Product Reference Literature

IBM

Automatic Punches
General Information Manual

IBM General Information Manual

Automatic Punches

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Records Repeat Themselves

IBM Automatic Punches were conceived and built because most of the data that is significant to business is used over and over again. It makes no difference whether the business is large or small — the greatest part of the information that figures in recordkeeping is repeated many times, daily, weekly, or monthly. As business grew to its modern proportions, writing repetitive information became a greater and greater problem. Recordkeeping began to occupy more people, to consume more time, and to cost more money.

Let's look at the problem a little more closely. A business has customers whose names, addresses, and code numbers must be repeated many times. Orders, invoices, discounts, credits, accounts receivable, sales analysis, history records — all these, and many others, must be identified by a customer's name and address and the customer number. The same is true of payroll records, inventory records, manufacturing control, equipment accounting, and general ledger records. In every phase of modern business, more than 90% of the information used has been recorded somewhere before. This means that 90% of the manual operations of writing information could be eliminated.

Many ideas and many concepts have been applied to this problem. Many of the attempts to solve this problem are familiar to all of us. Here we find carbon paper, rubber stamps, metal plates, pre-written gummed labels — an almost endless list of ideas and devices. However, all these are based on the old concept of written characters, letters, and symbols. They can be recognized and reproduced only by the human eye. They can be read and interpreted only by a human agency.

The real need actually was for a new language — a language that could be read, used, and written by a machine, automatically. The punched-hole concept provided this language. Punched holes can be read and translated into electric impulses that perform all the routine tasks in recordkeeping.

Why do we have automatic punches?

The question, *Why do we have automatic punches?* could as well be *Why do we have punched cards?* The answer to both is the same. We have them because of the tremendous volume of business data that has occurred before. It takes time and money to manually transcribe names and numbers — names and numbers that have been transcribed and used before. In every business procedure, from Payroll, to Billing, to Financial Control, almost all the data used has either been used on a previous transaction, or its use can be anticipated.

NATIONAL PRODUCTS INC.
GREENVILLE, MASS.

SOLD TO: SQUARE DEAL OIL CO
255 ESSEX STREET
CLEVELAND OHIO

BRANCH 7 — CUSTOMER'S NO 71308

SHIP TO: ARNOLD SIMPSON
1487 SMITH ST
CLEVELAND OHIO

MAKE ALL CHECKS PAYABLE TO AND FORWARD REMITTANCE DIRECTLY TO
NATIONAL PRODUCTS INC.
GREENVILLE, MASS.

SHIPPED VIA: TRUCK PREPAID

TERMS: 2 PCT 10 DAYS NET 30

CUSTOMER'S ORDER NO	SALESMAN'S NAME	SALESMAN'S NO	INVOICE DATE	INVOICE NUMBER
487629AL	NELSON	69	23159	12345

QUANTITY	DESCRIPTION	COMMODITY NO	UNIT PRICE	AMOUNT
25	SQ SHANK RIGID	21103	177	4425
20	SQ SHANK RIGID	51105	411	8220
2	SQ SOCKET RIGID	26104	244	488
35	ADJ ADAPTER SQUARE	23702	222	7770
3	ROUND SOCKET SWIVL	55706	651	1953
35	FLAT TOP SWIVEL	33202	279	9765
5	FLAT TOP SWIVEL	53209	505	2525
	FREIGHT			117
				35263*

Figure 1. Typical Invoice

In a billing operation, for instance, we might think the information that appears on the customer's invoice is being handled for the first time. It is, supposedly, new information.

Repetition

But look at the invoice (Figure 1). Over 93% of the 344 characters that appear on that invoice either have been used in previous transactions, or can be established automatically. Less than 7% (the customer's order number, the date, the invoice number, and the freight amount) is being written for the first time. In many billing operations, only the customer's order number (Figure 1 — about 2% of the total number of characters) would be new. Often, even this is not needed, which means that all the information is being repeated.

Accounts-receivable cards can be summary-punched during the billing operation. This is a completely automatic operation. Here is one of the best examples for the development of automatic punches. What does this mean to a business operation? It means dollar benefits, accuracy, time-saving, and convenience.

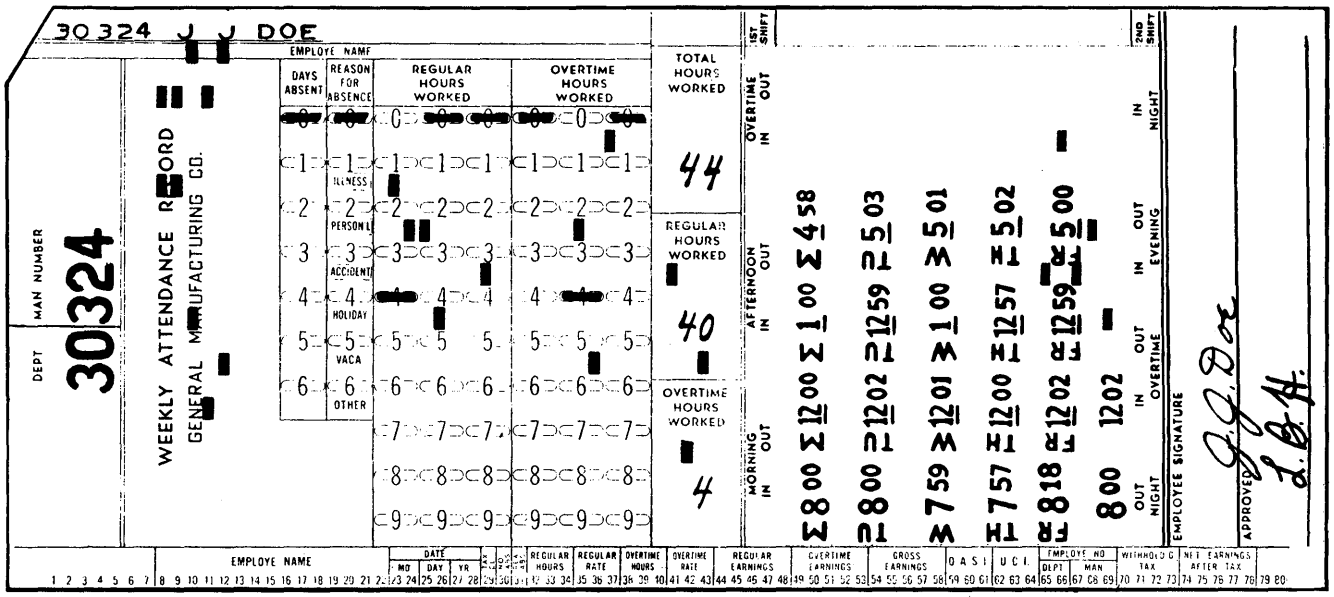

Figure 2. Mark-Sense Punched Card

Two Punches — One Payroll

In Payroll and Labor Accounting, more than 90% of the data needed to process all reports can be produced automatically. Less than 10% of the figures used in the average payroll need be produced manually. A clear illustration of this is the aircraft manufacturing company with a peak employment of 30,000 people. They process the entire weekly payroll with just two key punches. These two key punches are used to prepare only master name and master deduction cards for new employees. All punching in attendance cards and job cards is done by high-speed automatic punches. Attendance cards and job cards are prepunched with all indicative information reproducing from master files. Variable data is entered by mark-sense punching (Figure 2).

This story can be repeated in one accounting procedure after another — Material Accounting, Accounts Payable, Manufacturing Control, and all the others.

Automatic punches, by their reproducing and gang-punching features, have solved the problems of handling repetitive information and constant data. Mark sensing moves automatic handling closer to source information. Summary-punching features solve many problems in summarizing, and in file-space conservation. End printing facilitates manual handling of files.

It is the purpose of this manual to discuss the following machines with respect to their characteristics, their capabilities and functions, and their place in the unit-record data processing picture:

1. IBM 514 Reproducing Punch
2. IBM 519 Document-Originating Machine
3. IBM 521 Punch Unit
4. IBM 523 Gang Summary Punch
5. IBM 524 Duplicating Summary Punch
6. IBM 526 Printing Summary Punch
7. IBM 528 Accumulating Reproducer
8. IBM 529 Punch Unit
9. IBM 541 Card Read Punch
10. IBM 542 Card Read Punch
11. IBM 549 Ticket Converter

MACHINE FUNCTIONS

Each of the machines being considered performs some of these principal functions either as standard or optional features:

1. Reproducing (IBM 514, 519, 528, 549)
2. Gangpunching (IBM 514, 519, 521, 523, 528, 529, 541, 542, 549)
3. Comparing (IBM 514, 519, 528)
4. Editing (IBM 514, 519, 521, 523, 528, 529, 541, 542, 549)
5. Summary Punching (IBM 514, 519, 523, 524, 526, 528, 549)
6. Mark-Sense Punching (IBM 514, 519)
7. End Printing (IBM 519)
8. Accumulating (IBM 528)
9. Input-Output for a System (IBM 521, 529, 541, 542)

Reproducing

Reproducing is copying punched information from one document into another document. Information may be copied from cards into cards, or from tickets into cards (Figure 3). Here is a technique that enables you to:

1. rewrite master information
2. establish working decks of cards
3. produce a second file to permit simultaneous processing of data
4. reproduce files of cards that are worn out
5. provide duplicate cards for other uses.

Reproducing information has become such an integral part of business operations that a complete industry has been built on machines that perform this function. Some are called addressing machines, some are called duplicating machines, others are called reproducing machines. But all are for the purpose of producing documents or information similar to existing documents or information.

In most cases, these devices produce a fixed reproduction of the data — a printed envelope, a strip of paper, a label, etc. There is no flexibility. This reproduced information is used once; then it is dead.

On the other hand, punched-hole information is very much alive. It can be re-read, arranged in different sequences and forms; it can be separated and selected; it can be added, subtracted, multiplied, and divided; it can be used in many, many ways. And all this handling can be done by automatic machines.

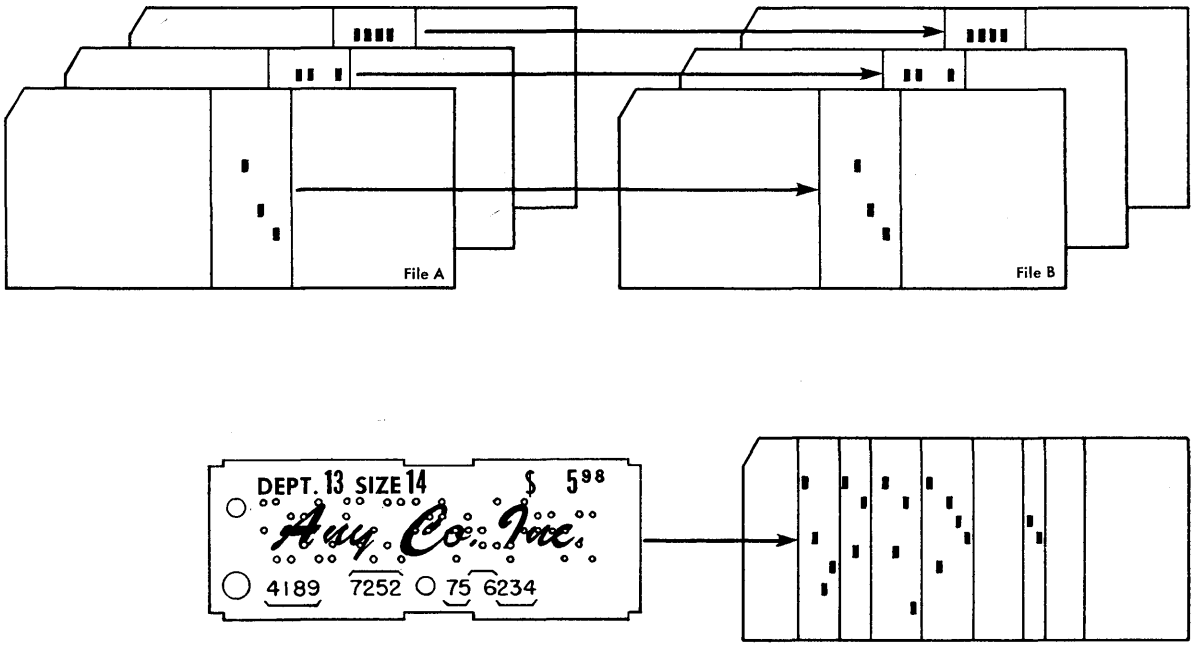

Figure 3. Reproducing

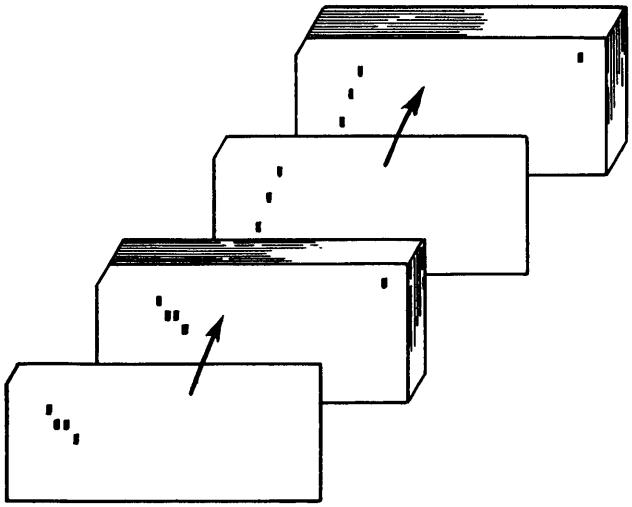

Figure 4. Gangpunching

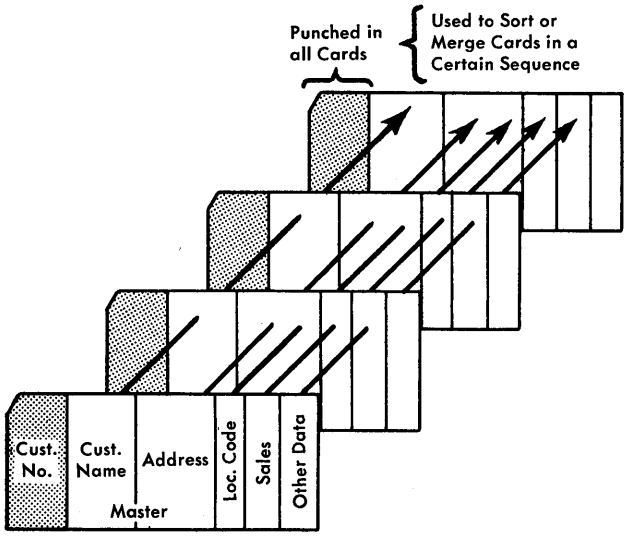

Figure 5. Coding by Gangpunching

A typical reproducing operation is the production of working decks of cards from bill-of-material master files, labor-specifications master files, personnel-history master files, payroll master file, price tickets, and many others. These duplicate sets of cards facilitate file processing. They can be used for control purposes, or for future matching when card documents are to be sent outside the department. A good example is reproducing card checks into a file of cards that can later be used for check-reconcilation purposes. Another is reproduction of labor cards into a progress file. Returned labor cards are matched against the file to determine progress of work in the shop.

Again: Reproducing is the operation by which information punched in one set of cards is duplicated into another set.

Gangpunching

Gangpunching is copying punched information from a master card into a group of detail cards immediately following (Figure 4).

Here, then, is the first operation that permits automatic reproducing of repetitive data. Information to be used again and again can be keypunched into a master card along with identifying information. Such data can then be used for:

1. Coding and de-coding
2. Pricing and rating
3. Extending.

Coding and De-coding

In manual or key-driven recordkeeping, it is frequently necessary to look up considerable information about a customer, a product, a procedure, etc. For instance, we may have only a customer number, and need to know his name, his location, the salesman, the city and state codes, and other information. Looking up this information, and transcribing it manually, are time-consuming and error-inducing. The job can be done by gangpunching. The necessary information is keypunched into master cards, one for each customer. The detail cards are associated with the masters. Then the required information is gangpunched (Figure 5).

Pricing and Rating

This can be a very expensive and time-consuming operation in any record-keeping procedure, if the job must be done manually. In many medium-sized companies, four, five, or more persons may spend full time looking up selling and cost prices for use in billing and material accounting jobs. Others may search for employee or job rates to be used in payroll. Here again, high error-frequency plays a major role.

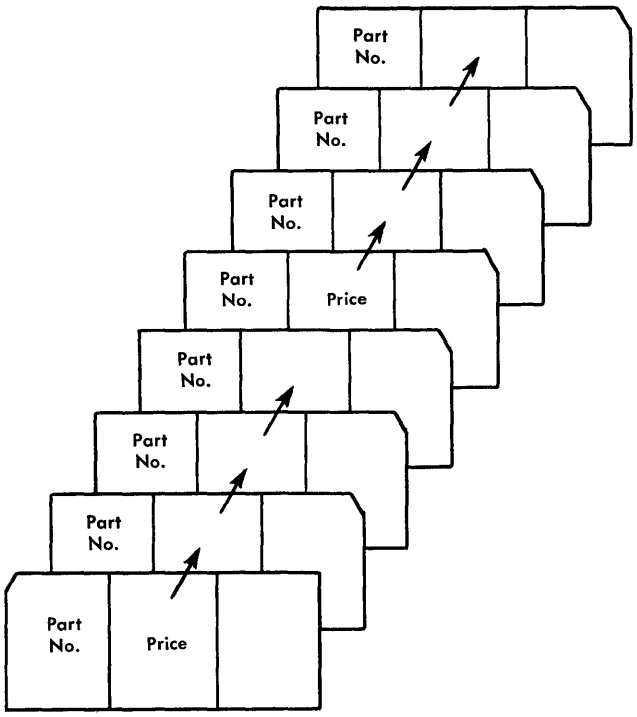

Figure 6. Pricing by Gangpunching

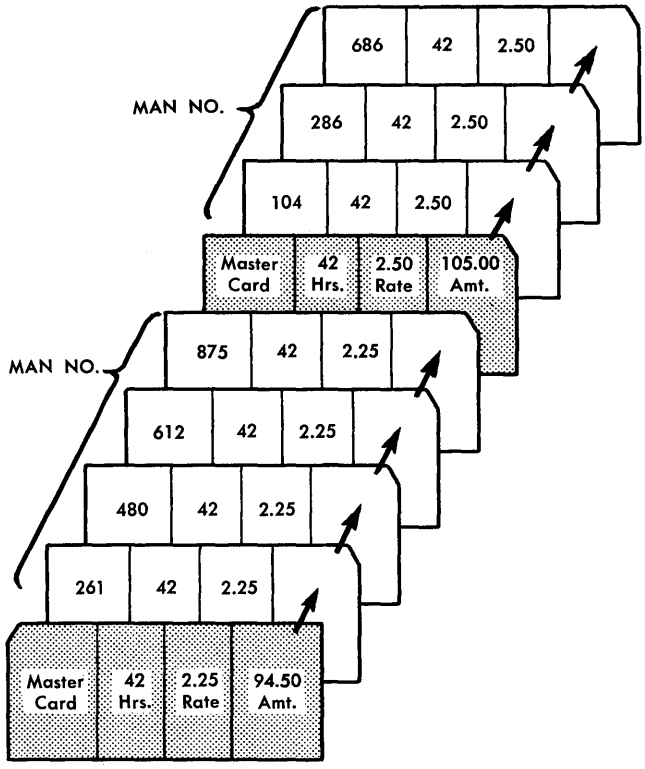

Figure 7. Extending by Gangpunching

Let's consider the problem encountered in a company handling 20,000 parts. Assuming 80 parts to a page (which, incidentally, would be fine print and difficult to read), the price manual would be 250 pages long. It doesn't require much imagination to appreciate the problem that exists when prices are being looked up in a book of that size.

This is a time-consuming procedure. It invites error. Data can be transcribed incorrectly. The wrong price might be chosen. The right price might be written incorrectly.

Prices, rates, and identifying data can be stored in master cards. The master card can be used to gangpunch the figures into the detail cards rapidly and inexpensively. And what is more important — it is done with a greater degree of accuracy than manual pricing and independent verification.

The rates or prices are conveniently stored in a mobile, machine-read record. Also, punched cards provide an easy method of arranging detail cards so that, instead of looking up a price or rate five, ten, or twenty times each day or each week, the price is looked up once, automatically. All cards are arranged by a given part, employee, item, or other classification, behind a master card. Then the required information is gangpunched (Figure 6).

EXTENDING

In mathematical calculations, 2×2 is always 4; 6×5 is always 30; and 42 hours $\times$ \$2.25 per hour is always \$94.50. The stability of mathematical relationships ($A \times B = C$) can be put to use through punched cards, much as it is put to use in the logarithm tables of a high-school trigonometry book. If the factors 42 hours, \$2.25 per hour, and \$94.50 are placed in a master card, this card can be used the same way as a multiplication table, to make extensions by gangpunching (Figure 7).

The various factors (A and B) and the calculated result are punched into master cards. These cards are merged with the detail cards having the same multipliers and multiplicands. The calculated result in the master card is then gangpunched into the detail cards following.

These simple extensions ($A \times B = C$) are made at high speed, and for a number of different transactions at the same time. An extension made once, and proved correct, can be used over and over again. The extension need not be verified again. Nor is there the chance of a clerk reading a chart wrong.

Again: Gangpunching in copying punched information from a master card into each detail card of the group following.

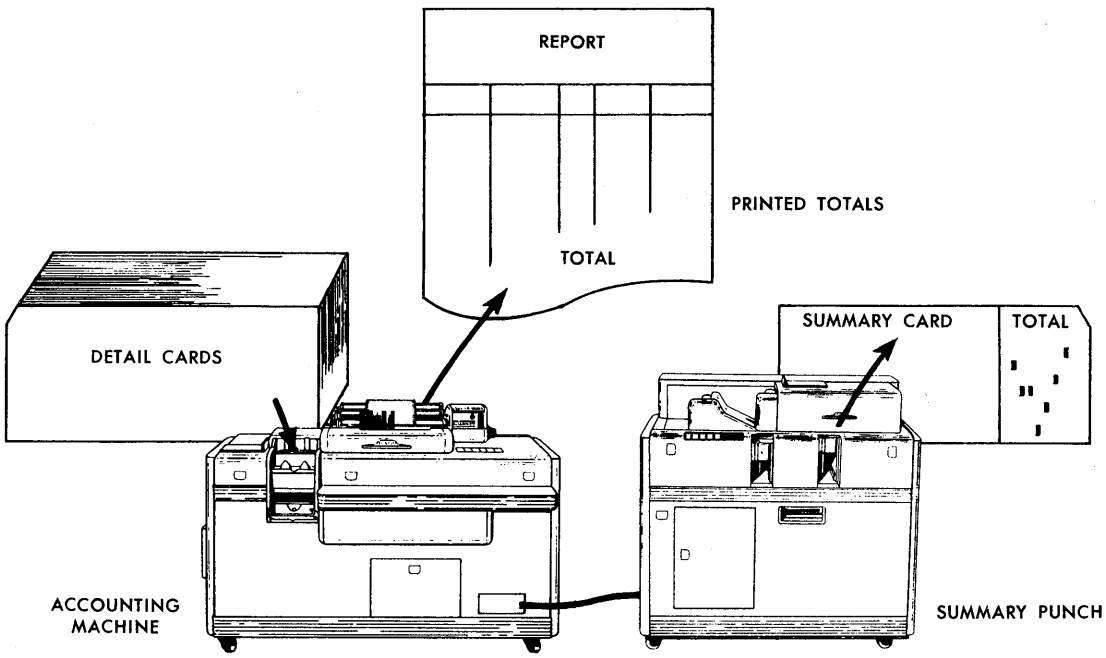

Figure 8. Summary-Punching Operation

Editing and Comparing

Accuracy is a prime factor in the punched-card method of data processing. Means are provided in IBM Automatic Punches to assure correctness of the cards. Any field in a card passing through the machine can be edited for faulty punching – double punches or blank columns. When such errors are detected, card feeding stops and a signal light goes on.

The operation in which both reproduced and gang-punched information is checked for agreement with the original source is called *comparing*. If the field punched in the new document is not identical to that in the original card, card feeding stops, a signal light goes on, and the position containing the error is indicated.

Summary Punching

Here is an outstanding feature that enables data to be punched automatically into a total or new-balance card after being accumulated in an accounting machine (Figure 8).

There are two major uses for summary punching:

1. To carry balance figures forward. In Accounts Receivable, account balances; in Payroll, year-to-date earnings, withholding tax, social security tax, and bond balances; in Inventory, stock balances; in Sales Accounting, sales to date, both month and year; in Financial and Budget Accounting, both actual and budgeted expenses year-to-date along with the differences—all of these are typical applications of carrying balances forward.

   There are, of course, many others.

   In many manual, or semi-automatic (bookkeeping machine) procedures, carrying balances forward is a volume job, with two major hazards:

   Is the amount correct?

   Has it been entered to the correct account, ledger, statement, or bill?

   The IBM method of carrying balances forward by summary punching produces accuracy of both account and amount. This accuracy is established by machine balancing, or other machine control methods, to eliminate both hazards.

2. To reduce card volume and provide summary data. Summary cards alleviate peak loads due to accumulating card volume. In addition, summary cards can be used as entries to other accounting procedures, such as General Ledger Accounts (Figure 9).

   Let's look at card-volume reduction. A fire and casualty insurance company operation illustrates the importance of the summary punch. A relatively small company in this industry can produce about 11,000 statistical cards per month. In the period of a year, this would be close to 200,000.

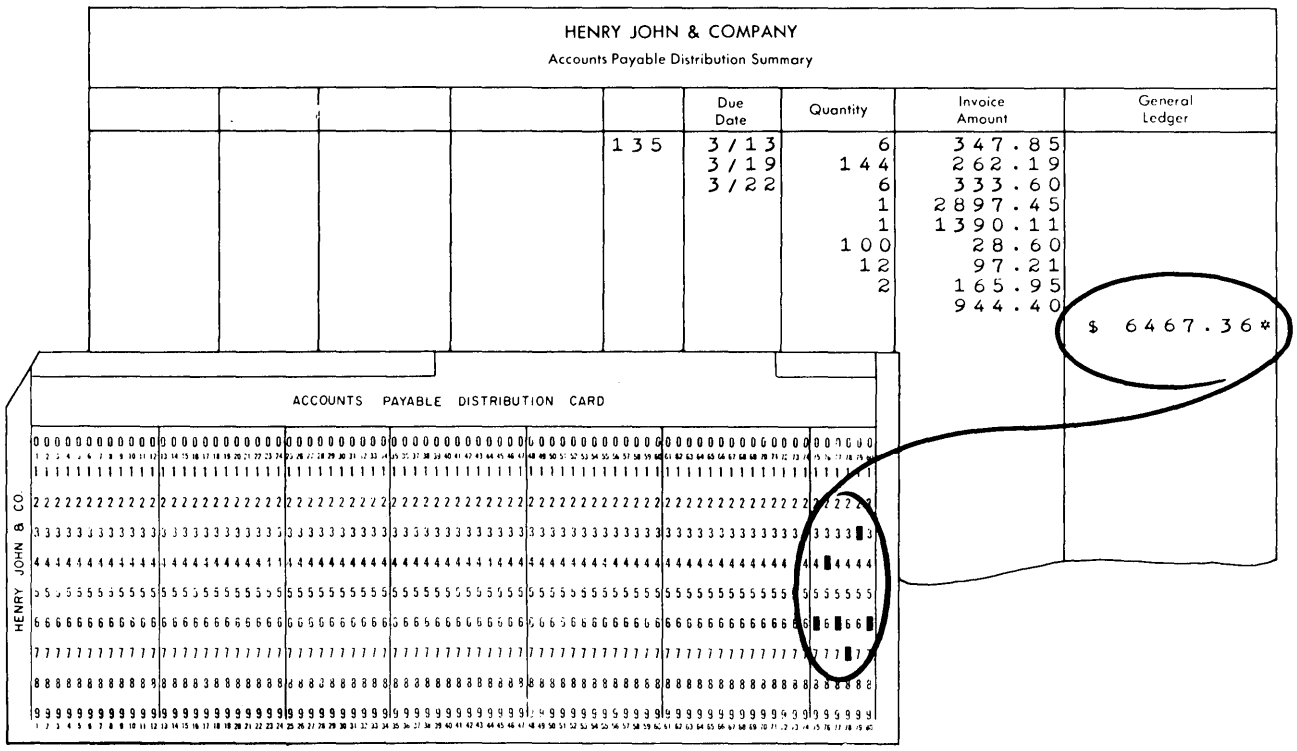

Figure 9. Summary Card

The statistics must be analyzed in many different ways for the annual reports to government and insurance-controlling agencies. These reports are due within two months after the close of the year. To prepare just one of these reports using all 200,000 cards, would require something like 30 hours of accounting-machine time. Even more time would be needed for sorting and arranging the cards.

Even if machine time were available, the required reports would take several months to complete. The only alternative is periodic summarization of data. Because of the automatic summary-punching feature, the job can be done with very little additional cost.

Again: Summary punching is punching into total or new-balance cards amounts that have been accumulated in the accounting machine.

Mark-Sense Punching

This is the operation in which information recorded on a card with a special pencil is read and automatically punched into the card (Figure 10). Mark-sense punching, in combination with reproducing and

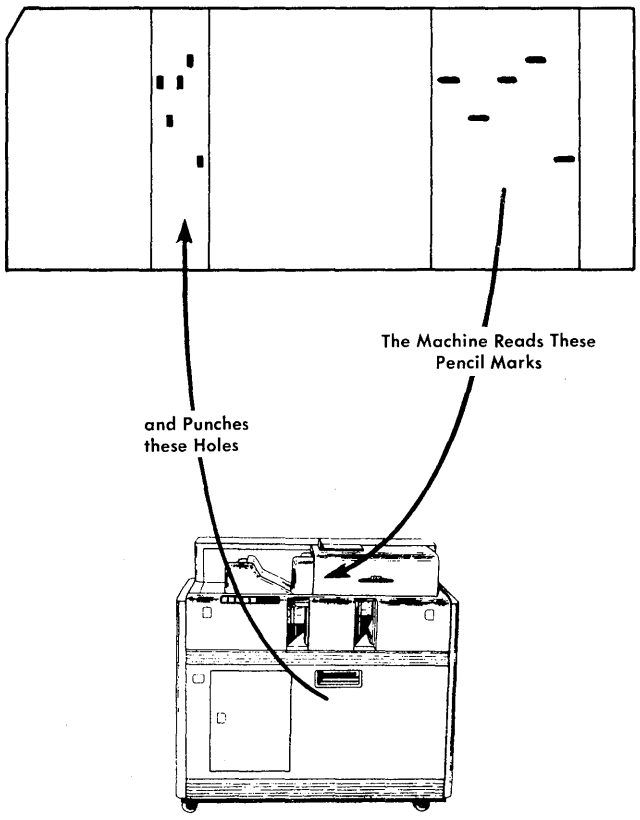

Figure 10. Mark-Sense Punching

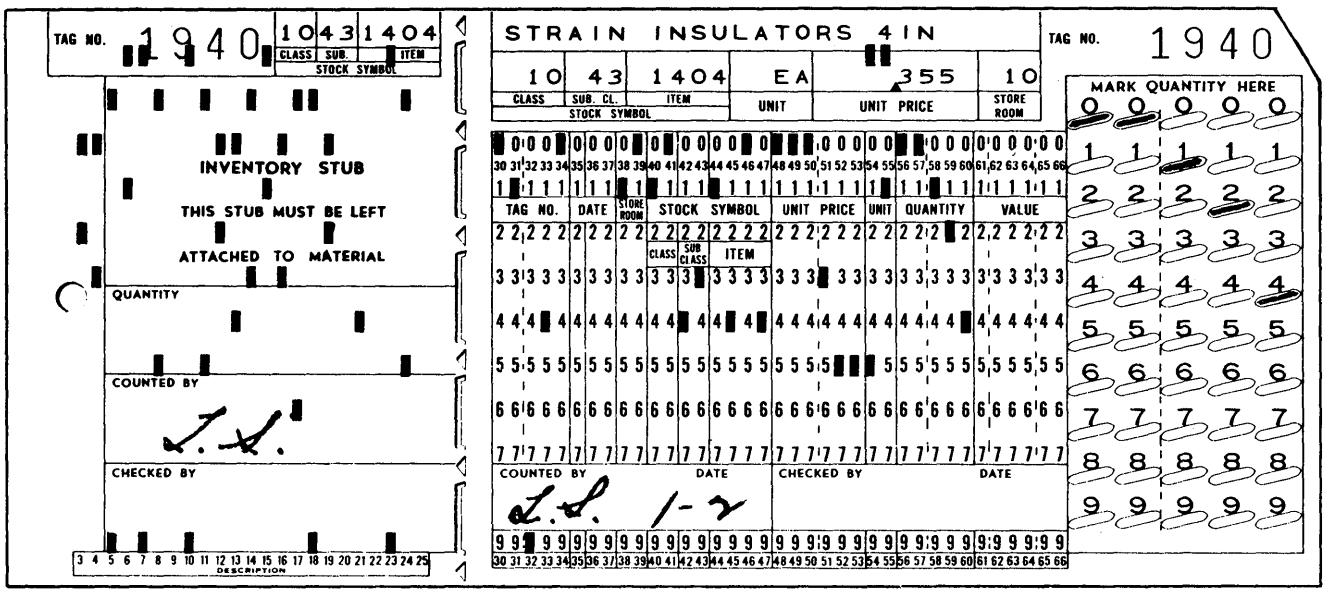

Figure 11. Mark-Sensed Punched Card

gangpunching, provides a method that produces punched cards without a single key-stroking operation. When the proper pencil marks are made (instead of writing the figures), the card is actually completed with no more effort and expense than it would take to make the first recording by manual methods. This punched card (Figure 11) is now available to make subsequent recordings automatically.

End Printing

This feature makes it possible to print punched or predetermined figures in bold numbers across one end of the card. Eight digits at a time, in one of two locations, provide easily-read identification of the card.

End printing permits printed identification of cards without a separate interpretation step in the procedure (Figure 12). More often than not, end printing is

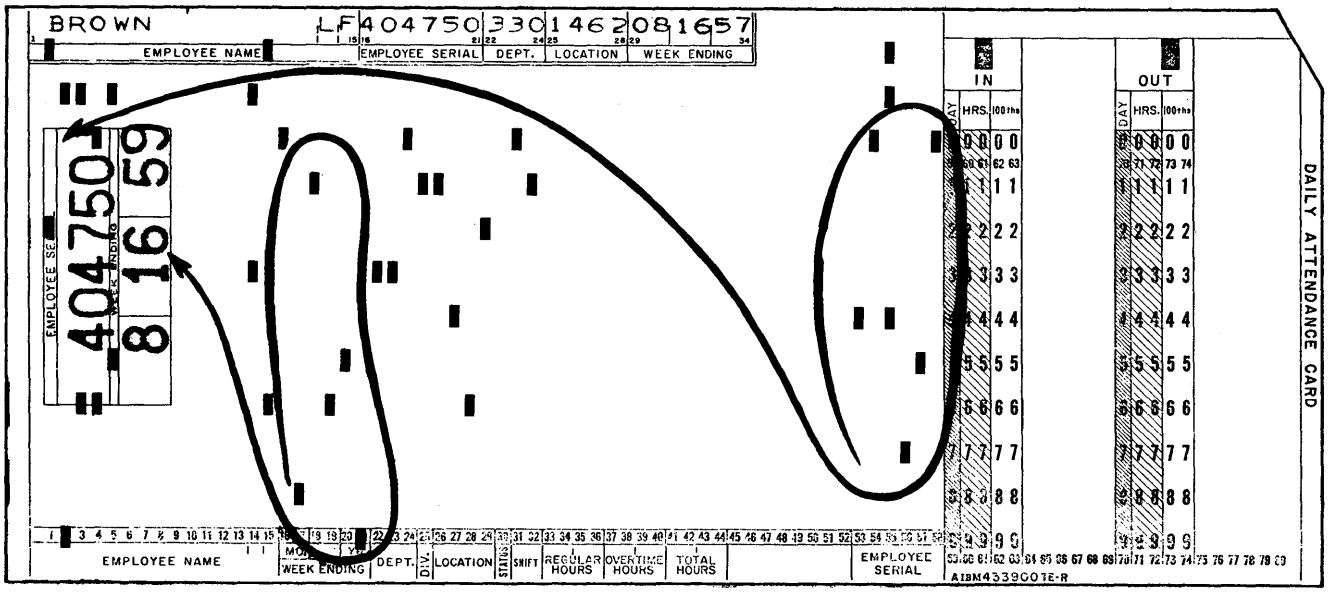

Figure 12. End Printing

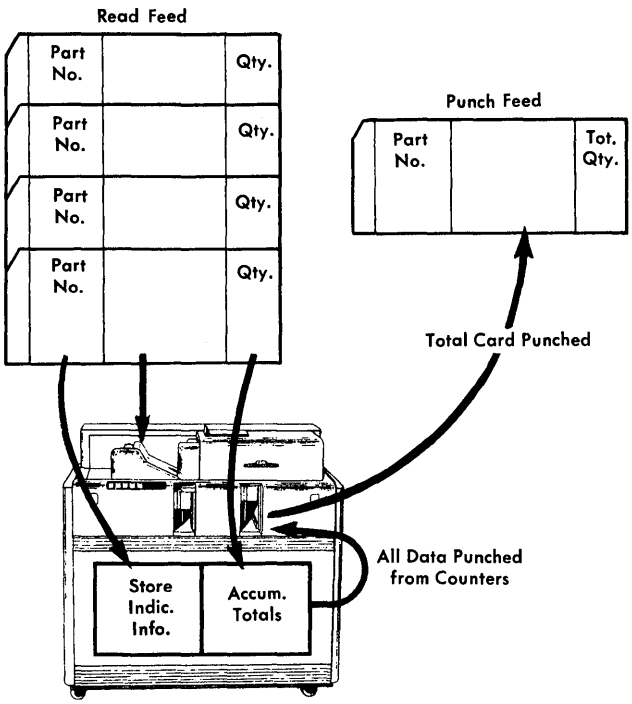

Figure 13. Accumulating

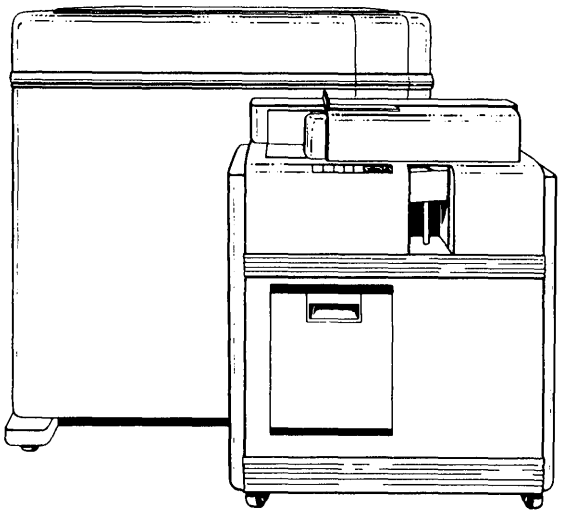

Figure 14. IBM 604 Electronic Calculating Punch

Some of the uses of this feature are card identification by part number, man number, account number, commodity code, clock number, and many others.

sufficient for identification purposes, and frequently is preferable to interpreting.

The information to be end printed can come from several different sources:

1. Printing information that is punched in the same card is called *interpreting*. Eight columns of information can be read in a card at the punch brushes, and can be printed on either of two lines at the end of the card. Interpreting can be part of a gangpunching operation. While preparing attendance cards, for example, the date could be gangpunched, and interpreted on the end of the card.
2. Printing information from an independent source is called *transcribing*. Information can be read from punching in another card, or from the punch emitter. If information read from another card is to be printed, that card is placed in the read unit.

Accumulating

This is the operation in which amounts punched in the card are added and subtracted by counters and the total punched in the card. Amounts in the same card can be crossfooted and the total punched in that card. Amounts from multiple-card groups (or from an accounting machine) can be accumulated and the sum punched in a new balance-forward card (Figure 13).

Input and Output for a System

Some calculators and high-speed data processing systems require an automatic punch as the means whereby information is admitted to, or received from, the system (Figure 14).

Punch Feed

Basic to all automatic punches is the punch unit (Figure 15). Cards are fed from a feed hopper face down, 12-edge first. They first pass six punch X-brushes, which can be set to any six columns of the card, with not less than two columns between brush settings. The primary purpose of the punch X-brushes is to read control X-punches that distinguish master cards from detail cards, to suppress punching into master cards. (In the IBM 521, 529, 541, and 542 the card, instead, first passes 80 brushes that read the entire card for calculating.)

Next the cards pass 80 punches, one for each card column. As each card passes the punches, *12's* are punched first, *11's* are punched next, and so on through the *9's*. Thus, the card is punched completely.

After passing the punch station, the cards can be read by 80 punch brushes at the read station. As each card reaches the read station, the next card gets to the punch station. The cards are timed so that the 12's position of one card is read by the punch brushes at the same time that the 12's of the next card are under the punches. As the 9's position of the first card is being read by the punch brushes, the 9's position of the following card is under the punches. This is the basis for gangpunching from one card to the following card – each card serving as a master card for the following card.

From the punch brushes, the cards are moved to the stacker for removal. An offset-stacking device (optional) can offset cards 3/8 inch in the stackers for identification (error cards, for example).

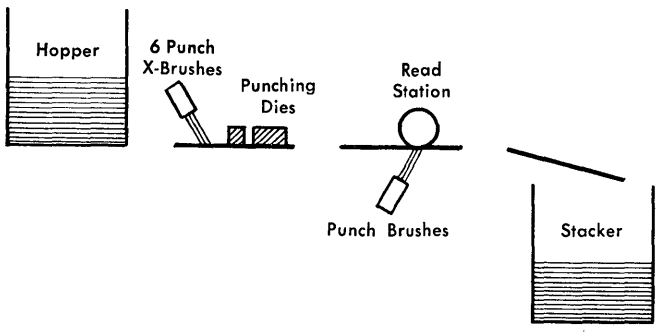

Figure 15. Sketch of Punch Feed

Read Feed

Automatic punches that are classified as reproducing punches have a read unit (Figure 16) as well as a punch unit. Cards are placed in the feed hopper face down, 12-edge first.

Cards first pass under five read X-brushes. These are similar to the punch X-brushes and perform the same functions – reading the control X-punches in the cards to suspend or start punching, or to control selectors.

At the reproducing brush station is a set of 80 brushes, one for each column of the card. They are timed so that a card passing over them is in the same relative position as a card passing the punch station in the punch feed. This is the basis for reproducing.

The cards then reach a second set of 80 brushes called *comparing brushes.* They are timed so that a card passing over them is in the same relative position as a card passing the punch brushes. Actually, the reproducing brushes, comparing brushes, punch brushes, and punch station are machine-timed so that cards at the four stations are in the same relative position to each other.

Finally, the cards pass into the stacker for removal. An offset-stacking device (optional) can offset certain cards 3/8 inch for identification (error cards, for example).

Control Panel

The control panel is a removable electrical plugboard that acts as the *brain* of an automatic punch (Figure 17). A machine operates in accordance with the electric connections made on this panel. Internal wiring from the functional units terminates at the control panel.

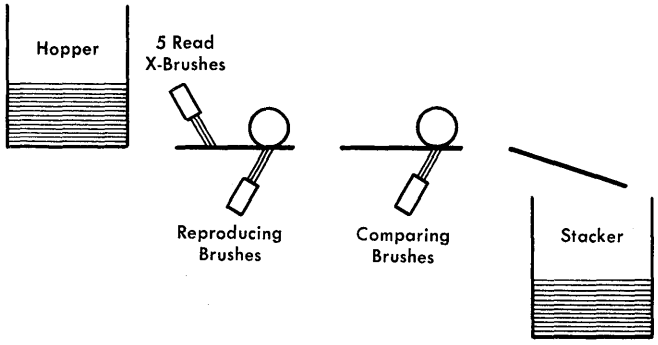

Figure 16. Sketch of Read Feed

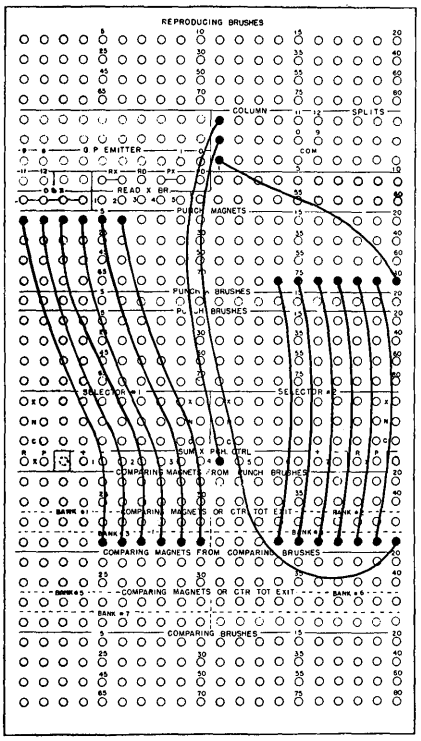

Figure 17. Control Panel

External wires are plugged into these terminals to complete the circuits. Information from the cards translated into electric impulses is conveyed to the control panel where the circuit is made to the punches.

Summary-Punch Cable

When the punch is operating as a summary punch, the summary-punch cable is connected to a receptacle in the accounting machine. Information from the counters or storage units of the accounting machine is transmitted through the cable and control panel to the punches.

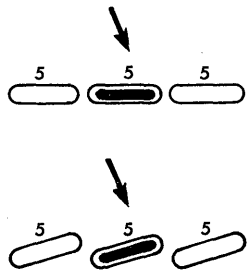

Figure 18. Electrographic Marking

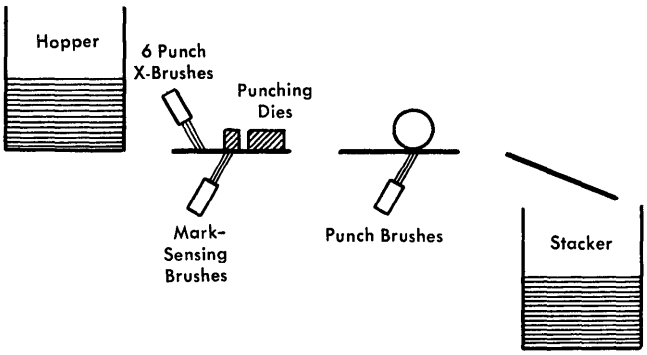

Figure 19. Location of Mark-Sensing Brushes

Mark-Sensing Unit

Mark sensing is an electronic method for converting electrographic pencil marks (Figure 18) on cards into punched holes in any columns of the cards. This eliminates manual keypunching and verifying, because the cards to be processed can themselves be used as the original source documents. The position of this slanted or horizontal mark on the card indicates the numerical value of the information recorded.

These marks are sensed by a set of 27 brushes located just ahead of the read station or punch station (Figure 19). As the marked card passes through the mark-sensing reproducer, the pencil mark is spanned by three brush contacts (Figure 20). Electric impulses conducted by these marks are amplified and used to operate the punch magnets according to control-panel wiring.

Each side of an IBM card designed for mark sensing has a capacity of 27 columns of marked data. Each column has 12 mark-sensing positions corresponding to the punching positions in the card.

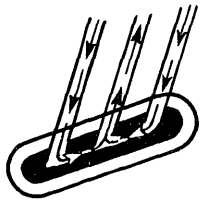

Figure 20. Path of Electric Impulse

Print Unit

In machines designed for end printing, the print unit is located in the punch feed just preceding the stacker (Figure 21). This unit (Figure 22) has eight print wheels, each of which contains the digits 0-9 and a blank position. Zeros carry to the right only when they are actually punched in the card, and proper instructions are wired in the control panel. A zero does not print unless there is a significant digit on its left, although a space may intervene if a column is unpunched or a position is unwired.

Information is normally printed on the left end of the card on either of two lines on the card: first, 5/16 inch from the end of the card; second, 5/8 inch from the end of the card (Figure 23).

The printing line is selected by latching the print unit in one of three notches: middle notch to print on the first line; notch farthest away from the operator to print on the second line; notch nearest the operator to disengage the print unit (Figure 22). It is possible to print on selected cards (X or No-X) by control-panel wiring.

The information to be end printed can be interpreted from the same card, or transcribed either from the card at the read station or from the punch emitter. For this reason, the sets of brushes on the IBM 519 Document-Originating Machine are called *comparing and transcribing brushes,* and *gangpunching and interpreting brushes.*

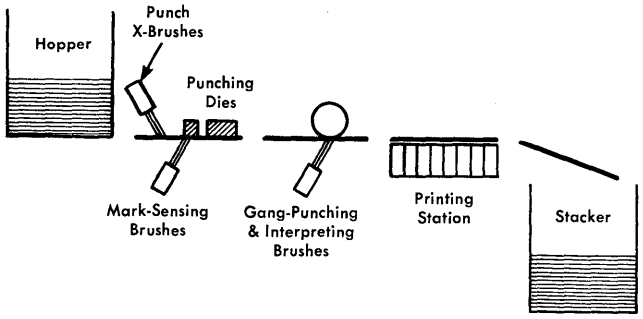

Figure 21. Sketch of Punch Feed with Printing Station

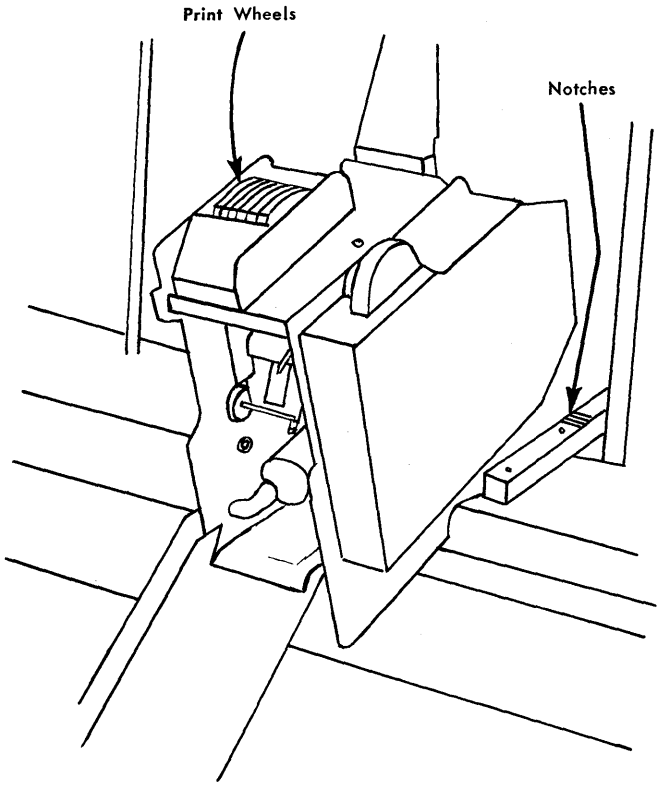

Figure 22. Printing Unit

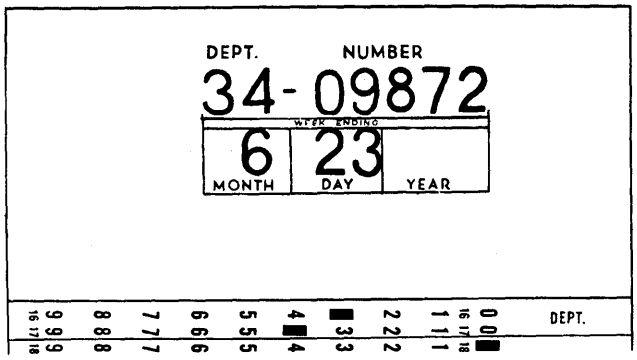

Figure 23. End-Printed Card

REPRODUCING

Reproducing, we have seen, is a machine function by which all or any part of the information contained in one set of cards, is read and punched into another set of cards.

In reproducing we have not just a means to punch cards rapidly, but also a method for producing card documents, such as time cards, job cards, material requisitions, and move tickets. We have a method for duplicating files of cards; preparing working decks of cards so that master files can be kept intact; and producing a second or third file of transaction cards, permitting parallel operations on the same data.

Machine Operation

We have already described how the read and punch feeds of the machine are timed so that the position of a card feeding through one is in exactly the same position as a card feeding through the other. When a 5-punch in a master card is sensed at the reproducing brushes in the read feed, the 5-position of the card passing through the punch feed is directly under the punches (Figure 24).

The reproducing brushes sense the hole, and signal the proper punch. This punch is driven through the card and a 5-hole is punched. This process is repeated for each row of numbers in the cards: *12's* are punched then *11's*, then *0's, 1's, 2's, 3's*, etc.

Comparing-Verification of Reproducing

The reproduced data can be verified one card cycle later, during the same operation. As the source card passes the comparing brushes in the read feed, the corresponding reproduced card passes the punch brushes in the punch feed. If the holes sensed by the two sets of brushes are in the same position, the machine continues.

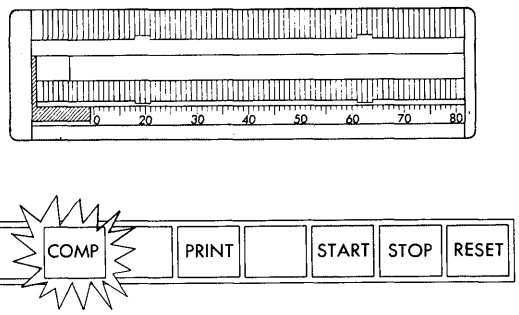

Figure 25. Comparing Error Indication

If there is any discrepancy, the comparing light goes on, and the machine stops. At the same time, the comparing indicator shows which comparing positions recognized the discrepancy (Figure 25). The number of the comparing position may be the same as the card column, if the control-panel wiring is so arranged.

A comparing check of reproducing is advisable. In processing data some punching error might occur that could involve thousands of dollars. Suppose, for example, an 8 in the thousand-dollar position of a billing card failed to be punched. This means an error of $8,000. The IBM method of data processing includes controls to prevent such a loss. An error of this kind must be found and corrected before control requirements can be satisfied.

Verification by comparing is available in two capacities — 45 or 80 columns of comparing positions. In many cases, 45 columns are enough to handle reproducing or gangpunching operations. Even when more than 45 columns are being reproduced, some of the data may be common to all cards. In that case, they can be checked visually.

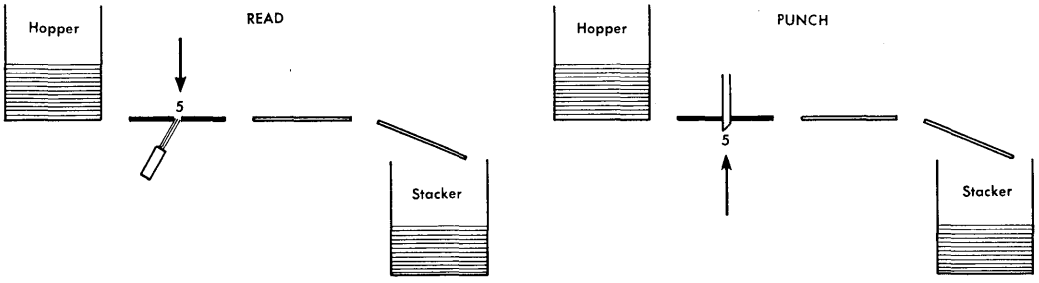

Figure 24. Reproducing

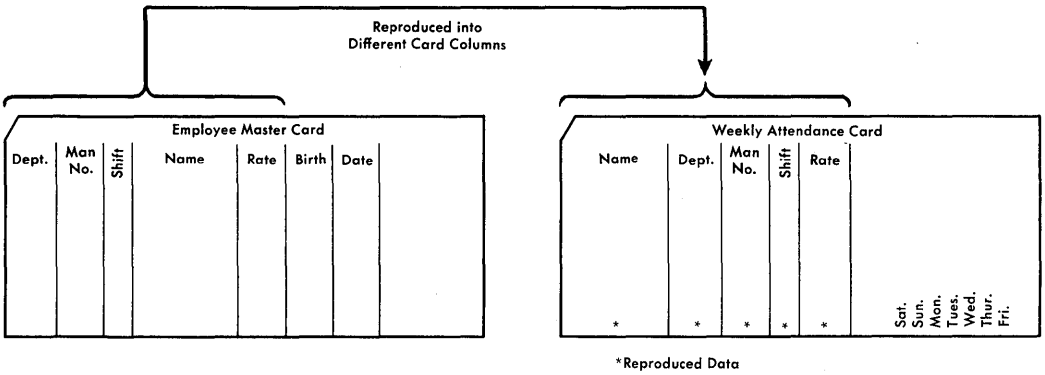

Figure 26. Card-for-Card Reproducing

Card-for-Card Reproducing

Card-for-card reproducing is straight reproducing. It is used to reproduce files or to prepare duplicate sets of cards. In some cases, only portions of a card need be reproduced — perhaps into different fields in the blank cards.

A typical operation is preparation of prepunched attendance cards from a set of employee master cards. Employee master cards usually contain personnel data that would not be used in attendance cards. The data to be reproduced might be punched in different fields. In the attendance cards reproduced from the master file, only the required information is punched; and it is punched into any desired card columns (Figure 26).

Selective Reproducing

We know that the read X-brushes at the control station in automatic punches can recognize distinctive X-punches in cards, and signal various machine operations. This way, it is possible to pass a master file of cards through the read side of an automatic punch, and reproduce only those cards with a control X, or only those without the control X. This is called *selective reproducing.*

An example might be reproducing all the cards in a certain product category, from a file of perpetual inventory cards. The inventory cards in the special category have a distinctive X-punch.

By selective reproducing, only the cards with X's are reproduced (Figure 27). A blank card passes through the punch feed for every card not reproduced. Then the reproduced set is sorted to remove the blank cards, so that only the special-category cards remain for analysis. In selective reproducing in the

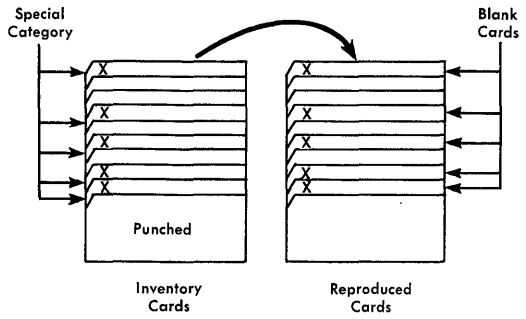

Figure 27. Selective Reproducing

528, the read feed operates continuously, but the punch feed operates only when a card is reproduced.

It is sometimes necessary to select information from one of two punched fields in source cards, and reproduce the selected field into a single field in the reproduced cards. This operation is called *field-selected reproducing.*

An example of this operation can be found in Payroll, in reproducing attendance cards from the master payroll file. Two hourly rates are punched in the employee master cards — a first-shift rate and a second-shift rate. Second-shift cards are identified by an X-punch code (Figure 28). Whenever a second-shift code is recognized in a master card, the second-shift rate would be reproduced into the attendance cards instead of the first-shift rate. The absence of the second-shift X-punch would cause the first-shift rate to be reproduced.

The ability of these machines to reproduce data from a card or ticket into another card offers many advantages. If material is already in punched-hole form—whether in a master file, a price ticket, another transaction card, a document (such as a check or cash stub being returned), or any other form—that material can be made to work for you, by the reproducing function.

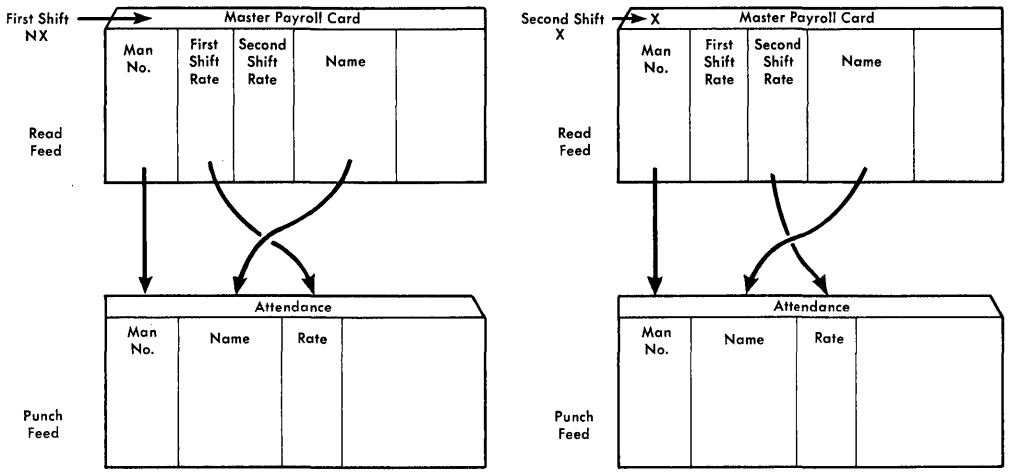

Figure 28. Field-Selected Reproducing

GANGPUNCHING

We have discussed some of the reasons why gangpunching is a valuable feature of punched-card data processing. We examined its ability to code and decode, to rate and price, to extend, and to serve as a method for reducing keypunching of common data.

Let's review what we know about gangpunching:

1. Any information that may be used again, can be keypunched into a master card.
2. The master card can be used to transcribe punched data into other cards automatically, saving time and money, and increasing accuracy.

Whatever the master card may be — customer name card, pre-extended card, pricing card, payroll rating-card, the first card of a group of cards being keypunched, date card, or any other — gangpunching from that master card into detail cards is a valuable tool in a punched-card procedure. It saves both machine and operator time; it reduces the possibility of error; and it makes work scheduling easier.

Machine Operation

As we know, in gangpunching, cards feed continuously through the punch feed of the machine, face down, 12-edge first. They first pass the punch X-Brushes, where X-punches can be recognized. These X-punches are used as control instructions to the machine.

The card continues into the punch station, where it is punched first in the 12's row, then the X's, the 0's, the 1's, etc., through the 9's row. The card continues and passes over the punch brushes, where 80

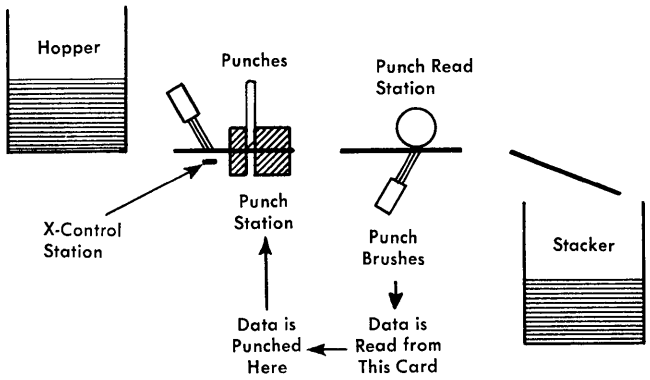

Figure 29. Schematic of Gangpunching

brushes read the 12's, the 11's, the 0's, etc. Simultaneously, the following card is passing under the punches, its position synchronized with the first card (Figure 29).

Feeding continues this way until the last card has left the feed hopper. The machine stops when the card lever, normally held down by the weight of the cards, rises. The operator may then refill the hopper and restart the machine by pressing the START key; or he may run all cards out by pressing and holding the START key.

Straight Gangpunching

Straight gangpunching is column-for-column gangpunching from one card to another. Only one master card is required.

A typical example of straight gangpunching can be found in an accounts-receivable application, where

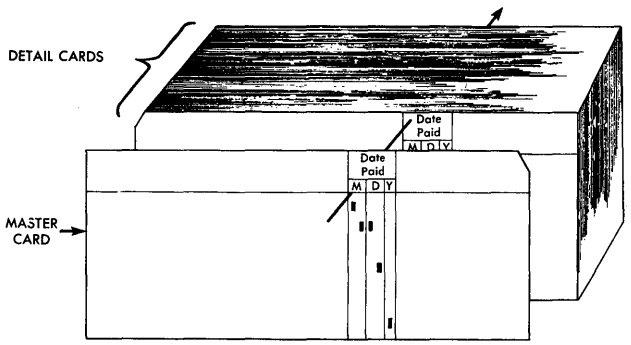

Figure 30. Straight Gangpunching

cards are pulled daily from the accounts-receivable file upon receipt of payment, and gangpunched with the date paid. Because they are pulled daily, they are all punched with the same date (Figure 30).

The job is completed in a fraction of the time required to keypunch the dates. Exactly how much time and money is saved depends on the number of columns being punched and the proficiency of the keypunch operator. Gangpunching operates at a rated speed of 6,000 cards an hour, regardless of the number of columns punched.

In this operation there is no need for an X-punch in the master or detail cards. The date, or any other information, is read from the master card at the punch brushes, and punched into the first cash card at the punch station. It is carried from the first cash card into the second, from the second into the third, etc., until all cards have been fed and punched.

The quickest method of verification for this type of gangpunching is to compare the master card with the last card punched. Gangpunching is a copying process, with each card serving as the master card for the succeeding card. The operator can be sure that the information has been passed along correctly, from card to card, merely by comparing the first and last cards (Figure 31). The operator should also be able to hold the deck of cards up to the light and see through the holes gangpunched with common data.

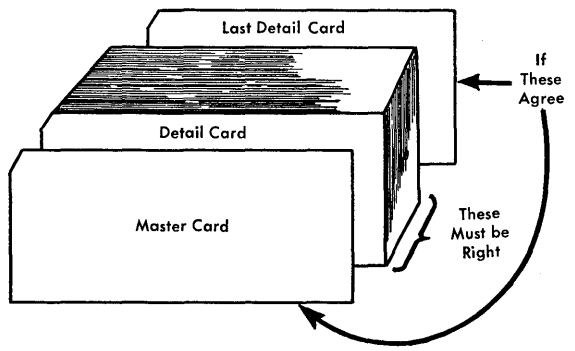

Figure 31. Verification of Gangpunching.

Interspersed Gangpunching

Interspersed gangpunching occurs when many groups of detail cards are each preceded by an individual master card from which data must be punched. Instead of processing each group separately (straight gangpunching), the groups are processed together, as one complete file. This results in a much faster operation because of the great reduction in card-handling time, especially when some of the groups contain only a few cards.

A typical interspersed-gangpunching operation can be found in a payroll application, where employee master cards are used to gangpunch hourly rates into individual job tickets (Figure 32).

Each employee may receive a pay rate different from the one preceding or following him. We want to pick up new gangpunching data as each new master card is fed into the machine. In addition, we must suspend gangpunching when the last detail card of each group passes the punch brushes, or the rate for that employee will be overpunched in the following employee's master card and, from there, into the detail cards. This is called *lacing*.

Suspending punching from group to group is controlled by the X-punches. The X may be placed in either the master card or the detail cards. The presence or absence of the X-punch is detected by the punch X-brushes, to suspend punching for master cards.

There are many uses for interspersed gangpunching in various applications. One of the most frequent uses is punching indicative or descriptive information into a group of detail cards, eliminating keypunching this material.

Let's look at an accounts-payable punching job as an example. We can see in the accounts-payable cards shown in Figure 33 that columns 1-39, 53-57, and 64-69 (a total of 50 columns) are identical in all the cards relating to a particular invoice. One way to produce these cards would be to keypunch the first card of each invoice (probably the accounts-payable card), then duplicate the 50 columns of common information into the distribution cards, and keypunch the variable data. Assuming 200 invoices a day, with an average of six items per invoice, time for duplicating the common data is 48 minutes per day. If the duplicated information is verified, an additional 48 minutes is needed. These time estimates, of course, do not include time to keypunch the other columns of the cards.

The same operation, using interspersed gangpunching instead of duplication, requires a maximum of 20 to 22 minutes, including setup and verification time on the gangpunch. (See *Gangpunch Verification.*) The saving in time is better than 50%.

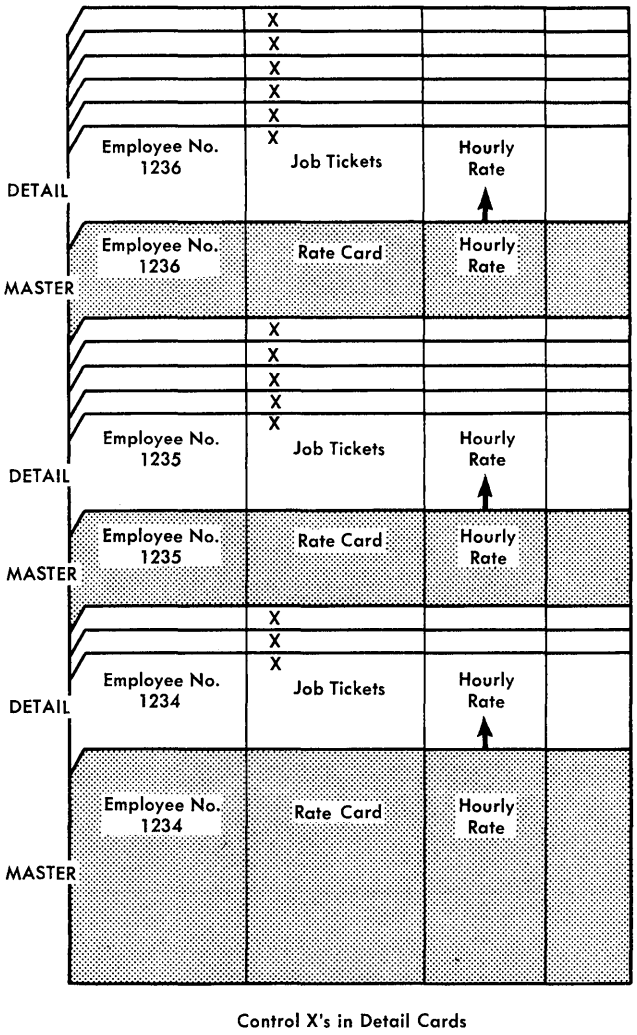

Figure 32. Interspersed Gangpunching

Offset Gangpunching

In our discussions of straight gangpunching and of interspersed gangpunching, the information read from the master card was located in the same card columns as the gangpunched information in the detail cards. We called this column-for-column gangpunching. Most jobs using gangpunching (straight or interspersed) are done this way. Whenever it is possible, cards are designed so that common information falls in the same fields in all of the cards involved. This is not only to make gangpunching more convenient, but also to make card-handling in general more efficient.

You can easily see that if similar classifications of data are in the same columns of all cards involved in the job, they can be sorted in groups in simple sorter operations; they can be sequence-checked, merged, matched or selected in collator operations; they can be filed, pulled, and handled more easily in every phase of operations.

But it doesn't always happen this way. Circumstances may make it impossible to locate card fields ideally. IBM machines have been designed so that unusual cases can be handled with the same speed, efficiency, and accuracy as all the others.

Offset gangpunching accommodates gangpunching common information where the card fields are not the same in the detail cards as in the masters (Figure 34).

In the production cards shown, the master job cards contain the job number and the order number. This information is common to all the job tickets used as the production pieces move through the plant. But suppose problems of card design make it impossible

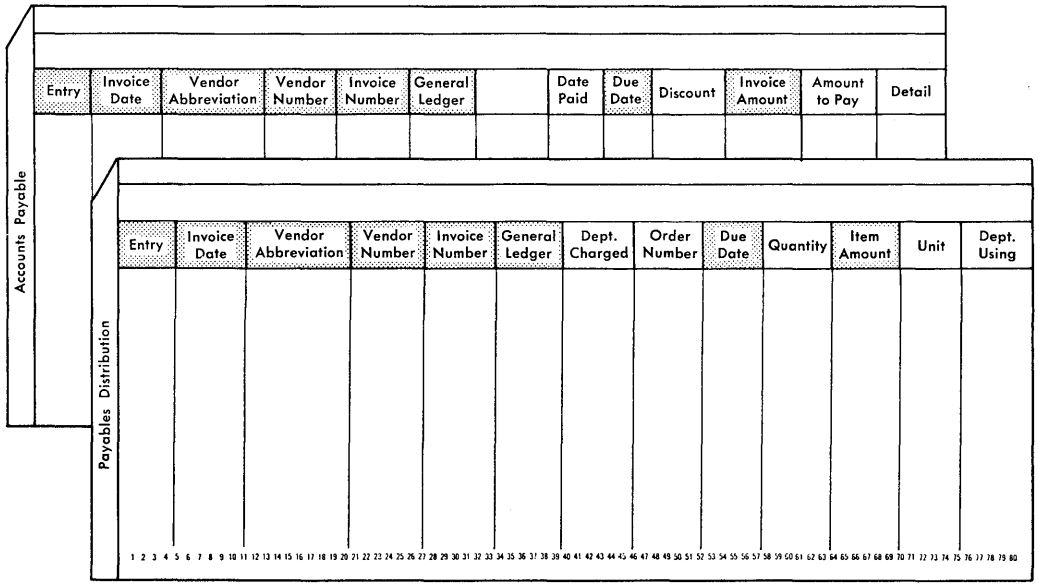

Figure 33. Interspersed-Gangpunching Application

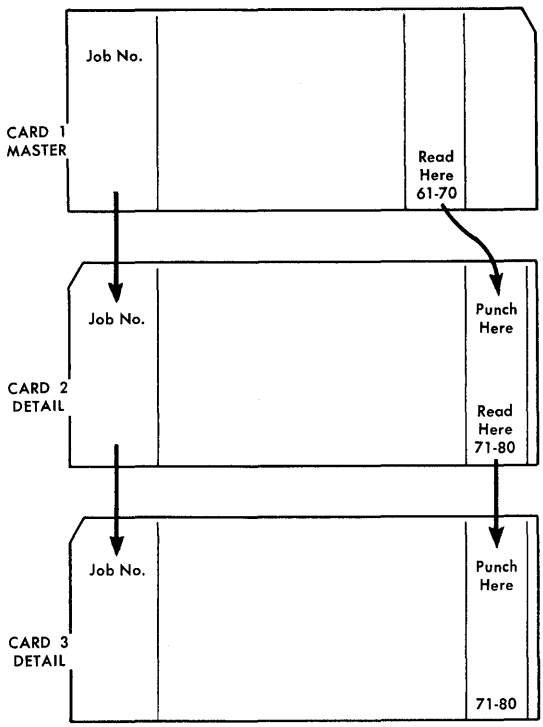

Figure 34. Offset Gangpunching

to use the same card fields for the order number. Therefore, when job number and order number are gangpunched from the master cards into the job tickets, order number must be offset from columns 61-70 in the masters to columns 71-80 in the detail cards.

The master card feeds in first. No punching takes place. Then the punch brushes read columns 1-10 (job number) and punch into columns 1-10 in the next card, a detail card; simultaneously, the punch brushes read columns 61-70 (order number) in the master card, and punch into columns 71-80 of the detail card.

The cards move one station, and the first detail card is now at the punch-brush station; the second detail card is at the punch station. The punch brushes can read columns 1-10 just as they did with the first card. But there is no punching in columns 61-70 as there was before. Now the information is in columns 71-80. This is the problem of offset gangpunching, and it requires the use of selectors to handle it.

A selector group must be used to pick up the proper field. A second selector group must be used to check the gangpunching. (See *Gangpunch Verification*.)

Major-Minor Gangpunching

Certain gangpunched information may remain constant throughout a major card group, while other gangpunched information changes for minor groups within the major classification.

A labor-distribution application illustrates the use of major-minor gangpunching to reduce keypunching. Weekly job reports for each man are received in department groups for keypunching. Several cards are to be punched with department number, man number, and variable information for each man. Department number is keypunched only in the first card for each department; man number is keypunched only in the first card for each employee. Major-minor gangpunching is used to punch department number (major) and man number (minor) in the card.

Because the first card for each department (major), and for each man (minor), serve as master cards, they must be distinguished from the detail cards that follow. The detail cards are to be gangpunched with both department and man number. To distinguish the detail cards, both fields contain an X-punch. The first card for each man is to be gangpunched with department number. This field alone contains an X-punch to distinguish the man (minor) master cards. The first card for each department (major) is keypunched for both fields. It is distinguished by containing no X's.

Department number is gangpunched into all cards of a major group, including the minor masters. Man number is gangpunched only into the cards for that man (Figure 35).

Gangpunch Verification

There are, basically, three methods of verifying gangpunching operations:

Manual Sight Checking

We have already discussed this as the quickest and easiest way to verify straight gangpunching operations. It is simply checking the last detail card with the first (or master) card visually (Figure 31). This method is satisfactory for checking interspersed gangpunching only when the groups are large. Each group is sight-checked individually.

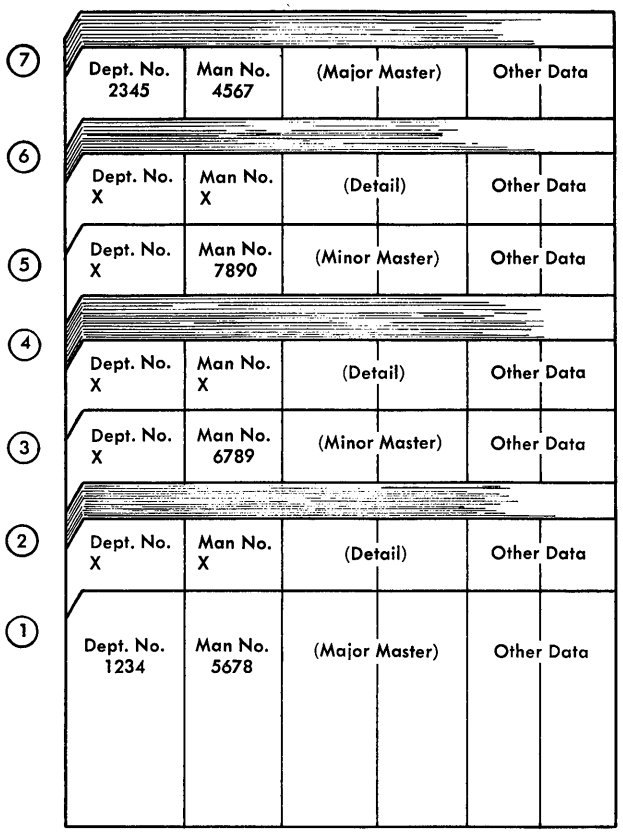

Figure 35. Major-Minor Gangpunching

Machine Comparing

The most satisfactory method of checking interspersed gangpunching is with the comparing feature that is available on many automatic punches. Comparing is done in the read feed of the machine and is similar to the punching operation. The machine reads the first card at the comparing brushes and compares it with a card at the reproducing brushes (the second card). If the cards agree, the machine continues operating. If they disagree, the machine stops and a red light signals an error.

Comparison is made by comparing magnets in the machine. If the machine senses a 5-punch at both sets of brushes, for instance, two magnets corresponding to that position are energized simultaneously. An equal or satisfactory condition is recognized. If the machine made an error in punching, however, one of the comparing magnets would be energized by a 5-punch while the other was energized by a different punch, or not energized at all. An unequal condition, or error, would be recognized. The machine goes into its error routine, stopping and turning on the red light (Figure 36).

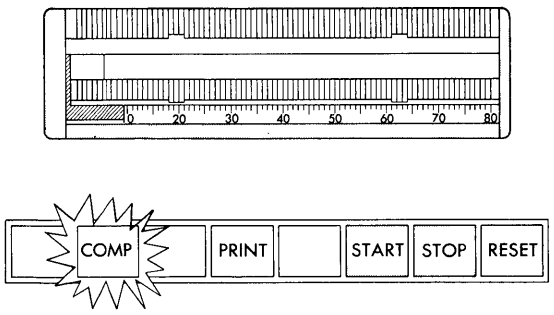

Figure 36. Comparing Error Indication

The position of the error is immediately apparent in the comparing indicator, located on the front of the machine. The indicator represents the 80 possible comparing positions, not the columns of the card. If the error described is in column 25 of the cards, and column 25 is wired into comparing position 37, the indicator points out an error in position 37. Whenever possible, of course, the comparing magnet number should correspond to the card-column number to make it easier to locate errors.

The indicator is reset by a lever to the left of the indicator. This lever also turns off the error signal light.

Read X-brushes read X's in either the master or detail cards to suspend comparing between the last detail card of a group and the next master card.

Gangpunch comparing can take place simultaneously with gangpunching, so that very little time is lost on the operation. As soon as three or four hundred cards have been gangpunched, you can stop the machine. Take the cards from the punch stacker and put them in the read hopper. Push the START key, and both feeds will run simultaneously, one gangpunching, and the other checking what was previously gangpunched.

Offset gangpunching can also be machine-checked, but a selector group is required.

Double-Punch and Blank-Column Detection

In gangpunching, 98% of the errors occur as blank columns and multiple-punched columns. These errors are due to mispunching by the keypunch operator, or possibly some mechanical or wiring failure in the machine.

Checking for blank columns and multiple-punched columns is a satisfactory way to verify gangpunching. This is done by the Double-Punch and Blank-Column-Detection Device.

Gangpunching Applications

We have already discussed some of the many varied uses of gangpunching. Gangpunching is not just punching holes – it's a method for automatic pricing, automatic coding, decoding, and extending. Let's look at these jobs:

Automatic Pricing or Rating

Many accounting and recordkeeping operations can make use of gangpunching for automatic pricing or rating. In billing and sales, selling prices and cost prices of each item sold can be applied by gangpunching, rather than by looking up prices in large price books. In material accounting, material issues can be costed by punching. In a payroll operation, man-hour rates or job rates can be applied to job or attendance cards by gangpunching. Overhead rates can be applied the same way.

We can see how it works by going through a procedure for costing-out sales cards. In many businesses, cost prices change too frequently to maintain that price in tub-file cards. The other alternative is looking up the current price in a large book, and writing it on the order form for keypunching. But that would be time-consuming and expensive. Gangpunching can be the answer.

We establish a file of cards in item-number sequence, one card for every item sold. Each card contains the item number, any other pertinent indicative data, and the current cost price. You can see that as costs change, it is simple to pull a card out of the file and substitute a card with the new price.

Daily or weekly, the file is brought together, in item-number sequence, with the detail sales cards. This can be done with either the sorter or the collator. Doing the job with a collator means that master costing cards for inactive items can be dropped out, reducing gangpunch time.

The merged file can be processed through an IBM Automatic Punch at 100 cards per minute. Cost price is read from the master card and punched into all following detail cards in that item-number group (Figure 37).

Assuming a week's volume of 15,000 detail sales cards, and 2,000 items in stock, the entire pricing job can be completed in approximately 3.2 hours, allowing about 12% for card-handling time. To this, of course, must be added time to arrange the cards, and sorting time to separate them upon completion of the operation.

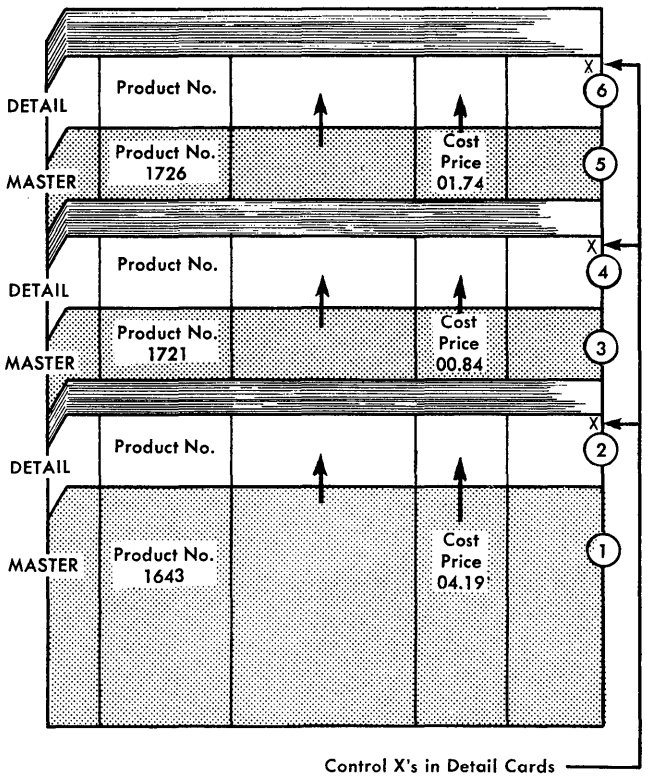

Figure 37. Automatic Pricing by Gangpunching

Automatic Coding or De-coding

Frequently, numerical codes are used in punched-card data processing to reduce keypunching, sorting, and card-capacity problems. Cards punched with these codes must later be de-coded to permit preparation of significant reports. A sales report showing product names as well as numbers is more valuable than report showing numbers only.

Gangpunching can provide additional coding on cards, too. We know that a certain product is always in the same warehouse location, that its product class is always the same, that its cost doesn't change often.

In circumstances like these, all the information needed could be keypunched. This would be time-consuming and expensive, however. Gangpunching can handle the job much better. All that must be punched into the detail sales card is the product number. These cards can then be combined, by product number, with a master file composed of one card for each item. In addition to the product number, the master cards contain product name, location codes, cost prices, product-class codes, etc.

All this information can be gangpunched into the detail sales cards. This has a number of advantages:

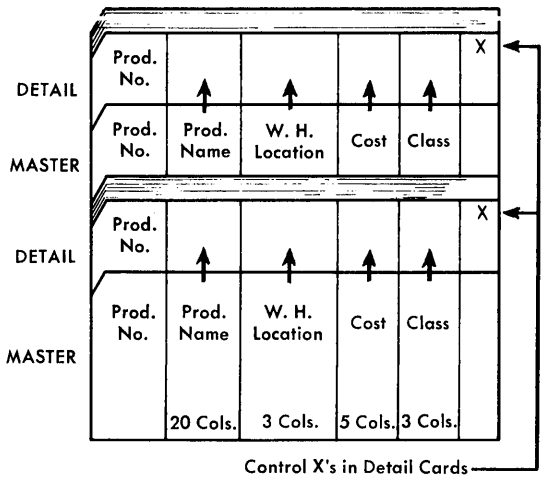

Figure 38. Automatic Coding by Gangpunching

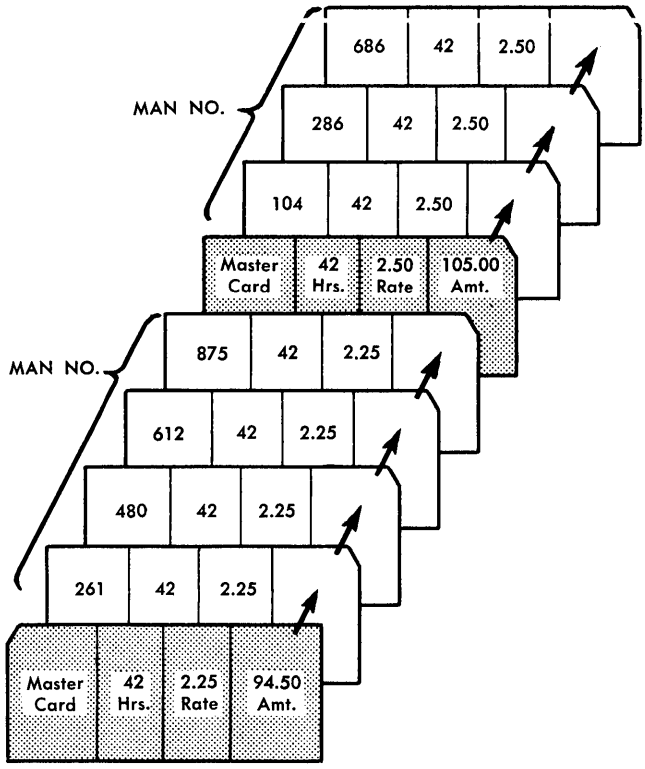

Figure 39. Automatic Extending by Gangpunching

Speed. Keypunching product name (20 columns), location code (3 columns), cost price (5 columns), and product class (3 columns), into 4,000 sales cards a day requires 12.4 hours. (If done, key-verification of the same information would add another 12.4 hours to the punching job.) Sorting 4,000 detail cards together with 3,000 master cards, gangpunching the data (Figure 38), and then separating them from the masters, require about 2.8 hours. Decisions based on reported facts can be made at least 9.6 hours sooner.

Accuracy. Key-verification checks the accuracy of punching, but we have seen how much time it takes. Gangpunching, combined with comparing or double-punch, blank-column detection insures accuracy with no significant addition of time.

Economy. Considering both the keypunching and verification time, over 24 hours of operator time is required each day for the keypunch method; only 2.8 hours in the gangpunch method. The difference represents extensive savings not only in time, but also in personnel and wages.

Extending or Simple Multiplication

If the card volume of an installation is small, the cost of a calculating punch for making extensions like $A \times B = C$ is not justified. In most of these cases the master-card-extension method, usually referred to as *gangpunch extension,* can be used.

Factors A and B that are normally encountered in extension work are punched into master cards with the entire calculation. The master cards are then merged with detail transaction cards, so that detail cards with the same multipliers and multiplicands are grouped together behind the master card containing those factors (Figure 39). Normal interspersed gangpunching transfers the extension products from the master card into the following detail transaction cards.

In an hourly payroll procedure, for example, daily job or attendance cards can be extended this way. Prepunched master extension cards are kept in a master file, one card for each possible rate and number of hours, with the total pay due for those hours at that rate. The job or attendance cards, in sequence by rate and hours, are sorted or collated behind the master card for each combination of rate and number of hours. The total pay extension is then gangpunched.

Ordinarily, this procedure is used only when cards can be extended daily. If time is recorded in tenths of hours, cards are provided for each rate for every tenth of an hour from 1 to 10. If rates are in the range of \$1.00 to \$3.25 with \$ .05 intervals, the file contains a maximum of 4,186 cards (46 x 91). You can see that if weekly intervals were used, the size of the file could easily be 20,000 cards or more.

In many cases, gangpunch extension at the rate of 100 cards per minute (less handling time) would actually be faster (including the preparatory sorting operations) and less expensive than a calculator. And when you consider that checking can be done in the read feed at the same time extensions are punched in the punch feed, its use becomes even more practical.

SUMMARY PUNCHING

Summary punching is automatic preparation of one total card to replace a group of detail cards. A total, or summary, card contains the identification of a group and one or more totals accumulated for that group. The primary purpose of summary punching is to reduce card volume and, as a result, speed preparation of periodic reports. When totals, or balances, are carried forward from one period to another (as in stock-status summary or accounts receivable), the summary cards are called balance-forward cards.

In a summary-punching operation, the automatic punch is connected to the accounting machine by a cable (Figure 40).

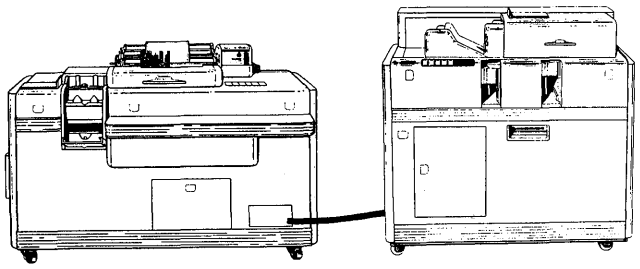

Figure 40. Accounting Machine and Summary Punch

Machine Operations

Information that is to be summary-punched into a card comes from one (or both) of two sources in the accounting machine — counters and storage. Regardless of the source, however, the operation of the punch is the same.

The information to be summary-punched is transferred from the accounting machine through a cable to the magnets that actuate the punches.

Any or all the columns in the card can be punched. The only other restriction on the number of different items that can be punched is the capacity of the accounting machine used. If the accounting machine is equipped to handle it, there is no limitation on the punching of alphabetic or special characters. Any value stored or standing in a counter can be punched when the accounting machine sends out the impulses.

Summary-Punching Applications

Summary-punching applications improve almost every punched-card procedure. Summary cards serve many purposes (Figure 41). In stock-status applications, for example, they are used to forward balances automatically. In accounts receivable, they serve as automatic accounting entries. In sales analysis, they are used to accumulate year-to-date totals.

Regardless of the application, the same factors make it useful — the need to reduce card volume, or the need to carry balances forward. Let's look at some of the applications:

Accounts Receivable

Could we use our detail sales-cards for accounts receivable? It's possible, but not too practical. We'd have the problem of applying cash in payment of an invoice (6 to 20 detail cards might represent that invoice in the accounts-receivable file). Preparing statements and aged trial-balances would be lengthy and time-consuming jobs. Summary punching makes this job simple and efficient. One card represents each invoice in the accounts-receivable file, and simplifies all procedures involving that file.

There are many summary-punching applications in accounts receivable. Here are a few:

1. Producing original accounts-receivable cards by summary punching during the billing operation.
2. Preparing general-ledger entry cards by summarizing the daily accounts-receivable register and cash-register operations.
3. Preparing a new balance-forward card for each customer, at the beginning of each month.

Sales Analysis and Sales Accounting

Very few recordkeeping procedures require as much card volume as sales analysis. Using detail cards to process the required sales reports by product, salesman, customer, etc., could make the job too late and too costly to be useful.

Some of the most useful reports in a sales-analysis job are comparisons between this year's figures and last year's; this month's and last month's year-to-date actual, and year-to-date budgeted. These comparisons are made between summarized figures.

Let's look at a typical example:

A wholesale distributor mails 500 invoices a day — an average of 17 items on each invoice. There are 8,500 separate sales each day to be analyzed. Who bought?

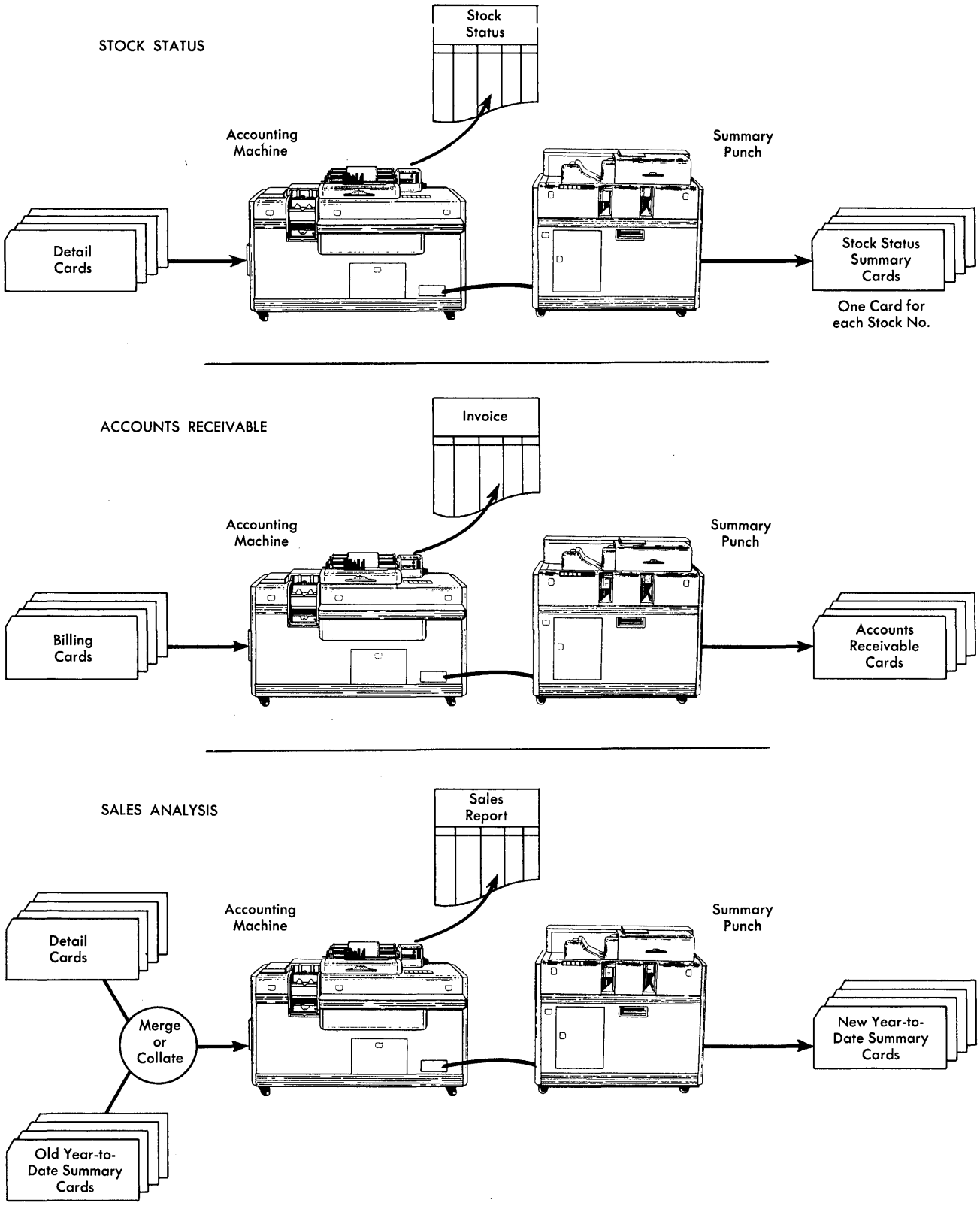

Figure 41. Summary-Punching Applications

What did they buy? Which salesmen did the best job? How profitable were the sales?

These are just a few of the questions asked by an executive about these 8,500 sales. What he really wants to know is *Are we doing a good job?* and *How can we do a better job?* The other questions are merely to gather facts to answer the major questions. But the fact-gathering job is difficult without summarization.

To get his answers, this executive needs these reports:

1. Sales by salesman, by customer (weekly, for first three weeks of month).
2. Sales by product (weekly, for first three weeks of month).
3. Sales by salesman, by customer (current-month; this-month-last-year; year-to-date; last-year-to-date).
4. Sales by product.

This is the volume involved in these reports:

3500 customers (Active: 1800 per week
3100 per month)
18 salesmen
500 products (Active: 300 per week
450 per month)

REPORT NUMBER	DESCRIPTION	DETAIL CARDS
1	first week	42,000
	second week	42,000
	third week	42,000
2	first week	42,000
	second week	42,000
	third week	42,000
3	current-month cards	168,000
	current-month-last-year cards	168,000
	first-5-months cards	840,000
	first-5-months-last-year cards	840,000
4	current-month cards	168,000
	Total	2,436,000

Those are the cards needed for the required reports during the month of June (the mid-point of the year) without summarized figures.

With group listing at a rate of 150 cards per minute in an accounting machine, card-feed time would amount to 271 hours a month. Total print time (1.7 hours for the 10,300 totals) as well as setup and handling time would have to be added, too. Here's how it would work out with summary-punching:

REPORT NUMBER	DESCRIPTION	DETAIL (D) OR SUMMARY (S) CARDS
1	first week	1,800 (S)
	second week	1,800 (S)
	third week	1,800 (S)
2	first week	300 (S)
	second week	300 (S)
	third week	300 (S)
3	current-month cards	5,400 (S)
		(from report #1)
		42,000 (D)
	current-month-last-year cards	3,500 (S)
	first-5-months cards	3,500 (S)
4	current-month cards	900 (S)
		(from report #2)
		42,000 (D)
	Total	107,100

Machine time required under this procedure for all reports (including extra summary-punching time) is 45 hours — a reduction of 228 hours from the non-summary-punching method. The difference in cards handled is 2,328,900.

Although summary punching does not always produce such startling time savings, it effects significant reductions in every procedure where analysis reports are used.

Payroll and Labor Distribution

There is probably no accounting procedure in which summary punching plays a more important role than in payroll and labor distribution.

Summarizing a daily-pay card from the job cards is a common operation on an accounting machine with summary punch attached. The procedure is:

1. Calculate pay due on each job card. This can be calculated both for piecework and hourly rate.
2. Sort job cards by man number.
3. Prepare daily-earnings statement in an accounting machine; summary punch daily-earnings card for each man number.
4. If both incentive pay and hourly pay have been computed, select the larger.

Summarizing weekly gross pay from the daily-pay cards is another important summary-punching job in payroll. Others include:

Summarizing a new year-to-date earnings card each week.

Summary punching a card to be used as a check.

Summary punching totals for the various distribution classifications.

Summary punching can be used to good advantage whenever one card can be made to do the job of many. This is true of any information that is to be used in future operations, where the detail behind the card is not needed.

A description of summary-punching jobs for other applications follows the pattern already presented. The principles we have discussed are the basis for good summarizing techniques in any punched-card procedure to reduce card volume, card handling, peak loads, and report-preparation time.

MARK SENSING

We know that effective use of machines for automatically handling data depends on coding information into a language that the machines can read. This is the basis for reducing manual handling of source information.

Punched-card data processing has been the most effective method devised for mechanization of record-keeping. This means keypunching original information, verifying the punched holes, and automatic handling from that point on.

But it is possible to reduce manual keypunching in many cases. IBM has developed devices that make it possible for machines to read pencil marks on IBM cards, and translate them into punched holes. This has been a major step toward automation in the office. This function, called *mark sensing*, has permitted wider use of IBM cards as original source documents—source records that can be automatically processed by machines.

Mark-Sensing Applications

Mark sensing can be a valuable tool to reduce manual keypunching and verifying. It is particularly useful where an IBM card can replace a source document.

Data to be mark sensed may be either numerical or alphabetic. Because it takes two pencil marks in the same column for recording alphabetic information, (Figure 42), this should be done only when necessary.

Many successful procedures are built around mark sensing. Some involve punching recorded data into the same card. In these, the mark-sensing feature is installed in the punch feed. If the marked card is used to produce new cards, mark sensing is installed in the read feed, so that the marks can be read from one card and reproduced into another card.

Mark sensing has been used successfully for recording physical inventories, taking surveys, noting receipts to stock, recording job cost data, utility meter readings, and many other applications. Here is a typical mark-sensing application:

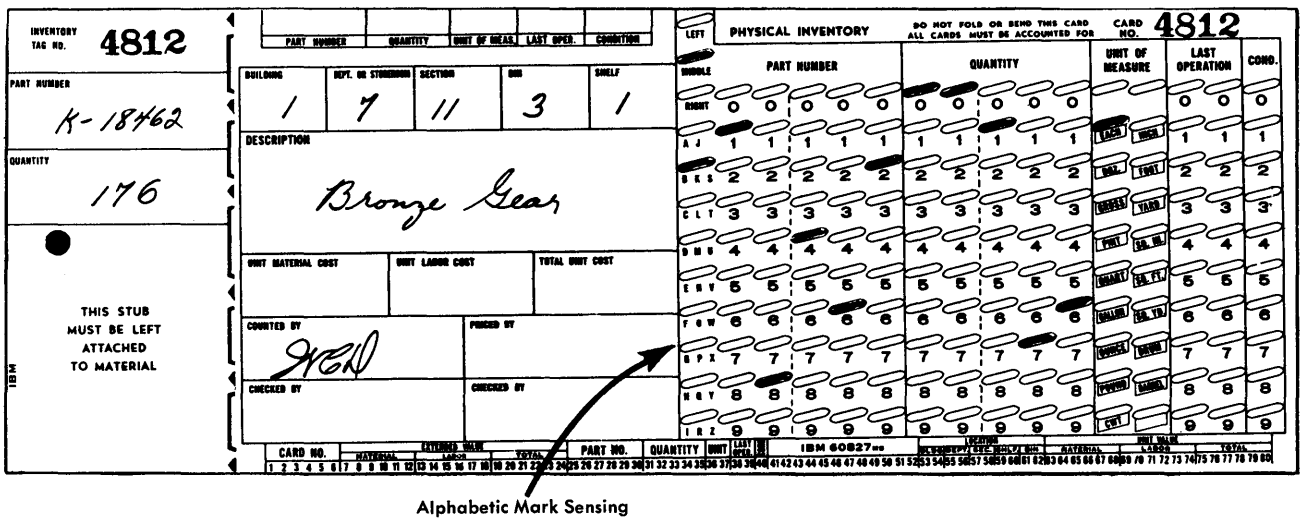

Figure 42. Physical-Inventory Card

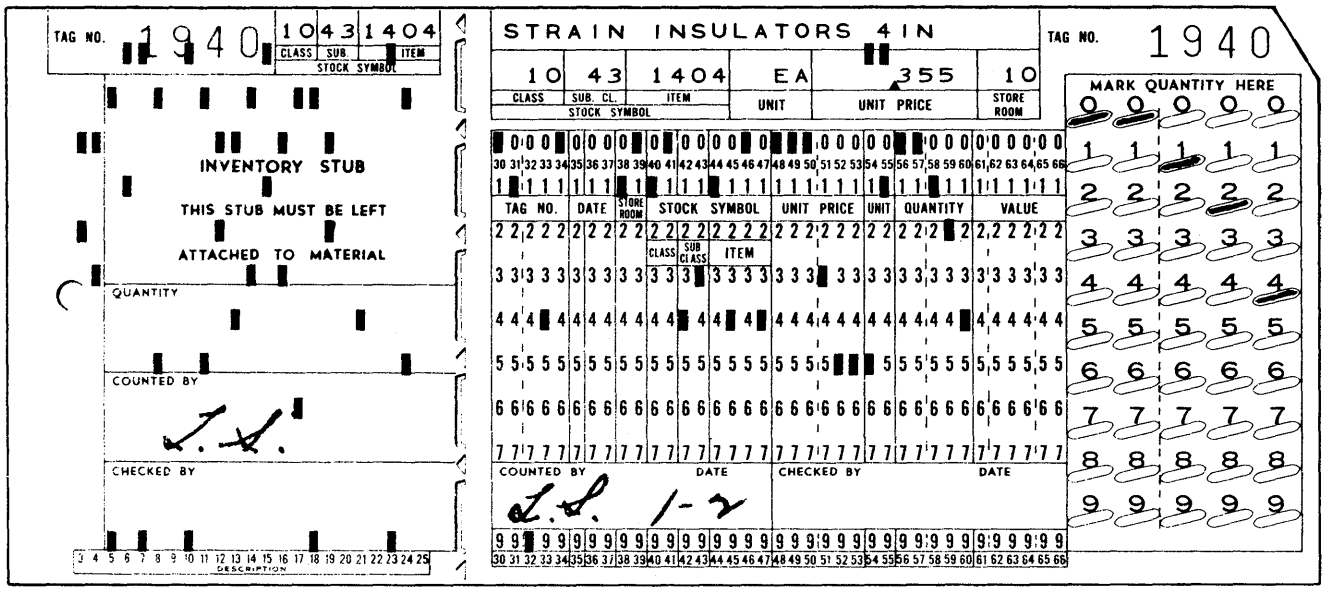

Figure 43. Prepunched Physical-Inventory Card

The IBM stub card (Figure 43) is used to record a physical inventory. The stub is left attached to the item being inventoried, and the card is processed in a mark-sensing reproducer. Notice that the punching fields do not coincide with mark-sensing columns. Mark-sensed data can be punched in any area of the card.

After the mark-sensed material has been punched, the card is keypunched and verified with the first line of handwritten information at the top left portion of the card.

In this particular application, mark sensing has reduced the amount of keypunching and verifying by 16 columns. This speeds preparation of inventory reports, as well as cutting down expense of the inventory.

In many physical-inventory jobs, it is possible to prepunch all identifying data for each item to be inventoried (Figure 43). Only the quantity in stock need be marked. This procedure has a number of advantages:

1. Because we provide one card for each item in stock, pre-numbering the cards insures a complete inventory.
2. The time and effort spent on mark sensing is reduced. The inventory is completed much faster.
3. Errors are reduced, because we have reduced the amount of data to be recorded manually (mark sensed).

Mark sensing is ideally suited to physical-inventory work because the marks are the original recording of data. From that point on, the entire inventory can be completed without manual operations.

END PRINTING

A number of procedures involve card handling by people who are not trained in this field. Perhaps the most common is registering attendance on IBM time cards.

The apparent need is for an easily read form of card identification. End printing was developed to fill this need.

One of the greatest advantages of end printing is that it takes place in the same operation as punching. Attendance cards, for example, can be punched and end printed in the same operation.

Applications of End Printing

The major applications of end printing involve the use of card documents or tub files. Whenever cards are filed on end (such as time card racks or tub files), end interpreting is very valuable. It is easy to read and clearly visible. People not familiar with actual card procedures quickly and easily identify man numbers, part numbers, stock numbers, prices, dates, departments, or product numbers (Figure 44).

End printing is a standard feature of the IBM 519 Document-Originating Machine. It is available only on this machine. The printing unit has the capacity to print as many as eight columns on either of two lines, across one end of a card. Inverted end printing and right-hand end printing are available as optional features.

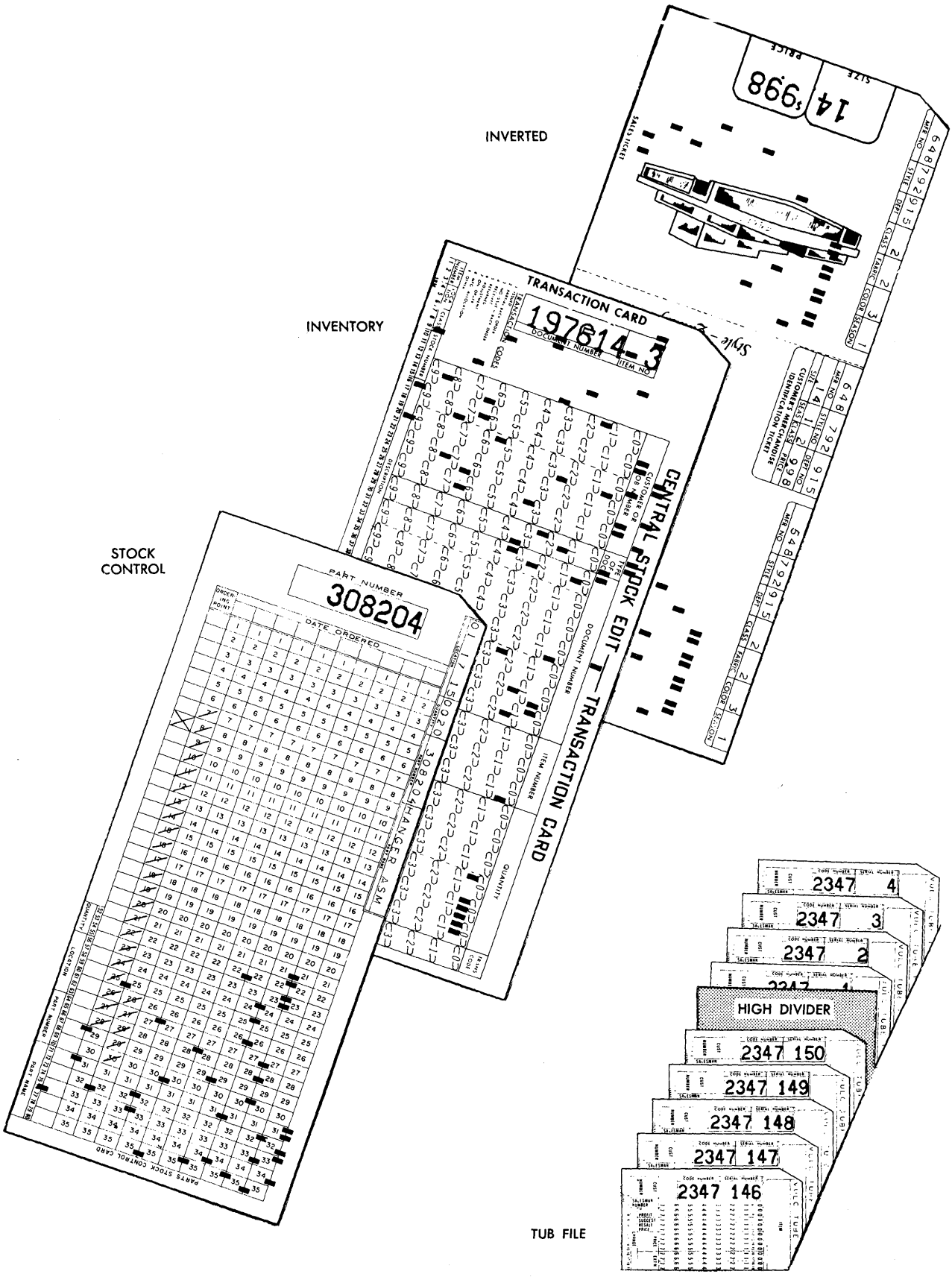

Figure 44. End-Printed Cards

ACCUMULATING

Accumulating and total-punching involves adding and subtracting amounts from different cards to provide a summary total of all of them within a given group. The cards to be processed are placed in the read feed; the total cards are placed in the punch feed.

In a crossfooting procedure, the amounts in different fields of the same card are added or subtracted to obtain a result for that card. This operation is done in the punch feed.

Of the automatic punches, only the IBM 528 Accumulating Reproducer performs the function of accumulating. This machine is particularly adaptable to any application requiring punching of totals without a detailed report listing. Detail cards in the read feed can be accumulated at 200 cards per minute, and the total cards punched at 100 cards per minute.

An Application of Accumulating

An inventory-control application is a good example of accumulating and total-punching. The initial stock record is punched into a balance-forward card. Whenever material is issued, an issues or sales card is punched; as new stock arrives, a receipts card is prepared. The inventory file is composed of these three types of cards: balance-forward, receipts, and issues cards.

The stock status at any time is obtained by adding the receipts cards to the old balance-forward card, and subtracting the issues cards: (old balance) + (receipts) — (issues) = (new balance).

The inventory file is fed through the read feed of the IBM 528, and the blank new balance-forward cards through the punch feed. Balance cards are identified by an X-punch in column 80. Receipts cards do not have an identifying punch. Sales or issues cards are distinguished by an X-punch in column 77 (Figure 45).

The machine punches a new balance-forward card for each group passing the read brushes. The information to go with the new balance-forward card comes from two sources: from the counter, with the new stock status; and from the last card in the group (old balance-forward card), with the identifying and descriptive information.

COMBINED OPERATIONS

Real economy and efficiency in data processing methods are the result of combining the basic functions. Some of the possibilities are:

Summary Punching and Gangpunching
Reproducing and Gangpunching
Reproducing, Gangpunching, and Summary Punching.

End printing, mark sensing, and accumulating can be done along with the primary functions on machines equipped with these features.

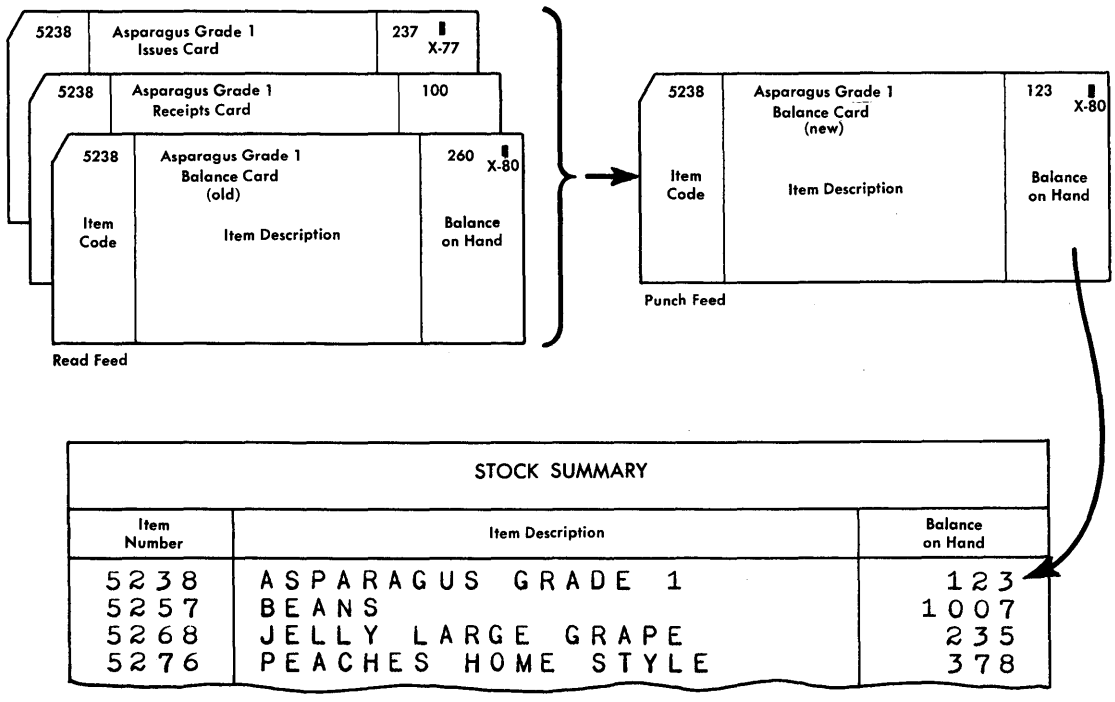

Figure 45. Inventory Control — Applications

Machine Summary

Now that we have had an introduction to the basic functions of automatic punches, let's look at the machines themselves. We can see what functions they perform, how they differ from one another, and the optional features available to extend the versatility of each machine.

SPECIAL DEVICES

Auxiliary Card Counter

A five-position unit counter, which registers a total count of 99,999, is available to count cards passing through the machine, or the number of cards in a certain classification or control group.

Two counters can be installed in the IBM 514, 519, and 528. This feature device is not available for the IBM 524, 526, and 529.

Consecutive-Number Gangpunching and Checking (IBM 514, 519)

This device can be used to gangpunch consecutive numbers into a group of cards (usually a predetermined quantity). The group of cards to be numbered is preceded by a prepunched master card that contains the starting number. This number is gangpunched into the first detail card. For subsequent detail cards in the group, one of the following operations can be performed:

1. Each detail card can be punched with a number one higher than that of the preceding detail card; or
2. Each detail card can be punched with the same number unless the card contains a control X (or NX). In that case, the card is punched with a number one higher than that of the preceding detail card.

An interspersed-gangpunch master card prevents continuation of the number series from group to group, and permits a new series to be started from a new number read from the master card. This device functions by reading a number at the punch brushes, and increasing that number for punching. Each card of the consecutive-number series must be punched to permit continuation of the number series.

Numbers as high as 99,999 can be punched. During a separate operation, the number punching can be checked by gangpunch checking, using the comparing brushes and the comparing relays.

Count-Controlled Punching and Serial-Number Printing (IBM 519)

The purpose of this device is to prepare a group of detail cards from a single master card in the read feed, and to serial-number end print the cards within each group. The serial number can only be printed, and cannot be punched.

This device is particularly useful in unit-inventory control, tub-file operations. The cards in the tub file, each representing an inventory unit, can be serially numbered in either descending or ascending sequence but not both. The first or last card of a group (depending on the sequence) indicates the number of units for that particular item in inventory.

Count-Controlled Punching

A master card containing information to be reproduced and gangpunched is placed in the read feed. A prepunched number-control trailer card, containing a number that represents a quantity of cards to be gangpunched, is placed behind each master card; this number cannot exceed 9999. Blank cards are placed in the punch feed. At least two cards must be placed for each master card. An offset-stacking device is provided with this device so that the first card of each group is offset to identify the groups.

Count-Controlled Serial-Number Printing

This device is available for printing in either ascending or descending sequence, but not both. The trailer card in the read feed can be prepunched with the starting serial number to be printed, in addition to the quantity of cards. The first card of each group in the punch feed is printed with the starting serial number. Each succeeding card of the group is printed with a serial number one higher or one lower (depending upon whether the device is for ascending or descending sequence).

Double-Punch and Blank-Column Detection

This feature is designed to detect errors in numerical punching. The device automatically senses the presence of more than one punch in a column with or without simultaneously sensing blank columns. When this type of error is recognized, a red signal light comes on and the machine stops. The RESET key must be pressed before the operation can continue.

This feature is not available for the IBM 524 and 526, but is supplied as an integral part of the mark-sensing mechanism.

Feeding Devices

The hoppers and card transports of automatic punches can be adapted to feed cards of specific sizes.

FOLDED STUB-CARD FEED (IBM 514, 519)

This device can be installed in the punch feed only. It permits feeding an 80-column card, with a 7¼-inch stub attached. The 80-column card is fed face down, with the stub accurately folded back and on top. After the stub is detached, the card can be processed as a separate card.

Applications for this device can be found in payroll and billing, where the document is an IBM card. In payroll, the detached check is used for reconciliation when it is returned from the bank. In billing, the 7¼-inch stub becomes the bill. The full-sized IBM card serves as a transmittal stub and the automatic entry to accounts-receivable when it is returned with payment.

INTERCHANGEABLE FEEDS

This device permits feeding either 51- or 80-column cards, according to the adjustment made by the operator. It can be installed on read and punch feeds of all automatic punches except the IBM 524 and 526.

INTERCHANGEABLE STUB-CARD READ FEED (IBM 514, 519)

This feed permits reproducing 22-column stub cards into 80-column cards. The feed can be readily adjusted by the operator to handle either 22- or 80-column cards.

Typical uses for 22-column cards can be found in physical inventory applications, or in unit control of merchandise where the 22-column stubs are detached from goods and used for sales and inventory records.

POSTCARD STOCK FEED

This feed can be installed on either or both feeds to permit feeding cards of a thickness specified by United States Postal Regulations. Machines cannot be adjusted to feed both standard IBM cards and postcard stock. (This feed is not available for the IBM 524 and 526.)

Mark Sensing (IBM 514, 519)

This feature can be installed on either the punch feed or the read feed to sense electrographic pencil marks on an IBM card. These marks are converted into electric impulses for punching.

This device permits the source document to be processed directly without keypunching and verifying the marked information.

Offset Stacking

The offset-stacking device can be used in conjunction with comparing or double-punch and blank-column detection. Even though an error is recognized, the machine continues to operate. However, the card involved is offset in the stacker ⅜ inch toward the front of the machine.

In machines that have both punch and read feeds, this feature can be installed in either feed or both feeds. The offset-stacking device is supplied as a standard feature for the punch stacker when mark sensing in the punch feed is specified. (This device is not available for the IBM 524 and 526.)

Right-Hand and Inverted End Printing

End printing can be done on the right-hand (column-80) end of the card instead of the column-1 end. The standard end-printing unit also can be replaced by a print unit for inverted printing.

Reproducing Punches

IBM 514 REPRODUCING PUNCH (Figure 46)

The IBM 514 is capable of performing all functions of automatic punches except end printing and accumulating. The standard machine can reproduce, gangpunch, summary punch, and compare.

Cards are fed from the hoppers, face down, at the rate of 100 cards per minute. They pass under the X-brushes in each feed (see Figures 16 and 18) where the control punches are read to control punching or selectors. At the reproducing brush station, information in the card is read and conveyed to the punch station where it is reproduced into the new card. The cards in each feed then reach another set of brushes where the punched information is compared with the original card.

Information read at the punch brush station can be conveyed to the punch station for punching into the following card. This is the basis of gangpunching.

The machine can be equipped with the following optional features:

Mark-sense punching
Double-punch and blank-column detection
Offset stacking
Auxiliary card counter
Interchangeable feeds.

The IBM 514 is available in 5 basic models:

IBM 514 Model	1	2	3	4	5
Summary Punching	X	X	—	—	—
Comparing Positions	80	45	80	45	—

IBM 519 DOCUMENT-ORIGINATING MACHINE (Figure 47)

The major difference between the IBM 519 and 514 is the ability of the IBM 519 to end print indicative information on the card – hence, its name *Document-Originating Machine.* The cards in the punch feed pass a printing station before they reach the stacker (Figure 21). Here ¼-inch numbers or special characters are printed in one of two locations along one end of the card.

Optional features available on the IBM 519 are:

Mark-sense punching
Double-punch and blank-column detection
Offset stacking
Right-hand end printing or inverted end printing
Auxiliary card counter
Interchangeable feeds.

The IBM 519 is available in 5 basic models:

IBM 519 Model	1	2	3	4	5
Summary Punching	X	X	—	—	—
Comparing Positions	80	45	80	45	—

Figure 46. IBM 514 Reproducing Punch

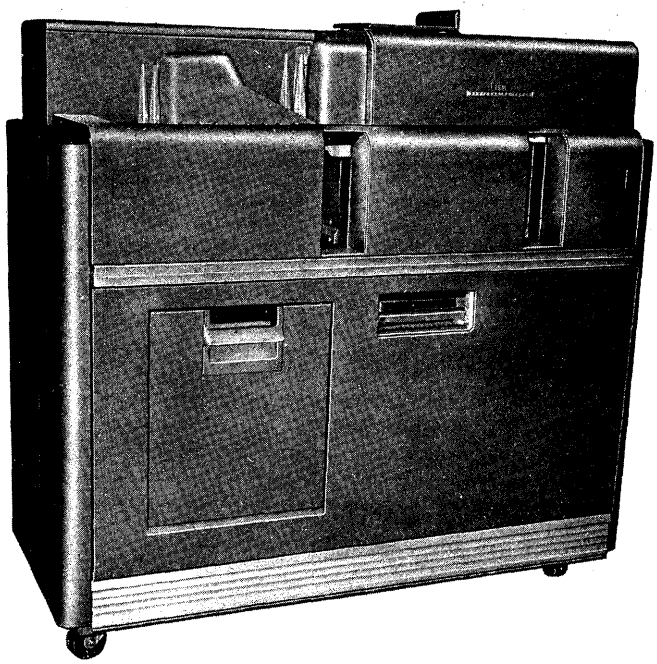

Figure 47. IBM 519 Document-Originating Machine

IBM 528 Accumulating Reproducer (Figure 48)

The IBM 528 operates according to the basic principles of the IBM 514. However, this machine combines the normal functions of a reproducing punch with the ability to operate as a self-contained, high-speed summary punch. Items can be crossfooted in the same card, and totals can be accumulated from detail cards. For each control group, the machine can summary-punch the accumulated information, gangpunch common information, and reproduce identifying information. These operations are performed in the punch feed at the rate of 100 cards per minute.

A second major feature of the IBM 528 is its independent feed control, which enables certain cards in the read feed to be reproduced while others are ignored. Card feeding is suppressed in the punch feed while unneeded cards are passed at the rate of 200 cards per minute. Selective reproducing thus effects economy in time and money by eliminating sorter and collator operations and substantially reducing card handling.

The optional features for the accumulating reproducer are:

Double-punch and blank-column detection
Offset stacking
Auxiliary card counter
Alphabetic storage device
Interchangeable feeds.

The IBM 528 is available in ten models of varying capacities, with or without the summary-punching feature, and with 80 or 45 comparing positions as shown in the chart on this page.

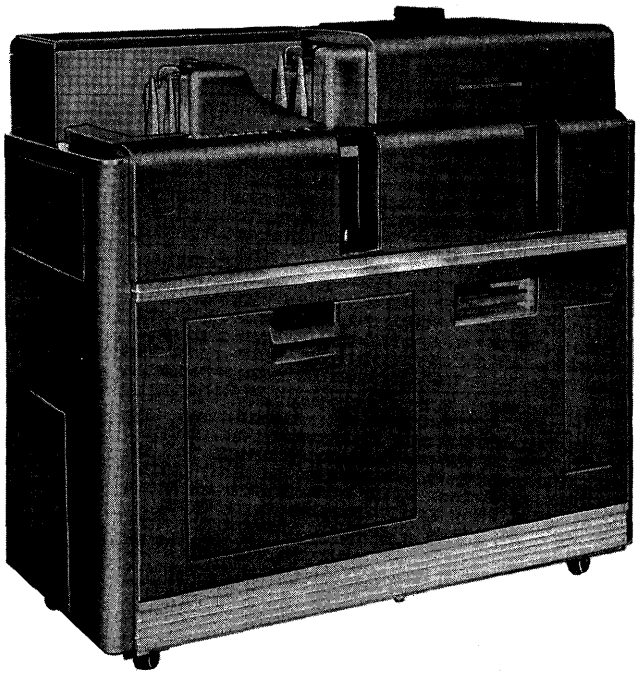

Figure 48. IBM 528 Accumulating Reproducer

IBM 549 Ticket Converter (Figure 49)

The IBM 549 is especially designed to convert punched price tickets or tags into IBM punched cards.

The punched price ticket (Figure 50) makes possible a completely mechanized punched-card Merchandise Control procedure, without writing or keypunching data from sales slips or regular price tickets.

	Group Control	Columns of Comparing				Counter Capacity	Counter Groups
		Summary Punching		Non-Summary Punching			
Model		A	B	C	D		
1 2	10 positions None	80	45	80	45	48	4 two-position counters 4 four-position counters 4 six-position counters
3 4	10 positions None	80	45	80	45	36	4 two-position counters 4 four-position counters 2 six-position counters
5 6	10 positions None	80	45	80	45	24	2 two-position counters 2 four-position counters 2 six-position counters
7 8	10 positions None	80	45	80	45	12	2 two-position counters 2 four-position counters
9 10	10 positions None	80	45	80	45	None	

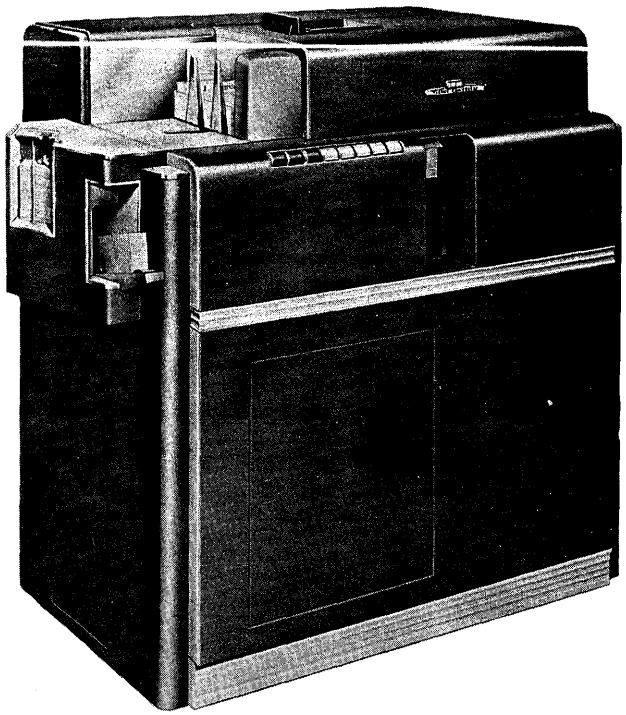

Figure 49. IBM 549 Ticket Converter

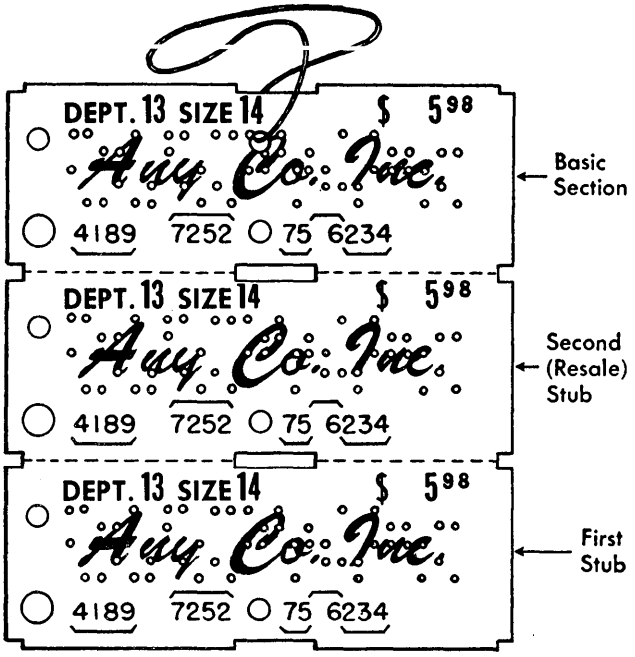

Figure 50. Price Ticket

While this is the most common use for tickets of this type, they can also be used as pay tickets in piecework payroll jobs, as inventory tags in warehouses, etc.

Price tickets (made by the Dennison Company of Framingham, Mass., and originally punched and printed on a machine manufactured by this company) are placed in a special ticket receiver as they are removed from the merchandise. Tickets are stacked face up in the receiver by dropping them on a spindle. This receiver becomes the ticket hopper for the read feed of the machine.

Tickets are fed one at a time to the reading pins of the IBM 549. Simultaneously, blank IBM cards are fed into the punch feed. As the unpunched cards pass under the punches, the machine translates the pinholes in the ticket and punches the information into regular IBM cards (Figure 51).

Information may also be gangpunched from one card to the next. Both feeds operate at 100 cards per minute.

The optional features for the ticket converter are:

Auxiliary card counter

Offset stacking

Interchangeable feeds.

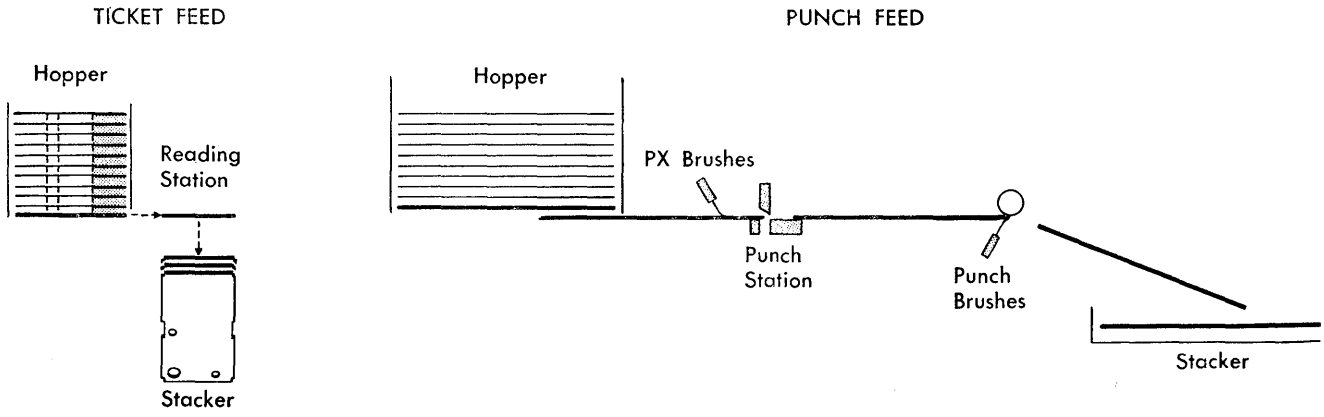

Figure 51. Schematic of Ticket and Punch Feeds

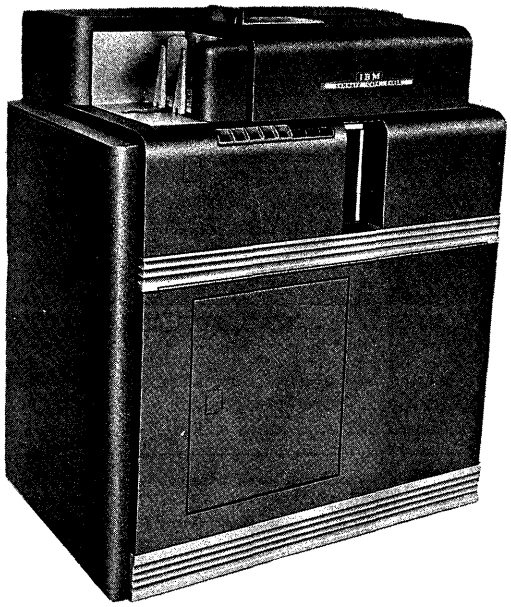

Figure 52. IBM 523 Gang Summary Punch

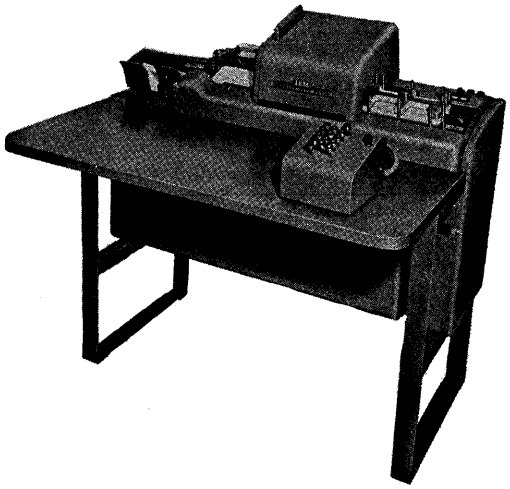

Figure 53. IBM 524 Duplicating Summary Punch

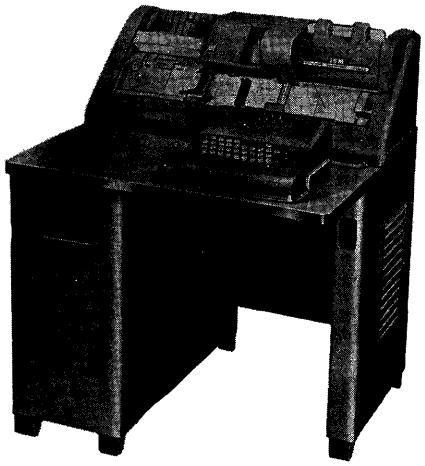

Figure 54. IBM 526 Printing Summary Punch

Summary Punches

IBM 523 Gang Summary Punch (Figure 52)

As the name implies, this machine is designed to perform two of the basic functions – gangpunching and summary punching. It performs them individually or in combination, in conjunction with an IBM accounting machine.

Cards are fed through the IBM 523 face down, 12-edge first, at the rate of 100 cards per minute.

First they pass six punch X-brushes, which can be set to any six columns of the card, with not less than two columns between brush settings. The purpose of the punch X-brushes is to read X-punches, which distinguish master cards from detail cards. They are normally used to suppress punching into master cards. Next the cards pass 80 punches—one punch for each column of the card; and as each card passes the punches, *12's* are punched first, *11's* are punched next, etc.

IBM 524 Duplicating Summary Punch (Figure 53)

The IBM 524 is specifically designed as the summary-punch attachment to the IBM 101 Electronic Statistical Machine. It is used to summary punch group indication, total counts and accumulated totals. The punching speed is about ten columns per second.

When connected to an independent source of power, the IBM 524 can be used as a manual keypunch.

IBM 526 Printing Summary Punch (Figure 54)

The IBM 526 punches summary cards automatically while reports are being prepared on an IBM 402, 403, or 419 Accounting Machine. The punched numerical information can also be printed on the summary cards. Alphabetic information can be summary punched when the accounting machine is equipped with the Alphabetic Summary-Punching Device. The punching speed is approximately 17 columns per second.

When it is not being used for summary punching, the IBM 526 can be used for any regular card-punching (and printing) operations performed by the IBM 26 Printing Card Punch and its optional features.

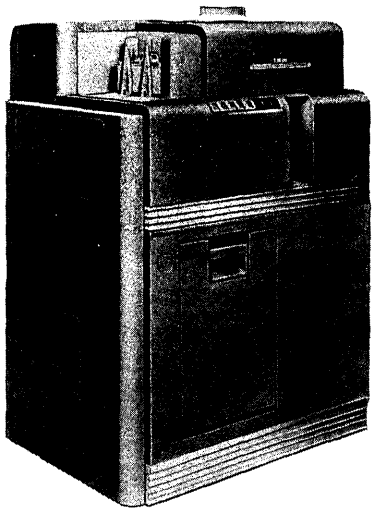

Figure 55. IBM 521 Punching Unit

Card Read Punches

This group of automatic punches is fully discussed in manuals on the calculators for which these machines serve as input-output units. These machines perform the functions of card reading and punching, gang-punching, and double-punch and blank-column detection.

IBM 521 PUNCHING UNIT (FIGURE 55)

This machine is part of the system of the IBM 604 Electronic Calculating Punch. Operating speed is 100 cards per minute.

IBM 529 PUNCH UNIT (FIGURE 56)

This machine, operating at 100 cards per minute, is used with the IBM 607 Electronic Calculator.

IBM 541 CARD READ PUNCH (FIGURE 57)

This machine is the high-speed punch (200 cards per minute) used with the IBM 604 Electronic Calculating Punch.

IBM 542 CARD READ PUNCH (Figure 58)

This machine is the high-speed punch (200 cards per minute) used with the IBM 607 Electronic Calculator.

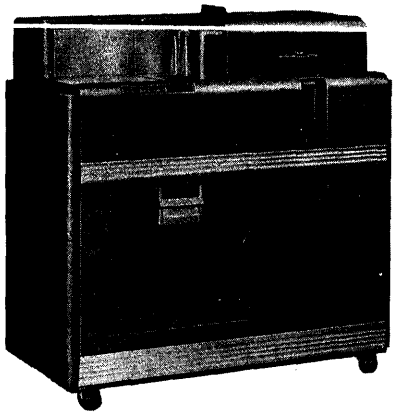

Figure 56. IBM 529 Punch Unit

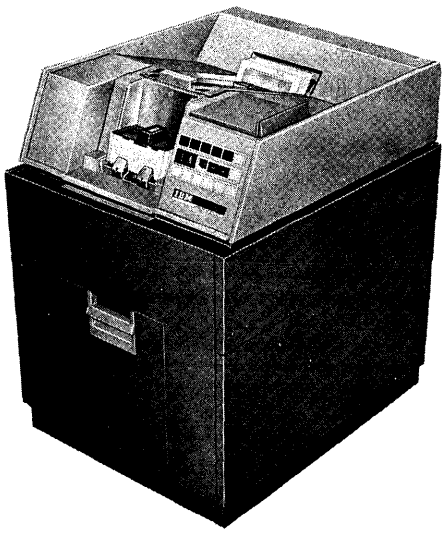

Figure 57. IBM 541 Card Read Punch

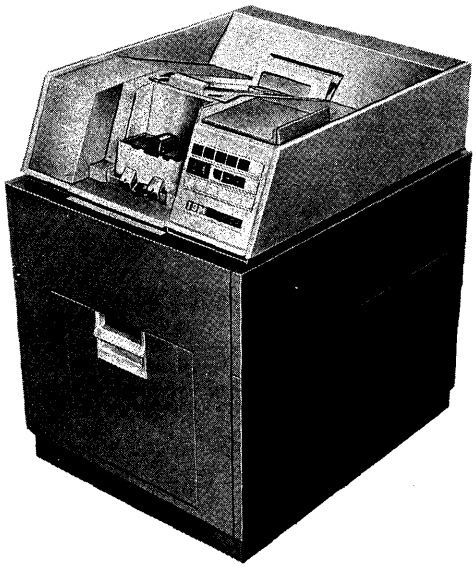

Figure 58. IBM 542 Card Read Punch

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