Punched Card Data Processing Principles

Section 1: The IBM Card and Its Preparation

IBM Personal Study Program

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The IBM Personal Study Program offers the opportunity to develop an understanding of and an appreciation for the tools of data processing, their operation and application. In recent years, the use of automatic data processing equipment has been extended into almost every area of business, government and science. As a result, the need for people knowledgeable in the subject has multiplied manifold—and is continuing to multiply.

The purpose of the IBM Personal Study Program is to help satisfy this need by providing simplified self-study texts covering the fundamentals of data processing. With the background these texts provide, the interested student will be prepared to delve further into those areas of greatest interest to him and his career.

PUNCHED CARD DATA PROCESSING PRINCIPLES deals with the basic functions and operation of IBM punched card equipment. Introductory in nature, the text provides the necessary background for the more detailed courses and manuals provided by IBM.

This text has been divided into seven separate sections, each a convenient booklet covering a specific topic:

Section 1: The IBM Card and Its Preparation
Section 2: The Sorter
Section 3: The Reproducer
Section 4: The Collator
Section 5: The Calculator
Section 6: The Accounting Machine
Section 7: Other Unit Record Machines

Review questions are scattered throughout the text to aid the student in measuring his understanding of the material covered. It is recommended that at the completion of each section, the student go back through the text and again answer each of the review questions. In this way, the student will be able to proceed through each lesson at a pace most satisfactory to himself.

Contents

IBM 26 Printing Card Punch

Section 1: The IBM Card and Its Preparation

The basic element in IBM punched card accounting is the IBM card. IBM cards contain data in the form of punched holes. The holes in the cards actuate the IBM machines to automatically perform various operations for keeping records. Some of the operations are reading, printing, adding, subtracting, multiplying, dividing, comparing, classifying, and summarizing.

An initial step in any punched card procedure is converting source information from printed or handwritten documents to punched cards. The IBM card and the way in which it is prepared is the topic of this lesson.

Recording information in punched card form offers many advantages. The two most important are:

1. Once information is punched (recorded) in a card, the card is a permanent record. Its information can be used over and over again and will be the same for each use.

2. Each card contains all the necessary information about a single *transaction* (see Figure 1). Therefore, all similar transactions can be easily grouped. These factors constitute the unit record principle.

*1. What are the major features of a unit record?**

The IBM Card

The IBM card measures 7⅜ inches by 3¼ inches and is .007 inches in thickness. The card stock is of controlled quality which must meet rigorous specifications in order to provide strength and long life. This is necessary to insure the accuracy of results, the proper operation of IBM data processing machines and the continued usability of information long after it is recorded.

The card is divided into 80 vertical areas called *columns* or *card columns*. These are numbered 1 to 80 from the left side of the card to the right. Each column is then divided into twelve punching positions called *rows*, which are designated from the top to the bottom of the

*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.

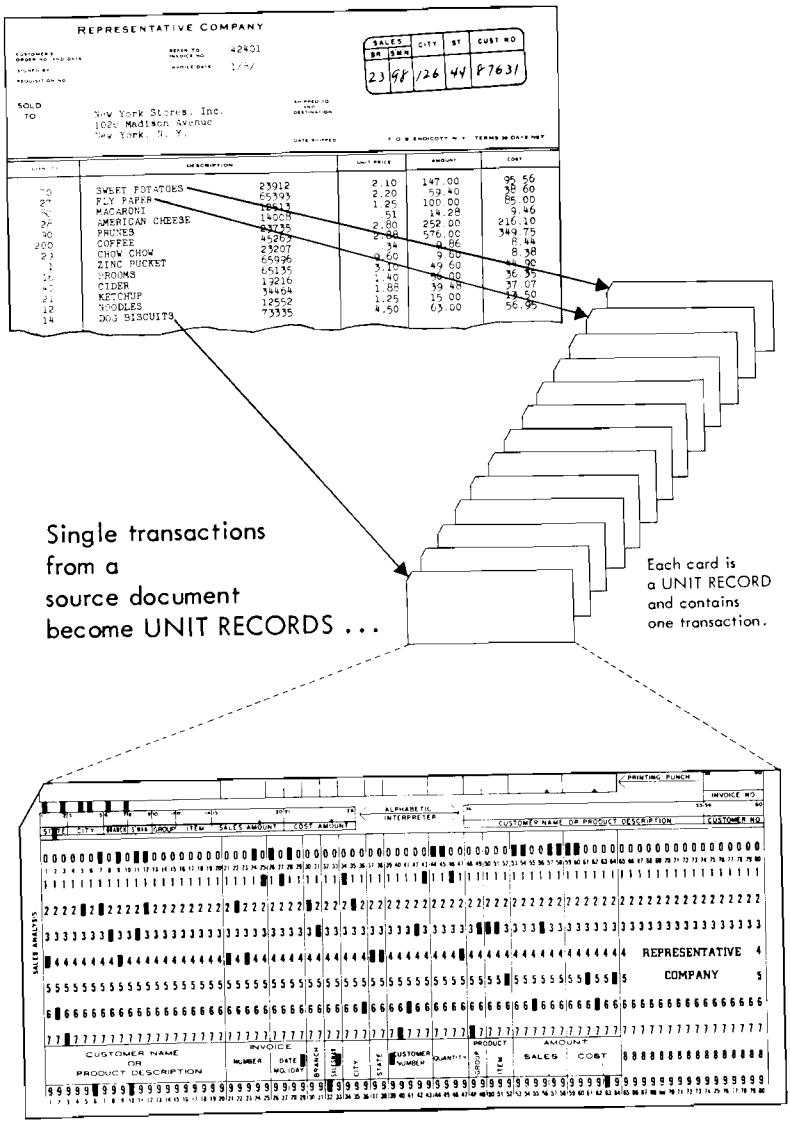


Figure 1.

card by 12, 11 (sometimes referred to as X), 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 (see Figure 2).

The punching positions for digits 0 to 9 correspond to the numbers printed on the card. The top edge of the card is known as the *12 edge* and the bottom of the card is known as the *9 edge*. These designations are made because cards are fed through machines either 9 edge first or 12 edge first. "Face up" means the printed side facing up and "face down" means the opposite. These designations are used in describing the manner in which punched cards are to be inserted into various machines.

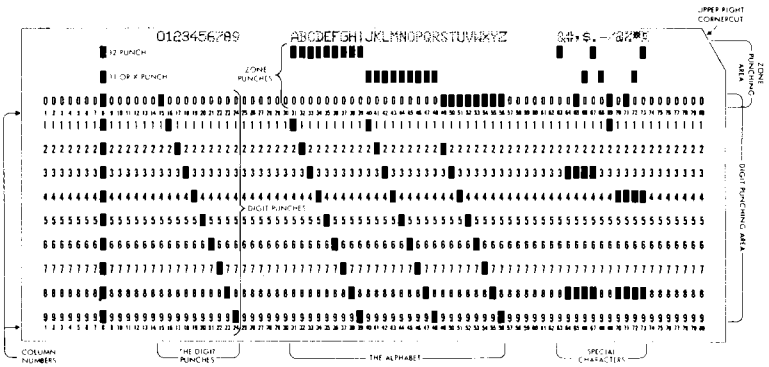


Figure 2.

2. *How many columns are there in a card?*
3. *How many rows are there in a card? How are they designated?*

Each column of the card is generally used to accommodate a digit, a letter or a special character. Digits are recorded by holes punched in the *digit punching positions* of the card from 0 to 9.

The top three punching positions of the card (12, 11, and 0) are known as the *zone punching positions* of the card. (It should be noted that the 0 punch may be either a zone punch or a digit punch.) In order to accommodate any of the 26 letters in one column, a combination of a zone punch and a digit punch is used. The various combinations of punches which represent the alphabet follow a simple pattern.

The first nine letters of the alphabet, A to I, are coded by the combination of a 12 punch and the digit punches 1 to 9. Letters J through R are coded by an 11 punch and the digits 1 through 9. S through Z, the last eight letters, are the combinations of the 0 zone punch and the digit punches 2 through 9. The eleven special characters are recorded by one, two or three punches in a column.

4. *Why is it necessary to represent alphabetic characters with two holes?*
5. *Mark with a pencil the proper rows in each column of the card shown in Figure 18 to indicate the hole pattern for your name, address and today's date.*

Items of information are recorded in a card in groups of consecutive columns called *fields*. The information to be included in the card is determined by the requirements of the reports and documents which will be prepared from it. A field may consist of one column to eighty columns, depending upon the length of the particular item of information to be recorded in it. For example, a name field would be longer

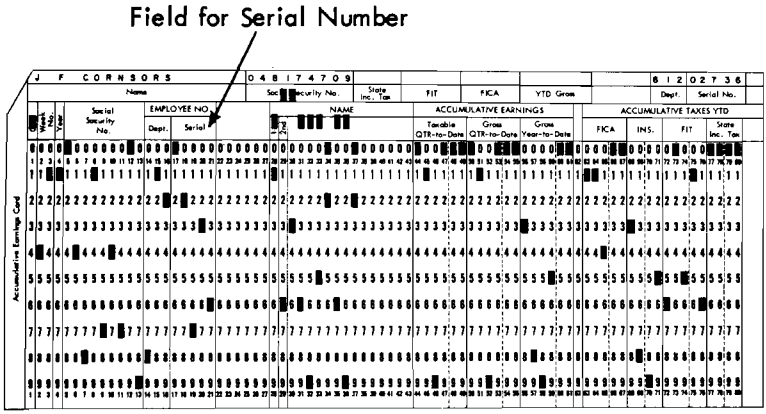


Figure 3. The information between solid lines is a field of information.

than a telephone number field. Machine processing requires a consistent arrangement of data in cards used in the same job. Once a field is assigned specific columns for cards in any one job, the columns should not be used for other data. Actually this is no different from the restrictions for a handwritten document. For example, in the standard arrangement of a check, the upper right portion is usually assigned for check number and the center right portion for amount.

Field length is determined by the maximum length of information which will be entered into the field. A numerically coded employee serial number may take up only five columns, so a field of five columns is assigned for the punching of the serial number. A typical serial number field is illustrated in Figure 3.

A company engaging in manufacturing may have 78,500 employees, with no prospect of having more than 99,999 employees. A five-column field would therefore be assigned to the recording of employee number. If the company were expanding rapidly and an increase in the labor force to 100,000 or more were anticipated, a six-digit field would be assigned. Field assignments and card layout are made after analysis of individual needs.

6. *If an employee's number is 8005, in which columns of the five-column field (see Figure 3) are the 8, 0, 0 and 5 punched? What is punched in the other column?**

Figure 3 illustrates a common type of *corner cut*—upper left. The corner cut is used to identify visually a card type or to insure that all of the cards in a group are facing the same direction and are right side up. Card types may also be identified by the use of colored cards or the use of a colored stripe on cards.

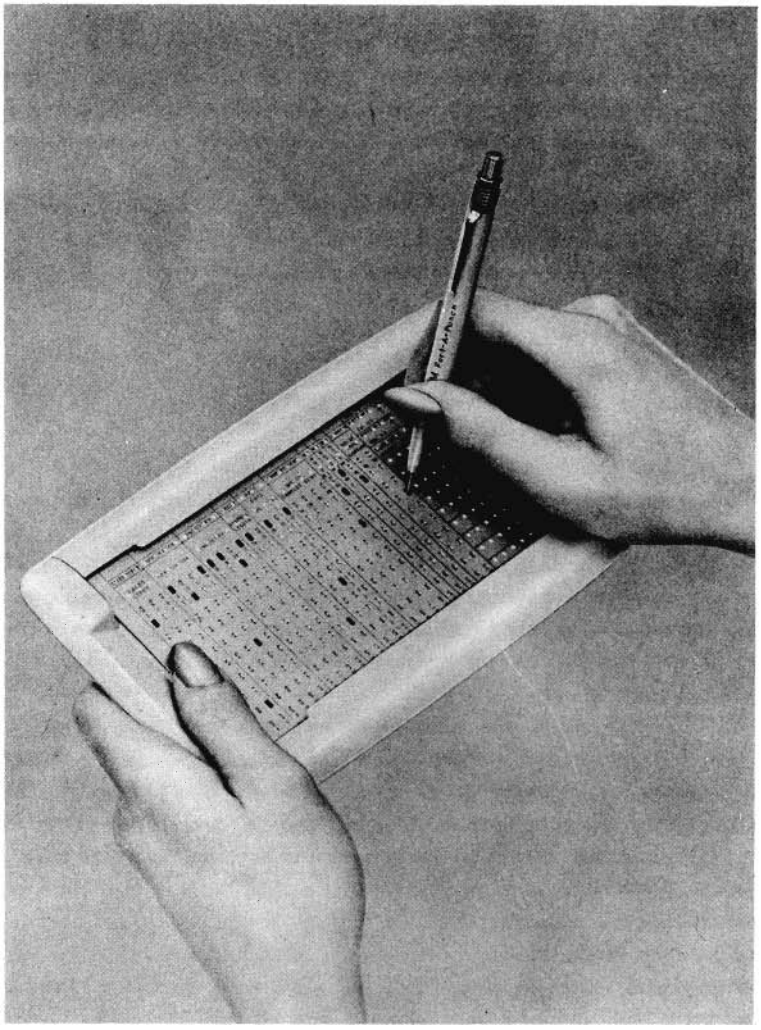


Figure 4. Creating a card with an IBM PORT-A-PUNCH.

IBM machines can add, subtract, multiply, divide, read, print, compare, classify, summarize, etc., automatically. However, these activities can take place only after information is punched in the card.

Thus the very first operation in the whole process is transcribing written records to punched cards. Punching holes in an IBM card can be done very simply with a device called PORT-A-PUNCH® (see Figure 4). Although such a device is extremely useful for "on-the-spot" recording, jobs involving large volumes of cards require a speedier method for punching. Thus the need arises for an efficient device with as much automaticity as practical. This need is fulfilled by an IBM card punch.

The IBM Card Punch

Several types of IBM card punches are available for transcribing written data to holes in an IBM card. The two most commonly used are the IBM 24 Card Punch and the IBM 26 Printing Card Punch (see frontispiece).

Many automatic features are incorporated in modern IBM card punches, thus allowing rapid and efficient operation. Although it is not the function of this course to provide card punch training, the essentials should be known to anyone connected with machine accounting, in case it is ever necessary to:

1. Replace damaged cards.
2. Correct cards that have incorrect punching.
3. Prepare "test"* cards.

The card punch operation is very similar to that of a typewriter. When a typist depresses a key on a typewriter, a letter is printed on a piece of paper. When a card punch operator depresses a key, a hole or combination of holes is punched into a card.

The card punch keyboard is connected to the punch by a cable and can be moved on the reading board to suit the convenience of the operator. There are two types of keyboard available (see Figure 5):

A. Numerical only

B. Alphabetic and numerical—with eleven special characters

On the combination numerical and alphabetic keyboards a group of keys serves for punching digits as well as letters (see Figure 6). The shift is made from one to the other manually by a shift key (keys 30 and 31), or automatically by the program unit (to be discussed later). On the typewriter, numerical keys are located at the top of the keyboard. However, since most card punching is composed of numerical information, the numerical keys on the card punch are closely grouped for one-hand, ten-key operation. This close grouping eliminates the back and forth hand motion which would be required if the numerical keys were arranged as they are on a typewriter. This is the main difference between the layout of the typewriter keyboard and that of the card punch (see Figure 7).

Operating the Card Punch

Several other basic components of the card punch (see Figure 8) are:

1. A *hopper* for supplying the cards to the punching mechanism.

2. Two stations, *punching* and *reading*, through which the card traverses in being punched and read.

*"Test" cards are prepared to check the operation of a machine before the actual data cards are processed.

Figure 5a. Numerical keyboard.

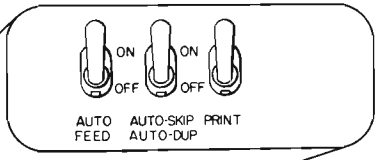


Figure 5b. Combination numerical and alphabetic keyboard.

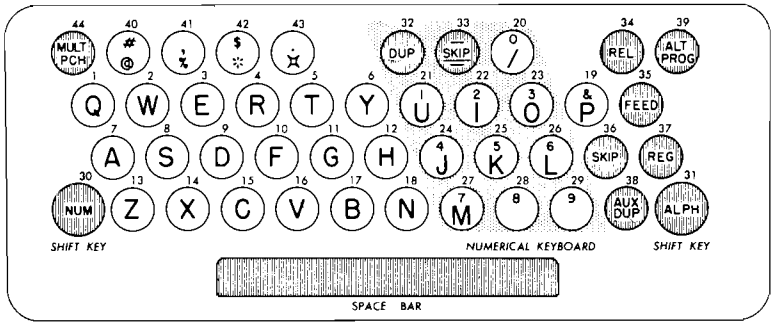


Figure 6. This is a keyboard chart. Next to each key is a reference number.

Character Keys Key Number	SHIFT Alphabetic	SHIFT Numerical
1.	Q	Depressing any of these keys while in numerical shift will cause the keybaard to lock up.
2.	W	
3.	E	
4.	R	
5.	T	
6.	Y	
7.	A	
8.	S	
9.	D	
10.	F	
11.	G	
12.	H	
13.	Z	
14.	X	
15.	C	
16.	V	
17.	B	
18.	N	

Character Keys Key Number	SHIFT Alphabetic	SHIFT Numerical
19.	P	& *
20.	/	0
21.	U	1
22.	I	2
23.	O	3
24.	J	4
25.	K	5
26.	L	6
27.	M	7
28.	8	8
29.	9	9
33.	- *	- *
40.	@ *	# *
41.	% *	, *
42.	* *	$ *
43.	*	. *

Control Keys Key Number	Function
30	Numerical shift
31	Alphabetic shift
32	Duplication
34	Releases card from its station
35	Feeds card from hopper
36	Initiates a skip
37	Registers card at station
38, 39	Special Devices
44	Suppresses card movements after punching a hole in card.

* Special character

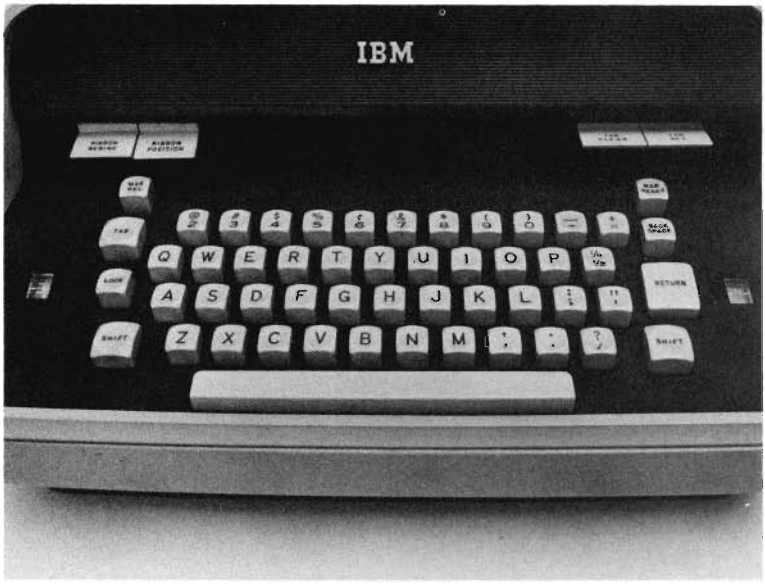


Figure 7. Typewriter keyboard.

Note the key layout for printing numerical characters. Although this design is very desirable for typing, an operation usually concerned with printing alphabetic information, it is quite undesirable for card punching, an operation concerned primarily with numerical information.

3. A *stacker* for holding the cards just punched.
4. Switches, program control unit, etc.

Card Hopper

The card hopper, which holds about 500 cards, is located at the upper right of the machine. The cards are placed in it face forward, with the 9 edge down, and are fed front card first.

A card is fed down from the hopper to the card bed by pressing the feed key (key 35).

The first two cards to be punched must be fed by key depression, but all other cards in the hopper can be fed automatically under the control of the auto feed switch. (See enlargement of toggle switches in Figure 5.)

Punching Station

Punching is performed at the first of two stations along the card path. *Normally*, to start large volume punching operations, two cards are fed into the card bed at the right of the punching station. As the second

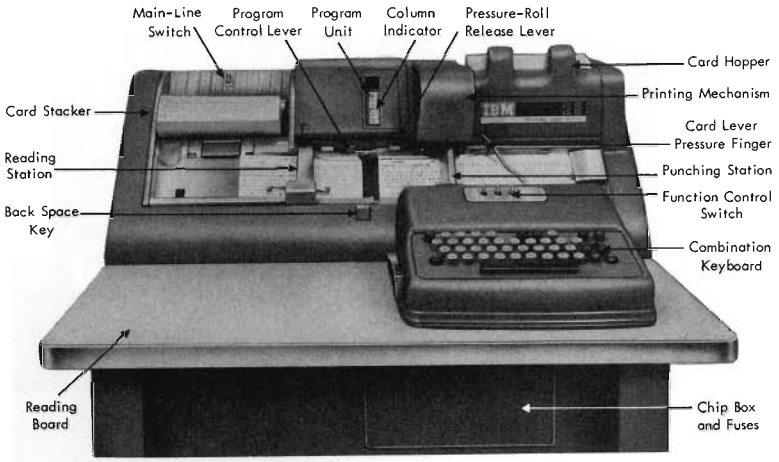


Figure 8. This illustration shows the location of the important components of a card punch. The card punch shown here is the Model 26. On a Model 24, the printing mechanism is not present.

card is fed, the first card is automatically registered for punching—that is, the left end of the card is positioned at the punching station.

While the first card is being punched, the second card is on deck—that is, it waits at the right of the card being punched. When column 80 of the first card passes the punching station, it moves to the read station, the second card registers at the punching station, and the next card in the hopper feeds down to the card bed.

A single card can be inserted in the card bed by hand and then registered in punching position by pressing the register key (key 37).

7. *How are the cards positioned into the card hopper?*
8. *What switch controls automatic feeding of cards from the hopper after the first two are manually fed?*

Reading Station

After the desired number of columns have been punched, the card is released from the punching station to the reading station. A new card moves to the punching station.

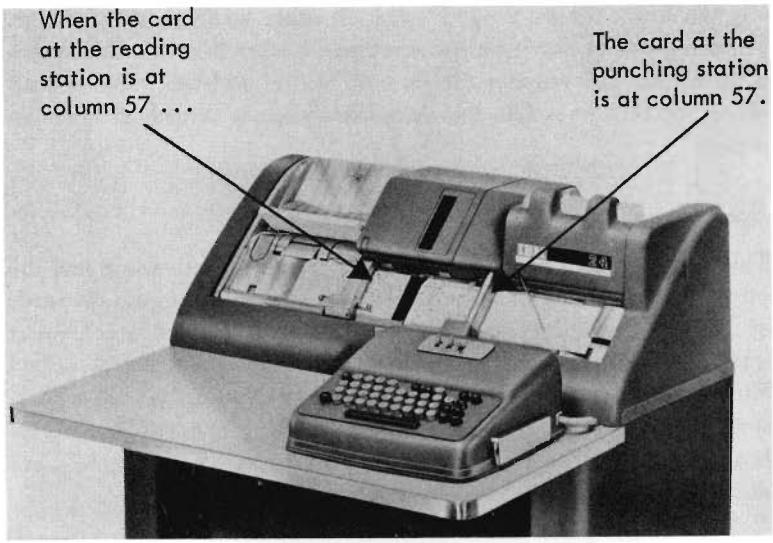


Figure 9.

The depression of a character key or space bar on the keyboard moves these cards along in exact unison. For example, in Figure 9, column 57 of the card at the reading station is read at the same time that column 57 of the card at the punching station is ready for punching.

The reading station performs an important function. Some of the information in a group of cards is often repetitive. Duplicating these holes from card to card would save time. The depression of the "duplicate" key (key 32) will cause the reading station to become active. The holes in the column under the reading station actuate the punching station, where those holes are duplicated.

9. *How is the reading station activated? What is the main purpose of the reading station?*

Card Stacker

The card stacker, which holds about 500 cards, is located at the upper left of the machine. After each card passes the reading station, it is fed into the stacker. Cards are stacked 12 edge down, with the back of the card facing the operator. A pressure plate holds the cards in position. Cards are sent to the stacker in the same sequence as they were punched.

Main-Line Switch

The main-line switch is located at the top of the card stacker. When turned on, it provides electricity to operate the card punch. When it is

off, the keyboard is "locked" and all other switches are inactive. Punching can be started about one minute after the main-line switch is turned on. This allows sufficient time for the electronic tubes to heat. When the stacker is full, the main-line switch is turned off automatically.

Backspace Key

This key is located below the card bed between the reading and the punching stations (see Figure 8). As long as it is held down, the cards at the punching and the reading stations are backspaced, a column at a time. At the same time the automatic program unit (to be described later), which controls automatic skipping and duplicating, is also backspaced. In addition, the backspace key can be used to release the keyboard when it becomes locked. This may happen when keys 1-18 are depressed while the keyboard is in numerical shift.

10. What three objects space backwards upon the depression of the backspace key?

Column Indicator

The column indicator indicates to the operator the *next* column to be encountered as cards pass the punch and read stations (see Figure 8). The numbers are written around the base of a drum, which turns synchronously with the cards being punched and read. Spacing forward or backspacing to a particular column is facilitated because of the indicator.

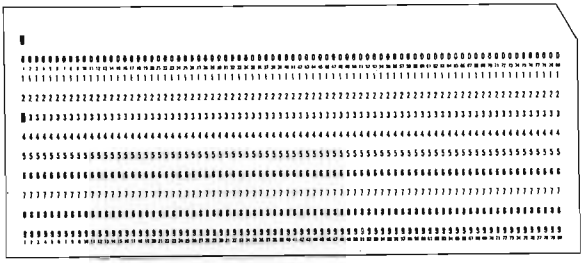
11. Does the column indicator show the column to which something has just happened, or the column about to be encountered?

Program Control Unit

Although the operation of the program control unit is not explained until later, several of its minor effects are discussed now. When program control is off, the keyboard is in alphabetic shift—which means that if a combination key is depressed, an alphabetic character is punched. Program control is put in either on or off status by manipulating the program control lever near the column indicator (see Figure 8). When the left side of the lever is down, program control is on. When the right side of the lever is down, program control is off. If it is required to punch a numerical character with the lever in the off position, it is necessary to depress the combination key concurrently with the numerical shift key (see Figure 10).

As was previously mentioned, this is not a course for becoming a card punch operator. However, certain characteristics of a card punch

1. If the key shown on the right-hand side of the keyboard is depressed with program control off, an L will be punched.



2. If the key shown is depressed with program control off AND with the numerical shift key depressed, a 6 will be punched.

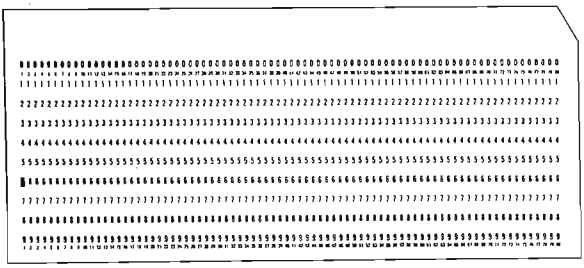


Figure 10.

have been described so that you will have the background for intelligently preparing an occasional card. For each of the cases where this may be necessary, a sequence of steps is required.

12. *Refer to the keyboard chart in Figure 6. With program control off, and column 10 of a card ready for punching, what key or keys should be depressed to punch the numeral 7?*

Replacing Damaged Cards

Cards that are to be entered into relatively high speed machines must be in good condition. Cards in damaged condition can jam the feeding mechanism, causing delays. Thus damaged cards should always be replaced with good duplicates.

Naturally, the plan of action depends on how badly a card is damaged. If it is mutilated so badly that it cannot be read, the best procedure is to consult some person or document(s) concerning its contents. Usually, however, a damaged card is only creased from bending or contains a staple or pin. After being smoothed out, it can be duplicated as follows (assuming that the card punch has been "warmed up"):

1. Push right side of program control lever down (turn program control off). Turn off auto feed switch.
2. Put damaged card in reading station position and leave just a slight space between card and reading station. Place blank card in same relative position at punching station.
3. Depress register key (key 37). This registers the blank card at the punching station and the damaged card at the reading station. Now column 1 of the damaged card is ready to be read and column 1 of the blank card is ready to be punched.
4. Depress and hold the duplicate key for the number of columns to be duplicated.
5. Move the cards to the stacker by depressing the release key (key 34), then the register key, then the two keys again in that order.

Correcting Cards Having Incorrect Punching

In spite of the many precautions followed by card punch operators, a card is occasionally mispunched. This is not necessarily the fault of the card punch procedure but may be a misinterpretation of some illegible script. Whatever the reason, the correct information must be ascertained and a new card created. Therefore:

1. Do steps 1 to 3 as in making over a damaged card.

2. a) Depress the duplicate key for those columns that are correct.
   b) Depress the proper character key to punch the correct information. If the information is numerical, the numerical shift key must be depressed.
3. Release the cards and remove from the stacker.
4. Place the corrected card in front of the incorrect card, hold both up to the light and make certain that all the required columns have been punched. (A type of "sight-checking.")
5. Upon ascertaining that the new card is completely correct, file or destroy, as appropriate, the old and incorrect version. (There is nothing more harrowing than finding an isolated card lying on some table top or machine, just after a critical calculation has been performed or a report written, and not knowing whether this card should have been included.)

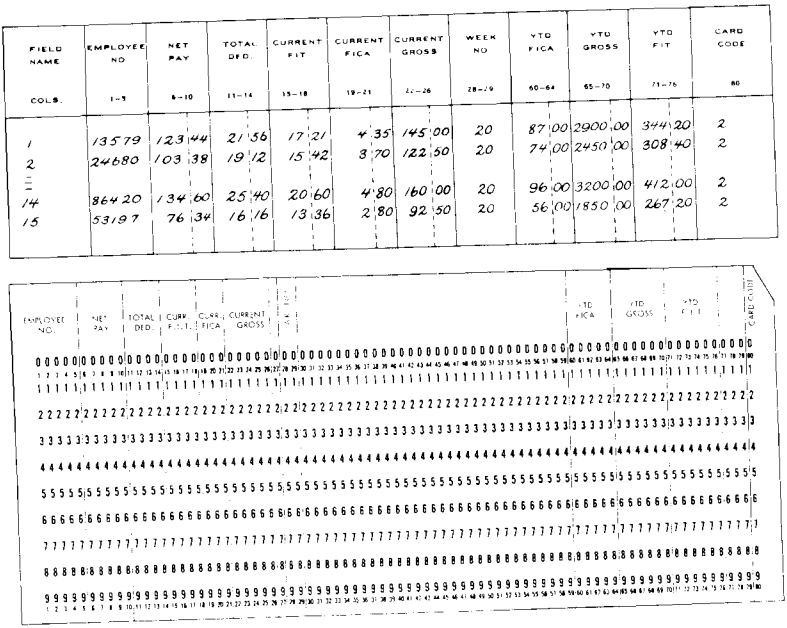
Preparing Test Cards

Practically all machine operators follow the practice of preparing test cards to check out a data processing machine control panel before processing the data cards, regardless of how simple the wiring of that control panel might be. Of course, for the more simple jobs in which the cards all have the same format, this may require punching only a half-dozen identical cards. For the more complex reports and calculations, however, it is not unusual to contend with three or four different card formats. Of course, if a file of cards already exists, then the machine operator could simply select some representative cards from the file, have them duplicated, and use the duplicate deck for testing. However, there are many times when there is no such thing as an existing deck. This is particularly true when a company has a new punched card installation.

Naturally, before the test cards can be punched, data must be created and written on a sheet of paper, preferably in the same sequence in which it is to be punched (see Figure 11).

Now the data can be punched into cards by one of two procedures—nonautomatic or automatic. The nonautomatic procedure is discussed first, using the year-to-date card format of Figure 11 for the example. (Assume that in order to test the control panel for every conceivable condition, 15 cards have to be punched.)

1. Place blank cards in the hopper, and turn program control off.
2. Turn on the auto feed switch. This will allow automatic feeding and registering of cards from the hopper after the first two have been fed manually.
3. Depress the feed key twice.
4. The first year-to-date card is now positioned for punching into column 1.



FIELD NAME	EMPLOYEE NO	NET PAY	TOTAL DED.	CURRENT FIT	CURRENT FICA	CURRENT GROSS	WEEK NO	YTD FICA	YTD GROSS	YTD FIT	CARD CODE
COLS.	1–5	6–10	11–14	15–18	19–21	22–26	28–29	60–64	65–70	71–76	80
1	13579	123 44	21 56	17 21	4 35	145 00	20	87 00	2900 00	344 20	2
2	24680	103 38	19 12	15 42	3 70	122 50	20	74 00	2450 00	308 40	2
14	86420	134 60	25 40	20 60	4 80	160 00	20	96 00	3200 00	412 00	2
15	53197	76 34	16 16	13 36	2 80	92 50	20	56 00	1850 00	267 20	2

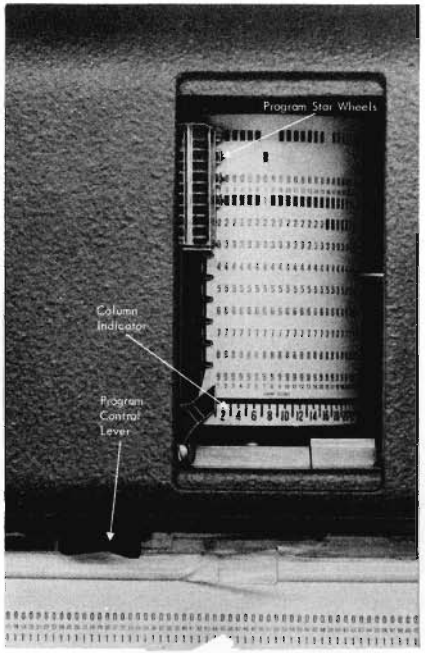
Figure 11.

a. Depress the proper keys for punching the required information into columns 1-26.
b. Hit spacc bar to skip column 27.
c. Punch week number in columns 28-29.
d. Hit space bar 30 times to skip columns 30-59.
e. Depress the proper keys for punching information into columns 60-76.
f. Hit space bar three times to skip columns 77-79.
g. Depress proper key to punch code into column 80.
h. Because the auto feed switch is on, a card at the reading station moves into the stacker, the card just punched moves and registers at the reading station. a blank card moves and registers at the punching station and another blank card feeds from the hopper to the card bed.
i. Return to step 4 and repeat a-i until all the cards have been punched.

An analysis of the procedure shows that a lot of nonproductive time is being expended in several areas:

1. Depressing the space bar to skip over column 27, columns 30-59, and columns 77-79.

2. Punching the same information in each card in columns 28-29 and column 80.



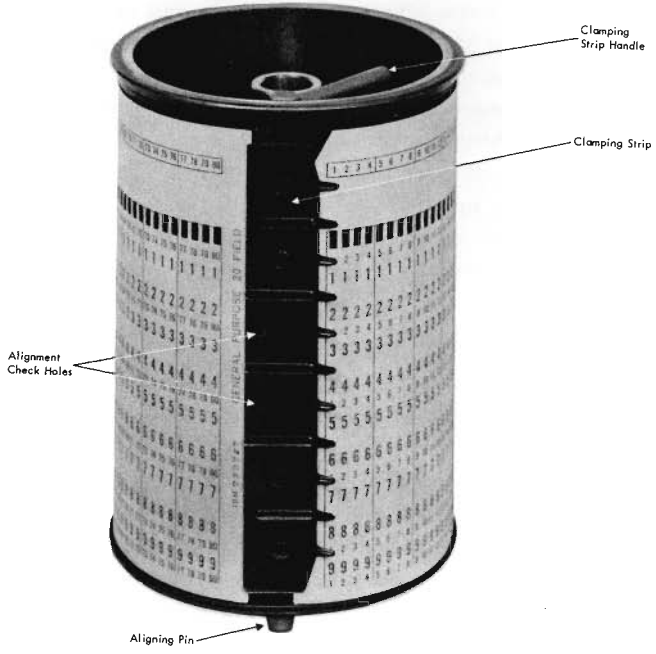


Figure 12. The illustration on top shows the relationship between the program card, program drum, star wheels, and program control lever. The bottom illustration shows a program card wrapped around a program drum.

Program Unit

Earlier it was mentioned that there are several automatic devices incorporated into the design of card punches to increase operator efficiency. Obviously, the case of preparing even these few cards for testing indicates that the procedure might be made considerably more efficient.

In each modern IBM card punch there is an automatic device called the *program unit*. Its function is to allow certain repetitive operations to be accomplished automatically. The program unit can control automatic skipping over columns not to be punched, automatic duplicating of repetitive information, and the shifting from numerical to alphabetic punching mode and vice versa.

The operation of the program unit in the card punch is very similar to the operation of the program unit in a clothes washing machine. In the washing machine the program unit is composed of some rigid timing disks and contact points which control the valves, agitator or tumbler action, etc., in a predetermined sequence. As these disks rotate, water is turned on and off, the agitator is made to rotate at a particular speed, the pump is actuated to drain the tub, and so on according to the washing program selected.

The big difference between the program unit of a card punch and the program unit of a clothes washing machine is that the latter has an unalterable program. This is because a completely variable program for a washing machine is expensive and unnecessary. Conversely, to meet card-punching requirements where many different card formats are possible, an alterable program is required. Thus the program unit of a card punch incorporates simple and flexible components so that the programs for automatic card-punching operations can be easily prepared and inserted.

Components of the Program Unit

The program unit of the card punch comprises four main components (see Figure 12):

1. IBM card. This card is punched with a pattern of holes which, when detected by a sensing device, initiate the desired operations and continue the operations for the required number of columns. This card is referred to as the *program card*.

2. Program drum around which the program card is wrapped. The drum has twelve grooves in the same relative positions as the twelve punching positions of the card so that if the sensing device detects a hole, it can penetrate deeply enough to close a contact point.

3. Sensing device for detecting holes, which rides along on the pro-

gram card as it moves from column to column. In IBM 21 and 26 card punches, the sensing device is a *star wheel.* When the star wheel, *held in contact with the card under spring tension,* detects a hole, it falls into the hole and closes a contact point.

4. Program control lever for raising and lowering the star wheels. Several times throughout the text it has been mentioned that when program control is off (star wheels raised) the card punch is in alphabetic shift. Contrariwise, then, when program control is on, the card punch is in numerical shift. The last statement must be further clarified: the card punch is in numerical shift with program control on, IF a card is on the program drum.

SPECIAL NOTE: If there is no card on the program drum and the star wheels are down (program control on), the star wheels, under spring tension, all react as though they had detected holes. Needless to say, "detecting" holes in several rows simultaneously could give the card punch contradictory instructions and can cause damage to the card punch.

13. Why should the star wheels never be lowered when there is no card on the program drum?

Preparing Program Cards

The simplest program card is one into which no holes have been punched—that is, a blank card. With a blank card on the program drum and the star wheels lowered, the card punch remains in numerical shift.

As was previously mentioned, the card punch program unit can control automatic skipping over columns not to be punched, automatic duplicating of repetitive information from the card at the reading station and the shifting from numerical to alphabetic punching mode and vice versa.

Skipping is initiated by detecting an 11 punch in the program card. The length of the *skip field* (which may comprise one or more information fields) is indicated by detecting consecutive 12 punches which immediately follow the 11 punch.

Duplicating is initiated by detecting a 0 punch. The length of the *duplicate field* (which may be one or more information fields) is indicated by detecting consecutive 12 punches which immediately follow the 0 punch.

Shifting to alphabetic mode is accomplished by detecting a 1 punch in the program card. When the keyboard is in alphabetic shift, any character key (1-27, 40-43) may be depressed and the proper pattern of holes will be punched. The keyboard is in numerical shift when a 1 punch in the program card is absent. NOTE: During duplication of

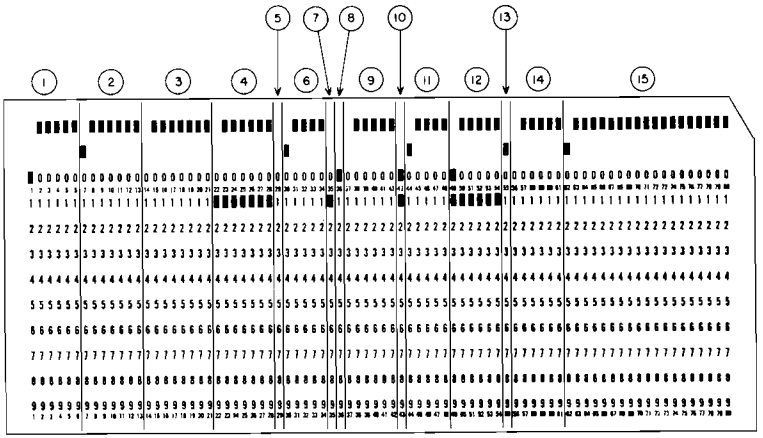


Figure 13.

alphabetic information, the 1 punches permit automatic spacing over blank columns. IBM card punches have been designed to recognize blanks as being valid only in an alphabetic field. Thus, if duplication of a blank column is attempted while in numerical shift, the keyboard will "lock up"—that is, character keys cannot be depressed.

14. *A punch in what row of the program card initiates skipping? Duplicating?*
15. *What punch indicates the length of a skip field? For a duplicate field?*
16. *Why does the card punch recognize a blank column at the reading station as invalid during numerical duplication?**
17. *If the program card is punched with a 1 in column 25, and, according to the indicator, the next column to be punched is column 25 but numerical information is required, how would this be accomplished?**

Figure 13 shows how a program card for performing various functions is prepared. If this card is used in the program unit of a card punch, the following actions take place:

1. Columns 1-6 of the card at the punch station are duplicated with information from the corresponding columns of the card at the read station.

2. Columns 7-13 are skipped.

3. Columns 14-21 are programmed for numerical punching. That is, if a combination key is depressed, a numerical character will punch. (If a non-combination key is depressed, the card punch locks up.)

4. Columns 22-28 are programmed for alphabetic punching. That is, if a combination key is depressed, an alphabetic character will punch.

5. Column 29. Same as item 3 except that there is only one column.

6. Columns 30-34. Same as item 2.

7. Column 35. Same as item 4 except that there is only one column.

8. Column 36. Same as item 1 except that there is only one column.

9. Columns 37-42. Same as item 3.

10. Column 43 of the card at the punch station is duplicated with the alphabetical information (or a blank), from the corresponding column at the read station.

11. Columns 44-48. Same as item 2.

12. Columns 49-54. Same as item 10 except that there is more than one column.

13. Column 55. Same as item 2 except that there is only one column.

14. Columns 56-61. Same as item 3.

15. Columns 62-80. Same as item 2. NOTE: When the cards at the punch and the read station pass column 80 they will release automatically to the next station if the automatic feed switch is on. If this switch is off, the cards will hang up after column 80 (i.e., column 81) and can be released only by depressing the release key.

Summary of Program Card

Five basic program codes are summarized below:

Code	Function
Blank	Indicates the beginning of a field to be manually punched.
1	Shifts keyboard to alphabetic mode for the column in which it appears.
0	Starts automatic duplication.
11	Starts automatic skipping.
12	Defines the length of the field or operation.

There are two additional codes which control printing features on the IBM 26 Printing Card Punch. These two codes, together with the significance of the remaining six codes, are explained in the reference manual for the IBM 24 and 26 punches.

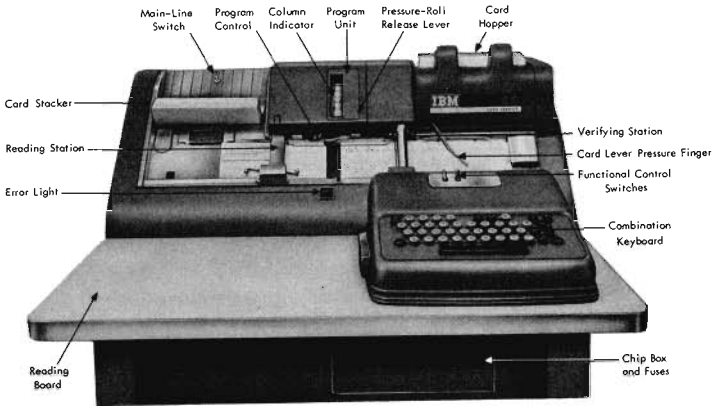


Figure 14. IBM 56 Card Verifier.

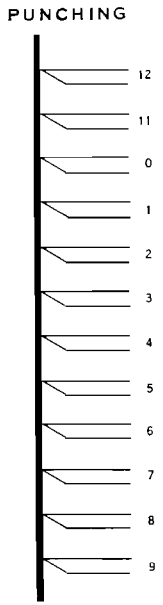
Note that the features of the IBM 56 Verifier are almost identical to those of the IBM 24 Card Punch.

Verifying Punched Cards

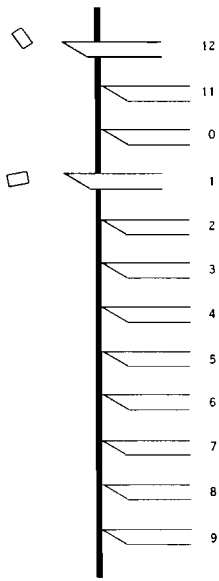
While the number of cards prepared by a machine operator will probably never be great enough to require a machine verification, the function of the IBM 56 Verifier should be understood (see Figure 14). Verification of the few cards punched by a machine operator for testing a control panel can be done by a visual comparison of each hole punched with the written character.

While in most cases the card punch operator is immediately aware of the mistake she has made and can thus correct it, mistakes occasionally pass undetected. Such mistakes may be due to her misinterpretation of the handwritten character. Therefore, after a batch of cards has been punched, they are taken to a verifier operator who checks the work of the card punch operator. With the source documents in the same sequence as the cards to be verified, the verifier operator duplicates the key strokes of the card punch operator. But, no holes are punched. In the verifier, a sensing mechanism consisting of twelve pins has replaced the twelve punch dies (see Figure 15). If a verifier operator depresses the same key which the card punch operator selected in making the original hole, the card proceeds to the next column to be checked. If, however, she depresses a different key, the verifier "lights up." This is a signal that the hole pattern detected by the sensing mechanism did not agree with the depressed key.

The verifier operator has two more chances to seek agreement between the key which she regards as correct and that depressed originally by the card punch operator. If there is no agreement after three tries, the top edge of the card is automatically notched in that column (see Figure 16).



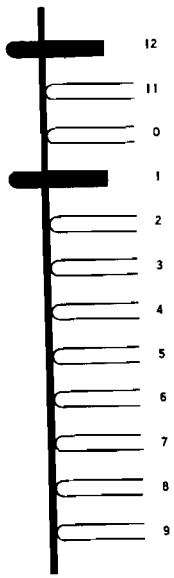
Schematic of punch dies on an IBM 24 or 26 Card Punch.



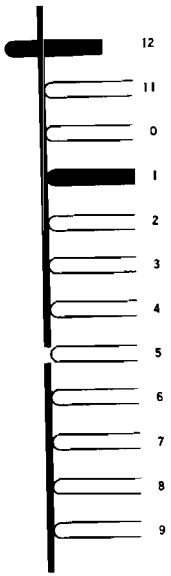
Schematic of punch dies if the letter A is being punched.

Figure 15a.

VERIFYING



Schematic of sense pins in an IBM 56 Verifier checking holes in a card upon depression of the A key. In this case there is agreement so the card will advance to the next column to be checked.



Another schematic of pins checking holes in a card when an A key is depressed. In this case there is no agreement; the error light comes on and the keyboard locks up.

Figure 15b.

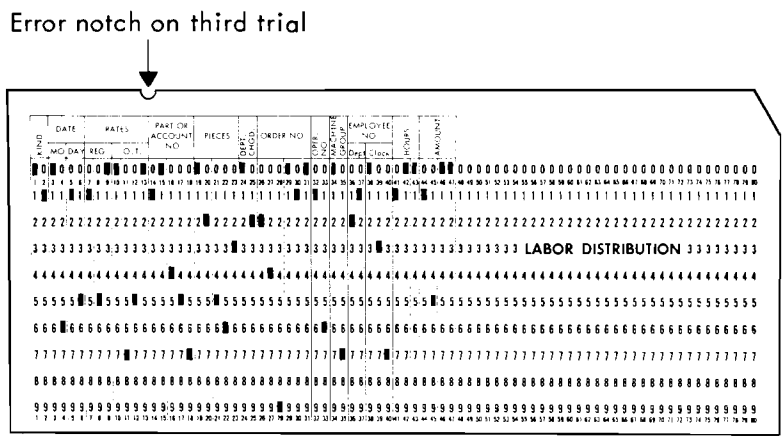


Figure 16. Error Cord.

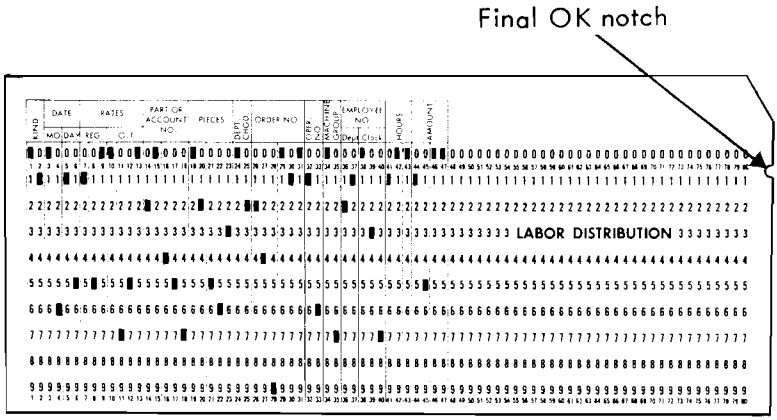


Figure 17. Correct Card.

All cards that pass the verifier test are notched on the column-80 end of the card just opposite the 1 row (see Figure 17). Naturally, any cards which did not pass verification are not notched on the column-80 end. Thus it is easy to separate the correct cards from the incorrect cards after the verifier operator has completed her task. If the number of incorrect cards is relatively high, it is quite possible that they will be analyzed for a pattern so that the number of future errors will be reduced.

18. *Comment on another card punch operator punching the cards a second time, then checking the columns for double punches instead of using an* IBM *56 Verifier for verifying the cards.**
19. *Write the steps for creating a new card from a slightly damaged card.*

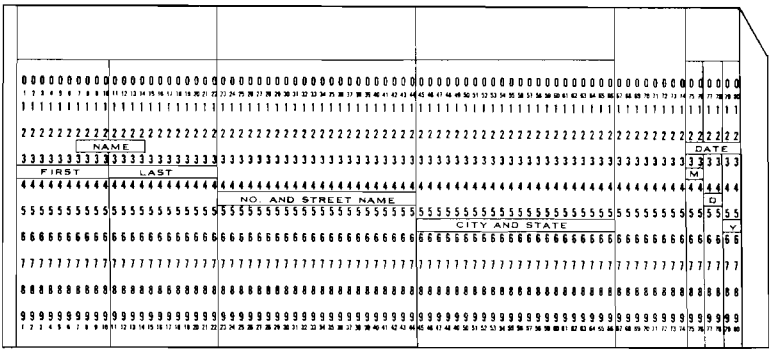


Figure 18.

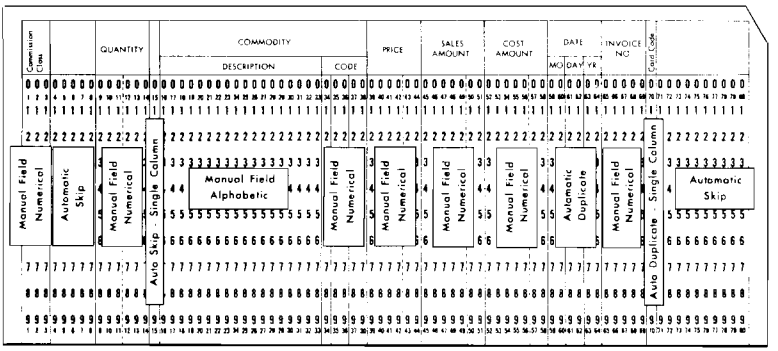


Figure 19.

20. *Write, in detail, the steps for creating a new card from one containing errors. Assume that the numerical information in columns 7-12, 23-27, and 51-65 is* incorrect *and that the correct information has been made available.**
21. *Indicate the punches required to prepare a program control card for punching the card in Figure 19.**

Answers to Asterisked Questions

1. The unit record principle is that all data concerning a single transaction is recorded in one punched card and the punched data remains the same for each use of the card. In Figure 1, each transaction involves the sale of a specific product. Related data that is required is the number of the customer to whom the item was sold, the number of the salesman who sold the item, etc.

Another example of a unit record is shown in Figure 3. Here the transaction involves an employee. Related data that is required is his Social Security number, various accumulative earnings, etc.

6. The 8, 0, 0 and 5 are punched into columns 18, 19, 20 and 21 respectively. Zero is punched in column 17. Almost without exception, numerical information is punched into a field so that the digit of the lowest order (in this case the 5) is the rightmost column of the field. When the number of significant digits is less than the number of columns allotted, the field is filled (punched) with zeros in the high-order positions. Punching zeros rather than depressing the space bar is a more positive indication that the card punch operator ascertained the correct number of significant digits.

In the case of an alphabetic field (Figure 3, columns 30-43, for last name), the letter of the highest order, in this case the C in Cornsors, is punched in the leftmost or highest-order column; followed by O, R, N, S, O, R, S in columns 31-37; zeros do not fill in the unused columns, in this case columns 38-43.

16. The answer to question 6 provides one of the clues to this answer. That is, since a zero and a blank are two distinct characters and the only numerical characters are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, a blank is obviously NOT a numerical character. IBM card punches have been designed so that if a blank is detected during duplication of numerical field, they will stop, thus calling the error to the attention of the card punch operator.

17. The numerical shift key must be depressed concurrently with the proper combination key. Raising the star wheels (turning program control off) does not put the keyboard into numerical shift; rather, it places it into continuous alphabetic shift. Therefore, if a numerical character is to be punched when the program card is punched with a one (or when program control is off), the numerical shift key must be depressed.

18. This method may be used in instances where the volume of cards is low and no verifier is available. For large scale card-punching operations, however, its main disadvantage is that it gives the verifying operator only one chance to seek agreement. For once a hole is punched in a card, it cannot be "unpunched." With the IBM verifier, however, if the operator's first attempt at agreement is unsuccessful (perhaps because of an inadvertent key depression or misinterpretation of a character in the source document), she has two more chances.

20. Assuming that the machine has been turned on, that the auto feed switch is off, and that program control has been turned off:

a. Place the card in error just to the right of the reading station and a blank card just to the right of the punching station.

b. Depress the register key. This positions both cards at column 1 of their respective stations.

c. Depress the duplicate key for columns 1-6. This may be six consecutive momentary depressions or one lengthy depression. However, since manual duplication takes place at a rate of ten columns per second, it is advisable to use consecutive momentary depressions.

d. Keep the numerical shift key depressed while punching the proper keys for columns 7-12.

e. Depress the duplicate key for columns 13-22.

f. Keep the numerical shift key depressed while punching the proper keys for columns 23-27.

g. Depress the duplicate key for columns 28-50.

h. Keep the numerical shift key depressed while punching the proper keys for columns 51-65.

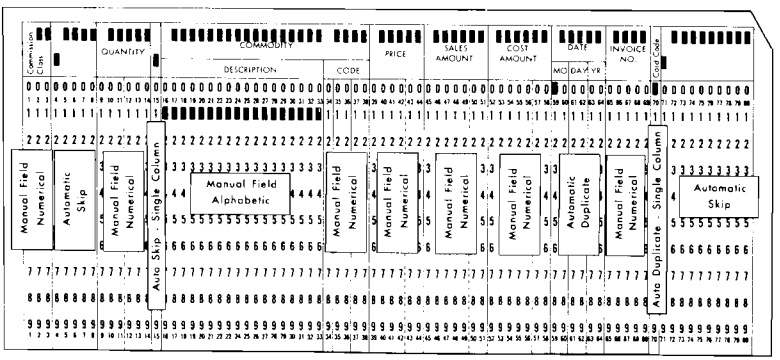
i. Depress the duplicate key for columns 66-80.

j. Depress the release key and register key alternately twice.

k. Remove the cards from the stacker and sight-check for verification.

l. Appropriately file the card which was in error.

21.



Program Card.

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