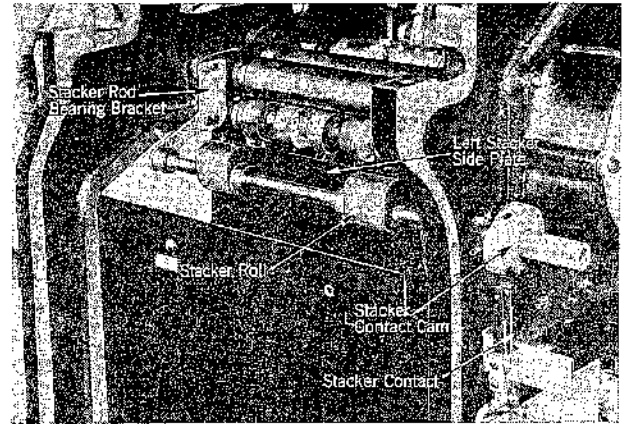


Figure 43. Stacker

3. Remove the left stacker side plate.
4. Remove top stacker cover; two screws in right hand stacker side plate hold it.
5. Remove front stacker rod bearing bracket.
6. The stacker may now be pulled out from the front of the machine.
7. Check timing when stacker is replaced.

#### To Remove a Contact Roll

1. Drop brushes away from the contact roll.
2. Remove the front cover.
3. Remove the two large screws (8-32) which hold the contact roll bushing plate to the side castings. The contact roll may now be pulled out the front of the machine. When replacing the roll, be careful of the common brushes. It will be necessary to turn the roll by hand until the tongue or key on the rear end of the roll lines up with the slot in the driving spindle. The holes in the front bushings should line up with the oil lines.

## ADJUSTMENTS

### CLUTCHES

#### Punch and Read Clutch

1. Mount clutch assembly with the three mounting screws.
2. Set clutch latch stop screw for  $.015''$  clearance between the latch point and the tail of the clutch pawl when the latch is against the latch stop screw. Move magnets if necessary (Figure 44).
3. Set the clutch latch backstop screw for  $\frac{1}{16}''$  overlap of the latch over the tail of the pawl (Figure 45).
4. Move the magnet coil mounting plate in elongated holes to provide for  $.008''-.010''$  clearance between the armature and cores when the latch is against the stop screw (Figure 46).

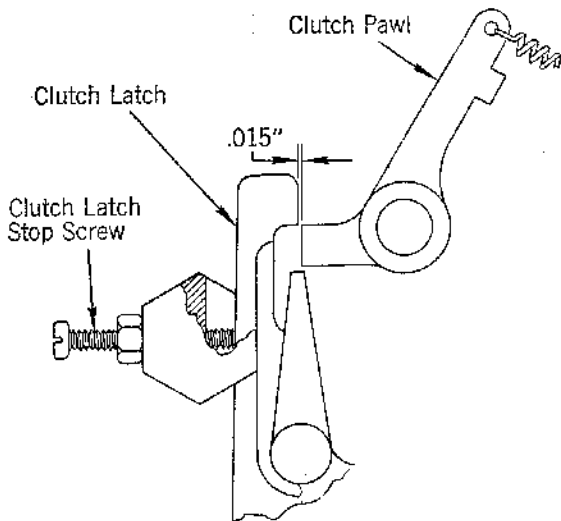


Figure 44. Clutch adjustment

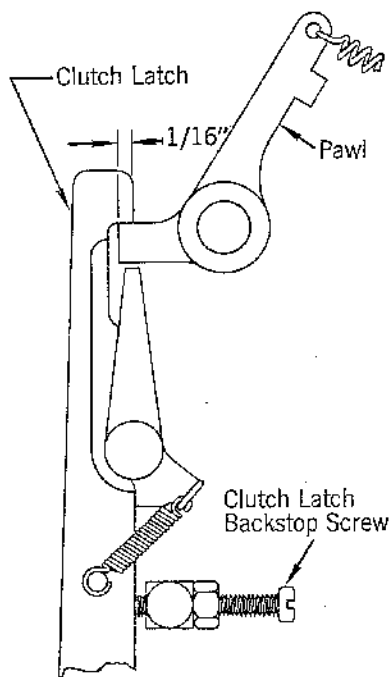


Figure 45. Clutch adjustment

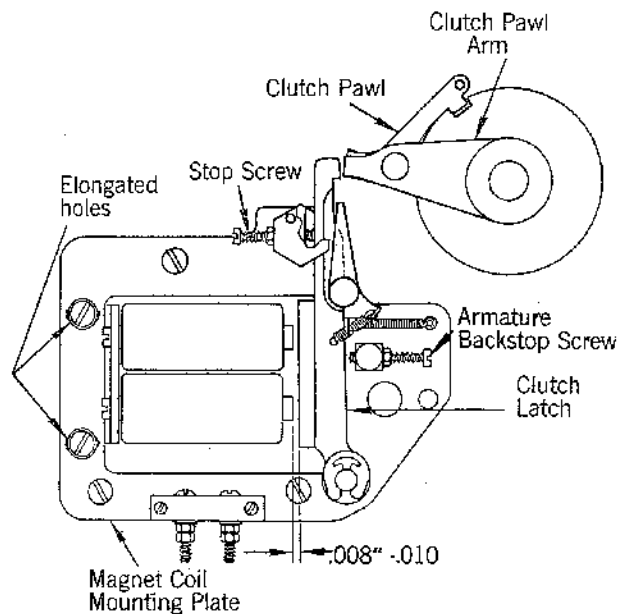


Figure 46. Clutch adjustment

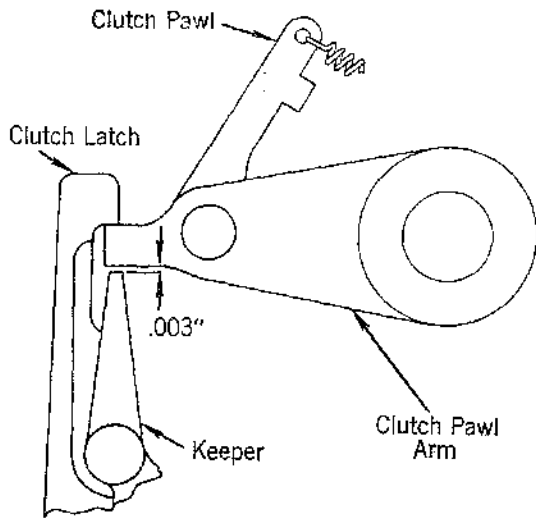


Figure 47. Clutch adjustment

5. There should be .003" clearance between the keeper and the clutch pawl arm when the pawl is latched. This is obtained by stoning or peening the keeper (Figure 47). If the clutch is removed and replaced, the clutch plate should be mounted with the mounting screws in the center of the elongated holes. The other adjustments should then be checked.

#### GENEVA MECHANISM

##### Single Revolution Timing Cam — Figure 48

This cam should be timed so that the flat side of the cam is up and in a horizontal position at one tooth past 14 on the index. Move the cam and gear out on the shaft far enough to unmesh the teeth and remesh for above condition.

The geneva pawl should be engaged when checking this adjustment.

##### Single Revolution Timing Cam Bracket — Figure 48

Loosen the holding screw. Move the bracket up or down until the cam holds the geneva pawl disengaging roller in position to hold the geneva pawl away from the one-tooth ratchet on the geneva gear when the punch clutch is latched up

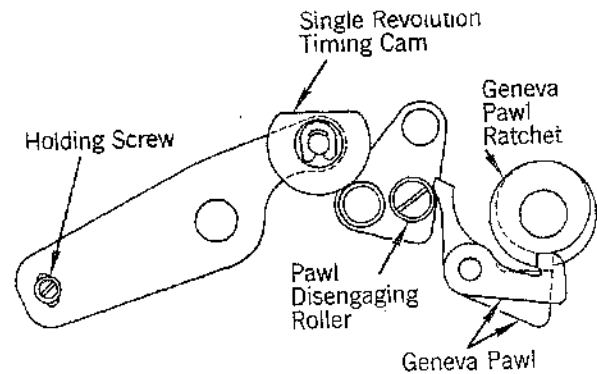


Figure 48. Single revolution timing cam and bracket

at D and the machine is operated by hand. Only the raised portion of the tail of the pawl should operate against the roller. An approximate adjustment may be obtained by setting the bracket so that the locking screw is about one-third of the way up from the bottom of the elongated hole.

Set bracket so that geneva clutch pawl just nips the one-tooth ratchet. Then move the left end of the bracket up until the pawl just clears the one-tooth ratchet.

#### Geneva Clutch

A two-pawl geneva clutch is used on Type 513 machines. This assembly is more positive in its action than the single-pawl type, and is interchangeable with the geneva clutch assembly on all high speed punches.

Two pawls, one a driving pawl and the other a detenting pawl, are used to eliminate the critical knockout timing of the clutch. The pawl disengaging roller is positively positioned on the bracket.

#### PUNCH UNIT

##### Belt Tension

The belt tension is adjustable by moving the motor up or down on its pedestal. The belt should be adjusted for enough tension to prevent slippage; excessive tension, however, will cause the motor bearings to overheat and should be avoided.

### Feed Roll Tension

Feed roll tension is determined by compression springs in the feed roll pressure bracket. The springs in the first and second feed roll pressure brackets of the punch feed are heavier than in the other feed roll pressure brackets.

If for any reason any pressure spring in any one bracket is replaced, all springs in the bracket should be replaced to provide for even tension.

### Feed Knife Guides

The adjustable guides for the feed knife racks should be positioned for a minimum of play of the racks between the guides, without causing any binds. Check this over the entire length of the stroke (Figure 49).

### Feed Knives

The card feed knives are adjustable and should be set evenly on each side for a projection of .004"-.0045". To adjust a feed knife, remove the feed knife block from the feed knife rack. This may be done without changing the left-to-right position of the knife block if the knife holder adjusting screw is held with a 1/4" open end wrench while the knife block holding screw is removed.

A Go-No Go gauge is provided with two accurately ground surfaces at opposite ends. The

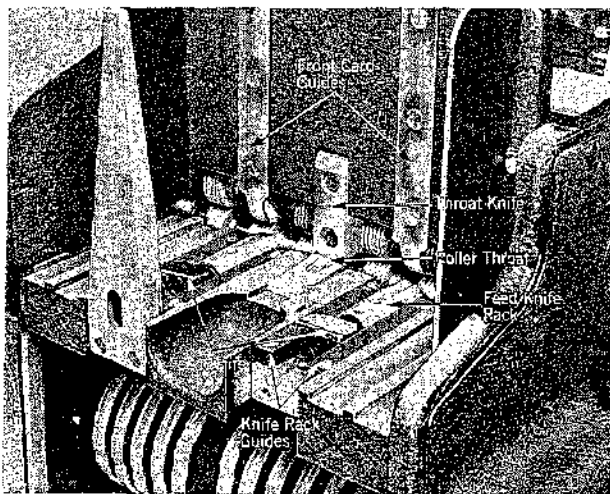


Figure 49. Feed hopper

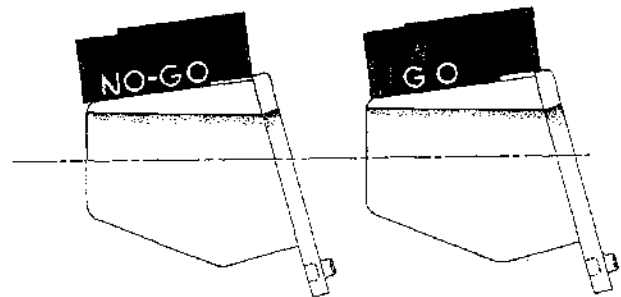


Figure 50. Go no-go gauge

surface marked "Go" is cut .0045" deep and the opposite surface marked "No Go" is cut .004" deep. When the feed knives are adjusted, the locking screws should be loosened until they are just snug enough to prevent the knives from moving with a slight pressure. Turn either in or out on the adjusting screws, as required, to raise or lower the feed knife. If the knife is properly adjusted, the "Go" end of the gauge will pass over the feed knife on either side (Figure 50). The "No Go" end will not pass over the projection as shown in Figure 50.

The knife must project evenly all the way across and both knives must be adjusted for the same condition.

After a period of use, the knife blocks may wear, particularly at a point near the feed knife, in which case accurate adjustment is not obtainable. If such a condition exists, it should be remedied in the following manner before the above adjustment is performed.

Set feed knife for the slightest possible projection above the knife block. Stone knife and block assembly until the top surface of the knife and block are even. Then proceed as above.

### Throat

The throat block should be adjusted laterally with the vertical center line of the roller directly in line with the edge of the throat knife. This

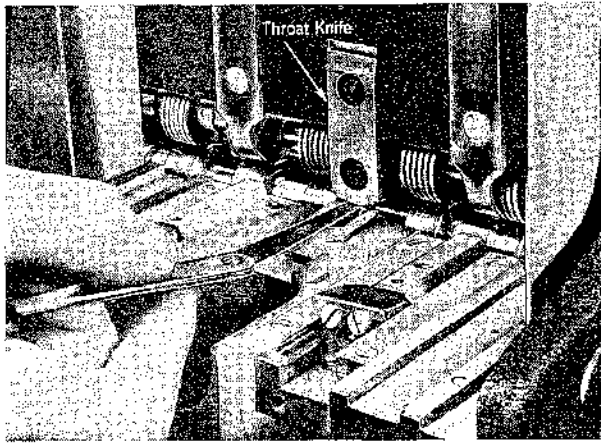


Figure 51. Throat adjustment

can be determined by a small ridge on either side of the roller on the throat block.

The throat opening should be .010" to .011" on the roller type throat. This is adjusted by positioning the throat knife vertically so that the .010" gauge just enters snugly when it is parallel to the bed of the machine (Figure 51). It should not be possible to enter the .011" gauge.

#### Feed Roll Opening Device — Figure 52

When the two cam rollers are on the high dwells of the opening cams, the feed rolls should open .020" at both ends. This is obtained by adjusting the eccentric studs on which the cam follower rollers pivot.

The rolls should just close at four teeth past 5. To adjust them, loosen the roll opening cams on the shaft and turn the machine to four teeth past 5. Turn the roll opening cams back against the cam rollers attached to the links and tighten the cam setscrews. Turn the machine to one tooth past 3 and check that rolls have not started to open. Turn to one tooth past 4 and check that rolls are open at least .015". Be sure there is no feed roll pressure until after one tooth past 5 on the index and that the feed rolls are fully closed by 5 teeth after 5.

Check for evenness at both ends at the time the rolls are just closing. This can be done by inserting a strip of card at each end and noting the drag on the card. Also check when rolls are fully open for at least .015" at center of rolls, as the lower roll has a tendency to bow or the top center bushing may have excessive pressure. The card friction finger springs should be adjusted for even tension.

#### Die

The stop studs in the stripper must be maintained snugly against the die. These studs provide minimum clearance between the die and the stripper. Adjust this by positioning the left end of the magnet unit assembly up or down by means of the adjusting screws, one beside each of the two clamping screws at the left end of the unit (Figure 39). Remove and replace the die several times to be sure that latching bars have a slight drag as they enter and leave the castings.

The two angle guides, one on each end of the die assembly used on high speed punches, are for the purpose of keeping the die in a level position when placing it in position in the machine. The following method should be used to correctly

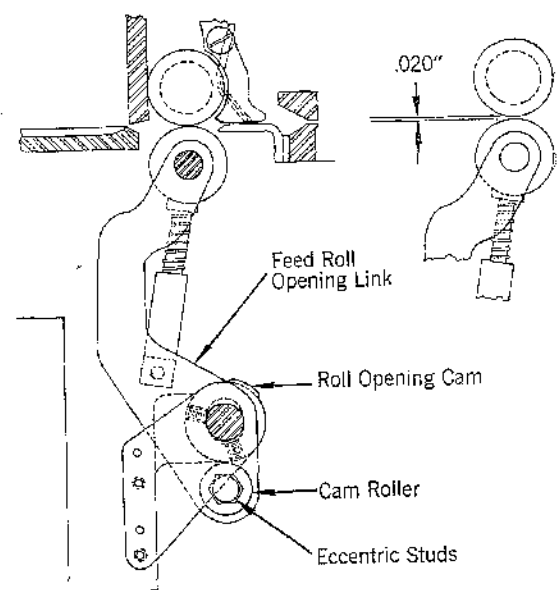


Figure 52. Feed roll opening device

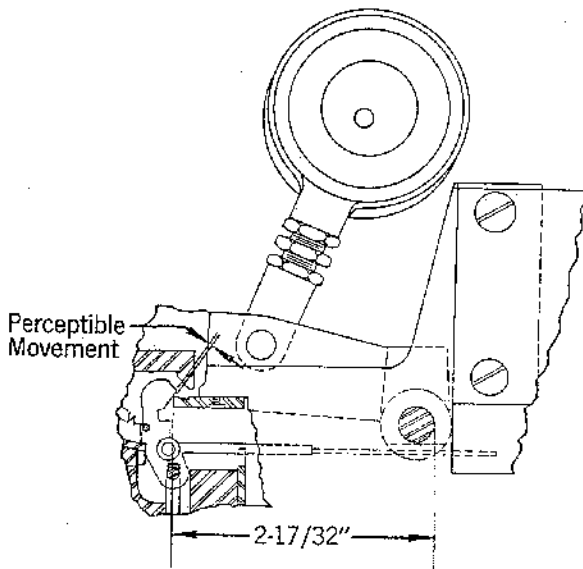


Figure 53A. Punch bail tongue adjustment

adjust these guides which, if properly adjusted, will make it easier to remove and replace the die in the machine.

Install the die assembly in the machine with the angle guide loose, and lock the die in place. Each angle should then be pressed lightly toward the side frame and tightened in this position. An excessive amount of pressure must not be placed on these guides, or they will bind and cause difficulty in the removal of the die.

#### Punch Bail Tongue — Figure 53A

The punch bail tongue should be adjusted so that it is  $2\frac{17}{32}$ " from the front edge of the tongue to the back of the punch bail pivot shaft. Loosen the four holding screws. Then position the tongue in relation to the bail by means of the two adjusting screws. This should not require adjustment unless a punch bail or punch bail tongue is replaced.

#### Interposer Spring Bail — Figure 53B

The interposer pawl lock bar is positioned and pinned at the factory so there is a minimum clearance between the interposers and the punch bail tongue when the interposers are engaged with the punch bail tongue and are driven to their

extreme downward limit by the punch bail. The interposer spring bail should be positioned so that it does not touch the interposers and thereby change the condition of a minimum clearance as given above. Check several interposers at each end.

#### Punch Magnet Armatures

The magnet armatures should be adjusted so that the interposers will move  $\frac{1}{8}$ " toward the magnets when the armatures are attracted. The  $\frac{1}{8}$ " travel is obtained by increasing or decreasing the armature air gap by bending the armature just above the point where the pull rod connects. The interposers should line up when in a normal position and should move freely.

#### Punch Bail Connecting Links — Figure 53A

There must be a perceptible movement between the punch bail tongue and the interposers when the bail is in its uppermost position. This condition prevents binds and also provides for a minimum travel of the punches into the die. Proceed as follows:

1. Remove the front punch bail connecting link pin.

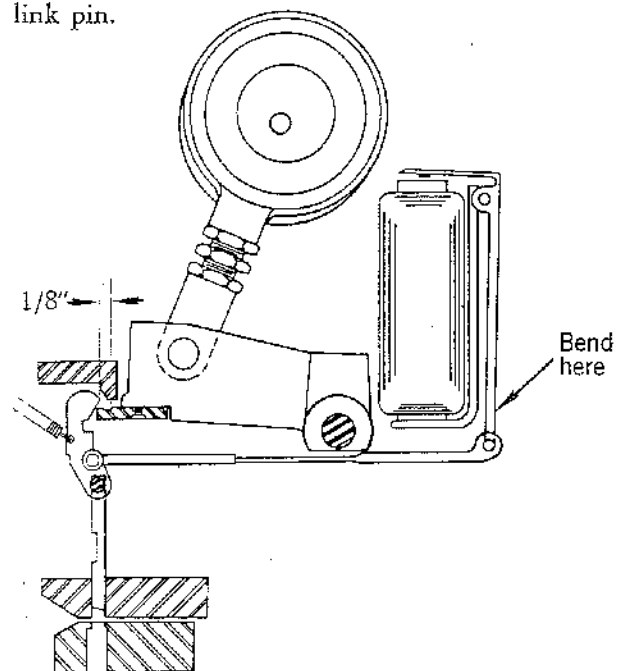


Figure 53B. Punch magnet armature adjustment



2. Turn the machine until the punch bail is in the extreme upward position (eccentric up).

3. Adjust the rear punch bail connecting link adjusting screw for a slight clearance (.003") between the punch bail tongue and the interposers. If there is any variation in the clearance from one end to the other, the .003" clearance should apply to the closest end. This may be checked with a leaf gauge or by moving the interposers.

4. Adjust the front connecting link adjusting screw so that the front punch bail connecting pin will slide freely into position in the punch bail and punch bail connecting link. This assures an even adjustment on both connecting links and eliminates strain on the punch bail.

After adjusting the connecting link adjusting screws, check to see that the punches are not jammed down against the punch stop bar. Check in the following manner.

1. Engage the interposer at each end of the punch bail and turn the machine until the punch bail is at its extreme downward limit of travel.

2. Press on the top of the interposer with a screwdriver and check for a slight movement.

The punch stop bar should be set as near the

punch as possible without interfering with the movement of the punch.

Punch Magazine Side Plates

The punch magazine front and rear side plates are adjustable forward or backward so that cards punched are in proper horizontal alignment on the card registration gauge. Adjustment is provided by means of an elongation of the holes provided for the mounting screws. This should result in the punched holes lining up with the grooves in the first upper feed roll. Since the X brushes line up with the grooves in the upper feed roll, this condition is necessary to provide for proper tracking of the X brushes. If the registration does not align with the grooves in the feed roll, the X brush holder may be positioned and possibly worked to allow for reading the hole in the card. The magazine side plates should have approximately .005"-.008" clearance over the length of the cards. This may be checked by placing a card vertically between the stack of cards and the magazine side plate. There should not be room for two cards and there should be little or no drag on one card. The magazine should be half full of cards when this adjustment is made.

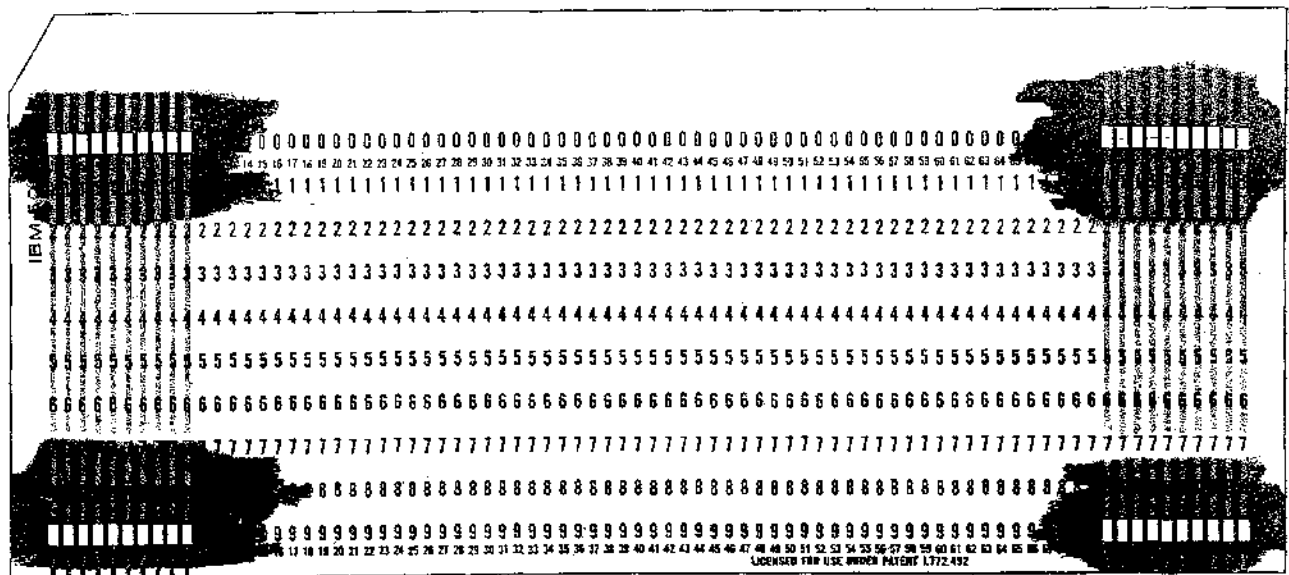


Figure 54. Properly aligned card

### Punch Brush Lateral Alignment

The punch brushes should be positioned so that the brush strands will track through the center of the holes in the card. This may be visually checked if a deposit of some soft substance, such as carpenter's chalk, is placed across the 0 and 9 edges of the printed surface of a card punched 9, 0, 9, 0, etc., and the card is run through the machine. The brush tracks will be plainly visible on the chalked surface of the card. A properly aligned card should appear as in Figure 54. The brush holders and separators can be moved to the front or back if the three locking screws in the slide assembly are loosened (Figure 55).

### Anchor Slide Adjustment

The clearance between the contact roll and the brush separators must be  $.012''-.018''$ . Adjust the brush slide unit up or down by means of the anchor slide adjusting screws in the front and rear support castings (Figure 56).

### Punch Feed Knives — Lateral Adjustment to Obtain Brush Timing

The punch feed knives must feed the card evenly and at the proper time. The punch brushes are set in their holder so that the heels of the brushes are aligned with the scribed line (Figure

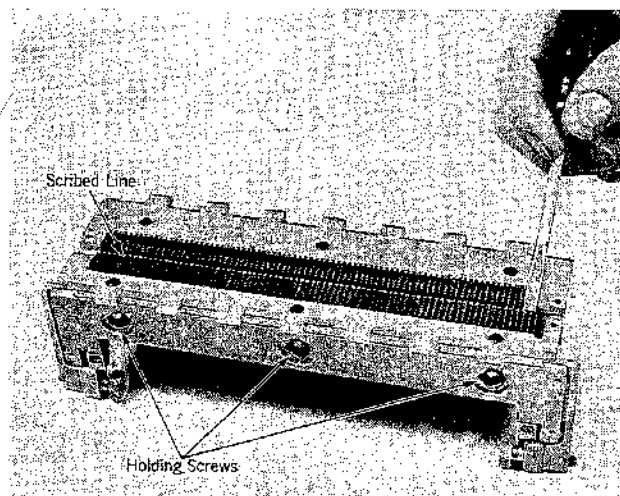


Figure 55. Brush slide assembly

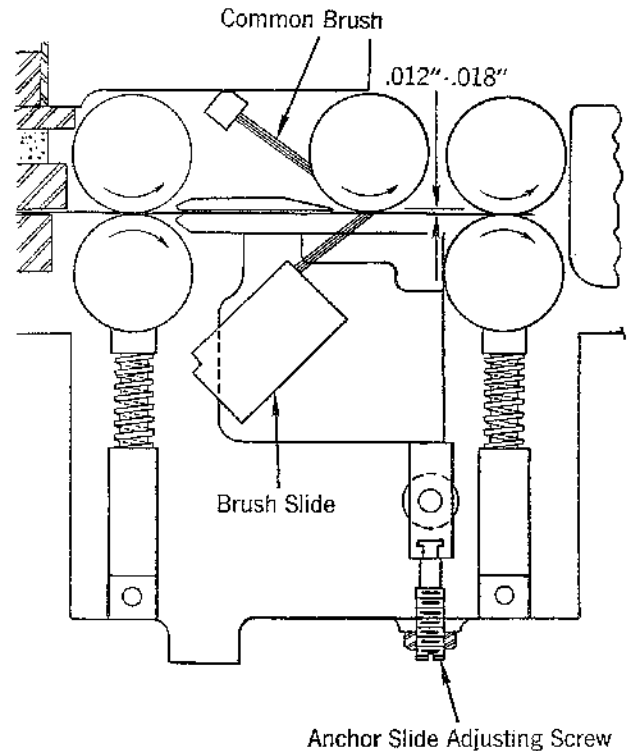


Figure 56. Anchor slide adjustment

55). The brush projection should be  $\frac{1}{8}''$  above the separators (Figure 57) which requires a measurement of  $\frac{3}{32}''$  from the brush block to the toe of the brush. Adjust the knife holder adjusting screw (Figure 58) for two conditions: first, to obtain even feeding, that is, both ends of the card entering the feed rolls at the same time; second, to feed the card so that the brushes make through the holes in the card  $\frac{3}{4}$  to  $\frac{1}{2}$  tooth before the line of index (check with a test light).

The punch brushes should not be moved off the scribed line unless it is necessary to move one end slightly so that both ends will be timed exactly alike. The feed knives must travel at least  $.020''$  past the left edge of cards in the magazine.

### X Brush Timing

The X brushes in the punch unit should make contact through an X hole punched in a card at  $\frac{3}{4}$  of a tooth before 13 on the index and

should not break before  $4\frac{3}{4}$  teeth after D. This duration must be maintained to provide proper operation. The brush may be stoned to increase its duration to meet the above timing. This timing is obtained by moving the brush in its holder. An approximate setting may be obtained by aligning the heel of the brush with the scribed line on the X brush holder after which the timing should be checked with a test light. A slight change may be necessary to obtain the proper make time. The clearance between the X brush holder and the X contact bar should be  $.010''-.012''$ . This is obtained by moving the X brush holder mounting bar up or down on the mounting screws. The holes in the mounting bars may be enlarged if necessary.

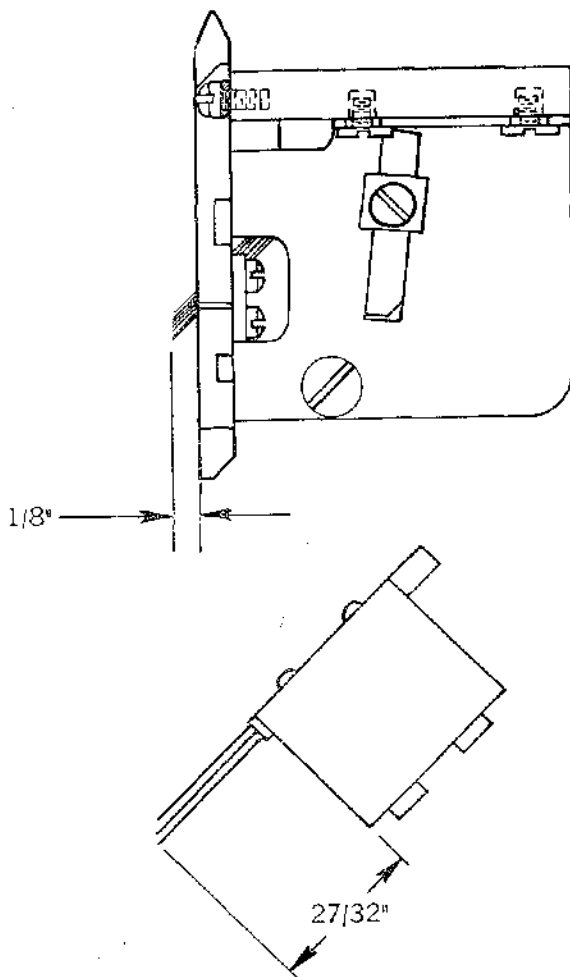


Figure 57. Brush projection

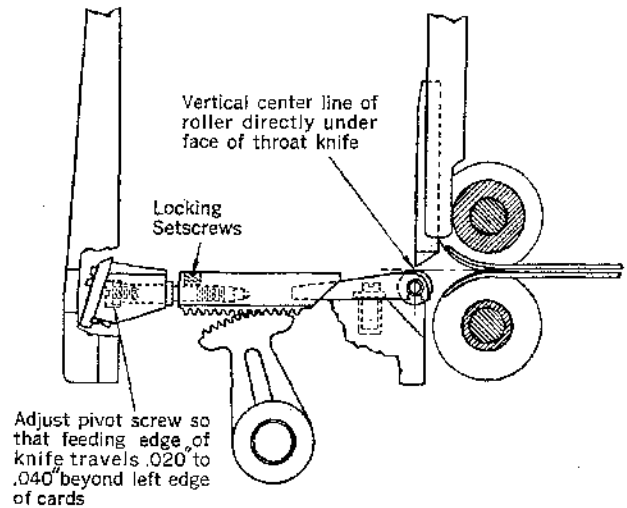


Figure 58. Schematic of feed

#### Vertical Registration

Cards must be punched in proper alignment. Registration should be checked with a card gauge. To change the registration, loosen 4 magnet unit screws and adjust the 2 magnet unit aligning screws (Figure 39) to position the magnet unit assembly toward the right or left, for proper vertical registration of the holes punched in the card. (Move the vertical registration aligning screws evenly and only when the magnet unit holding screws are loosened; otherwise, the unit may be strained and incorrect horizontal registration may result.) Be sure the aligning screws and holding screws are tight after making this adjustment. The vertical registration should be set with the magazine half full of cards. With a full magazine a slight variation may be noted in one direction, and with a nearly empty magazine a slight variation in the other direction may be noted.

After repositioning the magnet unit for the proper vertical alignment as in the above adjustment, recheck for the slight clearance between the punch bail tongue and the interposers when the punch bail is "up," because repositioning the magnet unit will affect that adjustment.

**Stacker Plate**

If the stacker has a flat plate (no indentations under rubber rollers), adjust the stop nut on the rod in the bottom of the stacker tube so that there is .006"-.010" clearance from the stacker plate to the face of the rubber rollers when the rubber rollers are in the extreme downward position. The felt washer serves as a brake to prevent the stacker from returning to its upper position too fast when cards are removed. The braking action is adjusted by compressing the felt washer by means of an adjusting nut.

**Stacker Timing**

To time the stacker roll:

1. Remove the blue steel clip from the stud of the idler gear.

2. Disengage the idler gear.
3. Engage the punch clutch and turn the machine to 4 on the index.
4. Turn the stacker roll so that the high side is down and remesh the idler gear. This timing should result in the card being carried to within  $\frac{1}{32}$ " of the right side of the stacker. If the stacker of the punch unit is retimed, it will be necessary to check the timing of the stacker roll contact.

**COMPARING UNIT**

The adjustments are as follows:

1. Adjust the eccentric screw A so that with the bail in normal position there will be  $\frac{3}{32}$ " between the top edge of the bail and the end of the pawl (Figure 59).

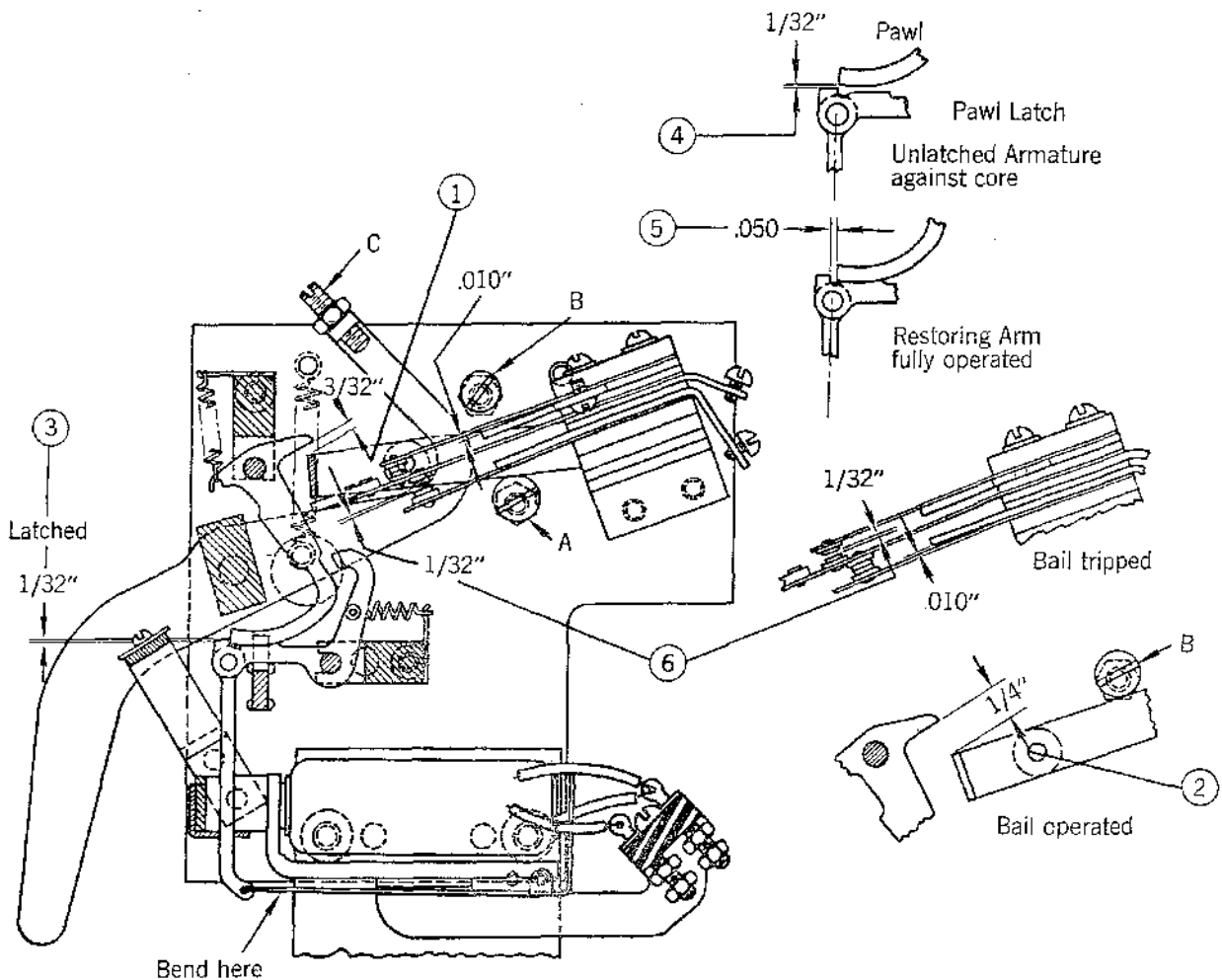


Figure 59. Comparing unit adjustment

2. With the bail in the operated position (tripped), adjust the eccentric screw *B* so that there will be  $\frac{1}{4}$ " between the top edge of the bail and the end of the pawl.

3. With the comparing magnet armature in a de-energized position, the pawl latch should overlap the pawl by  $\frac{1}{32}$ ".

4. With the comparing magnet armature held against the core, there should be  $\frac{1}{32}$ " unlatched clearance between the pawl and the pawl latch. Form the armature at a point near the pull rod.

5. Screw *C* is adjusted to give .050" clearance between the pawl and the pawl latch when the restoring arm is fully operated manually.

6. With the bail in normal position, the transfer contacts should be adjusted by bending the support straps and the center strap so that there is .010" rise off the support on the top strap and  $\frac{1}{32}$ " air gap between the center and bottom contact points. The same adjustments apply when the bail is operated and the center strap is transferred as shown in Figure 59.

## READ UNIT

### Read Magazine Side Plates

The read magazine front and rear side plates are adjustable forward or backward so that the punched holes in the card will line up with the grooves in the first upper feed roll. The magazine side plates should have approximately .005"-.008" clearance over the length of the cards. This may be checked by placing a card vertically between the stack of cards and the magazine side plate. There should not be room for two cards and there should be little or no drag on one card.

### Reproducing and Comparing Brush Alignment

After the magazine side plates have been adjusted, a visual check may be made to determine that the brushes are properly aligned with the punched holes in the card. Place a deposit of some soft substance, such as carpenter's chalk, across

the 0 and 9 edges of the printed surface of a card punched 9,0,9,0 etc. Run the card through the machine. The brush tracks will be plainly visible on the chalked surface of the card. A properly aligned card should appear as in Figure 54. The brush holders and separators can be moved to the front or back if the three locking screws in the slide assembly are loosened (Figure 55).

### Reproducing Brush Timing

The reproducing brushes should be placed in the brush holder so that the heels of the brushes line up with the line scribed across the brush separators (Figure 55). The projection above the face of the brush separators should be  $\frac{1}{8}$ ". Timing is accomplished by varying the time that the card is picked up by the first set of feed rolls. Move the knife holder adjusting screw (Figure 58) so that the knives will feed the card at the proper time to have the brush make contact through the hole in the card at 2 teeth before the line of index and to remain made until at least 5 teeth past the corresponding line on the index. Check for proper timing at both ends of the brush assembly. The individual brush may be moved in its holder to care for variation in timing.

### Comparing Brush Timing

These brushes should make contact through the punched holes in the card at 2 teeth before the line of index and should not break earlier than 5 teeth past the line of index. This condition is obtained by shifting the comparing brush holder to the left or to the right as required. These brushes should always be timed after the reproducing brushes.

### Common Brushes

The common brushes on each contact roll should have good tension to insure positive contact. Beveled brush, Part 109339, is now being used for common brushes to reduce wear on the contact roll.

In order to further decrease the tendency of the common brush to wear a groove in the

contact roll, it is well to draw it across an oil stone to remove any burrs or feather edges before installing it.

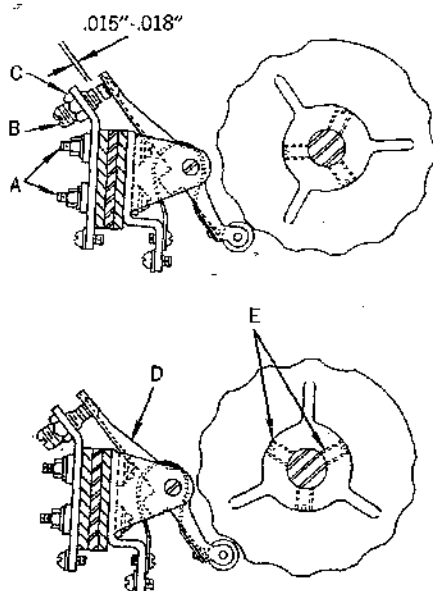
#### X Brush Timing

The X brushes in the read unit should make contact through the X hole punched in a card at 3 teeth before 13 on the index and should not break before 2 teeth after D. This duration must be maintained to provide proper operation. This is obtained by moving the brush in its holder. An approximate setting may be obtained as given under "Punch Unit, X Brush Timing."

### CONTACTS

#### Circuit Breakers — Figure 60

1. Clean points.
2. Loosen screws A and align the contact points so that the full contact area is used.
3. Loosen the locknut C and adjust screw B for correct air gap. There are 40 threads per inch on the contact screw, giving .025" movement for



CIRCUIT BREAKER ASSEMBLY

Figure 60. Circuit breaker adjustment

each turn. Air gap on circuit breakers should be .015"-.018".

4. Form at D so that contact surfaces meet squarely.

5. Loosen screws E and turn cam to obtain proper timing as given on the electrical timing chart supplied with each machine.

#### Cam Contacts

There are two types of contacts, commonly referred to as *Make* or *Break* contacts. They are identified by their position after the operating strap falls off the high dwell of the cam. When the operating strap falls off the high dwell of the cam and the contact opens, it is designated a break contact. When the operating strap falls off the high dwell of the cam and the contact closes, it is designated as a make contact.

The plastic cams used to operate the contacts are stamped with a fraction indicating the size of the cam. The size is given in fourteenths or a fraction of 1/14 and it indicates the proportion of the circumference that is high. Thus, a 4/14 cam has approximately 4/14 of its circumference high and 10/14 low. When used with a break contact, such a contact will be closed 4/14 when the operating strap is on the high portion of the cam and will be open 10/14 when on the low dwell of the cam. If a make contact is used, the contact will be open for 4/14 and closed for 10/14 of the cam's circumference. A make contact is open when the operating strap is on the high portion of the cam (Figure 61).

Make adjustments as follows (Figure 62):

1. Clean points; stone pitted points; check all contacts for loose points. The point must be securely fastened to the contact strap.
2. Align the contact points for full contact by loosening the contact mounting screws, and shifting straps for proper alignment. Be sure screws are tightened.

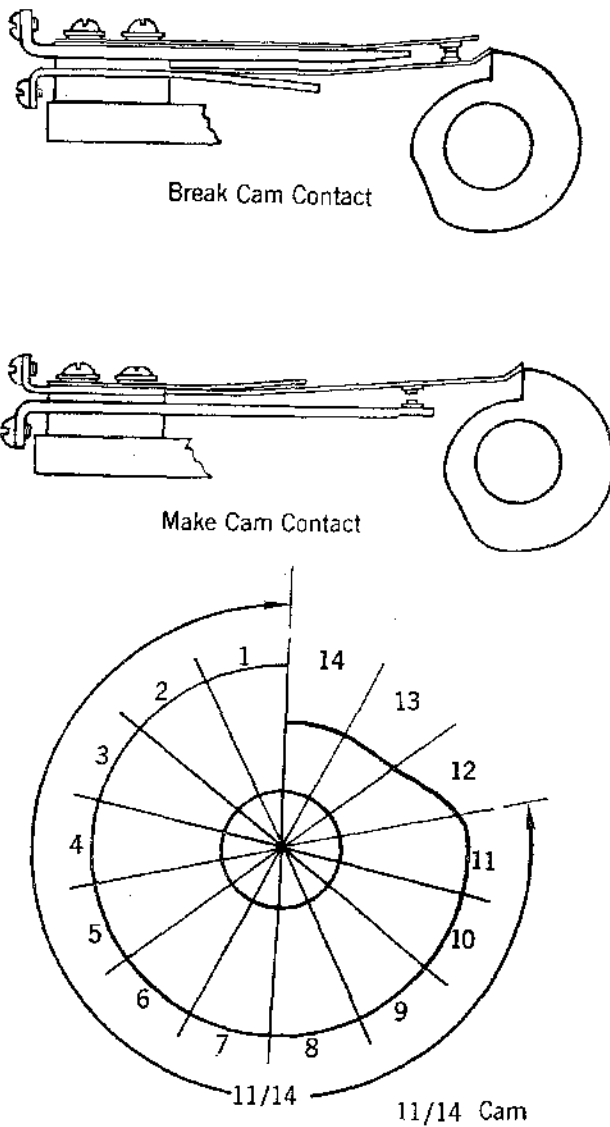


Figure 61. Cam contact

3. Adjust the make contact by bending the non-operating strap for an air gap of  $\frac{1}{32}$ " between points when the operating strap is on the high dwell of the cam. The operating strap should have sufficient tension to assure good contact when the points are closed.

4. Adjust the break contact by bending the non-operating contact support for  $\frac{1}{32}$ " rise of the

non-operating strap off its support when the operating strap is on the high dwell of the cam. When the operating strap drops off the high dwell of the cam, there should be at least  $\frac{1}{16}$ " air gap between the points. There should not be too much tension on the operating strap. Too much tension will cause noisy operation and excessive wear on the cams.

5. Adjust the timing of the contacts by loosening the cam setscrew and shifting the cam on the shaft. The timing of the individual contact is obtained from the timing chart which accompanies the machine. *Make* contacts are timed for the making point (the point at which the contact strap falls off the high dwell of the cam). *Break* contacts are timed for the proper breaking point, according to the timing chart (the point at which the operating strap falls off the high dwell of the cam).

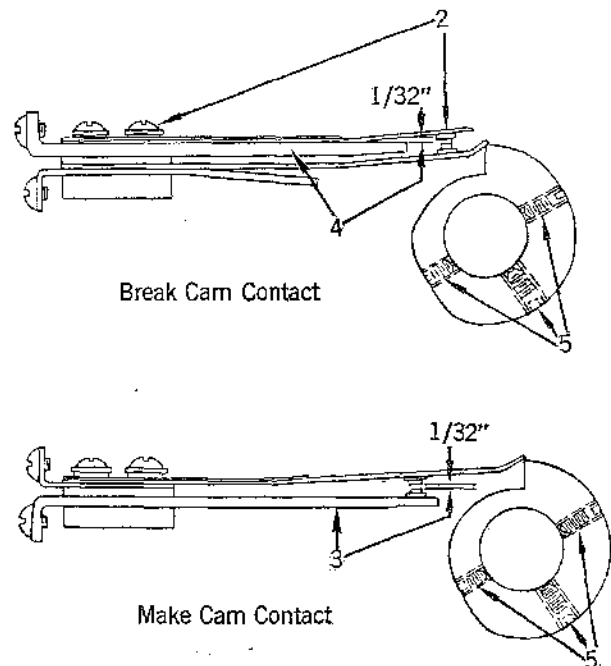


Figure 62. Cam contact adjustment

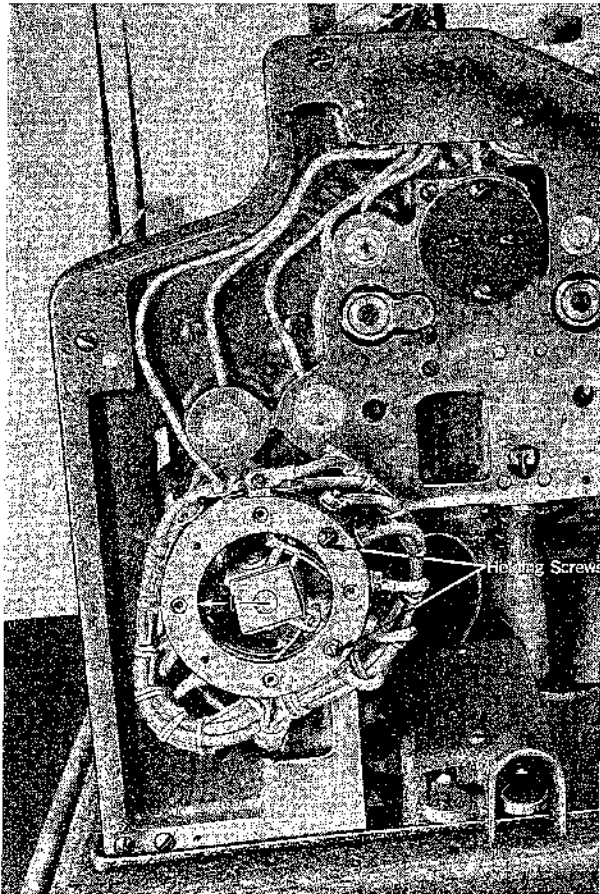


Figure 63. Summary punch emitter

#### Summary Punch Emitter — Figure 63

1. The emitter should be accurately centered with respect to the shaft on which the emitter brush holder is mounted. This may be checked by observing the radius from the center point of the shaft to the inside circumference of the emitter at each segment of the emitter. By loosening the holding screws, the emitter can be shifted enough to position it properly. The emitter must be accurately centered in order that the brushes may make uniformly at the various points of the index. The proper radius is approximately 1".

2. A beveled brush, Part 109339, should be used. The face of this brush is so beveled that a contact duration of  $5\frac{1}{2}$  to 6 teeth will result.

The brushes should be timed to make 1 tooth before the line of index and checked to see that they do not break before  $4\frac{1}{2}$  to 5 teeth after the line of index. Check this timing at 0, 5 and 9. The circuit breakers make at the line of index and break 3 teeth after the line of index. Thus a definite overlap of the brushes to the circuit breakers is provided.

#### Card Lever Contacts

1. Loosen contact screws and move the contacts so that all points line up.

2. Adjust contacts by bending brass supports so that contacts have  $\frac{1}{32}$ " rise off brass support when made and at least  $\frac{1}{32}$ " air gap between points when open.

3. The non-operating strap of the contact should have sufficient tension to rest against its brass support when there is no card under the card lever.

#### Stacker Roll Contact

1. Loosen contact screws and move the contacts so that the points line up.

2. Adjust contacts by bending brass supports so that the contact has  $\frac{1}{32}$ " rise off brass support when made and at least  $\frac{1}{16}$ " air gap between the points when open.

3. To time the stacker roll contact, loosen set-screws and turn the cam on the shaft so that when the punch clutch is engaged the stacker roll contact makes at 8.9 and breaks at 13.9.

#### Start and Stop Keys

1. Loosen contact screws and move the contacts so that all points line up.

2. Adjust the start key contacts for  $\frac{1}{16}$ " air gap between the points when the key is in normal position.

3. Adjust the stop key contact for  $\frac{1}{32}$ " rise off the brass when the key is in its normal position.



## LUBRICATION

## IBM 6

Clutch magnet armature pivots—read and punch units.

Roller throat.

Relay armature pivots.

Feed roll opening device cam follower—follow with IBM 17.

C.B. cam rollers—follow with IBM 17.

C.B. cam pivots.

Felt wick in stripper, behind punches.

## IBM 9

Card feed knife slides—read and punch units.

Center bearing of first upper feed roll—read and punch units.

Oil cups on all lower feed roll bearing brackets.

Oil wells in side frame castings.

Oil wells (cups) on punch bail connecting links.

Oil cups on punch bail for pivot shaft bearings.

Contact roll driving spindles and keys—follow with IBM 17.

Stacker roll bearings and gears.

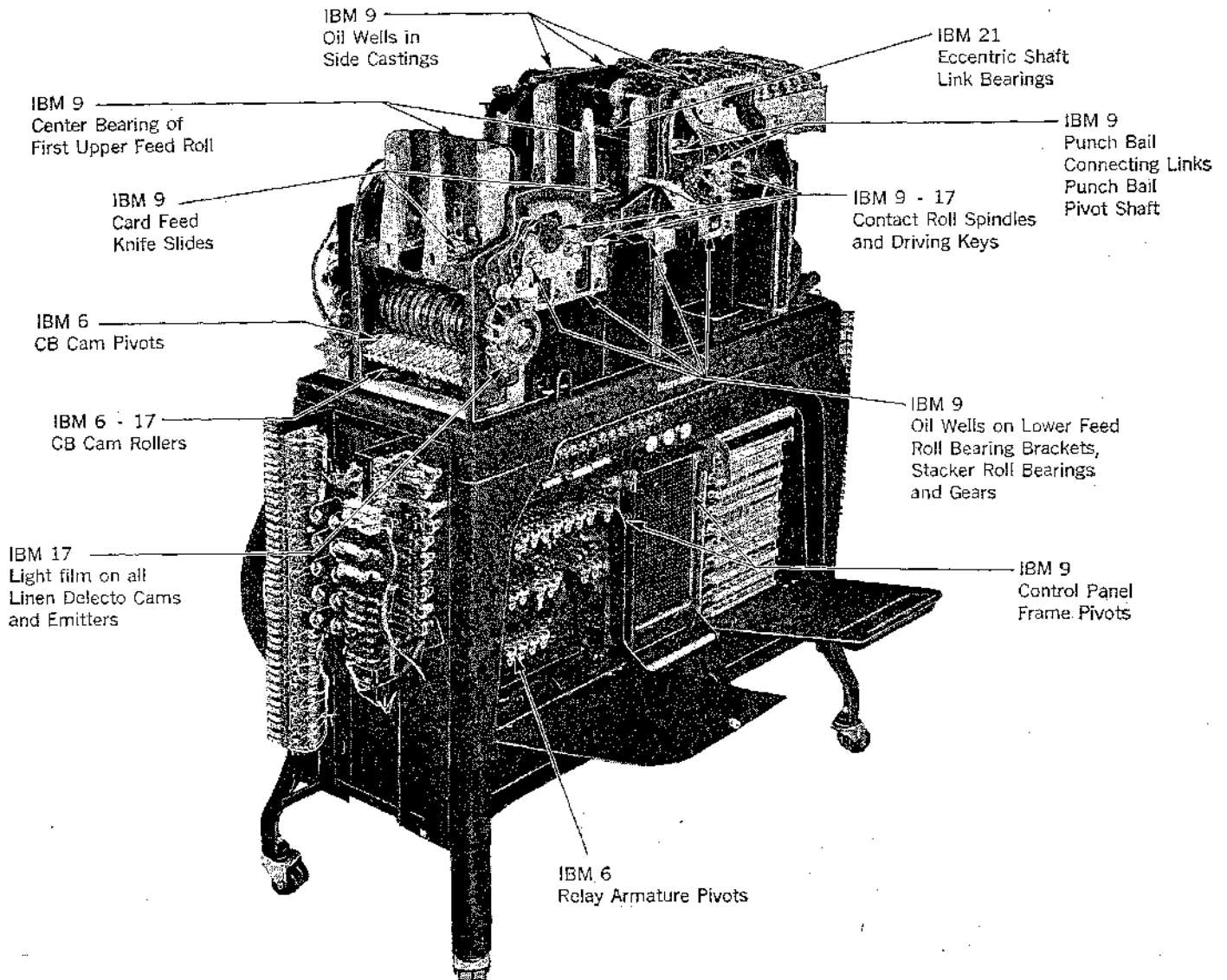


Figure 64. Lubrication

Control panel frame pivots.  
 Motor and generator oil cups.  
 Drive pulley pawl pivots.  
 P- and R-cam idler gear shafts.

## IBM 12

Drive housing.

## IBM 17

Drive pulley ratchet.

Magnet unit armatures at point where pull wires fasten.

Feed roll drive gears.

C.B. cam rollers.

A light film on all linen delecto cams and summary punch emitter.

A light film on the tips of pawls and contact cams on the mark sense mechanical delay unit.

## IBM 21

Eccentric shaft Zerk fittings, motor-generator bearings.

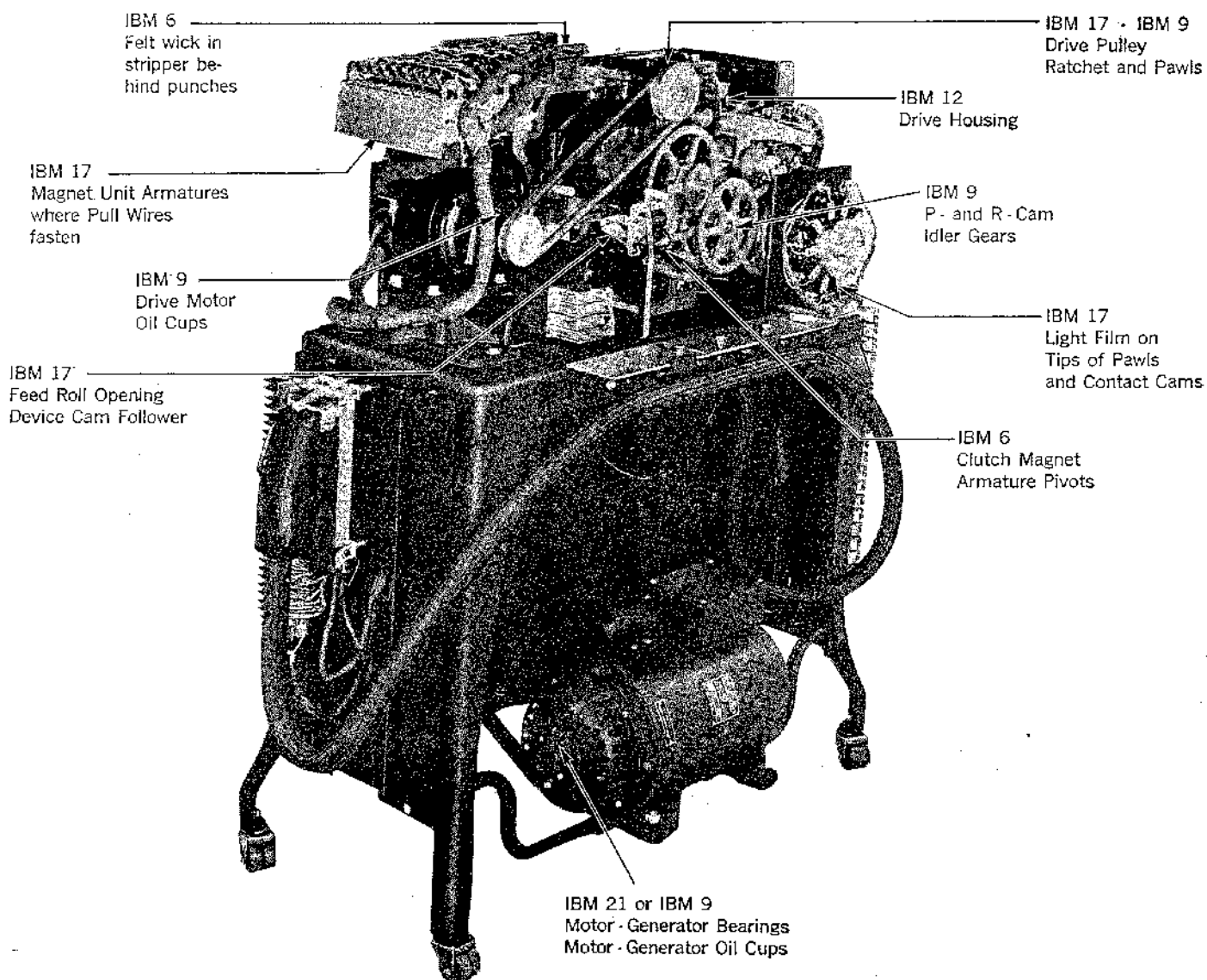


Figure 65 Lubrication

## CIRCUITS

In any discussion of circuits, it will be necessary to know the operation and placement of the card levers. Figure 66 gives the location of the card levers and brushes with respect to the position of the cards at the end of the various card cycles.

The magazine card lever contacts signal the presence or absence of cards in the magazine.

The other card lever contacts are used to sense the presence or absence of cards in the various card stations of the feed. Card levers generally function in two types of circuits, first, to provide continuous machine operation, and second, to provide circuits to reading brushes.

After establishing the location of the contacts and units in the machine it will be well to establish their placement on the blueprint.

The motor generator and drive motor appear at index 2B and C. The die, punch magazine, read 1, read magazine and punch brush card levers are found at index 4B. The read 2 and comparing card levers are found at indices 11B and 12B respectively.

The punch and read clutch magnets are found at index 3C. The summary punch emitter is found at index 14C. The relay location chart is found at the top of the blueprint at indices 6-9. The brushes, contact rolls, punch magnets and comparing magnets are in 13B and C.

At indices 1 and 2 is found the power supply for all operations of the machine. The test lamp outlet to which commercial current is supplied is separately fused. The Westinghouse and Holtzer Cabot motors for M.G. sets are protected by fusetrans which break the circuit in case of a light overload over a relatively long period of time. The drive motor operates from the commercial supply source and is protected by the thermal element in the sentinel switch. The field winding of the 40 volt D.C. generator is wired to a voltage control resistance which may be adjusted to the proper voltage. All relays operate on 40 volt current supplied by the motor-generator set.

### REPRODUCING

Reproducing operations require one file of cards in which the information punched in a given field (or fields), or the cards must be punched into a given field (or fields) of another file of cards.

This operation is performed when duplicate files of cards must be prepared. For example, in a payroll application a set of master name cards punched with department number, employee number, employee's hourly rate, and other information is kept in a file, and from these cards all or any part of the information may be reproduced into employee payroll earnings cards.

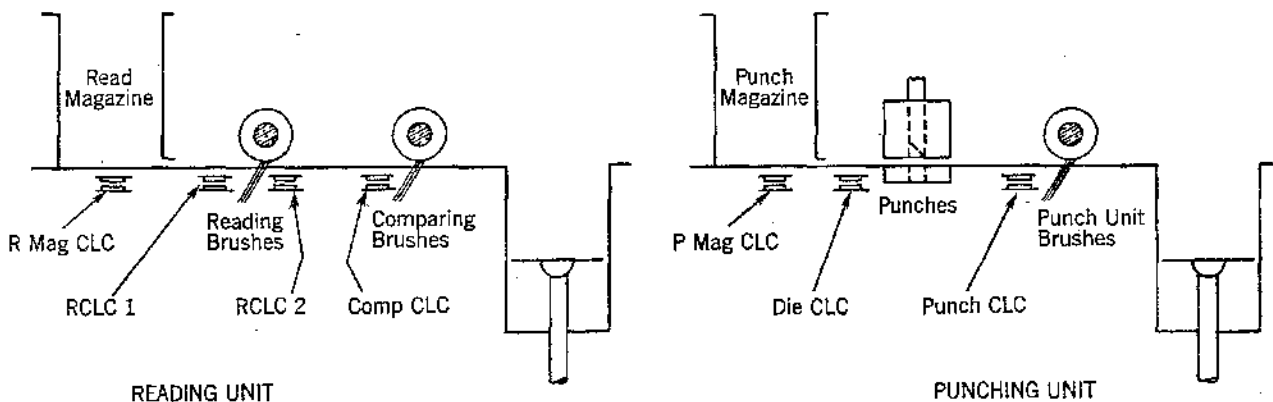


Figure 66. Location of card levers

Such operations require the use of both feed units of the Automatic Reproducing Punch. The original cards (punched cards) are placed in the read unit and the cards to be punched (blank, or blank in certain fields) are placed in the punch unit. The columns to be reproduced are wired from the read brushes of the columns to be read to the punch magnets of the columns to be punched, as shown in Figure 6.

Switch settings for this operation would normally be: Reproducing switch ON, detail or master switch set at MASTER, and selective reproducing switch OFF.

With the cards placed in the read unit and the punch unit as described, the start key will be depressed and cards will feed through the machine. As cards are placed in the feed magazine and run through the machine, the cards will operate card lever contacts at the various card stations in the machine. These card lever contacts and the relays associated with them provide for continuous operation of the machine as long as cards are feeding. They also provide for controlling the circuits to the contact rolls so that the contact rolls will be "hot" only when cards are at the respective contact roll positions, and further, these card lever contacts provide for interlocking the two feed units so that they will remain in step with each other.

#### Punch Hopper and Read Hopper Card Levers

Cards placed in the read magazine will close the read magazine card lever contact completing a circuit to energize relay 6. Cards placed in the punch magazine will close the punch magazine card lever contact energizing relay 3.

A study of the contact points of relays 3 and 6 will show:

At index 6C, R3AL—in running circuit for start relay 10.

At index 6B, R3AU—in running circuit for start relay 10.

At index 6C, R3BL—in start key circuit to energize start relay 10.

At index 4D, R3BU—in start circuit for summary punch operation.

At index 6B, R6AL—in running circuit for start relay 10.

At index 5B, R6AU—when reproducing and comparing, permits the machine to be cleared of cards after an error without restoring the comparing unit if cards are removed from both hoppers.

At index 5B, R6BL—in start key circuit to energize start relay 10.

At index 4D, R6BU—in start circuit for summary punch operation.

With cards in the feed magazines, the points of relays 3 and 6 will be transferred. These points will remain in their transferred positions as long as there are cards in the feed magazines.

#### Circuit to Start Machine

To start the machine, motive power must be supplied to the drive housing and the feed clutches must be energized to permit the feeding of cards. The sequence of establishing these circuits will be found in Figure 67.

#### Motor Circuit Analysis

The motor relay points must close. This requires energizing the motor relay. Start relay 10 and the heavy duty motor relay can be energized only if the start key is depressed. In studying this circuit, keep in mind the switch settings.

When the start key is depressed, the following circuit is completed to energize relay 10: 40V5, knockoff contact, 40V6, die contact, 40V7, to R22BU, through I17 and I18, to R22BU, R22AU, through comparing contact left, to stop key, through start key, R6BL N/O (now closed), R25BU N/C, R3BL N/O (now closed), R10 to fuse 2.

When R10 is energized, R10AU closes and, in conjunction with R24B and P6, provides a hold circuit for R10. R24 is energized when the read unit clutch is latched because R-cam 2 is closed



at that time. R10AL, being closed, provides a pick up and hold circuit for heavy duty motor relay 1. R9 will pick up at any time between 11.6 and 9.5 because R13B points are closed at that time.

A hold circuit is established for R9 and HDR1 through 10AL points for as long as R10 is held. After R10 drops out, R9AU and R9AL in conjunction with C3 provide a hold circuit for R9 and HDR1. C3 is so timed that the motor drives the machine to a point between 6 and 9 on the index. This allows the greatest saving of time when summary punching.

R13B is placed in the R9 pick circuit to prevent its energization if the machine should coast to a stop between 6 teeth after 9 and 5 teeth after 11. The R9BU points in the clutch circuits insure that both clutches receive full time impulses so that one clutch cannot be operated without the operation of the other. This condition would be possible if the machine were to stop between D and 14.1, if it were not for R9BU interlock. This motor-running control circuit may be interrupted by any of the contacts in this circuit. Cards running out of either unit, card jams or failure to feed, stop key depression, stackers filling to capacity, and the die not in position are the more common causes for interrupting this circuit.

If for any reason R10 becomes de-energized, C3 will provide a hold circuit for R9 and HDR1.

This will cause the motor to run until the index has been turned to a point between 6 and 9.

#### Drive Motor Circuit

When HDR1 is energized, a circuit for the drive motor is established from 40V5, through HDR1 points and the drive motor to 40V2.

The transferring of R1AL and R4AL will be discussed under interlocking circuits.

#### Feed Clutch Circuits

To energize the punch and read clutch, R9BU and R10BL must be closed at the same time C-cam 1 and C-cam 2 are closed. It is necessary to hold the start key depressed to keep R9, R10, and HDR1 energized until C-cam 1 and C-cam 2 are made. The only card lever relays which are energized at this time are relays 3 and 6. With R9BU and R10BL closed, a circuit is completed to the punch clutch through R1AL N/C and C-cam 1 at 9.7 on the index. When C-cam 2 makes at 13.5, a parallel circuit will be completed to the read clutch through reproducing switch 1, R14B N/C, master switch 1 in the master setting, R4AL N/C, R10BL and R9BU. The machine will run for one cycle and one card will be fed from each magazine.

On this first feed cycle, the read card lever contact 1 and the die card lever contact will be closed by a card entering these stations (Figure 68) and will energize R4 and R5, and R1, respectively. Read card lever 2 also closes to provide a circuit to the reproducing brushes.

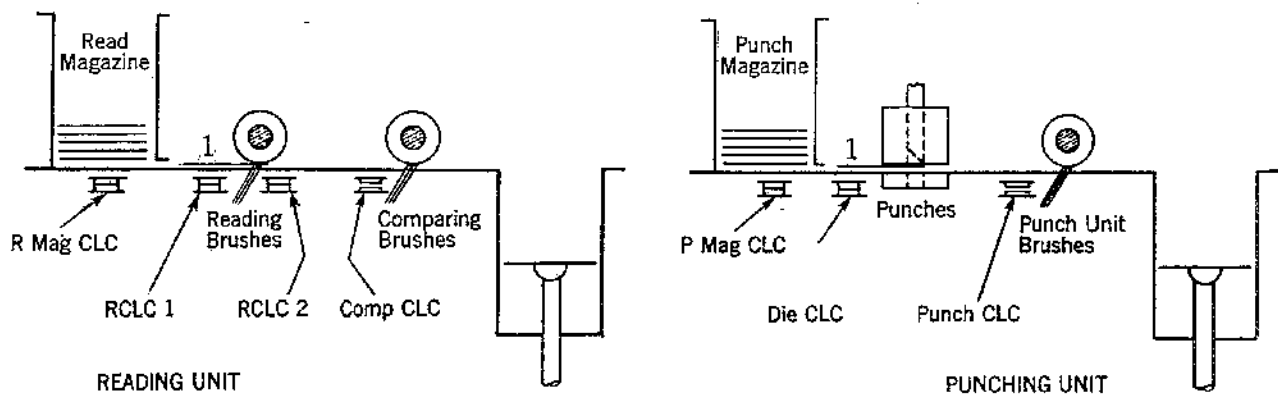


Figure 68. Position of cards at end of first feed cycle

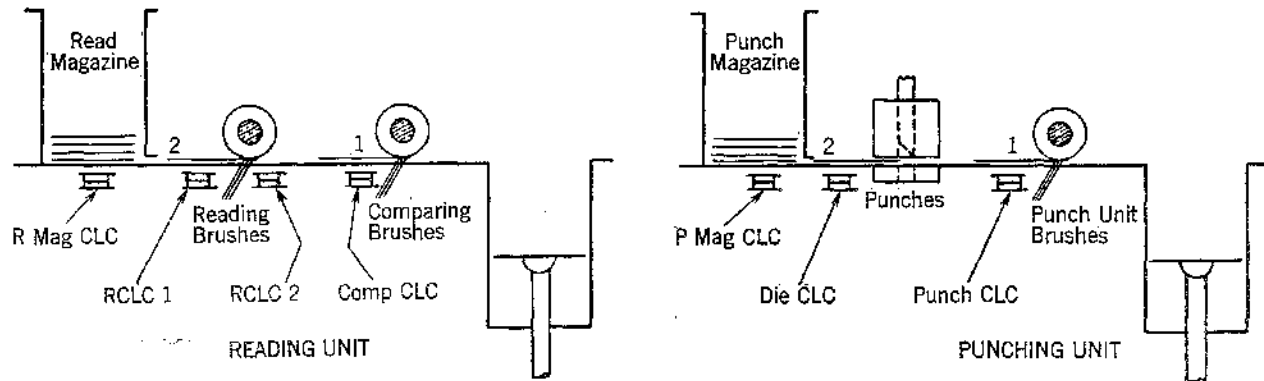


Figure 69. Position of cards at end of second feed cycle

#### Motor Running Circuit

If the start key is released, the machine will stop because R10 will be de-energized when P6 opens at 9.5. To provide for continuous operation, some circuit must be found which will be closed for the time during which P6 is open. Only one such circuit can be found, now that R1, R3, R4, and R6 are energized. However, this circuit would also require energizing R7 so that the R7AL N/O points will be closed.

A study of R7 shows that the punch brush card lever contact must be closed in order to energize R7. The punch brush card lever contact is closed at the very end of the second cycle (Figure 69). However, R-cam 2, which energizes R24, opens at 9.4, which is before the punch brush card lever

closes. R24B points are in the shunt hold circuit around the R7AL points. Since R7AL N/O points are not closed before R24B points open, the motor relay 10 hold test circuit allows R10 to become de-energized. Therefore, it will be necessary to hold the start key depressed for three cycles or to depress the start key each cycle until cards have fed far enough to close the punch brush card lever contact before R-cam 2 opens. R10, being held by the start key contact, will hold R9 and HDR1 energized until the punch brush card lever is closed. After the punch brush card lever contact closes to energize R7, the machine will continue to run. Figure 70 shows the position of cards at the end of the third cycle.

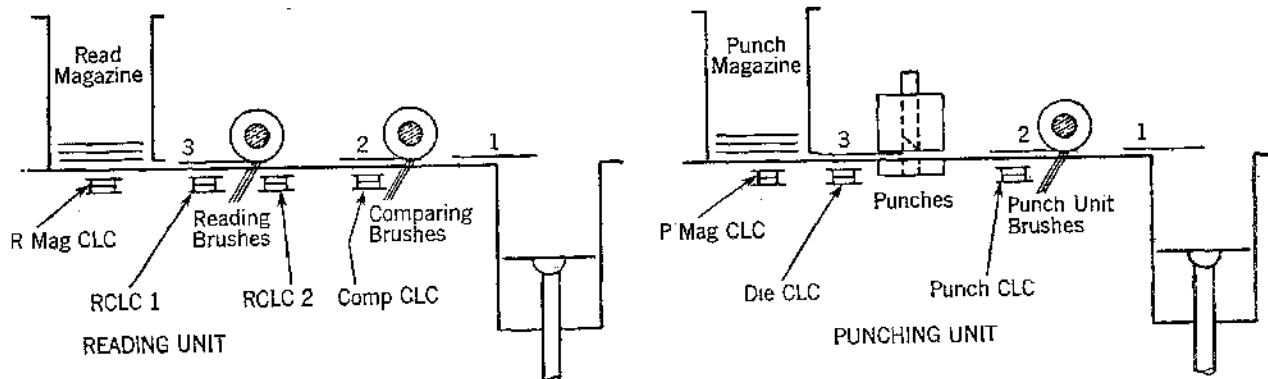


Figure 70. Position of cards at end of third feed cycle

### Reproducing Circuit (Punch Magnet)

Circuits completed at the reading brushes energize the punch magnets to punch corresponding holes in cards passing the die.

The circuit for punching is as follows: from 40V post 5, P1, C11, C12, C13 and C14, R-cam 1, read card lever 2, common brush, contact roll, card brush, control panel wire, punch magnet, R43-R56 points, R15AL, R25BL and R28B, dummy fuse 4. Relays 43 through 56 are energized each punch unit cycle by P1 for a time which includes all punching positions of the card, 12 through 9. A chart at index 8 and 9 indicates the point used for each punch magnet position.

*Note.* If the machine is not equipped for summary punching, relays 43-56 inclusive may be omitted, in which case the circuit is carried through R15AL.

### Interlocking Circuits

When reproducing from one file of cards to another, it is necessary that the two feed units remain in step with each other. For each card fed from the read magazine, there must be a card fed from the punch magazine, and *vice versa*. In order to insure this operation, interlocking circuits have been incorporated in the machine.

### Feed Magazine Interlocks

When the last card leaves either feed magazine, the machine will stop because of the opening of a magazine card lever contact. When the last card leaves the read unit, the read magazine card lever contact will open, R6 will be de-energized, and R6AL will return to its normal position. The opening of R6AL N/O will break the circuit in parallel with P6. When P6 opens, R10, R9 and HDR1 will be de-energized. When the last card leaves the punch magazine and the punch magazine card lever contact opens, R5AL point performs the function of stopping the machine.

When either of these conditions occurs, it will be impossible to restart the machine unless more

cards are placed in the empty magazine, or the cards are removed from the other magazine. If either R6BL or R3BL points return to normal, the start key circuit cannot be completed. This interlocking circuit prevents the possibility of restarting the machine unless there are cards in both magazines.

### Read and Punch Station Interlocks

On the first feed cycle when read card lever contact 1 and the die card lever contacts close, relays 1 and 4 are energized. With R1AL and R4AL transferred, the circuit for the read clutch magnet is controlled by R1AL N/O and the circuit for the punch clutch magnet is controlled by R4AL N/O. This means that the read clutch is controlled by the card passing from the punch magazine to the die, and the punch clutch is controlled by the card passing from the read magazine to the reproducing brushes.

If a card fails to feed from either magazine, the machine will stop through the operation of R1 or R4. If this occurred in the punch unit, the die card lever contact would open and R1 would be de-energized. R1AU would return to its normal position and stop the machine. Before the read unit can be permitted to feed another card, a card must be fed from the punch magazine to the die. When R1 is de-energized, putting R1AL in its normal position, and R4 remains energized, putting R4AL in its transferred position, the circuit to the read clutch is open. When the start key is depressed, the circuit will be completed to energize the punch clutch, but not the read clutch. As the card feeds from the punch magazine to the die, it closes the die card lever contact and R1 becomes energized. Thus R1AL transfers, and as cards continue to feed, the read clutch magnet can be energized through R1AL N/O. In this way the read unit is inoperative for one cycle to make up for the cycle lost in the punch feed. Thus the two feeds are kept in step.



If the read unit failed to feed a card, the read card lever 1 would open, thereby de-energizing R4 and 5. When R4 is de-energized, putting R4AL in its normal position, and R1 remains energized, putting R1AL in its transferred position, the circuit to the punch clutch magnet is open. When the start key is depressed, the punch clutch will not operate until the read unit feeds a card into the reproducing brush position. When a card is fed, the read card lever 1 will close, energizing R4; R4AL will transfer and the punch clutch will operate in the normal manner. In this way the punch unit is inoperative for one cycle to make up for the cycle lost in the read feed. Thus the two feeds are kept in step.

#### Verifying Reproduced Information

The accuracy of the punching may be verified in the comparing unit simultaneously with the reproducing operation. The comparing brushes read the newly punched card one station after the punch station. The punches in the two cards are compared; if they are alike, the machine will continue in operation, but if they are not alike the machine will stop and the error light will signal the discrepancy.

The comparing magnets are wound with two coils so connected that if a circuit is completed to either magnet coil, a magnetic field will be formed which will attract the armature. If circuits are completed to both coils, the magnetic effects of the coils will be such that they will neutralize each other and the armature will not be attracted.

When any one of the comparing magnet armatures is attracted, a pawl is released to indicate the position in error, and the check bail is transferred to its operated position to transfer the check bail (comparing) contacts. The transfer of the comparing contacts will stop the machine and light the comparing signal light.

The N/C comparing contact left is in the hold circuit for R10. When it is transferred, the R10 hold circuit is broken and the machine will stop.

When the contact is transferred, the comparing contact left completes a circuit to the comparing signal light. The circuit follows: 40V5, through knockoff contact, 40V6, die contact, 40V7, I17 and I18, the transferred comparing contact left, the comparing signal light to fuse 2.

If the readings from the two cards are alike, the machine will continue running because circuits will be completed to both coils of the comparing magnets. The circuits are completed from the brushes by control panel wire through the comparing magnet coils, the reproducing switch 1 right in the ON position, R7BL, R19B N/C, to R18B N/C, through master switch 2 in the master setting, R28B and R25BL to dummy fuse 4.

#### GANG PUNCHING

The punching of common data from a master card into a group of cards is called gang punching. The master card is read by the punch brushes and the impulses are transmitted to the punch magnets to cause the first detail card to be punched. Every card passing through the machine serves as the setup card for the following card.

The switch settings for gang punching are:

Reproducing switch OFF.

Detail or master set at MASTER.

Selective reproducing switch OFF.

#### Motor Circuits

Since this operation involves only the punch unit, and since the reproducing switch is turned OFF, the motor start and running circuits will differ from those used when reproducing. Furthermore, no interlocking circuits are necessary when gang punching.

#### Motor Start Circuit

R10 is energized when the start key is depressed. The circuit follows: 40V5, through knockoff contact, die contact, I17 and I18, to R22AU, through comparing contact left, to R22AU, stop key

through start key, to operating point of R6BL, through reproducing switch 2 left, to R3BL operating point, through R10. R6BL and R3BL do not affect the circuit in gang punching, as they are shunted by reproducing switch 2 left, in the OFF position. This circuit causes R9 and HDR1 to be energized through R10AL points.

#### Motor Running Circuit

With no cards in the read unit, R4 and 6 will remain de-energized, and the circuit for holding R10 and the motor relay energized will differ from the circuit used for this purpose when reproducing. As in reproducing, however, it is necessary to hold the start key depressed until the punch card lever contact closes to energize R7. The holding circuit for R10 and the HDR1 is controlled by R3AL N/O, R1AU N/O, R7AL N/O, R6AL N/C, R3AU N/O, R4BL N/C, stacker stop switches, stop key, comparing contact left, die contact, and knockoff contact.

#### Punch Feed Clutch Circuit

Only the punch clutch is energized during a gang punching operation. The circuit to energize the punch clutch follows: 40V4, through R9BU, R10BL, R1AL N/O (now closed), to R4AL N/C, through R4AU N/C, to R14B operating point, through reproducing switch 1 left in the OFF position, to R1AL N/C, through C1 and the punch clutch magnets to 3 amp. fuse 1.

#### Punching Circuit

The circuit for actuating a punch magnet on a gang punch operation is as follows: 40V5, through P1, C11, C12, C13, and C14, R7BU, contact roll, control panel wire to punch magnets, R43, to R56 points, R15AL, R25BL and R28B, to dummy fuse 4.

#### Gang Punch Verification

The quickest method of verifying this type of gang punching is to compare visually the master card with the last card punched.

#### Interspersed Gang Punching

It will be recalled that this type of gang punching requires more than one master card. To prevent the information from the last detail card of a group from being punched into the master card of the succeeding group all punching must be suspended. This requires opening the punching circuit whenever a master card is passing the die.

The punching circuit can be broken by the R43 to R56 points which are controlled by 15AL (or by 15AL directly if it is a non-net balance summary punch machine). If R15 can be energized and R15AL N/C opened for this cycle, the punching can be suppressed. In order to energize R15, when the switch is set to X master, the R14AL points must be transferred. If one of the X brushes is located on the column indicator corresponding to the column in which the master card X is punched, and a wire is inserted from that X brush hub to the PX hub, R14 can be energized. The circuit follows: 40V5 to C4, C5, through P3, R1BL N/O (now closed), the X brush common bar, the X brush, by control panel wire to the PX hub, through R14P coil. With cards feeding, the closing of the die card lever contact energizes R1, closing R1BL. The X hole in a master card is read by the punch X brush as the master card is on its way to the die. When R14AL transfers, the circuit to energize R15 may be completed as follows: 40V5, to C4, C5, P3, through P2, R14AL N/O (now closed), master switch 1 right, R15 hold coil, which in this instance is used as a pick coil. A hold circuit for R14 is provided from 40V5, to C4, C5, P3, through P2 which makes at 13.3 and breaks at 9.4, to R14AL, through R14AU, R14 hold coil. R15 is held through a circuit from 40V, to C4, through C5, which makes at 9 and breaks at 13.9, R15AU and the pick coil of R15. In this case the pick coil is used as a hold coil. Thus, R15AL N/C is held open during the cycle in

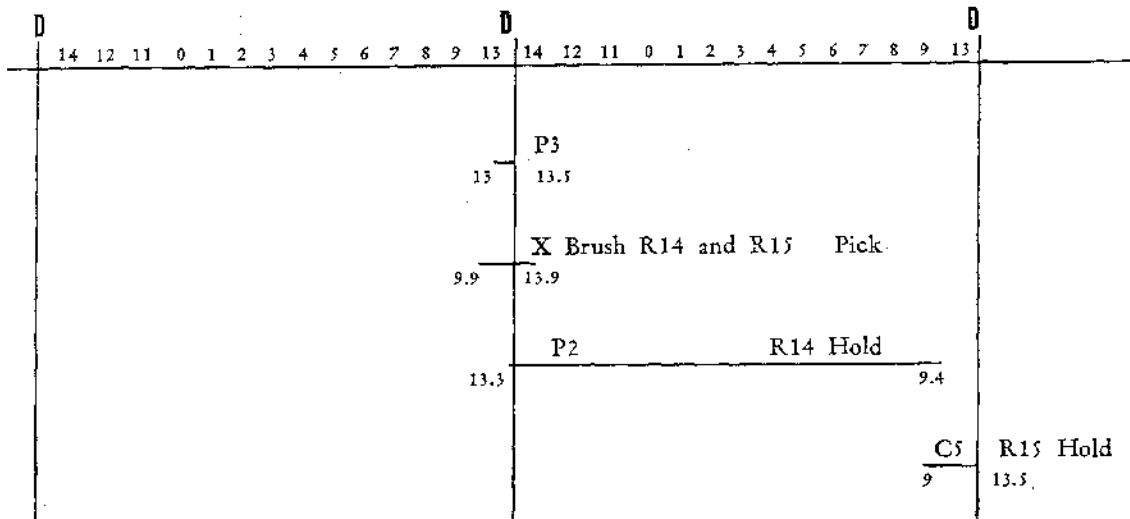


Figure 71. X-interpersed gang punching

which the master card is passing the die and stripper and all punching is suppressed for this one cycle. When the new master card reaches the punch brushes, the new setup will be read back into the detail cards following the new master card.

The sequence of operations is shown in Figure 71.

#### Verifying Gang Punching with Interspersed Master Cards

To verify gang punching with interspersed master cards, the cards are taken from the punch unit stacker and placed in the read magazine. This operation may be performed concurrently with gang punching. The verification is accomplished by comparing the punched holes of the card at the comparing brush station with those of the card which is at the reproducing brush station. The reproducing brushes are wired to one set of comparing magnets, the comparing brushes are wired to the other set of comparing magnets and the read X brush is wired to the RX hub (Figure 12). The relationship of cards for verification is similar to that for gang punching; the master card is compared with the first detail card

and each subsequent detail card is compared with the card which immediately precedes it. When a discrepancy occurs, the machine stops and the signal light glows. To verify gang punching at the same time, the read unit is also required. Therefore, a circuit must be completed to the read unit clutch. This circuit is completed by the selective reproducing and gang punch comparing switch in the ON position. The selective reproducing and gang punch comparing switch, when in the ON position, shunts or by-passes the R1AL and R4AL interlock points. Therefore, the read clutch circuit will not be affected by the interlocks but will operate continuously.

This operation presents a problem similar to that encountered in gang punching with interspersed master cards, that is, to eliminate comparing the last detail card of one group at the comparing brush station and the master card of the following group at the reproducing brush station. If these cards were compared there would be an error stop and signal every time a master card passed the reproducing brushes.

In the punching operation all punching was suppressed when the master cards were passing the die. In the verifying operation, all comparing must be suppressed when the master card is passing the reproducing brushes.

This is accomplished by opening the R18B N/C points in the same manner as R15AL N/C was opened to suppress punching.

When comparing gang punching one of the read X brushes must be located in the column of the master card X, and the read X brush must be wired to the RX hub. When R3 makes at 13, R18 will be energized, thus breaking the comparing circuit to suppress comparing by transferring R18B points. R18 is held through R-cam 2 from 13.3 to 9.4. Thus, comparing is suppressed for the card-sensing portion of the next cycle after the X master card has passed the X brush station and during which time it is passing the reproducing brush station.

When comparing gang punched data concurrently with a gang punch operation, the motor hold circuit for continuous operation will function as for a reproducing operation. If the read unit is being used alone, that is, if only a verifying operation is being performed, the motor hold circuit for continuous operation is controlled by the card levers of the read unit.

#### Motor Hold Circuit for Verifying Operation Only

The hold circuit for R10 follows: 40V5, through knockoff contact, 40V6, die contact, 40V7, to R22BU, through I17 and I18, to R22BU, R22AU, through comparing contact left, stop key, stacker switches, R4BL N/O (now closed), R6AL N/O (now closed), R7AL N/C, R3AL N/C, R10AU and the coil of R10 to the fuse.

#### X Elimination

In gang punching with interspersed master cards, the X distinguishing the master card may

be punched in one of the columns to be gang punched. In most cases, it is desirable to prevent the X in the master card from being gang punched into the detail cards to maintain an X-No X punching relation between master and detail cards. Furthermore, it would be impossible to verify the gang punching automatically if all cards were X punched as all cards would then act as master cards.

Therefore, for this one column (X on master card) the problem resolves itself into one of permitting the characters 0 to 9 to be gang punched, but eliminating the X punch. The machine is equipped with the X eliminators (or column splits) which consist of transfer contacts operated by relays and controlled by cams. These contacts are so timed that there is a connection established on one side of the contact for 12 and 11 on the cycle, and a connection is established on the other side of the contact for 0 through 9, as shown in Figure 72. Wiring for this operation is shown in Figure 14.

#### Class Selection

A class selecting operation requires the use of a device commonly called a class selector. A class selector consists of a group of four relays which control a group of ten transfer contacts. Each of these contacts has three straps (Figure 8). The

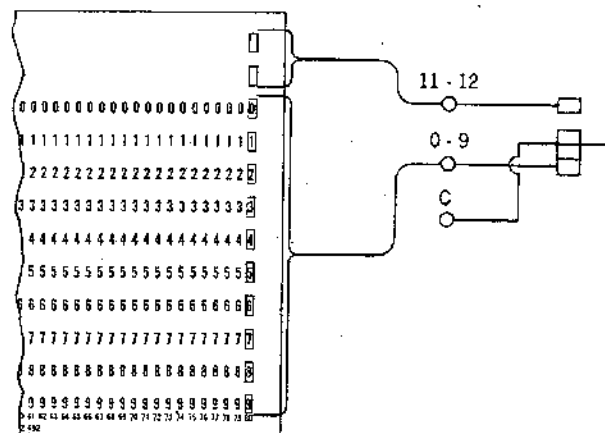


Figure 72. X-elimination

center strap is wired to a hub labeled C, the N/C side is wired to a hub labeled NX, and the N/O side is wired to a hub labeled X. When the coils of the class selector relays are de-energized, there is a connection established between the C and NX hubs. When the relays are energized, there is a connection between the C and the X hubs. Wiring is shown in Figure 9. Refer to the example of field selected reproducing on page 14.

Cards without the X in column 47 will not affect the class selector. Therefore, information read from columns 47-54 of the source cards will be reproduced into columns 67-74 in the new file. When an X47 card passes the read X brush station, the class selector must be energized to transfer the contacts in order to read from columns 62-69 for punching into columns 67-74.

#### Class Selector Relay Circuit

The read X brush is wired to the RX hub. A wire is also connected from the RX hub to the RX pickup hub of the class selector. This places the class selector relay 34 in parallel with R18. Therefore, when an X card passes the read X brush, R18 and the class selector relay 34 will be energized. Relay 18 will be held through R18A and R-cam 2. Class selector relays 34, 35, and 36 will be held through the R34AU and AL points, and R-cam 2 until 9.4 on the cycle, during which the X punched card passes the reproducing brushes.

The sequence of operations is similar to that for interspersed master gang punching. In this case R18 and R34 replace R14 on the sequence chart, and R34, R35 and R36 replace R-15. R-cam 3 and R-cam 2 replace P-cam 3 and P-cam 2, respectively, for this operation.

#### Verifying Class Selected Reproduced Data

Verification of reproduced information is performed one cycle after punching. Where reproduced data has been class selected, a class selector will also be used for verification. This second class selector must be operated by the same X as that

which operated the first class selector. Since the second class selector (used for verifying) must wait one cycle before operating, a delay circuit is used.

A delay circuit consists of cam contacts and relays so connected that an impulse received during one cycle can be "stored" or "remembered" and used on a later cycle to operate a desired machine unit such as a class selector. Refer to Figure 9 for control panel wiring.

By wiring the class selector pickup to RD, the class selector relay is placed under the control of R17B points. The class selector must operate when the X punched card is passing the comparing brushes.

The circuits for this operation involve some important principles of circuit operation which are used throughout IBM Accounting Machines. Therefore, the student should become very familiar with these principles.

The sequence of operation of these circuits is analyzed below and shown in graphic form in Figure 73.

1. Relay 34 can be energized only if R17B points are closed.
2. Relay 17B points can be closed only by energizing relay 17.
3. Relay 17 can be energized only through R-cam 4 at a time when R18A and R-cam 2 are closed.
4. Relay 18A will be closed only when X cards are passing the reproducing brushes.

Therefore, the sequence of operation for relay 17 and class selector relays 34, 35, and 36 is as follows:

1. X card is read by read X brush, energizing R18.
2. Relay 18 holds through R18A and R-cam 2 until 9.4, when the X card is passing the reproducing brushes.
3. From 8.5 to 9.3 of cycle mentioned in 2, R-cam 4 makes. This energizes relay 17.

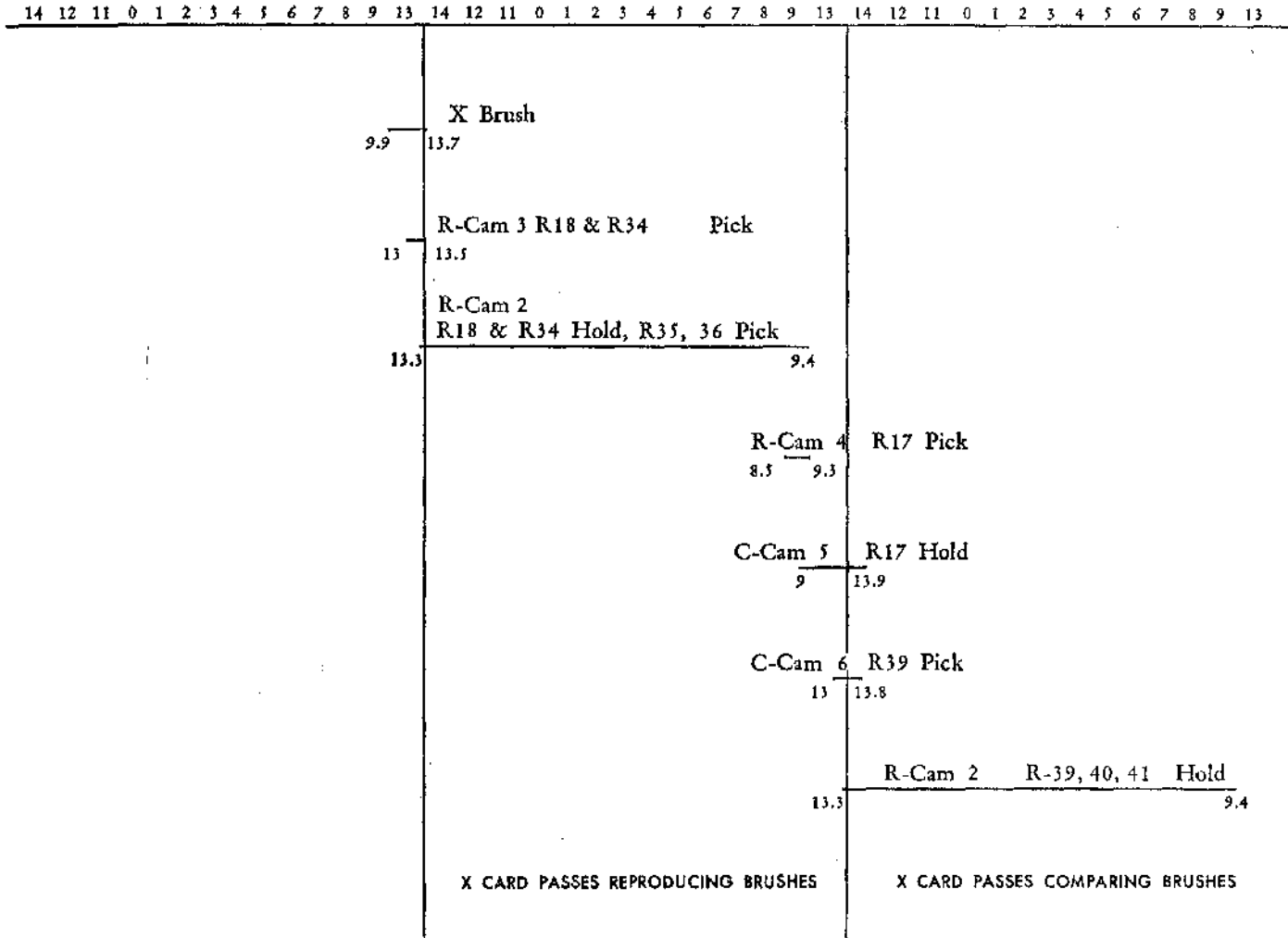


Figure 73. Sequence of operations for reproducing and verifying class selected data

4. Relay 17 holds through R17A and C5 from 9.0 until 13.9 on this cycle.

5. With R17 energized and 17B points closed, R39 will be energized when C6 makes at 13. Relays 40-41 will also be energized when R-cam 2 makes at 13.3.

6. R39, R40, and R41 will hold through R39AU and AL points and R-cam 2 until 9.4 of the cycle during which the X punched card passes the comparing brushes. At this time, columns 67-74 of the punched card will be compared with columns 62-69 of the original card.

#### Offset Gang Punching

In offset gang punching, information in one field of interspersed master cards is to be punched into different columns in the detail cards. In this case the class selector must operate when the X card passes the punch brushes. This involves the use of the punch delay circuit. This circuit for the class selector functions in the same manner as the class selector for verifying class selected reproduced data.

The sequence of operations may be analyzed as follows:

1. X in master card is read by punch X brush, energizing R14.

2. Relay 14 holds through R12AU and P-cam 2 until 9.4 of the cycle when the X master card is passing through the punch station.

3. From 8.5 to 9.3 of this cycle, in which the master card is passing the punch station, P-cam 4 makes contact and energizes R16.

4. Relay 16 holds through R16A and C5 from 9 to 13.9 on this cycle.

5. With R16 energized and R16B points closed, R34 will be energized when C6 makes at 13. Relays 35-36 will also be energized when P-cam 2 makes at 13.3.

6. R34, R35, R36 will hold through R34AU and AL points and P-cam 2 until 9.4 of the cycle during which the X card passes the punch brushes.

At this time the field of the master card will be read into the punch magnets of the field to be punched.

#### Detail or Master Switch

In the preceding discussion master (X) cards and detail (NoX) cards were considered. By setting the detail or master switch to DETAIL, the conditions will be reversed. When the switch is set to DETAIL, the detail cards should be X punched and the master cards should not be X punched.

When using an X master card, suppression of punching depends upon sensing an X. If the X brush fails to sense an X hole, the information from the last detail card of one group will be punched into the master card of the next group. This results in a ruined master card as well as the detail cards of the group following the master card.

By using the X in the detail card, this condition can be avoided because punching depends upon the energization of relay 18 or 19 respectively when gang punching or reproducing. This relay is dependent upon the sensing of the X hole in the card. Therefore, if the X brush fails to read, nothing is punched. The blank card indicates that such a failure has occurred.

#### Combination Reproducing and Gang Punching with Master Cards Interspersed in the Punch Unit

For every master card fed from the punch unit, the read unit must be inoperative one cycle, as nothing is to be reproduced into the interspersed master card in the punch unit. R14B points, working in conjunction with the detail or master switch, control the operation of the read unit clutch when this operation is being performed. Energization of R14 will prevent energization of the read clutch, causing the read unit to be inoperative for this one cycle when R14B is transferred.

#### Selective Reproducing

In selective reproducing, the feeding in the read unit should not be affected by an impulse

to the PX hub. For each X card in the read unit, a blank card will be fed through the punch feed. For wiring, refer to Figure 10.

The selective reproducing and gang punch comparing switch will shunt the R14B points and allow continuous feeding in the read unit. R14AL points also provide a pickup for R15 to prevent punching in the punch unit as the X card is passing the reproducing brushes.

#### O and X Circuit

The 0 and X hubs provide a circuit at X or 0 time controlled by C7 if cards are under the die. These impulses are further controlled by C-cams 11, 12, 13, and 14. For wiring, refer to Figure 15.

#### Summary Punch Emitter

The summary punch emitter provides timed impulses to the emitter segments of the counters in the accounting machine. These impulses in turn are directed to punch magnets to cause holes to be punched in the summary card indicative of the information in the counters of the accounting machine.

Relay points 4AU, shunt relay points 14B, and the detail or master switch 1 left, in combination, cause the punch feed clutch to operate on an initial feed-in operation when performing interspersed gang punching, regardless of the detail or master switch.

It also serves to provide a circuit to the read clutch on the initial feed-in operation when performing interspersed gang punching in combination with a reproducing operation.

#### Special Interlocking Features

R8 is provided as a cycle interlock. It is energized by the BL points of the motor hold relay 9 and R23AL. R8B points prevent an auto start impulse from the accounting machine from reading R10 in the summary punch for a second energization of R10. This assures only one summary card for each control change.

R9BU points are inserted in the clutch magnet circuit to insure a full time impulse to the clutches. Since the punch clutch latches at D and the read clutch latches at 14.1, it is possible that the read clutch might be energized without the punch clutch if the machine coasted to a point between D and 14.1.

Relays 11 and 12 operate to provide points for column split readings. The coils are energized between 9.6 and 11.5. The points of these relays are the transfer type and all three straps are wirable. The normally closed side is wired for 0 to 9 inclusive and the normally open side is wired for 11 and 12 readings.

R13 is operated by C-cam 4. R13A points shunt the punch and read unit stacker switches and also the stop key so that the start relay hold circuit is not interrupted between 9.6 and 11.5. This allows a cycle to be completed when either stacker stop switch opens or the stop key is depressed. R13B points serve as a timing interlock to prevent energizing R9 in the event the machine should coast to a stop between 9.6 and 11.5 on the index. In this manner, the possibility of energizing the read clutch without energizing the punch clutch is avoided. This is necessary because the punch clutch engages at D while the read clutch engages at 14.1.

R15BU points serve to keep the punch running for one additional card cycle for each master card in the punch unit when the machine is used as summary punch.

R21 is provided for balance selecting operations on the alphabetical accounting machines. The coil is energized on a control change. The R21AU and R21AL points are wired in the pick circuit of relays 33 and 38. This circuit is wired to sense a 9 standing in a counter position in order to transfer selection relay points when balance selecting.

R21BU is wired in the 9 emitter circuit for the balance test impulse. Since this balance test impulse must be completed before the summary



punch is in operation, R21BU N/O is wired directly to 40V4 to provide a test impulse any time R21 is energized.

R21BL points are inserted in the clutch magnet circuit to prevent an early energization of the clutches during double test time on pre-May 1st machines. On these machines the summary punch auto start impulse is controlled by a CF-cam on the last card feed cycle of a control group. Thus the impulse to start the summary punch might come before the balance test and balance circuits were set up. This condition is avoided by R21BL points.

R22BU points are wired in the start relay hold circuit to insure that the cable connector is placed in its receptacle on the punch when the machine is used for operations other than summary punching. This interlocking of the start circuit is required because some of the comparing circuits are completed through the connector cable.

Relay 25 is provided as a comparison interlock. The coil is energized by the transfer of the comparing contact left, and is held energized through R25AL until this contact is manually restored.

R25AU points are connected to shunt the punch card lever controls in the accounting machine start circuit in summary punching. When summary punching is combined with a reproducing opera-

tion, a comparison is made between the control number which is being summary punched and the control number in the master card which is in the read feed.

In case of an error in sequence in either group, the error light will light. With R25AU it is possible to run the cards from the accounting machine. The cards may also be removed from the summary punch and either or both of the files (that is, one file from the accounting machine and one from the summary punch) may be checked for proper sequence.

R25BU points make the start key inoperative on a combination reproducing and summary punching operation as long as both hoppers contain cards.

Relays 37 and 42 are provided in order to summary punch an X in a specific column when balancing on the accounting machine. The points of this relay are the transfer type. The normally open point and the normally closed points are wirable.

Relays 43 to 56 inclusive are provided to prevent possible back circuits when the punch is connected to the accounting machine for a summary punch operation and the accounting machine is in operation.

## MARK SENSING DEVICE

### OPERATION

The mark sensing device for the Type 513 Automatic Reproducing Punch permits conversion of special pencil marks on IBM cards into corresponding holes. The regular operations of the machine are not affected, and most operations may be performed in combination with mark sensing. Cards are run through the machine in the usual manner, face down, top edge first.

The record on the card can consist solely of the pencil marks. Hourly payroll is an example in which time worked by a man or group of men is indicated by means of pencil marks on the cards. In other cases, a part of the record is written in longhand for descriptive purposes and part is marked for automatic punching. In some applications, cards which have been prepunched and interpreted in some columns are completed by marking the remaining information required. In a billing application, cards prepunched with description and price can be pulled and marked with quantity shipped.

In many applications, it is necessary to gang punch the cards with common information, such as date, department, etc. It is now possible to gang punch such information during the mark sensing operation. Reproducing can also be combined with mark sensing. Marked cards may be used as master gang punch cards; the information marked on a card is punched into the card itself and into a group of detail cards following it.

The machines having mark sensing may be arranged to operate on any domestic commercial source of power. On machines equipped to run on D.C., the attachment cord must be wired into the commercial supply properly for correct polarity. The 110 volt post number 2 must be negative.

### Cards, Pencils and Leads

Cards designed for mark sensing must be printed with ink of some color other than black because black ink contains carbon. Blue and green are recommended. Each pencil mark is made in an area three punching columns wide. The allowable vertical marking area is shown on the wiring diagram. This area is directly above normal punching position, so that if punching is to take place in a marked field, the pencil marks will not be destroyed. It is imperative that the mark be in the space provided and be made by pressing firmly on the pencil to deposit carbon because the marks are used as conductors. This explains the requirement that the marking be done with special pencil leads, which insure the highest possible conductivity of all marks.

A pencil containing special mark sensing lead must be used when marking the IBM cards. These leads can be used in any automatic pencil designed for ordinary, not thin, leads. The marks can be erased when necessary, if the erasure is thorough. The pencil should be rotated in the hand so that a sharp writing point is available. If the pencil is gripped firmly, a single stroke should produce an adequate mark. By moving the pencil across and back for each mark, however, a better carbon deposit is made than with a single stroke.

### Control Panel — Figure 74

The control panel has not been increased in size, but the hubs necessary for mark sensing have been put in available spaces or combined with hubs already in use. This limits the machine in that it is not possible to summary punch from some counters and mark sense at the same time.

The hubs for the mark sensing brushes are located in two positions on the board; hubs 1-14

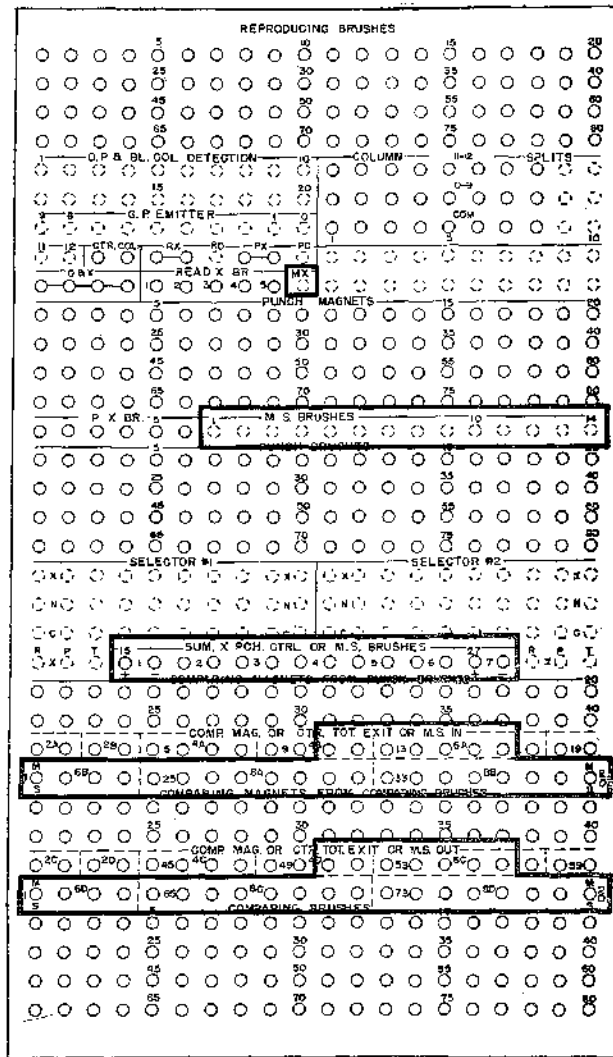


Figure 74. Location of mark sensing hubs

are below the punch magnets and hubs 15-27 are combined with the summary X punch control hubs below class selectors 1 and 2. These hubs are wired to the mark sensing IN hubs.

The mark sensing IN hubs 1-20 are combined with the comparing magnets (from punch brushes) positions 61-80 and counter total exit positions 6B, 8A, and 8B. Mark sensing IN hubs 21-27 are in positions 51-57 in the row above. These hubs are wired to the mark sensing brushes.

The mark sensing OUT hubs 1-20 are combined with the comparing magnets (from comparing

brushes) 61-80 and counter total exit positions 6D, 8C and 8D. Mark sensing OUT hubs 21-27 are in positions 51-57 in the row above. These hubs are wired to the punch magnets during mark sensing.

#### Switches

In addition to the regular switches, several more have been added for the mark sensing device. These are located in the front of the machine to the right of the standard reproducer switches (Figure 5).

The mark sensing switch must be ON for any mark sensing operation. When the switch is ON, the last twenty comparing positions become mark sensing IN and OUT hubs and the summary X punch control hubs become outlets for mark sensing brushes 15-27. When mark sensing is not being used, the switch should be OFF.

The master card switch, when ON, allows marked information to be punched into a card regardless of the operation of the PX hub. It is turned ON only for a combinational operation of reproducing and gang punching with marked master cards. It should be OFF for all other operations.

#### Capacity

The mark sensing device is furnished in groups of 10, 20, or 27 positions; however, each machine equipped for mark sensing is equipped with a full set of mark sensing brushes. If the machine is equipped with less than full capacity of 27 positions of mark sensing, additional runs must be made in order to punch all possible marked columns.

#### Units

The mark sensing device adds five extra units to a standard machine:

1. A set of mark sensing brushes consisting of 3 brushes in each of 27 groups, located just ahead of and attached to the die and removable with the die for inspection.

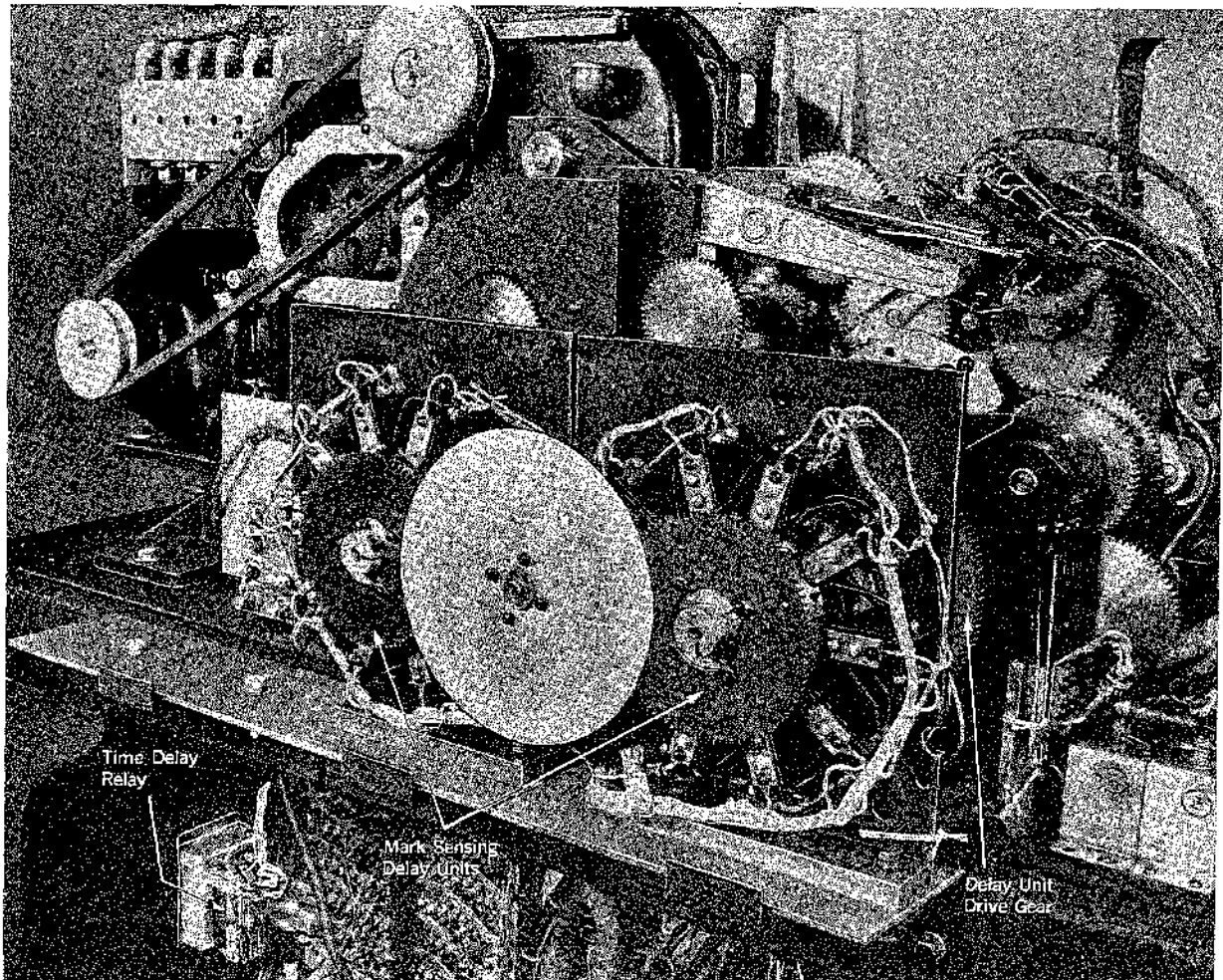


Figure 75. Mark sensing units

2. A maximum of 27 electronic tube amplifiers, mounted 20 positions in the left-end cabinet and 7 positions in the right-end cabinet, serve to amplify the small current read through the pencil marks to energize the magnets in the mechanical delay unit.

3. The mechanical delay units (10, 20, and 27 positions) are mounted on the base at the back of the machine (Figure 75) and provide impulses to the punch magnets two cycle points after the mark has been sensed.

4. An electronic delay unit is located in the cabinet at the rear of the comparing unit and prevents operation of the machine before the electronic tubes in the amplifier have reached operating temperature. It also assures correct polarity of

the attachment cord on D.C. machines. If the polarity is incorrect, the time delay unit will not operate.

5. The double punch and blank column detection device is furnished with mark sensing. It is also available for other than mark sensing machines and is explained under a separate heading.

#### MECHANICAL-ELECTRICAL PRINCIPLES

##### Feed Rolls

The pressure on the first two sets of feed rolls in the punch unit has been substantially increased to insure correct feeding of cards past the mark sensing brushes. This increased pressure on the first set is secured by new feed roll shafts and a

new pressure bracket assembly having 20 pound pressure shoe springs. Additional pressure on the second set of feed rolls is secured by stronger feed roll pressure shoe springs.

#### Die Card Lever

The die card lever contact is located at the front of the machine near the gears on the first set of feed rolls.

#### Mechanical Delay Unit

The mark on the card is  $\frac{1}{2}$  cycle point ahead of the punching position, and the mark sense brushes are  $1\frac{1}{2}$  points ahead of the punches; therefore, a total delay of 2 cycle points is necessary. This delay is accomplished by the mechanical delay unit.

Each delay unit is composed of ten magnets, one for each mark sensing column, located radially on a stationary plate. Through the center of this plate a shaft is driven by an idler gear. On this shaft is a drum containing 30 armature contact pawls controlled by the magnets. Therefore, since this is a 14 point cycle machine, the drum is geared to revolve  $\frac{7}{15}$  of a cycle for each revolution of the punch index. One pawl passes each magnet every cycle point. A delay unit magnet, when energized by the pencil mark through the tube circuit, unlatches one of the pawls. Spring action carries this pawl out beyond the ends of the other pawls. Two cycle points later this pawl completes a circuit when the end of the pawl wipes against a contact cam. The pawls and contact cams work in conjunction with the standard circuit breakers to complete circuits to the punch magnets. The whole unit is insulated from the base by a thin sheet of linen delecto to prevent grounding.

As the drum revolves, the face of the contact cam causes the pawl to be returned to a latched position. Each armature makes contact with a contact cam as it passes, but unless the armature has been previously unlatched, it does not make

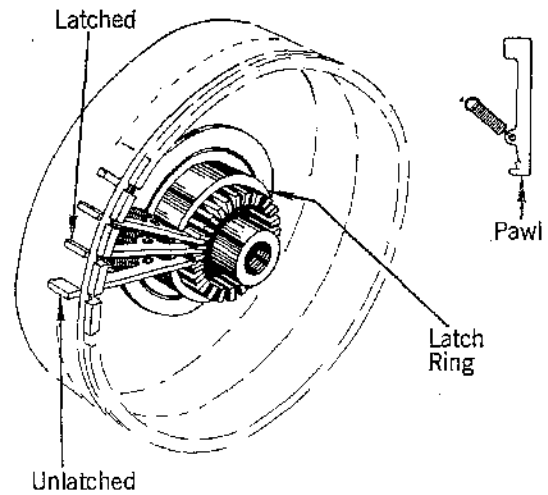


Figure 76. Armature and latch ring assembly

contact until after the circuit breakers have opened, and no circuit is completed.

The fact that an unlatched pawl is relatched two cycle points after tripping permits the same pawl to be used for a hole which is lower on the card in another column.

The arm controlling the position of the assembly holding the magnet coils is adjustable. Figure 76 shows the armature and latch ring assembly removed from the magnet assembly.

#### Adjustments

1. Set latch ring for .007"-.010" clearance of unlatched pawls to the mark sensing pawl stop. This is obtained by moving the magnet pawl latch ring in or out by means of opposing setscrews and locking screws in the mark sensing pawl drum assembly (Figure 77).

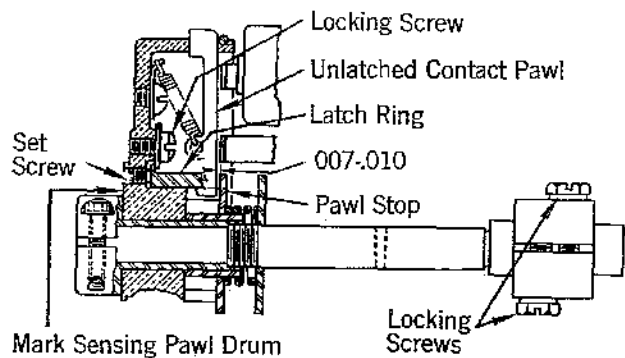


Figure 77. Mark sensing adjustment

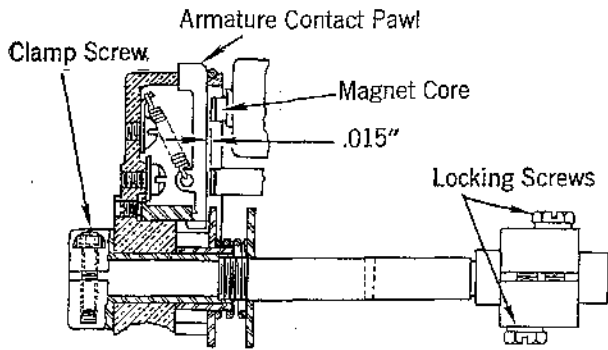


Figure 78. Mark sensing adjustment

2. Loosen clamp screw on rear end of drum mounting hub (Figure 78). With all pawls latched, turn in contact drum until there is no clearance between pawls and magnet cores. Then back off contact drum  $3/10$  of a turn. This provides  $.015''$  clearance between unlatched pawls and magnet cores. Lock the clamp screw.

3. Adjust each contact cam for  $.032'' \pm .002''$  clearance to the outer surface of the contact drum (Figure 79). This provides for proper relatching clearance.

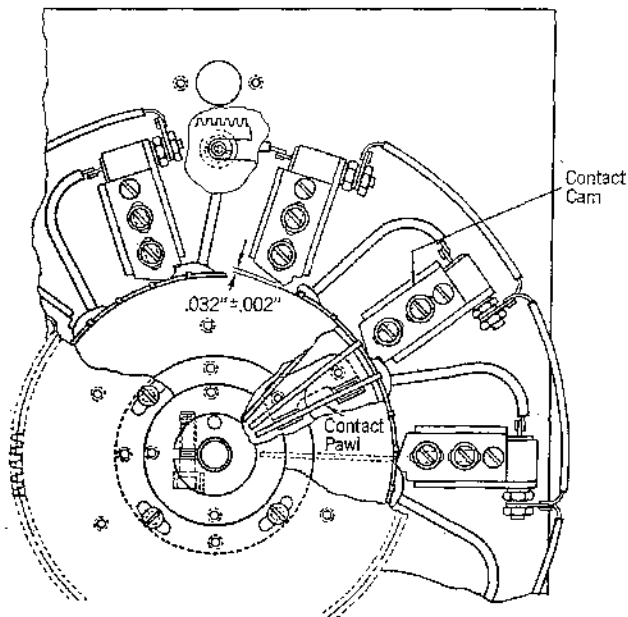


Figure 79. Mark sensing adjustment

4. With the unit on the machine, loosen the locking screws (Figure 78) at the clutch end of the drum shaft and time the drum so that latched pawls make contact at 4 teeth after the line of index (Figure 80). Tighten the locking screws.

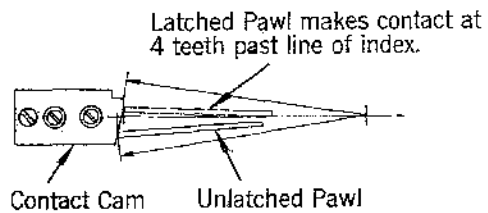


Figure 80. Mark sensing adjustment

5. Adjust the position of the magnet coil mounting plate assembly by moving the assembly in the screw slot so that the center line of the pawls coincides with the center line of the magnet cores between any numbered point on the index and  $1/4$  tooth past that point (Figure 81). Check carefully.

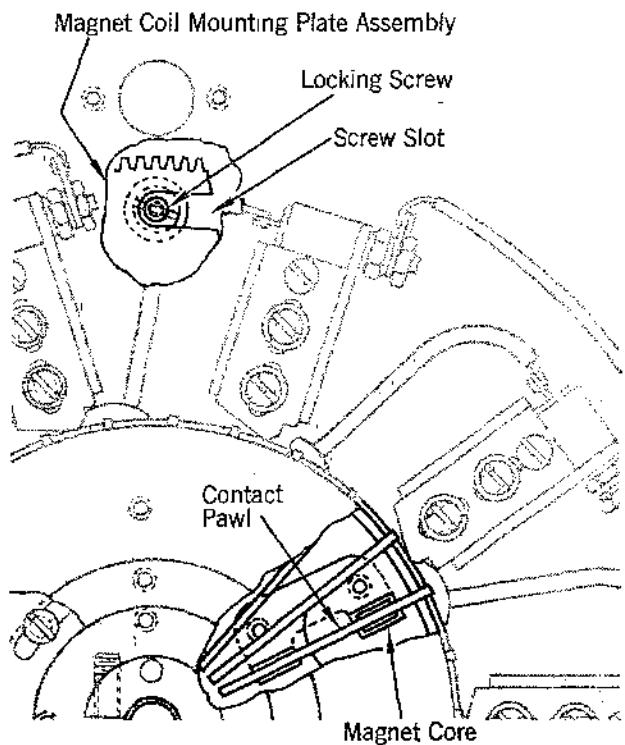


Figure 81. Mark sensing adjustment

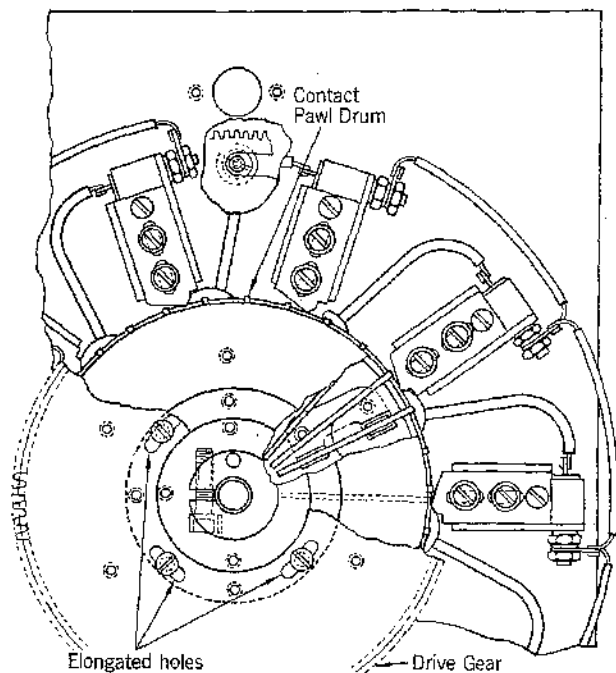


Figure 82. Mark sensing adjustment

6. To time the pawls on units 2 and 3, move drum in elongated holes in drive gears (Figure 82).

#### Mark Sensing Brushes — Figure 83

The mark sensing brush holder is fastened to the leading edge of the die and becomes an integral part of the assembly. There are 81 brushes, 3 for each position of mark sensing, so wired that a lead is taken from brush number 2, 5, 8, 11, etc., to the mark sensing brush hubs. All other brushes are connected common. The mark sensing brushes normally rest against a glass insert along the leading edge of the stripper and are so located to read columns 1 to 81 inclusive. A conductive mark on the card is read from any of the 27 center brushes to either or both of the adjacent brushes.

The adjustments for the X and mark sensing brushes are shown in Figure 55.

1. Mark sensing brushes should be installed in the brush block with a projection of  $\frac{43}{64}$ " measured from the brush holder to the toe of the brush. This should provide a brush projection of  $\frac{1}{16}$ " above the brush separators.

2. Mark sensing brushes should line up with the line scribed on the brush separators with the brushes resting against the glass insert in the stripper. This is obtained by moving the brush block assembly laterally in elongated holes. This is only a starting point as the brushes may have to be moved later for proper timing.

3. The clearance between the X brush holder and the X contact bar should be  $.010$ "-. $.012$ ". This is obtained by moving the X brush holder mounting bar up or down on the mounting screws.

#### Mark Sensing Brush Timing

When studying the limits of the mark sensing brush as shown on diagram 184879, it must be remembered that the cards in the punch unit move intermittently. All motion takes place between  $2\frac{1}{2}$  teeth before a line of index and 1 tooth past a line of index, or a total of  $3\frac{1}{2}$  teeth on the index. The cards are stationary for  $6\frac{1}{2}$  teeth of each cycle point. Therefore, a mark on a card which makes contact with a brush by 1 tooth past the line of index will remain in contact position until  $2\frac{1}{2}$  teeth before the next line of index. This accounts for the long duration of the mark sensing brush as shown by the timing chart at the bottom of print 184879.

When the mark is at the upper limit, the brush makes before C10. The make timing of C10, then, determines the upper limit of the mark sensing area. If the mark is beyond the upper limit, the mark will have made contact with the brush and broken before C10 provides a circuit of proper duration.

When the mark is in the center position, C10 makes up to  $\frac{1}{2}$  tooth before the brush makes. The mark sensing brush, therefore, completes the circuit. This is not troublesome because of the minute current of the circuit.

When the mark is at the lower limit, the factor which determines the point at which such a mark

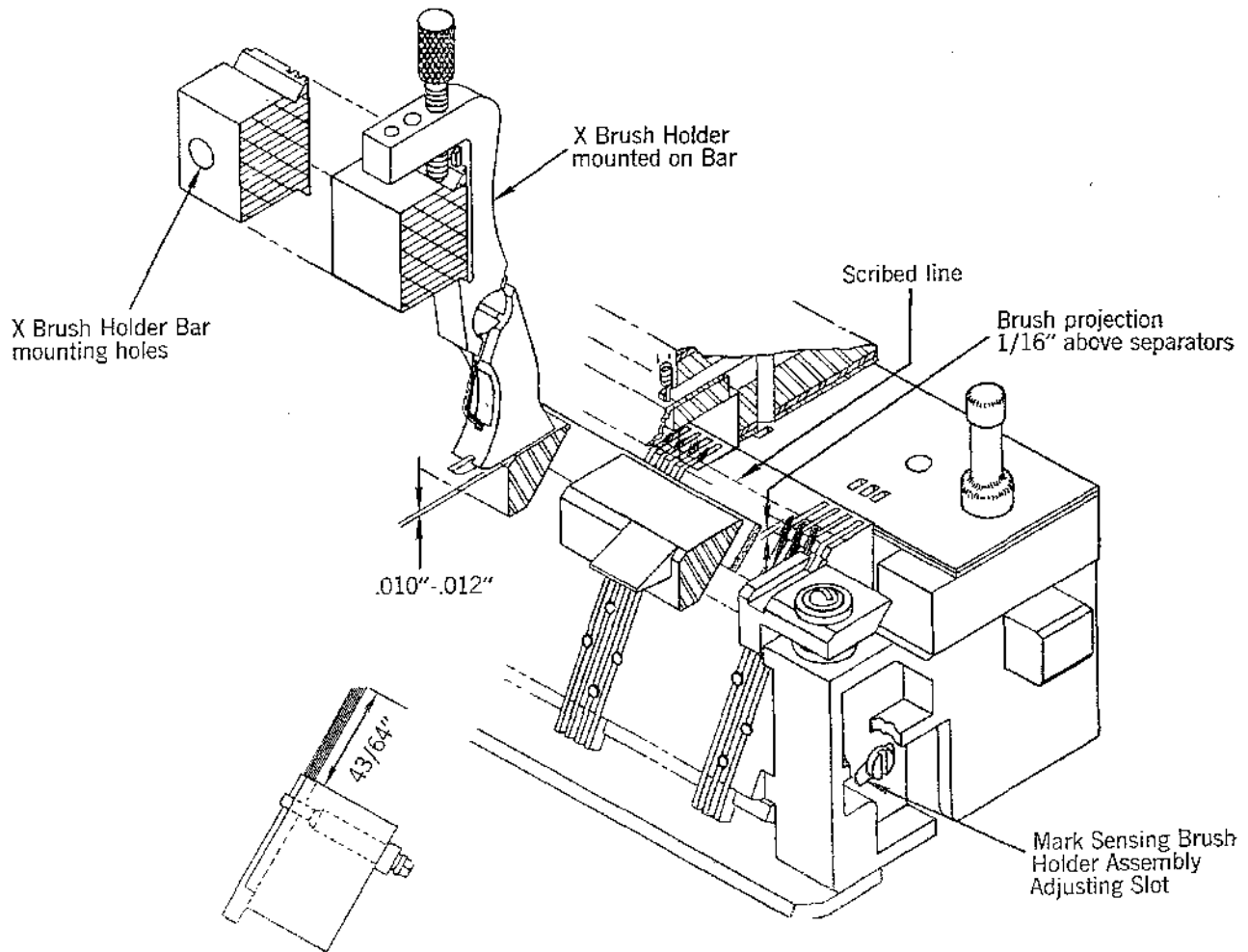


Figure 83. Mark sensing brush assembly

fails to be sensed is whether or not the mark has reached the brush by 1 tooth past the line of index at which time the card is stopped. This lower limit, therefore, is obtained by shifting the brush assembly to the left or right.

#### Heat Units

The mark sensing brush block has a heat unit built into the brush block to prevent moisture from collecting. The tube circuits are sensitive to extremely small currents, and moisture in these units is undesirable and will affect machine operation. A heat unit (resistor) is also placed just beneath the control panel for the same purpose.

## CIRCUITS

### Mark Sensing Switch Circuits

The mark sensing switches complete circuits to make the mark sensing feature operative.

Mark sensing switch 1 upper, when ON, places the time delay relay B points in the start circuit to prevent operating the machine until the amplifier tubes reach proper operating temperature.

Mark sensing switch 1 lower, when ON, provides power to the transformer, rectifier or directly to the tube filaments, depending upon the type of current supply.



Mark sensing switch 2 left, when ON, picks relays 91 through 108 whose points transfer circuits from the comparing magnets and summary X punch relays to the mark sensing brushes and amplifier tubes in those positions which share a hub on the control panel.

The left side of the master card punching switch, when ON, completes the circuit to the punch magnets to permit punching into the master card when using marked master cards. It shunts R15AL.

The right side of this switch, when ON, shunts around the detail or master switch and the R19AL transfer contacts to assure blank column checking of punched master cards. This switch is shown on the auxiliary diagram for the double punch and blank column detection device (184471D).

#### Tube Types

Two types of tubes are used in the mark sensing device, the OA4G and 25L6. The OA4G tube serves to delay the operation of the machine until the amplifier tube filaments have heated to the proper operating temperature.

The 25L6 tube serves to amplify the current through the pencil mark to such an extent that it will energize a magnet in the delay unit. There is one 25L6 tube for each position of mark sensing.

The 25L6 tubes are mounted in groups of 10 per chassis. For 27 positions of mark sensing 3 chassis are used. The filament or heater of each tube is designed to operate on 25 volts; therefore, each row of five tubes in the chassis is connected in series across the 110 volt line. It is important that all tubes be in position, even in the last three unused positions of the third amplifier unit of 10 tubes, if the machine is equipped for 27 positions of mark sensing. These tubes, although of a standard type, are selected and must pass a more rigid inspection than those generally on the market. Therefore, it is advisable to order replacement tubes from Endicott.

#### Polarity

Polarity is of extreme importance in the operation of vacuum tubes, and circuits must always be maintained so that the anodes of the tubes are positive with respect to the cathode. This condition is assured, if post 2 is negative.

When the machine is equipped to run on 220 volts D.C., resistors are added to the circuit as shown in the wiring diagram.

A rectifier and capacitor are mounted in the machine if 110 volts A.C. is used as a supply. For 220 volts A.C. operation, a transformer is used in addition to the rectifier. A polarized attachment cord is not necessary on an A.C. machine.

#### Operation of the Electronic Delay Unit (Using OA4G)

The following explanation assumes a power supply of 110 volts D.C.

When the mark sensing switch 1 lower is ON, a positive potential (voltage) is applied to the upper plate of the .5 mfd capacitor through the time delay relay coil, the time delay relay A points, and the 35 megohm resistor. A negative potential is applied to the lower plate of the .5 mfd capacitor. As the capacitor charges, a difference of potential appears between the cathode and the starter anode of the OA4G tube. When this reaches approximately 70 to 80 volts, the tube becomes conductive and sufficient electrons will flow between the cathode and anode to energize the time delay relay. The 35 megohm resistor determines the charging rate of the .5 mfd capacitor. This value of resistance provides for approximately 30 seconds' delay before the tube becomes conductive.

The circuit to energize the time delay relay follows: from the negative side of the line at post 2, through the MS fuse 2, to the negative side of the 150 mfd capacitor, through the cathode, to the anode, through the time delay relay coil, to the positive side of the 150 mfd capacitor, through MS fuse 1, MS switch 1 lower, to the positive side of the line at post 5.

The time delay relay A points transfer to open the tube circuits and provide a hold circuit for the relay. The circuit follows: post 2, MS fuse 2, to the negative side of the 150 mfd capacitor, to the cathode of the OA4G, through the 1500 ohm resistor, the transferred A points of the time delay relay, the coil of the time delay relay, to the positive side of the 150 mfd capacitor, through MS fuse 1, mark sensing switch 1 lower, to the positive side of the line at post 5.

The B point of the time delay relay is in series with start relay 10 when mark sensing switch 1 upper is in the ON position. Thus, the machine cannot be started until the time delay relay is energized.

**Theoretical Tube Circuit 25L6 — Figure 84**

The screen grid of the tube is connected to the

positive side of the 110 volt line through a 3000 ohm resistance. The 40 volt output of the generator is connected to the control grid and the cathode through a 1.5 megohm resistor, the negative terminal to the grid and the positive terminal to the cathode. This circuit furnishes a 40 volt negative bias to the control grid of the tube so that no current flows to the anode as long as the external circuit through the mark sensing brush circuit is open. The cathode is connected directly to the 110 volt D.C. line, negative side. The mark sensing brush circuit is connected to the 110 volt D.C. line, positive side. Polarities indicated are the polarities of the machines as shown on the wiring diagram.

When a pencil mark shorts the mark sensing brushes the control grid is driven less negative with respect to the cathode. The 40 volt negative bias

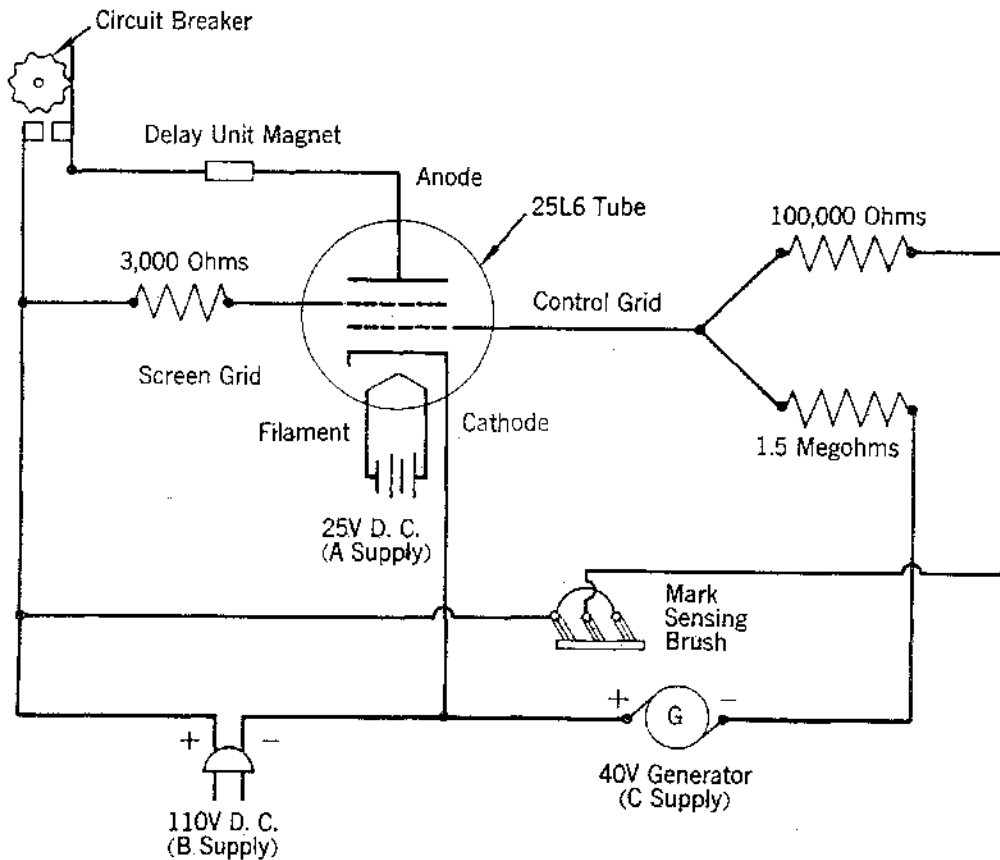


Figure 84. Theoretical tube circuit

is neutralized by the 110 volt positive potential. However, the 100,000 ohm resistor limits this opposing current so that the control grid is driven to zero potential or only very slightly positive. When the grid reaches zero potential with respect to the cathode, maximum electron flow through the delay unit magnets from the 110 volt D.C. line will be obtained under the control of the circuit breaker C10.

The 100,000 ohm resistor becomes effective to limit the grid current when the brushes are shorted by the pencil mark.

The 1.5 megohm resistor determines the maximum sensitivity of the tube. The ratio of the 100,000 ohm resistance plus the resistance of the pencil mark to the 1.5 megohm resistor for all reasonable values of mark resistance is small. This insures a relatively high potential drop across the 1.5 megohm resistor for all values of mark resistance within the intended range of operation and consequently a potential on the grid which will render the tube conductive within this range. If the resistance value of the 1.5 megohm resistor were greatly reduced, the ratio would not be small except for very low values of mark resistance. In other words, the sensitivity would be reduced. On the other hand, if the value of resistance were increased above 1.5 megohms, the ratio would be low for very high values of mark resistance and the sensitivity of the circuit would be very great. In this case, trouble would probably be experienced since leakage currents due to moisture and imperfect insulation in the grid circuit would probably be sufficient to bring the grid potential within the range where conduction through the tube occurs. The resistance value of 1.5 megohms has therefore been chosen to allow as wide a range of mark resistance as possible and at the same time reduce the possibility of trouble from leakage currents.

The 3000 ohm resistor limits the screen current to a safe operating value.

#### Read Circuit

When there is not a mark on the card, no current flows from the cathode to the anode because a negative bias is maintained on the control grid.

If the MS brush hubs are wired to MS IN hubs and the MS OUT hubs are wired to the punch magnet hubs, the circuit will be as follows:

From post 5, the positive side of the line ON position MS switch 1 lower, fuse, rectifier on A.C. binder posts on D.C., connector back of control panel, die contact 2, common connecting MS outer brushes, MS outer brushes, pencil mark, MS inner brush, MS brush hub, wire, MS IN hub, relay points R91AU N/O, G1 terminal, tube socket post 6, 100,000 ohm resistance, tube socket post 5, to the grid of the tube. This positive polarity applied to the grid overcomes the negative bias and allows current to flow in the anode circuit, thus energizing the delay unit magnets as follows: From post 5 on the positive side of the line, MS switch 1 lower, fuse, rectifier on A.C., binder posts on D.C., R-57A N/O, C10, delay unit magnet 1, R88B N/C, anode post P1, tube socket post 3, anode of tube, cathode of the tube, tube socket post 8, tube chassis control panel cathode post 5, rectifier on A.C., binder posts on D.C., fuse, to post 2 on the negative side of the line.

#### Delay and Punch

The circuit that is completed through the delay unit when the card is in position to be punched is as follows (refer to 513 wiring diagram for complete circuit):

From 40V post 3, fuse 2, 10A fuse, posts 4 and 5, cam contact P-1, CB's 11-14 on 513, to R7BU, common of delay unit, (MS wiring diagram), any one of 10 time delay contacts, normally open side of R93BU, through R95BL, MS OUT hub, punch magnets hub, punch magnet, relay points R43 through R56, jumper around R15AL, through R25BL and R28B, No. 4 dummy fuse, No. 1 fuse 10A, to 40V post 1.

### Mark X

The first position of the mark sensing device is the only one in which a position marked 12 can be used for X control. An X hole will be punched for a 12 mark wired to this position. However, the 12 mark can be located in any of the 27 marking columns of the card.

This circuit is provided for the operation of units normally controlled by a punched X. The circuit is arranged so that an X may be punched during the same cycle; however, the punching of an X can be suppressed, if desired, by omitting the control panel wire from the first position of the amplifier MS OUT hubs or by wiring through the column split device.

The reason for this mark 12 circuit is that a marked X would not be sensed early enough to provide declutching of the read feed as the master card passed the die station.

This feature functions as follows:

R88 is energized by C5 during 12 mark reading time, so that a 12 mark will cause energization of R89 through the 88B points. R89 holds through R89AL and C6 until 13.8. At 13, R90 picks up through R89B and P3. R90 holds through its A point and P2 until 9.7 of the next punch unit cycle. R89PU No. 1 is energized through R90B and C4 until 11.5. This allows the X impulse only from C7 to pass through the R89AU points to the MS OUT hubs in the first position so that an X will be punched.

The purpose of shifting from the delay unit magnet to the relay delay is that this particular mark must be delayed three cycle points instead of the two available from the delay unit. This is in addition to the necessity for obtaining a set of points R89B for the completion of the MX control pickup circuits.

Note that at 13.5 the R88B points are restored to normal, and from 0 through 9 the unit is available for two-point delay, should the X mark be undermarked with some numerical character.

In all other positions of mark sensing, a 12 mark will punch in the 12 position, the X mark in the X position, etc.

When the feature of mark sensing X control is used, it is essential that the master card punching switch be ON if punching into the master card is desired.

### Circuit Grouping

Each tube in the chassis serves as a separate amplifier, and acts in conjunction with a particular mark sensing brush in one column, and with a particular magnet of the delay unit. Hence, failure of any one individual column to operate properly may be due to the failure of either an individual sensing brush, amplifier tube (or its associated resistor combination), delay magnet, pawl, or cam contact. The possibility of such individual or random failures being due to failure in the vacuum tube chassis can be checked by tests made on individual tubes and their associated resistors, as indicated below.

### Heater Open Circuit

The cathode heater circuit for the five tubes in each row on the chassis is a series circuit. Hence, if any single tube in either row fails through a heater open circuit, all five tubes in that particular row will be without heater current, and consequently all five associated columns will fail. This condition may readily be recognized by noticing whether exactly five columns fail to operate. If so, the failure may be verified as a heater open circuit by touching the tubes with the hand; tubes of the 25L6 type supplied with rated heater current normally reach an uncomfortably high temperature within fifteen minutes after being turned on. If either row of tubes is cold after this, while the other row is hot, one of the tubes in the cold row may have an open cathode heater. The defective one may be located by testing all tubes with a tube tester, or by replac-

ing each tube in the cold row successively by a new tube, allowing warm-up time after each replacement.

#### Heater Short Circuit

Occasionally tube heaters fail through short circuit, either between the heater wires or leads or between one side of the heater and the cathode. Heater shorts may cause failure in a single column only, because the defective tube receives no heater excitation. Such a tube will run cold or nearly cold, and the other four tubes in the row will run excessively hot, as may be determined by hand. Cathode-to-heater short circuits will usually cause a burnout of one or more of the tube heaters in the row containing the defective tube; the resulting open circuit may be detected as given under heater open circuit. Since a short circuit may cause the burnout of tubes in the same row in addition to the defective unit, it is advisable to check or replace all tubes in the effected row after a heater failure of any sort has been located. The check may be made with any commercial radio tube tester having a "heater-short" checking feature, such as is available at most radio stores.

#### Bias Voltage Tests

The normal bias rating is 40 volts. This is taken from the machine generator with satisfactory results obtained down to 38 volts. An open circuit in either bias lead wire will cause the machine to punch many extra holes in the cards even when they are unmarked blanks; it may cause all holes in all active columns to be punched.

Hence, a good test of the bias voltage is to feed blank cards through the machine and see if any holes are punched. This test is only significant if the machine is connected to the proper line voltage and polarity and if the control panel is properly wired. If many holes are punched in several rows, the bias may be at fault and should be checked.

#### Checking the Mark Sensing Device

There are three major elements of the mark sensing device; the mark sensing brush unit, the tube (amplifier) unit, and its associated resistors, and the mechanical delay unit. By the following procedure each of these units may be isolated and checked. The following checks may all be made by running the machine under power on a gang punch operation.

If an individual brush position fails, the tube and delay magnet may be checked by wiring another brush position in place of the one in question. If the tube and delay unit operate properly from another brush impulse, the fault lies in the brush circuit of the brush position failing.

The mechanical delay unit may be checked by operating it directly from the 40 volt current supply. Remove the anode (plate) lead and the grid lead for any particular tube position from the binding post panel at the top of the tube chassis (the position of these wires are shown at the top of the mark sensing wiring diagram) and short them together. This removes the tube from the circuit. The delay unit may then be checked by wiring the punch brushes to the mark sensing IN hubs. A hole in a card read by the punch brushes should be punched into the card following it. This hole in the second card will have two cycle points' difference in value because of the two cycle points' delay. A 5 read under the punch brushes will cause a 7 to punch into the card following it.

If the brushes and mechanical delay unit operate properly and a position fails, the tube and its associated resistors should be checked. The tube may be checked as follows:

Wire from the punch brushes to the MS IN hubs and from the MS OUT hubs to the punch magnets. As in the previous run, a 5 hole read by the punch brushes will cause a 7 hole to be punched in the next card. Any failure to punch would indicate tube failure if the delay unit had previously proved normal. By substituting an-

other tube in this position, continued failure may be isolated to the resistors of the tube circuit.

If the 1.5 megohm resistor is open, the machine will lace a card in the position associated with the 1.5 megohm resistor.

If the 100,000 ohm resistor is open, the machine will not punch in the position associated with it.

Resistor failure may be determined by substitution of a new resistor or by testing with a meter.

#### Meter Test

A check may be made to determine that the tube circuit is functioning properly. Steps in this test are:

1. Remove the covers housing the delay unit and vacuum tube chassis.
2. Remove the belt.
3. Turn on the main line and mark sensing switches and crank the machine by hand. Engage the punch clutch so that R57 becomes energized by P1. Be sure the time delay relay is energized.
4. Disconnect the wire from minus C (the fourth wire on the terminal panel just above the tube chassis). This wire, which wires into the front of the terminal panel, goes to standard fuse 1.
5. Short minus C (number 4 terminal) to plus C (number 5 terminal) on the chassis for positions 11-20 and 21-27; this may be done by wire. Terminals 5 and 6 are common behind the terminal panel. This shorts the control grid and cathode together, thus removing the grid bias and allowing the tube to become conductive.
6. Set the meter on the 250 volt D.C. scale. Connect the meter in parallel with the delay magnet. The positive lead should be connected to the delay magnets common.
7. Turn the machine until C10 makes. The meter should read approximately 70 volts. This reading will go ON and OFF as C10 makes. Each of the positions may be checked by taking a reading across each of the coils of the delay unit.

There are three resistances associated with each tube. The 1.5 megohm resistor is colored brown

and green. The 100,000 ohm resistor is colored brown, black and yellow. The 3,000 ohm resistor is wire-wound and is about  $\frac{1}{2}$ " in diameter by 1" long.

The following test checks the 1.5 megohm resistor for value. The 100,000 ohm resistor is in the circuit also but will not appreciably alter the reading of the meter.

1. Remove one tube from the chassis. This prevents the tubes from heating because the filaments of the 5 tubes in a chassis are in series.

2. Turn the main line and mark sensing switches ON.

3. Set the meter on the 10 volt scale. Place the plus lead of the meter on the mark sensing brush common; place the minus lead in the MS IN hub for the position being tested. The meter should read 1 volt on the 10 volt scale.

This circuit may be readily seen on the theoretical tube circuit diagram. The circuit is as follows: from 110V plus to the mark sensing brush common, through the meter to the MS IN hub, through the 100,000 ohm resistor, through the 1.5 megohm resistor through the generator to the 40V plus and back to the 110V minus side of the line.

The following test will check the 100,000 ohm resistor.

1. With all tubes in the chassis, turn on the main line and mark sensing switches.

2. Set the meter on the 50 volt scale and connect the meter leads, the plus lead to the common of the mark sensing brush and the minus to the MS IN hub.

3. The meter should read 38 volts.

The 3,000 ohm resistor may be checked in the following manner:

1. Remove chassis mounting screws.
2. Set the meter on 100 or 250 volt D.C. scale.
3. Clip the terminals of the meter on the resistor, one at each end.
4. Turn the main line and mark sensing switches

ON. Remove the belt and turn a marked card under the mark sensing brushes.

5. The meter should read between 30 and 60 volts when the tube is conducting.

Sometimes an accumulation of conditions may cause a poor contact between the pawls and the contact cams of the delay unit magnet, causing failure to operate the punch magnet. This con-

dition may be verified by connecting a neon indicator lamp bulb between the suspected cam contact and the rotor common. If this flickers ON during the normal operation of the machine, on cards bearing marks in that particular column, there is a faulty contact which should be removed and cleaned.





A holding circuit will be established for R87 and the double punch signal lamp in parallel through R87AL points. The circuit follows: from 40V5, through the double punch reset contact, through R87AL N/O (now closed) points, through R87 and the double punch signal lamp to the common side of the line at R15.

R87B N/C points are in the R10 motor start circuit. Therefore, if R87 is energized, R87B points open to de-energize R10 and the machine is stopped.

The circuit for blank column detection is as follows: When P5 makes at 9.3 a circuit will be completed from 40V5, through the punch brush card lever, to R7, through P5, through the detail or master switch in the Master setting, through R19AL N/C points, through blank column check switch, through the B points remaining closed of R109-R149, through the coil of R87P2 and the double punch signal lamp to the common side of R15. If any B points of R109-R149 or R65-R77 remain closed, it indicates that no hole was sensed in that column; therefore, R87P2 should be energized through the preceding circuit.

### OFFSET STACKER

The offset stacker is designed for use with the double punch and blank column detection device. It is generally installed on the punch unit stacker. Without any special wiring a card having either a blank or double punched column will be offset  $\frac{3}{8}$ " forward in the stacker.

With the switch turned to OFFSET the machine operates continuously. If the switch is turned to OFFSET STOP, the machine stops whenever an error card is detected. In either case, the error card will be offset in the stacker.

#### Mechanical Electrical Principles

The offset stacker device consists of a split stacker roll and a cam assembly, a pair of camming fingers, and a magnet which controls the operation of the cam fingers (Figure 86).

The two cam fingers are so arranged mechanically that they operate simultaneously and one controls the operation of the other. One cam finger latches on the magnet armature; this cam finger carries a stud which in turn operates the

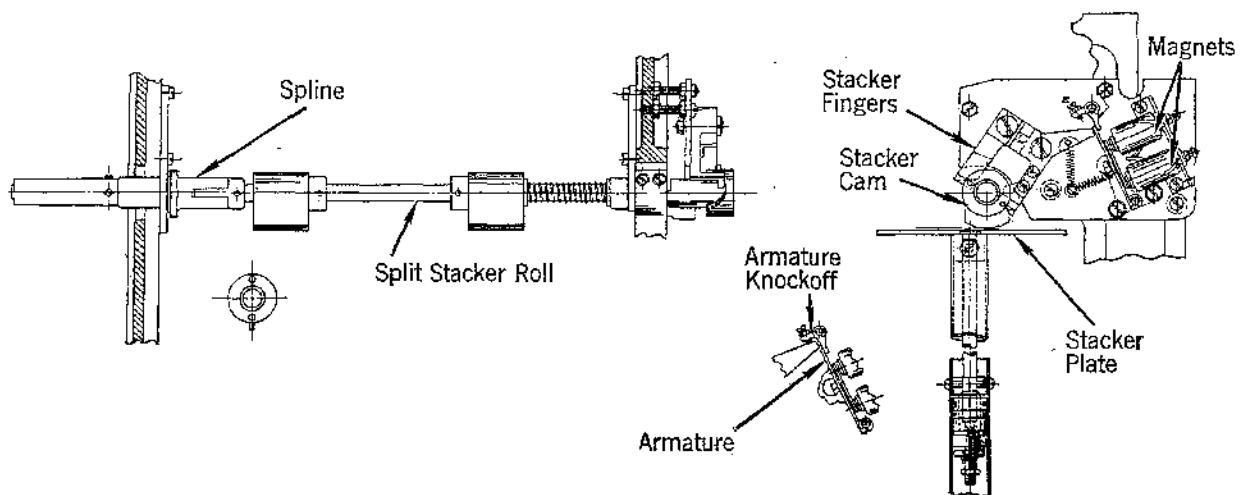


Figure 86. Offset stacker

other cam finger. This assures that the two cam fingers operate at the same time and permits them both to be controlled by a single latch. When the cam fingers are latched in an open position they clear the cam surface and are inoperative. When the magnet coil is energized its armature is attracted, releasing the cam fingers and allowing them to close about the cam shaft. As the stacker roll revolves, the cam surface causes the stacker roll to be carried toward the front of the machine. The stacker roll has a split shaft so splined that it may be driven when in either a normal or an extended position. At the end of the cycle the restoring cam carries the cam fingers beyond the latching point and knocks the armature away from the cores. With the cam fingers relatched, the stacker roll is free to be returned to its normal position by spring tension.

From the schematic of the feeds (Figure 1) it will be noted that the unpunched or double punched column is sensed by the punch brushes one cycle before the card reaches the stacker. Therefore, the operation of the offset stacker magnet is delayed for one cycle until the card containing the blank or double punched column is being stacked.

The offset stacker magnet may be energized under either of two conditions; in one case the column is blank and in the other case the column is double punched.

In the case of a blank column, one of relays 77-109, depending upon the position being used, will not have been energized. Therefore, a circuit will be completed from 40V5, through the punch brush card lever contact, to R7, through P5, through MASTER setting of the detail or master switch 2, through R19AL N/C, through blank column check switch 1, through R109B, through R87 and SR1 pick coil 1 in parallel to the other side of the line. This circuit is completed under the control of P5 between 9.3 and 9.7 on the index. SR1 is held through P1 and SR1AL points. The circuit follows: 40V5, through P1 which is

made from 14.3 to 13.3, through SR1AL points, through SR1 hold coil, to the other side of the line.

When SR1 is energized, the SR1B points are closed and SR2 is energized under the control of C5 which makes at 8.6 and breaks at 13.6 (see note on print 291579A).

A hold circuit for SR2 is established through P2 and SR2A points from 13.3 to 9.7 of the next cycle.

When SR2 is energized, a circuit may be completed to the offset stacker magnet through the stacker roll contact, which makes at 0 and breaks at 2, and SR2B points.

If a column is double punched the circuit to energize SR1 is somewhat different. Pick coil 2 of SR1 is used in this case.

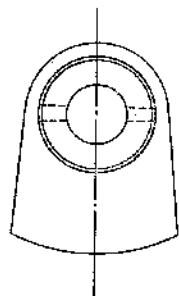
The fact that a column is double punched will be sensed by the double punch and blank column detection device and a signal must be directed to the offset stacker device. This signal is effected by the double punch relays.

For double punch detection the punch brushes are connected by wire to the double punch and blank column detection hubs. Assuming position 10 to be the position used, the first impulse from any hole within the specified column of the card will pass from the punch brushes through R128A N/C, and through R127 coil, thus energizing relay 127. When R127 is energized, the R127A N/O points close and provide a hold circuit for R127 and a pick circuit for R128. This circuit passes from one side of the line through P1, R127A points, R128 and R127, to the other side of the line. Since P1 makes from 14.3 to 13.3, R127 and R128 will be held energized for the rest of the sensing part of the cycle. Therefore, if a second impulse is read from the same column of a card, it is directed through the double punch and blank column detection hub, through R128A N/O points (now closed) through SR1 pick coil 2. After SR1 is energized, the SR1B points are closed and SR2 and the offset stacker magnet are energized as previously discussed.

If the switch is set to OFFSET STOP, a R87 is placed in parallel with SR1 and is energized at the same time. The R87B N/C point is in the R10 motor start circuit. Therefore, when R87 is energized the motor stops. The double punch error lamp is also in parallel with R87 and glows to indicate a discrepancy in the punching.

#### Adjustments

1. Time stacker so that the high side of the stacker roll is down at 4 on the index (Figure 87).



Vertical position

Figure 87. Stacker timing

2. Set cam stacker shaft so that the restoring cam is down and the center lines of the holes in the cam are in a vertical position at 6.3 on the index (Figure 88).

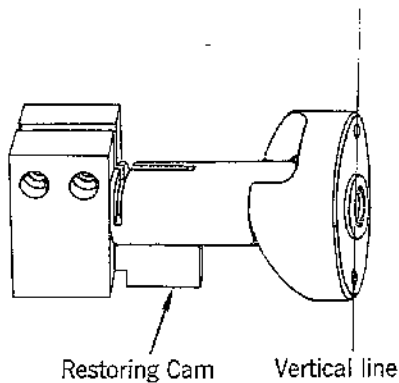


Figure 88. Offset stacker adjustment

3. Loosen the two screws in the right cam finger and adjust the finger so that it strikes the cam surface at the same time as the left finger to insure an even pull on the stacker shaft (Figure 89).

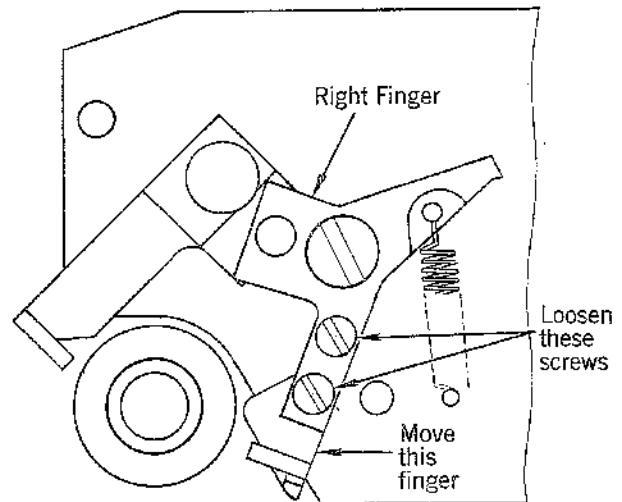


Figure 89. Offset stacker adjustment

4. The armature pivot and backstop are one assembly. Loosen holding screws and adjust horizontally so that the latch overlaps the armature .020"-.025" with the armature against its backstop. At the same time adjust the armature pivot vertically so that the cam fingers clear the periphery of the cam by .020"-.030" when latched upon the armature (Figure 90).

5. Adjust the magnet mounting bracket to provide an unlatching clearance of .008"-.010" with the armature touching the upper core and clearing the lower core by .003"-.005" (Figure 91).

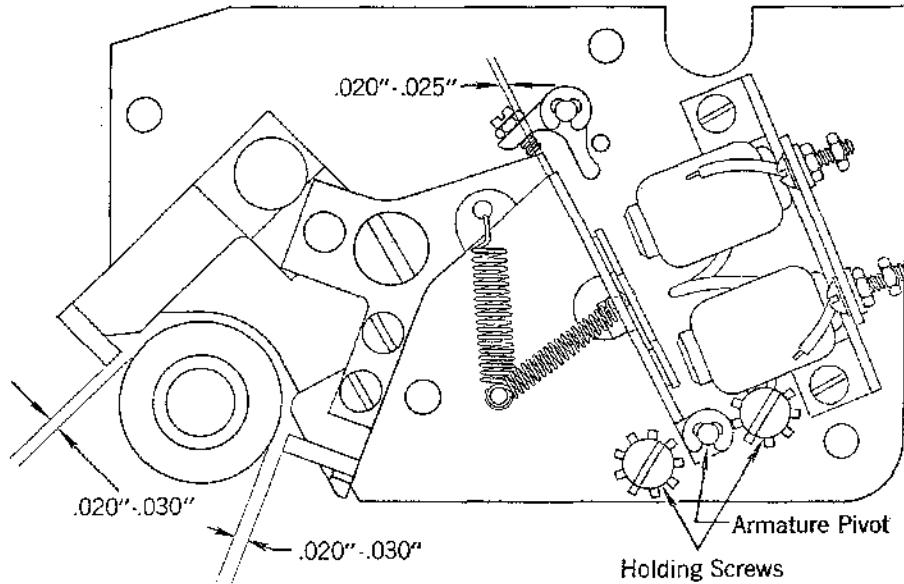


Figure 90. Offset stacker adjustment

6. Turn the machine until the right finger is on the high point of the restoring cam. At this time adjust the armature knockoff screw to provide  $.005''-.008''$  clearance between the armature and the armature backstop. When the left finger

is on the high point of the restoring cam, there should be sufficient clearance between the latching arm of the right cam finger and the armature to allow attraction of the armature without pressure on the latching surfaces (Figure 92).

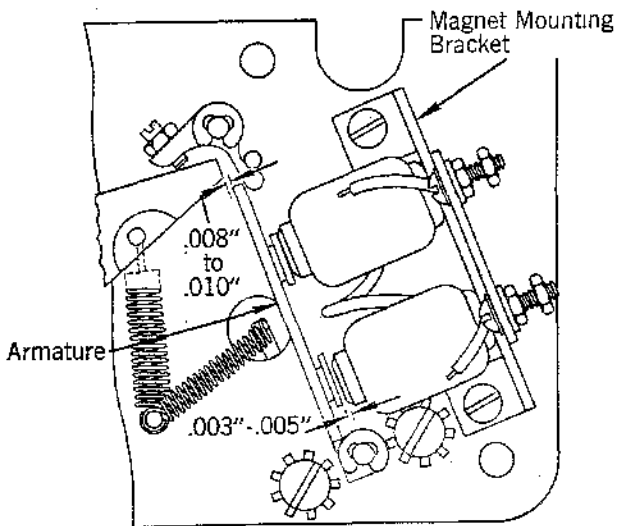


Figure 91. Offset stacker adjustment

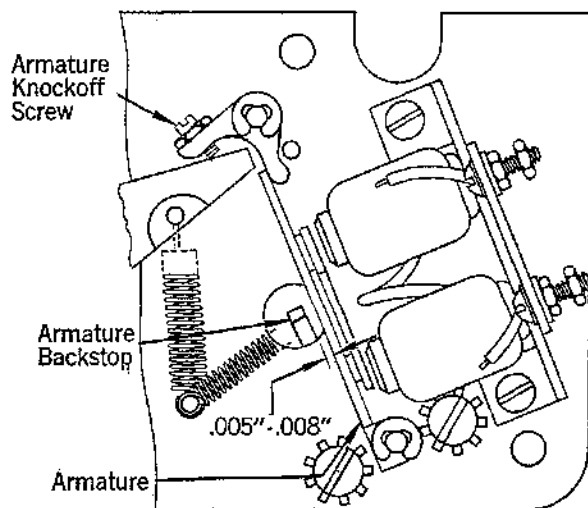


Figure 92. Offset stacker adjustment

7. With the spline on the stacker shaft fully engaged, loosen the locking screws in the cam and position it laterally so that the cam fingers, when tripped, clear the low dwell of the cam by  $\frac{1}{32}$ " (Figure 93).

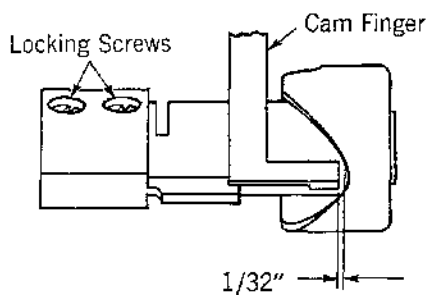


Figure 93. Offset stacker adjustment

8. Turn the adjusting sleeve on the stacker rod to provide for .006"-.010" clearance between the stacker roll and stacker plate when the stacker rolls are down (4 on index). See Figure 94.

9. To adjust the braking action of the felt washer use a  $\frac{1}{4}$ " end wrench on the bottom of the adjusting sleeve to keep it from turning, and tighten the compression nut.

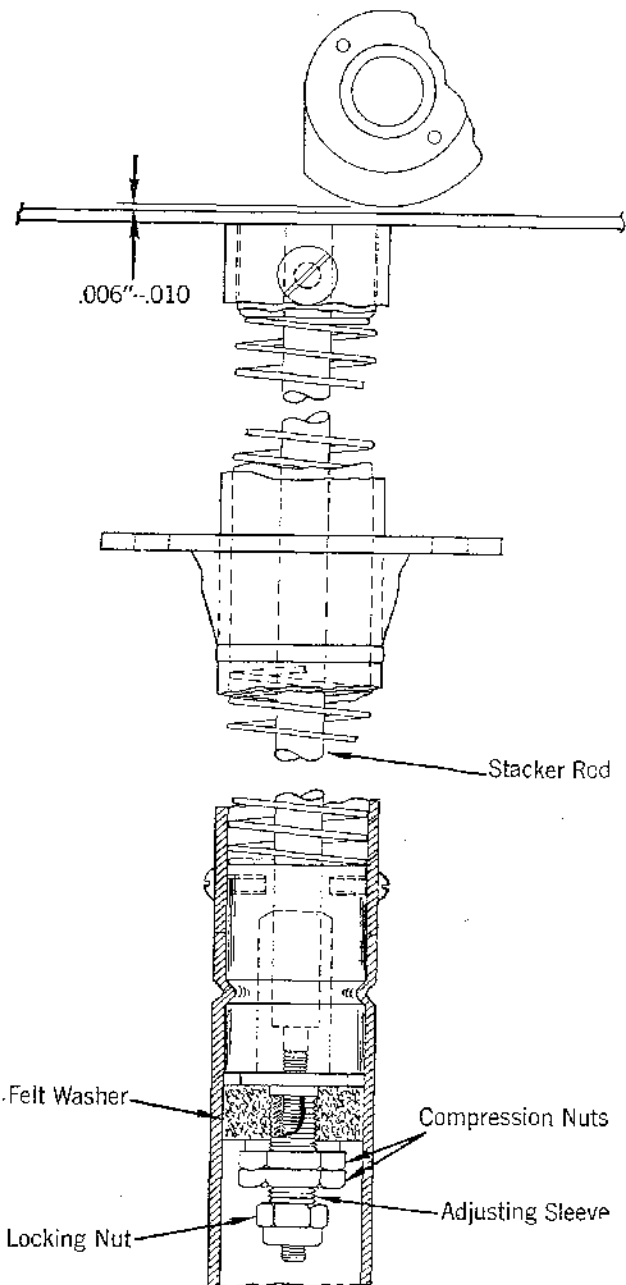


Figure 94. Stacker plate

## PURPOSES OF CAMS AND CONTACTS

### STANDARD MACHINE RELAYS

*R1AU* when closed, completes circuit for *R10* hold coil in conjunction with other card lever contacts to continue machine operation. When open, it breaks the circuit to *R10* hold coil to stop the machine in case it fails to feed a card from the punch magazine.

*R1AL* operates in conjunction with *R4AL* to control the circuits to the punch and read clutches, to keep the feeds in step in the event of a feed failure in either unit; that unit in which the failure occurred will operate.

*R1BL* completes the circuit to the punch X common and relay 2 when cards are feeding. When cards are not feeding, it is open to prevent circuits to the X control relays.

*R1BU* completes the circuit to start relay 10 for first cycle when summary punching, reproducing and comparing to permit feeding without restoring the comparing unit. In this manner the cards may be run out of the summary punch, replaced in the proper order and run in again without restoring the comparing unit.

*R2AL* provides a circuit to the 0 and X hubs, when a card is in punching position on the second and each succeeding punching cycle.

*R2AU* provides a hold circuit for *R2H* coil through the die card lever after *R2* has been energized at the end of the first punch feed cycle.

*R2BL* N/C point (in summary punching) causes the punch to take 2 feed cycles when cards are first placed in the machine and the start key is depressed.

*R2BU* prevents an accounting machine auto start when summary punching unless a card is at the die station.

*R3AL* N/C point operates in conjunction with *R7AL* N/C to shunt out punch card lever contacts to permit operation of the read feed only. The N/O point in conjunction with other card lever contacts completes a holding circuit for relay 10. It opens the holding circuit for *R10* when the last card leaves the punch magazine. It also operates in conjunction with other card lever contacts to complete the accounting machine auto start circuit when summary punching.

*R3AU* operates in conjunction with *R4BL* and *R6AL* N/C to shunt out read unit card levers to permit operation of the punch unit alone.

*R3BL* operates in conjunction with *R6BL* so that when reproducing, it is necessary to have cards in or out of both feeds in order to start the machine.

*R3BU* prevents an accounting machine automatic start when summary punching unless there is a card in the punch magazine.

*R4AL* operates in conjunction with *R1AL* to control the circuits to the punch and read clutch to keep the feeds in step in the event of a feed failure in either unit; that unit in which the failure occurred will operate.

*R4AU*, when reproducing and gang punching with interspersed master cards in the punch feed and using an X detail setup, completes the circuit to the read clutch for the first feed cycles when starting a run.

*R4BL* N/C point operates in conjunction with *R3AU* and *R6AL* N/C to shunt out the read card lever contacts to complete the holding circuit to *R10* when only the punch unit is being operated. The N/O point operates in conjunction with *R6AL* N/O to feed a card from the read magazine.

- R4BU* completes a circuit to the R-X common when cards are feeding. When cards are not feeding, it is open to prevent circuits to X control relays.
- R5B(L)* operates in conjunction with other card lever contacts to provide an automatic start circuit to the accounting machine when summary punching. It prevents an accounting machine automatic start unless there is a card under read card lever 1 when performing a combination reproducing and summary punching operation.
- R6AL* N/C point operates in conjunction with *R3AU* and *R4BL* N/C to shunt out reading card lever contacts to complete the holding circuit to R10 when the punch unit only is being operated. The N/O point operates in conjunction with *R4BL* N/O to open the circuit to R10 when the last card leaves the read magazine. It operates in conjunction with other card lever contacts to provide an automatic start circuit to the accounting machine when summary punching.
- R6AU*, when reproducing and comparing, permits the machine to be cleared of cards after an error without restoring the comparing unit if cards are removed from both magazines.
- R6BL* operates in conjunction with *R3BL* so that when reproducing, it is necessary to have cards in or out of both feeds in order to start the machine.
- R6BU* prevents an accounting machine automatic start when summary punching and reproducing unless there is a card in the read magazine.
- R7AL* N/C point operates in conjunction with *R3AL* to shunt out punch card lever contacts to permit operation of the read feed only. The N/O point in conjunction with other card lever contacts opens the holding circuit for R10 in the event of a feed failure at the die station.
- R7AU* prevents an automatic start circuit to the accounting machine if a jam occurs at the punching station.
- R7BL* eliminates back circuits on the second card feed cycle when performing a reproducing and interspersed master card gang punching operation in conjunction with comparing and increasing the card field by wiring from the 0 and X hubs. Control panel wiring for this operation has the effect of shorting around *R7BU* points so that when the punch magnet common is broken by the master card X impulses, a back circuit would be completed through the comparing unit magnets and common, to the fuse if *R7BL* N/O were not in the line.
- R7BU* completes a circuit to the punch brush contact roll when cards are at the brush station. When open, it prevents energization of magnets connected to the punch brushes.
- R8AL* provides a hold circuit for R8 long enough so that the *R8B* points may prevent a second start impulse from reaching R10.
- R8BL* opens the punch automatic start circuit from the accounting machine to eliminate the possibility of more than one cycle of the punch for each summary punch operation.
- R9AL* provides a hold circuit for R9 after R10 drops.
- R9AU* provides a hold circuit for R9 during the time R10 is energized and C3 is open.
- R9BL* picks relay 8 after relay 10 is energized to assure only one cycle of operation for each summary punching operation.
- R9BU* operates in conjunction with *R10BL* to control circuits to the punch and read clutches. The pick time of R9 under the control of *R13B* is such as to prevent the clutch magnets from receiving a short impulse

when restarting in case the machine had stopped during the time when C1 or C2 had already closed.

*R10AL* provides a pick circuit for HD1 and R9.

*R10AU* has two separate points to prevent back circuit which permits starting machine with comparing contact open.

*R10BL* operates in conjunction with R9BU to open the circuit to the punch and read clutches (at the time C1 and C2 are open) when the machine stops for any reason.

*R10BU* prevents pickup of R25 until the end of the cycle to prevent opening R25BL until after the card has been punched.

*R11* and *R12* points function as column splits.

*R13A(L)* maintains a hold circuit for R10 to allow the machine to complete its cycle in case either the read or punch stacker switch is opened because either stacker has become filled.

*R13B(L)* provides a time interlock to prevent R9 from being picked between 9.6 and 13.9 so that the clutch magnets may not receive a short impulse when restarting in case the machine had stopped during the time when C1 or C2 had already closed.

*R14AL N/O* provides a pick circuit for R15 when the switch is set to Master X and the PX hub has been impulsed by a hole in a card under the punch X brushes for the purpose of preventing punching or comparing master cards. The N/C side provides the operation when the switch is set to Detail X, and no impulse is received at the PX hub.

*R14AU* provides a hold circuit for R14.

*R14BL* controls the operation of the read clutch on X or No X cards depending upon the setting of the Master X, Detail X Switch.

*R15AL* on machines with punch magnet relays, prevents their pickup when R15 is impulsed; on machines without punch magnet relays, it opens the punch magnet circuit directly.

*R15AU* provides a hold circuit for R15.

*R15BL* opens the summary punch end circuit to allow another punch cycle when a master card passes the die.

*R15BU* permits an extra cycle on summary punching to get the master card past the die.

*R16A(L)* provides a hold circuit for R16.

*R16B(L)* completes a circuit to the PD OUT hub.

*R17A(L)* provides a hold circuit for R17.

*R17B(L)* completes a circuit to the RD OUT hub.

*R18A(L)* provides a hold circuit for R18.

*R18B(L)* N/C point, when the switch is set to Master X, opens the common to the comparing magnets when an X card is sensed; the N/O points, when the switch is set to Detail X, closes the circuit to the comparing magnets when an X card is sensed. This point functions only when the reproducing switch is OFF.

*R19A(L)* provides a hold circuit for R19.

*R19B(L)* opens the circuit to the comparing magnets when a master card is passing the comparing brushes.

*R21ALAU* operates in the pick circuit through T hub for selectors 1 and 2 respectively so that this circuit can be completed only on a control change in the accounting machine.

*R21BL* opens clutch circuits until after the counters have been tested for negative balance on balance selection machines.

*R21BU N/C* permits the 9 impulse from the summary punch emitter to be transmitted to the counter mouldings for summary punching. The N/O point transmits a circuit to the 9



mouldings for balance control sensing on a control change to pick the selector relays if so wired.

*R22AU* shunts *R6AU* and comparing contact left to permit running cards in after checking a comparing error on a combination summary punching and reproducing operation before the comparing unit is restored to prevent getting an auto start circuit to printer on the run in cycles.

*R23AL* permits energization of cycle interlock relay 8 when summary punching to assure punching only one summary card for each control change.

*R23AU* permits the summary punch emitter to send impulses through the counters of the accounting machine only on summary punching operations.

*R23BL* permits the summary punch start circuit to be completed only after *R60* in the accounting machine is energized.

*R24B* has the effect of an R-cam in the circuit. It functions to prevent the machine from continuing in operation under the following conditions: When a jam occurs in the read feed, *R4* drops back to normal and remakes the card or straightens it, replaces it in the read magazine, and depresses the start key to pick *R10*, the read feed only will feed. If it should happen that this first card again jams at the throat, *R10* would continue to hold through *P6* because the punch feed does not operate on this cycle. However, *R24B* in the *R10* hold circuit opens and stops the feed.

*R25AL* point provides a hold circuit for *R25* when relay 10 is energized to feed cards without restoring the comparing unit.

*R25AU* point permits cards to be run from the machine when the comparing unit is tripped thus eliminating the necessity for relatching

the comparing unit and thereby maintaining the error indication until after the feed is cleared so that it may be checked against the cards. It also permits clearing feed without punching additional errors.

*R25BL* eliminates punching while cleared from the machine provided the comparing unit is not restored.

*R25BU* opens start circuit on combination reproducing, comparing and summary punching operation, when a comparing error is sensed. *R25BU* works in conjunction with *R1BU* to permit proper handling of cards on a summary punch comparing error. It forces the operator to remove cards from both feed hoppers before running out cards. Then die *CL* opens *R1BU* N/C and permits feed in before comparing unit is restored.

*R28B* purpose same as *R25BL*, added to reduce arcing.

*R33AL* and *R34AL* points provide a pick and hold circuit for class selector number 1, relays 35, 36 and 37.

*R33AU* and *R34AU* provide a hold circuit for *R33* through *P2* and *R2* respectively for the card reading portion of the cycle.

*R33* and *R34 BU* and *BL* are so arranged that either one will be effective to transfer the class selector C hub in the two left-hand positions from NX to X depending upon whether the R or P hub of the selector is impulsed.

*R35 through R41* points are class selector transfer points.

*R37AL* and *R42AL* points provide + and - punching control for indicating positive and negative totals when balance selecting or net balancing.

Points of relays 43-56 eliminate back circuits at punching time on summary punching machines.

## MARK SENSING RELAYS

*R88B N/C* point provides a pick circuit to the number 1 delay unit magnet. The N/O point provides a circuit to pick R89 for MX operation.

*R89AU* provides an impulse to the MX EXIT hub 1 to punch an X hole for a marked 12.

*R89AL* provides a hold circuit for R89.

*R89B* provides a circuit to the MX OUTLET hub and in conjunction with P3 provides an impulse for operation of relays normally controlled by a punched X.

*R90A* provides a hold circuit for R90.

*R90B* permits energization of R89 in parallel with R11, 12 and 13 in the standard circuits to provide a hold circuit for R89 through X time on the index.

*Relays 91-107* points transfer the circuits from those used on comparing or summary punching to those used for the mark sensing application.

## OFFSET STACKER RELAYS

*SR1AL* point provides a hold circuit for SR1.

*SR1B* point provides a pickup for SR2 to delay the circuit to the stacker magnet.

*SR2A* point provides a hold circuit for SR2 through P2 until the end of the cycle in which the card is stacked.

*SR2B* point provides a pick circuit for the offset stacker magnet when the stacker roll contact makes.

DOUBLE PUNCH AND BLANK COLUMN  
DETECTION RELAYS

*R87AL* provides a hold circuit for R87 and the double punch error light until the double punch reset switch is depressed.

*R109A* points provide a pick circuit for R110 in the first position and a hold circuit for R109 in the same position. The A points of relays 65-77 and 109-149 serve the same function for other positions.

*R109B* permits an impulse to R87P2 and the error lamp if relay 109 has not been previously energized. This indicates a blank column.

*R110A N/C* provides a pick circuit for R109 in the first position. This circuit is completed by the first impulse read into this position. It opens to prevent a second impulse read into this position from de-energizing R110. The A points of relays 110-150 and 66-78 serve the same function for other positions.

The N/O points of R110 provide a circuit to pick R87P2 if a second impulse reaches the entry hub. The N/O points of the other relays mentioned previously serve the same purpose for other positions.

*R19AL N/C* permits a shunt circuit around the master card punching switch right in the OFF position. R19AL opens to prevent blank column check for master cards. The N/O point permits a blank column check for X detail cards.

## C-CAMS

1. Controls the punch clutch timing and eliminates arcing of the relay points in the circuit by making the circuit after the relay points are closed and breaking the circuit before the relay points are opened.

2. Controls read clutch timing and eliminates arcing of relay points in that circuit.

3. Controls the drop out time of motor hold relay 9. It should be timed to cause the machine to coast to a point between 6 and 9.

4. Controls the pick and drop out time of column split relays and R13.

5. Provides proper timing hold for delay circuit relays.
6. Controls impulses to the read and punch delay OUT hubs and to delay circuits for other devices.
7. Controls impulse to 0 and X hubs and emits impulse to the MS EXIT hub 1 to punch an X hole.
8. C8 in conjunction with the stacker roll contact assures that the movement of the card is synchronized with the punch emitter. If the geneva pawl failed to engage on the first cycle, the card and the punch emitter would be out of step. If the two are in step, the accounting machine auto start will be completed.
9. Provides a circuit to energize the zone control transfer relays for alphabetic summary punching.

#### P-CAMS

1. Controls the circuit to the circuit breakers so that the reading brush and emitter circuits are completed only when the punch unit operates. It also controls the pick of the punch magnet relays.
2. Controls the holding circuit for relays which must be held during the punching period and X control relay for double punch and blank column detection.
3. Completes a circuit to the punch X brush at X time only and to the MX outlet for mark sensing.
4. Provides a pickup for PX delay relay 16.
5. Not used.
6. Provides a hold circuit for R10. It opens once during each cycle to test the condition of the card lever relays to determine if the machine should stop.

#### R-CAMS

1. Controls the circuit to the reproducing brushes to complete circuits to them only when the read feed operates.
2. Controls the holding circuit to the relays which must be held throughout the reading portion of the cycle under the control of the read feed.
3. Completes circuit to the read X brushes at X time only.
4. R4 provides a pickup for RX Master delay relay 18.

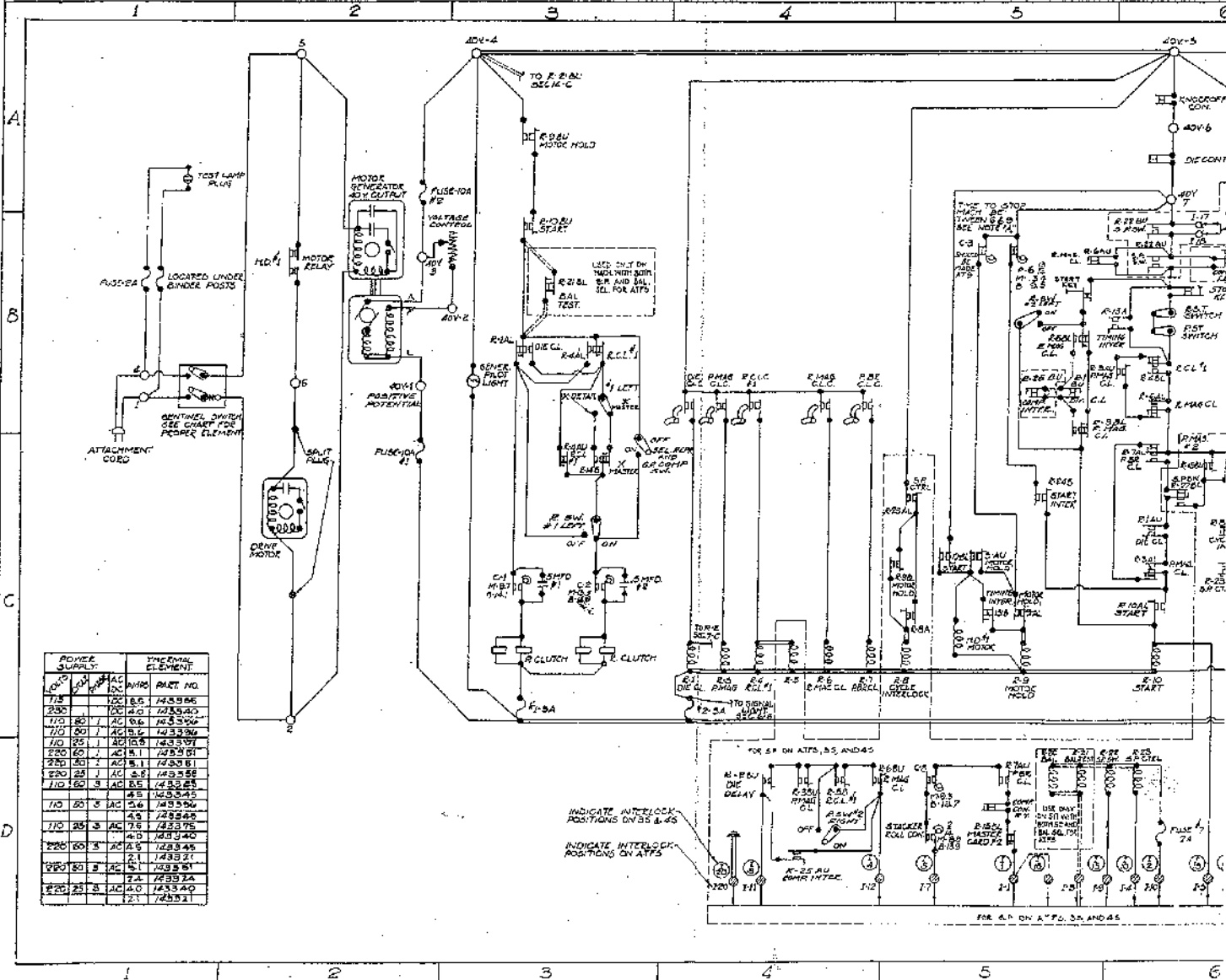
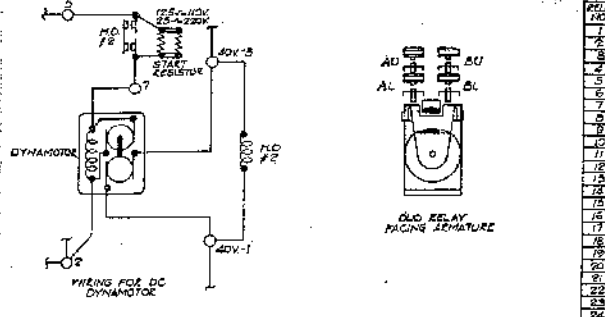
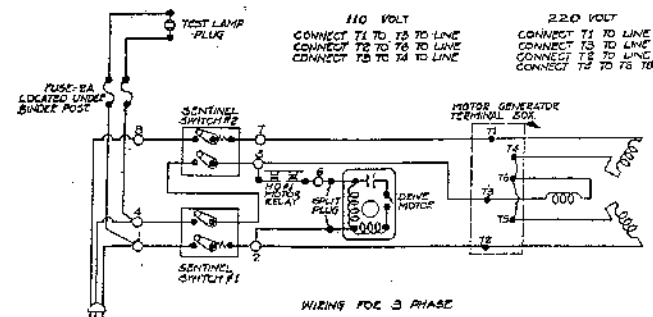
## MECHANICAL REVIEW QUESTIONS

1. Which feed knives operate under the control of the punch clutch?
2. Which feed rolls operate under the control of the punch clutch?
3. What difference do you observe in the operation of the feed rolls in the punch and read units?
4. Which contact rolls operate under the control of the punch clutch?
5. Which stacker rolls operate under the control of the punch clutch?
6. Which set of contact cams operate under the control of the punch clutch?
7. Which feed knives operate under the control of the read clutch?
8. Which contact roll operates under the control of the read clutch?
9. Which set of contact cams operate under the control of the read clutch?
10. Which contact cams operate when neither clutch is engaged and the drive gears are turned?
11. The punch is positively retracted by what mechanism?
12. The circular motion of the driving gears is transformed into reciprocating motion for punching by what mechanism?
13. What is the purpose of the interposer knock-off bar?
14. Why is the geneva type gear necessary in the punch feed?
15. What is the purpose of the cam surface on the hub of the geneva drive gear?
16. How many revolutions of the geneva disc are required to complete one machine cycle?
17. What links the geneva gear to the feed roll drive gears?
18. What allows the geneva pawl to engage and what causes it to disengage?
19. What controls the movement of the latch cam roller arm?
20. What is the purpose of the single revolution timing cam?
21. What is the purpose of the keeper on the clutch latch arm?
22. Why is it not possible to replace the geneva gear with the factory timing marks aligned?
23. Why are three types of interposers used in the magnet unit?
24. How is lateral punching registration obtained?
25. How is vertical punching registration obtained?

## ELECTRICAL REVIEW QUESTIONS

1. In what two types of circuits do card levers generally function?
2. What is the principle of operation of the thermal switch?
3. Why are thermal fuses (fusetrans) used in motor circuits?
4. What is reproducing?
5. Why are the read and punch clutches interlocked during a reproducing operation?
6. What is the purpose of R18BU points?
7. What card lever contacts are closed on the first feed cycle of a reproducing operation; the second; the third?
8. The comparing magnets are wound with two coils. What is the effect when only one coil is impulsed?
9. What is gang punching?
10. When performing an interspersed master card gang punching operation, on what cycle must punching be suspended? Why?
11. What relay provides the minor control over punching?
12. What relay provides the major control over punching?
13. What is the purpose of the punch magnet unit knockoff bar contact?
14. Relays energized by what card lever provide the final link in the circuit for continuous operation when reproducing?
15. Why is comparing suspended for one cycle when performing an interspersed master card reproducing and comparing operation?
16. Why are interlocking circuits not required for a gang punching operation?
17. In what two ways may a single master card gang punching operation be verified?
18. Why is a delay circuit required for verifying field selected information?
19. What is the function of the summary punch emitter?
20. Which of the three mark sensing brushes used in each position are common electrically?
21. What is the purpose of the thermal delay relay used with mark sensing?
22. What is the purpose of R88B point in the first position of the mark sensing unit?
23. What is the purpose of R9BU in the feed clutch circuit?
24. Why does the mark sensing delay unit delay the circuit to the punch magnet for two cycle points?
25. What is the purpose of the electronic delay unit in the machines equipped with mark sensing?

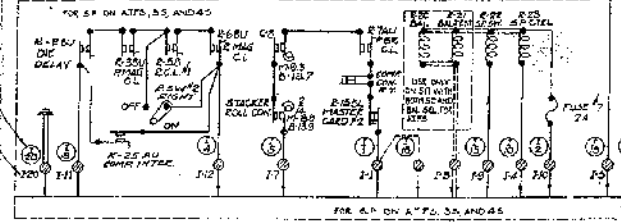
MOTOR CONNECTIONS



POWER SUPPLY:	TERMINAL ELEMENT		
NO	AC	AMP	PART NO.
110	25	1	143346
220	25	1	143340
110	20	1	143347
110	20	1	143348
110	25	1	143349
220	25	1	143350
220	20	1	143351
110	25	1	143352
110	20	1	143353
220	25	1	143354
220	20	1	143355
110	25	3	143356
110	20	3	143357
220	25	3	143358
220	20	3	143359
110	25	3	143360
110	20	3	143361
220	25	3	143362
220	20	3	143363

INDICATE INTERLOCK POSITIONS ON 35 & 45

INDICATE INTERLOCK POSITIONS ON ATFS

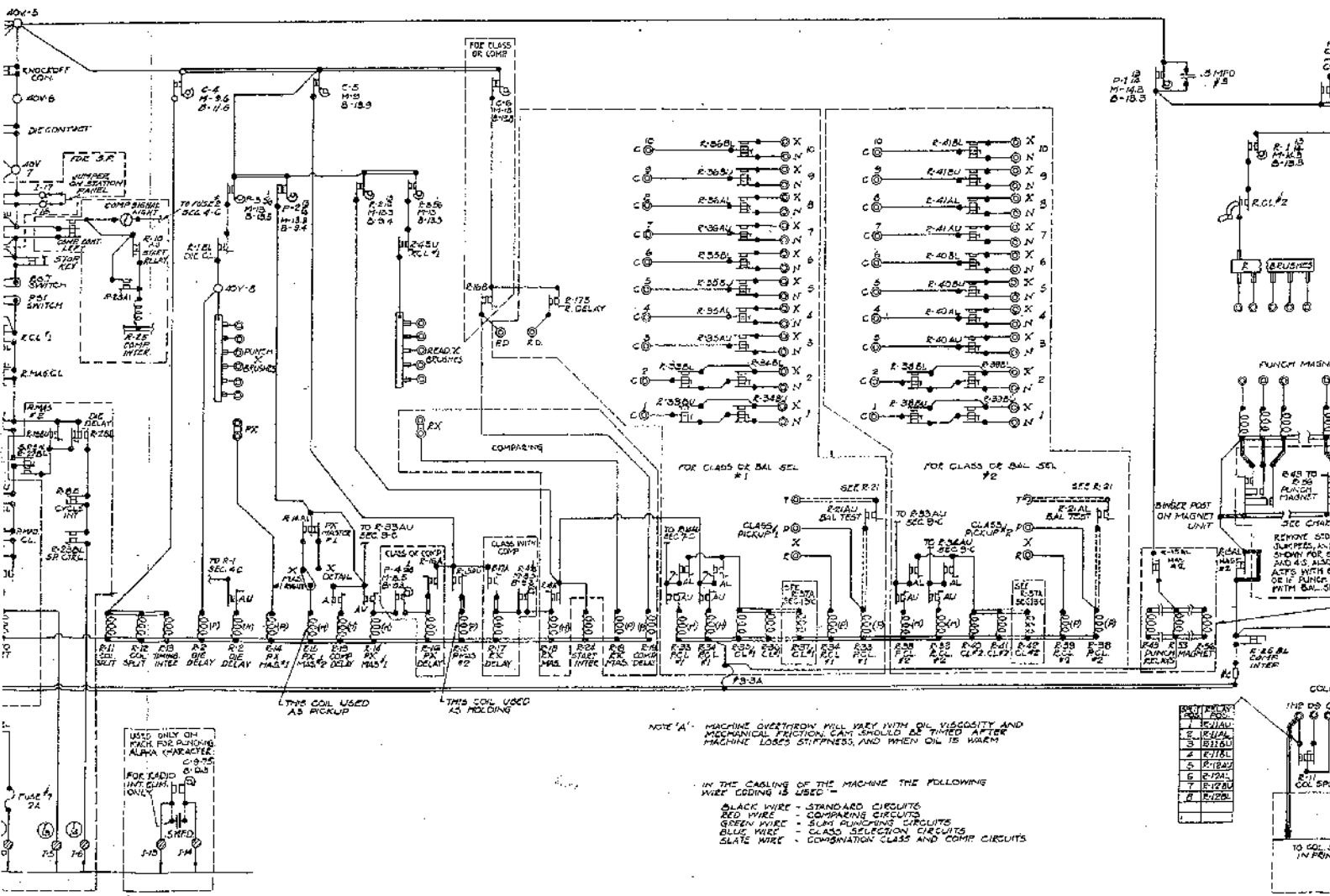
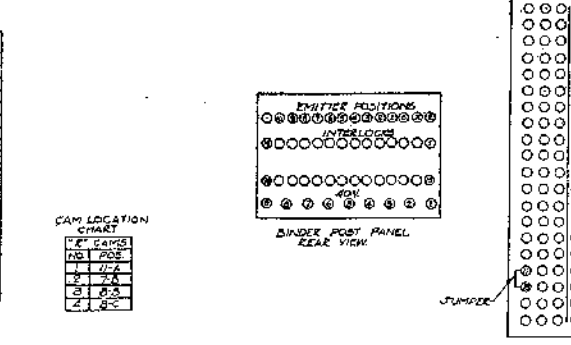


RELAY NO.	P. COIL	H. COIL	AL. PT.	AL. PT.	BL. PT.	BU. PT.
1	2-C	7-C	7-A	7-B	7-C	7-D
2	2-C	7-C	7-A	7-B	7-C	7-D
3	2-C	7-C	7-A	7-B	7-C	7-D
4	2-C	7-C	7-A	7-B	7-C	7-D
5	2-C	7-C	7-A	7-B	7-C	7-D
6	2-C	7-C	7-A	7-B	7-C	7-D
7	2-C	7-C	7-A	7-B	7-C	7-D
8	2-C	7-C	7-A	7-B	7-C	7-D
9	2-C	7-C	7-A	7-B	7-C	7-D
10	2-C	7-C	7-A	7-B	7-C	7-D
11	2-C	7-C	7-A	7-B	7-C	7-D
12	2-C	7-C	7-A	7-B	7-C	7-D
13	2-C	7-C	7-A	7-B	7-C	7-D
14	2-C	7-C	7-A	7-B	7-C	7-D
15	2-C	7-C	7-A	7-B	7-C	7-D
16	2-C	7-C	7-A	7-B	7-C	7-D
17	2-C	7-C	7-A	7-B	7-C	7-D
18	2-C	7-C	7-A	7-B	7-C	7-D
19	2-C	7-C	7-A	7-B	7-C	7-D
20	2-C	7-C	7-A	7-B	7-C	7-D
21	2-C	7-C	7-A	7-B	7-C	7-D
22	2-C	7-C	7-A	7-B	7-C	7-D
23	2-C	7-C	7-A	7-B	7-C	7-D
24	2-C	7-C	7-A	7-B	7-C	7-D
25	2-C	7-C	7-A	7-B	7-C	7-D

RELAY NO.	P. COIL	H. COIL	AL. PT.	AL. PT.	BL. PT.	BU. PT.
26	2-C	7-C	7-A	7-B	7-C	7-D
27	2-C	7-C	7-A	7-B	7-C	7-D
28	2-C	7-C	7-A	7-B	7-C	7-D
29	2-C	7-C	7-A	7-B	7-C	7-D
30	2-C	7-C	7-A	7-B	7-C	7-D
31	2-C	7-C	7-A	7-B	7-C	7-D
32	2-C	7-C	7-A	7-B	7-C	7-D
33	2-C	7-C	7-A	7-B	7-C	7-D
34	2-C	7-C	7-A	7-B	7-C	7-D
35	2-C	7-C	7-A	7-B	7-C	7-D
36	2-C	7-C	7-A	7-B	7-C	7-D
37	2-C	7-C	7-A	7-B	7-C	7-D
38	2-C	7-C	7-A	7-B	7-C	7-D
39	2-C	7-C	7-A	7-B	7-C	7-D
40	2-C	7-C	7-A	7-B	7-C	7-D
41	2-C	7-C	7-A	7-B	7-C	7-D
42	2-C	7-C	7-A	7-B	7-C	7-D
43	2-C	7-C	7-A	7-B	7-C	7-D
44	2-C	7-C	7-A	7-B	7-C	7-D
45	2-C	7-C	7-A	7-B	7-C	7-D
46	2-C	7-C	7-A	7-B	7-C	7-D
47	2-C	7-C	7-A	7-B	7-C	7-D
48	2-C	7-C	7-A	7-B	7-C	7-D
49	2-C	7-C	7-A	7-B	7-C	7-D
50	2-C	7-C	7-A	7-B	7-C	7-D
51	2-C	7-C	7-A	7-B	7-C	7-D
52	2-C	7-C	7-A	7-B	7-C	7-D
53	2-C	7-C	7-A	7-B	7-C	7-D
54	2-C	7-C	7-A	7-B	7-C	7-D
55	2-C	7-C	7-A	7-B	7-C	7-D
56	2-C	7-C	7-A	7-B	7-C	7-D
57	2-C	7-C	7-A	7-B	7-C	7-D
58	2-C	7-C	7-A	7-B	7-C	7-D
59	2-C	7-C	7-A	7-B	7-C	7-D
60	2-C	7-C	7-A	7-B	7-C	7-D

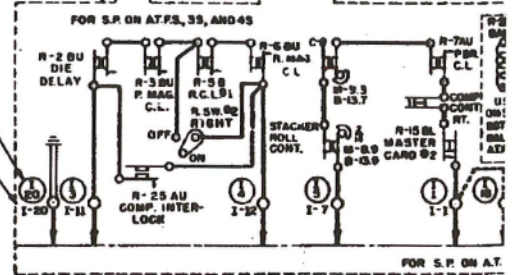
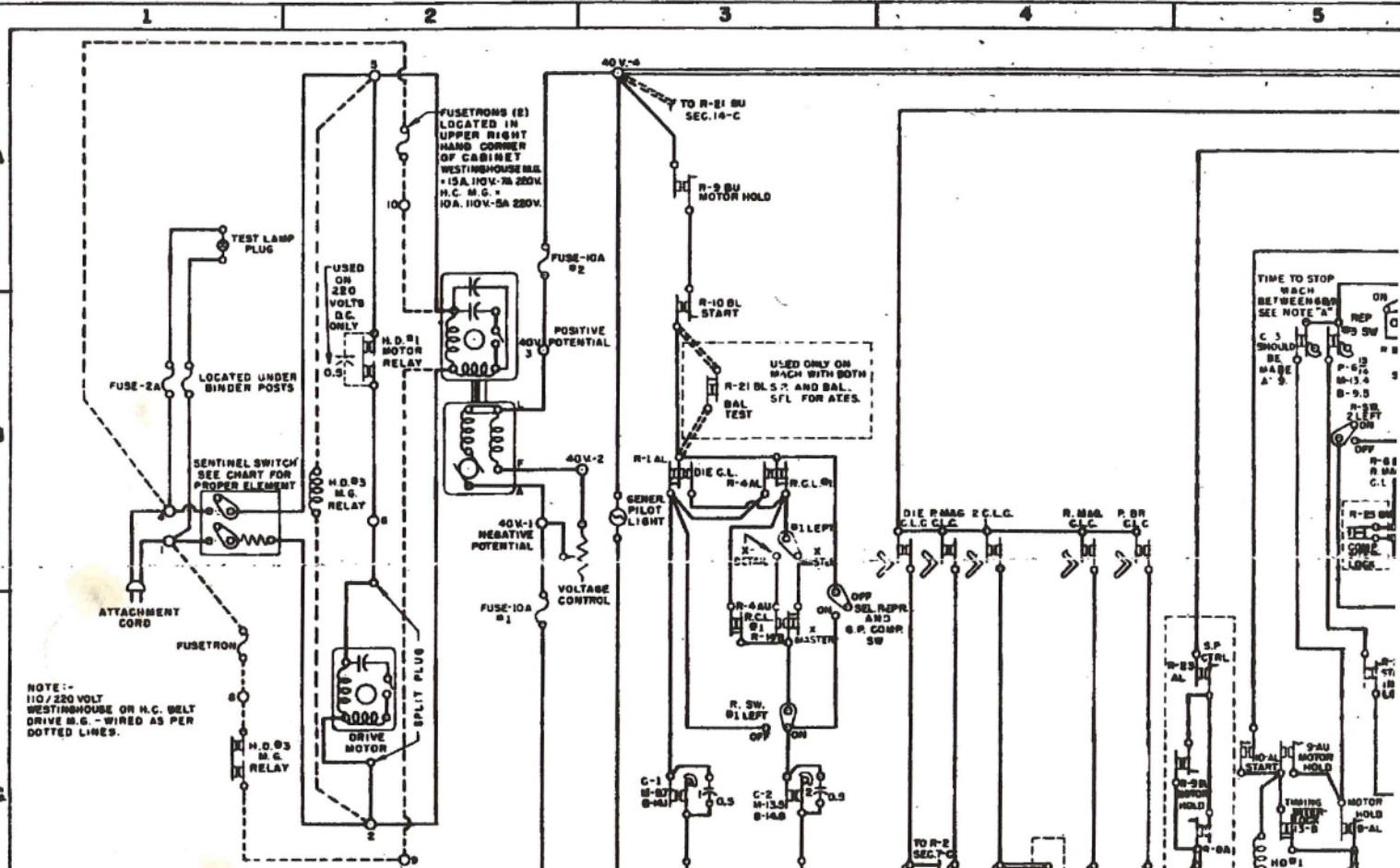
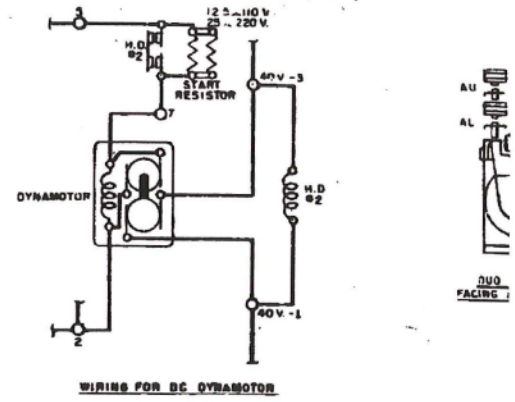
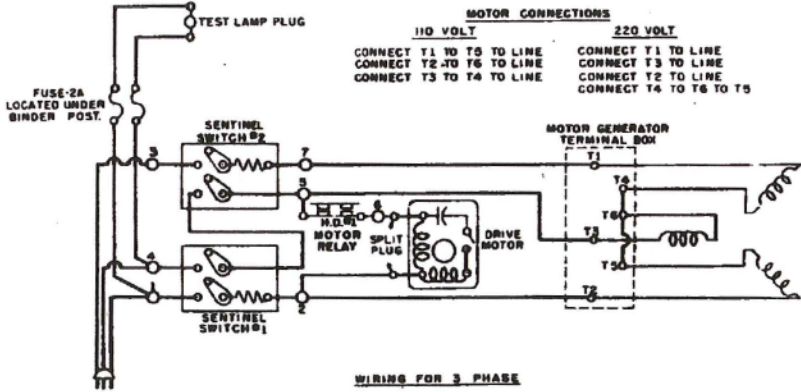
CAM LOCATION CHART
1 3-C
2 3-C
3 3-C
4 3-C
5 3-C
6 3-C
7 3-C
8 3-C
9 3-C
10 3-C
11 3-C
12 3-C
13 3-C
14 3-C
15 3-C
16 3-C
17 3-C
18 3-C
19 3-C
20 3-C
21 3-C
22 3-C
23 3-C
24 3-C
25 3-C
26 3-C
27 3-C
28 3-C
29 3-C
30 3-C
31 3-C
32 3-C
33 3-C
34 3-C
35 3-C
36 3-C
37 3-C
38 3-C
39 3-C
40 3-C
41 3-C
42 3-C
43 3-C
44 3-C
45 3-C
46 3-C
47 3-C
48 3-C
49 3-C
50 3-C
51 3-C
52 3-C
53 3-C
54 3-C
55 3-C
56 3-C
57 3-C
58 3-C
59 3-C
60 3-C

PUNCH MAGNET RELAY POSITION CHART
1 R-261U
2 R-262U
3 R-263U
4 R-264U
5 R-265U
6 R-266U
7 R-267U
8 R-268U
9 R-269U
10 R-270U
11 R-271U
12 R-272U
13 R-273U
14 R-274U
15 R-275U
16 R-276U
17 R-277U
18 R-278U
19 R-279U
20 R-280U
21 R-281U
22 R-282U
23 R-283U
24 R-284U
25 R-285U
26 R-286U
27 R-287U
28 R-288U
29 R-289U
30 R-290U
31 R-291U
32 R-292U
33 R-293U
34 R-294U
35 R-295U
36 R-296U
37 R-297U
38 R-298U
39 R-299U
40 R-300U

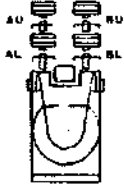




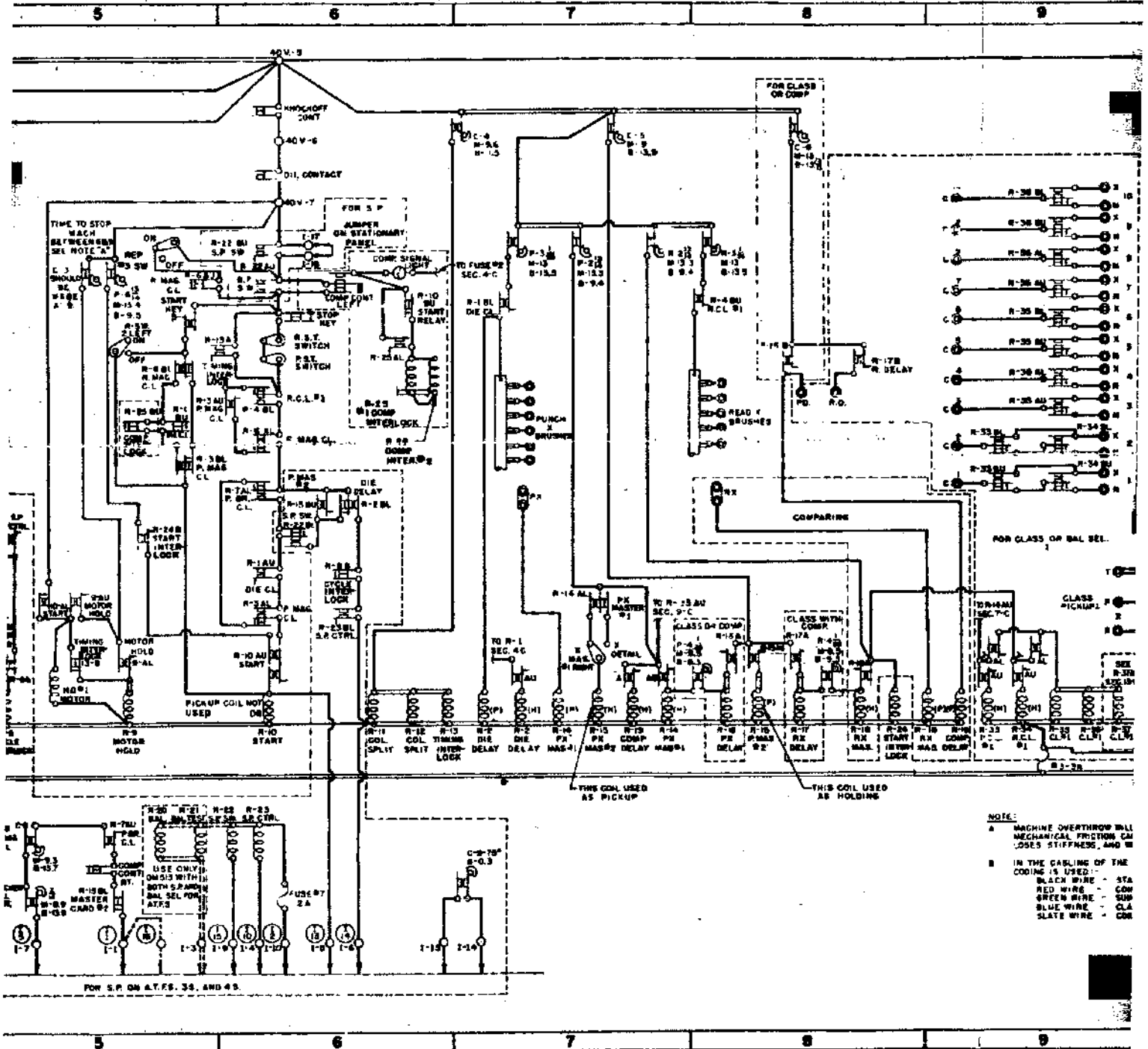




184300-M-S



DUD RELAY  
SAVING ARMATURE

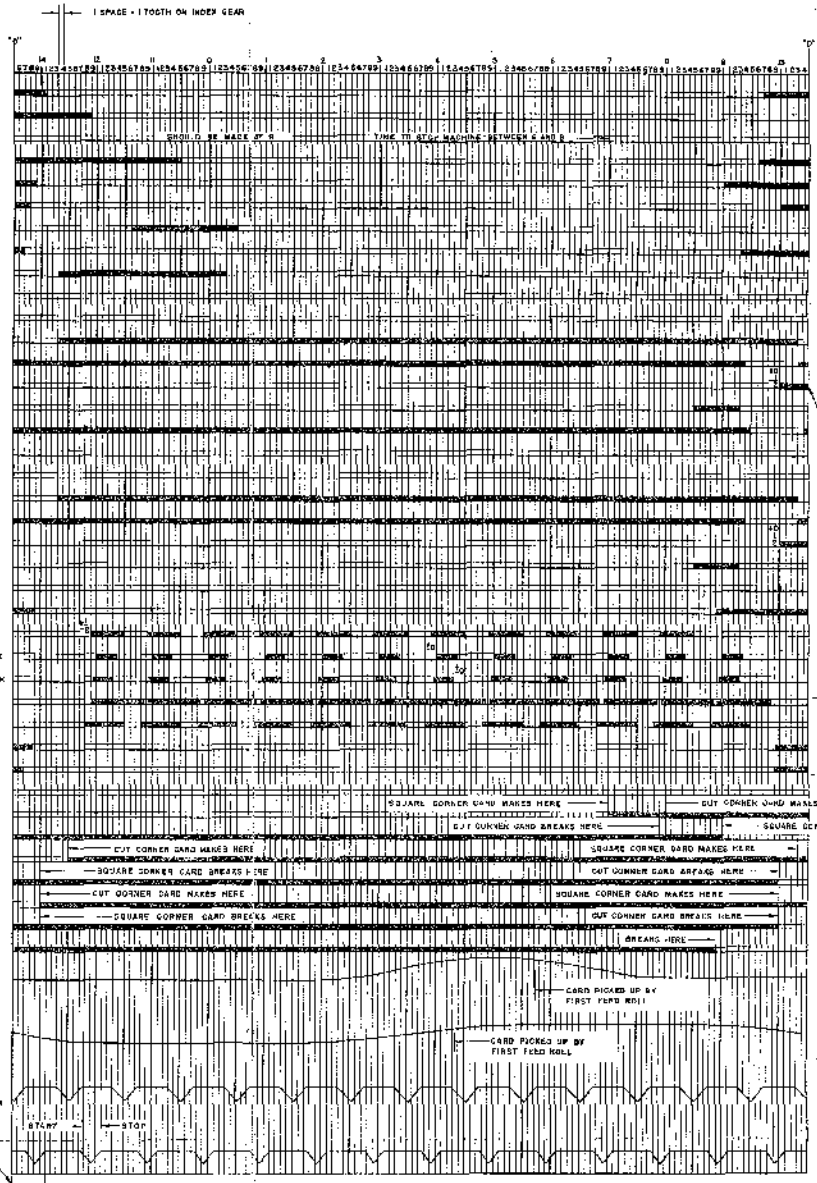


NOTE:  
 A MACHINE OVERTHROW WILL MECHANICAL FRICTION CAUSE LOSSES STIFFNESS, AND W  
 B IN THE CABLING OF THE COILING IS USED:  
 BLACK WIRE - STA  
 RED WIRE - COM  
 GREEN WIRE - SUP  
 BLUE WIRE - CLA  
 SLATE WIRE - COM

FOR S.P. ON A.T.S. 34, AND 45.







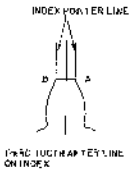
CONNECTIONS DO NOT BREAK BETWEEN  
PAGES IN SERIES RUN CONTINUOUSLY

- 01-24" PUNCH CLUTCH
- 02-36" HEAD CLUTCH
- 03-24" MOTOR STOP CTRL.
- 04-100" COLL. SP. LH. CTRL.
- 05-50" DELAY HOLD
- 06-60" NO DELAY IMPULSE
- 07-50" ZERO AND X
- 08-26" PRINTER AUTO. START
- 09-75" G.R. ALPHABET
- 010-
- 11-1/2" B. DIVE BRK. CTRL.
- 12-1/2" B. PA. HOLD
- 13-1/2" B. PA. IMPULSE
- 14-1/2" B.R. DELAY RELAY P.U.
- 15-1/2" START HOLD
- 21-1/2" S.A. BRK. CTRL.
- 22-1/2" S.A. X HOLD
- 23-1/2" S.A. X IMPULSE
- 24-1/2" S.A. DELAY RELAY

- STAKER ROLL CONTROL D SPECIAL
- SUM. PUNCH UNIT
- CHUCK BREAKERS
- PUNCH UNIT HELD OPEN SWITCHES
- REPR. UNIT READING BRUSHES
- PUNCH UNIT X BRUSH
- REPROD. UNIT X BRUSH

- REPRO. 1 & 2 CARD LEVER (FIRST CARD)
- REPRO. 1 & 2 CARD LEVER (LAST CARD)
- REPRO. 2 CARD LEVER (FIRST CARD)
- REPRO. 2 CARD LEVER (LAST CARD)
- PUNCH & CHECK CARD LEVER (FIRST CARD)
- PUNCH & CHECK CARD LEVER (LAST CARD)
- REPRO. 3 PUNCH MAGAZINE
- CARD LEVER COAT. (LAST CARD)
- PUNCH CARD PICKER

- REPRO. CARD PICKER
- PUNCH STRIKE
- INTERMITTENT MOVEMENT
- PUNCH CARD FEED CLUTCH ENAGES & DISENGAGES HERE
- PUNCH FEED ROLL CLUTCH ENAGES & DISENGAGES HERE
- REPRO. CLUTCH ENAGES AND DISENGAGES HERE



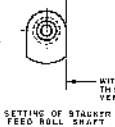
A TOLERANCE OF  $\frac{1}{4}$  TOOTH IS ALLOWABLE ON ALL CONTACT  
TIMING EXCEPT AS OTHERWISE NOTED

USE WIRING DIAGRAM NO. 184300

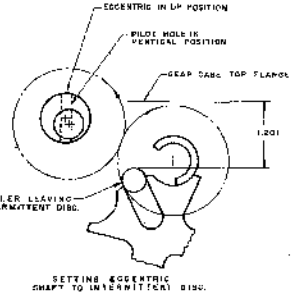
C-18-C-12 MAKE ON INDEX LINE  
TIME C-18 TO BREAK AS SHOWN AT A  
3 TEETH AFTER LINE

TIME C-14 TO BREAK AS SHOWN AT B  
3 TEETH AFTER LINE

T-12 DIFFERENCE IN TIMING BETWEEN  
C-18-C-14 IS DISTANCE BETWEEN  
A & B ON THE INDEX GEAR OR THE  
WIDTH OF THE TOP OF THE TOOTH



TIMING OF FEED ROLL OFF-NEW DEVICE



SET MAGAZINE 11 1/2 TEETH AFTER P.U.  
BACK ROLL SPRING BEING AGAINST GEAR  
MAGNETS IN JUNGLE AND TOOTH ON GUY  
SERVING. TURN MAGAZINE OVER BY HAND AND  
WITH A RELEASED GUIDE GEAR FEED ROLL  
TO BE SURE THEY DO NOT STICK TO OPEN  
BEFORE ONE TOOTH AFTER TOOTH. THEY  
THEY ARE EVEN & LEAST 0.5 AT 2 TOOTH  
SPREAD & ASK THAT THEY ARE FULLY  
CLOSED BY 6 TEETH AFTER 1.

101

184301	184302	184303	184304	184305	184306	184307	184308	184309	184310
184311	184312	184313	184314	184315	184316	184317	184318	184319	184320
184321	184322	184323	184324	184325	184326	184327	184328	184329	184330
184331	184332	184333	184334	184335	184336	184337	184338	184339	184340
184341	184342	184343	184344	184345	184346	184347	184348	184349	184350





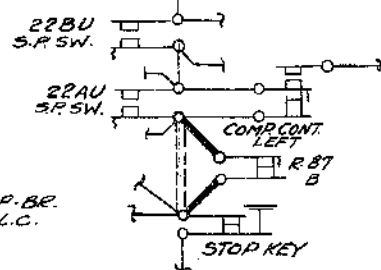
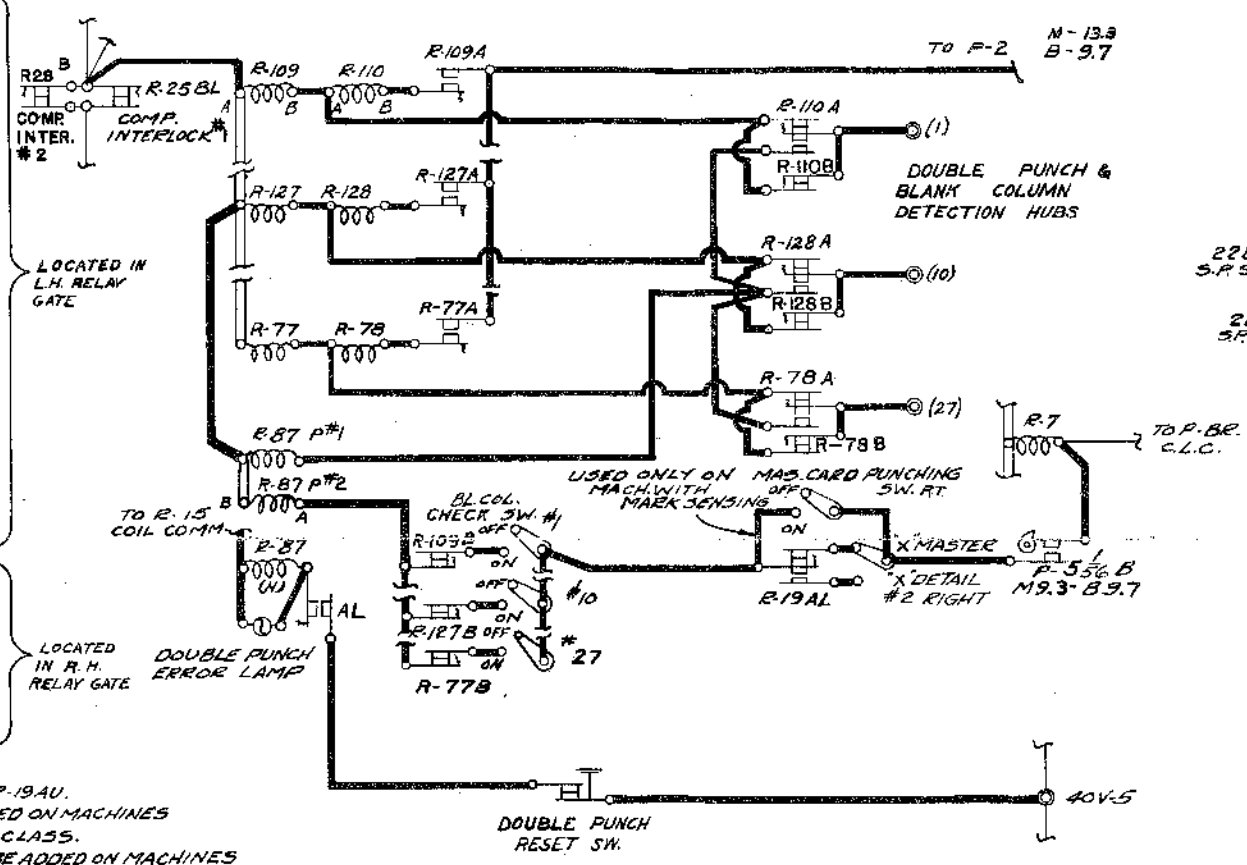


USED ON ASSEM. 170343 184471-F

**MASTER**

DATE	CHANGED BY
1-7-41	3050-A
2-5-41	3050-C
3-17-41	3411-A
3-24-42	3632
3-13-46	8144
4-22-46	8569
8-27-46	9136

POS.	RELAY
1	109 - 110
2	111 - 112
3	113 - 114
4	115 - 116
5	117 - 118
6	119 - 120
7	121 - 122
8	123 - 124
9	125 - 126
10	127 - 128
11	131 - 132
12	133 - 134
13	135 - 136
14	137 - 138
15	139 - 140
16	141 - 142
17	143 - 144
18	145 - 146
19	147 - 148
20	149 - 150
21	65 - 66
22	67 - 68
23	69 - 70
24	71 - 72
25	73 - 74
26	75 - 76
27	77 - 78



CHANGE R-19A TO R-19AU.  
 R-16 MUST BE ADDED ON MACHINES WITHOUT COMP. OR CLASS.  
 R-19 & R-25 MUST BE ADDED ON MACHINES WITHOUT COMP.  
 CHANGE P.B. #14 TO #156 TIMED TO MAKE 13.3 & BREAK 9.7  
 MACHINE MUST BE EQUIPPED WITH PUNCH MAG. RELAYS AS SHOWN ON WIRING DIAGRAM FOR 513

LIGHT LINES = STANDARD WIRING  
 HEAVY LINES = ADDED WIRING  
 DOUBLE DOTTED = STD. WIRING REMOVED

TOLERANCE ON FRACTIONS ±		UNLESS OTHERWISE NOTED	
SPECIFICATIONS		MFG. ENG. ANALYSIS	
FINISH		DATE	
HEAT TREAT	SPEC. NO.	TECH. RESEARCH	
MATERIAL	SPEC. NO.	DATE	
STOCK			
SIZE			
		INTERNATIONAL BUSINESS MACHINES CORP.	
		MACH.	SUM PUNCHING REPRODUCER
		NAME	WIRING DIAGRAM
		MODEL	513
		SCALE	
		DRAW.	HAG 32641
		CHECK	CHM 584
		TRAC	" " " "
		APPROV.	6004 3-12-41

184471-F



