

# Punched Card Data Processing Principles

## Section 3: The IBM Reproducer

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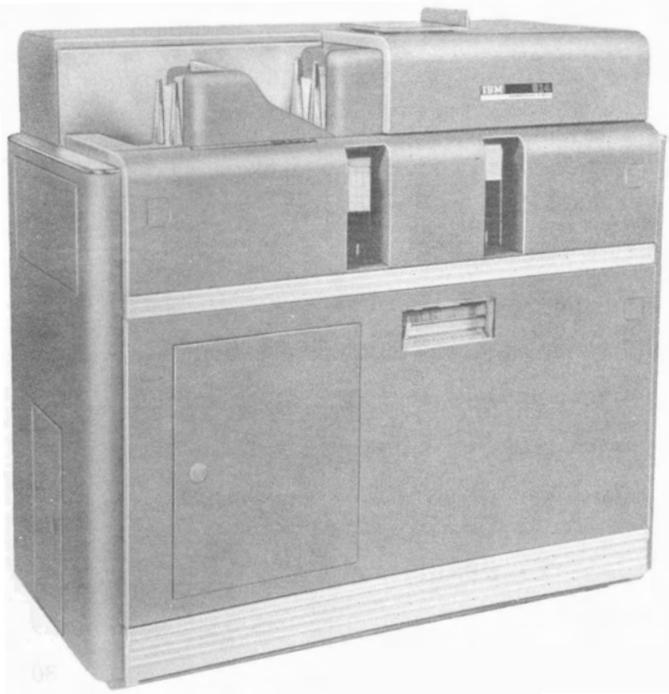
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# Contents

Introduction .....	1
Path of Cards in a Reproducing Operation.....	4
Path of Cards in a Gang-Punching Operation.....	7
Comparing .....	10
Setting Up the Reproducing Punch.....	13
The Control Panel .....	13
Wiring the Control Panel for Reproducing .....	13
Control Panel Wiring for Comparing .....	18
Wiring the Control Panel for Gang Punching.....	18
Combined Reproducing, Comparing and Gang Punching.....	18
Other Gang-Punching Operations .....	21
Punch Suppression and the PX Brushes.....	21
Comparing Cards from an Interspersed Gang-Punching Operation .....	27
Offset Interspersed Gang Punching .....	27
Selection .....	29
Comparing Offset Interspersed Master Card Gang Punching.....	30
Other Reproducing and Gang-Punching Considerations.....	34
Mark Sensing .....	37
End Printing .....	37
The Reproducer and Some Applications.....	38



*IBM 514 Reproducing Punch*

# Section 3: The IBM Reproducer

## Introduction

Maximum efficiency in IBM punched card accounting is achieved by recording source data only once. When information is recorded in the form of holes in a card, an IBM machine can reproduce some or all of the information into another card. For example, if a company is to participate in a fund-raising campaign, it may choose to prepare deduction authorization cards for each employee (Figure 1).

Some of the information required in the deduction authorization card is available from the employee's accumulated earnings card (Figure 2).

By using an IBM 514 Reproducing Punch, the required information can be reproduced into the deduction authorization card from the accumulated earnings card (see Figure 3) at the rate of 100 cards per minute.

Another example of punching information into cards from a source which already contains some of the required information is shown in Figure 4. Notice, too, that there is a field of information in the attendance card not available from the accumulated earnings card: the week-ending field in columns 14-18. This is certainly repetitive information. This data could be entered into the card by use of the automatic column-by-column duplication feature of the card punch at the end of the week, when hours worked is punched. However, the week-ending date has to be in the card during the work week as a safeguard against erroneous time recording. Since this date is not available from the accumulated earnings card, it must come from another source if it is to be punched into the attendance cards. This type of reproducing operation is accomplished by a technique called *gang punching* (see Figure 5).

As can be seen from Figure 5, gang punching on an IBM reproducer is similar in principle to duplicating on the IBM punches.

J F CORNSORS		02736	812
EMPLOYEE NAME		SERIAL NO.	DEPT. NO.

As my share and in consideration of the gifts of others, I pledge to the solicitation of any city Community Chest:

**UNITED RED FEATHER CAMPAIGN FOR 1961**

SUBSCRIPTION PERIOD: 25 22

CASH NOW: [ ]

BALANCE DUE: 25 22

I authorize the Company to Deduct: 1.00 each (week) biweekly for 26 (week) biweekly

PAYDAY PAYMENT PLAN

SIGNATURE: John F. Cornsors

TO THE SOLICITATION OF THE ANYCITY COMMUNITY CHEST

**UNITED RED FEATHER CAMPAIGN FOR 1961**

GIVEN GLADLY

SOLICITOR: W. O. Daugh

DATE: 10/17/61

Figure 1. Soliciting funds for a community drive can be effectively executed by using punched cards. A deduction authorization card is prepared for each employee and then submitted to him. The employee writes the requested information on the face of the card. Card punch operators then punch the written information into the card. The cards are then processed for payroll deduction purposes.

J F CORNSORS		048174709		FIT		FICA		YTD GROSS		81202736	
NAME		SOCIAL SECURITY NO.		INCOME TAX		ACUMULATIVE EARNINGS		ACUMULATIVE TAXES YTD		DEPT. SERIAL NO.	
EMP. NO.	SOCIAL SECURITY NO.	DEPT.	SERIAL	TAXABLE QTR TO DATE	GROSS QTR TO DATE	F. I. C. A.	INS.	F. I. T.	STATE INCOME TAX		
0000	00000000	0000	0000	00000000	00000000	0000	0000	0000	0000	0000	0000
1111	11111111	1111	1111	11111111	11111111	1111	1111	1111	1111	1111	1111
2222	22222222	2222	2222	22222222	22222222	2222	2222	2222	2222	2222	2222
3333	33333333	3333	3333	33333333	33333333	3333	3333	3333	3333	3333	3333
4444	44444444	4444	4444	44444444	44444444	4444	4444	4444	4444	4444	4444
5555	55555555	5555	5555	55555555	55555555	5555	5555	5555	5555	5555	5555
6666	66666666	6666	6666	66666666	66666666	6666	6666	6666	6666	6666	6666
7777	77777777	7777	7777	77777777	77777777	7777	7777	7777	7777	7777	7777
8888	88888888	8888	8888	88888888	88888888	8888	8888	8888	8888	8888	8888
9999	99999999	9999	9999	99999999	99999999	9999	9999	9999	9999	9999	9999

The initial information required in the deduction authorization card is available from the accumulated earnings card. This is

DEPARTMENT NO., SERIAL NO., and EMPLOYEE NAME

Figure 2.

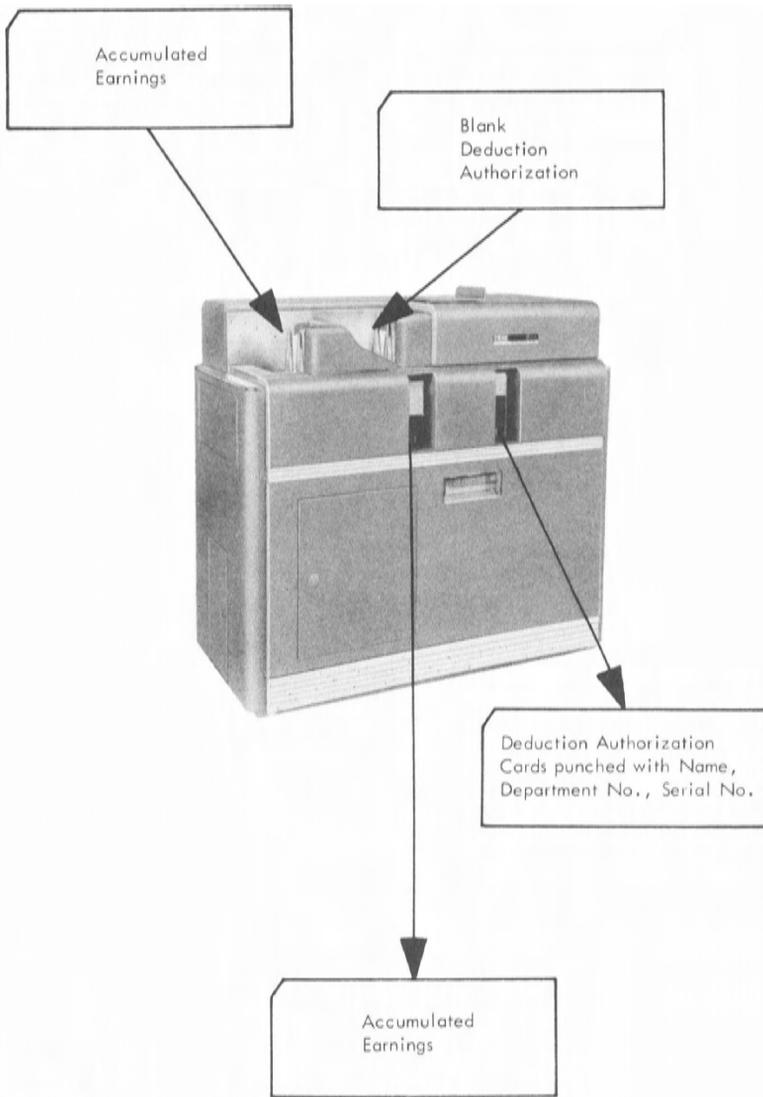


Figure 3.

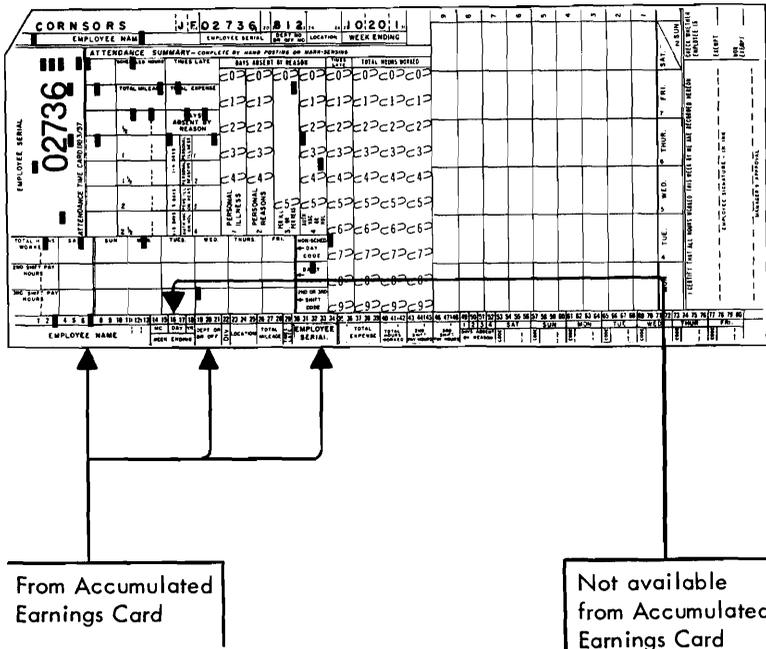


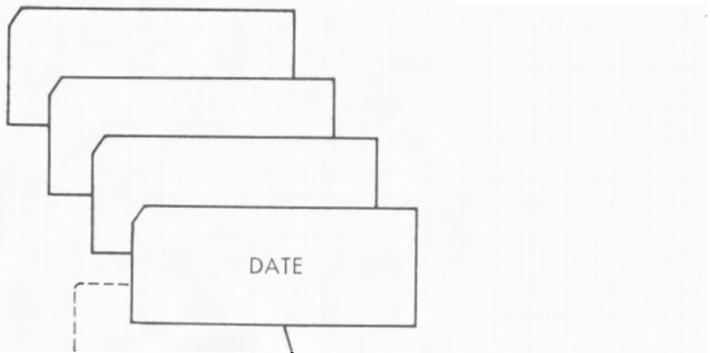
Figure 4.

## Path of Cards in a Reproducing Operation

Figures 6 and 7 are schematics of the paths cards follow in going from hopper to stacker in the IBM 514. Reproducing the required information from the accumulated earnings card into the attendance card is accomplished as follows:

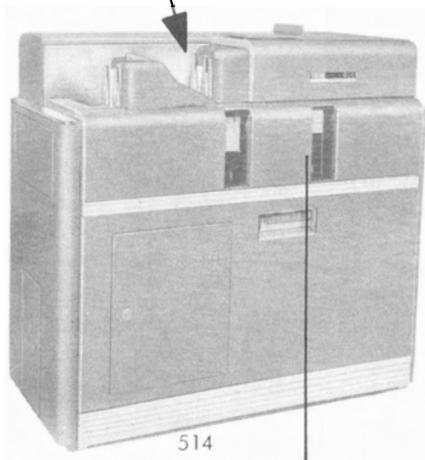
1. The accumulated earnings cards are placed in the feed hopper of the reading unit, the unpunched (blank) attendance cards are placed in the feed hopper of the punching unit.
2. The cards in both hoppers are automatically fed in synchronism after certain switches are set and the start button depressed.
3. As an accumulated earnings card passes the first set of 80 reading brushes (one brush for each card column), a blank attendance card passes the 80 punching dies (one punch die for each card column). Although each reproducing brush provides an impulse when it detects a hole, only those brushes which provide impulses from the required columns are chosen for use.

The punch dies which correspond to the columns of each blank attendance card into which the required information is reproduced are chosen to receive the impulse from the proper reproducing brush.



(1) Card 1 is the source of the required information.

(2) As these cards pass through the IBM 514, the required information is ganged back (duplicated) from each card to the one following.



514  
REPRODUCING  
PUNCH

(3) At the completion of the gang-punch operation, all the cards contain what was punched in the original card.

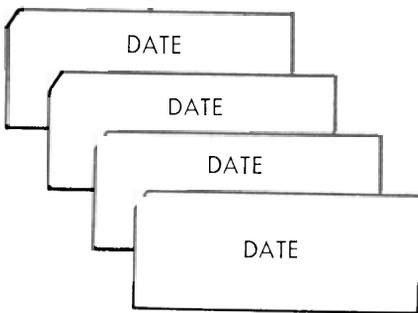


Figure 5.

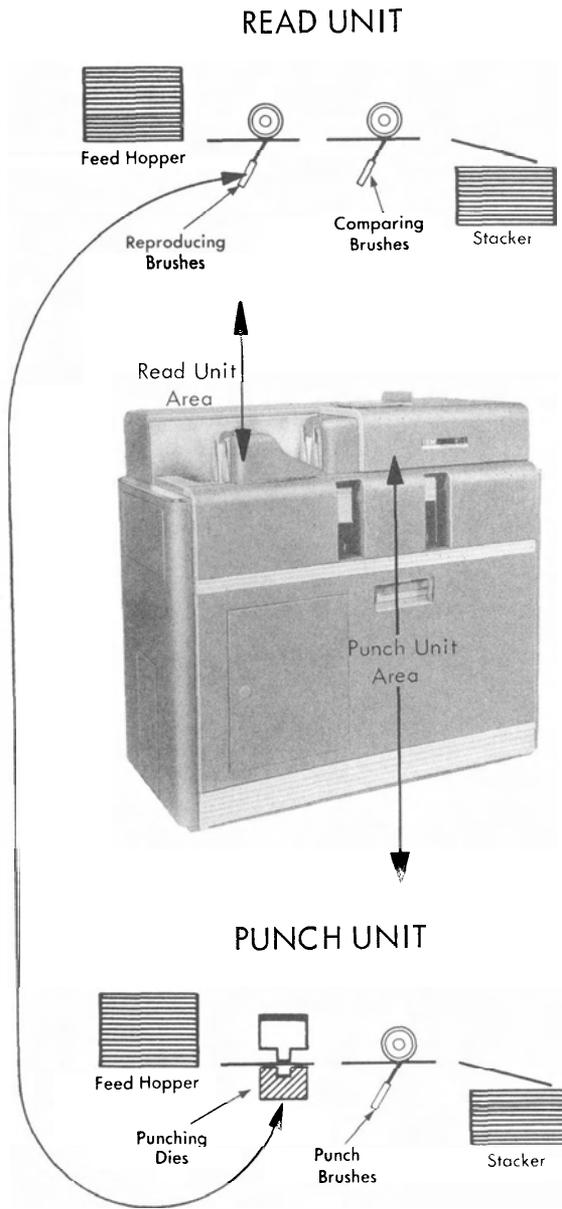


Figure 6. Cards proceed through the IBM 514 row by row, just as through the IBM sorters. However, they are normally fed 12 edge first.

4. After the accumulated earnings card has been read by the reproducing brushes, it is read by a set of brushes (comparing), and enters the read stacker. After the attendance card has been punched by the punch dies, it too is read by a set of brushes (punch), and enters the punch stacker.

1. *What are the names of the three sets of reading brushes? How many brushes are there in each set?*
2. *What is meant when the cards are said to be “fed in synchronism”?\**
3. *Which reproducing brushes read the columns of the accumulated earnings card that contain the name, department number and serial number?\**
4. *Which punch dies punch the holes in the columns of the attendance card that are to contain the name, department number and serial number?\**

## Path of Cards in a Gang-Punching Operation

Figure 8 is a schematic of the path cards follow in going from hopper to stacker. Notice that there are no cards in the read unit hopper. Gang punching the required information into the attendance card is accomplished as follows:

1. The attendance cards are placed in the feed hopper of the punch unit. Only the first attendance card is punched with the week-ending date.

2. The cards are automatically fed after certain switches are set and the start button depressed.

3. As one attendance card passes the punch brushes, another passes the punch dies. The brushes which read the punched date field provide the impulses which actuate the dies to produce holes in the required columns. As the card at the punch brushes moves on to the stacker, it is replaced by the card just punched, which, in turn, is replaced by a blank card from the hopper.

5. *What is a simple procedure for verifying that all the cards in the gang-punching operation have been properly punched?\**

\*Review questions have been interspersed throughout the text. If, as in this case, the question is marked with an asterisk, the answer is supplied at the end of the book. If the question is not marked with an asterisk, the answer can be found in the text preceding the question. When the book is completed, answer all questions again—this time without using the book. Then compare your answers with those in the book.

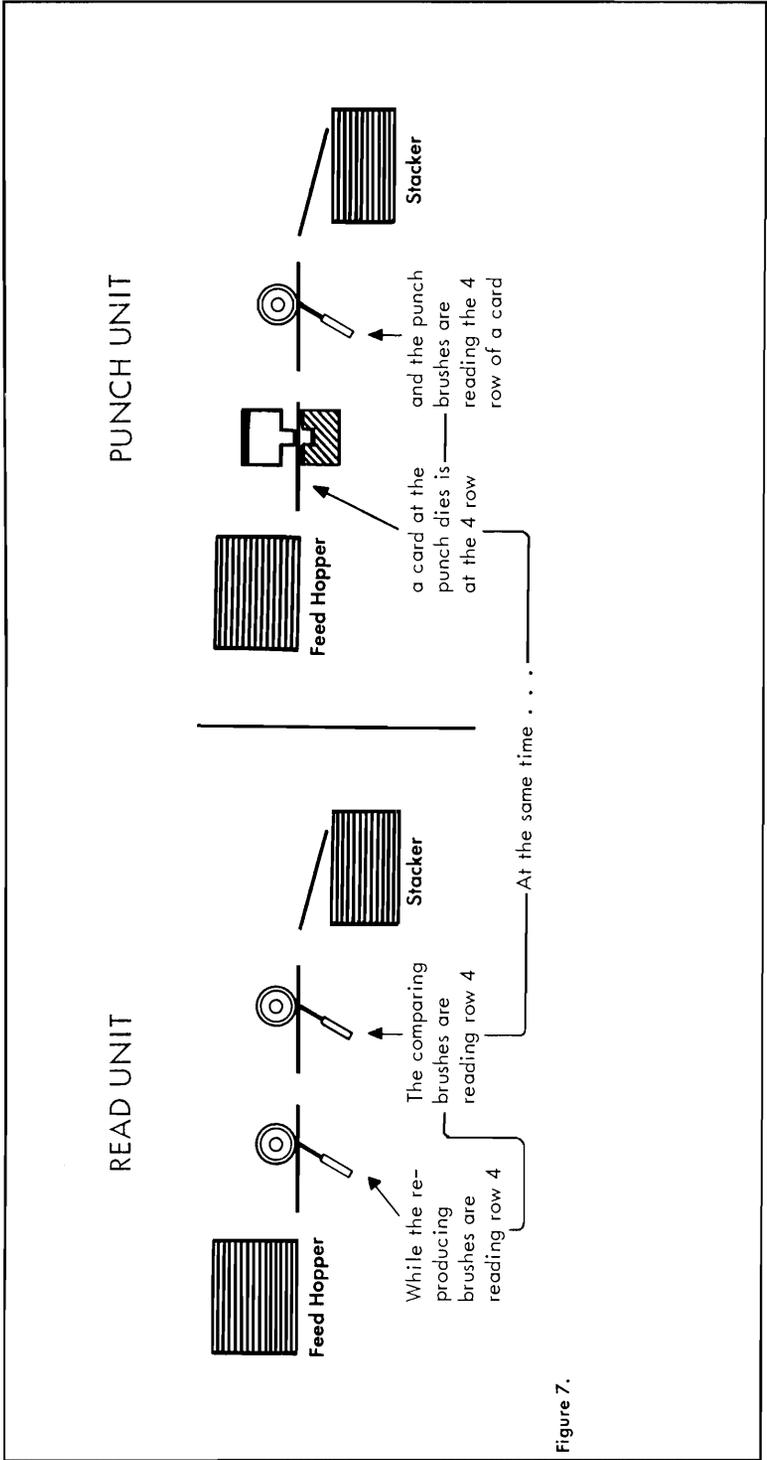
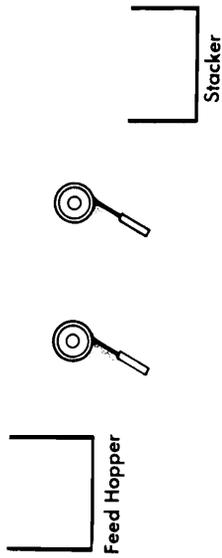


Figure 7.

READ UNIT



PUNCH UNIT

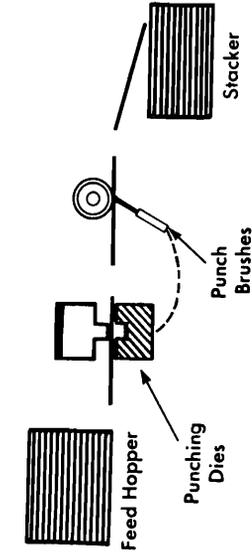


Figure 8.

## Comparing

The answer to question 5 explains a simple visual verification procedure for gang-punched cards. There are a number of other operations, however, that do not lend themselves to visual verification. One of these is reproducing data from one set of cards into another set, as in the case of accumulated earnings cards and attendance cards. Not only would there have to be a card-for-card comparison but also an alignment of the fields, since the two cards use different columns for the same field.

The solution to the problem is realized by using the built-in comparing feature of the IBM 514 Reproducing Punch. This feature comprises up to 80 individual comparing devices, each of which can accept impulses from two different sources. If the impulses come from different rows, the individual comparing device can signal that an error has occurred.

Consider the example in Figure 9, which concerns information in column 1 of one card to be reproduced into column 1 of another card.

The error is detected by again reading column 1 of the card in the read unit and reading column 1 of the card in the punch unit which was just "reproduced." Row 4 of both cards is read simultaneously.

6. *In reading column 1, which brush, comparing or punch, provides an impulse while reading row 4? Which one does not?*

By connecting the column 1 comparing brush (which provides an impulse) to one side of one of the comparing devices, and the column 1 punch brush (which does not provide an impulse) to the other side of the comparing device, the comparing device becomes "unbalanced." The reproducer can be set up to stop when an unbalance occurs (see Figure 10).

7. *Suppose that through an oversight a card punched with an 8 in column 1 was inserted with the blank cards to be reproduced. The card to be reproduced has a 4 punch in column 1 and is successfully reproduced into the card with the 8 punch. Can the comparing device detect the error?\**

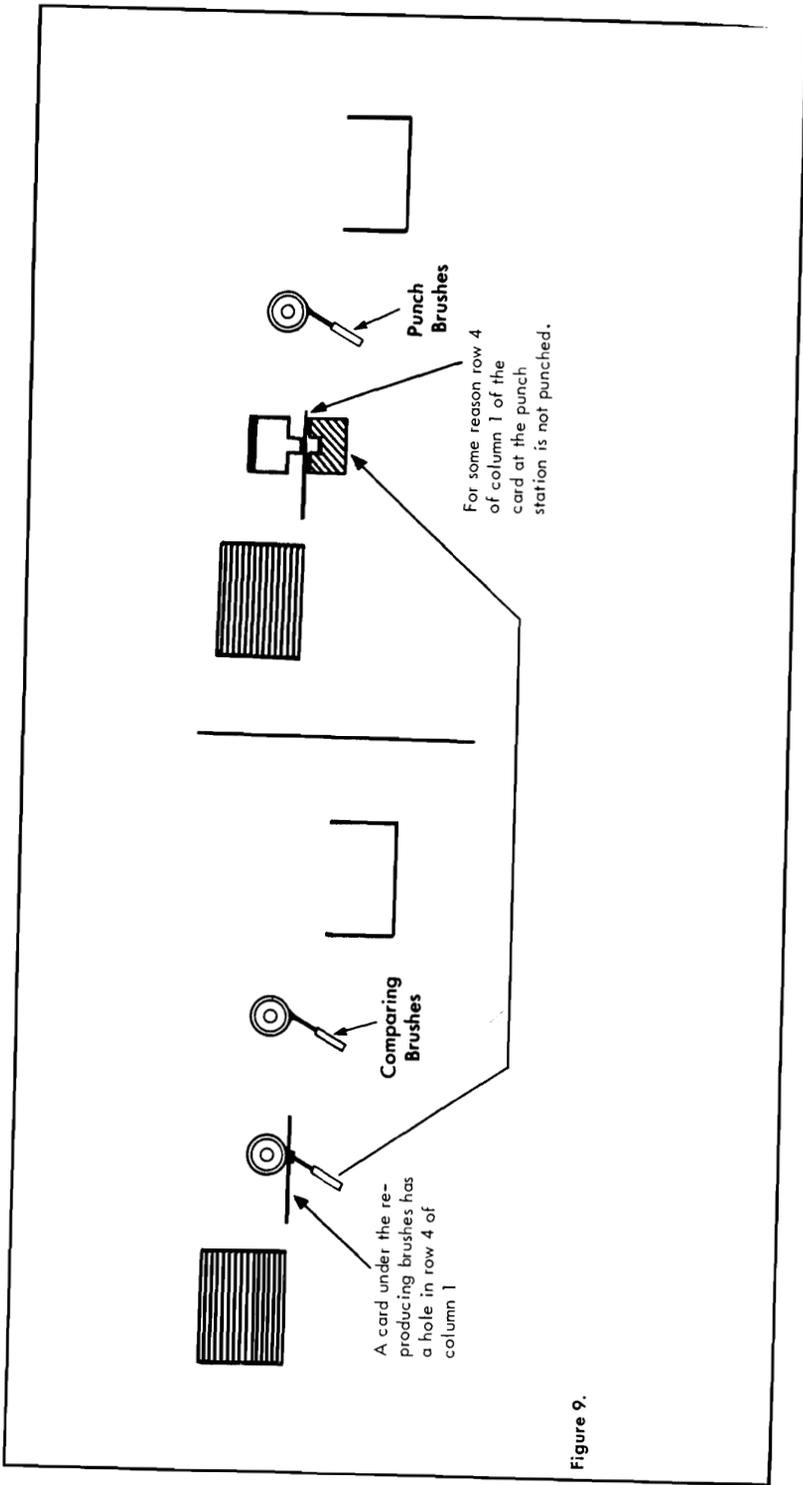
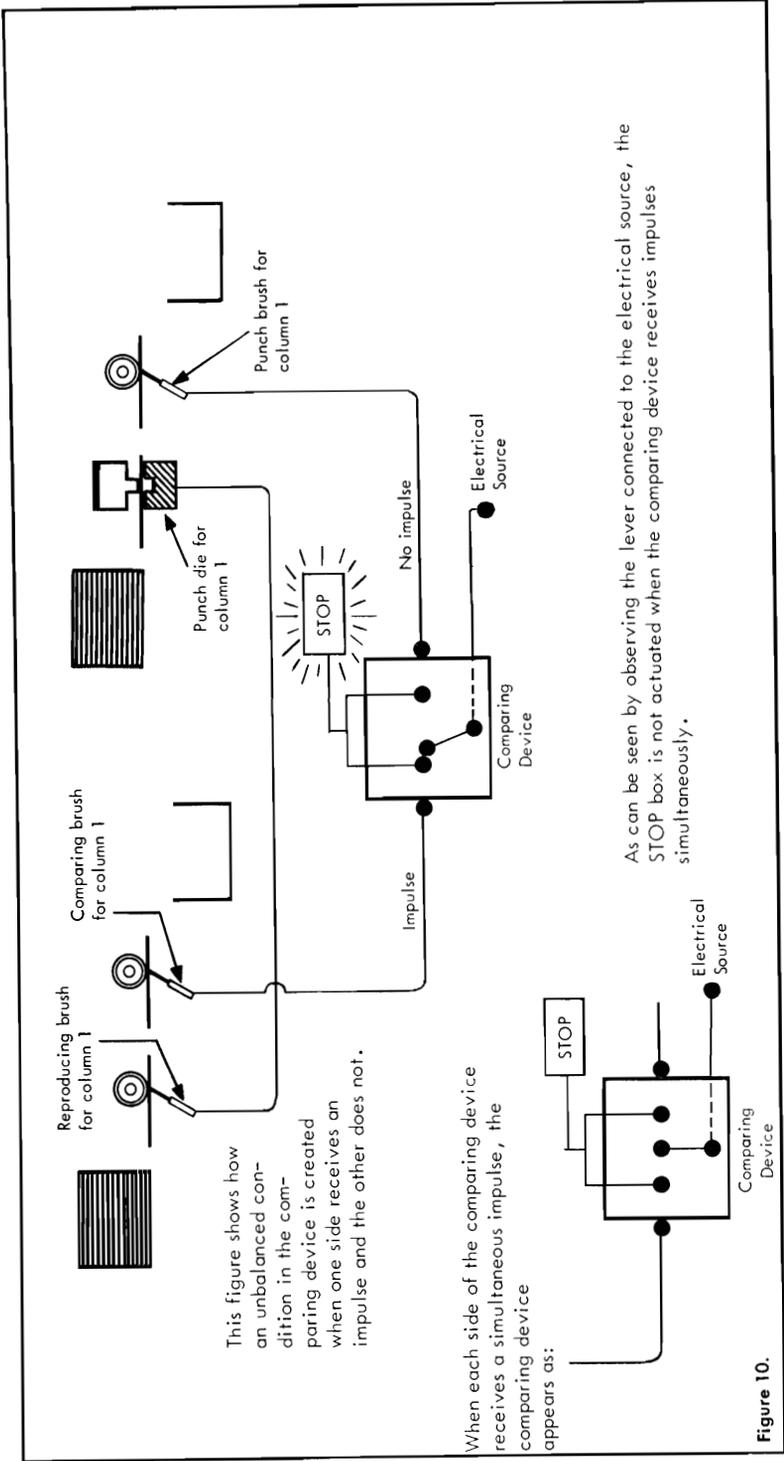


Figure 9.



## Setting Up the Reproducing Punch

The IBM 514 is designed to do any reproducing, comparing, or gang-punching job, regardless of which columns contain the originating information or into which columns the information is to be punched. In order to set up the reproducing punch to do a specific job, then, a device is needed for easily choosing the columns in question. This device is called a *control panel*.

### The Control Panel

Automatic operation of the reproducing punch is achieved by wiring the control panel and setting certain switches. A control panel *diagram* is shown in Figure 11. A wire inserted into a control panel hub touches a contact on the back of the control panel. When the control panel is inserted into the reproducing punch, each contact on the back of the control panel touches a corresponding contact on the machine itself. This, in turn, is connected to an internal device such as a reproducing brush, punch die (hereafter referred to as a punch magnet), etc. The relationship of all these contacts, hubs on the control panel, and wires is schematically illustrated in Figure 12.

### Wiring the Control Panel for Reproducing

Figure 4 shows an attendance card into which employee name, department number and employee number are to be punched from an accumulated earnings card as shown in Figure 2. Figure 13 shows the required wiring to perform the desired reproducing operation.

8. *Prepare a wiring diagram (from supplies packet) to reproduce name, department number and employee serial number into deduction authorization cards (Figure 1) from the attendance cards just reproduced. The field columns in the deduction authorization card are department number 2-4, serial number 5-9, first initial 10, second initial 11, and last name 12-22.\**

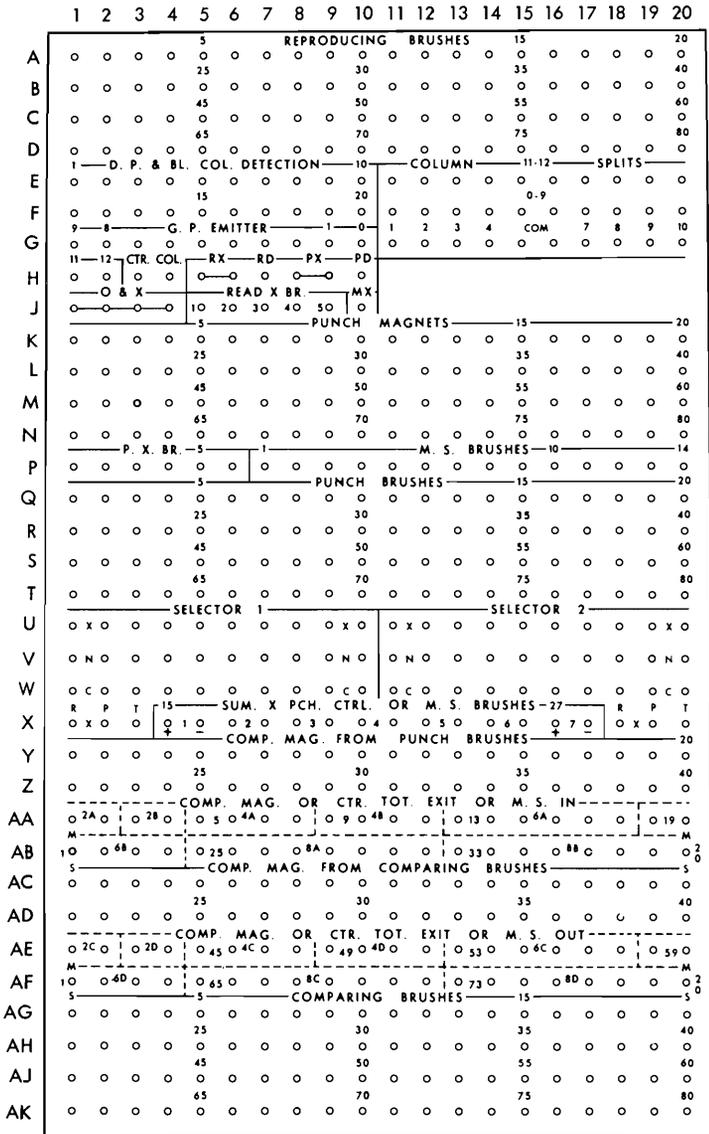


Figure 11. The control panel consists primarily of holes called hubs (680 of them). To assist in locating hubs, the control panel in this figure is divided into numbered columns (1-20) and numbered rows (A-AK). For example, the location of the comparing brushes hub is given by (AG-AK, 1-20).

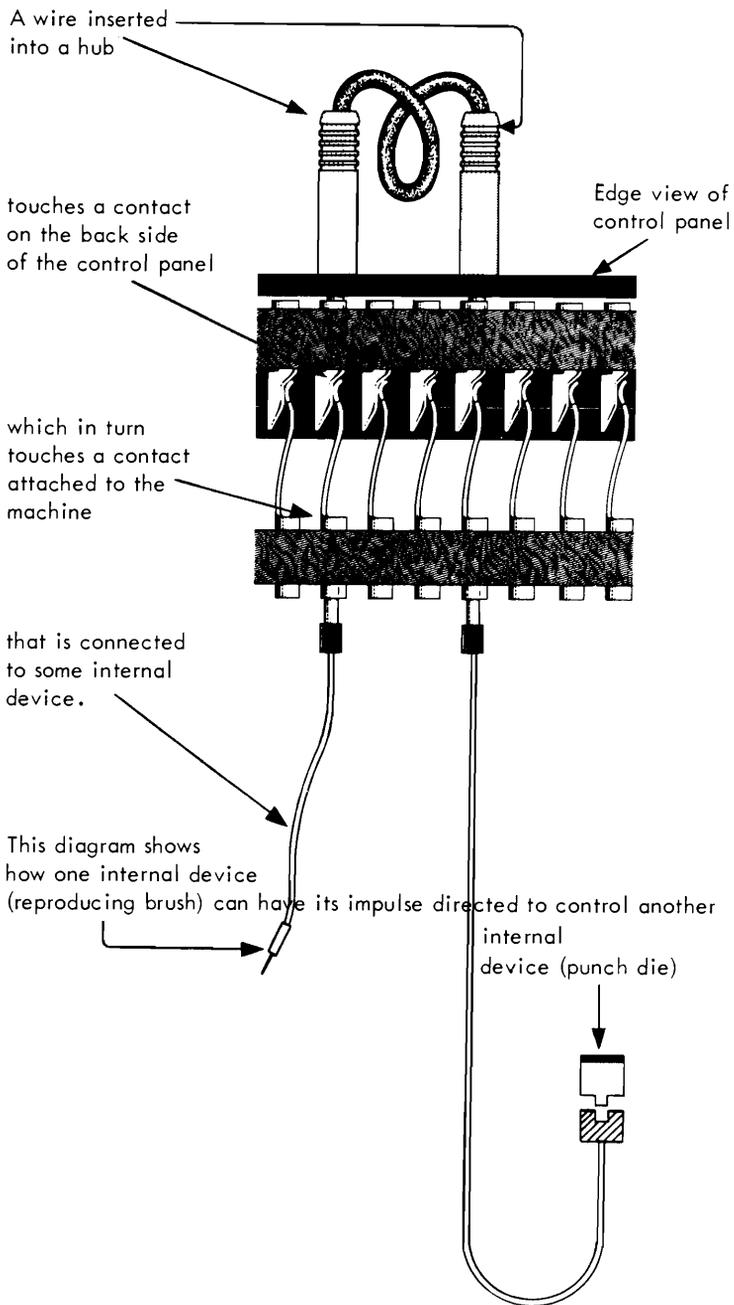


Figure 12.

Part A indicates the control panel wiring necessary to accomplish the job of reproducing name, department and serial number, as previously stated. As can be seen from the diagram below, wiring diagrams would become unintelligible for jobs involving many columns.

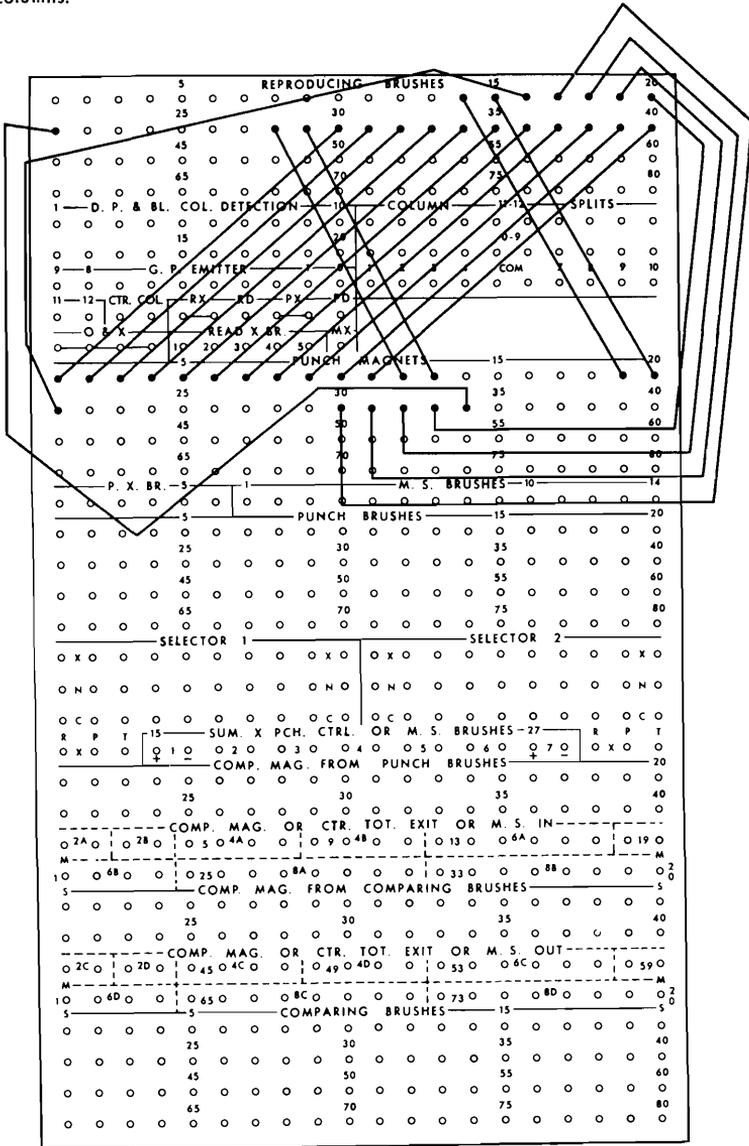


Figure 13, Part A.

Part B. For this reason, a wiring diagram is drawn compactly, as shown below. Each field of information is indicated by drawing a solid line through the corresponding hubs. If a field extends into another control panel row, it is indicated by a hooked line.

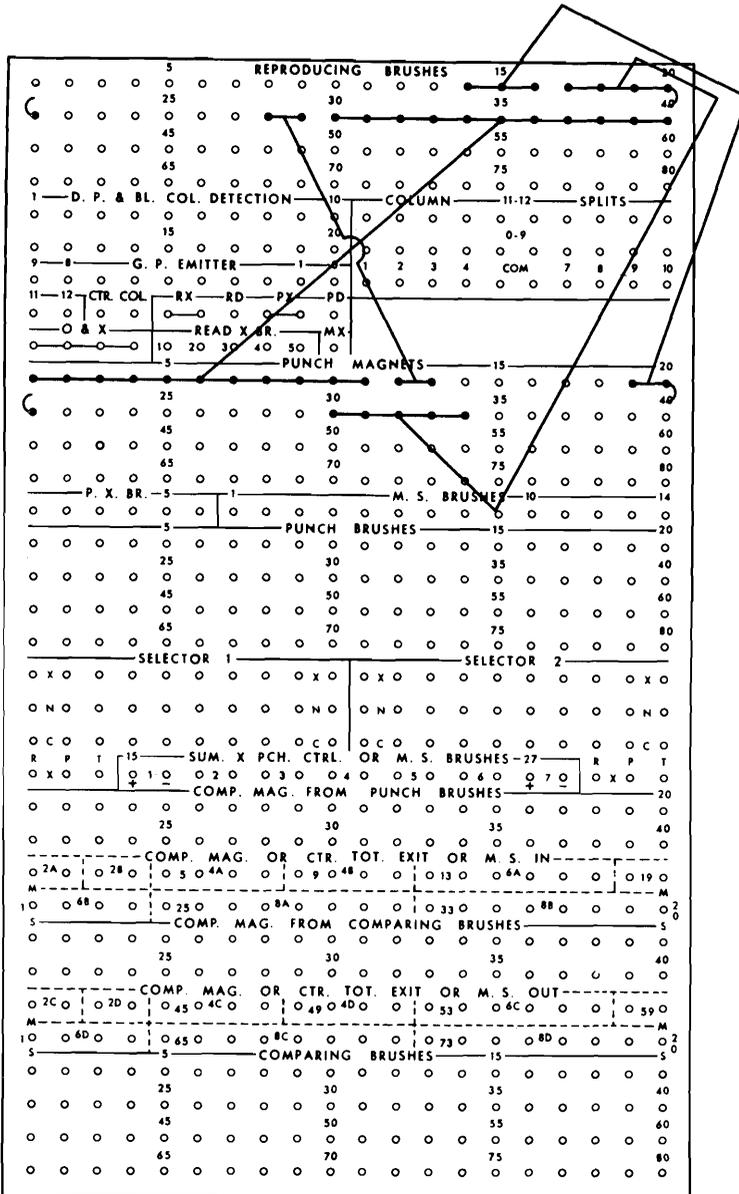


Figure 13. Part B.

## Control Panel Wiring for Comparing

Figure 10 indicates that after the card in the read unit passes the reproducing brushes it is read by the comparing brushes. Likewise, after the card into which information is being reproduced passes the punch magnets, it is read by the punch brushes. By setting up a comparing device to receive impulses from the columns to be compared, the IBM 514 can be caused to stop when a discrepancy exists. An indicator on the front of the IBM 514 indicates the number of the comparing magnet which detected the discrepant columns. Since a comparing device must receive impulses from two sources, each comparing device (hereafter referred to as “comparing magnet”) has two control panel hubs. The comparing magnet hubs are located at Y-AB, 1-20 and AC-AF, 1-20. The hubs for the last 40 comparing magnets (AA-AB and AE-AF) serve other purposes also, which are discussed later.

The control panel wiring required to compare the accumulated earnings card columns (*from* which the information was reproduced) with the attendance card columns (*into* which the information was punched) is shown in Figure 14.

9. *Complete the wiring diagram which you used for question 8. That is, diagram the wiring for comparing the required columns of the attendance cards with the columns punched into the deduction authorization cards.\**

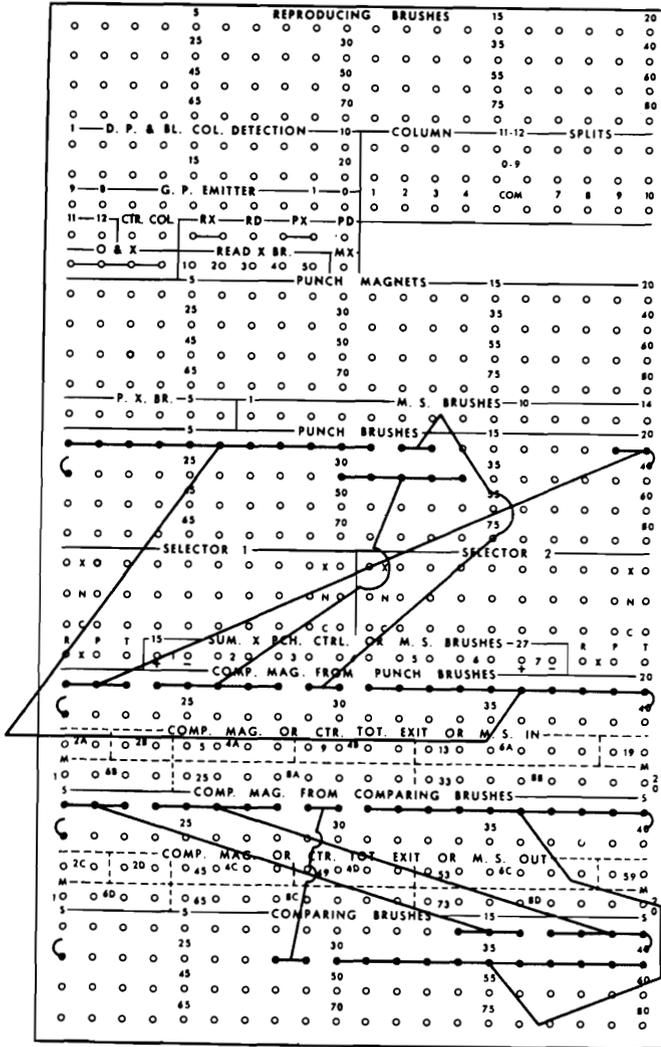
## Wiring the Control Panel for Gang Punching

The operation schematically illustrated in Figure 5 shows the simplest form of gang punching. By placing one card already punched with the necessary information in the required columns ahead of the blank cards, the information is read by the punch brushes and gang-punched back into the blank card at the punch magnets. Thereafter, as each card just punched passes the punch magnets, the required columns are duplicated into the card which follows. The control panel wiring for gang-punching date into the attendance cards is shown in Figure 15.

## Combined Reproducing, Comparing and Gang Punching

To punch the required information into the attendance card shown in Figure 4 requires both a gang-punching operation and a reproducing operation (with comparing). Both of these operations are often done simultaneously to conserve time.

Note: The wiring from the reproducing brushes to the punch magnets has been excluded in this figure to highlight the wiring required for comparing. After you have studied the comparing wiring, complete the diagram by drawing the reproducing wiring in red pencil.



The punch brushes read the attendance card:

Dept.	19-21
Serial No.	30-34
Initials	12-13
Last Name	1-11

The comparing brushes read the accumulated earnings card:

Dept.	14-16
Serial No.	17-21
Initials	28-29
Last Name	30-40

Figure 14.

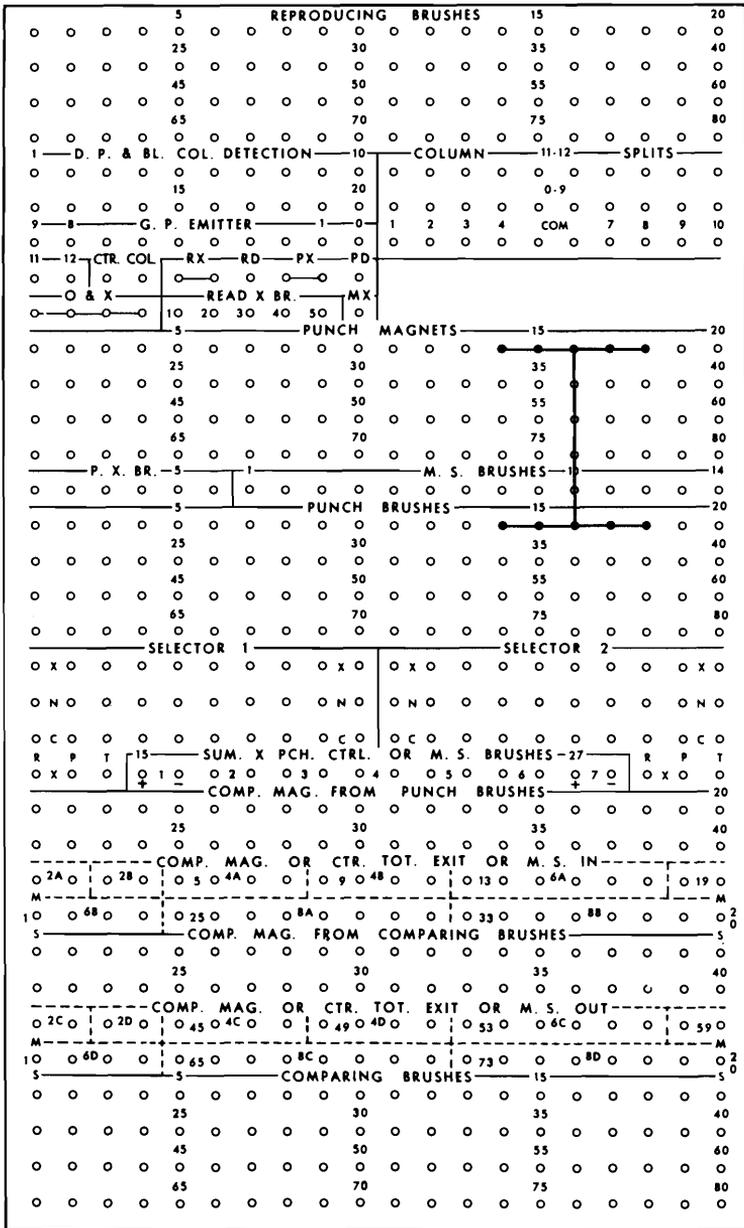


Figure 15. Gang-punching week-ending date into columns 14-18 of the attendance card.

10. *Add to the diagram which you used for question 8 the wiring required for gang-punching the date into columns 46-50 of the deduction authorization card.*

The two-step schematic in Figure 16 shows cards in both the read unit and the punch unit passing their respective stations for a combined gang-punching and reproducing with comparing operation. The first step shows how the master gang punch card passes the punch magnets as card 1 in the read unit passes the reproducing brushes. The second step shows how the cards continue in their respective paths.

## Other Gang-Punching Operations

The example in Figure 5 illustrating a gang-punching operation shows how constant information, originating from a master card placed at the beginning of a blank deck of cards, is duplicated from card to card. Another gang-punching operation involves interspersing master cards into the deck of blank cards. For example, a manufacturing company may require that each employee be provided with ten IBM cards a week, on the face of which he should write information pertaining to his job, such as order number, department number, quantity, work center or invoice number and actual hours worked (see Figure 17). In order to guarantee the employee that the cards he fills out will be properly credited to him, the ten cards he receives are already gang-punched with his clock number. To perform the gang-punching operation requires that there be ten blank cards behind each master card punched with a serial number.

The same considerations are involved in gang-punching the first ten blank cards as in the case of gang-punching the date into *all* of the attendance cards. Figure 18 shows what cards are at the punch magnets and punch brushes after the tenth card of the first serial number has been punched.

11. *According to Figure 18, what will happen to the new master serial number card as it passes under the punch magnets while the last gang-punched card of the previous group passes the punch brushes?\**

## Punch Suppression and the PX Brushes

The condition discussed in the answer to Question 11 can be easily eliminated by providing the IBM 514 with a device for detecting a certain characteristic of a card. The detection of this characteristic could then be used to control all 80 punch magnets for one card cycle. That is, it can be used to suspend punching for those cards which do have the

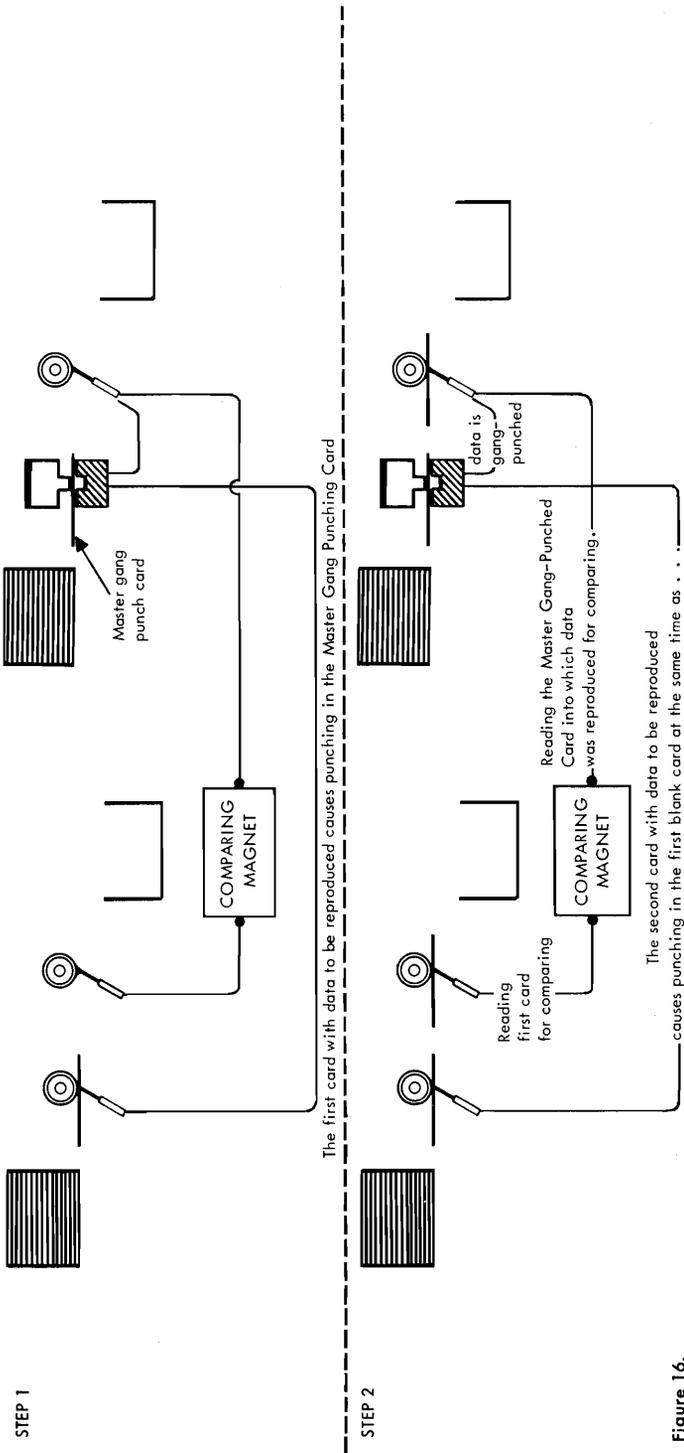
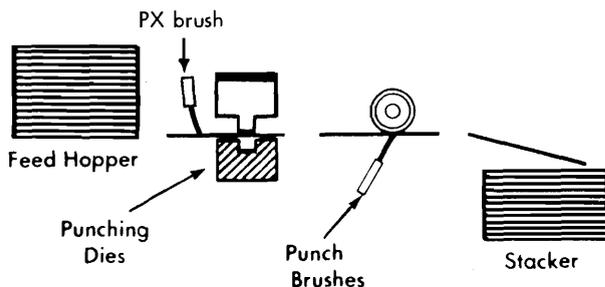


Figure 16.



## PUNCH UNIT



There are six punch X brushes in an IBM 514. Each is removable so that it can be manually inserted over the column which contains the X punch.

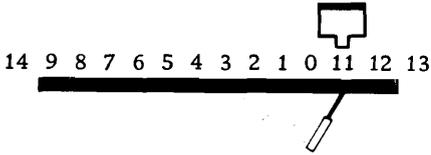
The distance between the punch magnet and the PX brush is equivalent to two rows in length.

Figure 19.

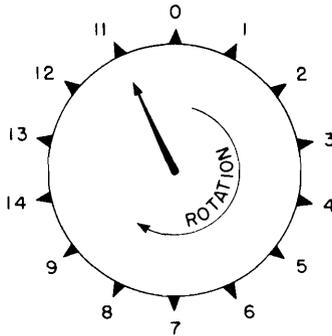
When a PX brush detects an X punch, an impulse is available from the hubs located at P, 1-6 of the control panel. The timing of this impulse is significant. Generally speaking, when a hole is detected by a brush in the 11th row, the impulse generated occurs at 11 time. Figure 20(A) shows a theoretical brush placed under the punch magnet reads an 11 punch at 11 time. *If a review of timing is required, refer to page 15 of Section 2, "The IBM Sorter."* Because of the IBM 514's design requirements, detecting an X punch at the PX brushes must generate an impulse that occurs at 13 time. The manner in which this is accomplished is schematically illustrated in Figure 20, part B.

The impulse from the chosen PX brush is connected to either one of the two joined hubs identified as PX and located at H,8-9. When the PX hub receives a 13-timed impulse from the master card, the punch magnets become ineffective for one cycle as the master card passes them.

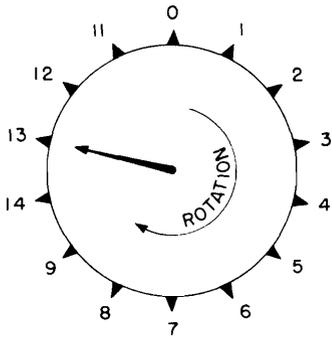
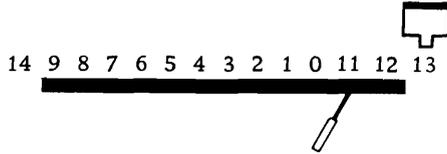
12. *What determines whether an impulse from the PX brush is to be used for suspending punching or allowing punching?\**
13. *Where in relation to the punch magnets are the PX brushes located?*
14. *How many PX brushes are there?*
15. *What is the timing of an impulse when a PX brush detects an X punch?*
16. *When cards with X punches are interspersed with cards without X punches, how are the X-less cards referred to?*



(A) In this illustration, reading the 11 row produces an 11-timed impulse when a hole is detected. This is because the timing clock is synchronized with the motion of the card — that is, the 11 row is read by the brushes at the same time that the timing clock indicates 11.



CLOCK SHOWING TIME



CLOCK SHOWING TIME

(B) If a brush is set back equivalent to two rows in length, it will read a hole two rows earlier than usual. Note where the hand of the clock is now when reading a hole in the 11 row.

Figure 20.

Figure 21 shows the control panel wiring necessary to gang-punch serial number into the blank cards from the master card. It also shows how punching is suspended when the master card is under the punch magnets.

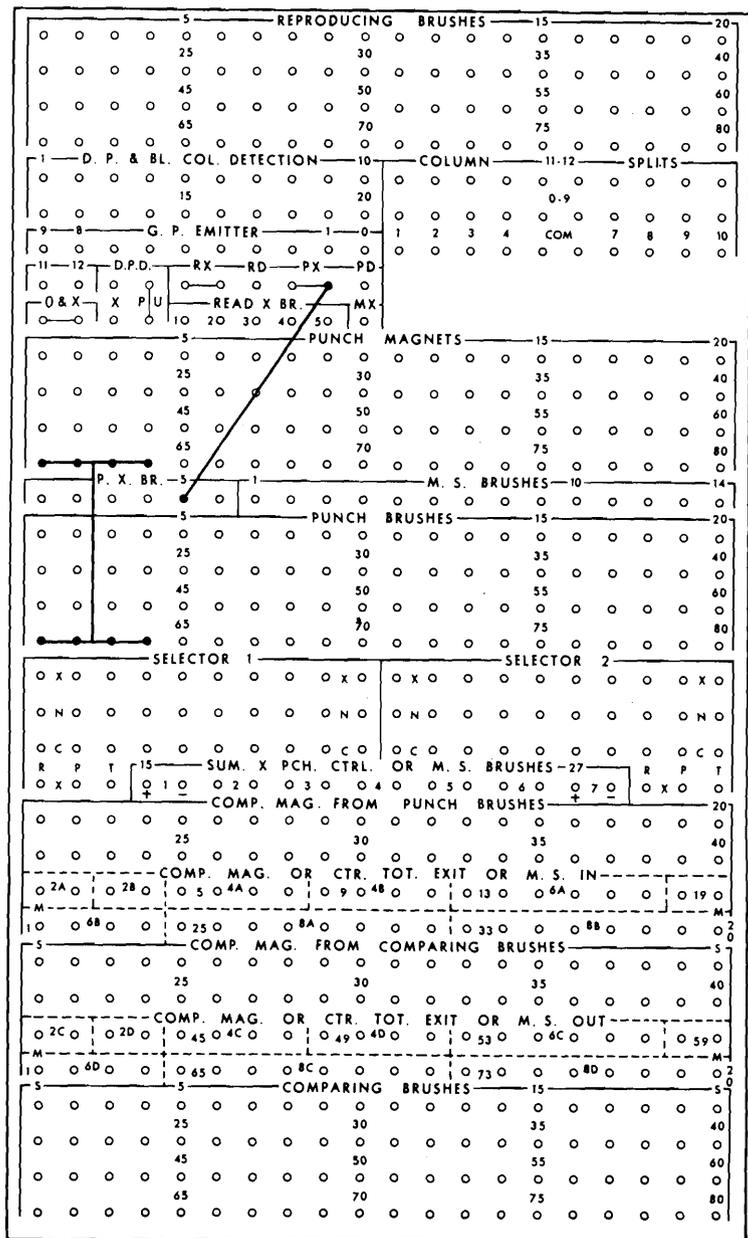


Figure 21. The master cards have an X punch in column 1. A PX (number 5) brush is positioned over column 1. When the PX hub receives a 13 timed impulse from the PX brush, punching is suspended for the next cycle, that is, when the master card passes under the punch magnets.

## Comparing Cards from an Interspersed Gang-Punching Operation

The simple technique for verifying the punching of data in the attendance card is not possible for the serial number operation. However, it is possible to utilize the same comparing magnets for the interspersed gang-punching operation as were used for the reproducing operation.

After a batch of cards (perhaps 150) are gang-punched, they are removed from the punch stacker and placed in the hopper of the read unit. (This allows concurrent gang-punching and comparing.) Impulses from the card at the comparing brushes are wired to one side of a comparing magnet. Impulses from the card at the reproducing brushes are wired to the other side of the comparing magnet (see Figure 22a). As can be seen from the diagram, if an unbalance occurs it will cause the IBM 514 to stop. Figure 22b shows a condition which causes the comparing magnet to become needlessly unbalanced, which results in an unnecessary stop. Therefore, it is required that when this type of master, gang-punched card condition exists, comparing should be suspended. The technique used to suspend comparing is based on the same principle employed in suspending punching. Figure 23 is a schematic showing the location of RX brushes. The 13-timed impulses they provide are available from J,5-9 on the control panel. When the RX brush hub impulses either of the joined RX hubs (H,5-6), comparing is suspended for the following cycle.

17. *Add to Figure 21 the wiring required to compare the punching of columns 61-64 of successive cards, and the wiring required to suspend comparing. Assume that RX brush 3 is positioned over column 1. (Use comparing magnets 61-64.)*

## Offset Interspersed Gang Punching

Occasionally a gang-punching operation involves master card data which is not in the same card columns as those in which it is to be gang-punched. For example, it may be required that each employee of a manufacturing concern be provided with *two* cards, punched in columns 1-10 with his last name. The accumulated earnings cards, with last name in columns 30-43 and an X punch in column 1, are used for the master card. Figure 24 represents schematically what columns are involved in this operation.

The only difference between offset interspersed gang punching and regular gang punching is that the 514 must *select* the origin of the impulses (either from punch brushes 30-39 or 1-10). Since there is no way of deactivating punch brushes, a device must be available into

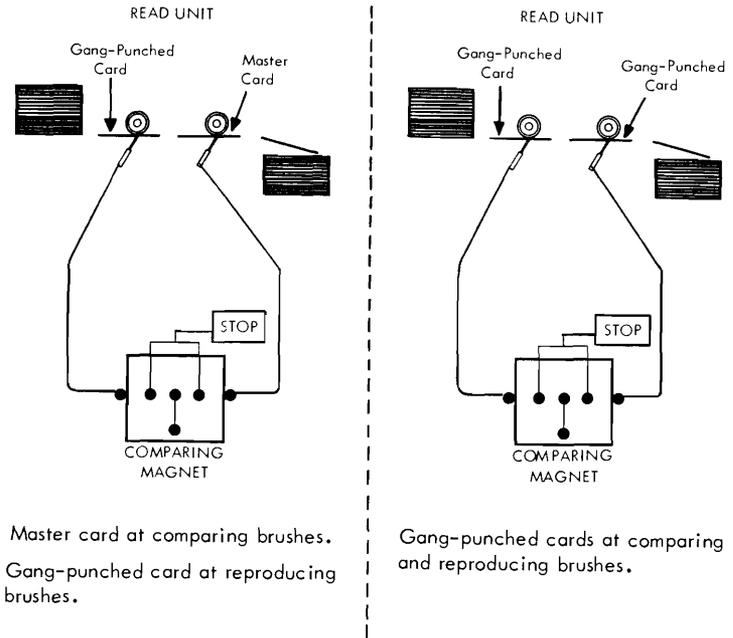


Figure 22a.

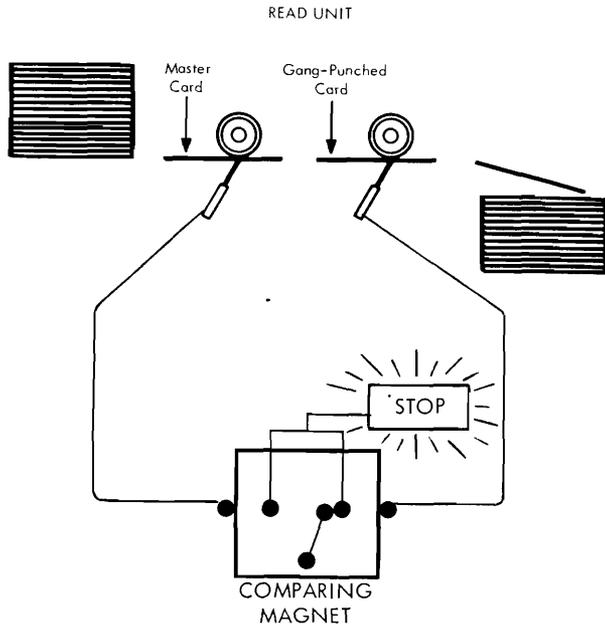


Figure 22b.

## READ UNIT

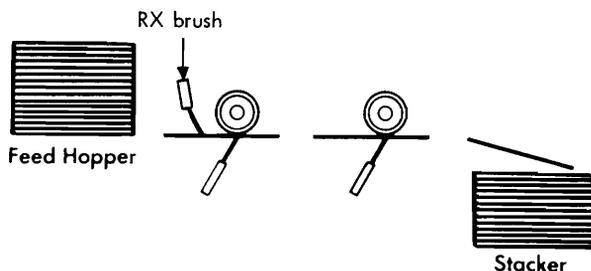


Figure 23.

which impulses from both sets of columns (30-39 and 1-10) are entered, but out of which come only the selected ones. Also, an X punch must be available in either the master card or blank card to control the device.

## Selection

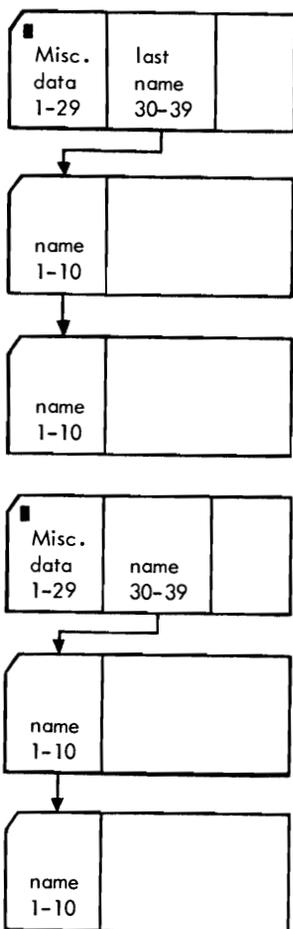
Figure 25 is a schematic of two impulses entering a device called a selector.

18. Wire a control panel diagram from the supplies packet. Connect punch brush hubs 1-10 to the N hubs of selector 1 (V,1-10). Connect the punch brush hubs 30-39 to the X hubs of the selector 1 (U,1-10). Connect the C hubs of selector 1 (W,1-10) to punch magnet hubs 1-10. Connect PX brush hub 2 (reading the X in column 1 of the accumulated earnings card) to the PX hub to suspend punching.

The 514 control panel is now set up so that when the wiring to control the selector is added, punch magnets 1-10 will receive impulses from either punch brushes 1-10 or 30-39.

Figure 25 shows the two possible states of a selector—namely, normal or transferred. Unless something attracts the armature, it will always remain down, or in the normal condition. Figure 26 schematically illustrates that by providing an impulse to the *pickup* of the selector, the armature is attracted and raised to the transferred position.

19. Add to the control panel diagram of question 18 the wiring to control the selector. Connect the PD hub (H,10) to the P pickup hub of selector 1 (X,2).



Notice that when an X1 master card is at the punch brushes, columns 30-39 supply the required data. When a NX1 card is at the punch brushes, columns 1-10 supply the data. Of course, punching must be suspended when a master card is under the punch magnets.

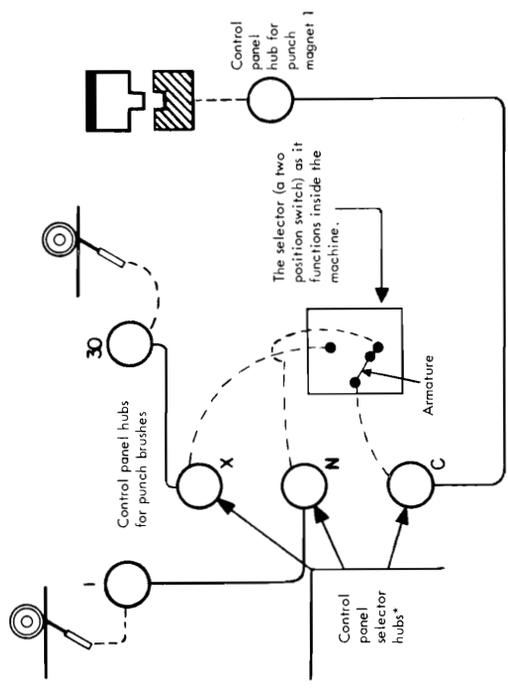
Figure 24.

## Comparing Offset Interspersed Master Card Gang Punching

Comparing offset gang-punched cards in the read unit can be done concurrently with the punching operation in the punch unit. The same factors must be considered in suspending comparing for offset gang punching as for regular gang punching. In addition, the *comparing brushes* that provide the comparing magnets with the impulses to be compared, must be selected. In the example, it is comparing brushes 1-10 for NX cards and comparing brushes 30-39 for X master cards that require selection.

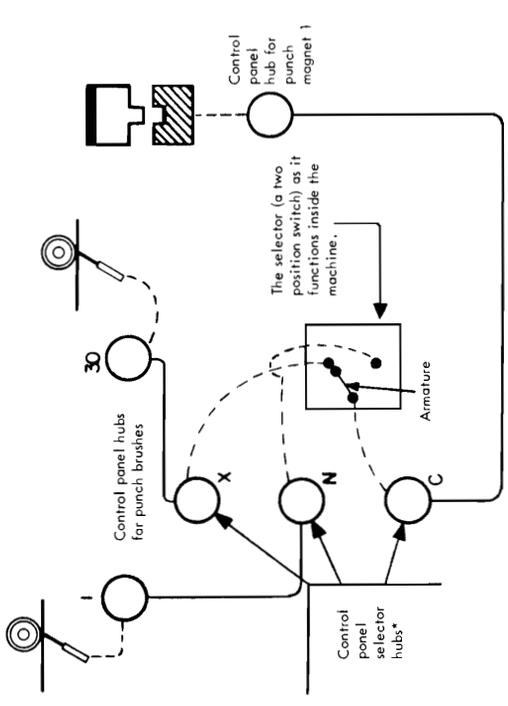
To impulse the comparing magnets from comparing brushes 30-39 of the X master card requires that comparing brush hubs 30-39 be

Control panel wiring is shown by the dark lines.



(A)

Internal machine circuitry is shown by dotted lines.



(B)

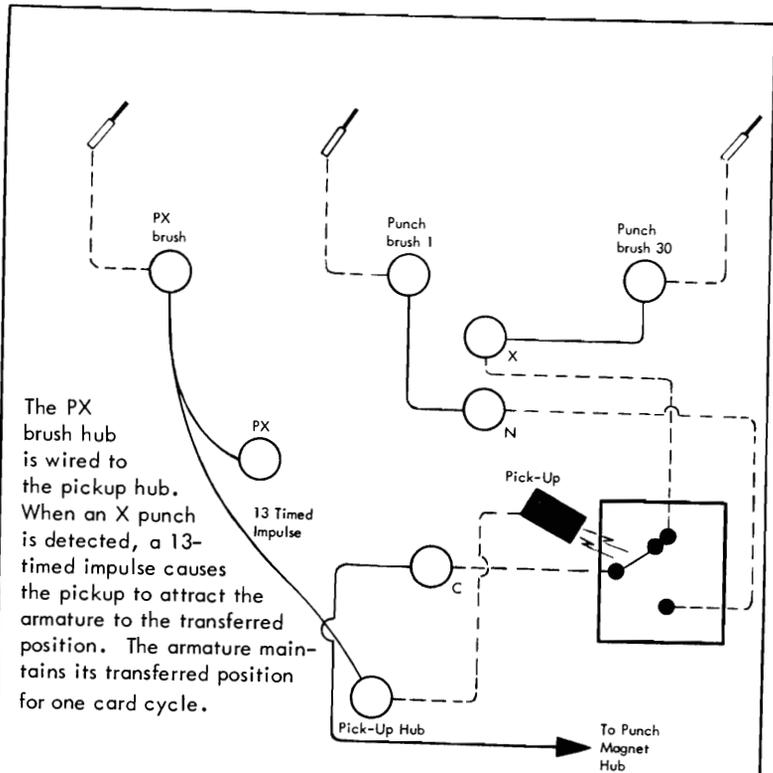
The same diagram except that this time the impulse from column 30 gets through and the one from column 1 does not.

\* X stands for transferred. That is, the selector is in transferred state when the armature is raised.

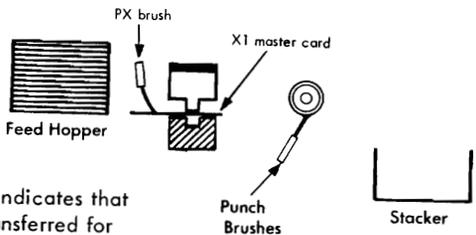
\* N stands for normal. That is, the selector is in its normal state when the armature is down.

\* C stands for common. That is, an exit common for either of the two entries.

Figure 25.



The PX brush hub is wired to the pickup hub. When an X punch is detected, a 13-timed impulse causes the pickup to attract the armature to the transferred position. The armature maintains its transferred position for one card cycle.



This part of the figure indicates that when the selector is transferred for one cycle as a result of being picked up directly from a PX brush, the X1 master card will be passing the punch magnets.

Figure 26. Part 1.

Thus it is two card cycles after the PX brush detects the X1 master card that the selector is transferred. To transfer the selector two cycles later rather than one cycle later requires that the impulse from the PX brush be "saved" for one cycle. This is accomplished by an "impulse delaying mechanism."

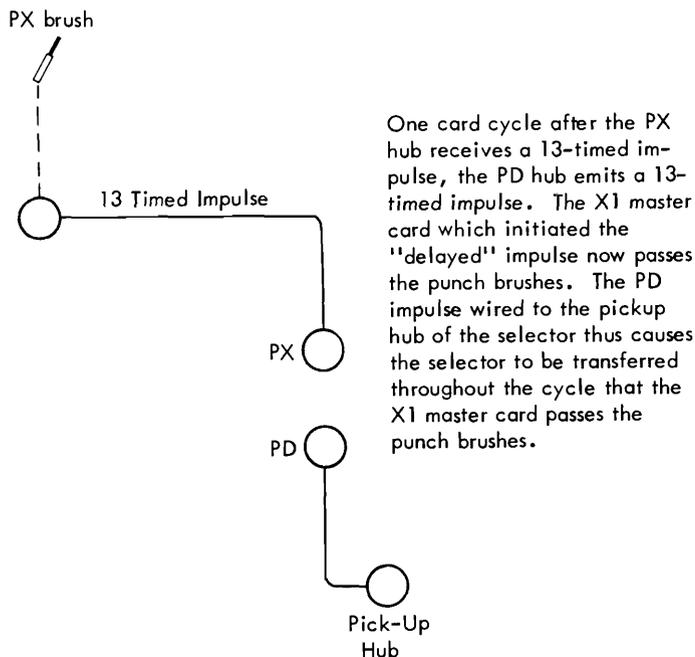


Figure 26. Part 2.

connected to the X hubs of selector 2 (U,11-20). To impulse the comparing magnets from comparing brushes 1-10 of the NX1 cards requires that comparing brush hubs 1-10 be connected to the N hubs of selector 2 (V,11-20). The comparing brush wiring is completed by connecting the C hubs of selector 2 (W,11-20) to the comparing magnets, for example, comparing magnets 1-10. Of course, reproducing brush hubs 1-10 are connected to the other side of comparing magnets 1-10.

20. *What wiring is required to suspend comparing between a NX1 card at the comparing brushes and an X1 card at the reproducing brushes?\**
21. *Where does the impulse come from to cause the selector to be transferred when the X1 master card is at the comparing brushes?\**
22. *Add to the diagram of question 18 all the wiring necessary to compare the cards of the offset gang-punching operation.*

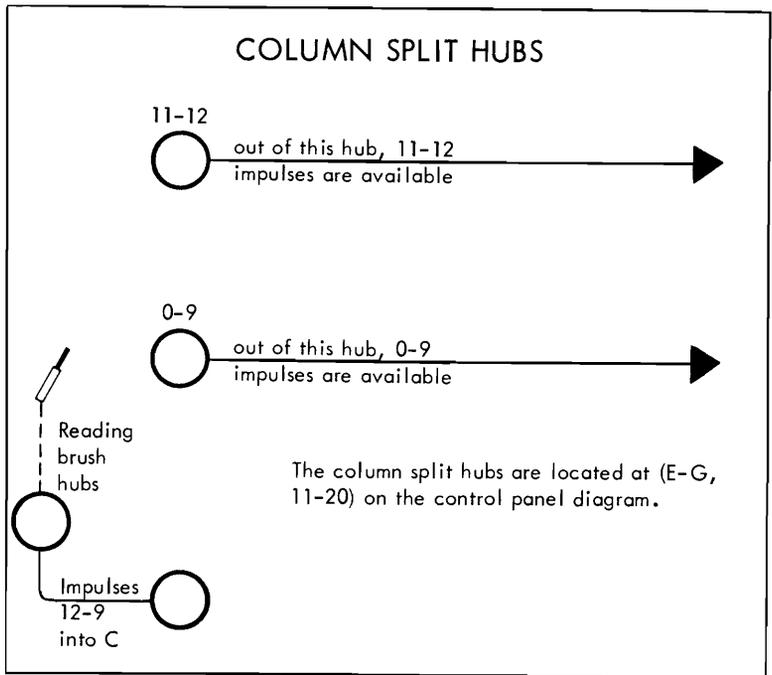


Figure 27.

## Other Reproducing and Gang-Punching Considerations

In addition to using an X punch to distinguish card types, a 12 punch is often used. The use of an X or 12 punch in a column for distinguishing cards permits the 0-9 rows to be used for data. (There are certain data processing applications when the 0-9 rows of a column must be used to distinguish card types.)

Occasionally in a reproducing or gang-punching operation, the X or 12 punch is in a column containing data to be reproduced but the X or 12 itself should not be reproduced. Although there is no way to tell the reproducing punch not to read a certain row (and thus ignore the X or 12 punch), it is possible with the use of a device called a *column split* to eliminate or redirect either the X and 12 impulses or the 0-9 impulses (see Figure 27).

Another useful device is the gang-punch emitter (G,1-10 and H,1-2). Figure 28 is a schematic of this operation. It is of great value for such operations as punching cards with data that is not available from any other source. For example, if it were required to punch the date into the NX1 cards in Figure 24, the date would have to be available either from the accumulated earnings card or from the emitter. And, since the accumulated earnings card has no date (Figure 2), it must come from the gang-punch emitter.

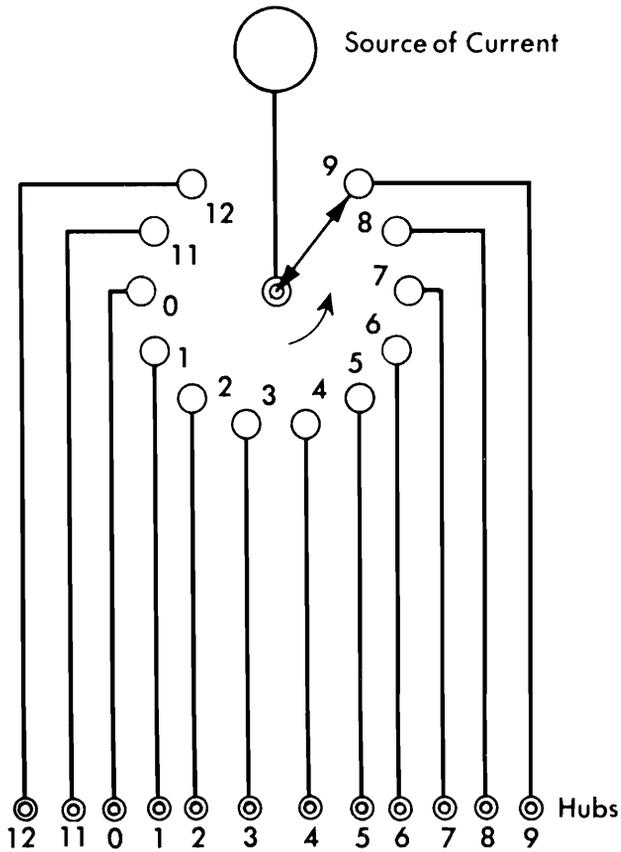


Figure 28. The gang punch emitter is simply a switch with twelve positions. Each position is connected to a control panel hub. The switch is automatically operated by the 514 so that the twelve positions are connected to the source of electricity, one at a time. The 12 hub emits an impulse at 12 time of each card cycle; the 11 hub emits an impulse at 11 time of each card cycle; etc.

The two following problems are included so that you may evaluate your understanding of Section 3. Make sure you understand each problem thoroughly before attempting to "wire" the control panel diagram. If there is any uncertainty about any aspect of the problem, consult that part of the text related to it.

23. *Reproduce and Compare*

<i>From X1 Accumulated Earnings Card</i>	<i>To NX1 Blank Cards</i>
<i>Columns 14-16 Department Number</i>	<i>1-3</i>
<i>17-21 Serial Number</i>	<i>4-8</i>
<i>5-13 Social Security Number</i>	<i>9-17</i>
<i>63-67 FICA Year-to-Date</i>	<i>18-22</i>

*Some of the accumulated earnings cards also contain an X in column 17 (the high-order column of serial number). Do not reproduce this X. (Be sure to consider this X for the comparing operation.)\**

24. *Offset Interspersed Master Card Gang Punching and Comparing*

*Behind each X1 accumulated earnings card are five cards already punched with an X in column 10. The data to be duplicated originates from the following columns of the X1 card:*

*Department Number 14-16*  
*Serial Number 17-21*

*and is to be gang-punched into the X10, NX1 cards in the following columns:*

*Department Number 6-8*  
*Serial Number 9-13*

*PX brush 1 is positioned over column 1.*

*In addition, 090161 (date) is to be gang-punch-emitted into columns 75-80. (Be sure to consider the X in column 10 for the comparing operation. Do not compare date.)\**

*To assist in planning the wiring diagram, first draw a schematic similar to the one in Figure 24.*



## The Reproducer and Some Applications

The ability of the reproducing punches to reproduce data from one card to another offers many advantages. Several of these have been implied throughout the text.

Many concerns today use a punched card bill. The card is perforated to provide a 22-column stub, which contains the customer's account number and the amount due. When the customer remits his payment, he also sends in the stub. The stub is then reproduced into an 80-column card that can be used for mechanized cash accounting.

The subscription departments of many magazines use punched cards for soliciting new subscriptions and promoting renewals. A card printed with the sales message is punched with name, address, predetermined subscription code number, the duration of the subscription and the subscription offer amount. It is then sent to the prospect. When it is returned and the prospect has become a subscriber, the card is placed in the mail file. A few weeks before expiration the mail cards are reproduced into promotional cards to start another cycle.

The above uses illustrate how the reproducer speeds the tasks of accounting for cash and subscription promotion. In addition to permitting a faster operation, the reproducer assures a more accurate operation.

## Answers to Asterisked Questions

2. Refer to Figure 6. Notice that there are two stations in the read unit (the reproducing brush station and the comparing brush station) which the cards pass. Likewise, there are two stations in the punch unit (the punch station and the punch brush station). Whenever a specific row of one card passes one station, the same row of another card is passing its station. Thus, when there are cards at each of the four stations and the 4 row of a card is being read by the reproducing brushes, the 4 row of the other three cards is "active." (See Figure 7.)

3. The first initial of the name field is in column 28, the second in column 29; columns 30-43 are punched with the last name. Department number is in columns 14-16 and serial number is in 17-21. Therefore, reproducing brushes 28-43 read the name field, 14-16 read the department number field, and 17-21 the serial number field.

4. The first initial of the name is to be punched into column 12, the second into column 13; columns 1-11 are to be punched with last name. Department is to be punched into columns 19-21 and serial number into 30-34. Therefore, punch dies 1-13 are impulsed to punch the name field; 19-21 to punch the department number field, and 30-34 to punch the serial number field. NOTE: Since there is a difference of three in the number of columns allocated to the name field, the last three columns of the name field in the accumulated earnings card are ignored and are not reproduced.

5. A simple verifying procedure is to compare the date punched in the first card with the date in the last gang-punched card. If the hole patterns of both agree, all the other cards in between are correct also.

7. Yes. Diagram A shows column 1 being successfully reproduced with a 4 punch.

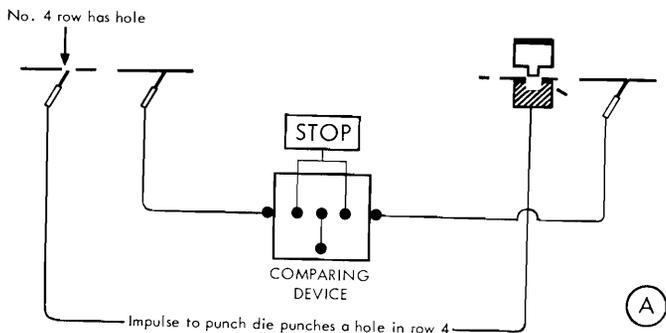


Diagram B shows that both cards impulse the comparing device at 4 time (while reading the 4 row), thus indicating a favorable compare at 4 time.

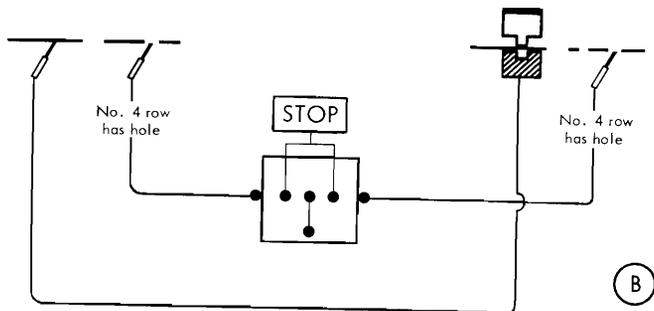
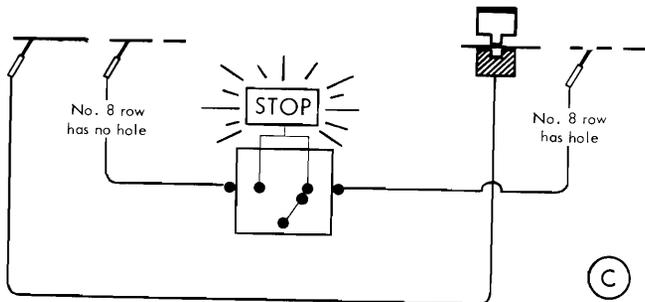
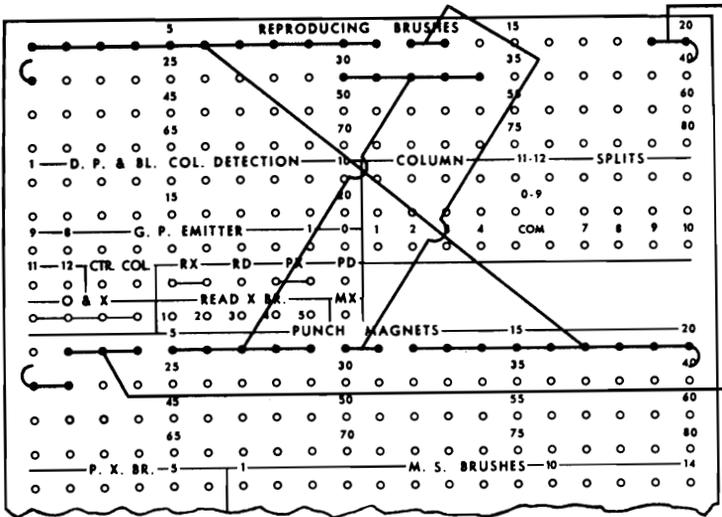


Diagram C shows that only the reproduced card (the one from the punch feed hopper with the 8 hole) impulses the comparing device. This causes an unbalance and causes the machine to stop.



8.



Attendance Cards  
at  
Reproducing  
Brushes

Deduction Authorization  
Cards at  
Punch  
Magnets

FROM COLUMNS

TO COLUMNS

1-11  
(last name)

12-22

12-13  
(1st & 2nd initial)

10-11

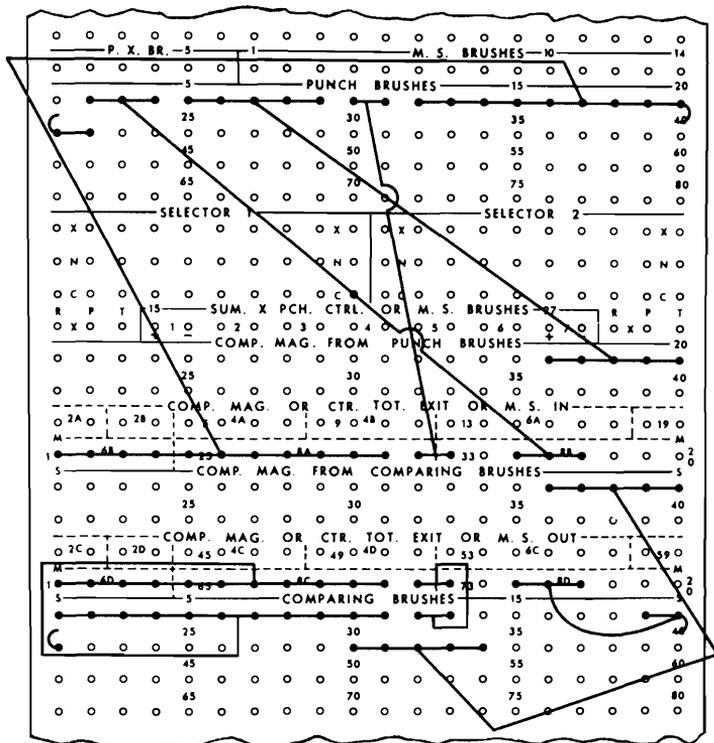
19-21  
(Department Number)

2-4

30-34  
(Serial Number)

5-9

9. NOTE: It is quite probable that the comparing magnets you chose for completing the diagram differ from those chosen here. This need not concern you, however. Of importance is that the corresponding comparing brush hubs and punch brush hubs are wired to hubs that are connected to opposite sides of a comparing magnet.



Attendance Cards  
at  
Comparing  
Brushes

- 1-11  
(last name)
- 12-13  
(1st & 2nd initial)
- 19-21  
(Department Number)
- 30-34  
(Serial Number)

Deduction Authorization  
Cards at  
Punch  
Brushes

- 12-22
- 10-11
- 2-4
- 5-9

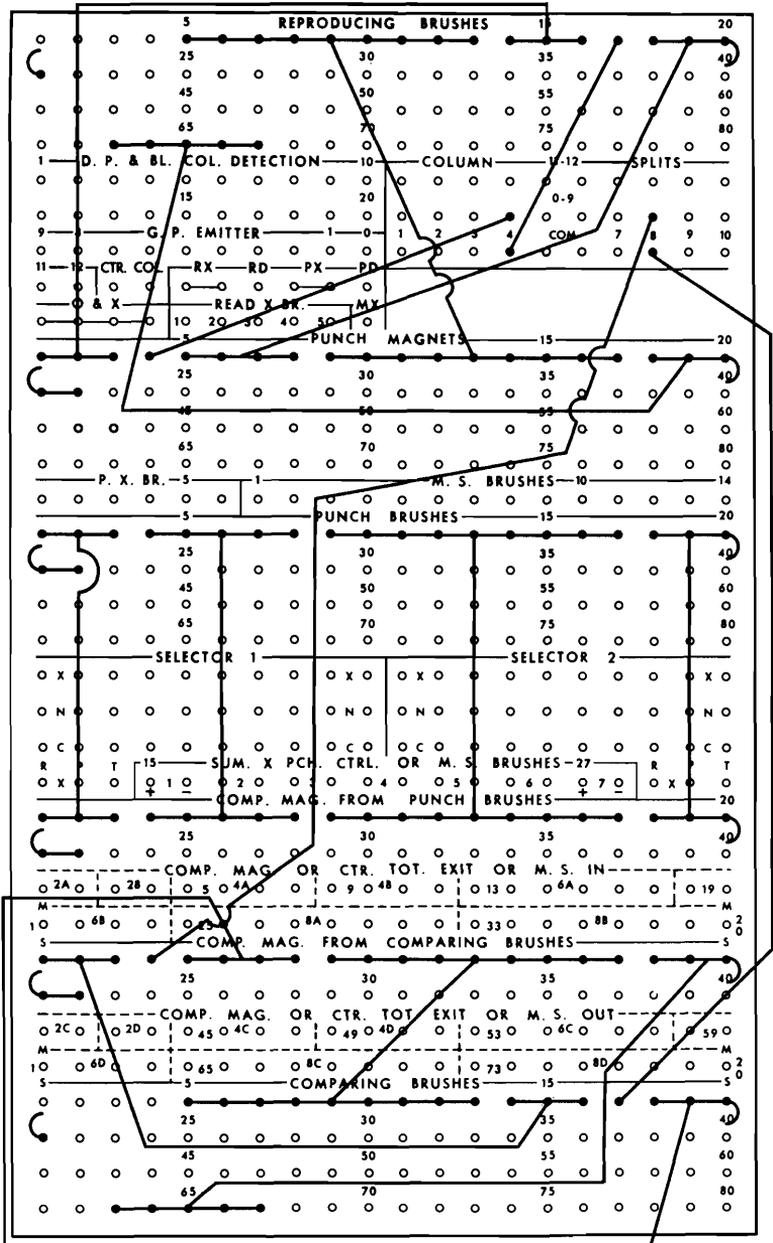
11. The new master card is treated just as though it were another blank card—that is, it is gang-punched from the card at the punch brushes. This is most undesirable, in that the new master card would then have useless extra holes in the serial number field.

12. A two-position switch determines for what type of cards punching is to be suspended. When the switch is in one position, cards with an X are not punched and cards without an X (commonly referred to as NX cards) are punched. When the switch is in the other position, punching is suspended for NX cards and allowed for X cards.

20. An impulse from the RX brush reading the column containing the X punch, is required by the RX hub to suspend punching. The RX hub suspends comparing, just as the PX hub suspends punching.

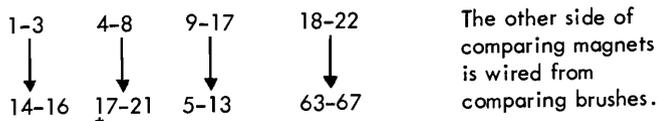
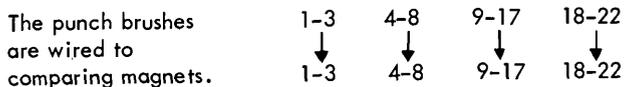
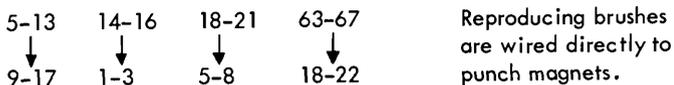
21. Controlling the selector for comparing is accomplished in a manner similar to controlling the selector for punching. That is, the impulse from the RX brush to the RX hub is “saved” for one cycle and then is available from the RD hub which emits a 13-time impulse just as the X card approaches the comparing brushes.

23(a).



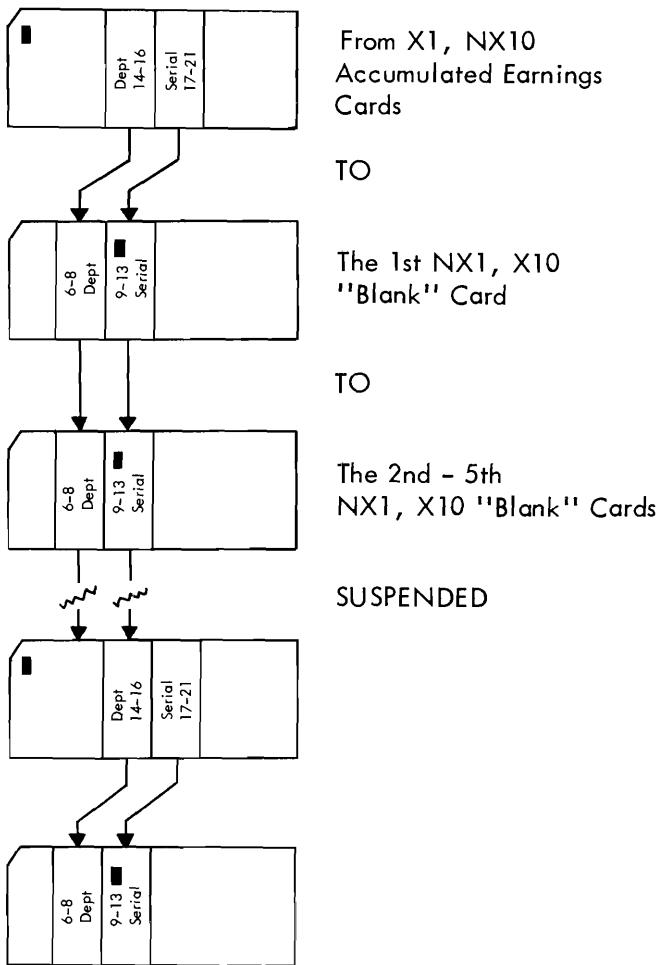
23(b).

\*In order to eliminate the X in column 17, reproducing brush 17 is wired to the common of a column split. The 0-9 hub is then wired to punch magnet 4.

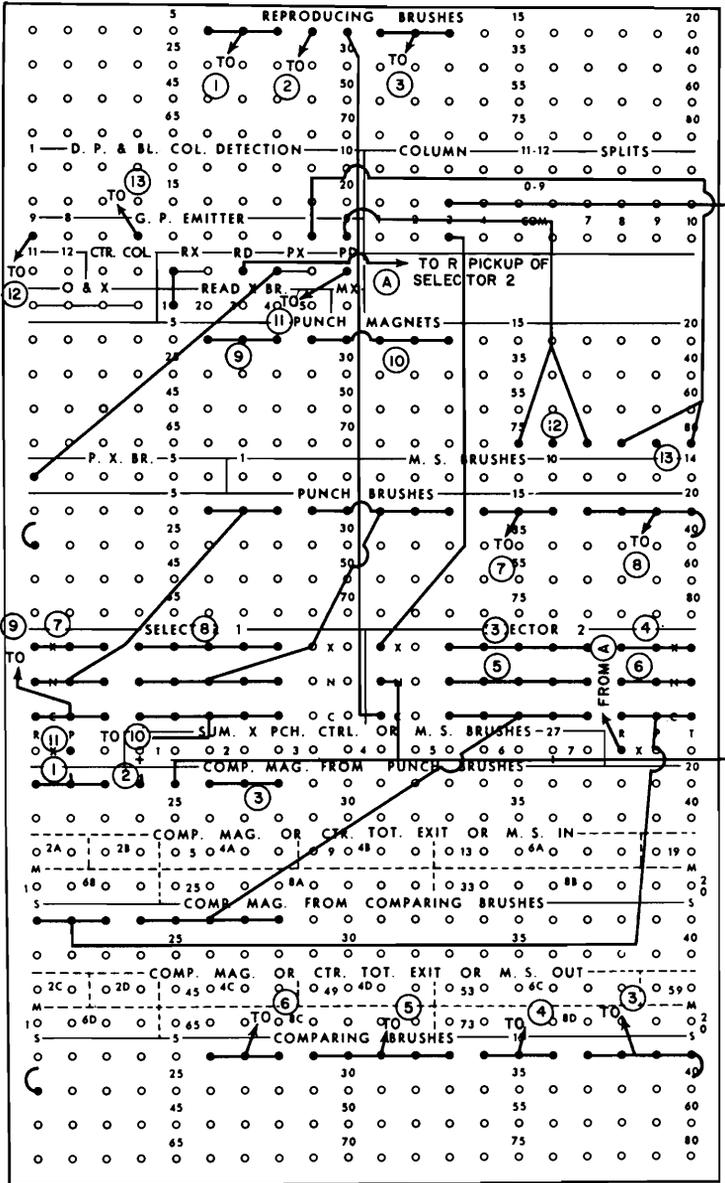


\*Before comparing brush 17 is connected to comparing magnet 4, it is wired to a column split to eliminate the effect of the X impulse. Failure to column-split column 17 would cause an unbalance in the comparing device.

24(a). The relationship of the cards in this gang punching operation appears as follows:



24(b).



The only columns to be gang-punched are 6-8 and 9-13 of NX1, X10 cards. The first "blank" card receives its data from columns 14-16 and 17-21 whereas the second to fifth cards receive their data from columns 6-8 and 9-13. Thus, selection is required. Columns 6-8 and 9-13 actuate punch magnets 6-8 and 9-13 when selector 1 is normal. Columns 14-16 and 17-21 actuate punch magnets 6-8 and 9-13 when selector 1 is transferred. PX brush 1 is wired to the PX hub to suspend punching when there is an X1 card following an X10 card. So that the selector transfers at the proper time (that is, when the X1 card is at the punch brushes and the first X10 card is at the punch magnets), selector 1 is impulsed from the PD hub.

To compare the department and serial number fields between an X1 card at the comparing brushes with the NX1 card at the reproducing brushes, the comparing brushes 14-16 and 17-21 impulse comparing magnets 1-3 and 5-8 when selector 2 is transferred. To compare the fields between NX1 cards, comparing brushes 6-8 and 9-13 impulse comparing magnets 1-3 and 5-8 when selector 2 is normal. RX brush 1 is wired to the RX hub to suspend comparing when there is an X1 card following an X10 card. So that the selector transfers at the proper time (that is, when the X1 card is at the comparing brushes and the first X10 card is at the reproducing brushes), selector 2 is impulsed from the RD hub.

In order to eliminate an unnecessary stop when the X1 card is at the comparing brushes (with no X punch in column 10) and the first X10 card is at the reproducing brushes (with an X in column 10), it is necessary to eliminate the X impulse from column 10 from the reproducing brushes when there is an X1 card at the comparing brushes.

This is accomplished by wiring reproducing brush 10 to the common of selector 2, out of the transferred side to a column split, and out of the 0-9 hub of the column split to impulse comparing magnet 5. (Thus, when selector 2 is transferred—an X1 card at the comparing brushes—an X impulse from reproducing brush 10 is eliminated.) So that comparing magnet 5 is impulsed when there is an NX1 card at the comparing brushes, the normal hub is also wired to comparing magnet 5. (Thus, when selector 2 is normal—an X10 card at the comparing brushes—the X impulse from reproducing brush 10 is not eliminated.) The date is emitted into columns 75-80.

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