IBM

General Information Manual

An Introduction to IBM Punched Card Data Processing

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Contents

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For almost three quarters of a century the punched card has been utilized to solve record-keeping problems. Since the first governmental application of punched cards, their use has extended into virtually every type of commercial and scientific enterprise. The development of the cards, and the machines to process them, began as the result of a specific need. Demands from government, science and industry have brought about today's IBM punched card data processing machines and large electronic computers. They are called data processing machines because their primary function is to process business, scientific or commercial information (data) in such a fashion as to give desired results. Results may take the form of a paycheck, a commission statement, a purchase order, a customer invoice, a sales report, a profit or loss statement, or an inventory report. All of these tasks, and many others, may be performed on the same set of equipment.

The development of the punched cards and the machines to process them was stimulated by the needs of the United States Census Bureau. In 1880 the ten-year census was taken for the tenth time as required by law. Census data was handwritten on large cards. In order to compile facts, the cards had to be hand-sorted into the proper classifications (such as home owner, occupation, etc.) and counted manually for desired totals. They were then sorted and tallied again and again to complete the whole Census Report. This method was tedious, cumbersome and costly, as millions of cards were involved. The possibilities for error were great and checking for accuracy was nearly impossible.

By 1885 the Census Bureau was still struggling to compile the collected facts of the 1880 census into useful and meaningful form. When it became apparent that in the future the compilation could take longer than the ten-year span between each census, the need was realized for a faster and more accurate way to perform the required task. By 1887, when the 1880 Census Report was finally completed, Doctor Herman Hollerith, a statistician with the Census Bureau, had worked out the basis for a mechanical system of recording, compiling and tabulating census facts. His system consisted of recording the census data crosswise on a long strip of paper. The facts were recorded by punching holes in the strip in a planned pattern so that each hole in a specific location meant a specific thing. A special machine was able to examine the holes and electrically perform the tabulation as the long strip was passed over a sensing device. For ease of handling and for durability the paper strips soon were replaced by cards of a standard size and shape. Each card was used to record the facts about an individual or a family – a unit situation. These cards were the forerunners of today's punched cards, or "unit records."

The first users of the punched cards employed them for vital statistics. Some of the early users were the City of Baltimore, the Bureau of Vital Statistics of New Jersey and the Board of Health of New York City. In 1890 tabulating equipment was used for the first time in census work with great success in reducing the time necessary to complete census reports. The completed reports were available for use in two and one-half years, or about one-third of the time spent on the previous compilation, despite an increase in population from 50 million to 62 million in the intervening ten years.

Through the next years the equipment became more developed for the purposes of the Census Bureau. Then came a wider application of the idea. If the equipment was satisfactory for use in tabulating the census, might it not also be suitable for business? The answer was yes, and firms found uses for the equipment, mostly statistical. Insurance companies adopted the machines for analyzing risks in various classifications (actuarial work). Railroads were early users for the analysis of freight statistics. A large department store used punched cards for sales analysis. Cost accounting in a steel company was a commercial use for punched cards prior to 1900.

In the late 1800s and early 1900s, market areas were widened by improved transportation, and manufacturers were adopting mass production techniques. Commercial enterprises were growing. Their record-keeping and accounting functions required more and more personnel. Each individual in the office was performing a smaller part of the overall operation. The time necessary to combine the individual's results with all of the others was excessive. Accounting results were often received so late by management that they were of an historical rather than operational nature. The solution to many such problems was the use of data processing machines, which were employed to reduce the mountains of paperwork, to effect standardization of methods, to speed up results and to reduce the cost of record keeping.

In addition, the application of punched cards to commercial problems has resulted in the ability to manage "by exception." Management is notified of those situations which call for decision at a specific time. For example, in using punched cards for inventory control, only those items which are overstocked or understocked (according to previously established standards) are called to management's attention. The items for which there are adequate inventory amounts are automatically passed over. Management does not have to examine each inventory record to locate the few calling for attention. The time of the individual may be spent on more productive tasks. The importance of this is that many firms maintain thousands of different items in stock.

In recent years record-keeping problems have multiplied because of the size of business, its competitive nature and the demands of management in wanting up-to-date facts with which to guide their business. IBM punched card data processing equipment has been augmented by the development of the electronic computer which enables the user to accomplish data processing tasks hitherto determined impossible. The tremendous power of the electronic computer is the direct outgrowth of the need for it.

The use of the punched card has spread to almost every area of commerce, science and industry, and to almost every size of enterprise within each area. The punched card meets the record-keeping requirements of the small wholesaler, the scientist or the small town just as easily as those of the largest. The success of the punched card in meeting these requirements is expressed through its widespread use in the world today.

Fundamentals of IBM Accounting

The basic principle of IBM accounting: information is recorded once in an IBM card which is then available as required to give desired results by machine processing. Data is registered in IBM cards in the form of punched holes. Once the punching is completed there is a lasting record which may be processed at machine speeds to obtain desired or needed results, when required. Transactions of a similar type are processed together to increase machine effectiveness.

In accounting, one transaction usually affects more than one account. The source document on which the transaction is recorded is used to post to all affected accounts. However, if more than one transaction occurs in a given period, the usual method is to summarize the transactions for that period by each account and then post the total to the appropriate account.

This system requires the sorting of documents manually to obtain the proper groupings. Totals are taken by each group and then posted. For example, in a sales enterprise some of the entries which might be made as the result of a sale are to sales records, accounts receivable ledgers, inventory records, and salesmen accounts. Each posting requires a different sorting of the same source document. Totals are taken manually and posted manually after each sort.

Utilizing the IBM method of accounting, the details of the transactions are punched — one transaction to a card, or unit record. Once the accuracy of the punching is verified, the grouping by account may be accomplished on a sorting machine at a high rate of speed; then the total may be summarized by group mechanically. After that the cards are re-sorted and resummarized by machine. This continues until all the necessary totals have been taken and the entries made.

In summary, the basic principle of IBM accounting is that information once recorded in an IBM card may be used time and time again. Data is punched and verified and may then be classified (sorted) and summarized to produce desired results by machine processing.

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 eighty vertical areas called "columns" or "card columns." They are numbered one to eighty from the left side of the card to the right. Each column is then divided into twelve punching positions. Thus in the IBM card there are 960 punching positions altogether. The punching positions are designated from the top to the bottom of the card by 12, 11 or X, 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. 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 is facing up and "face down" means the opposite.

Each column of the card is able to accommodate a digit, a letter or a special character. Thus the card may contain up to eighty individual pieces of information. Digits are recorded by holes punched in the digit punching area of the card from 0 to 9. For example, in the card in Figure 1, there is a 1 punched in column 63, a 9 in column 72 and a 4 in column 77.

The top three punching positions of the card (12, 11 or X, and 0) are known as the zone punching area 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 are based upon a logical structure (or code).

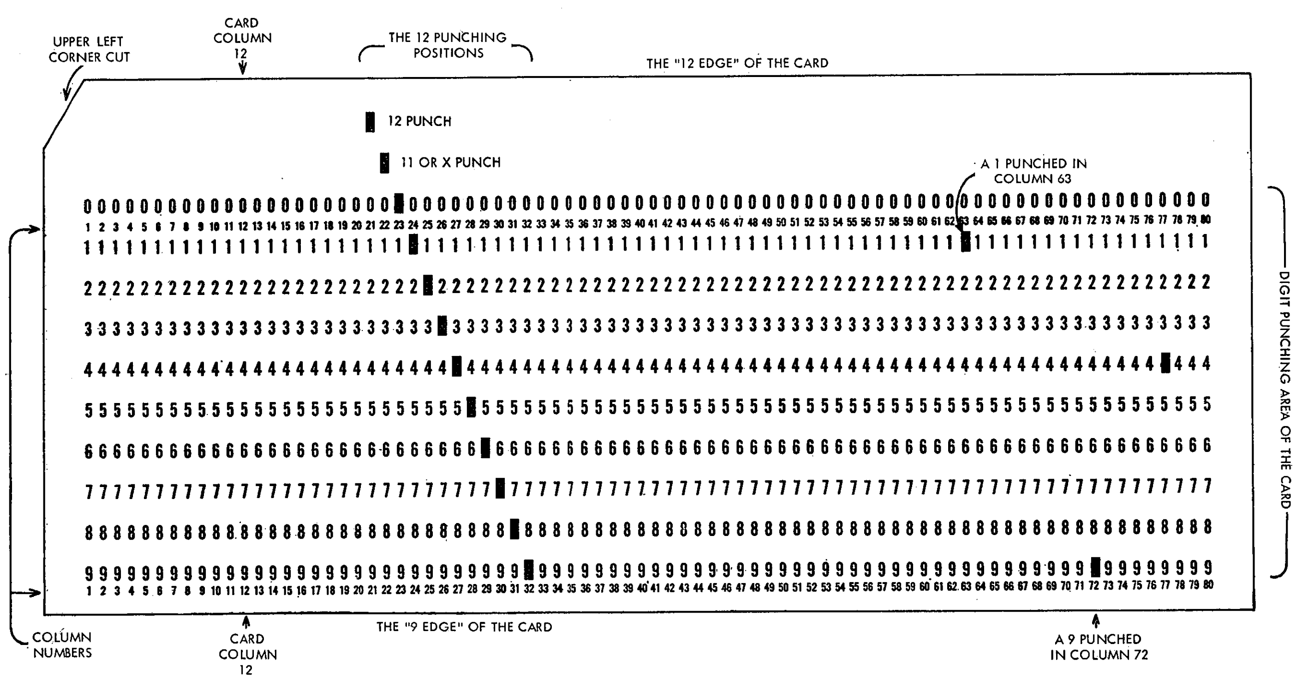

Figure 1. An IBM Card

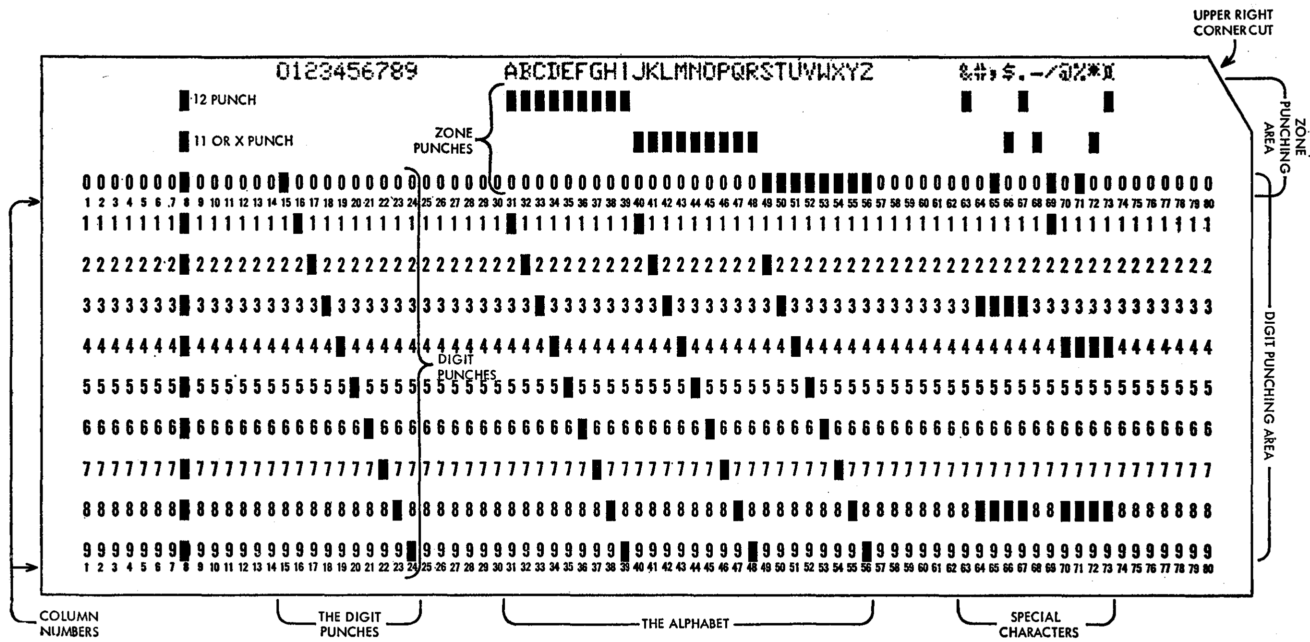

Figure 2. Punching

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 or X punch and the digits 1 through 9. S through Z, the last eight letters, are the combination of the 0 zone punch and the digit punches 2 through 9. This alphabetic coding is illustrated in Figure 2. The conversion of letters to and from this coding structure is done automatically by the various machines used to record or process data and it is rarely necessary to refer to data in its coded form.

The eleven special characters are recorded by one, two or three punches. Their function is to provide printed symbols as required, to cause certain machine operations to occur, or to identify various cards.

Cards are divided into segments called "fields." A field is a column or columns reserved for the punching of data of a specific nature. The field may consist of one column or eighty columns, depending upon the length of the particular type of information. For example, a name and address field would be longer than a telephone number field. Machine processing requires a standard arrangement of data in the card; therefore, once a field is assigned to a specific purpose, it is reserved for one kind of data in cards used in the same job.

Field length is determined by the maximum length of information which will be entered into the field. A numerically coded date may take up only six columns, so a field of six columns is assigned for the punching of the date. A typical date field is illustrated in Figure 3. A company engaging in sales activity may have only 34 salesmen, with no prospect of having more than 99 salesmen. A two-column field would be assigned to the recording of salesman number. If the company were expanding rapidly and an increase in the sales force to 100 or more were anticipated, a three-digit field would be assigned. Field assignment and card layout are usually made after analysis of individual needs.

Figures 1 and 2 illustrate the two most common types of corner cuts — upper left and upper right. 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 of a similar nature.

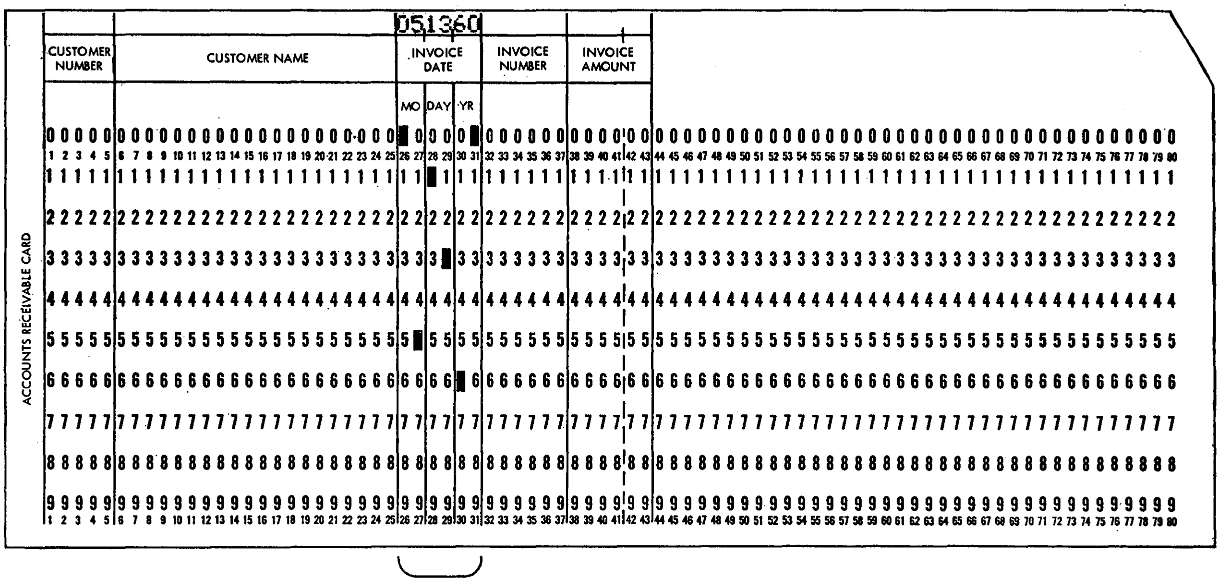

Figure 3. A Date Field

Coding Data

One purpose in assigning codes to data is to enable presentation of the data in the most meaningful, orderly and useful fashion, taking into account the relationship of each item of data with other items of the same or similar nature. The ability to present related data in report form depends greatly upon the coding structure used. The assignment of codes to data is the most accurate and easiest way to express the relationship of items or information. The complexity of the relationships governs the complexity of the coding structure.

Prior to the selection of the type of code used and the assignment of the code to the data, the identity and nature of the data must be analyzed. The informational needs and desires of management are also considered in the analysis.

A code may be alphabetic, numerical, or both, although numerical codes predominate. The simplest type of coding is the assignment of the numbers in sequence to items on a list. Another type is the assignment of numbers in sequence to data in alphabetic order, such as a listing of names or firms. Other codes more sophisticated take into consideration family relationships of data, such as related items of hardware, screws, nails, garden implements, and so forth. Some codes are constructed so that each segment of the code is descriptive of a specification of an object, such as bolt, carriage, steel, hexagonal head, 2 inch, etc.

The use of a coding structure usually permits faster machine processing in classifying or arranging. This results from the ability to act upon the code number rather than the longer designation of the data. By coding there is often a saving in the number of card columns utilized, thus reducing the amount of card punching.

The use and assignment of codes does not mean that the user must familiarize himself with the coding structure involved. Reports usually reflect the data designation by name rather than the code number, although both are often printed.

Punching and Verifying Data

Figure 4. The IBM 26 Printing Card Punch

Data is recorded in the form of punched holes by means of a card punch. The IBM 26 Printing Card Punch is illustrated in Figure 4. A keyboard on the punch, similar to that of a typewriter, is activated by key depression to cause punching of the proper letter, digit or special character in a card column. Data being punched may be printed at the top of the column depending upon the type of punch used. The punch operates serially; one column at a time is punched. After one column is punched the card is automatically positioned for punching the next.

Cards pass through the punch as indicated in Figure 5. A card moves from the card hopper to the punching station. After punching, the card is automatically released to the reading station. The card then passes through the reading station in phase, column by column, with the card behind at the punching station. After the card behind it is released from the punching station, the card at the reading station moves into the card stacker.

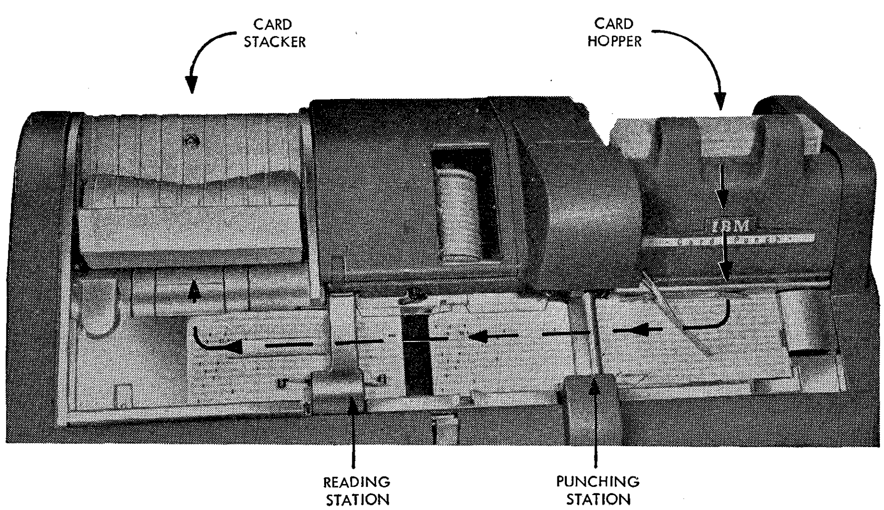

Figure 5. The Path of the Card through the Punch

Because a card passes the reading station in phase with the card at the punching station, it is possible to have automatic duplication from card to card. The information in a specific column of a card at the reading station may be read and transmitted back to be punched in the same column of the card at the punching station.

The ability to duplicate from card to card reduces the amount of manual punching necessary. Data common to a group of cards (such as a date) may be punched into the first card of a group and then duplicated into the rest of the cards in that group. Duplication may be started by the depression of a key, or it may be under the preplanned control of the machine itself upon reaching the first column of the field to be duplicated.

Other functions which may be under automatic or manual control of the punch are skipping, ejecting and feeding, and printing. Because cards are punched in batches by type of job, a pattern of punching is established which permits instructing the punch to skip fields, duplicate fields or release the card when punching is complete. This instruction of the punch to skip, duplicate or release at a particular card location is known as programming.

The ability to perform many of the machine functions automatically permits faster job processing. Skipping takes place at the rate of 80 columns per second. Automatic feeding of a card takes one-fourth of a second. Duplication proceeds at a rate of either 18 or 20 columns per second, depending on the type of punch. The ability to duplicate from one card to the next increases overall punching speed, and accuracy is increased because the possibility of error is reduced. Data to be duplicated is punched once and then automatically copied at machine speed.

In addition, the ability to duplicate makes the correction of punching errors easier. If an error is noted, the card is duplicated up to the point of error, the correct data is punched and then the rest of the card is duplicated. Thus only the incorrect portion needs to be repunched.

From right to left the positions in a field are known as the units position, the tens position, the hundreds position, thousands position and so on. Numbers to be punched may be labeled in the same fashion. Punching is from left to right with the units position of the number punched in the units position or right-hand column of the field. If the number to be punched is shorter than the field, zeros are added to the left until the number equals the field size.

For example, if the number to be punched is 764 and the field is five columns in length, the number as punched would be 00764 and would appear as illustrated in Figure 6. Because the fields are laid out in advance to accommodate the maximum number of digits expected, data should not exceed field size.

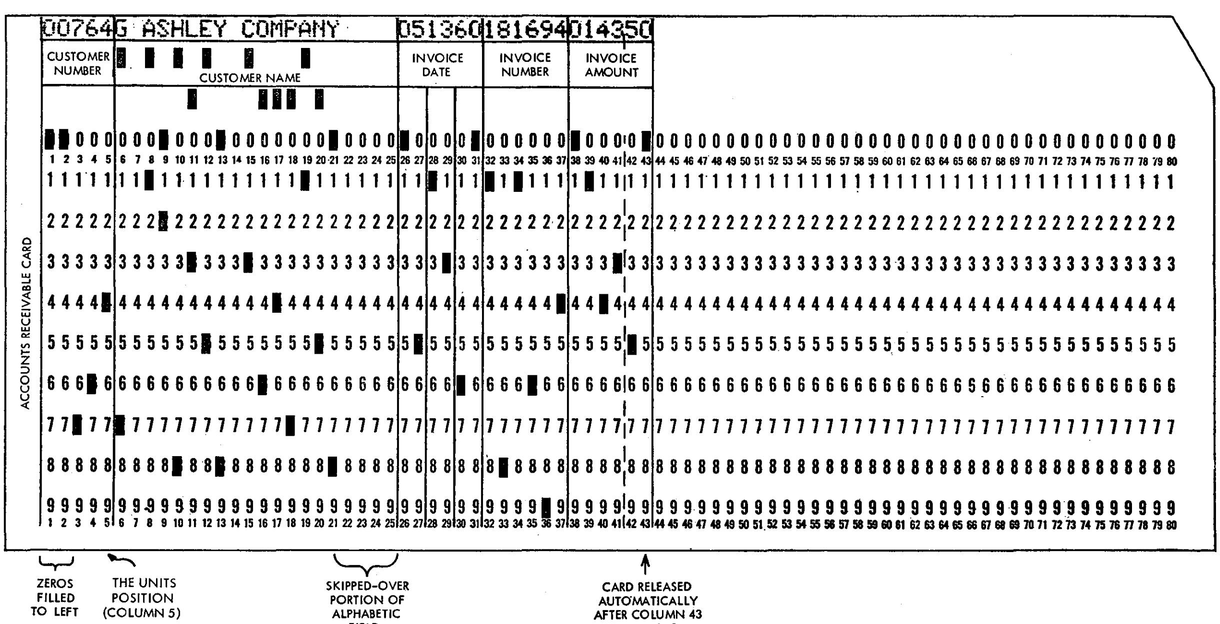

Figure 6. Examples of Punching Practices

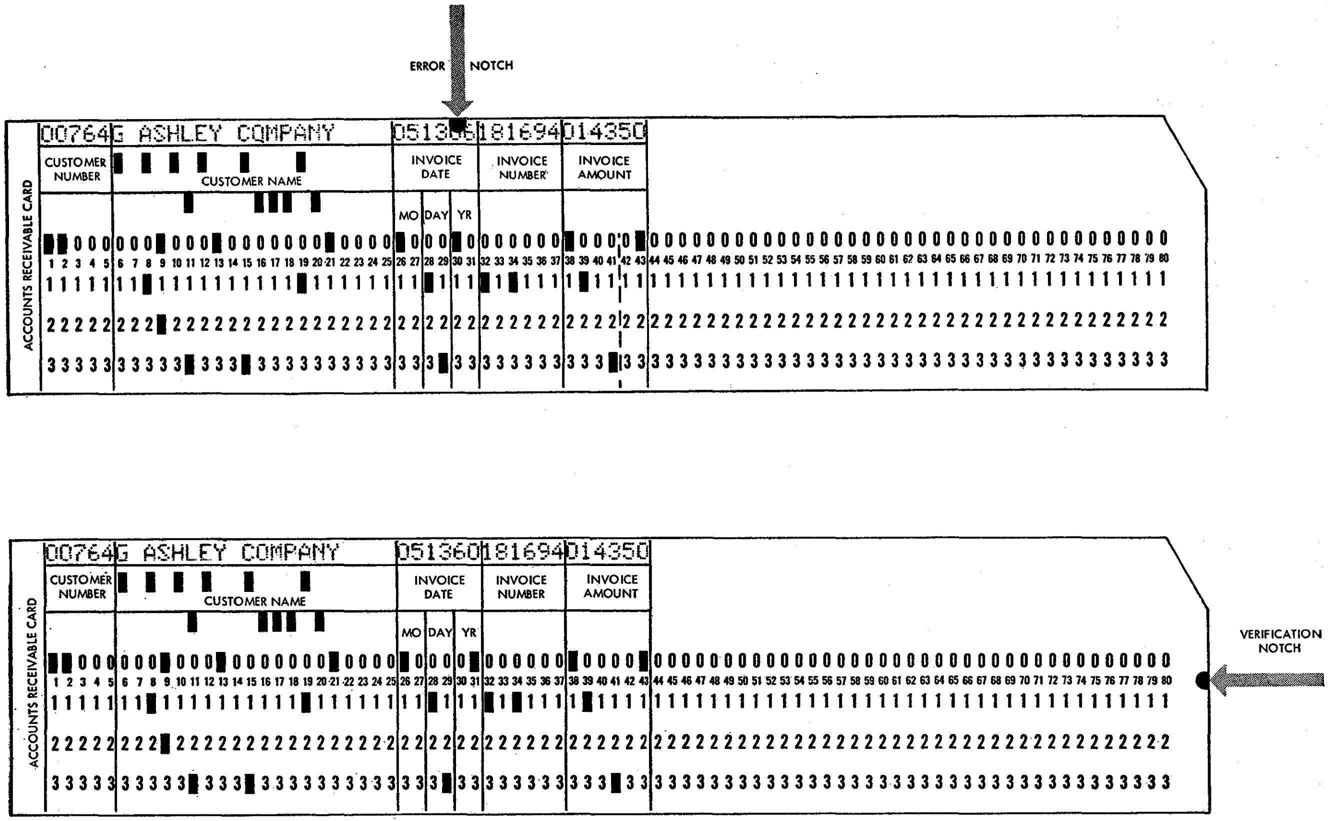

Figure 7. Error and Verification Notches

In punching an alphabetic field, the punching starts in the leftmost column of the field and continues to the last letter to be punched or the end of the field. If alphabetic data does not fill the field, the remainder of the field is skipped over unpunched, as illustrated also in Figure 6.

After cards have been punched, the data in them is usually checked for punching accuracy. The two most common methods are visual and machine verification. Visual verification involves reading the data printed at the top of the card during punching and comparing what is read with the data on the source document. This method may be accomplished by one person alone or by one person proofreading to another. The data may also be printed from cards and then proofread.

Machine verification is performed on the IBM 56 Verifier, a machine similar in appearance to the card punch. The first station of the verifier is called the verifying station rather than the punching station. The operation is similar to card punching. Previously punched cards are placed in the hopper and the first card is fed into position at the verifying station. Reading the source document, the operator depresses keys as if punching.

As the proper key of the keyboard is depressed, a thin metal plunger passes through the hole or holes previously punched in a column. The plunger passing through the hole permits the card to advance to the next column. If an error was made in the original punching of the card, the plunger will have no opening through which to pass and the card will not advance to the next column. After depression of the proper key and no column advance, the machine recognizes an error condition and puts a notch over the incorrect column, as shown in Figure 7. The last digits in the date field are transposed. Correctly punched and verified cards are notched as indicated.

Principles of IBM Machine Processing

The IBM card with data punched in it serves two major functions. The card is the means by which the data is stored; information in the card is available over long periods of time for use as needed. The card also serves as the conveyor of the data, as it is the means by which the data is introduced into IBM machines for processing.

Before data in the card is processed the machine must change the punched holes into electrical impulses. IBM machines operate on data which has been converted into electrical impulses. The process of converting the punched holes in a card into electrical impulses is known as "reading." Reading is done by the completion of an electrical circuit through the hole punched in a card column.

As a card passes into the machine each column goes under a separate wire brush. If there is a hole in a column, the brush makes contact with a source of electricity (the contact roller) through the hole, creating an electrical impulse which the machine is able to process. The impulse is of short duration, lasting only as long as contact is maintained through the hole by the roller and the brush. If there is no hole in a column, no circuit is completed and there is no impulse. The thickness of the card and its nonconductive qualities prevent contact. Between cards, contact is made, but no impulse is created. The principle of card reading, or converting the punched hole into an impulse, is illustrated in Figure 8.

The passage of the card between the brushes and the contact roller occurs at a specific time in the cycle of the machine. Because of this relationship between the card movement and the machine, the difference in impulses created by different holes in a column is recognized. Thus the punched hole is actually converted into a "timed" electrical impulse. A hole in the 3 position of a column gives an impulse at a different time than a hole in the 9 position or a 4 or a 2. Furthermore, if there is more than one hole in a column, two or more impulses are created, each of which is distinct to the machine.

Once data has been converted into electrical impulses, the impulses are processed by the machine. The type of processing which the data undergoes depends upon the type of machine used and the results desired. Once processing has occurred, the results are in the form of impulses also. These resulting impulses are then converted into output form, which may be holes punched in the same card or another, a printed line, a machine function, or some combination of these.

The processing cycle is thus: cards are fed into machines which "read" the data and convert it from punched holes into electrical impulses. The impulses are processed, resulting in other impulses which are then converted into the desired output form or function.

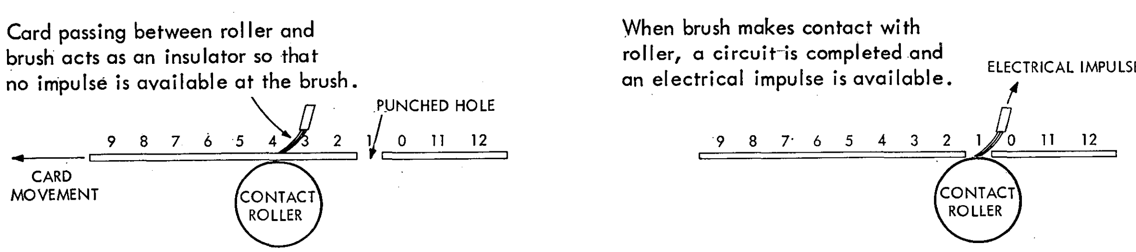

Figure 8. Converting the Punched Hole into an Electrical Impulse

Sorting Data

Prior to the preparation of data in report form, the data is arranged in an orderly fashion for easy use and ready reference. The process of arranging data in a sequence which will meet a specific requirement is known as sorting, or classifying. Data arrangement is accomplished on the sorter. The three basic types of classification performed on the sorter are sequencing, grouping and selecting.

Sequencing is the process of arranging data in alphabetic or numerical order, either ascending or descending. For example, it may be desirable to have a register of current transactions. Before preparing the transaction register, the cards representing the transactions are sorted on the transaction number field by means of a sorter. The transaction numbers are in ascending sequence after sorting. Thus any transaction might be referred to on the subsequent report with a minimum of effort. Sequencing is illustrated in Figure 9.

Grouping is the process of arranging like items together. For example, it may be desirable to have a report showing sales by each salesman. The cards are sorted on the salesman number field, which results in the grouping by salesman needed for the report. Grouping prepares data for reports in summarized form, or for analysis of like data. Figure 10 shows an example of grouping.

Selecting is the process of extracting a desired item or items of data from a larger file of data. If all credit transactions are needed to prepare a special analytical report, it is possible to remove them from a file of all transactions. This is done on the sorter without disturbing the sequence of the remainder of the file. Because of this ability to select specific data, reports reflecting only items under consideration may be prepared. Selecting is illustrated in Figure 11.

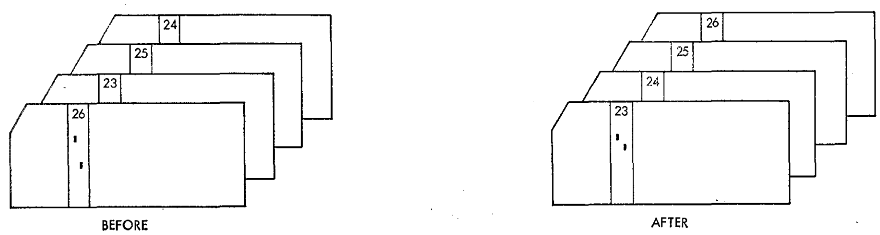

Figure 9. An Example of Sequencing

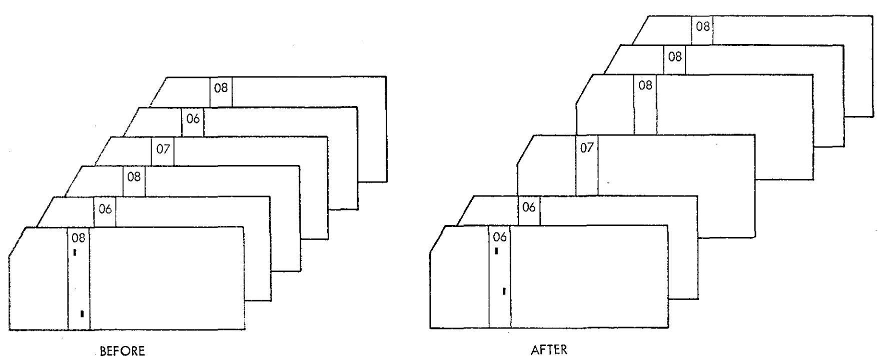

Figure 10. An Example of Grouping

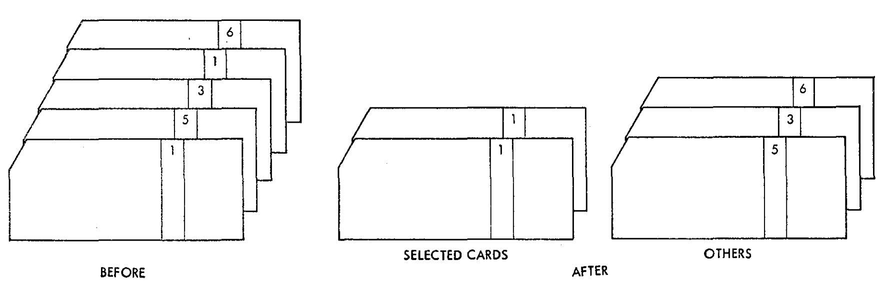

Figure 11. An Example of Selecting

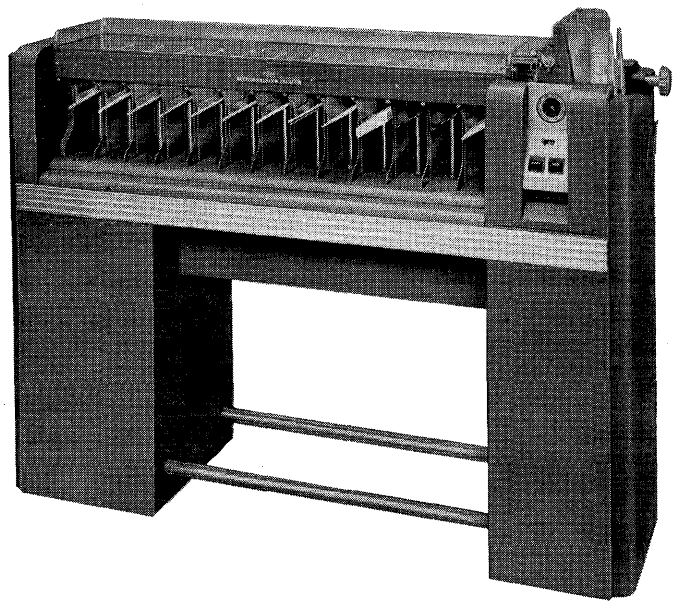

Figure 12. The IBM 82 Sorter

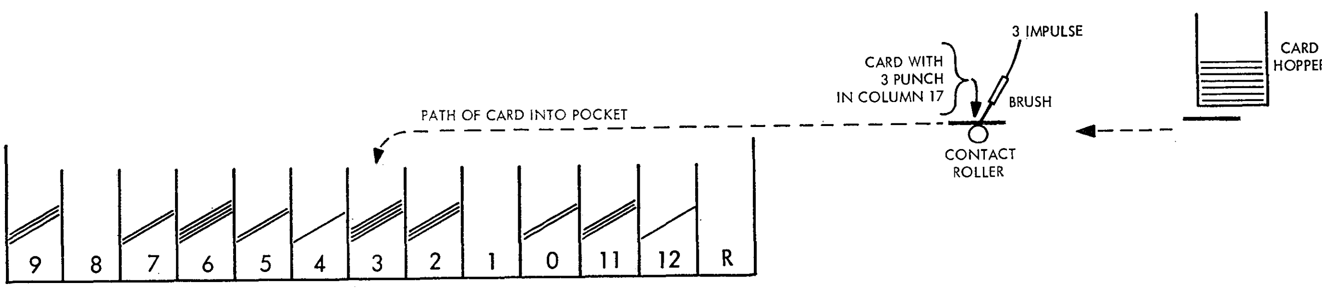

Figure 13. Diagram of Sorter Operation

There are a number of different IBM sorters which may be used for data arrangement. They range in speed from 450 cards per minute to 2,000 cards per minute. The IBM 82 Sorter is illustrated in Figure 12. Its speed is 650 cards per minute.

An IBM sorter operates on one column of data at a time. The sorter has 13 pockets to receive sorted cards. There is a pocket for each of the punching positions in a column, and one pocket for cards with no hole in the column being sorted. Because one column is sorted at a time, only one brush is needed by the sorter for reading. This brush is movable and is placed to pass over the column being sorted. As contact is made by the brush with the contact roller through a hole punched in the column, an impulse is created which is used to open a path for the card to be carried by other rollers to the appropriate pocket. For example, if there is a 3 in column 17, which is the column being sorted, the impulse created at "3 time" opens the path for the card to fall in pocket 3. A 7 punch causes the card to be directed into the 7 pocket, etc. Figure 13 illustrates sorter operation.

If the data field being sorted is five digits in length, the group of cards must be sorted five times. Alphabetic information may also be sorted. Two sorts per column are required, one for the digit punch of the letter, and the other for the zone punch.

The Accounting Machine

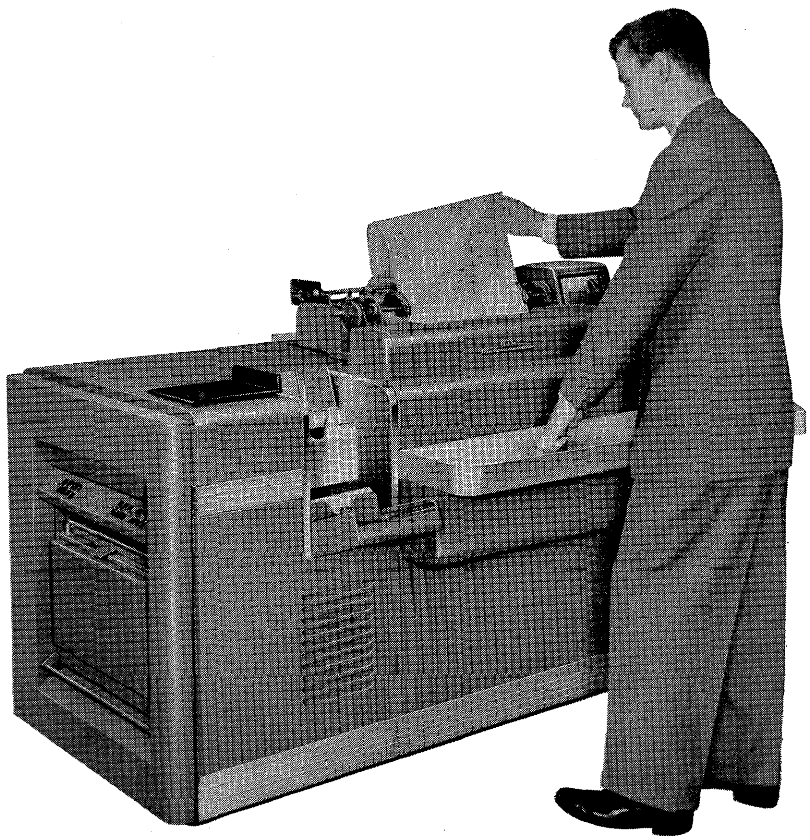

Figure 14. The IBM 402 Alphabetical Accounting Machine

The basic purpose of the accounting machine is twofold: to print alphabetic and numerical data from punched cards in an orderly, meaningful and desired fashion, and to total data by proper classifications. Accounting machines vary in the number of totals which may be accumulated at one time, in speed and in processing capacity. The type and capacity of the machine used depends upon the requirements of the individual task. The accounting machine illustrated in Figure 14 is an IBM 402 Alphabetical Accounting Machine. The 402 prints up to 88 characters on a line at speeds up to 100 lines per minute, while accumulating up to 80 positions of totals.

The printing unit consists of two sections of typebars which print the data. The left section contains 43 typebars, each capable of printing any alphabetic or numerical character. The right section has 45 typebars which print numerical data. Up to 88 characters may be printed simultaneously on one line of the report. To take full advantage of the printing speed of the 402, report forms in continuous form are used. Hand feeding of single forms is thus eliminated. Forms spacing and positioning during printing are performed automatically. After printing, the forms are usually separated. Preprinted headings on the report forms permit easy reference to the data. A number of carbon copies may be made at the same time by using multiple-part forms.

Printing is performed in two different manners. Data may be printed from cards with one line printed per card. This method is known as detail printing, or listing. Detail printing is performed when complete information about transactions is desired, such as for registers, statements of account or detailed inventory transaction listings. All of the information in a card or specific segments of the data may be printed on the report form in the sequence desired. At the same time, transaction amounts may be added and subtracted in counters for totals. Figure 15 illustrates an inventory transaction listing.

UNITS
EA=EACH C=HUNDRED
DZ=DOZEN GR=GROSS
M=THOUSAND

INVENTORY TRANSACTION LISTING

TRANSACTION CODES
1. BALANCE FORWARD
2. RECEIPTS FROM VENDORS
3. RETURNS TO VENDORS
4. ISSUES FROM STOCK
5. RETURNS TO STOCK
6. DEBIT ADJUSTMENT
7. CREDIT ADJUSTMENT

DATE: 3/ 31 /

PART NUMBER	PART NAME	UNIT	UNIT COST	TRANSACTION REFERENCE NUMBER	TRANSACTION DATE	TRANS CODE	OPENING BALANCE	TRANSACTIONS RECEIPTS	TRANSACTIONS ISSUES	ON HAND
171203	WATER PAIL 1 G	EA	1 89		2 28	1	68			
171203	WATER PAIL 1 G	EA	1 89	16129	3 03	4			36	
171203	WATER PAIL 1 G	EA	1 89	16431	3 07	4			18	
171203	WATER PAIL 1 G	EA	1 89	A0649	3 10	2		144		
171203	WATER PAIL 1 G	EA	1 89	16842	3 14	4			40	
171203	WATER PAIL 1 G	EA	1 89	17361	3 21	4			12	
171203	WATER PAIL 1 G	EA	1 89	C0036	3 22	5		1		
171203	WATER PAIL 1 G	EA	1 89	D0567	3 22	3			1	
171203	WATER PAIL 1 G	EA	1 89	18902	3 30	4			24	
171203						1				82*
171364	FRYING PAN 4 IN	EA	94		2 28	1	84			
171364	FRYING PAN 4 IN	EA	94	15937	3 01	4			6	
171364	FRYING PAN 4 IN	EA	94	16389	3 04	4			15	
171364	FRYING PAN 4 IN	EA	94	B1089	3 07	6			1	
171364	FRYING PAN 4 IN	EA	94	17361	3 21	4			36	
171364	FRYING PAN 4 IN	EA	94	18437	3 25	4			6	
171364	FRYING PAN 4 IN	EA	94	18866	3 29	4			18	
171364	FRYING PAN 4 IN	EA	1 04	A0676	3 30	2		156		
171364						1				158*
171366	FRYING PAN 6 IN	EA	1 25			1	148			
171366	FRYING PAN 6 IN	EA	1 25	16150	3 03	4			24	
171366	FRYING PAN 6 IN	EA	1 25	A0640	3 08	2		180		
171366	FRYING PAN 6 IN	EA	1 25	16820	3 14	4			12	

Figure 15. An Inventory Transaction Listing

The other way in which data may be printed is by group printing. In this method of printing, data from cards is summarized by each different classification. The line printed for a particular classification contains group identification and the totals. Group printing is performed at speeds up to 150 cards per minute. Figure 16 shows a Stock Status Summary, a group printing of the same data listed on the report in Figure 15.

Group printing may be accomplished because of the ability of the accounting machine to distinguish cards of one classification from those of another. As cards pass through the accounting machine, data in a specific field of one card is compared with data in the same field of the card following. If the data in both fields is the same, each card is recognized as being of the same group. If comparison indicates the data is different, the lead-

STOCK STATUS SUMMARY

DATE: 3/ 31 /

PART NUMBER	PART NAME	UNIT	UNIT COST	OPENING BALANCE	TRANSACTIONS RECEIPTS	TRANSACTIONS ISSUES	ON HAND
171203	WATER PAIL 1 G	EA	1 89	68	145	131	82*
171364	FRYING PAN 4 IN	EA	1 04	84	156	82	158*
171366	FRYING PAN 6 IN	EA	1 25	148	180	175	153*
171368	FRYING PAN 8 IN	EA	1 38	75	288	184	179*
171370	FRYING PAN 10	EA	1 54	64	72	56	80*

Figure 16. A Stock Status Summary

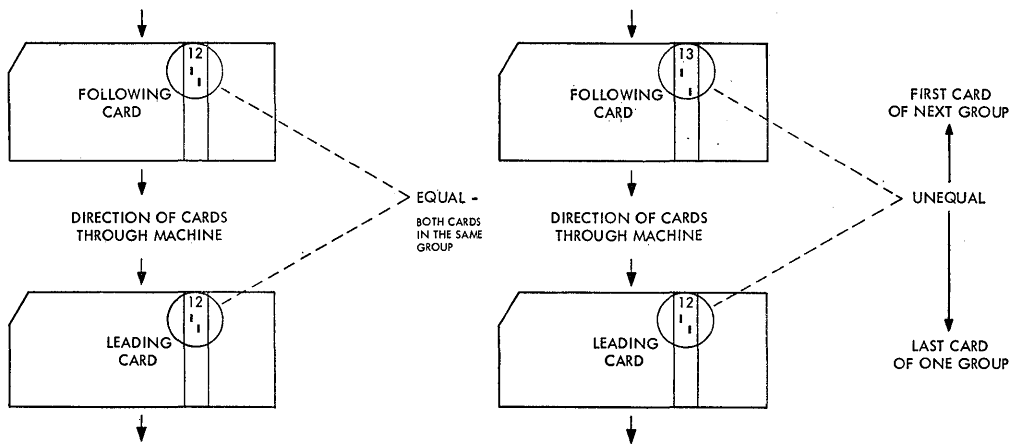

Figure 17. Equal and Unequal Comparisons

ing card is recognized by the machine as being the last card of one group and the card after it as the first card of the next group. Comparing is illustrated in Figure 17.

Between processing the last card of one group and the first card of the next, the machine goes through a series of steps known as the "total cycle." The total for the group is printed and the form is spaced. The total cycle is activated by the recognition of the difference between groups, the unequal condition resulting from comparison of the same field in successive cards.

The 402 Alphabetical Accounting Machine illustrated is able to perform accumulations of three different levels of totals. For example, it may be desirable to have sales performance figures for each salesman in a company, for each office and for each district. Such a report is possible in one processing of cards through the 402. The lowest (or smallest) category is the total of each salesman. The total for each salesman (the lowest level) is known as the minor total. The next level is the total by office (the sum of salesmen's activity in that office) and is the intermediate total. The district total comprises the total of all offices in the district and is in this case the major total. In addition to these totals a final total may be obtained which gives the sales total for all districts in the company and represents the whole company's activity for the period. Such a report is illustrated in Figure 18. Prior to the preparation of this report on the accounting machine, cards are sorted first by salesman, then by office and then by district.

Three different fields are compared to achieve the proper grouping of data for totals. To get a total by each salesman, the salesman field in cards is compared. To get the office total, the office number field in cards is compared. For district totals the district fields must be compared. It should be noted that when the office number changes, the salesman number does also. When the unequal comparison occurs in office number, the salesman total is printed first and then the office total. When the district number changes, the salesman total prints, the office total and then the district total. Thus three different totals print when the district number changes, the lowest classification first. The ability to accumulate and print three levels of totals increases the power of the accounting machine by eliminating multiple runs.

Counters in the 402 Alphabetical Accounting Machine are of different sizes, in units of two, four, six and eight positions. A two-position counter can total up to 99, a four-position counter 9999, etc. Larger totals may be accommodated by joining counter groups. For example, if a counter large enough to hold a ten-digit total is needed, it may be made from a six-position counter and a four-position counter, two fours and a two, or a six and two twos, or any other combination adding up to ten positions. One total is accumulated per counter grouping.

Counters are able to add or subtract data on the basis of punches in the individual card. As a rule the amounts to be subtracted (credits) are identified as such. The most common way to identify a credit is through an X (11) punch in a specific column of the card containing the credit amount. Cards punched with data to be added would not have the X punch, or credit X. Thus cards are usually added unless otherwise punched. In punching it is easier and faster to identify the few credits by a significant punch than to punch all cards with debit identification.

When accumulating data from a group of cards, the machine is instructed to add or subtract data according to the presence or absence of the significant punch.

While the X punch is the most commonly used method of identifying credits, other punches, such as digits, may also be used.

This ability of the accounting machine to perform an operation based upon the punches in the card is known as "selection." Selection enables the machine to pick the proper course of action for a card depending on the nature of the data punched in it and the instructions given to the machine. One punch in a column may initiate one action while another punch in the same column causes a somewhat different processing of the data.

Figure 16 illustrated a group-printed inventory report which was prepared from a Previous Balance card and Transaction cards. If cards representing new transactions were continually added to the file for processing, the file would soon be unwieldy to process. To keep card volume to a minimum for processing, files are periodically summarized and a New Balance card is created. This may be done at the same time that the tabulation is made. One card may be created which represents the current status. Any transaction in the next period would then be associated with the appropriate balance card prior to running the new inventory report. The New Balance card may be prepared during the preparation of the tabulation by a process known as "summary punching."

Summary punching is the process of punching one card to represent the total of a particular group or classification of data. Summary punching is done by the transfer of totals and indicative, or identifying, data from counters in the accounting machine to a machine which punches the summary card. The machines are connected for this operation by a cable, and the data is transferred prior to printing totals on the report form.

Summary punching is often of value in reducing the number of card passes necessary. If three processing runs must be made to produce various statistics, quite often a summarization may be performed on the first run which will reduce the number of cards to be processed on the next two runs. In cases where cards are referred to visually for information, maintenance of summary cards reflecting account status will reduce error and time by eliminating the mental computation of new balances from Previous Balance cards and Transaction cards.

SALES PERFORMANCE REPORT

DATE: 3/ 31 /

DIST. NO.	OFF NO	SLSMN. NO	DISTRICT, OFFICE OR SALESMAN	PRODUCT "A"	PRODUCT "B"	PRODUCT "C"	PRODUCT "D"	TOTAL BY SALESMAN	TOTAL BY OFFICE	TOTAL BY DISTRICT
1			NORTHEAST DIST							
	1		BOSTON OFFICE							
		5	J G CARGILL	2316 85	4819 37	3098 17	972 55	11206 94		
		43	A E JOHNSON	4018 61	3627 18	1085 36	258-9 02	11320 17		
		77	G I ROSS	4001 35	3869 92	4781 03	1968 45	14620 75		
									37147 86	
	2		NEW YORK OFFICE							
		2	P E AKERS	3213 98	4890 97	1344 45	1861 03	11310 43		
		17	A K DEERING	3544 40	2315 86	3987 03	2932 23	12779 52		
		36	R T INGEBRETSEN	2843 16	3720 10	2815 77	1504 32	10883 35		
		79	F H RUSH	1444 83	2315 16	1591 47	1416 37	6767 83		
		89	T L WESTMORE	2429 76	3402 10	3295 14	2678 01	11805 01		
									53546 14	
										90694 00 *
2			MID COAST DIST							
	1		BALTIMORE OFFICE							
		3	B L BARNEY	5584 36	4715 96	3620 93	1926 18	15847 43		
		27	P W GOODE	3231 64	1780 41	4099 82	2078 68	11190 55		
8			SOUTHWEST DIST							
	1		DALLAS OFFICE							
		51	R X MILLER	5028 00	1858 95	2468 31	3769 70	13124 96		
		58	R M NORTH	2338 71	3066 30	3517 89	3010 53	11933 43		
									25058 39	
	2		EL PASO OFFICE							
		56	A R NELSON	5419 02	4380 65	3729 77	4380 91	17910 35		
									17910 35	
										42968 74 *
										872106 87 * *

Figure 18. A Sales Performance Report

The Control Panel

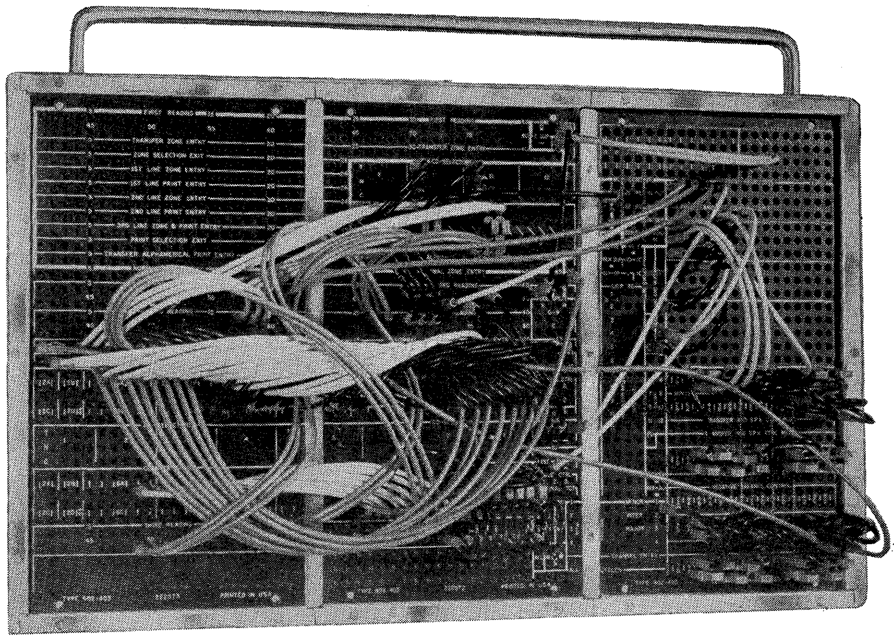

Figure 19. A Wired Control Panel

The accounting machine is instructed to process data by means of a control panel, placed in a rack on the machine and locked into position on the end of the accounting machine. A few of the functions of the control panel are to tell the machine what data to print from cards, where to print it, what to accumulate and by what groups, and when to print the totals. The control panel gives the accounting machine its flexibility, because by changing control panels a new set of instructions for processing data is given to the machine. The control panel makes possible the processing of diverse jobs in unrelated areas calling for various reports.

In each section of the panel there are rows of holes which pass through the panel. In each hole, commonly called a hub, is a metal socket. When the control panel is inserted in the machine each socket on the front of the panel is connected to the internal wiring of the machine. By joining two hubs with special wires, circuits are completed which cause various operations of the machine to be performed. A control panel, with wires inserted, is illustrated in Figure 19.

Some of the hubs are connected to typebars which do the printing, others are connected to counters which will accept data for addition or subtraction and still other hubs are connected to cause machine functions. As cards feed into the accounting machine, the 80 columns are read simultaneously by separate reading brushes. Each brush in turn is connected to a hub on the control panel. In order to print the data in a card column, the impulse created in reading the column is directed to one of the typebars by connecting the hub from the reading brush with the hub connected to the typebar. The completion of this circuit causes the character in the column to be printed on the report. Figure 20 illustrates internal and external wiring which will cause printing.

For example, by joining the hub from reading brush 56 (which reads card column 56) to the hub connected internally to typebar 3, the data in column 56 of the card is printed on the report in the location in front of typebar 3. In a similar fashion, data may be directed to counters for addition or subtraction, or to a hub which will cause a machine function, such as forms spacing or forms skipping. In each case a circuit is completed by a wire put in the control panel to connect two hubs.

The process of preparing the control panel for use is known as control panel wiring, or board wiring. Prior to any wiring, the job must be planned. The purpose of the accounting machine is to process available data and put it in a form desired by management. The first step is to determine the format of the report, consistent with available data. Once the report is designed, the control panel is wired, taking into account the design of the report and the layout of the card. The sequence of data on the report does not have to conform to the sequence of data in the card. If the data in columns 75 to 80 in the card is to be printed by typebars 1 to 6, the hubs from the reading brushes for columns 75 to 80 are each connected by a wire with the hubs for typebars 1 to 6.

Once the panel is wired and the cards are in sequence, the particular report is prepared by inserting the control panel in the machine, taking the few necessary setup steps, putting the cards in the feed hopper and pushing the start button. Thus the accounting machine is able to process completely different reports with a minimum of time spent in setup, making more machine time available for processing. Control panels for regularly prepared reports are usually wired once and held for subsequent use.

The ease of wiring control panels facilitates the preparation of special reports when desired by management. As needed, and dependent upon the availability of data in cards, reports may be prepared quickly to meet special or changing requirements.

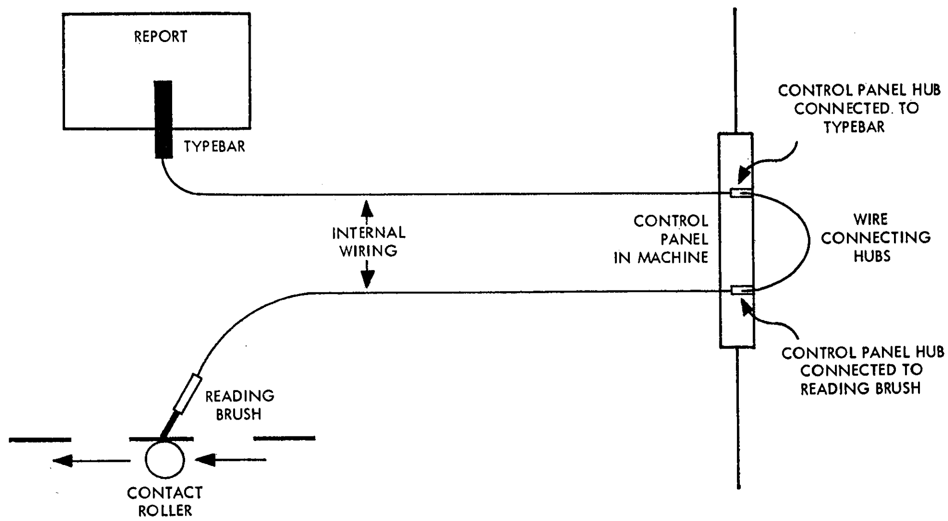

Figure 20. The Internal and External Wiring to Cause Printing

Accounting Controls

Accompanying any accounting system are safeguards to insure the accuracy of all data in the system and to insure the presence of all pertinent information. These safeguards are known as "controls." Controls are also an integral part of the successful application of IBM machines and methods to accounting. Controls not only provide accuracy of data but permit easier audit by providing a clear and concise audit trail by which transactions may be traced back from end to beginning.

Accuracy of conversion of source data to IBM punched cards is assured by verification. Next, a register is prepared on the accounting machine, a complete listing of all data punched into the cards. Then totals which accompany the source data are compared to totals on the register. The data totals are entered into the system of controls.

Accounting totals maintained throughout processing assure the accuracy and completeness of data. Comparisons of totals on reports with control figures should signify correct results. If the comparison indicates missing data, standard procedures facilitate swift referral to the original register, from which the data may be repunched and returned to the system. When normal care is taken in the handling and processing of the cards in which the data is punched, loss of data is rare. Controls are designed to assure the completeness and accuracy of reports upon which management decision is made.

Other Punched Card Machines

A basic installation of IBM machines normally consists of a card punch, a sorter and an accounting machine. The IBM 26 Card Punch, 82 Sorter and 402 Alphabetical Accounting Machine are typical of these machines. In addition to the three basic types, machines in other categories were developed to meet various data processing needs. Each category includes more than one machine of different speed and capacity.

Collators are machines designed to match (compare) fields of data in two card groups for equality, to merge two groups of cards on the basis of the data in them, to select cards punched with specific data, and to sequence-check a file of cards to insure correct ascending or descending order. A combination of these functions may be performed at the same time. Cards enter the collator from two separate feeds.

For many reports, data in two sets of cards must be combined. The Inventory Transaction Listing illustrated in Figure 15 was prepared from Previous Balance cards and Transaction cards. One set of cards was placed in one feed, the second set in the other, and the Transaction cards were merged behind appropriate Previous Balance cards. Each feed operates at rates of speed from 120 cards per minute to 650 cards per minute, depending on the model of the collator.

Calculators are machines able to perform addition, subtraction, multiplication and division. Information punched in a card is read into the calculator where computations are made. A series of mathematical steps may be performed in one processing and the results punched into the same card. For example, an employee's payroll information may be read from the card into the machine, all taxes calculated and the net pay determined. All taxes and the net pay may then be punched into the card. Processing takes place at speeds up to 200 cards per minute.

Interpreters print on a card data punched in it. Either alphabetic or numerical data may be printed in any desired sequence. One line at a time is printed at speeds up to 100 lines per minute. Normally interpretation appears at the top of the card, although the 557 Alphabetic Interpreter can print on any of 25 lines on the card. Cards are usually interpreted when visual reference may be required to data punched in the card.

Reproducers are machines designed to perform three basic functions: reproducing, gang punching and summary punching. Reproducing is the process in which data in one set of cards is machine-read and punched into another set of cards. Reproducers have two separate feeds, one called the read feed and the other the punch feed. Cards to be reproduced are placed in the read feed of the machine. Blank cards in which the data is to be reproduced are placed in the punch feed. The machine reads a card with data in it, transmits the data to the punching mechanism where it is punched into a blank card. After punching, the data read and the data punched may be compared to assure the accuracy of the reproduction. Some or all of the 80 columns of data may be reproduced and the sequence of the data may be changed. Reproducing is done at speeds up to 100 cards per minute.

Gang punching is the process of duplicating data from one card in a group to the next. Data in a card is read, punched in the card behind it, which in turn is read and the data punched in the next card. For example, it may be desirable to have a date punched into a group of cards. The date need be punched manually in the first card only. The group of cards is placed in the punch feed of the reproducer. The data is read from the first card and punched into the second, read in the second card and punched in the third, and so forth through the group. Either entire cards or parts of them may be gang-punched at rates of speed up to 100 cards per minute.

Summary punching is the process of punching one card to represent the total of a particular group or classification of data. Summary punching may be done by the transfer of totals and identifying data from counters in an accounting machine to a reproducer which punches the summary card. The two machines are cable-connected for this operation. Prior to printing, totals are transferred to the reproducer where blank cards in the punch feed are punched with the data.

In the same category with reproducers are the summary punch machines which are able only to summary-punch and gang-punch. They have just the punch feed and are unable to reproduce cards.

In addition to the categories of machines mentioned, there are others which are composed of machines designed for more specialized use, such as statistical machines, paper tape processing machines, card transmission equipment and typewriter output machines. There are others too which do not fit into categories but have been designed to fulfill specific data processing needs.

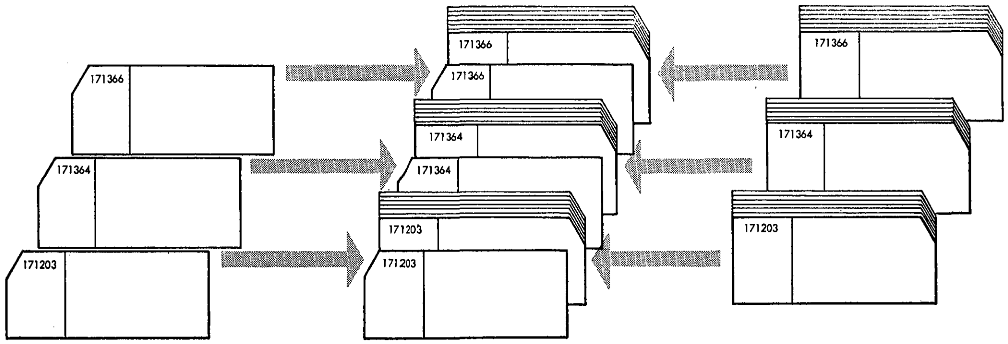

Figure 21. An Example of Merging

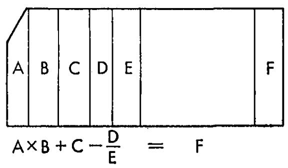

Figure 22. An Example of Calculating

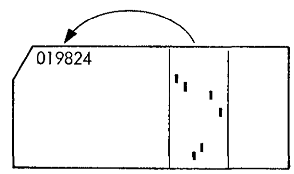

Figure 23. An Example of Interpreting

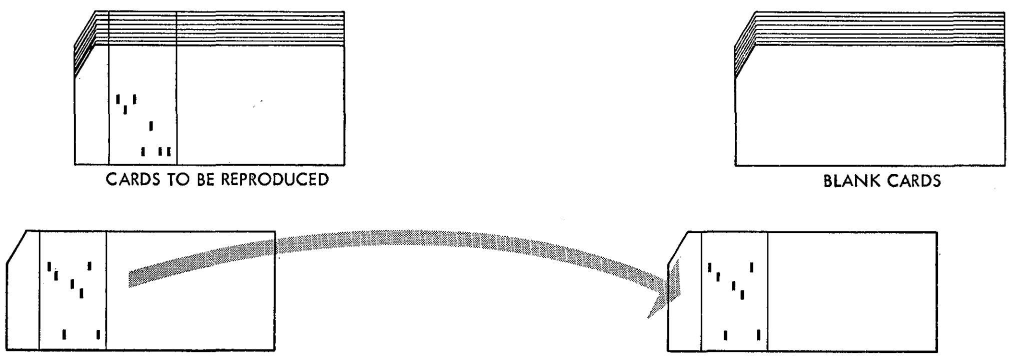

Figure 24. An Example of Reproducing

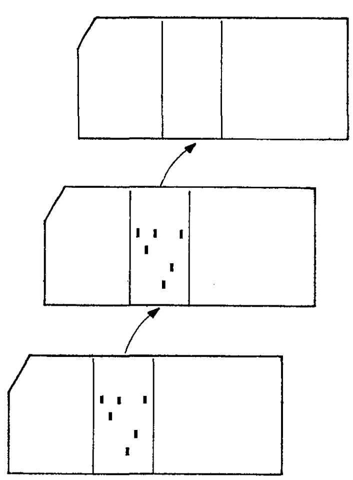

Figure 25. An Example of Gang Punching

The Use of Prepunched Data

To take advantage of the fact that much information processed is of a repetitive nature, data is "prepunched" into cards as much as possible. Prepunched cards are cards which have been punched manually once, verified for accuracy and then reproduced for later use as needed. For example, a company which sells products must print the customer's name and address and the products sold on a bill every time a sale is made. Cards prepunched with the name and address of the customer may be removed from a file and used in preparing the bill. Punching and verifying the name and address each time is thus eliminated.

The same process may be performed with cards containing the product data which must appear on the bill. A card is punched manually once and verified with such product information as product code, product description, sales price, weight and warehouse location. The card is reproduced mechanically in needed numbers. When a customer orders the product, a card is removed from the group and only the quantity is manually punched. Sales amount (quantity times unit price) is automatically calculated and punched into the product card. The name and address cards and product cards then prepare the bill. In such a case manually punched information often amounts to less than 10% of all punched data.

Prepunching data in cards assures the accuracy of the data because the information punched once and verified is automatically reproduced and is automatically checked at machine speeds. In addition, removing prepunched cards from a file is normally faster and less expensive than punching and verifying the same data.

Glossary

Card Column—One of the 80 vertical divisions of a card, normally accommodating one letter, digit or special character. Each column contains 12 punching positions.

Coding—Assignment of letters, digits or both to identify or classify data.

Collating—Interfiling two sets of cards in sequence.

Comparing—Examination of fields (usually in two cards) for equality of data punched.

Control Panel—The removable device which contains external wiring to cause data to be processed in the desired fashion.

Detail Printing—The printing of one line of data from each card passing through the accounting machine.

Duplication—The automatic punching of data from one card into the next, normally performed on a card punch.

Field—A column or columns reserved for the punching of data of a specific nature.

Gang Punching—Duplicating data from the first card in a group to the cards behind, usually performed in a reproducer.

Grouping—The arrangement together of data of the same classification.

Group Printing—Machine summarizing of a group or groups of cards with one line printed for each group's totals and identifying data.

Interpreting—Printing on a card data punched in it.

Listing—See "Detail Printing."

Merging—Interfiling in sequence two sets of cards.

Punching Position—One of the 12 divisions of a card column, into which a hole may be punched.

Punching Station—On a card punch, the place where holes are punched into the card.

Reading—Converting punched holes into electrical impulses.

Reading Station—On a card punch, the place where the holes punched into the card may be read.

Reproducing—Punching data from one set of cards into another set of cards.

Selecting Data—The extraction of a desired item or items of data from a larger group of data. Sorters and collators are used in selecting data.

Selection—The ability of a machine to perform an operation based upon what is punched in a card. Almost all IBM machines have the ability of selection.

Sequencing—Arranging data into a predetermined order.

Source Document—The original paper on which are recorded the details of a transaction.

Summary Punching—The automatic process of punching one card containing data summarized from a group of cards.

Tabulating—See "Group Printing."

Verification—Checking for accuracy what is punched in a card with data on the source document.

Zone Punch—One of the top three punching positions in a card column (12, 11 or X, and 0).

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