# Punched Card Data Processing Principles

Section 6: The IBM Accounting Machine

IBM Personal Study Program

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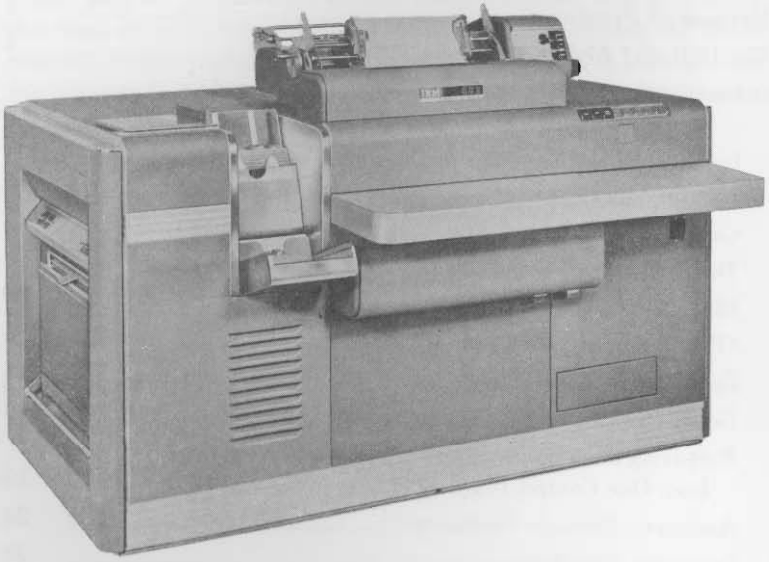
IBM® Personal Study Program

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

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

# Contents



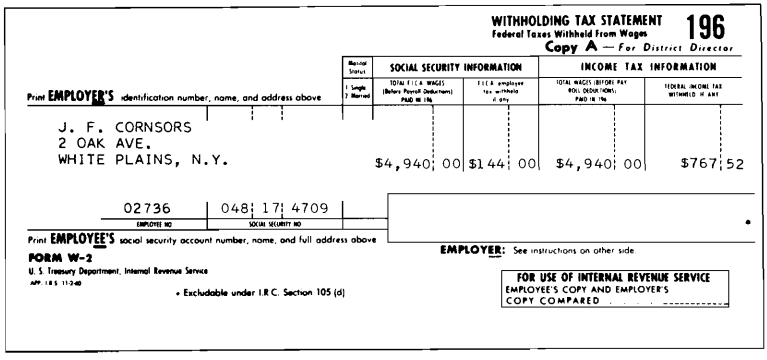
*IBM 402 Alphabetical Accounting Machine*

# Section 6: The IBM Accounting Machine

Printing is one of the most important functions of IBM accounting machines. It is through the medium of printing that the finished products of a data processing system are produced. These products are printed reports and document forms which are required for the efficient operation of any business. Of vital interest is the quality and legibility of the printing on these forms because many of them, such as statements, invoices, checks and reports, are placed in the hands of people whose only contact with the business is through the printed form.

IBM accounting machines, in addition to performing the important function of printing, have the ability to (1) summarize, in counters capable of addition and subtraction, the numerical data punched in a file of cards, (2) print the summarized data—that is, subtotals and final totals—whenever required, (3) punch summarized data into cards, when connected to another machine capable of *summary punching*, such as the IBM 514, and (4) position continuous paper forms automatically to the line where the data should be printed.

Figure 1 shows various printed forms that were prepared by IBM accounting machines. (It is possible to prepare each one on the same accounting machine.) While the characters on these reports are all of the standard variety, any type of character may be printed. That is, the accounting machines can be equipped with custom-made symbols that are printed when a certain code is punched into a card.


WITHHOLDING TAX STATEMENT 196
Federal Taxes Withheld From Wages
Copy A — For District Director

Marital Status: 1 Single 2 Married

SOCIAL SECURITY INFORMATION | INCOME TAX INFORMATION

Print EMPLOYER'S identification number, name, and address above

J. F. CORNSORS
2 OAK AVE.
WHITE PLAINS, N.Y.

| TOTAL F.I.C.A. WAGES (Before Payroll Deductions) PAID IN 196 | F.I.C.A. employee tax withheld, if any | TOTAL WAGES (BEFORE PAY ROLL DEDUCTIONS) PAID IN 196 | FEDERAL INCOME TAX WITHHELD IF ANY |
|---|---|---|---|
| $4,940 00 | $144 00 | $4,940 00 | $767 52 |

EMPLOYEE NO: 02736
SOCIAL SECURITY NO: 048 17 4709

Print EMPLOYEE'S social security account number, name, and full address above

EMPLOYER: See instructions on other side.

FORM W-2
U. S. Treasury Department, Internal Revenue Service
APP. I.R.S. 117-240

• Excludable under I.R.C. Section 105 (d)

FOR USE OF INTERNAL REVENUE SERVICE
EMPLOYEE'S COPY AND EMPLOYER'S COPY COMPARED . . . . . .

**Figure 1a.**

CHECK NUMBER
012345

A-Z SERVICE CORPORATION
112 POST STREET, BLUE PLAINS, N.Y.

1-2
789

PAY TO THE ORDER OF

W. O. DACH

| MO. | DAY | YEAR |
|---|---|---|
| 9 | 22 | |

94.65
PAY THIS AMOUNT

EMPLOYEE PAYROLL ACCOUNT

THE STATE NATIONAL BANK
55 KIRCHEN ST.
BLUE PLAINS, N.Y.

Noel Neers
AUTHORIZED SIGNATURE

012345
CHECK NUMBER

A-Z SERVICE CORPORATION
BLUE PLAINS, N.Y.

| GROSS INCOME YEAR TO DATE | GROSS PAY | DEDUCTIONS | | | | | NET PAY |
|---|---|---|---|---|---|---|---|
| | | FIT | FICA | STATE TAX | BONDS | OTHER | |
| 3990 00 | 105 00 | 7 20 | 3 15 | | | | 94 65 |

DETACH AND RETAIN THIS STUB AS A RECORD OF YOUR EARNINGS AND DEDUCTIONS

**Figure 1b.**

FROM

NATIONAL PRODUCTS INC.
GREENVILLE. MASS.

INVOICE NUMBER
12345

SOLD TO
SEAVIEW HOME SUPPLY CO
14 OCEANSIDE AVE
RICHARDS REEF N H

SHIP TO
SEAVIEW HOME SUPPLY CO
14 OCEANSIDE AVE
RICHARDS REEF N H

| CUST. NO. | SHIP VIA | SALESMAN | CUST. ORDER NO. | INVOICE DATE |
|---|---|---|---|---|
| 10341 | FREIGHT | 86 | 311 | 4 15 |

| COMMODITY CODE | DESCRIPTION | QUANTITY | UNIT PRICE | AMOUNT |
|---|---|---|---|---|
| 19941 | KOLDFLO ELEC FAN 12 IN | 36 | 2 95 | 106 20 |
| 19949 | KOLDFLO ELEC FAN 8 IN | 72 | 2 50 | 180 00 |
| 42641 | KORN KING CORN POPPER | 3 | 46 0 | 1 38 0 |
| 66488 | VACU-LOK VACUUM BTS 2PT | 36 | 88 | 31 68 |
| 12996 | LUXURY HEAT PADS | 12 | 3 50 | 42 00 |
| | | | | 373 68 |

**Figure 1c.**

EXPENSE DISTRIBUTION
By Department or Branch

| | ACCOUNT NO. | | | DATE | | | | |
|---|---|---|---|---|---|---|---|---|
| DEPT. CHGD. | GEN. LEDG. | SUB. LEDG. | OUR INVOICE NUMBER | MO. | DAY | AMOUNT CR * | AMOUNT BY ACCOUNT CR | AMOUNT BY DEPT.-BR. CR |
| 82 | 431 | 112 | 12066 | 12 | 10 | 3000 00 | | |
| 82 | 431 | 112 | 12153 | 12 | 28 | 3000 00 | | |
| | | | | | | 6000 00 * | | |
| 82 | 431 | 113 | 12066 | 12 | 10 | 1500 00 | | |
| 82 | 431 | 113 | 12066 | 12 | 10 | 1500 00 | | |
| 82 | 431 | 113 | 12066 | 12 | 10 | 5000 00 | | |
| 82 | 431 | 113 | 12066 | 12 | 10 | 1750 00 | | |
| 82 | 431 | 113 | 12153 | 12 | 28 | 1500 00 | | |
| 82 | 431 | 113 | 12153 | 12 | 28 | 1500 00 | | |
| 82 | 431 | 113 | 12153 | 12 | 28 | 1250 00 | | |
| | | | | | | 8500 00 * | | |
| 82 | 431 | 114 | 12066 | 12 | 10 | 500 00 | | |
| 82 | 431 | 114 | 12066 | 12 | 10 | 750 00 | | |
| 82 | 431 | 114 | 12066 | 12 | 10 | 500 00 | | |
| 82 | 431 | 114 | 12153 | 12 | 28 | 500 00 | | |
| 82 | 431 | 114 | 12153 | 12 | 28 | 500 00 | | |
| 82 | 431 | 114 | 12153 | 12 | 28 | 750 00 | | |
| | | | | | | 3500 00 * | | |
| 82 | 431 | 520 | 12149 | 12 | 28 | 360 43 | | |
| | | | | | | 360 43 * | | |
| | | | | | | | 2160 43 | |
| 82 | 432 | 135 | 12151 | 12 | 28 | 1792 86 | | |
| | | | | | | 1792 86 * | | |
| | | | | | | | 1792 86 | |
| 82 | 433 | 175 | 12151 | 12 | 28 | 1500 00 | | |
| 82 | 433 | 175 | 12151 | 12 | 28 | 2500 00 | | |
| | | | | | | 4000 00 * | | |
| 82 | 433 | 176 | 12155 | 12 | 10 | 1000 00 | | |
| 82 | 433 | 176 | 12155 | 12 | 10 | 1750 00 | | |
| | | | | | | 2750 00 * | | |
| | | | | | | | 6750 00 | |
| | | | | | | | | 4628 29 |
| 83 | 430 | 115 | 12075 | 12 | 10 | 7500 00 | | |

Figure 1d.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 82 | 431 | 112 | | | | 6000 00 | | |
| 82 | 431 | 113 | | | | 8500 00 | | |
| 82 | 431 | 114 | | | | 3500 00 | | |
| 82 | 431 | 520 | | | | 360 43 | | |
| | | | | | | | 2160 43 | |
| 82 | 432 | 135 | | | | 1792 86 | | |
| | | | | | | | 1792 86 | |
| 82 | 433 | 175 | | | | 4000 00 | | |
| 82 | 433 | 176 | | | | 2750 00 | | |
| | | | | | | | 6750 00 | |
| | | | | | | | | 4628 29 |
| 83 | 430 | 115 | | | | 7500 00 | | |

Figure 1e.

# Methods of Printing

In order to type the required characters, either of two printing methods is employed: serial and parallel. The typewriter is an example of the serial printing method. The characters are individually chosen and printed, one at a time, on the printing line. After the printing of each character, the paper is moved to the left by a carriage, positioning the paper to receive the printing of the next character.

The parallel printing method is used by IBM accounting machines. The printing mechanism consists of groups of typebars or typewheels.

Each typebar or typewheel of a group, in turn, consists of a full set of numerical characters alone, or of numerical, alphabetic and special characters together. During the setup portion of the printing operation, the required character is positioned for printing. At a definite time later in the cycle of the printing operation, all the type characters are pressed against the paper simultaneously. Thus an entire line is printed at one time. The chief advantage of parallel printing is speed.

## The IBM 402 Alphabetical Accounting Machine

The 402 printing mechanism consists of (1) up to 43 alphameric typebars, each of which prints the 26 alphabetic characters, the ten numerical characters and one special character, the ampersand (&), and (2) up to 45 numerical typebars, each of which prints the ten numerical characters and one symbol, either an asterisk (*) or the credit symbol (CR). Separating the set of alphameric typebars and the numerical typebars is a ribbon guide. The amount of space required for the ribbon guide is the same as the space required for a typebar. Figure 2 shows a 402 with the typebars raised as a line is being printed.

Figure 3 shows the type portion of a numerical typebar. When a numerical typebar receives either a CR (or *) impulse, or a 9-1 impulse, the typebar rises to print the corresponding character. When it receives a 0 impulse or none at all and there is a significant character to its left, the typebar positions to print zero.

Figure 4 shows the type portion of an alphameric typebar. An alphameric typebar positions to print an alphabetic, numerical or special character only when it receives the corresponding impulse. When an alphameric typebar receives no impulse, it positions to "print" a blank.

1. *What are the two methods of printing? Which method is used by* IBM *accounting machines?*
2. *What is the maximum number of typebars available on a 402?*
3. *What characters is an alphameric typebar capable of printing? A numerical typebar?*
4. *What character is positioned for printing when an alphameric typebar receives "no" impulse? When a numerical typebar receives "no" impulse?*
5. *What would a row of print look like when hammers strike the type of the numerical typebars that received "no" impulse?**

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

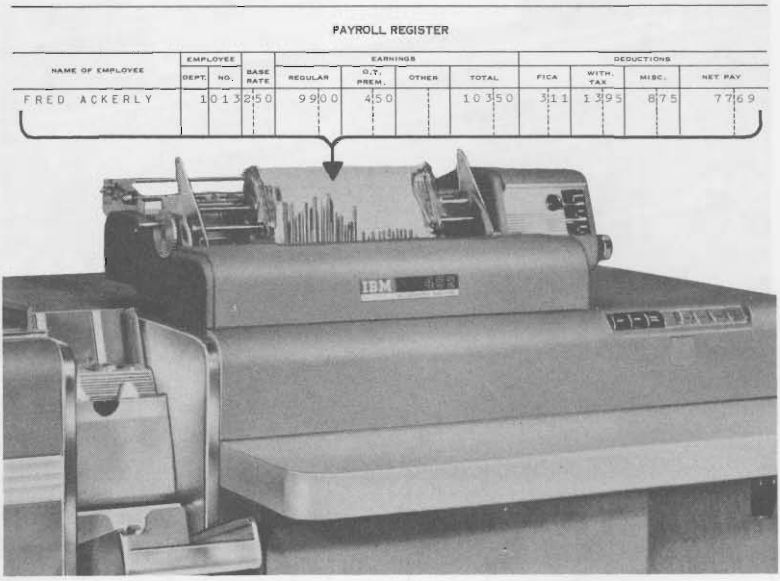



Figure 2.

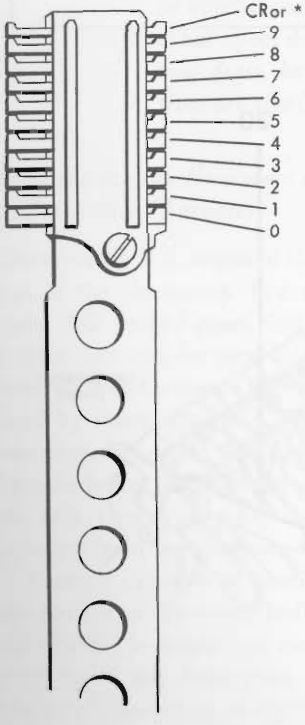
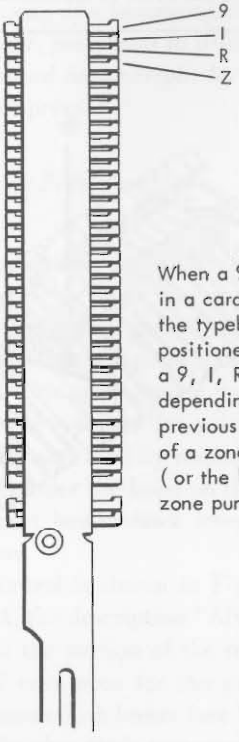



Figure 3.




When a 9 is punched in a card, it causes the typebar to be positioned to either a 9, I, R or Z depending upon the previous detection of a zone punch ( or the lack of zone punch ).

Figure 4.

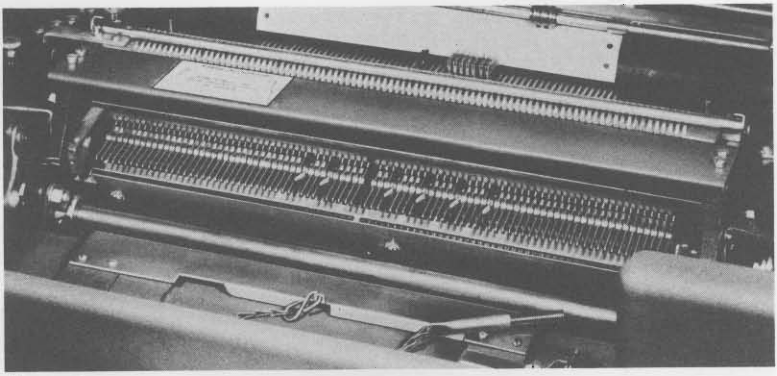


Figure 5.

| 24 25 26 27 28 29 30 31 32 33 34 | 35 36 37 38 39 40 41 42 43 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 |
|---|---|---|
| ABBOT BROS | 0 1 1 7 9 1 2 3 1 | 3 1 8 0 0 1 5 8 7 8 0 0 1 5 5 6 8 0 0 |
| ABBOT BROS | 0 1 1 7 9 1 2 3 1 | 1 9 6 0 0 0 9 8 1 3 0 0 0 9 0 1 7 0 0 |

Hammersplit levers not raised.

| | | |
|---|---|---|
| ABBOT BROS | 1 1 7 9 1 2 3 1 | 3 1 8 1 5 8 7 8 1 5 5 6 8 |
| ABBOT BROS | 1 1 7 9 1 2 3 1 | 1 9 6 9 8 1 3 9 0 1 7 |

Hammersplit levers 34 (alphameric) and 6, 13 and 20 (numerical) raised.

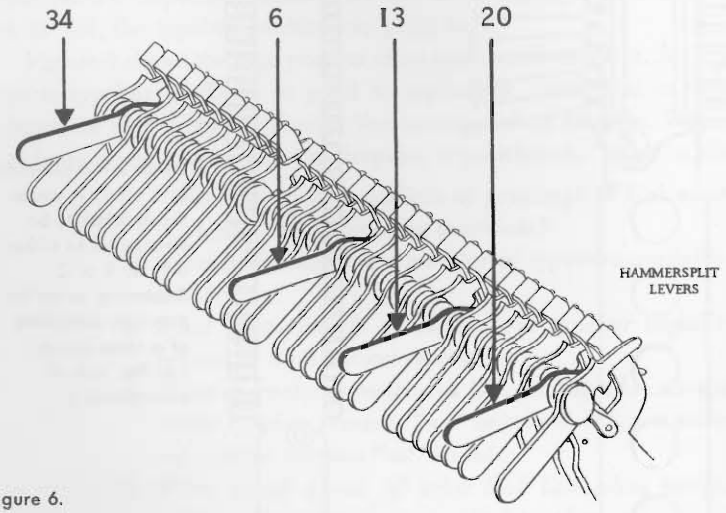



Figure 6.

### *Inactivating the Hammers of Typebars Positioned to Print Nonsignificant Zeros*

Eliminating the printing of zeros on an IBM 402 is accomplished by inactivating the hammers corresponding to the zero-positioned typebars. The hammers are inactivated by means of hammersplit levers (there being one for each alphameric and numerical typebar). The hammersplit levers are located in one continuous bank under a hinged cover just in front of the typebars (see Figure 5). When a hammersplit lever is *raised*, it inactivates the hammer or hammers next to it on the right which correspond to typebars positioned to print zeros. The first typebar to the right which is positioned to print a significant digit cancels the inactivating effect of that raised hammersplit lever. Figure 6 shows what is printed when hammersplit levers are not raised, as compared with what is printed when hammersplit levers are raised. (Notice, incidentally, that the number 1 numerical hammersplit lever was not raised. This is because there is an "automatic" hammersplit to the left of the number 1 numerical typebar.)

6. *How many hammersplit levers are there?*
7. *What is the positioning of a typebar for its hammer to be inactivated by the raising of a hammersplit lever?*
8. *What effect does a typebar, positioned to print a significant digit, have on a raised hammersplit lever?*
9. *How are significant zeros printed?**

### *Inactivating the Hammers of Typebars Positioned to Print Any Character*

Occasionally it is required that certain typebars be inactivated regardless of the characters they are positioned to print. For example, the same 402 control panel that is set up to print a payroll register (see Figure 7a) can be used to print a remittance statement for hospital insurance deductions (see Figure 7b). This same control panel can be used by inactivating the hammers of the typebars for printing gross earnings, FICA, etc. The hammers are inactivated by raising the short hammerlocks, which are levers located under the hood on the front of the 402 (see Figure 8). A raised short hammerlock lever prevents printing from the corresponding typebar.

Another example of hammerlock control is shown in Figure 9. At the portion of the report indicated at A, the description "ANCHOR 10 IN CONE" is printed on each line. At the portion of the report indicated at B, the description is printed only once for the group. This was accomplished by using the long hammerlock levers (see Figure 8). The long hammerlocks are effective only when their corresponding control panel hub receives an impulse. Thus by raising the long hammerlock levers which correspond to the typebars for printing description,

(PAYROLL REGISTER)

| Employee No. | Name | | Gross Earnings | Blue Cross | FICA | SUI | Savings Bonds | With. Tax | Total Deduction | Net Pay |
|---|---|---|---|---|---|---|---|---|---|---|
| 5556 | GRAHAM | GD | 100.00 | 2.40 | 3.00 | .50 | 6.75 | 12.20 | 24.85 | 75.15 |
| 5562 | GUERIN | JH | 77.00 | 2.40 | 2.31 | .39 | 1.00 | 13.00 | 19.10 | 57.90 |
| 5564 | HUMPHREY | TL | 48.72 | 2.40 | 1.46 | .24 | | 7.20 | 11.30 | 37.42 |
| 5571 | HUPPELL | ST | 110.00 | 2.90 | 3.30 | .55 | 5.00 | 14.20 | 25.95 | 84.05 |

Figure 7a.

(REMITTANCE STATEMENT)

| | | | |
|---|---|---|---|
| 5556 | GRAHAM | GD | 2.40 |
| 5562 | GUERIN | JH | 2.40 |
| 5564 | HUMPHREY | TL | 2.40 |
| 5571 | HUPPELL | ST | 2.90 |

SHORT HAMMERLOCKS ELIMINATE PRINTING IN REMITTANCE STATEMENT

Figure 7b.

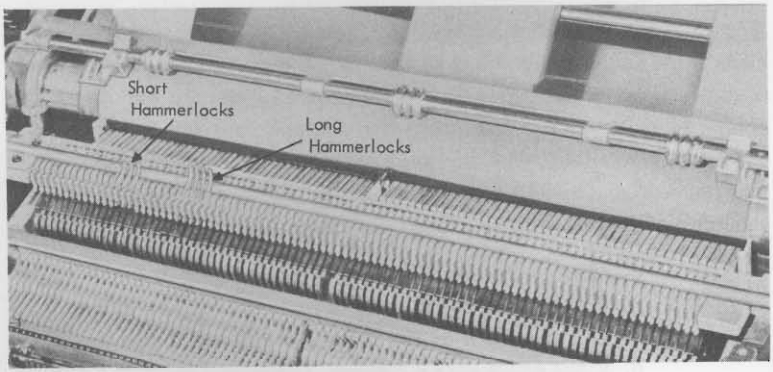



Figure 8.

CONSOLIDATED STOCK STATUS REPORT

| | DESCRIPTION | UNIT | UNIT PRICE | VALUE | DATE OF LAST ACTIVITY | NET ISSUES AVERAGE PER MO. | NET ISSUES CURRENT MONTH | ON ORDER |
|---|---|---|---|---|---|---|---|---|
| A | ANCHOR 10 IN CONE | EA | 2.250 | 308.25 | 25 | 58.4 | 52 | |
| | ANCHOR 10 IN CONE | EA | 2.250 | 168.75 | 25 | 21.6 | 24 | |
| | ANCHOR 10 IN CONE | EA | 2.250 | 45.00 | 25 | 5.1 | 3 | |
| | ANCHOR 10 IN CONE | EA | 2.250 | 103.50 | 25 | 25.0 | 18 | |
| | ANCHOR 10 IN CONE | EA | 2.250 | 72.00 | 25 | 20.0 | 26 | |
| | ANCHOR 10 IN CONE | EA | 2.250 | 171.00 | 25 | 39.5 | 34 | |
| | ANCHOR 10 IN CONE | EA | 2.250 | 94.50 | 25 | 21.0 | 19 | |
| | | | | 963.00* | | 90.6* | 176* | |
| B | ANCHOR 12 IN CONE | EA | 2.485 | 432.39 | 25 | 117.0 | 102 | 200 |
| | | | | 121.77 | 25 | 28.1 | 24 | |
| | | | | 178.92 | 25 | 46.0 | 52 | |
| | | | | 181.41 | 25 | 38.1 | 39 | |
| | | | | 62.13 | 25 | 15.6 | 16 | |
| | | | | 211.23 | 25 | 40.3 | 43 | |
| | | | | 186.38 | 25 | 43.5 | 36 | |
| | | | | 1374.23* | | 32.8* | 312* | 200 |

Figure 9.

and providing the control panel hub with the proper impulse, the description will print for the first line of the group but not for any other line.

*10. When are short hammerlock levers effective?*

*11. When are long hammerlock levers effective?*

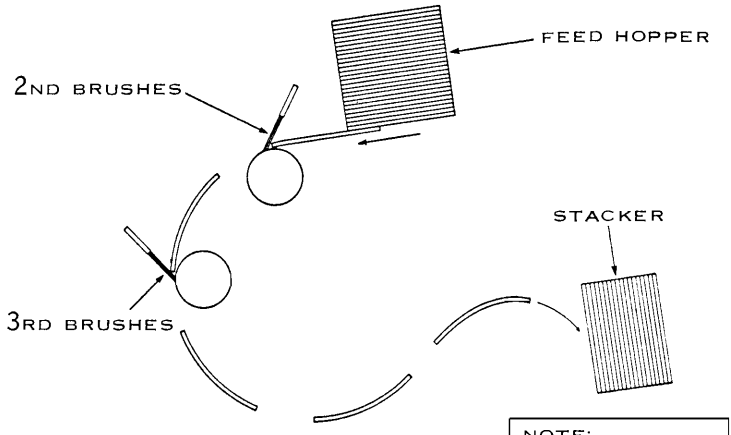



Figure 10.

## *Card Path*

Figure 10 shows the path cards take in passing through the IBM 402 Alphabetical Accounting Machine. (The note in the small block indicates that a "first reading" station is not available on 402 machines. When a "first reading" station is available, the accounting machine is the IBM 403.)

The location of the 80 brushes of the third reading station is one station below the second reading brushes. The cards should be placed in the machine hopper, 9 edge first and face down. As the cards feed from the hopper, they pass, in order, the second reading brushes, the third reading brushes and then on into the stacker.

The second reading brushes serve three main functions:

1. Detecting a characteristic of the card, such as an X punch, in order to control addition or subtraction, control the long hammerlock levers, position the paper form to a certain printing line, etc.

2. Conditioning one of the alphameric typebars according to the zone punch to print an alphabetic character.

3. Determining whether the same field of information (for example, employee number, customer number, state or city code, etc.) in the cards at the third reading brushes is equal or unequal. When the values in the fields are found to be different, it may be that a subtotal is to be taken, that the paper form is to skip to a predetermined printing line, that a summary card is to be punched with the accumulated information, etc.

The third reading brushes also serve three main functions:

1. Raising the typebars to the desired printing position.
2. Providing the counters with the data to be accumulated.
3. Determining whether the same field of information in the cards at second reading is equal or unequal.

12. *What are the names of the reading brushes on an* IBM *402?*
13. *How should cards be placed in the hopper of the* IBM *402?*
14. *What are the three main functions of the second reading brushes? Of the third reading brushes?*

### *The 402 Control Panel*

Obtain a 402 control panel diagram from the supplies packet. The hubs for impulses from the second reading brushes are located at (1-40, M-N); from the third reading brushes at (1-40, O-P) and at (1-40, DD-EE). The hubs for providing impulses to the 45 numerical typebars are located at (1-44, R) and at (45, S). The hubs for providing the 0-9 digit impulses to the 43 alphameric typebars are located at (1-43, Q). The hubs for providing the zone impulses to set up the 43 alphameric typebars to print the alphabetic characters are located at (1-43, L). (Note the names that these control panel hubs have been given.)

### *IBM 402 Counters*

One of the main functions of the IBM 402 is accumulation. This is performed by counters which are similar to the counters of the IBM 602. The maximum number of accumulating positions in a 402 is 80. These 80 positions comprise four 2-position counters, four 4-position counters, four 6-position counters and four 8-position counters. Counters can be used individually or coupled in any fashion desired to provide a total of up to 16 positions.

15. *What is the maximum number of accumulating positions on an* IBM *402?*
16. *How many counters are on a 402 and what are their denominations?*
17. *How would it be possible to accumulate an eleven-position total?**

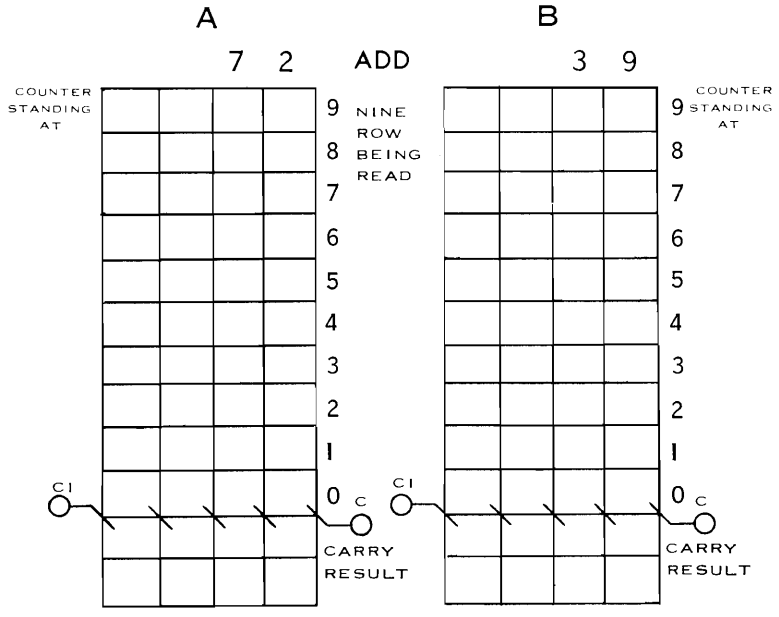



Figure 11.

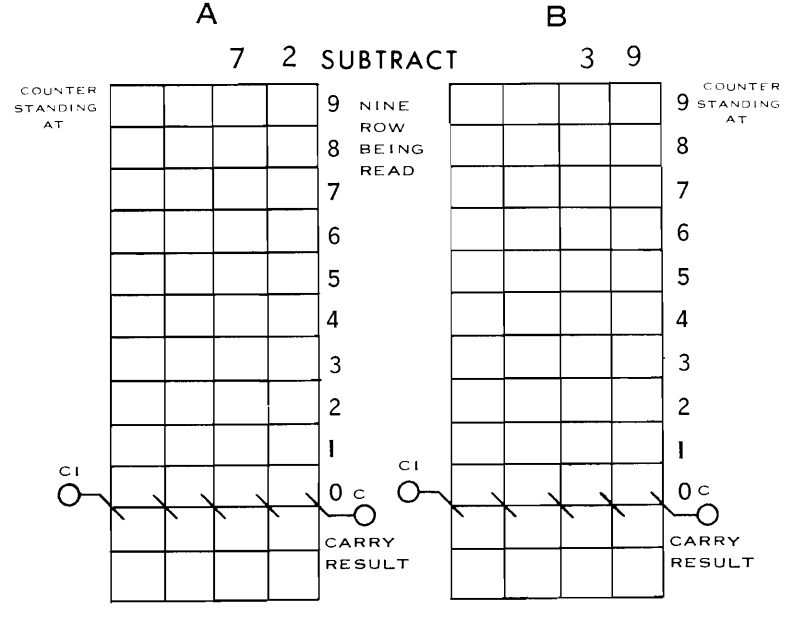



Figure 12.

### Counter Operation—Addition

A positive amount, including zeros, always appears in uncomplemented form in 402 counters. When a counter is instructed to read in plus (51-66, S-T), the counter wheels start moving according to the timing of the digit impulse.

18. *Figure 11 is a "counter chart" to be filled in to indicate the activity of a four-position counter when it is instructed to accumulate from a two-column field. In part A, indicate the activity when a 72 is added from card number 1. In part B, indicate the activity when a 39 in card number 2 is added to the result from card number 1. Draw a circle around the digit to indicate the beginning of motion of the counter wheel.**

### Counter Operation—Subtraction

A negative amount always appears in the nines-complement form in 402 counters. When a counter is instructed to read in minus (51-66, U-V), the counter wheels start moving at 9-time and stop according to the timing of the digit impulse.

19. *Figure 12 is a counter chart to be filled in to indicate the activity of a four-position counter when it is instructed to subtract. In part A, indicate the sequence of events when a 72 is subtracted from card 1. In part B, indicate the counter activity when a 39 from card 2 is subtracted from the result obtained in part A. Draw a circle around the digit to indicate the beginning of motion of the counter and a square around the digit to indicate when the counter motion stops.* Notice *that CI and C wiring is required to obtain the proper nines-complement amount. The CI and C hubs are located at (51-66, DD-EE).**

### Counter Operation—Read Out and Reset

Each counter can be read out and reset (51-66, GG-HH) at any time that it is not impulsed to add or subtract. Usually, a counter is read out and reset on a *program step*. Program steps on the 402 are very similar to program steps on calculators except for multiplication and division. A standard 402 can take up to three program steps whenever they are required.

### Putting the Counter into Motion

As with the 602 counters, the counters of a 402 require an impulse to put them in motion for data to be added, subtracted, or read out and

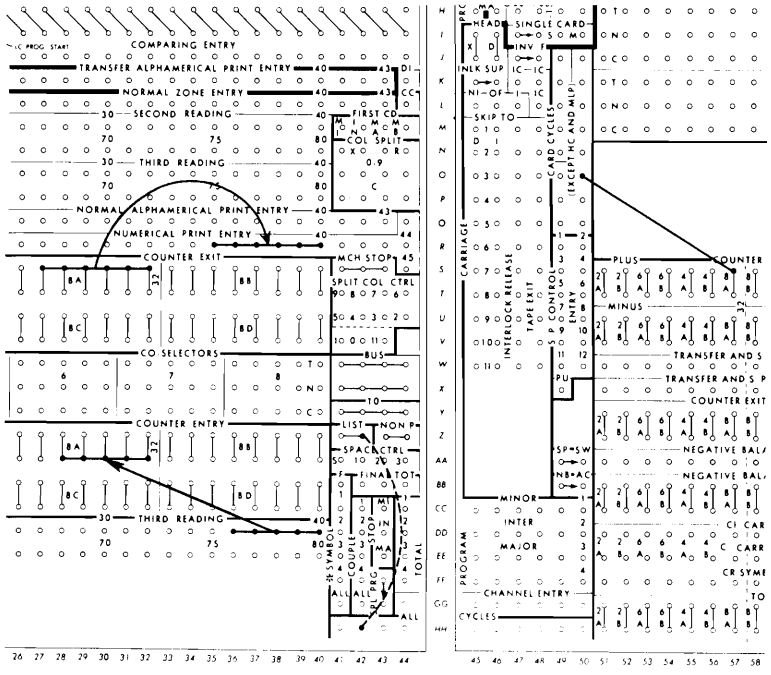



Figure 13.

reset. On a 602 this is a cycles-type impulse—that is, a read cycles, program step cycles, or an all cycles. On the 402 it is also a cycles-type impulse. To put a counter in motion during the reading of a card requires a card cycles impulse (49-50, J-Q). To put a counter in motion for readout and reset during a program step requires a PROGRAM CYCLES impulse (44-50, CC-EE). If the contents of one counter are to enter another counter during a program step, the COUNTER CONTROL PLUS or MINUS hub of the receiving counter should be impulsed by the TRANSFER AND S. P. X CTRL PLUS (or MINUS) hub of the counter being read out and reset (51-66, W-X).

Each counter position has entry hubs and exit hubs for receiving and providing data (1-40, Z-CC) and (1-40, S-V). The source of the data entering a counter may be a card, another counter, or an "emitter." The destination of data from a counter may be typebars, another counter or the punch magnets of a summary punch machine (such as the IBM 514), connected to the accounting machine by an external cable.

When data is "wired" to the entry hubs of a counter (and the counter is controlled to add or subtract), the data enters the counter and is also available at the exits. Figure 13 shows control panel wiring for data from third reading to simultaneously enter the counter, and set up the typebars for printing.

20. *What type of an impulse is required to cause a counter to add, subtract, or read out and reset?*
21. *What can be the source of data entering a counter? What may be the destination of data from a counter?*
22. *When data impulses are wired to the entry hubs of a counter, what action do they cause?*
23. *When is a counter usually instructed to read out and reset?*
24. *How many program steps can a standard 402 take?*

### Converting Negative Balances

Each counter has a control panel hub which emits an impulse when the counter is negative on a program step (that is, when there is a 9 in the high-order position of the counter). This negative balance impulse (51-66, AA) is used to instruct the counter to convert the nines complement to a true figure before it is printed. The conversion is actually accomplished by impulsing the NEGATIVE BALANCE CONTROL hub (51-66, BB-CC) of the proper counter.

### Identifying a Negative Value

In order to distinguish a negative value from a positive value, the 402 emits a special impulse (51-66, FF) whenever a counter is instructed to subtract or when the total readout of the counter is negative. This special impulse causes the chosen *even-numbered* numerical typebar to print a CR symbol.

25. *What digit identifies a negative value in a counter?*
26. *What must be done to accomplish the conversion of nines complements to true figures?*
27. *What symbol is used to identify a quantity subtracted in a counter or a negative total? What typebars are equipped to print this symbol?*

### Coupled Counters and Negative Balances

When it is possible to obtain a negative balance in coupled counters, only the high-order counter should be used to provide the impulse for converting all of the coupled counters.

28. *The four examples of "control panel" wiring in Figure 14 show several proposed negative balance test and negative balance control wirings for converting values in three counters coupled together. Write, in the space provided, what you think will print when the counters are instructed to read out and reset.**

WHAT YOU THINK WILL PRINT

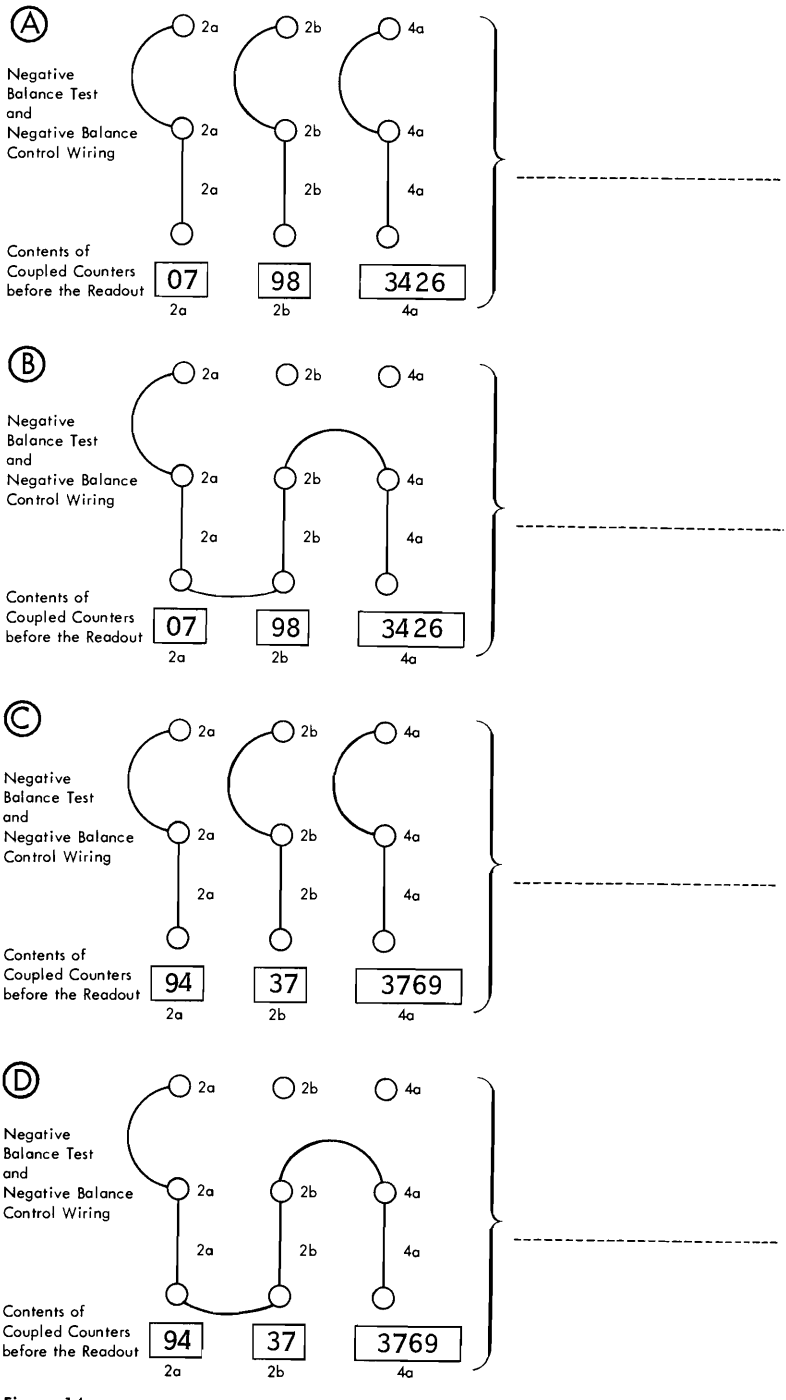



**Figure 14.**

## *"Programming" the IBM 402*

A standard 402 can be made to take up to three program steps. These are generally referred to as Minor Program, Intermediate Program and Major Program (44-50, CC-EE). Some of the things accomplished during a program step are the reading out and resetting of counters (for printing on a report or punching a card) and skipping the paper form to a particular printing line. The expense distribution report shown in Figure 1d shows a total readout of a counter during a minor program (indicated by the asterisk), a total readout of a counter during an intermediate program (in the column entitled "Amount by Account") and a total readout of a counter during a major program (in the column headed "Amount by Dept. or Branch"). Notice that each time a minor total prints, there is a change in the subsidiary ledger account number; and that each time an intermediate total prints, there is a change in the general ledger account number. When there is a major total, there is a change in department or branch.

Whenever a program step is taken, an impulse is available which, when wired to an odd-numbered numerical typebar, causes an asterisk to print (41, BB-GG).

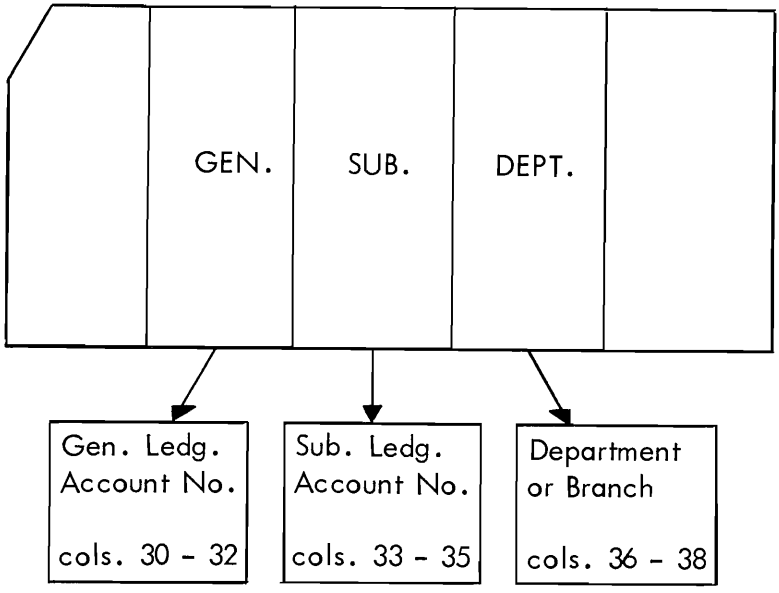
### Starting the Program

The series of one to three program steps can be started from almost any characteristic of the cards that are passing through the 402. The series of steps is started by impulsing either PROGRAM START MINOR (1 step), PROGRAM START INTERMEDIATE (2 steps), or PROGRAM START MAJOR (3 steps)—(45, F-H). The source of the impulse for initiating the program is usually obtained by detecting a difference between the card at the second reading station and a card at the third reading station.

## *Comparing*

The comparing unit of an accounting machine differs from that of the collator in that the comparison only indicates that two values are either equal or unequal. The comparing unit is primarily used to compare a value in a card at third reading (wired to one side of the comparing entry) with a value in a card at second reading (wired to the opposite side of the comparing entry). When the values differ, an impulse is available from the corresponding exit. This impulse can be used to start the required number of program steps as soon as the cards have been read by their respective reading stations (see Figure 15).

Look again at the comparing exit wiring of Figure 15. Notice that there are two diagonally connected comparing exits for each opposing set of comparing entry hubs. The upper comparing entry hub is directly above the corresponding comparing exit hubs. Figure 16 shows how the



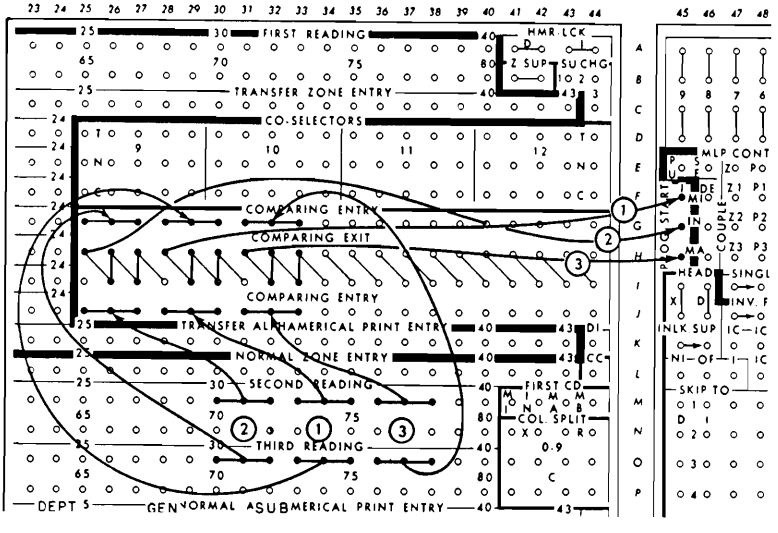




Figure 15.

1. When there is a difference in Sub. Ledg. Account No., a Minor Program (one step) is started.
2. When there is a difference in Gen. Ledg. Account No., an Intermediate Program (two steps) is started.
3. When there is a difference in Department or Branch, a Major Program (three steps) is started.

"unequal" impulse is available from the comparing exit "set" when there is a difference in the comparing entry "set."

29. *How are the program steps which are taken by a 402 generally referred to?*
30. *What are some of the things accomplished on a program step?*
31. *How is a series of program steps initiated?*
32. *What does the comparing unit of an accounting machine indicate?*
33. *What is the timing of an impulse from the comparing exit?*

### *Detail Printing and Group Printing*

The same cards (and in the same sequence) that are used for printing the report in Figure 1d are used to print the report in Figure 1e. Figure 1d is called a *detail-printed* or listed report and Figure 1e is called a *group-printed* or tabulated report. Note that in the group-printed report there is only one line of print for each subsidiary ledger account number (the minor field), regardless of how many cards constitute a subsidiary ledger group. In the detail-printed report there is one line of print for every card. Also, in the group-printed report there is single spacing between totals, whereas in the detail-printed report there is double spacing between a total and a line of print from the card.

In order to prepare a detail-printed report, the LIST (41-42, Z) hub must be impulsed from an ALL CYCLES (41-50, HH) hub. When the LIST hub is impulsed with an ALL CYCLES, the typebars will rise to print the required characters every time a card passes third reading. Also, single spacing is automatic before each line prints, except when the line is from the first card of a new group, in which case the automatic spacing is double.

In order to prepare a group-printed report, the wire that transports the ALL CYCLES impulse to the LIST hub must be removed or inactivated. When the LIST hub is not impulsed as each card passes third reading, typebars rise only twice for each group of cards—once from the impulses from the first card of the group and once to print the accumulated total for the group. Between these two risings of the typebars, *no spacing* takes place.

34. *How many lines are printed for each group of cards in a group-printed report?*
35. *What control panel hub must be impulsed to cause detail printing?*
36. *What kind of spacing takes place between the printing of the first card of the group and the printing of the group's totals?*

Note that when there is an "unequal" digit from any position of either second or third reading, an impulse is available from either of the two blacked-in control panel hubs.

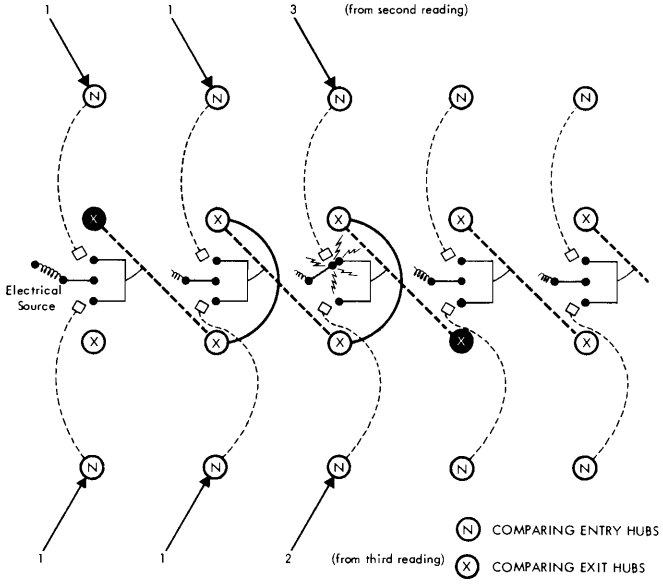



Figure 16. The impulses from the electrical source are "offset" in timing. For example, the third comparing unit "transfers" at 3-time. Then, before the 2 row is read, the electrical source emits an impulse and is therefore known as a "half-after" impulse. In this particular case a half-after-three impulse is available from the comparing exit.

## *Preparing a Group-Printed and a Detail-Printed Report from One Control Panel*

Located on the left side of the 402 Alphabetical Accounting Machine are three toggle switches called Setup Change 1, 2 and 3 (see Figure 17). When a setup change switch is turned on, there is an impulse available from the control panel on every cycle (43-44, B) and (44, C). By impulsing the IMMEDIATE pickup of a pilot selector (41-66, G) from the chosen SETUP CHANGE hubs, the selector is transferred for every cycle that the external toggle switch is turned on. Thus a setup change switch and a selector can be used to control such operations as alternating between detail and group printing. For example, an ALL CYCLES impulse into the COMMON and out of the NORMAL of a selector (under the control of the setup change switch) may be used to impulse LIST when the toggle switch is in the off position.

37. *How will turning the setup change switch on affect the wiring described in the previous sentence?**
38. *How many times do the typebars rise for each group of cards? What effect does this have on the printing positions, the impulses for which emerge from the counter exits?**

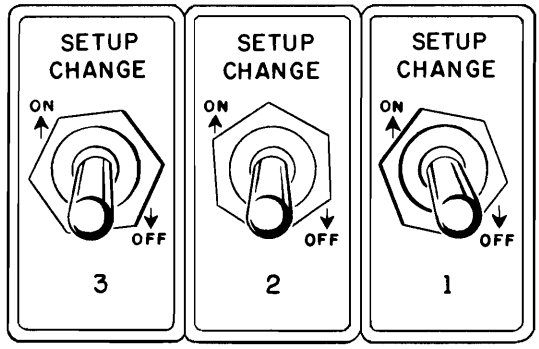



Figure 17.

Overprinting can be eliminated by suppressing the exits of the counters at the proper time. The proper time in the case of question 38 is during the reading of cards (which includes the first card of the group). Each counter has control panel hubs which, when impulsed, suppress the exits of the counter for the rest of the cycle (51-66, Y-Z).

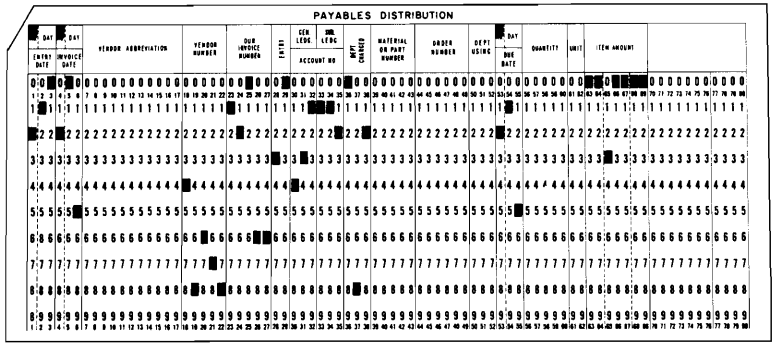



Figure 18.

## Wiring the 402 Control Panel to Prepare the Reports of Figures 1d and 1e

Obtain a 402 diagram from the supplies packet and "wire" it to prepare both the detail- and group-printed reports of Figures 1d and 1e (from cards as shown in Figure 18) according to the following instructions:

1. From upper THIRD READING hubs 36-38 (Department Charged) to NORMAL ALPHAMERIC PRINT ENTRY (A.P.E.) 21-23.

2. From upper THIRD READING hubs 30-32 (Gen. Ledg. Account No.) to A.P.E. 25-27.

3. From upper THIRD READING hubs 33-35 (Sub. Ledg. Account No.) to A.P.E. 29-31.

4. From upper THIRD READING hubs 23-27 (Our Invoice Number) to A.P.E. 33-37.

Note that only one column has been assigned for the entry date *month* (column 1). This is a technique often used to conserve card columns. To distinguish month 01 from month 11 and month 02 from month 12, a hole is punched in the X row. The X punch in column 1 is wired from *second* reading to the X pickup of a pilot selector. Impulsing the X pickup of a selector causes it to transfer on the next cycle. It returns to NORMAL after the card with the X in it has passed third reading.) The CC (card count) hub (44, L) emits a 1-timed impulse on every card cycle.

5. From SECOND READING hub 1 to X PU (51-66, E) of pilot selector 1 (PS 1). From the CC hub to COMMON of PS 1; from the TRANSFER of PS 1 to A.P.E. 39. From upper THIRD READING hub 1 to A.P.E. 40.

6. From upper THIRD READING hubs 2-3 to A.P.E. 42-43.

7. From lower THIRD READING hubs 63-69 to counter entry of 8A. From the counter exit of 8A to NUMERICAL PRINT ENTRY (N.P.E.) 1-7.

An X punched in column 69 indicates that the item amount is to be subtracted. Such a provision is necessary because of a previous erroneous distribution.

8. From SECOND READING hub 69 to the X PU of PS 2.

9. From a CARD CYCLES hub to the COMMON of PS 2. From the TRANSFER of PS 2 to COUNTER CONTROL MINUS of 8A. From the NORMAL of PS 2 to COUNTER CONTROL PLUS of 8A. From the CREDIT SYMBOL exit of 8A to the N.P.E. 8.

10. Add the comparing and program start wiring shown in Figure 15.

In this problem there are three levels of totals—minor, intermediate and major. One control panel method of obtaining more than one level of total is to enter the data from each card (as it passes third reading) directly into the counters for accumulating the 3 levels of totals. (Then, read out and reset on the proper program step.) Another control panel method is to enter the data from the card only into the minor total counter. Then, when the minor total counter is read out and reset, *transfer* its contents into the counter for the next higher level. The latter method has one major virtue—that is, if the highest-level total is correct, all the lesser levels are also correct.

> *39. If the first described method of the previous paragraph is used, why is it possible to have a correct highest-level total but have incorrect lesser-level totals?**

11. From the other counter exits of 8A to the counter entry of 8B. From the TRANSFER and S.P. X CTRL PLUS hub of 8A to the COUNTER CONTROL PLUS of 8B and from the TRANSFER and S. P. X CTRL MINUS hub of 8A to the COUNTER CONTROL MINUS of 8B. From a MINOR PRO-

GRAM hub to the TOTAL (READ OUT AND RESET) (51-66, GG-HH) hub of 8A. From the MINOR PROGRAM ASTERISK hub to N. P. E. 9.

12. From the counter exits of 8B to N.P.E. 11-17. From an INTERMEDIATE PROGRAM hub to the TOTAL hub of 8B. From the CR SYMBOL exit of 8B to N.P.E. 18.

13. From the other COUNTER EXIT hubs of 8B to the counter entries of 8C. From the TRANSFER PLUS hubs of 8B to the COUNTER CONTROL PLUS hub of 8C, and from the TRANSFER MINUS hub of 8B to the COUNTER CONTROL MINUS hub of 8C.

14. From the counter exits of 8C to N.P.E. 21-27. From a MAJOR PROGRAM hub to the TOTAL hub of 8C. From the CR SYMBOL exit of 8C to N.P.E. 28.

15. From the SU CHG (setup change) switch 1 hub to the I PU of pilot selector 3. From an ALL CYCLES hub to the COMMON of PS 3. From the NORMAL of PS 3 to the LIST hub. From a CARD CYCLES hub to the other COMMON of PS 3. From the TRANSFERRED of PS 3 to the COUNTER EXIT SUPPRESS hub of 8A.

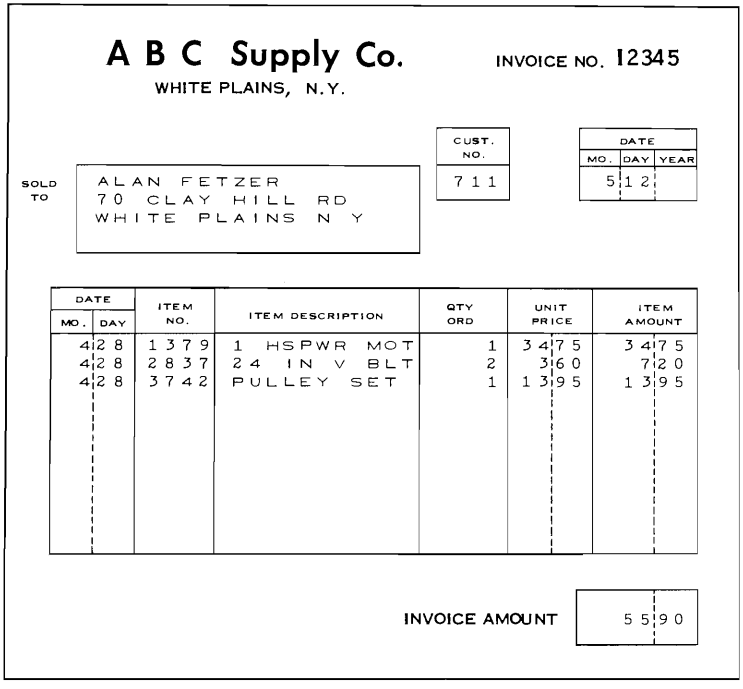
16. Provide the necessary diagramming for negative balance test and control, and for the CI and C.

*40. According to the wiring diagram so far, what happens to N.P.E. 11-17 when the contents of counter 8A are transferred to counter 8B?**

To prevent typebars 11-17 from printing except during an intermediate program step requires that the counter exits of 8B be suppressed during a minor program step. Likewise, to prevent typebars 21-27 from printing except during a major program step requires that the counter exits of 8C be suppressed during an intermediate program step.

17. From a MINOR PROGRAM hub to the COUNTER EXIT SUPPRESS hub of 8B and from an INTERMEDIATE PROGRAM hub to the COUNTER EXIT SUPPRESS hub of 8C.

The printing of "our" invoice number, month and day are of no value in a group-printed report. Also, it is not necessary to print the asterisk to indicate a minor total since the only figure that prints under "Amount" *is* a minor total. Thus, when the group-printed report is prepared, it is necessary to lift the short hammerlock levers corresponding to the appropriate typebars.



**A B C Supply Co.**
WHITE PLAINS, N.Y.

INVOICE NO. 12345

SOLD TO
ALAN FETZER
70 CLAY HILL RD
WHITE PLAINS N Y

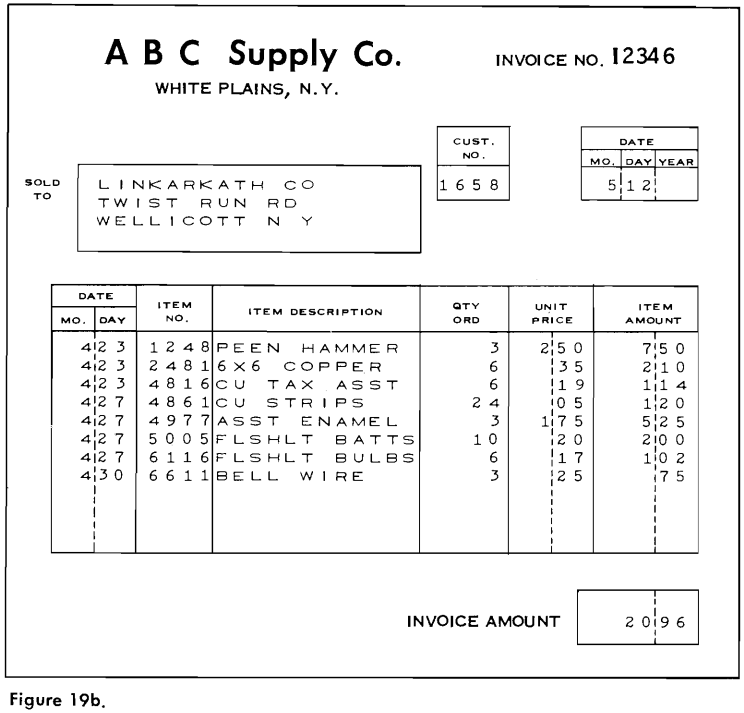
| CUST. NO. |
|---|
| 711 |

| DATE | | |
|---|---|---|
| MO. | DAY | YEAR |
| 5 | 12 | |

| DATE | | ITEM NO. | ITEM DESCRIPTION | QTY ORD | UNIT PRICE | ITEM AMOUNT |
|---|---|---|---|---|---|---|
| MO. | DAY | | | | | |
| 4 | 28 | 1379 | 1 HSPWR MOT | 1 | 34.75 | 34.75 |
| 4 | 28 | 2837 | 24 IN V BLT | 2 | 3.60 | 7.20 |
| 4 | 28 | 3742 | PULLEY SET | 1 | 13.95 | 13.95 |

INVOICE AMOUNT 55.90

Figure 19a.



**A B C Supply Co.**
WHITE PLAINS, N.Y.

INVOICE NO. 12346

SOLD TO
LINKARKATH CO
TWIST RUN RD
WELLICOTT N Y

| CUST. NO. |
|---|
| 1658 |

| DATE | | |
|---|---|---|
| MO. | DAY | YEAR |
| 5 | 12 | |

| DATE | | ITEM NO. | ITEM DESCRIPTION | QTY ORD | UNIT PRICE | ITEM AMOUNT |
|---|---|---|---|---|---|---|
| MO. | DAY | | | | | |
| 4 | 23 | 1248 | PEEN HAMMER | 3 | 2.50 | 7.50 |
| 4 | 23 | 24816 | X6 COPPER | 6 | .35 | 2.10 |
| 4 | 23 | 4816 | CU TAX ASST | 6 | .19 | 1.14 |
| 4 | 27 | 4861 | CU STRIPS | 24 | .05 | 1.20 |
| 4 | 27 | 4977 | ASST ENAMEL | 3 | 1.75 | 5.25 |
| 4 | 27 | 5005 | FLSHLT BATTS | 10 | .20 | 2.00 |
| 4 | 27 | 6116 | FLSHLT BULBS | 6 | .17 | 1.02 |
| 4 | 30 | 6611 | BELL WIRE | 3 | .25 | .75 |

INVOICE AMOUNT 20.96

Figure 19b.

*Automatic Carriage Operation*

A carriage is that part of an accounting machine into which paper is inserted for the preparation of a report. Either six or eight printing lines to the vertical inch are possible with a standard carriage.

Before an accounting machine of a data processing department prepares invoices to be sent to its customers, the cards to be used must be in the proper sequence and the forms to be used must be inserted in the carriage.

Single-sheet forms are rarely used because after each one is ejected, the accounting machine stops and the operator has to position a new form and depress the start key. Thus most forms that are used for printing by an IBM accounting machine are fanfolded and continuous in nature. With the cards in the proper sequence and the forms continuous, the printing operation proceeds from start to finish without operator intervention. Then, when printing is complete, the continuous forms are separated (or "burst") for distribution.

Figure 19 shows invoices prepared for three different customers, each with a different number of lines: Part A shows 3 lines, Part B shows 8 lines printed and Part C shows an invoice which requires more lines than a single form can accommodate.

With an automatic carriage, many lines or only one line per customer can be handled with equal ease. Through control panel wiring, the IBM 402 positions the forms for each line to be printed.

### Control Tape for Automatic Carriage

Continuous forms such as invoices are made up of two sections: the "head" and the "body."

The head of the invoice in Figure 19 contains the name and address of the customer, the customer number and the date of invoice preparation. Other data that may appear in the head of a form is a name and address where the goods should be shipped, if different from the address of the customer, the type and name of the common carrier (truck, rail, etc.), the terms offered for payment, and other information deemed necessary. All the information that appears in the head of a form comes from cards that are identified with an X or a digit punch in a chosen card column.

The body of the invoice in Figure 19 contains the date an item was ordered, the item number, an abbreviated description, the quantity ordered, the unit price of the item, the item amount and the invoice total. Notice that the total always appears in a predetermined location and not after the last item line.

The standard invoice form discussed here has four especially significant lines: (1) the first printing line of the form (the name), (2) the first body line, (3) the "overflow" line, as illustrated in Part C of Figure 19, and (4) the predetermined total line.

# A B C Supply Co.

WHITE PLAINS, N.Y.

INVOICE NO. 12347

SOLD TO

MRS C C NUDLEY
RTE 87
WINDHAM CTR CONN

| CUST. NO. |
|---|
| 3229 |

| DATE | | |
|---|---|---|
| MO. | DAY | YEAR |
| 5 | 12 | |

| DATE | | ITEM NO. | ITEM DESCRIPTION | QTY ORD | UNIT PRICE | ITEM AMOUNT |
|---|---|---|---|---|---|---|
| 4 | 23 | 1357 | STEAM IRON | 1 | 17.50 | 17.50 |
| 4 | 23 | 1537 | H20 DIST | 2 | 1.79 | 3.58 |
| 4 | 23 | 1689 | BLENDER | 1 | 31.95 | 31.95 |
| 4 | 23 | 1896 | REPAIR PLUG | 5 | .19 | .95 |
| 4 | 23 | 2444 | X10SHIN CORD | 3 | 1.10 | 3.30 |
| 4 | 24 | 2479 | ICE CRUSHER | 1 | 6.75 | 6.75 |
| 4 | 28 | 2799 | RESIN GLUE | 1 | 1.49 | 1.49 |
| 4 | 28 | 3014 | TORCH | 1 | 3.85 | 3.85 |
| 4 | 28 | 3140 | CLOTHES LINE | 2 | 1.16 | 2.32 |
| 4 | 28 | 3273 | MAIL BOX | 1 | 6.50 | 6.50 |
| 4 | 28 | 3278 | NAME PLATE | 1 | 4.35 | 4.35 |
| 4 | 30 | 4963 | CANISTER SET | 1 | 9.50 | 9.50 |

INVOICE AMOUNT

Figure 19c (#1).

# A B C Supply Co.

WHITE PLAINS, N.Y.

INVOICE NO. 12348

SOLD TO

| CUST. NO. |
|---|
| |

| DATE | | |
|---|---|---|
| MO. | DAY | YEAR |
| | | |

| DATE | | ITEM NO. | ITEM DESCRIPTION | QTY ORD | UNIT PRICE | ITEM AMOUNT |
|---|---|---|---|---|---|---|
| 4 | 30 | 5386 | GLASS CUTTER | 1 | 1.15 | 1.15 |
| 4 | 30 | 5493 | GRASS SHEARS | 1 | 4.15 | 4.15 |
| 4 | 30 | 6394 | INSECT SPRAY | 2 | 1.25 | 2.50 |

INVOICE AMOUNT 99.84

Figure 19c (#2).

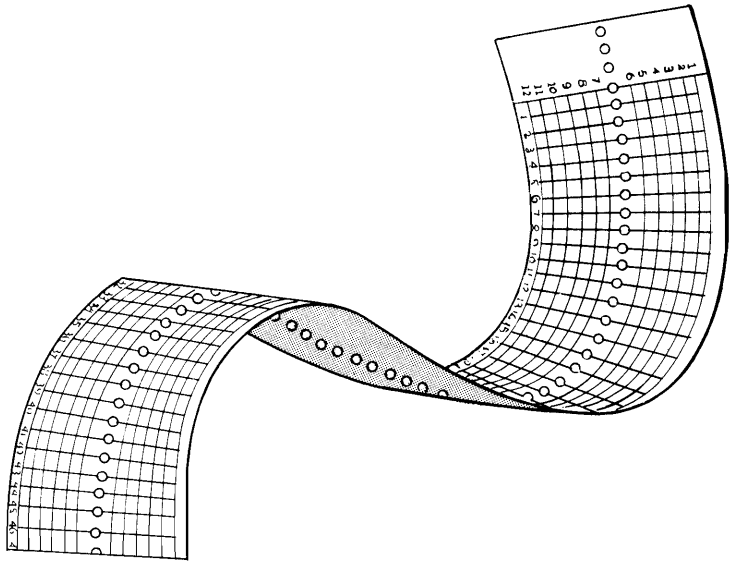


Figure 20. The control tape has 12 columnar positions called channels. The control tape has 132 "line" positions, each of which can correspond to a printing line.

To indicate the relationship between these lines and the accounting machine requires the use of a special strip of paper called a "control" tape (see Figure 20). The control tape should be exactly as long as the form or an exact multiple in length—that is, twice as long, three times as long, etc. Then, certain holes are punched into the control tape to indicate where the significant lines are.

For the invoices in Figure 19, the first printing line is eleven spaces from the top of the form. To indicate this a hole is punched in the 1 channel of the 10th space. *Note:* Channel 1 is always punched for the first printing line of any form.

To indicate the first body line, a hole is punched in the 2 channel of the 19th space. *Note:* Channel 2 is always punched for the first body line of a conventional two-part (head and body) form.

To indicate the overflow line, a hole is punched in the 12 channel of the 30th space. *Note:* Channel 12 is always punched for the overflow line. The only time that the detection of a 12-channel punch is effective is when the corresponding line is being printed from a card at third reading and that card has the same control number (in this case, customer number) as the card at second reading.

To indicate the predetermined total line, a hole is punched in any remaining available channel (for example, channel 4) of the 34th space.

*41. What is the function of a hole in channel 1; channel 2?*
*42. When is the detection of a hole in channel 12 effective?*

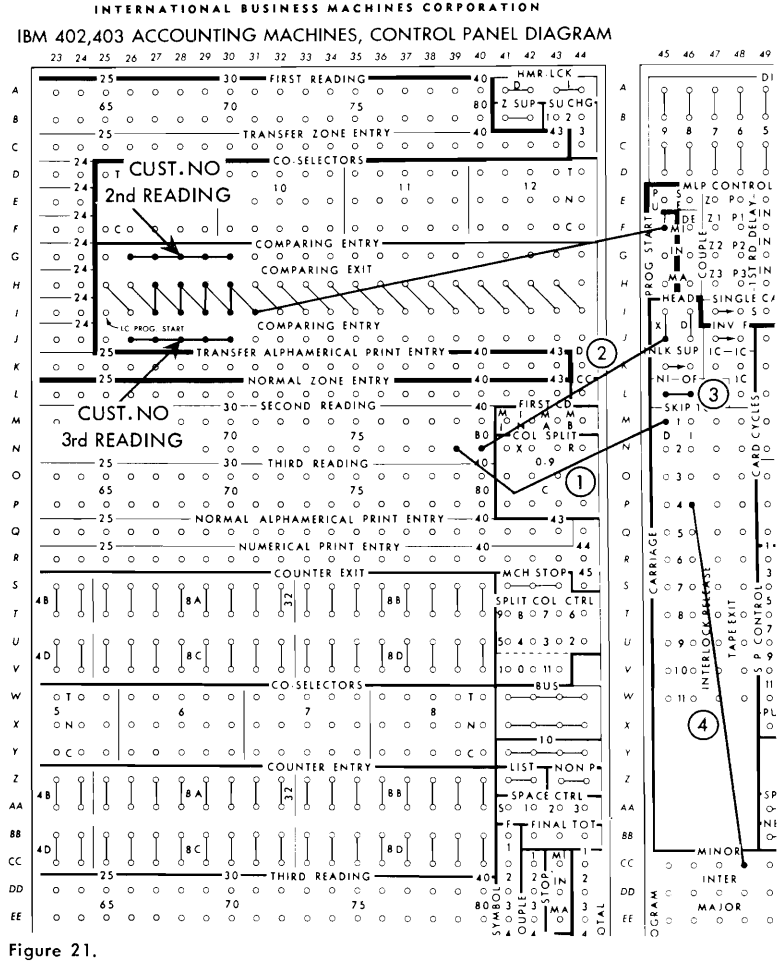



Figure 21.

## Control Panel Wiring for Automatic Carriage

Figure 21 shows that part of the control panel wiring which is necessary for positioning the invoice forms of Figure 19.

Three cards are required to print the head information: a name card, a street card, and a city and state card.

① The card for printing name on the first printing line is punched with an X in column 79. This X is detected at *second reading* 79 and is wired to SKIP TO 1 D (the D signifies delay). Just before the X 79 name card approaches the third reading station, the "delayed impulse" causes the carriage to start skipping the form. The form stops skipping when the hole in the 1 channel is detected.

② The name card, street card and the city and state card are punched with an X in column 80. This X is detected at second reading to identify these cards as head cards. The information from these cards is printed on successive lines.

When a body card is read at second reading, an X is not detected in column 80. This lack of an X is a signal to skip the form. The form skipping is automatically stopped when the hole in the 2 channel is detected.

③ The OF (Overflow) hub emits an impulse when the hole in the 12 channel is effective. When wired to NI (Non-Indicate), the next continuous form is positioned to print at the first body line. When OF is wired to I (Indicate), the next continuous form is positioned at the first printing line to print "indicative" information (such as the customer number which was previously read into the counter).

④ A MINOR PROGRAM STEP impulse is wired to SKIP TO 4 1 (the I signifies immediate). The program hubs emit a two-part impulse (similar to the cycles-type impulses of the IBM 602), only the first part of which is acceptable to the SKIP-TO-1 hubs. When these hubs receive such a timed impulse, the form skips immediately—that is, just before this cycles printing operation.

*43. Why is it necessary to have two X punches in the card which contains the name?*

*44. What is the signal to skip the form from the last head line to the first body line?*

*45. What happens when OF is wired to NI? To I?*

## *Summary Punching*

At the time that the invoices are prepared, an invoice summary card can be automatically punched. The information in the summary cards is used for preparing *accounts receivable* reports. One type of accounts receivable report is a monthly statement sent to the customer. The statement may contain the invoice numbers and amounts of the current billing period, the amount of payment received since the preparation of the previous statement, and amounts due for more than 30 or 60 days.

To perform summary punching requires that a machine such as the IBM 514 be connected to the 402 (see Figure 22). The summary punch machine has a cable which must be connected to the receptacle provided for it on the accounting machine. When the control panels on both machines are properly wired, the *exits of all counters* are available to the summary punch machine via the cable. The amount of time required to punch a summary card is approximately 1.2 seconds. This is a rate of about 50 per minute.

### Summary Punch Switch and Pickup

In order to instruct the accounting machine that it is to work with another machine for summary-punching purposes, the summary punch switch (49-50, AA) must be "wired" on. When this switch is on, it causes both machines to stop if either one runs out of cards.

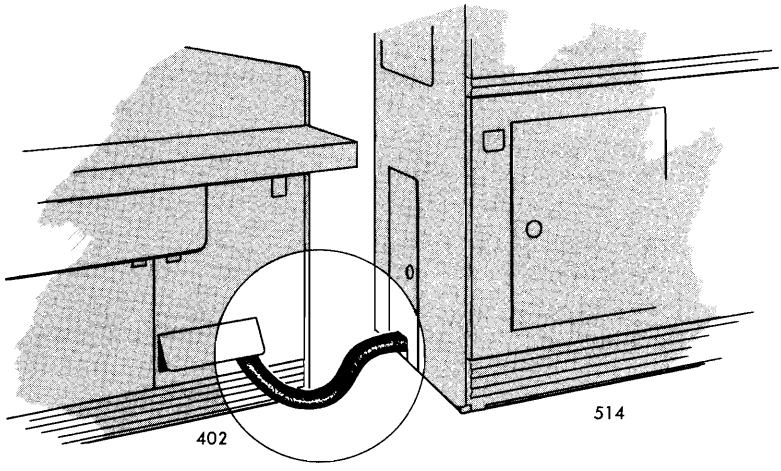



Figure 22.

The SUMMARY PUNCH PICKUP hub (49, X) must be impulsed whenever a card is to be fed in the summary punch machine. In the example of preparing invoices, this would be whenever a minor program step is taken. Thus the SUMMARY PUNCH PICKUP hub is impulsed from a program hub.

The punch magnets of the summary punch machine are actuated by impulses from the COUNTER EXIT TOTAL hubs located at (1-20, AA-AB) and (1-20, AE-AF)—(see Figure 11 of Section 3).

*46. Where in the accounting machine must data be for summary punching?*

*47. What is the function of the summary punch switch? What is the function of the summary punch pickup?*

### *Other Considerations—Selection*

Several examples of selection are shown in the preceding text. These selectors are used whenever there are two or more alternatives for accomplishing an operation—that is, add or subtract, group print or detail print, suppress counter exits or do not suppress counter exits, etc.

Frequently a report has to be prepared from cards of different formats. When this is the case, the accounting machine must decide which card columns are to provide data, or which typebars are to receive the data. To accomplish the task of selection, a 402 can have up to twelve 5-position coselectors and up to sixteen 2-position pilot selectors.

### Space Control

All printing is normally single-spaced, six lines to the inch. In detail printing, two spaces are taken before the first card of a group is printed. In group printing, the minor total prints on the same line as the data from the first card of the group and the intermediate and major totals each take a single space. One space is taken before the first card of a minor group and two spaces before the first card of an intermediate or major group. Variations from this spacing are obtained by the use of the SPACE CONTROL hubs (41-44, AA).

Spacing is normally automatic. Automatic spacing, however, is superseded when space control hubs receive acceptable impulses. For example, if all printing is to be double- or triple-spaced, an ALL CYCLES impulse is wired to SPACE CONTROL 2 or 3.

If no space is to be taken, the S (suppress) hub is impulsed.

### Crossfooting

The ability to add together several fields of the same card is an important feature of the standard 402, enabling it to handle many crossfooting jobs which would otherwise require a calculator. Figure 23 schematically illustrates how net pay can be "calculated" from information already available.

48. *What is normal spacing for detail printing? For group printing?*
49. *How many fields can be crossfooted with a standard 402?*

## The IBM 403 Alphabetical Accounting Machine

The 403 performs all the operations possible with the 402 and in addition can print up to three lines of alphameric information from an MLP (multiple line print) card. The most important aspect of this feature is that an entire mailing address can be punched in a single card (such as the one you prepared in Section 1, Figure 18). To accomplish the printing of up to three lines from a single card, the 403 is equipped with an extra set of reading brushes and a special MLP selector. Figure 10 shows the card path in a 402. In a 403 the second and third reading brushes are positioned farther away from the feed hopper to provide room for the first reading brushes. The special MLP selector differs from the usual type of selector in that it has 24 positions, has no "normal" points and has three levels of transferred points.

To indicate to the 403 that an MLP card is about to be processed, the MLP CONTROL PICKUP hub (45, E) is notified with a *9 and an 8 punch* in the MLP card. The MLP card should also contain a 1, 2 or 3 punch

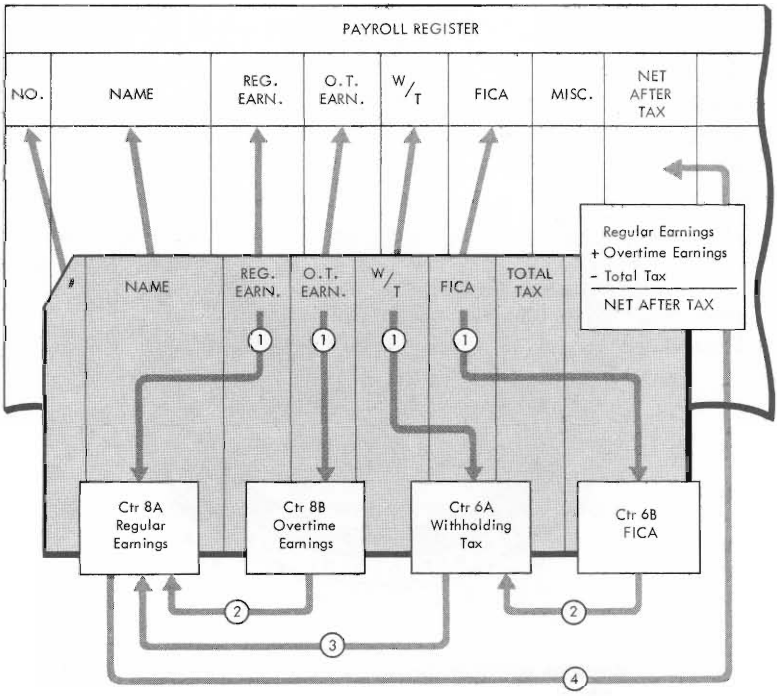



Figure 23.

As soon as each payroll card is read, the 402 takes three consecutive program steps. This is accomplished by impulsing PROGRAM START MAJOR with a CARD COUNT impulse.

1. As the card is read, these factors are entered into the counters as indicated.
2. During the minor program the contents of 8B are added to the contents of 8A and the contents of 6B are added to the contents of 6A.
3. During the intermediate program the contents of 6A are subtracted from the contents of 8A, which now contains the "net after tax."
4. During the major program the contents of 8A are made available to the typebars for printing.

to indicate to the MLP CONTROL PICKUP hub the number of lines to be printed from the card.

To set up a 403 control panel for printing three alphameric lines requires the following:

1. A 9, 8 and 3 punch to the MLP CONTROL PU.

2. From first reading (1-40, A-B) to FIRST LINE ZONE ENTRY (1-24, E), to condition the typebars with zones for printing the first line.

3. From second reading to FIRST LINE PRINT ENTRY (1-24, F), to position the typebars with the digit (1-9) impulses for printing. From second reading to SECOND LINE ZONE ENTRY (1-24, H), to condition the typebars with zones for printing the second line.

4. From third reading to SECOND LINE PRINT ENTRY (1-24, H), to position the typebars with the digit (1-9) impulses for printing. From

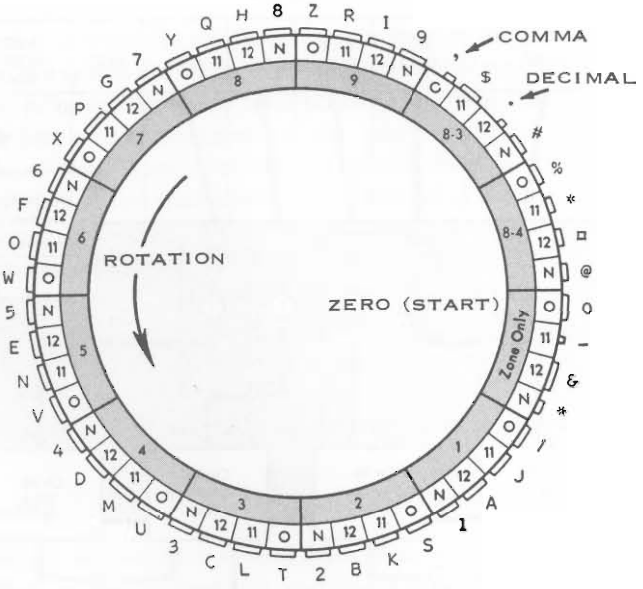



Figure 24. This shows the printwheel divided into twelve parts (shaded area). Each part corresponds to digit-row punch or punches and shows what prints when that digit punch is combined with other punches. For example, look at the 7 part. When combined with an X (11) zone punch, a P can print; when combined with no (N) zone punch, a 7 can print.

Likewise if an 8 and a 3 punch is combined with a X zone punch, a $ can print; when combined with no zone punch, a # can print.

third reading to THIRD LINE ZONE & PRINT ENTRY (1-24, I). The zones condition the typebars with the 0, 11 and 12 punches while the digits (1-9) are automatically entered into counters 2A, 2B, 6A, 6B, 4A and 4B, for a total of 24 positions. Then, when the card is one station beyond the third reading brushes, the counters automatically read out and reset to provide the typebars with the digit (1-9) impulses.

5. From ZONE SELECTION EXIT (1-24, D) to the chosen typebars via TRANSFER ZONE ENTRY (1-43, C) and from PRINT SELECTION EXIT (1-24, J) to the chosen typebars via TRANSFER ALPHAMERIC PRINT ENTRY (1-43, K).

*50. What is the most important aspect of the MLP feature?*

*51. How many sets of reading brushes are on an* IBM *403?*

*52. What holes must be punched in an MLP card to indicate that two lines are to be printed?*

*53. What counters are unavailable for accumulation during the printing of information from an MLP card?*

*54. Where in the feed unit is an MLP 3 card when the third line is being printed?*

## The IBM 407 Accounting Machine

The 407 printing mechanism consists of 120 typewheels (commonly referred to as printwheels), each of which prints the 26 alphabetic characters, the ten numerical characters and eleven different special characters (see Figure 24). For the actual printing operation, the printwheels are moved against the platen. The 120 printwheels are arranged in one continuous group which prints within a width of 12 inches.

55. *How many printwheels are in an* IBM *407? How many different characters are embossed on each printwheel?*
56. *What can print if a printwheel is impulsed with*
    a. *0 zone and 5*
    b. *No zone and 9*
    c. *X zone only*
    d. *0 zone and 8-3*
    e. *No zone and 8-4*
    f. *0 zone and 1*
57. *How many characters print in a width of one inch?*

### *Controlling the Printing of Zeros and Certain Special Characters*

It is often desirable to eliminate the printing of nonsignificant zeros by the IBM 407 for the same reasons as the IBM 402. In addition, it may be desirable, under certain conditions, to eliminate the printing of certain special characters. For example, printwheels 11-19 may be wired to print punctuated amounts from

$9,999.99 to (zero amount)

If it were *not* possible to control the printing of the dollar sign, comma and period, the 407 would print: $ , . for zero amounts—which would not be very attractive. The printwheels are designed to print *normally* only when they receive significant digit impulses 1 to 9 (as a number, part of an alphabetic character or part of a special character). It is quite obvious that 8-3 punching and 8-4 punching produce significant digit impulses. Thus, the ability to control the printing of the $ , and . requires a *non* 1 to 9 impulse for setting up the printwheel. Obtain a 407 control panel diagram from the supplies packet—and locate (41-50, AC); this is known as the special comma, decimal and $ emitter. When the desired hub is wired to a printwheel, either a , . or $ can print. There is not, however, an 8-3 impulse. The impulse that is emitted comes *before* 9 time (equivalent to two rows before) but has the same effect as an 8 and 3 impulse. Therefore, printwheels do not print normally when receiving impulses from these hubs.

58. *Do the printwheels* print normally *when impulsed from 8-3 punching from a card?*
59. *What is the timing of the "simulated 8-3 punching" from the special comma, decimal and $ emitter?*

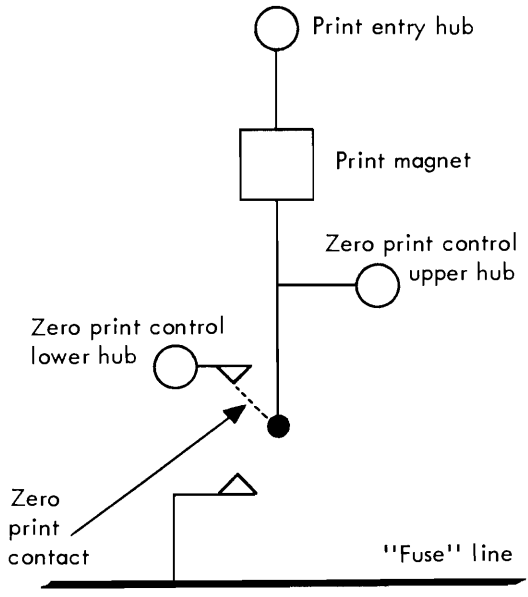


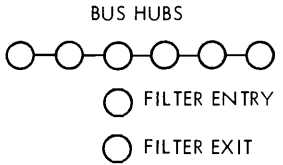

Figure 25. In order to energize the print magnet, the zero print contact must transfer. The transfer of the contact closes a circuit between the print entry hub and the "fuse" line. The transfer takes place for the rest of the cycle only if the print entry hub receives a 9 to 1 digit impulse.

Each of the 120 printwheel hubs has a corresponding set of zero print control hubs. Figure 25 schematically illustrates the relationship between several of the components required for zero print control.

By properly wiring the ZERO PRINT CONTROL hubs (41-80, BG-BL), the printing of zeros and certain special characters is made possible. Figure 26 illustrates the status of the zero print contacts for four different money amounts.

Notice that the zero print contacts for the entry hubs receiving the 0 impulses and the $ , and . impulses (from the special emitter) do not transfer and thus prevent the print magnets from becoming energized. The following illustrates (A) what prints without zero print control wiring and (B) what prints with properly set up zero print control wiring.

| | A | B |
|---|---|---|
| a. | 9 999 99 | $9,999.99 |
| b. | 1 3 | $ 10.03 |
| c. | 2 | $ .02 |
| d. | | |



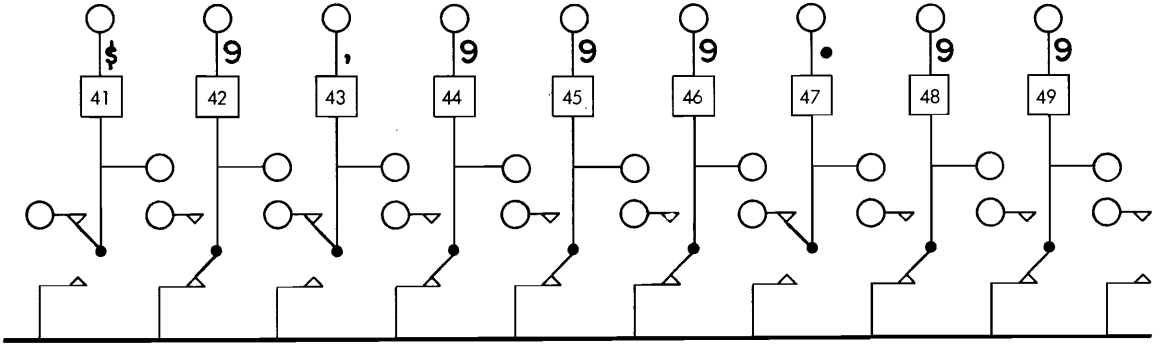
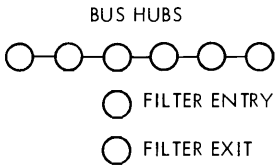




Figure 26a.





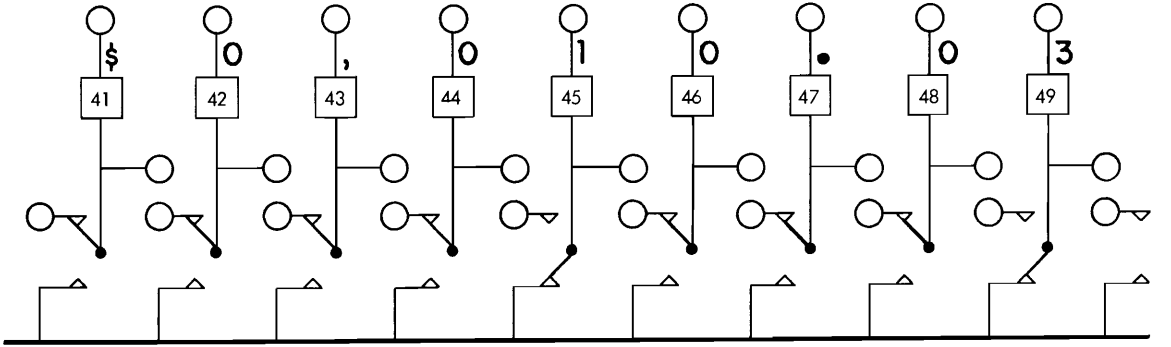




Figure 26b.

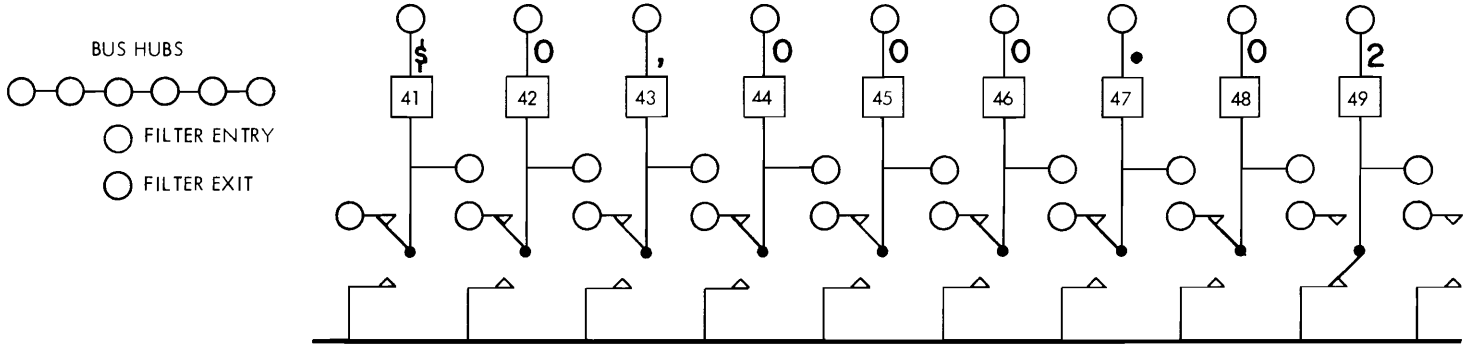



Figure 26c.

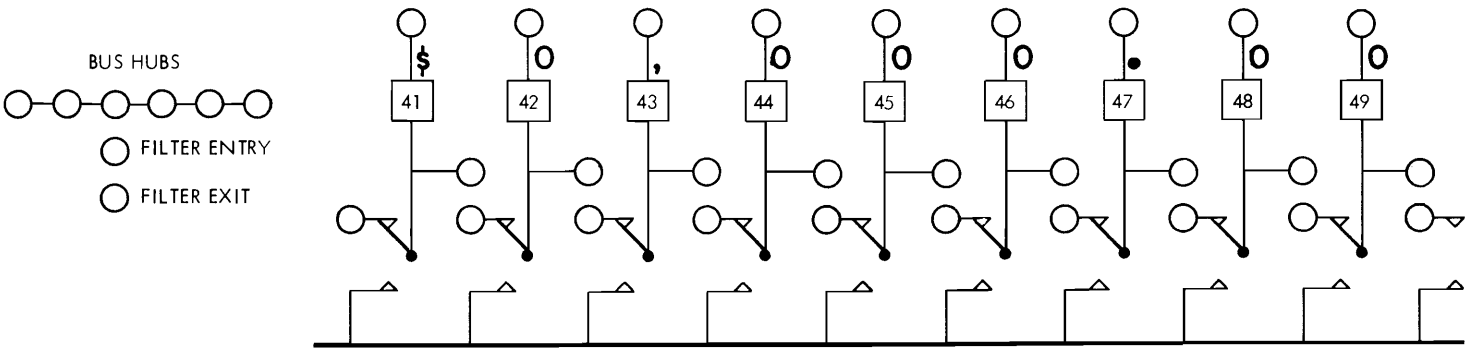



Figure 26d.

Figure 28a.

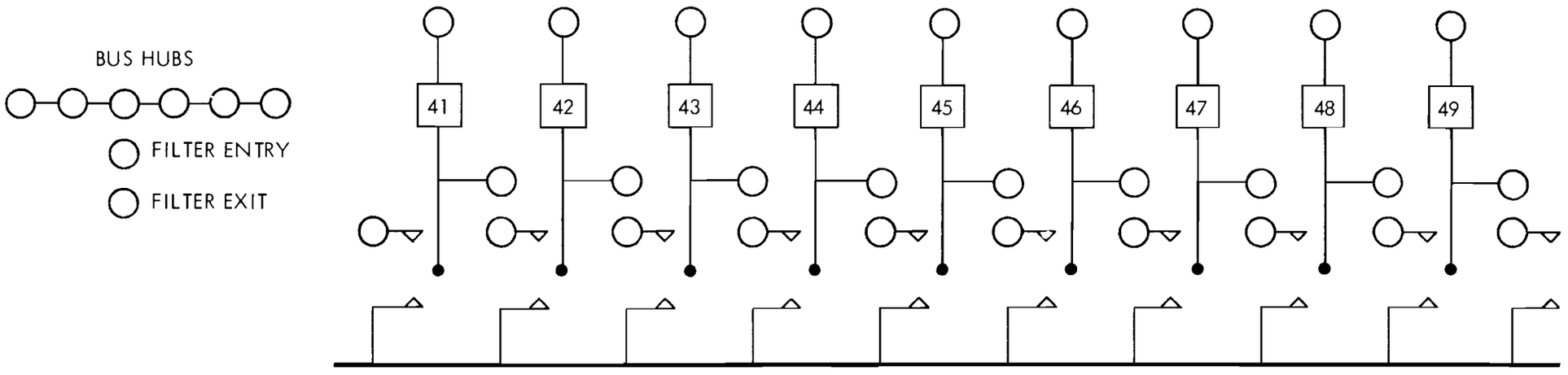



Figure 27.



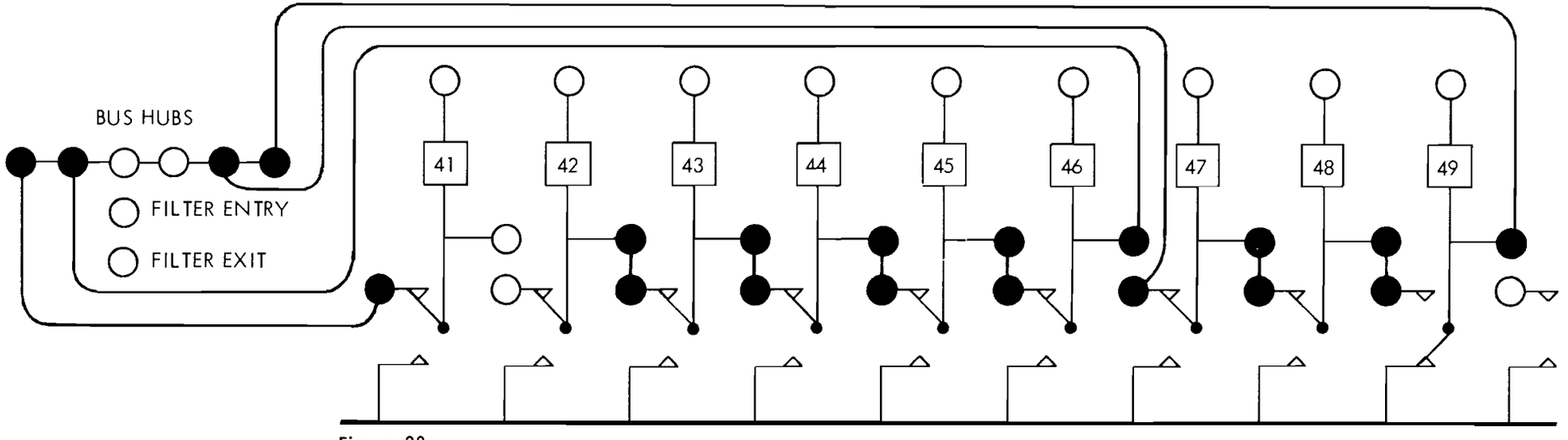



Figure 28.

Since the printwheels may be required to print any value containing all nines to nothing, the ZERO PRINT CONTROL hubs must be wired to accommodate all conditions. In any case, the print magnets controlling the $ , and . impulses can only be energized indirectly (that is, as a result of 1-9 digit impulses to some other print magnet). For example, in Figure 26C, the $ and the . print as a result of the 2.

To set up the zero print control for the previous values, "wire" Figure 27 as follows:

1. From the lower hub of 41 ZERO PRINT CONTROL (ZPC) ($) to one of the "bus" hubs and then from another bus hub to the upper hub of 49 ZPC. Note how this wiring causes the $ to print as a result of the 2 in Figure 26c.

2. From the upper hub of ZPC 48 to the lower of ZPC 49; from the upper hub of ZPC 47 to the lower hub of ZPC 48; from the upper ZPC hubs 42, 43, 44 and 45 to the lower ZPC hubs 43, 44, 45 and 46 respectively.

3. From the lower ZPC hub 47 to a bus hub—from another bus hub to the entry of a filter (a filter provides a one-way path for electricity) —then from the exit of the filter to the upper ZPC hub 46.

60. *Trace through the zero print control wiring for each of the four previously mentioned cases, and locate the path to the fuse for printing the required characters.*
61. *Figure 28 shows the same zero print control wiring* except *that a filter is not used. What will print in each of the four cases as a result of this wiring?**

## *Card Path*

Figure 29 shows the path cards take in passing through the IBM 407 Accounting Machine. After a card enters a reading station it *stops.* It remains in a motionless position until it is read by the 80 brushes. The reading technique is accomplished by a "sweeping" motion from the 9 edge of the card to the 12 edge of the card. After a card is read it is moved along or it is read again. (A card may be read at a station as often as desired by properly setting up the control panel.)

The first reading station is used primarily to identify certain characteristics of a card for controlling the skipping of forms, the addition or subtraction of amounts, etc., and for comparing values with cards at second reading. Zones for alphabetic character printing are not wired from first reading. Printing of all characters is normally accomplished from second reading only.

62. *What technique is employed in the reading of cards by the* IBM *407?*
63. *How often may a card be read?*

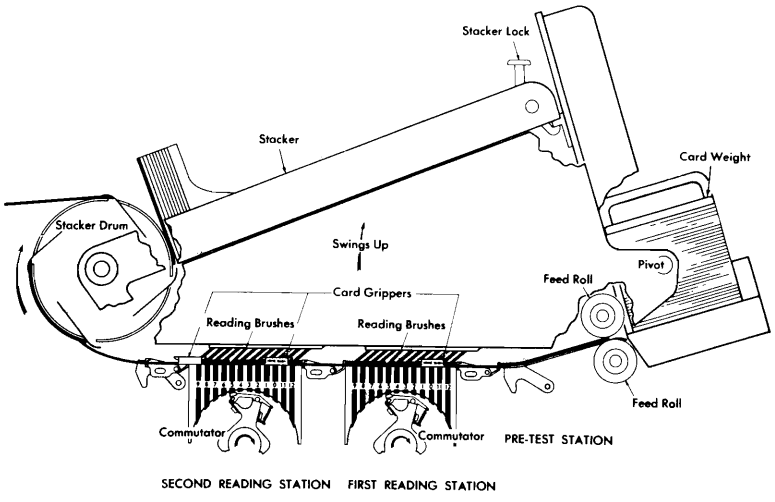



Figure 29.

64. *From what reading station are zones recognized for setting up the printwheels to print alphabetic characters?*

## *The Operating Speed of the 407*

Each minute the 407 takes 150 machine cycles. One machine cycle is required for such operations as reading a card, printing a line, adding or subtracting an amount in a counter and reading out the contents and/or resetting a counter. Each of these machine cycles is made up of three parts (see Figure 30).

65. *What card row is being read at the time our "echo 8" impulse occurs?*

## *IBM 407 Counters*

In a 407 the maximum number of accumulating positions is 168. These 168 positions comprise counters which vary in size from three to eight positions. The counters can be coupled in any desired arrangement by control panel wiring similar to that required for coupling 402 counters.

### Counter Operations

A positive amount (but not zero) always appears in uncomplemented form in 407 counters. When a counter is instructed to read in plus (53-80, S-T), the counter wheels start moving according to the timing of the digit impulses.

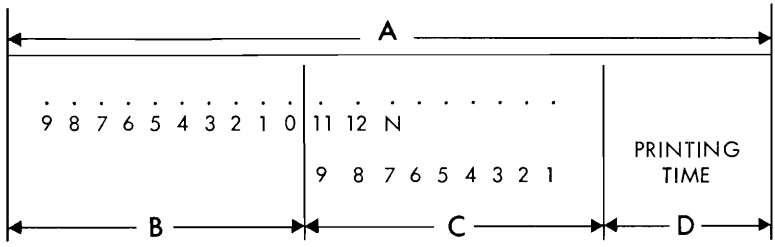



Figure 30.

A—represents the time required for one complete machine cycle.

B—represents the "first half" of a machine cycle.
During this time "first half" 9-0 impulses are available. These originate from a card being read, from an emitter, or from a counter that is being read out. These impulses are used for setting up a printwheel or for *directly* entering a counter.

C—represents the "second half" of a machine cycle.
During this time "second half" 9-0 impulses are available. These "echo impulses" originate from the printwheels which are set up from corresponding "first half" impulses. These impulses are used for *indirectly* entering a counter. Notice that an "echo 9" occurs at the same time that the 11 row of a card is read. The N which occurs at the same time as an "echo 7" is an impulse that the 407 generates when no zone punches are present.

D—represents the time that the set-up printwheels are moved against the platen for printing.

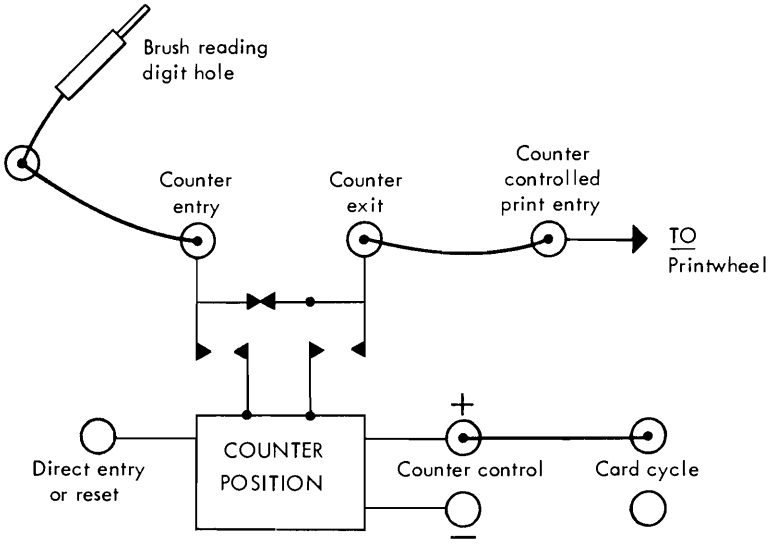
A negative amount and zero appear in the nines complement form in 407 counters. When a counter is instructed to read in minus (53-80, U-V), the counter wheels start moving at 9 time and stop according to the timing of the digit impulse. *Note:* Because a zero amount is represented by nines, it is necessary to connect the CI and C hubs of the counter when adding.

> *66. Prepare a four-position counter schematic (similar to the one used in Figure 12) with the counter standing initially at 9999 (a zero amount), and add 72. Note the "shortage" if the CI and C hubs are not connected.*

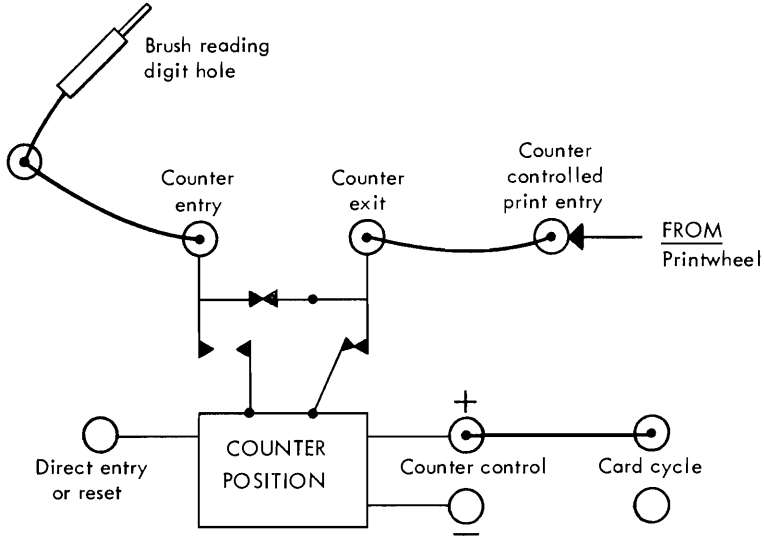
Each counter can be read out and reset (53-80, AL-AO) at any time that it is not impulsed to add or subtract. Usually, a counter is read out and reset on a program step. Program steps on a 407 are similar to the program steps of a 402. A 407 can take up to three normal program steps. It is also possible for a 407 to take any number of program steps when the control panel is set up for special programming.

### Control Panel Setup for Using Counters

Data can enter the 407 counters either during the first half of a machine cycle or the second half. If the data is to print, it enters during the second half as a result of the previously mentioned echo impulses. If the data is not to print, it must enter during the first half.




A—FIRST HALF OF CYCLE shows that the digit impulse from the reading brush gets only to the printwheel. None of the contacts to the counter are closed.




B—SECOND HALF OF CYCLE shows that the echo digit impulse from the printwheel gets to the counter via the counter exit.

Figure 31. Entering data into a counter (showing one position) indirectly from a card (that is, from the echo impulses of the printwheel).

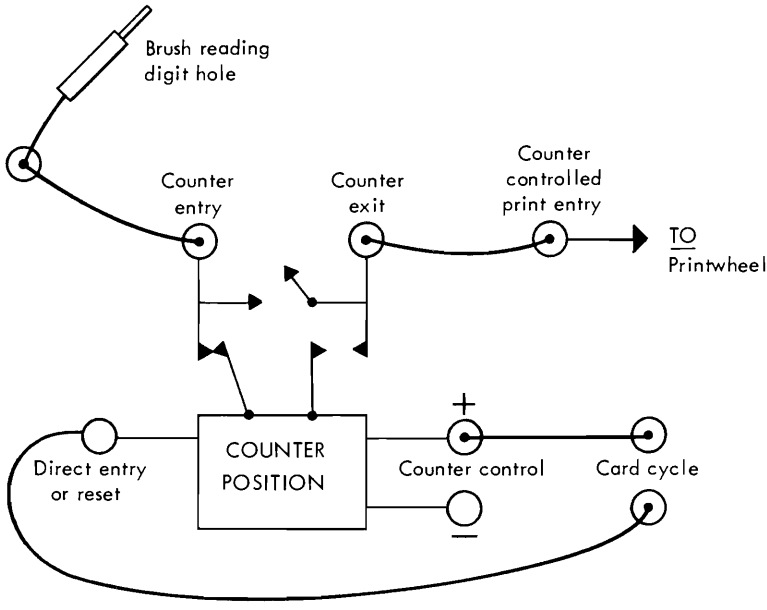



Figure 32.

FIRST HALF OF CYCLE shows that the digit impulse does *not* get to the printwheel. It does enter the counter directly because Direct Entry OR Direct Reset (53-80, W-X) is impulsed.

On the SECOND HALF of the cycle, the contacts remain "open" and therefore the counter contents are not affected.

*67. During what half of a machine cycle does data enter a counter if the data is to print also? What half if it is not to print?*

Whenever data is to be printed and also entered into a counter, or when the data to be printed comes from a counter, the COUNTER CONTROLLED PRINT ENTRY hubs must be used (1-40, AZ-BB) in conjunction with the COUNTER EXIT hubs (1-42, AR-AY). Figure 31 shows the relationship of various hubs used for printing and accumulating. Figure 32 shows the relationship of the various control panel hubs used for accumulating *without* printing.

When accumulated data in the counter is read out and reset for printing, the digit impulses set up the printwheels (via the counter controlled printing hubs) on the first half of the machine cycle. During the second half, the nines complements of the echo impulses from the printwheels enter the counter via the counter exits. This causes the counter to reset to zero (all nines). *Note:* Counter controlled print entry recognizes digit impulses 9-0 only.

When a counter is to be reset but the contents are not to print, the counters DIRECT ENTRY OR DIRECT RESET hub must be impulsed in addition to the readout and reset hub. Impulsing DIRECT ENTRY OR DIRECT RESET at the same time that the counter is impulsed to read out and reset disconnects the counter exits and thus prevents the contents of the counter from going anywhere.

68. *To what print entry hubs must data be wired if it is to accumulate in the counters?*
69. *What technique does the 407 use for resetting a counter to zero?*
70. *What hub, in addition to* COUNTER CONTROL PLUS *or* COUNTER CONTROL MINUS, *must be simultaneously impulsed if the information to the counter is not to print? What hub, in addition to the counter's* READ OUT AND RESET *hub, must be simultaneously impulsed if the counter is to be reset without its contents being printed?*
71. *Suppose that the code for the letter H were punched in a card and that second reading were wired directly to counter-controlled print. What character would print?**

### Other 407 Counter Considerations

In addition to receiving the data impulses, a counter requires a control impulse to put it in motion. When a counter is to accumulate during the reading of a card, the counter is usually put in motion with a CARD CYCLES impulse (53-72, O) and (37-40, Q). When a counter receives information from another counter, the receiving counter is usually put in motion with a TRANSFER PLUS or TRANSFER MINUS impulse (53-80, Y-Z) of the counter supplying the information. When a counter is to read out and reset, it is usually put in motion with a PROGRAM EXIT impulse (53-66, AP-AT).

Zero amounts and negative balances are indicated by nines complements in 407 counters. Thus, these values must be converted to true figures before being printed. Conversion takes place when the NEGATIVE BALANCE CONTROL hubs (53-80, AD-AE) are impulsed.

Each counter has a NEGATIVE BALANCE OFF hub (53-80, AF) which emits an impulse when the counter contains a zero balance. NEGATIVE BALANCE CONTROL should therefore be wired from NEGATIVE BALANCE OFF whenever only positive totals are accumulated, so that the all-nines will be converted to zero impulses before printing.

Each counter has a NEGATIVE BALANCE ON hub (53-80, AC) which emits an impulse when the counter contains a negative balance (indicated by a 9 in the high-order position of the counter). NEGATIVE BALANCE CONTROL should therefore be wired from NEGATIVE BALANCE ON whenever negative totals are possible, so that the complement totals will be converted to true figures before printing.

SINGLE SPACING

| DETAIL PRINTING | GROUP PRINTING |
|---|---|
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ----MINOR TOTAL* | ---- INTERMEDIATE TOTAL** |
| ---- | ---- |
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ----MINOR TOTAL* | ---- INTERMEDIATE TOTAL** |
| ---- | ---- MAJOR TOTAL*** |
| ----INTERMEDIATE TOTAL** | ---- |
| ---- | ----INDICATE MINOR TOTAL* |
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ----MINOR TOTAL* | ----INDICATE MINOR TOTAL* |
| ---- | ETC. |
| ----INTERMEDIATE TOTAL** | |
| ---- | |
| ----MAJOR TOTAL*** | |
| ---- | |
| ----DETAIL PRINT | |

DOUBLE SPACING

| DETAIL PRINTING | GROUP PRINTING |
|---|---|
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ---- | ---- |
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ---- | ---- |
| ----MINOR TOTAL* | ---- INTERMEDIATE TOTAL** |
| ---- | ---- |
| ---- | ---- |
| ---- | ---- |
| ----DETAIL PRINT | ----INDICATE MINOR TOTAL* |
| ---- | ---- |
| ----MINOR TOTAL* | ---- INTERMEDIATE TOTAL** |
| ---- | ---- |
| ---- | ---- MAJOR TOTAL*** |
| ---- | ---- |
| ----INTERMEDIATE TOTAL** | ---- |
| ---- | ---- |
| ---- | ----INDICATE MINOR TOTAL* |
| ---- | ---- |
| ----MAJOR TOTAL*** | ----INDICATE MINOR TOTAL* |
| ---- | |
| ---- | |
| ---- | |
| ----DETAIL PRINT | |

**Figure 33.**

NEGATIVE BALANCE ON, when wired to NEGATIVE BALANCE CONTROL, also causes an impulse to be emitted from the SYMBOL C and R or — hub (53-80, AH-AI) when a negative balance is being read out. (The SYMBOL C and R or — hub also emits when the counter is impulsed to subtract.)

72. *When do the* NEGATIVE BALANCE OFF *hubs emit? When do the* NEGATIVE BALANCE ON *hubs emit?*
73. *Under what conditions do the* SYMBOL *C and R or — hub emit?*
74. *How is it determined whether the* SYMBOL *C and R or — is to print?**

## *"Programming" the IBM 407*

Starting a minor, intermediate or major program on the 407 requires the same kind of control panel wiring as for the 402. The program start hubs are located at (31-34, C-E). Programs are generally started when a difference between cards at first and second reading is detected by using the comparing entry and comparing exit hubs located at (1-30, C-F).

## *Detail Printing and Group Printing*

In order to prepare a group-printed report, the IBM 407 must be instructed *not* to list. This can be accomplished by connecting the LIST OFF hubs (80, E-F) to each other.

If single spacing is desired, the SPACE 1 hubs must be connected; if double spacing is desired, the SPACE 2 hubs must be connected (74-75, K-L). *Note:* If neither of these hubs is connected, the platen will not stop revolving until either the 407 is turned off or the space hubs are wired. Figure 33 indicates single and double spacing for detail- and group-printed reports.

75. *What action takes place if neither space hub 1 nor 2 is wired?*

### One Control Panel for Either Detail- or Group-Printed Report

The setup change switches—called alteration switches on the 407—are located at the right side of the accounting machine. When an alteration switch is turned on, a corresponding alteration switch selector on the control panel is transferred (73-76, E-H). If one alteration switch is to control more than one function, it is possible to wire an alteration switch exit through COMMON-TRANSFER to the pickup of a coselector. The coselector, then, will be under direct control of the alteration switch and can be used as an extension of it.

Obtain a 407 diagram from the supplies packet and "wire" it to prepare the 407 version of both the detail- and group-printed reports of Figures 1d and 1e (from cards shown in Figure 18) according to the following instructions:

1. From SECOND READING (1-40, AC-AF) hubs 36-38 (Department

Charged) to NORMAL PRINT ENTRY (1-40, V-X) hubs 21-23 and to the TRANSFER PRINT ENTRY (1-40, S-U) hubs 21-23.

2. From SECOND READING hubs 30-32 (General Ledger Account Number) to NORMAL and TRANSFER PRINT ENTRY 25-27.

3. From SECOND READING hubs 33-35 (Subsidiary Ledger Account Number) to NORMAL and TRANSFER PRINT ENTRY 29-31.

4. From SECOND READING hubs 23-27 (Our Invoice Number) to NORMAL PRINT ENTRY 33-37.

The printing of the numerical code of 1 for the tenth, eleventh and twelfth month on the 402 was done by using the card count hub which emitted a 1-timed impulse on every *card* cycle, in conjunction with the X punch in column 1 recognized at the station preceding third reading.

On the 407, a 1-timed impulse is available from the CYCLE COUNT (41-42, AO) hubs on every machine cycle—this includes card cycles and program cycles. Therefore, to prevent a 1 from printing during a program cycle, the impulse from the cycle count hub must be selected to print only on a card cycle.

5. a. From FIRST READING (1-40, A-B) hub 1 to the X PU (53-72, D-G) of pilot selector 1 (PS 1).
   b. From a CARD CYCLES hub to the I PU of PS 2.
   c. From a CYCLE COUNT hub to the COMMON of PS 1.
   d. From the TRANSFER of PS 1 to the COMMON of PS 2.
   e. From the TRANSFER of PS 2 to NORMAL PRINT ENTRY 39.
   f. From SECOND READING hub 1 to the COMMON of a COLUMN SPLIT (41-52, AD-AF).
   g. From the 0-9 hub of the same column split to NORMAL PRINT ENTRY 40.

*76. Why is it necessary to column-split the impulse from column 1 on the 407 whereas it was not column-split on the 402?**

6. From SECOND READING hubs 2-3 to NORMAL PRINT ENTRY 42-43.

7. From SECOND READING hubs 63-69 to COUNTER ENTRY (1-40, AG-AN) of counter 8A and from the COUNTER EXIT of 8A (1-40, AR-AY) to COUNTER CONTROLLED PRINT ENTRY 45-51.

An X punched in column 69 indicates that an item amount is to be subtracted. Such a provision is necessary because of a previous erroneous distribution.

8. From FIRST READING 69 to the X PU of PS 3.

9. a. From a CARD CYCLES hub to the COMMON of PS 3.
   b. From the TRANSFER of PS 3 to COUNTER CONTROL MINUS of 8A.
   c. From the NORMAL of PS 3 to COUNTER CONTROL PLUS of 8A.
   d. From the SYMBOL — exit of 8A to NORMAL PRINT ENTRY 52 and to the TRANSFER PRINT ENTRY of 52.

10. Add the comparing and program start wiring. This is similar to the wiring shown in Figure 15 (for the 402).

11. a. From the other COUNTER EXIT hubs of 8A to the counter entry of 8B.
    b. From the TRANSFER EXIT PLUS hub of 8A to the COUNTER CONTROL PLUS of 8B and from the TRANSFER EXIT MINUS of 8A to the COUNTER CONTROL PLUS of 8B.
    c. From a MINOR PROGRAM hub to the READ OUT AND RESET hub of 8A.
    d. From the SYMBOL * exit (53-80, AG) of 8A to NORMAL and TRANSFER PRINT ENTRY 53.

12. a. From the counter exits of 8B to COUNTER CONTROLLED PRINT ENTRY 55-61.
    b. From an INTERMEDIATE PROGRAM hub to the READ OUT AND RESET hub of 8B.
    c. From the SYMBOL — exit of 8B to NORMAL and TRANSFER PRINT ENTRY 62.

13. a. From the other COUNTER EXIT hubs of 8B to the counter entries of 8C.
    b. From the TRANSFER EXIT PLUS hub of 8B to COUNTER CONTROL PLUS of 8C and from TRANSFER EXIT MINUS hub of 8A to COUNTER CONTROL MINUS of 8C.

14. a. From the counter exits of 8C to COUNTER CONTROLLED PRINT ENTRY 65-71.
    b. From a MAJOR PROGRAM hub to the READ OUT AND RESET hub of 8C.
    c. From the SYMBOL — exit of 8C to NORMAL and TRANSFER PRINT ENTRY 72.

15. a. From the lower LIST-OFF hub (80, E-F) to the COMMON of alteration switch selector number 1.
    b. From the TRANSFER of this selector to the upper hub of LIST-OFF.
    c. From a CARD CYCLES hub to the COMMON of alteration switch selector number 2.
    d. From the TRANSFER of this selector to a DIRECT ENTRY hub of counter 8A.
    e. From the other DIRECT ENTRY hub of 8A (the extension of the CARD CYCLES impulse) to TR PR (TRANSFER PRINT PICK-UP) located at (39-40, R).

16. Provide the necessary diagramming for NEGATIVE BALANCE ON and CONTROL, and for CI and C.

77. *According to the wiring diagram so far, what happens to* COUNTER CONTROLLED PRINT ENTRY *55-61 when the contents of 8A are transferred to 8B?**

To prevent printwheels 55-61 from printing except during an intermediate program step requires that the exits of 8B be cut off during a minor program step. Likewise, to prevent printwheels 65-71 from printing except during a major program step requires that the exits of 8C be cut off during an intermediate program step.

17. From a MINOR PROGRAM hub to the DIRECT ENTRY of 8B and from an INTERMEDIATE PROGRAM hub to the DIRECT ENTRY of 8C.

18. Wire SPACE 1 and the SYMBOL — hubs.

The printing of "Our Invoice Number," "Month" and "Day" are of no value in a group-printed report. To eliminate the printing under these headings during group printing, the TRANSFER PRINT ENTRY hubs are made active. (When TRANSFER PRINT ENTRY is active, NORMAL PRINT ENTRY is inactive, and vice versa.)

19. For zero print control, connect the following ZERO PRINT CONTROL hubs: 22, 23, 26, 27, 30, 31, 34-37, 40, 43, 46-52, 56-62 and 66-72. (The wiring of ZERO PRINT CONTROL hubs 52, 62 and 72 is required for printing the — symbol.)

### *Storage of Alphabetic Data*

One of the special attributes of the 407 is the ability to store alphameric information. This ability is especially useful for such things as printing the customer's name (and address, if necessary) on the overflow pages of an invoice and printing identification words as the result of a code punched in a card.

The 407 provides four 16-position storage units, capable of storing up to 64 numerical characters or up to 32 alphabetic characters. The data available to the STORAGE ENTRY hubs (1-32, O-R) is controlled to enter by impulsing the appropriate STORAGE IN hub (43-46, AG-AN). When the STORAGE IN, X or D (digit) hubs are impulsed, the corresponding storage unit is receptive to data on the next *card* cycle. That is, if the X or D is wired from a card at first reading, information is accepted by the storage unit when that card is read at second reading. When the STORAGE IN, NEXT CYCLE hubs are impulsed, the storage unit is receptive to data on the next *machine* cycle (that is, it may be a program cycle, overflow cycle or card cycle). Notice that reading into a storage unit can be affected only for some kind of *next cycle*, never on the same cycle. This is because time must be allotted for the storage unit to clear or reset.

78. *How many numerical characters can be stored in the storage units of the 407? How many alphabetic characters?*
79. *On what kind of cycle is the storage unit receptive to data when its* STORAGE IN *X or D hub is appropriately impulsed? Its* STORAGE IN, NEXT CYCLE*?*

The data in a storage unit is made available by impulsing the appropriate STORAGE OUT hub (47-50, AG-AL). When the STORAGE OUT X or D hubs are impulsed, the storage unit makes its contents available on the next *card* cycle. When the STORAGE OUT IMMEDIATE hubs are impulsed, the storage unit makes its contents available immediately.

80. *On what cycle does a storage unit read out when its corresponding* STORAGE OUT, *X or D is impulsed?*
81. *When does a storage unit clear or reset?*
82. *The sequence of the digit impulses on the 407 is 9-time, 8-time, 7-time, etc. If the contents of the storage unit are to be available in time, what must be the timing of the impulse to the* STORAGE OUT IMMEDIATE *hub?**

### *The 407 Tape-Controlled Carriage*

The 407 tape-controlled carriage is capable of performing the same functions as the 402 tape-controlled carriage. In addition, the 407 carriage controls have been designed with several extra features which increase its flexibility. For example, it is possible for the 407 to take several program steps as the result of an overflow (that is, detecting the hole in the 12 channel of the control tape). The significance of this capability is that on an overflow, it may be required to print two or three lines of indication (from the storage units or counters) in the heading of an invoice.

### *Summary Punching*

Summary punching with the 407 is done in conjunction with either an IBM 514, 519, 523 or 528. The information in the 407 counters or storage units travels over a cable to the summary punch machine. The primary difference between the summary punching capabilities of the 402 and those of the 407 is that the 407 can provide the summary punch with alphabetic data.

### *Multiple-Line Reading (MLR)*

A card can be read more than once in the 407. This operation is referred to as *multiple-line reading*. Each time the card is read, a line can be printed and factors can be read into the counters or storage units. There is no limitation to the number of times that a card can be read. The primary advantage of this ability is that any address (of 79 characters or less) can be punched into one card regardless of the number of lines required to print it. (The reason that the number of characters is not 80 is that one card column must be set aside to indicate that it is an MLR card.)

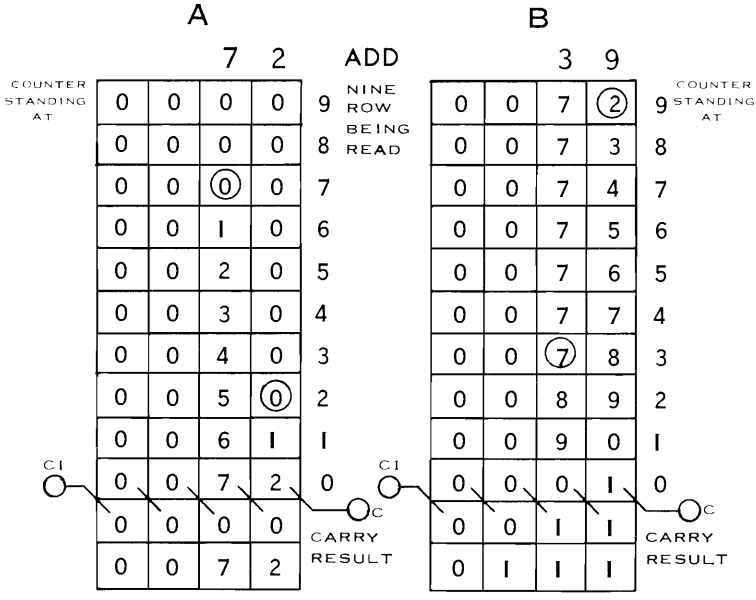
## Answers to Asterisked Questions

5. The row of print would have, interspersed with the significant digit characters and legitimate zeros, *automatic* zeros. Figure 6 illustrates what a report would look like if automatic zeros (and nonsignificant zeros) were printed. Such a report is hard to read. Therefore an IBM 402 is equipped with a device which can control the printing of zeros.

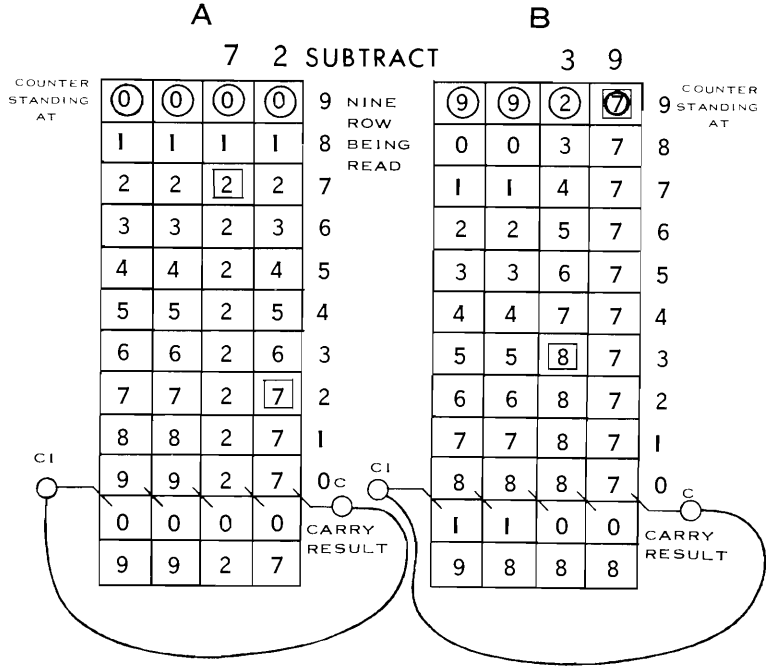
9. Refer to Figure 6. Notice that numerical typebar 18 prints a 0 on the second line of print. This zero prints because the significant digit (9) printed by typebar 17 *cancels* the effect of numerical hammersplit lever 13.

17. It would be possible to accumulate an eleven-position total by coupling two 6-position counters, three 4-position counters, two 2-position counters and two 4-position counters; in short, couple any counters together in such a way that those coupled will provide eleven or more positions.

18.



19.




28. The following shows what *will* print according to the wiring shown and what *should* print:

| | WILL | SHOULD |
|---|---|---|
| A | 07 01 3426 | 07 98 3426 |
| B | 07 98 3426 | 07 98 3426 |
| C | 05 37 3769 | 05 62 6230 |
| D | 05 62 6230 | 05 62 6230 |

A and C do not print correctly because of improper conversion. For example, A is a positive value and therefore none of the digits should convert. However, a 9 in the high-order position of counter 2b provides an impulse which causes the conversion of counter 2b.

37. When the setup change switch is turned on, the selector is picked up and the all-cycles-to-list circuit, necessary for detail printing, is broken. Breaking this circuit is one of the requirements in changing from detail printing to group printing.

38. The typebars rise twice (but without spacing) for each group of cards—once from the impulses from the first card of the group (including those impulses from the exit of counters instructed to add or subtract), and once to print the accumulated total for the group. This results in overprinting.

39. Each counter depends upon the cards at third reading for its data. Thus, if one of the lesser-level total counters is not functioning properly, the wrong result is not reflected in the higher-level total.

40. Remember that when data enters a counter, that data is also available from the counter's exits. Thus, when 8B is being read into, the data is available from the exits of 8B to N.P.E. 11-17. (A similar situation concerns typebars 21-27 and the exits of counter 8C.)

61. a. $9,999.99
    b. $ 10.03
    c. $0,000.02
    d. Nothing.

The zeros and the comma print in C (above) because each has a path to the fuse line via the upper 46 ZPC hub. The wiring of 27 prevents these zeros and comma from finding such a path in that the filter exit blocks their paths.

71. Since counter-controlled print recognizes only the digit impulses 0-9, an H code, punched in a card, will set up a printwheel to print the digit 8.

74. This is determined by control panel wiring. The C symbol hubs always emit when the aforementioned conditions are met. An "R" or "—" is emitted depending upon the wiring at (79-80, M-N). Printing CR requires two printwheels. Printing — requires only one printwheel.

76. On the 402, the typebar must receive a zone impulse from second reading and the digit impulse from third reading. Since column 1 was not wired from second reading to normal zone entry, the typebar was not "zoned" to print an alphabetic character.

On the 407, the printwheel receives both digit and zone impulses from second reading, for printing an alphabetic character. Therefore, the X in column 1 must be "split-off" before column 1 is wired to print entry.

77. These print entries are set up to print the contents of counter 8A. They are set up in a manner similar to that portrayed in Figure 31. That is, on the first half of the cycle, the impulses from counter 8A get to the printwheel and on the second half of the cycle the echo impulses from the printwheel enter counter 8B.

82. The timing must precede 9-time. This timing is provided by such things as card cycles, program exits, and all cycles.

IBM®
International Business Machines Corporation
Data Processing Division
112 East Post Road, White Plains, New York

Printed in U.S.A. 320-1448