

9-1940

Punched Card Accounting from the Audit Viewpoint

Leon E. Vannais

Follow this and additional works at: <https://egrove.olemiss.edu/jofa>



Part of the [Accounting Commons](#)

Recommended Citation

Vannais, Leon E. (1940) "Punched Card Accounting from the Audit Viewpoint," *Journal of Accountancy*. Vol. 70: Iss. 3, Article 2.

Available at: <https://egrove.olemiss.edu/jofa/vol70/iss3/2>

This Article is brought to you for free and open access by the Archival Digital Accounting Collection at eGrove. It has been accepted for inclusion in Journal of Accountancy by an authorized editor of eGrove. For more information, please contact egrove@olemiss.edu.

Punched Card Accounting from the Audit Viewpoint

BY LEON E. VANNAIS

I

HOW MANY practising accountants receiving substantial per diem rates for their professional services have had to mumble some vague noncommittal reply when their expert opinion was asked on a technical point related to machine accounting? Punched cards are a spectacular and progressive tool of accounting. Many public accountants are doing intelligent and informed work for their clients in the punched-card field. Too many, perhaps, are not so well informed, and their lack of information does less than justice to both their clients and themselves.

This paper has been written not in the hope that it will provide all the information about punched cards which a public accountant should have, but in the hope that it will provoke thought.

The first thing that needs to be done is to dispose of a few bromides.

Of course, the first is "Punched cards are fine for statistics but no good for accounting." Another one is frequently heard, "What happens if you lose a card?" Or the hundreds of references that infer that there is but one punched-card method—THE punched-card system. The initiated laugh at this one just as accountants would smile at a reference to THE pen-and-ink method. Or the more specific generalizations like "Punched cards are fine for payroll but no good for accounts receivable" or the equally frequent "Punched cards are no good in the electrical industry because the Spark Company threw them out." And by no means last, but merely enough for our present purpose, the famous "Punched cards are all right for big companies but not for little ones." No need to comment on each of these—

some date back to horse-and-buggy days. All indicate opinions that ignore the modern fact that punched cards have become an important, established, successful accounting tool. The indications are that their use will increase faster in the next ten years than ever before.

SOME BASIC CONSIDERATIONS IN AUDITING

The American Institute of Accountants bulletin, *Examination of Financial Statements*, says:

"An important factor to be considered by an accountant in formulating his program is the nature and extent of the internal check and control in the organization under examination. The more extensive a company's system of accounting and internal control, the less extensive will be the detailed checking necessary.

"In the large majority of cases, a detailed audit is not justified and the accountant relies on various test-checks of the records. The extent of the examination and of these test-checks is essentially a matter of judgment which must be exercised by the accountant, based on his experience, on his knowledge of the individual situation and on the extent of the internal check and control.

"The term 'internal check and control' is used to describe those measures and methods adopted within the organization itself to safeguard the cash and other assets of the company as well as to check the clerical accuracy of the bookkeeping. . . . These safeguards will frequently take the form of a definite segregation of duties or the utilization of mechanical devices."

Note at the start that auditing is essentially a matter of judgment. Note also that the importance of judgment is

Punched Card Accounting

equally applicable to accounting itself.

The bulletin also says:

“Financial statements . . . reflect a combination of recorded facts, accounting conventions and personal judgments; and the judgments and conventions applied affect them materially. The soundness of the judgments necessarily depends on the competence and integrity of those who make them.”

And thus, too, is judgment applicable to punched-card procedures. Punched cards, by themselves, are neither good nor bad. Their utility is dominated by personal judgment—their success or failure in specific cases is rarely mechanical, but almost invariably human. Their availability as an aid or a hindrance in auditing depends first upon the judgment shown in applying them for a specific purpose, and second, upon the auditor's knowledge of their scope, both as to limitations and possibilities.

In the auditor's exercise of judgment based on knowledge, three significant phases of modern procedure are emphasized in the previous quotations: *the utilization of mechanical devices, definite segregation of duties, and reliance upon test-checks.*

Punched cards are found in modern accounting routines which utilize mechanical devices to an amazing degree. At the same time, their use makes a definite segregation of duties an essential part of the flow of basic information into finished reports or accounts. In these first two phases, the presence of punched cards obviously contributes to conditions that are definitely designated as *safeguards.*

When punched cards are used, the possibility of reliance upon test-checks is not so obvious. The auditor's first duty in deciding upon an adequate test-check is to ascertain that the records of all of certain transactions could be checked if he cared to do so, and then to select from the available whole certain parts for expert scrutiny. There^s is

nothing inherent in punched-card principles which tends to reduce the possibility of satisfactory audit (these articles are intended to make this clear). They thus fit into the professional procedure that makes an adequate audit of large operations practicable and feasible. An accountant's knowledge of punched-card procedures—“his knowledge of the individual situation,” as the Institute bulletin says,—is not only often necessary for a satisfactory examination, but the presence of punched cards in a specific case plus this knowledge may expand the extent to which various “test-checks of the records” may be undertaken “at a cost that will be within the limits of a prudent economy.”

The bulk of my comments, then, will describe the operating principles and mechanical functions of card-operated machines. I need not tell auditors about auditing.

THE PUNCHED CARD

Everybody readily recognizes that a pencil can be made to do different things by different people, and this wide range of potential usefulness worries no one. A similar conception of a punched card is fundamentally important—it is always a tool and it need be nothing else. The card itself need never be a record. Like the pencil, it can produce a record—and like the worn-out stub, having done its recording work, it can often be as readily discarded.

In the early days of tabulating, the punched card was only a tool, and today the card is still a tool, vastly improved in its ability to produce results automatically, but still the same tool—a pencil in the hands of a craftsman instead of a child. Bear with this deliberate repetition, because modern use of punched cards permits the fundamental function of the card as merely a tool to be overlooked. It must be borne in mind by those who design systems susceptible of easy audit.

The purpose of punched cards is to actuate a variety of more or less automatic machines. These machines sense nothing but the position of the punched holes; they read no printing or writing that may be on the face of the cards. Hence, when you see a punched card

like the common example that follows, understand at once that the card is serving a dual purpose (it is called a dual card in tabulating parlance); it is not only the regular punched-card tool to actuate machines, it is also a conventional written record.

3-29 2153 3 0294 5					LABOR DISTRIBUTION CARD																													
DATE	EQUIPMENT CODE	EXP. CL.	JOB NUMBER	TIME	APPROXIMATE AMOUNT	EQUIPMENT CODE	JOB NO.	ACCOUNT	DATE	CLOCK NUMBER	HOURS	RATE	AMOUNT	[Punch grid]																				
Sill																																		
DESCRIPTION OF WORK																																		
Reline																																		
COMMUNITY																																		
CLOCK NO. OCCUPATION HOURS RATE AMOUNT																																		
8716 307 7.0 .90 6.30																																		
APPROVED: G. Foreman																																		

Daily Individual Job Ticket

The written record might well have been on a separate ticket except for expediency. Using the face of the tabulating card for writing may have merely saved a piece of paper; or there may have been additional advantages in having the written data flow along at all times wherever the punched information was directed to go.

And please pause for this point. If I can make it clear, we have, in my opinion, reached bed-rock for our foundation of punched-card principles. You have in the illustration before you identical information written and punched. You also have some information (like the foreman's name) written but not punched. Where the same information is both written and punched, there seems to me to be one fundamental difference in the form of the data that dominates its subsequent usefulness. Every time I want to use figures written on a flat surface, I have to move them. I can put them in analytical columns. I can make copies which still give me

figures on flat surfaces, fixed and not readily available for cross analyses. Some machines will prepare several different written records simultaneously but still on flat surfaces of different kinds. In many cases I can operate effectively within these limitations. I may, however, want the same data in a dozen different places at once, and it is then that, no matter how clever I am, I am limited in what I can do automatically with figures flat on paper. The photoelectric cell or comparable developments may expand this in the future. But the punching of information in holes in a card gives substance or body to the item—a third dimension, thickness; the possibility of mobility. The data has permanence in significant holes, and the position of the holes will direct the punched data wherever desired, directly from the original record to the final result.

This difference in the form of basic data naturally causes differences in technique in handling significant ac-

Punched Card Accounting

counting information. The auditor familiar with punched cards takes these in his stride. The auditor, anxious to take advantage of the presence of punched data, must develop the ability to recognize the many ways in which tabulating technique resembles manual or similar operations as well as the few ways in which punched cards are unique in their ability to produce required results. These articles will attempt to clarify some points of similarity and to explain the possibilities and functions that are peculiar to punched cards.

PUNCHED INFORMATION

Designing a punched card—in other words, determining what to punch—presents a problem somewhat like laying out a chart of accounts. Both seem like a logical first step in system procedure. But laying out a chart of accounts involves a full appreciation of what use is to be made not only of the final reports but also of the various subanalyses as these become currently available. Failure to foresee the needs of management in developing a chart of accounts need not be commented upon to accountants—satisfactory operation on such a basis can only be an accident.

Designing punched cards presents exactly similar problems; the final results must be anticipated with equal intelligence, but the related subanalyses or by-products frequently attain major importance because the extent of the practical subanalyses or the speed and economy of the by-products may be the very factors that make punched cards desirable. In addition, there is the vitally important factor in the design of a tabulating card—the fact that the punched holes are to actuate the various automatic machines.

In this, as in many other explanations, we seem to be on a merry-go-round—there is no obvious point of approach or departure. To take the first step, we must know what our last

will be. An explanation of what is in the cards covers all of the accounting and machine aspects of punched-card procedures—for nothing can be done with punched-card equipment if “it isn’t in the cards.” Your automatic piano is silent without its punched roll.

Purposes for which information is punched

Information punched in cards may serve one or more of four purposes—*calculate, indicate, actuate, or identify*. These distinctions are somewhat arbitrary but they are the best I can think of as a basis for analyzing punched-card procedure. A simple illustration will explain why the distinctions are theoretical, and of more help in thinking than in actual operations.

In many companies, the simple situation will be found where there is one punched card for each sales invoice. On each card will be punched the “amount” of some particular invoice. (Of course there will be other punched data in the cards regarding the many invoices, but bear in mind chiefly the punched “amount.”) Obviously, its principal purpose is for *calculating*; it will make accounting machines add or subtract the amount. (Parenthetically, the machine will add or subtract the amount, depending upon some significant hole other than the amount, indicating whether the item is a debit or credit.) But suppose an analysis of billing is desired by size (in money) of invoices. The cards are to be sorted by “amount.” The punched amounts will *actuate* a sorting machine which will group similar items together in size sequence. The sorted cards will *actuate* an accounting machine which will *calculate* the total money involved in each size-group, and count the number of invoices if desired. The machine will print these totals together with a printed *indication* of the size-group. Furthermore, the “amounts” punched in the cards will *actuate* the accounting machine so that the machine will sense

the end of each group, print indications and totals for the group, clear the counters carrying subtotals, and start automatically to tabulate the next group, and so on until the end of the run. Here then is one factor which under ordinary circumstances *calculates*, *actuates*, and *indicates*, and, in the illustration cited, does them simultaneously. Each operation is simple, in fact all punched-card operations are simple when analyzed. It is the simultaneous performance of many functions that makes machine operations apparently complex and often bewildering. The only other purpose mentioned as important—*identification*—is obviously present in these invoice cards, for the invoice number could be expected to be punched in each card. (Its absence would reasonably hamper ready audit as will be amplified in subsequent comments.)

Punched information for calculating

Calculating is not confined to addition, subtraction, and counting in modern punched-card practice. Multiplication is fairly commonplace, and is automatically actuated by punched amounts—the concept of amounts now being expanded to include rates.

Where both factors are present in each card, a special machine (with the descriptive name “multiplier”) actuated by the punched factors computes the product and automatically punches the result in each card. The operation is not only simple to appreciate but the possibility of back-track and audit is obvious. However, the multiplier does not need to have both factors punched in each card in order to compute and punch individual results in detail cards. The mobility of the cards and the existence of a sorting machine (perhaps the outstanding unique features of punched-card procedures which will recur frequently in these articles) makes it simple to arrange detail cards into groups where similar rates apply. When

this is done the rate need not appear in the detail cards. For example, the quantities and identifications of commodities may be punched in detail cards. It may be required to determine the cost per unit, multiply by the quantity in each card, and compute and punch the individual extensions. The sorter would not only bring together all cards for each commodity but would inject a rate card (cost per unit) in front of each group. The multiplier would then extend each card in a group by the rate for that group, automatically changing rates as each new rate card appeared but punching the extension only. The resulting lack of back-track is not an unusual situation in modern practice. There are many manual and machine-assisted operations where the factors resulting in a product are not recorded. In some machine calculations, the printed factors that apparently produce a printed result are not the ones which actuated the machine calculation. In practice the auditor must recognize these situations and must prescribe adequate test-checks. A knowledge of each situation is essential.

Unique multiplications

The mobility of the cards and the presence of the sorter leads to other calculations—apparently multiplications—where no multiplying machine is used at all. Public-utility billing provides a splendid example. A card is punched for each customer each month. Each card contains, among other data, identification of the rate applicable to the customer. All cards for similar consumption at similar rates, together with the applicable master rate cards (on which appears the rate, consumption, and money), are brought together by the sorting machine and the amounts of money (both “gross” and “net” where discounts are allowed) are automatically punched in the detail cards (at the rate of one hundred customers, two hundred calculations, a minute). The basic con-

Punched Card Accounting

dition that makes this operation advantageous in utility billing (frequent recurrence of similar situations in a mass of transactions) is also found in apparently unrelated instances, such as some kinds of payroll and cost work. No problems in auditing are presented by these calculations, for the maximum information is available for back-track.

Another type of punched-card "multiplication" exists that cannot be described in detail here because of lack of space. I mention it briefly for two reasons: first because it presents those difficulties in auditing that always occur when back-tracks are lacking, and second because it has always seemed to me that the potential usefulness of the procedure has been undeveloped in many places in practice. I refer to the punched-card facility of determining the sum of a series of extensions without individual computations, sometimes called digit extension. Standard cost procedures furnish many examples where the laboriousness of pricing and extensions leads to compromises in practice even though the applicable factors are known to exist. Suppose, in some particular instance, the elements of standard cost for each commodity are predetermined, and totals for labor, materials, factory overhead, scrap, and packaging would be significant and useful. The standard cost per unit for these five elements can be automatically introduced into punched-card summaries of the quantities, say, of production. The situation at this point is that one card exists for each identified commodity showing the number of units produced, together with the total standard cost per unit and the five analyses of this unit total. Of course, individual extensions of each element for each commodity could be computed and punched for each commodity. These may not be needed, even though the pricing has already been easily accomplished; the group extensions for classes of commodities may be entirely adequate.

These can be obtained at a rate equivalent to more than 6,000 individual extensions per hour under some conditions, again making use of the mobility of the cards and the sorting machine. The sorter first segregates the whole group of commodity cards into designated classes of commodities, and the cards for each class are handled separately. The cards for a class are sorted on the digits of the quantity and placed in an accounting machine—9's first, then 8's, and so on down. The machine adds the six prices (total and five elements) simultaneously, printing first the totals of cards with 9 units in the quantity, it then proceeds to add the 8's, but prints the progressive total of the 9's and 8's, and so on through the series. The total of the 9's therefore appears nine times in the progressive totals, the 8's eight times, and so on. The totals of the progressive totals are thus the extensions of prices by the units in the quantities. The operation is repeated for each digit in the quantity pointing off the result appropriately for tens, hundreds, thousands, etc. The grand totals thus available are the group extensions. The lack of back-track is disturbing but does not differ materially from the many situations where similar results are obtained from nonprinting, key-driven computing machines. In the instance cited, the presence of detail cost prices that crossfoot to the commodity total makes a check of the results by crossfooting a safeguard upon which some reliance can be placed. Furthermore, it would be possible to subject the entire file of cards to the group extension procedure and have six grand totals to which the class totals must balance. The auditor to whom such results are to be presented for audit, however, must first become familiar with the procedure. He can then improve his position if he analyzes the situation in advance and obtains the cooperation of the operating supervisor so that ample safeguards are provided

at the time the calculations are made. If he waits until the time of his audit, there may be difficulty and confusion in trying to recreate the original conditions that resulted in the original calculations. Foresight, in my opinion, becomes increasingly important as clerical operations become increasingly mechanized. This opinion is, to some extent, substantiated officially in the comment in *Examination of Financial Statements*:

"It should be understood that all of the work outlined need not necessarily be done as of the closing date of the period covered by the examination. It is frequently desirable to do the detailed work on the inventories or receivables as of an earlier date and, where conditions warrant it, this is satisfactory."

Punched information for indicating

The *indicating* information punched in cards tells the initiated what reports, analyses, or accounts can be prepared from the cards. Here is where judgment in card design is essential. Here is where the ultimate use of all tabulated figures must be foreseen, possibility of change or expansion anticipated, and the most effective mechanical procedures chosen, before anyone can decide what to punch, because the *indicating* information will govern every question that can be answered from a set of cards except "how much?"

A textile company which advertised some of its products (and which had punched cards for sales analysis) was confronted by the question of whether or not the advertising was effective. Within certain styles, some items were restricted (and specially labeled) for large distributors, some were for the trade, some items were advertised, some were not. There was nothing in the commodity coding to indicate this. The first step in getting the answer was to sort mechanically a million cards, pick out manually the advertised items, punch a distinctive hole in these, and then proceed with the required studies.

In other installations indicated information was thoughtfully provided in the original layout in case it might later prove to be useful. After long experience no use had been made of some of the punched data but the punching continued day after day, purely from habit. Original ideas, in punched cards as in other media, can be profitably reviewed from time to time. That this is frequently done in tabulating departments prompts a practical tip to auditors at this point. In any particular case, when you are examining a card in order to find out what information was originally planned to be punched, do not hesitate to say, "I understand the printed headings on this card but do you *now* actually use them as indicated?" You will often find that experience has led to modifications and that the tabulating operators may have improved the punched data without bothering to get a new electrotype for the card form—the punched data no longer conforms to the printed headings. Confusing, I'll admit, but quite practical, and just another illustration that the machines sense nothing but the position of the holes.

Indicating information is usually in the form of codes, numerical designations for persons (customers, creditors, or employees), locations (offices, states, cities, trading areas, departments, or bins), operations, commodities, services, accounts, or any of the hundreds of other classifications that appear as items, subtotals, or totals on analyses, reports, accounts, or statements.

This is no place for a long dissertation on coding but my personal opinion of its importance leads me to state emphatically that no punched-card installation can be any better than its coding. With good codes, or classifications, and poor operating personnel or conditions, a creditable job might still be done; without good codes, a good operating crew properly equipped will not only be hampered at all times but will deteriorate through frustration.

Punched information for actuating machines

Actuating information includes indicating information. In fact, it also includes the calculating data, which may well be mentioned first.

Just as an adding machine operator depresses keys to set an amount in an adding machine before she pulls her lever or pushes a motor bar to register the amount in a counter, so a punched amount in a card will similarly set an amount in one or more counters automatically. As a matter of fact, punched information in cards is very similar in appearance to keys depressed in an ordinary adding machine. The vertical columns contain all the digits with each column having a definite significance—units, tens, hundreds, etc.—and the significant punched holes are read like the depressed keys, from left to right. An accountant or executive, however, rarely has more occasion to read punched holes than he has to read the top of an adding machine. Bear in mind that both are tools—he reads the results.

A word about terminology

Momentary digression! Office appliance terminology is just as confusing to the layman as is accounting terminology. Both contain ordinary words which have a technical significance to the insider which others may not understand. "Counter" is such a word in the appliance field. In the punched-card field alone, the use of the word has followed the range of machine developments. The original machines, developed for the 1890 census, were strictly statistical and really counted punched holes. A six and a seven in the same column in separate cards may have been as different as a widow and an orphan—there was no intention to make thirteen of them. During the years that followed, the functions of adding and subtracting were incorporated in accounting ma-

chines which became, for example, seven distinct adding machines assembled under one cover, actuated by cards, and with supplementary printing mechanism for recording the accumulation of the amounts and the indication of each group total. The seven adding assemblies were still called counters. In some machines still in efficient use, these counters have visible dials where the accumulated amounts may still be read, a throwback to the days when no printing mechanism was available on tabulating machines, and operators then read, and in many cases still do read, the amounts on the dials for transcription on work sheets or records.

What makes the term "counter" more confusing today is the nature of the most modern machines, which can be connected very flexibly into numerous adding assemblies for a maximum variety of work from a single machine. You will thus find in operation so-called 32, 56, or 80 counter equipment, which refers to the maximum number of individual adding counters which are available for designation as desired. In a phrase not common in punched-card conversation, but descriptive to other machine men and, I think, accountants, this would be called "splitting" the counters. The problem, of course, is to group the adding units to the maximum capacity needed for carry-overs. After the original planning, this becomes automatic. I will from now on confine my use of the word "counter" to the assembly which accumulates totals, even though in some types of equipment the technical terminology actually in use includes the terms "adding units," or "accumulators."

Functions of a counter

One of the first things regarding the counter of importance to the accountant is the fact that it can *indicate* as well as accumulate. It does this, in one way, by adding the first card in each group.

Suppose a payroll is being run. There may be many cards for each man, each of which will contain his number. While the totals of his hours, earnings, deductions, and net pay are being computed in various counters, one other counter will pick up his number from the first card and hold it, without subsequent accumulation, until his last card has been accumulated. Then the machine prints the man's line on the payroll and goes ahead automatically with the next one. It has indicated the man by adding his number once, an automatic function of the machine. Any counter can be made to do this.

A counter, then, can *calculate* or *indicate*, but in modern machines particularly it must be *actuated*.

Another digression! The auditor will find in actual use practically every model of all kinds of punched-card equipment. The first and simplest tabulators are still extremely effective for some kinds of work, and are still in use. The fact that an auditor may not be able to distinguish one from another need not make him self-conscious. The tendency of the manufacturers has been to furnish universal bases for many of their models, so that features like additional capacity, subtraction, and selection of items may be installed on machines in customers' offices. The effect of this has been to prevent the most expert observer from knowing by casual inspection what capacity or features may be underneath the covers of a particular machine. Surely the auditor familiar with machine functions may very sensibly ask a supervisor or operator what a particular machine is built to do. He exhibits knowledge, not ignorance, when he does so. But back to our *actuated* counters.

It will not be possible to trace here the evolution of counter actuation, even though machines representing its various phases are still in use. It is still basic, however, that there is a connection between the card and the counter.

This connection is physically real and is either mechanical or electrical. The operating principle is that any part of a punched card may be connected with any counter of an accounting machine. Modern machines contain a modification of this principle which has had a tremendous effect on operating procedures. You may now connect any part of a card with any counter of a machine, but the counter won't do anything until it is told to do it. Hence the emphasis on *actuation*.

One illustration will cover several points at this time.

Suppose we have punched cards for budgetary control, and inject one technical term into the explanation. A "field" on a card is the number of vertical columns designated for a specific purpose. In this example, we will consider three fields only—the account number, the amount of money, and the kind of card. The number of columns set aside for account number or amounts would, of course, depend upon the job. In this case, we assign one column at the extreme right for kind of card, and indicate, by punching, the following:

1. Previous months' expenditures.
2. Previous months' appropriations.
3. Current month's expenditures.
4. Current month's appropriations.

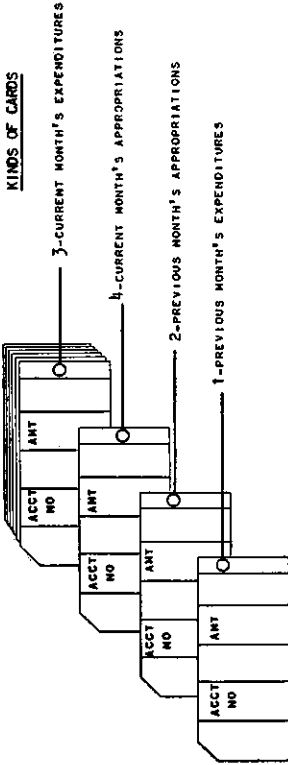
The connection between the cards and the counters can be illustrated as shown in the diagram on page 209, together with the instructions to the counters as to what to do.

In this case, the relation between the cards and the final report is simple.

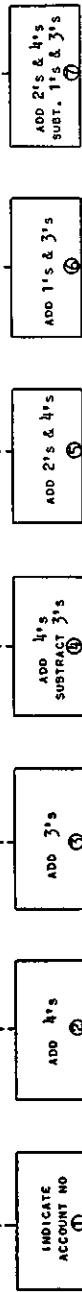
In the first place, it should be noted that the cards need to be sorted by account number only. The sequence of the "kinds of cards" is unimportant.

The account number is being *indicated* in counter number 1. Note, too, that this is also *actuating* the machine in an important manner. The machine senses the end of each group of cards representing an account number, causes

Punched Card Accounting



FOUR KINDS OF CARDS
FOR EACH ACCOUNT



ACTUATING SEVEN
COUNTERS AS NOTED

ACCOUNT NO.	CURRENT MONTH		YEAR TO DATE	
	APPROPRIATED	EXPENDED	APPROPRIATED	EXPENDED
1	1 000	900	1 000	1 0800
2	500	550	6000	5400
				BALANCE
				8000R
				600

TO PRODUCE A
PRINTED REPORT

the machine to stop accumulating in all counters, causes it to print the group totals, clear the counters ("reset" is the word), and to proceed with the next group or account. This is called "automatic control," a vague term but an important function.

In the meantime, the "amount" punched in the same field in each card has been connected with all six of the other counters, each of which has been *actuated* independently to produce the report.

Counter 2 went into action only when a number 4 card (in the column "kind of card") went by. It ignored every other card. It selected the 4's.

Counter number 3 did the same thing with current month expenditures. As a matter of fact, if the detail cards contained both debits and credits, significant punching could have been designed to actuate "net" results in this counter with no additional effort. This applies to the other net columns also.

Counter 4 would subtract the expenditures from the budget and print a special designation (a minus sign or a symbol like DR) if the expenditures exceeded the budget, showing the balances, of course, in both cases.

The actuation of counters 5, 6, and 7 similarly provide the year-to-date totals—all seven operating simultaneously.

When you bear in mind that the cards in each group are being handled at a maximum speed of 150 a minute, and that the printing and resetting time is slight, it is not surprising that the use of punched cards for this type of work is increasing.

"x" punching

The majority of accounting machines in use in 1940, however, would get this same result in a slightly different manner. The actuation of counters 2 through 6 in the illustration cited are by what is known as "digit selection," a comparatively recent development (the digits 1 through 4 appeared in a

vertical column). The same result was previously accomplished by a simple expedient with a confusing name, "x" punching, which is so important as to warrant description.

In each vertical column on a tabulating card the bottom ten positions represent the digits 0 through 9 and, in one type of equipment, these alone record in adding counters. There are two positions above these, the eleventh just above the 0 and the twelfth at the top of the card. I don't know who first called the eleventh the "x" hole or why they did it, but it certainly became a real factor in punched-card technique.

If a machine does not have the feature of digit selection, it will probably be equipped with "x" controls. This means that the counters can be actuated by "x" holes punched in significant columns. Here the explanation becomes involved because of the many things the "x" hole has been made to do (it grew like Topsy).

In the first place, both the "x" hole and the twelfth are used in combination punching on alphabetical cards, because, by clever arrangement of punching and machines, the twenty-six letters and ten digits can all be punched in one 12-position column. In one type of equipment, combination punching is used for numerals, doubling the normal capacity of the card. So any portion of a card containing combination punching excludes the use of the "x" position for the type of counter actuation illustrated in the budget report.

Then the "x" hole is used by punch operators to skip a field in which no punching is required for a particular card (like the tabular key on a typewriter). Sometimes this "x" skipping is so significant that the "x" thus punched can be used for actuating counters, but usually this is avoided.

Furthermore, the function of indicated information to actuate the automatic control of group totals precludes the use of x's in these fields.

Punched Card Accounting

It usually happens, therefore, that the significant x's for counter actuation appear above amounts or reference data. It should be remembered in each case that the location of this "x" has nothing to do with the other information punched in that column. The x's to actuate the budget report might have appeared in four columns above the "amounts"; the results would have been as indicated.

These same x's have also had assigned to them the actuation of several functions of the automatic carriage used in document preparation, like bills or production orders, where definite horizontal sections are provided for various types of information. On a bill, these might be the address of the customer, the address for shipment, the terms, and the body of the invoice. The automatic carriage will automatically space such a document even when the number of lines in each section varies.

The importance of all this to the auditor appears when he wants to test-check some of the reports, particularly when he realizes that the budget report used as an illustration is not the only one he will meet where every counter is cleared for every item printed. The balancing to controls in such cases presents situations where counter actuation is but the first step in developing an accurate knowledge of the individual situation.

This by no means exhausts the means of actuating machines by punched holes. Many will be mentioned later. One—sorting—has already been mentioned several times but deserves repetition. The actuation of the sorting machine by punched cards is an operation that should be seen to be appreciated. It is one of the few operations where the action of the machine is visible. Five minutes of looking is better than five hours of reading. The auditor will expand his opportunities for useful test-checking if he knows how cards may be mechanically sorted.

Punched information for identification or reference

The fourth purpose for punching, viz., information punched in a card to *identify* the item, frequently provides a reference from a result back to a source. The punching of a document number is the most common example. It undoubtedly amazes auditors how frequently this useful data is omitted in punched-card procedures. There are a number of contributing factors, some of which need but brief comment.

In the old days, tabulating equipment had no printing mechanism. It was often felt that anything that was not to appear in the visible dials could be conveniently omitted from the cards. Manual controls for batches of documents were kept, against which the totals of tabulations were balanced. The documents, the controls, and the results were all there—in fact, they still are—and as there was no way of preserving any record of the particular cards that went into tabulated totals, there was often no point in providing detailed reference data.

Bear in mind, too, that card capacities were then smaller, the 34 and 45 column cards were standard. The limited space for punching significant indicating information was a frequent problem. Reference data was, to many, a frill. Furthermore, even after card capacities were doubled, horizontal reports like the budget report could only be obtained by providing spread fields in the cards equivalent to the number of counters involved. The release of available card space by selecting six counters of varying data from one field in the cards is comparatively recent.

Even when modern printing tabulators are available, the experienced tabulating operator frequently resents leaving complete back-tracks for easy audit. His reasons are very human. In the first place, he is in the habit of "hitting his balances." In public-utility

billing, for instance, a good department will "flash" 98 per cent of its controls on the first attempt. The operators do this at tabulating speed, a maximum of 150 cards a minute. These same machines will list every card, printing from 75 to 120 complete lines (one card a line) a minute. This to the operators is slow, takes a lot of paper, and just doesn't seem necessary anyway. Providing lists for all runs, of which few are subsequently used, is inefficient. A check-up of a situation by an auditor may disclose many points in a procedure where lists of cards would provide valuable aids in subsequent auditing. These can often be readily run when the cards are in document sequence, and they frequently are. It may be inconvenient to recreate that situation at a later date, due to the various uses to which the cards may have been directed. Here then is another spot where foresight by the auditor can prove helpful to himself and his client.

MANUAL AND AUTOMATIC PUNCHING

The auditor has a very real interest in how cards are punched because the accuracy of final results is dependent primarily upon the accuracy of coding, punching, and verification.

Originally, each hole in a card was punched by an individual key stroke by an operator. Today automatic punching of all or any part of the punched data not only steps up speed and accuracy but opens new avenues of information.

There are so many types of punches available, each developed for specific needs, that their description if included here would make a catalog out of what must be a résumé of a broad subject. Basically, however, there are at present but four ways of punching cards: key stroke by an operator, pre-set information in the punch itself, a card actuating a punch, a counter actuating a punch.

Key-stroke punching is an efficient

machine-assisted operation very similar to calculating machine and typewriter operation. It might be mentioned here that the sequence of fields in card design is almost entirely governed by the sequence in which the data to be punched can best be seen by the operator. The sequence of fields on cards need have no relation to the design of reports to be prepared from the cards. The accounting machines to which the punched cards will go are flexible enough that it can be assumed that any information appearing anywhere on a card can be made to print anywhere on a report.

Verification of the accuracy of key punching has been mentioned as being important to the auditor, but here again lack of space prevents detailed treatment of this phase of the subject. One of the machine companies published a folder outlining twenty methods of verifying punched information and did not claim to cover all practical expedients in use. In general, verification is tied up with the routine controls established and maintained, and their effectiveness can be investigated by the auditor.

Pre-set information in the punch itself is set in the punch in the first place by key stroke or by manual movement of metal slides. Once set, the data can be identically repeated in any number of cards. In some types of punches, this feature is incorporated in a key punch so that information common to a batch of cards need be key stroked but once by an operator. In such cases, the common data is punched in all cards without any time involved in the operation except for the first card in each batch. Where the pre-set information is punched in a special machine, most of these models handle one hundred cards a minute, punching at this speed any part or all of each card.

A card actuating a punch is a simple idea with far-reaching influence. It is one of the outstanding distinctive fea-

Punched Card Accounting

tures of punched-card procedure. The early models of this type of punch duplicated the holes from one card to another at the rate of 600 holes a minute, ten a second. This was not exactly slow but the modern machines reproducing entire cards with both alphabetic and numeric data can punch 12,500 useful holes a minute. (They can actually punch 96,000 holes a minute but the cards wouldn't mean anything.) The use of pre-punched cards of many kinds is naturally increasing in many ways and for many reasons, some of which will be mentioned in the specific sections that follow.

A counter actuating a punch is another significant automatic feature, which must be understood by informed auditors. It is the mechanical link that makes possible a coordinated chain of mechanized records. A simple and widespread use of this is for punching summary cards. When detail cards are run in an accounting machine and tabulated totals are thus available, a punch connected with the accounting machine makes it possible for the counters to actuate the punch and punch one card for each group total. Here is where the significance of *indicated* information takes on added meaning. The indicating information picked up from the first card in each group and held in the counter until the last card has been fed can thus be transferred to the summary card.

The necessity of having indicated information in the first card only of a group provides for another useful operation, because data can thus be injected into the summary cards which did not appear in the detail cards. Suppose sales cards were being tabulated by commodity and cost of sales was desired. For good reasons, it had been decided that no useful purpose would have been served by getting the costs into the detail cards, but the cost of each commodity was known and was prepunched in a set of master cards by commodities.

These master cards, placed in front of the detail cards before sorting, would be the first in each commodity group after the machine sorting of the cards was finished. The cost prices could thus be indicated, printed on the report, and punched in the summary cards, for extension by the tabulated quantities.

But, even though new information can be picked up in summary cards, it should be remembered that the reference information in the detail cards is frequently lost in the summarization. In modern practice, the card to actuate a general-ledger entry may be a summary card. In fact, it is apt to be the last of a series of summary cards and the lack of visible back-track on written records may be a serious hindrance in auditing. This can be entirely overcome wherever it is practicable to do so and, with foresight, it is usually practicable. When summary cards are to be punched, the detail cards can be listed instead of tabulated, and reference data printed on the list or register. (This will be illustrated later.) The details making up each group total will thus be available for reference in auditing, and the punching of the summary cards is accomplished at the end of each group exactly as though a tabulation had been made.

The actuation of punching from counters is not confined to the accounting machines; the multiplier also uses this principle. In the multiplier each card first feeds past reading brushes which pick up the punched factors which the internal mechanism computes in counters, the card in the meantime passing to the punching mechanism where it receives the result from the counter-actuated punch.

Punches made in many models

That the four bases of punching which have been mentioned have resulted in a large number of machine models is due to the fact that practically every combination of all of the methods has been incorporated in single ma-

Punched Card Accounting

ture of the prepunched (and therefore somewhat permanent) information. The customers are numbered by cities in states. Obviously this is a rather simple, straightforward set-up because no provision is made, for instance, for identifying subsidiary companies or branches of national organizations. Furthermore, the specific customers are regularly served, not only by certain branch offices of the client but by assigned salesmen within the branch, indicating more or less stability of territorial assignments, because the master cards would have to be changed for each change in a salesman's territory. Indication of the class of customer (columns 67 and 68) may be merely for sales analysis, but as was mentioned in the previous paragraph, this classification might also determine what discount schedule to apply. The duplication of varying dates from permanent master cards is a mechanical trick which is easily understood when seen.

For the manual operation of punching, which in this case involves key punching the "quantities" only (columns 77 through 80), three things are necessary: a master card for the customer, a commodity card for each item ordered, and the document which described the transaction in the first place. The possibility of punching the right quantity in the wrong commodity card would probably be covered in a case like this by checking the bill (when subsequently prepared from the punched cards) against the original document. The punching of correct quantities in total can be established by checking against predetermined totals.

The cards are now ready for automatic calculation and punching of gross billing, discount, and net billing—all of which are performed on the multiplier. The gross billing is the simple multiplication of the prepunched price by the quantity, the only possible complication being the necessity for taking care of situations where the quantity punched

might represent units that differed from the units in the price. The computation of discounts might conceivably be influenced in this case by classes of commodities or classes of customers, or both. Intelligent coding would enable the whole group of cards to be mechanically sorted into sections where uniform discounts applied preliminary to automatic calculation and punching in the multiplier. (In cases where this might be cumbersome, this particular card form and procedure would not be used. You might even find provision for key punching discount rates if these varied so much that notation of them on the original documents was desirable.) The net billing can be accomplished in two ways: by multiplication, in which case the crossfooting of these computed totals (gross, discount, and net) would be some safeguard as to accuracy, or by automatic crossfooting in the multiplier itself (which the multiplier will do even though its name doesn't indicate it). It is interesting to note that the multiplier contains automatic circuits for checking and the auditor can investigate whether or not these are regularly used in routine operations. A visible dial shows the cumulated totals of computed extensions punched. At the end of a run, the particular total can be noted. Usually it is because this may be the first time it has ever appeared anywhere. A switch on the machine will transpose the multiplier and multiplicand, and a re-run of the cards (with or without punching) will re-compute the extensions and provide a visible total for check as to agreement.

The auditor will probably notice that meager reference data is punched in this particular card. In the first place, the card is full. Reference data, if necessary, could have been provided at the expense of alphabetical description of products. The identification of the items with the customer by dates, however, may be entirely adequate where customers do

Punched Card Accounting

MO	DAY	Y	MO	DAY	CUSTOMER NO.	TRADE CLASS	ST.	CO	CITY	BRANCH	COMM. RATE	SALES MAN	LINE	ITEM	SIZE	QUANTITY ORDERED	ORDER NO.	ENTRY	
DATE OF ENTRY			DATE PROMISED				LOCATION						COMMODITY						
1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	1	2

The relation between the punched data and the report figures becomes apparent by visual comparison.

Note too that this type of report illustrates the possibility of easy listing of punched information, where reference data can be completely recorded on typed sheets or registers in any systematic sequence, often in the same sequence in which basic documents will be finally filed, facilitating audit. You have probably also noticed that the words "list" and "tabulate" have a technical significance for machine men.

"List" means printing a separate line for each card. "Tabulate" implies that group totals only are recorded.

But now let us jump directly to a report normally tabulated (not listed) where a different test card must be significantly punched to represent each different type of transaction that might affect the report. We are now testing, principally, counter actuation and the actuating holes could be punched in the entry columns (28 and 29) for digit selection or in significant "x" holes (see section on actuating).

TRANSACTIONS FOR WHICH SEPARATE IDENTIFIED TEST CARDS ARE NEEDED	COMMODITY	SALES		UNFILLED ORDERS	STOCK ON HAND	DUE FROM FACTORY
		YEAR TO DATE	CURRENT MONTH			
PRODUCTION ORDERS ENTERED	3 4 5 6 7					8 9 1 2
DELIVERIES TO FINISHED GOODS INVENTORY	3 4 5 6 7				8 9 1 2	8 9 1 2 -
(THERE ARE SEVERAL WAYS OF TAKING CARE OF DIFFERENCES BETWEEN PRODUCTION ORDERED AND ACTUAL PRODUCTION WHICH ARE NOT SHOWN HERE)						
CUSTOMERS ORDERS	3 4 5 6 7			8 9 1 2		
SALES (PREVIOUS MONTHS FROM SUMMARY CARDS)	3 4 5 6 7	3 4 5 6				
SALES, CURRENT	3 4 5 6 7	3 4 5 6	3 4 5 6		3 4 5 6 -	
(NOTE THAT UPON SHIPMENT SIGNIFICANT PUNCHING MAKES THE ORIGINAL QUANTITY ORDERED IGNORED IN THE UNFILLED ORDER COLUMN).						

Either the quantity ordered or the quantity shipped was connected with every counter for every card. These test cards checked to make absolutely certain that each counter was properly actuated to give effect to particular

transactions—adding, subtracting, or ignoring them, as the case may be.

Adjustments, returns, and partial shipments would have to be provided for in practice—the above are, perhaps, enough to illustrate the procedure.

NOTE.—Part II of this article will appear in the October issue.