IBM® Reference Manual

407 Accounting Machine

MINOR REVISION (September, 1960)

This edition, A24-1011-1, is a minor revision of the preceding edition, but does not obsolete Form A24-1011-0. Principal changes in this edition are:

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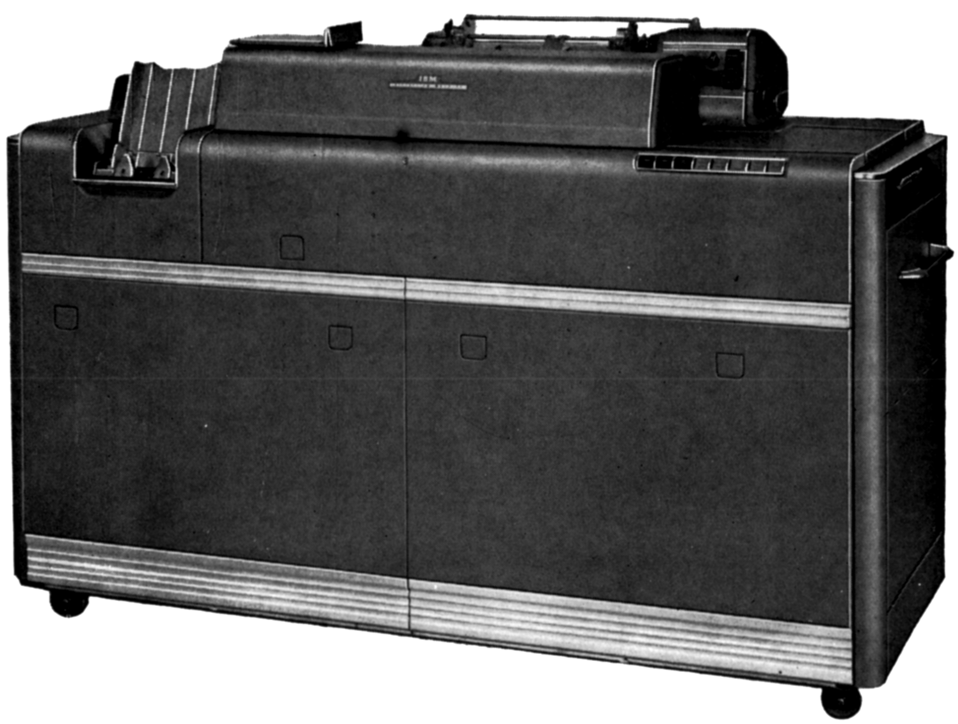


IBM 407 Accounting Machine

IBM 407 Accounting Machine

Features and Functions

The IBM 407 Accounting Machine prepares printed reports from IBM cards. The machine prints information from 120 printwheels, which form a solid bank 12 inches wide. Each printwheel has 47 different characters, namely, all the letters of the alphabet, all the numbers, and 11 special characters.

The 407 can print 18,000 characters a minute. IBM cards are read at the rate of 150 per minute. The same rate of speed is maintained for detail printing and group printing.

As a punched card is being read, it remains stationary at one of two stations and can be re-read as often as desired, which permits multiple line printing or cross-footing quantities and amounts from a single card.

Amounts can be added or subtracted in 112 counter positions which are arranged in 20 groups of 3, 4, 6 and 8 positions each. Numerical or alphabetic information may be stored in four storage units until ready for use.

Forms can be positioned in the machine automatically by the use of the carriage, which is set up for operation by inserting a prepunched tape in the tape control mechanism.

All summary punch wiring is included on the accounting machine control panel, thus allowing the use of selectors and other features of the machine for summary punching operations.

The functions of the machine are illustrated by examples of sample cards, reports and wiring diagrams. The control panel hubs are explained as they are first introduced.

Ready reference to the function of each control panel hub is in the index.

Feed Unit

Cards are placed in the hopper (Figure 1) with the 9-edge toward the throat. They feed into the machine from the bottom, under control of the feed rolls. The hopper holds approximately 1,000 cards. Each card in turn is positioned at the first, then at the second reading stations by means of card grippers which move horizontally as indicated by the arrows in Figure 2. The cards can be held at the reading stations for any given number of cycles, after which they move around the stacker drum into the stacker, where they are held in position by a pressure plate. When the stacker becomes full, the machine stops.

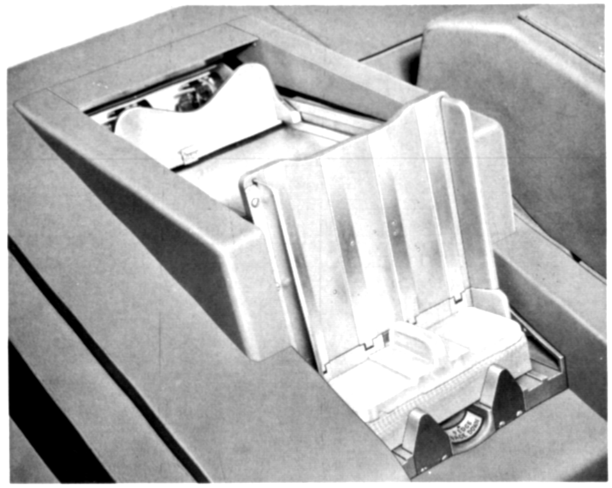


Figure 1. Hopper and Stacker

Card Reading

As a card is positioned at a reading station, it is lined up by the card aligners so that the 960 possible punching positions (12 digit positions times 80 card columns) are directly under the 960 stationary reading brushes and directly above the 960 metal segments (labeled 9, 8, 7—12 in Figure 2). Any hole that is punched in the card allows its corresponding brush to make contact with a metal segment. The electrical

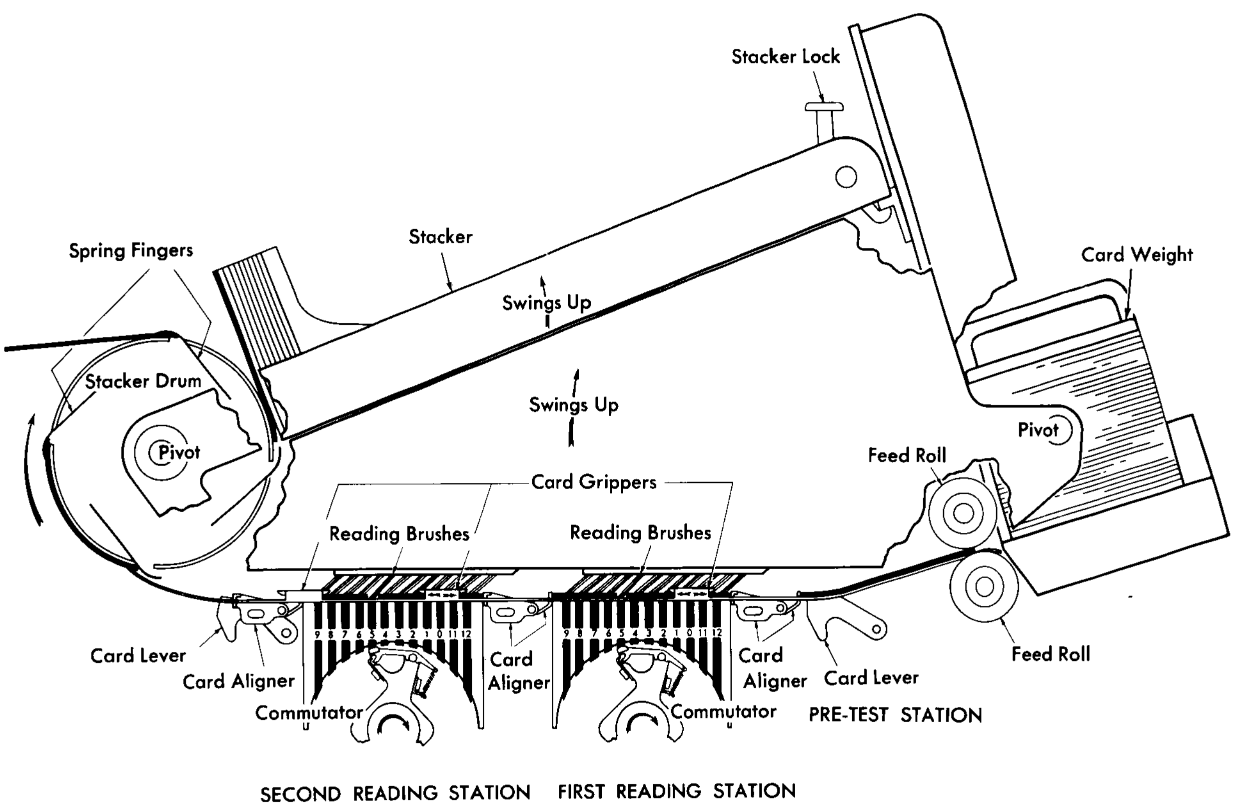


Figure 2. Feed Unit Schematic

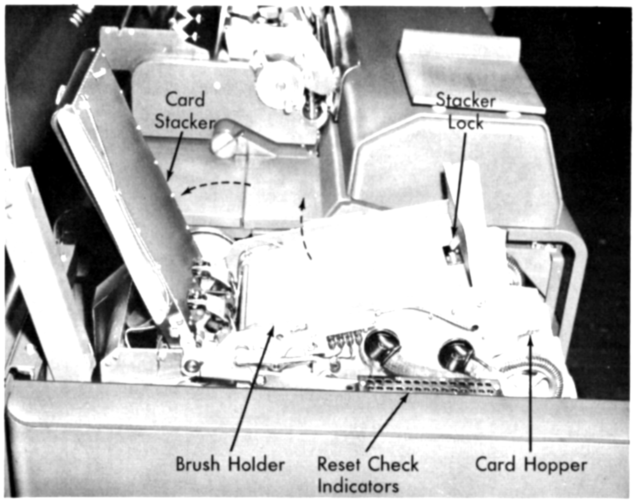


Figure 3. Stacker in Raised Position

impulse resulting from this contact is transmitted from the commutator as it rotates clockwise to the brushes in that position. There are 80 commutators at each reading station, representing the 80 columns of the card. They rotate together, starting with the 9 position and advancing progressively to 12. These commutators transmit impulses to the brushes in their corresponding position. The brushes transmit these impulses to the control panel, where they can be used to control a specific machine function.

It may be seen that a card is read as it is standing still, and that it can be easily re-read again and again, merely by holding the card stationary.

Card Feeding

Normally, card feeding is continuous and automatic when the start key has been pressed, except when a card fails to feed from the hopper, or when the hopper runs out of cards. A card feed failure is recognized at the pre-test station, and causes the machine to stop and the card-feed stop light to turn on. Card feeding may be resumed as described under *Card Feed Stop Light.*

Card Removal

Access to the cards after they have left the hopper is possible by pressing the stacker lock, then raising the stacker itself (Figure 3), and raising the brush holder (Figure 4). The cards can then be easily removed from the machine by hand. The brushes, which normally protrude slightly below the brush holder, recede into the holder when it is raised, thus preventing possible damage to the brushes.

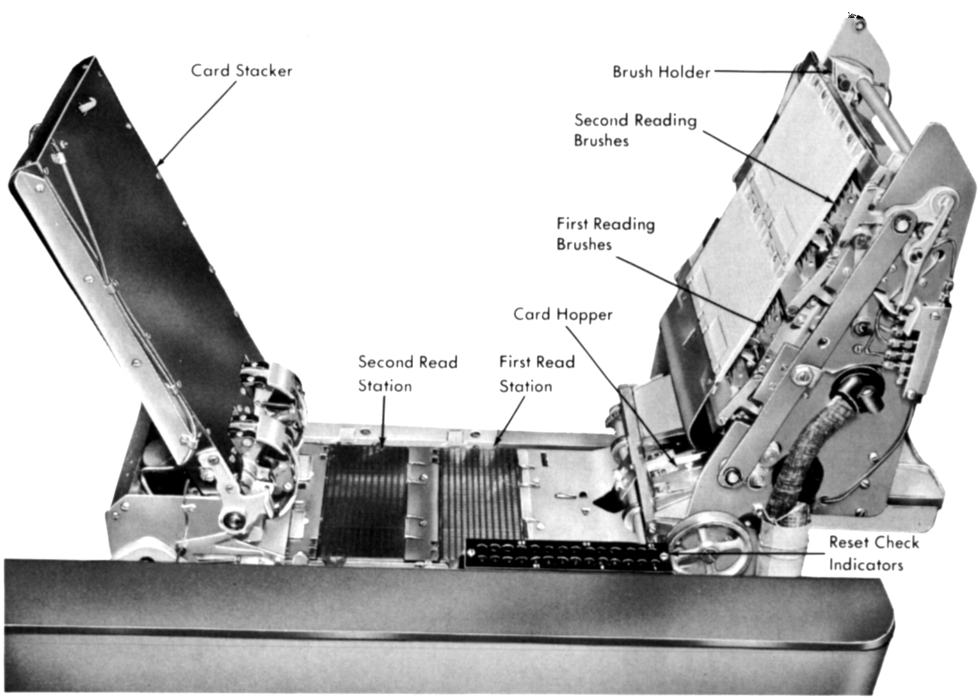


Figure 4. Feed Unit, Brushes Raised (NOTE: Remove cards from the stacker and the hopper before raising the stacker and the brush holder.)

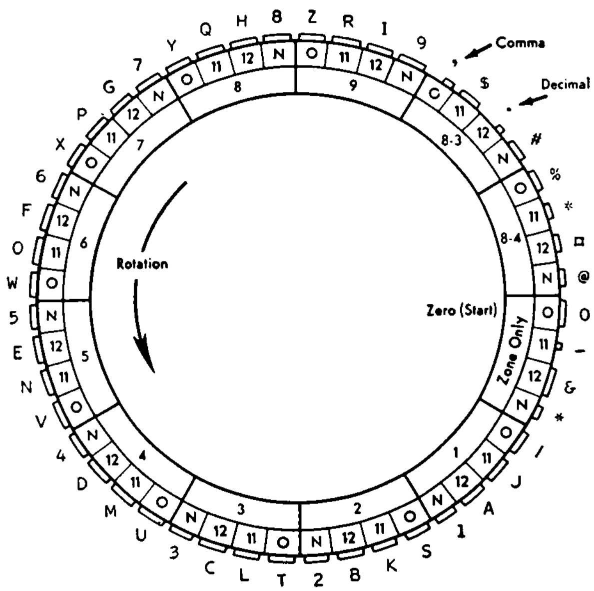


Figure 5. Printwheel Schematic

LOWER PUNCH	ZONE 12	11	O	N
1	A	J	/	1
2	B	K	S	2
3	C	L	T	3
4	D	M	U	4
5	E	N	V	5
6	F	O	W	6
7	G	P	X	7
8	H	Q	Y	8
9	I	R	Z	9
8-3	.	$	,	#
8-4	⌑	[1] *	%	@
	&	–	0	[2] *

1. Total Symbol 2. Check Protection

Figure 6. Character Codes

Print Unit

Printing by the 407 is accomplished by means of 120 printwheels arranged in a solid bank that prints within a width of 12 inches, 10 characters to the inch. Each printwheel contains 47 separate character positions:

10 digits: 0 through 9
26 letters: A through Z
11 special characters:
/ $ □ * % @ & — # . ,

As shown in Figure 5, the printwheel is divided into twelve equal parts:

Digits 1 through 9	9 parts
Combination of the digits 8 and 3 in one column	1 part
Combination of the digits 8 and 4 in one column	1 part
Zone only	1 part

Each of the twelve parts is in turn divided into four sections:

0 Zone
11 Zone
12 Zone
N (No) Zone

As shown in Figure 6, the 0, 11, and 12 zones control printing of 26 letters, zero, and nine special characters. The N (no) zone controls printing of nine digits and two special characters. An additional special character (*) position is provided for check protection.

The printwheels remain stationary until the digit punched in the card is read, at which time one of the twelve sections is selected. A further selection of one of the four parts within that section is made when the zone is read. The printwheel rotates at a high rate of speed until printing time, when its speed is reduced to 25% of normal. At the actual time of printing, the wheel is moved against the platen in a straight line, producing maximum legibility. The rotary motion of the wheel at print time is compensated by a special cam.

Although one line is printed during one cycle, the wheels print at four different times within that cycle. All the wheels zoned for 0 print first, followed in succession by those for 11, 12 and N.

Speed

The 407 operates at a rated speed of 150 cards per minute. With 120 wheels for printing, the maximum printing speed is 18,000 characters per minute. The same speed is maintained for accumulating totals for group printing, total printing, crossfooting, or taking special program cycles for other operations.

Operating Keys, Switches, and Signals

Switches and signals for controlling machine operations are shown in Figure 7.

Main Line Switch

The main line switch located on the upper left side of the machine must be turned on. This switch should not be turned off while cards are feeding or during any other machine operation.

Start Key

The start key must be pressed to start cards feeding through the machine. It is also used to turn off the form-stop and the automatic-stop lights.

Stop Key

When the stop key is pressed, the machine stops at the end of the cycle. The stop key is also used to turn off the card-feed stop light.

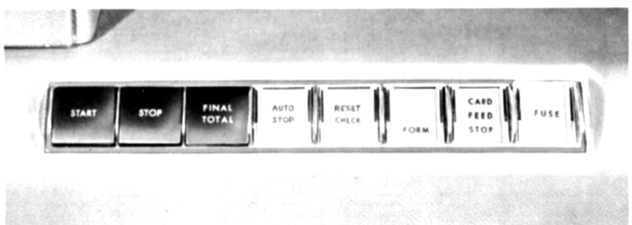


Figure 7. Operating Keys and Signal Lights

Final Total Key

If the final total toggle switch is ON, the final total key is used to print and reset final totals manually, provided the control panel has been wired acccordingly.

Card Feed Stop Light

The card feed stop light glows whenever a card fails to feed in either the accounting machine or the summary punch, and also when the summary punch runs out of cards. It also glows if a card fails to feed to the stacker from the second station. When the light turns on because of feed failure in the accounting machine, this procedure must be followed:

a. Remove cards from the hopper and correct the card that failed to feed.
b. Replace cards in the hopper.
c. Press the stop key to turn out the light.
d. Press the start key to resume operation.

The cards then feed normally, without interruption of the normal controls or spacing operations.

When the card feed stop light turns on because the summary punch hopper is empty, it can be turned off by replenishing the hopper and pressing the start key.

Form Light

The form light glows and the machine stops whenever the last form is within 13⅜ inches of the platen, provided the form-stop toggle switch is ON. The form light is turned off by inserting a new form and pressing the start key.

Automatic Stop Light

The automatic stop light glows whenever the machine stops because of an impulse received by the AUTO-STOP hub on the control panel. It can be turned off and operation resumed by pressing the start key.

Fuse Light

The fuse light goes on and the machine stops whenever a fuse burns out. The fuses are located on the lower left side of the machine. The light is turned off when the fuse has been replaced, and operation can be resumed by pressing the start key.

Light (unlabelled)

The unlabelled light (the upper half of the form light) goes on when the main-line switch is ON and the machine is idling.

Reset Check Light

The reset-check circuit determines if counters reset correctly. The circuit can be made inoperative or operative by setting a reset-check toggle switch to an OFF or ON position. If the reset-check switch is OFF, a reset-check light blinks while the machine is operating, thus making the operator aware that the check circuit is not operative. If the reset-check switch is ON, the reset-check light turns on, and the machine stops only when an error is detected upon reset.

A reset error is usually caused by improper counter wiring. The steps to be taken to locate the error are described under *Operating Rules and Suggestions.* However, before errors in counter wiring can be located and corrected, cards in the machine at the time the reset-check light turns on must be run into the stacker. To do this:

1. Remove cards from the hopper.
2. Press the start key to run cards out of the machine. At this time re-programming occurs, and the counters reset a second time. The machine continues to run.
3. To stop the machine, press the stop key. The reset-check light may or may not turn off.
4. If the reset-check light turns off, it means that all

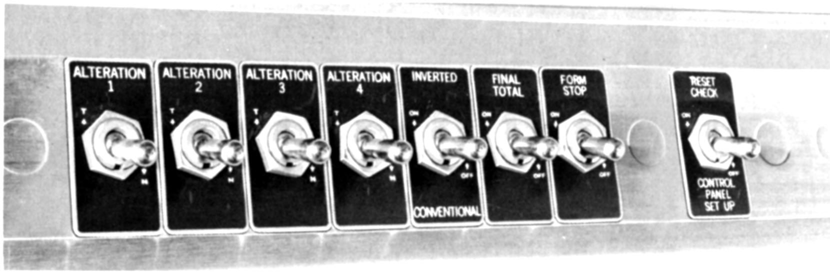


Figure 8. Operating Switches

cards have run out of the machine and are in the stacker.

5. If the reset-check light does not turn off, there are still some cards in the machine. To run them out, it is necessary to:

a. Turn off the reset-check switch

b. Press the start key to run the cards into the stacker

c. Press the stop key to stop the machine.

When the machine stops, the reset-check light will turn off.

Alteration Switches 1, 2, 3, 4 (Figure 8)

When an alteration switch is turned on, a corresponding selector in the control panel transfers. The selectors can be used to alter control panel setups.

Inverted Switch

This switch must be ON whenever inverted forms are being run. Inverted forms are those in which details precede the heading. The switch must be OFF for running conventional forms.

Final Total Switch

When the final total switch is ON, final totals can be manually printed and reset by pressing the final total key, provided the FINAL TOTAL hubs in the control panel have been properly wired. It also allows the run-out final total to print automatically when the LCT (last card total) switch is ON.

When the final-total switch is OFF, neither final totals nor run-out final totals can be taken, and the final total remains in the machine indefinitely.

Form Stop Switch

When the form stop switch is ON, the end-of-form stop, located in the center of the carriage, is operative and causes the machine to stop when the last form is within $13\frac{3}{8}''$ of the printing line. When the form-stop switch is OFF, the end of form stop is inoperative.

Reset Check Switch

The purpose of the Reset Check Switch is explained under *Reset Check Light.*

Control Panel

Automatic operation of the machine is obtained through a control panel (Figure 9), which directs the machine to perform various functions according to the requirements of the operation.

The machine operates from electrical impulses that result from sensing a hole in a card. The impulse

Figure 9. Control Panel, Inserted in Machine

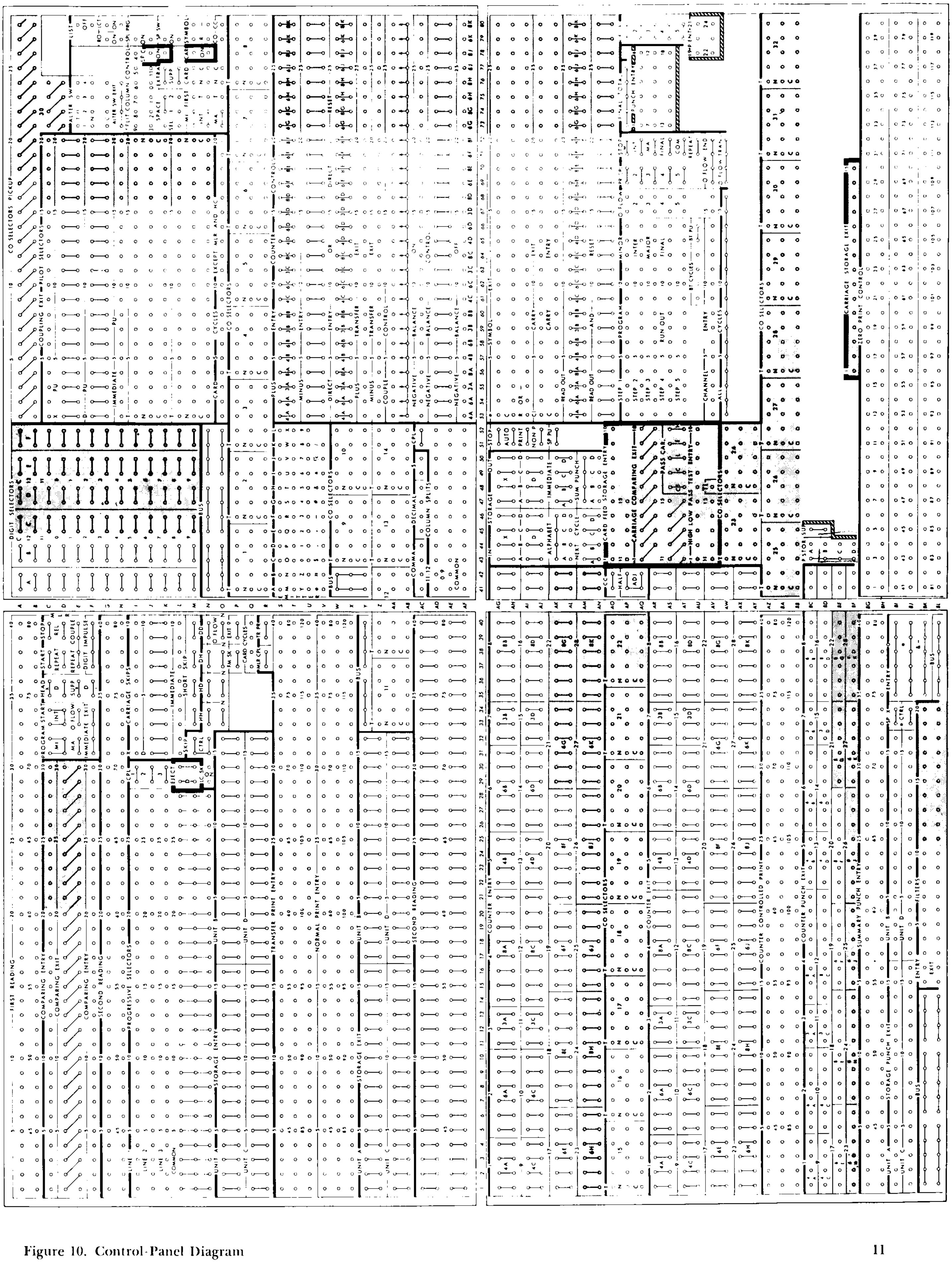
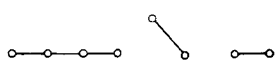


Figure 10. Control-Panel Diagram

travels by internal connections to the control panel, located on the right side of the machine; and by means of external wires, it can be directed to perform the required operation.

Two kinds of hubs are on the control panel, *exits* and *entries.* An exit is one that emits an impulse. Some exits are under control of the hole in the card, and others result from some function previously performed, or are automatic for every card. An entry hub is one that can accept an impulse wired to it. A connection must always be made from an exit to an entry by placing one end of a wire in the exit hub and the other end in the entry hub. The exits and entries to be used depend entirely on the job the machine is to do. Control panels can be changed to prepare each new report, thereby giving a single machine the flexibility needed to produce different types of documents or reports for many different applications.

Whenever two or more hubs are connected by lines, as shown here, these hubs are *common;* that is, two or more exits or entries serve the same purpose. Such an arrangement reduces the need for split wires (wires with more than two ends) since these hubs are actually connected together.



To facilitate reference to specific hubs on the control panel (Figure 10), the rows are numbered from 1 through 80 horizontally, and lettered from A through BL vertically. This arrangement divides the control panel into four equal sections. Generally, *position* wiring, such as card reading, counter entry and exit, storage entry and exit, comparing, and printing, is concentrated in the upper and lower left sections; wiring for *control* of entry, exit, adding, subtracting, and other functions is concentrated in the upper and lower right sections. Groups of hubs performing like functions are sectioned off by heavy lines. Shaded hubs indicate possible additional capacity for various features. A universal control panel is used with the 407, 408, and 409 machines. The hubs with the heaviest outlines are used for the 408 and 409 only; the hubs outlined with cross-hatching are used for the 409 only.

Summary of Machine Specifications

	Models		
	A 1	A 2	A 3
Co-Selectors (5-position)	16	16	20
Pilot Selectors (2-position)	15	15	20
Digit Selectors	2	3	4
Counter Positions	112	126	168
Filters	10	20	20

Printing is a medium used by the IBM 407 Accounting Machine to record information processed by the machine for completing reports.

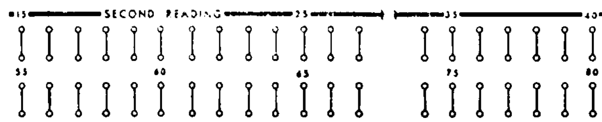
The variations of printing are initiated by the flexibility of control that can be used.

Detail Printing (Figure 12)

The 407 is basically a detail-printing machine. Detail printing is printing information from each card as it passes through the machine. Figure 11 shows the codes that must be punched in the card to print digits, letters, and special characters. The digits 0 through 9 are identified by single punches, while the letters and special characters are identified by combination punching. For example, the combination of 12 punches with the digits 1 through 9 are recognized by the machine as the letters A through I. Combinations of 11 punches with the digits 1 through 9 are recognized as the letters J through R. Combinations of 0 punches with the digits 2 through 9 are recognized as the letters S through Z. Eleven special characters are designated by various combinations of punches as shown in Figure 11. These are permanently assigned codes, and when the control panel is properly wired, the machine always recognizes a 12-1 as the letter A, 0-4-8 as the % sign, etc.

As previously explained, each one of the 120 printwheels can be impulsed to print any one of the 47 characters. Only one wire in the control panel is needed to print a number, a letter, or a special character.

Underpunching cannot be used as a means of correcting cards when they are to be processed in the 407.



G-H, 1-40;
AC-AF, 1-40

Second Reading. The IBM 407 has two sets of second-reading hubs, one in the left center of the control panel, the other at the left top of the panel. The corresponding hubs in both sets are common, and can be used interchangeably. The 80 second-reading hubs represent the 80 columns in the cards, and are used for all normal reading operations. In order to print information that is punched in the card, the second-reading hubs corresponding to the card columns are wired to NORMAL PRINT ENTRY. They may also be wired to TRANSFER PRINT ENTRY or COUNTER-CONTROLLED PRINT as explained in the discussion of those hubs.

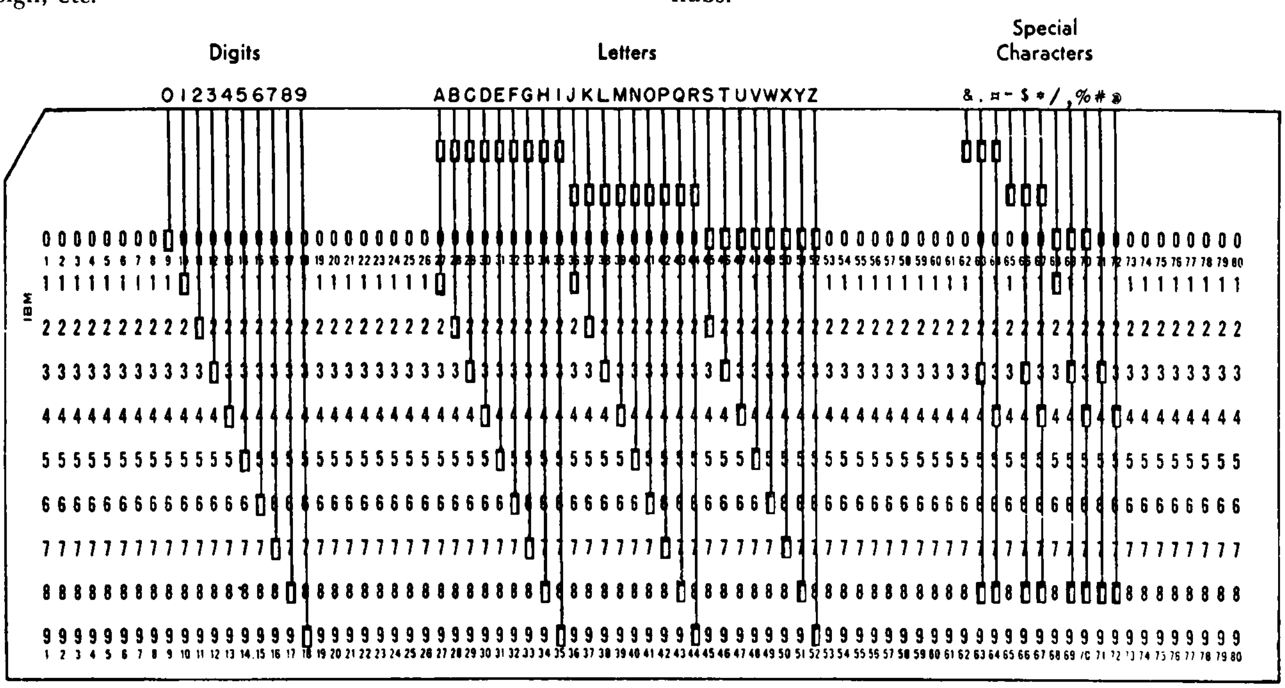


Figure 11. Character Punching

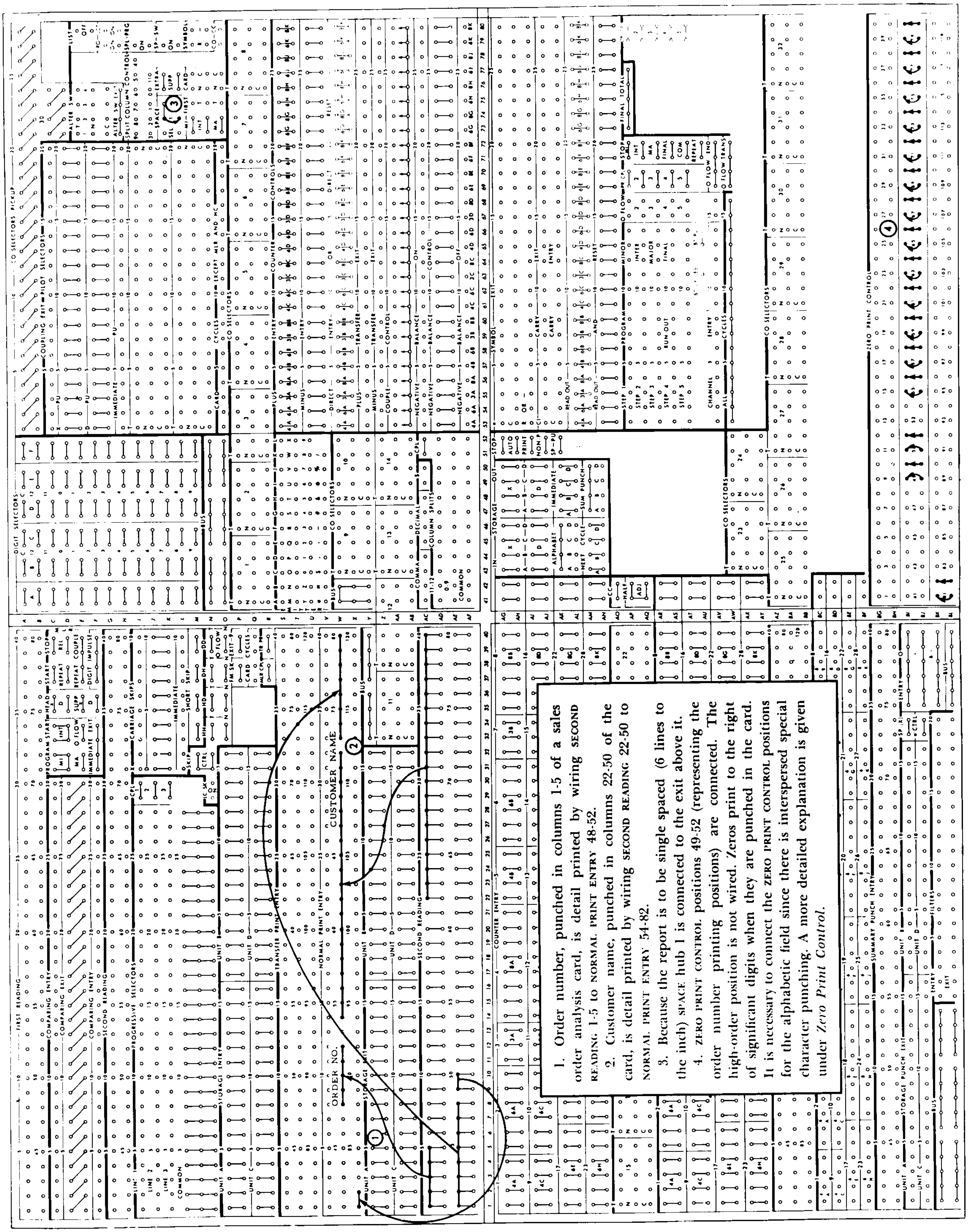
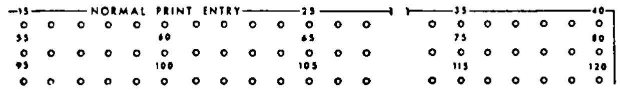


Figure 12. Detail Printing



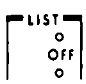
V-X, 1-40

Normal Print Entry. Each printwheel has a corresponding NORMAL PRINT ENTRY hub in the control panel. When a print entry hub is impulsed from a second-reading hub, directly or through selectors, the printwheel prints the numerical, alphabetic or special character information that is punched in that column of the card. Only one wire is required to print any one character. If a controlling X is punched over a numerical field, that X must be *filtered* out by means of a *column split,* or the column containing the X must be wired to COUNTER-CONTROLLED PRINT hubs.

The NORMAL PRINT ENTRY hubs may also be wired from the *emitter,* and the COMMA, DECIMAL and DOLLAR EXIT hubs. In some instances, they are also wired from FIRST READING.

Figure 12 shows wiring from SECOND READING to NORMAL PRINT ENTRY.

Group Printing



E-F-80

List Off. The 407 is basically a detail printing machine. It can print from each card as it passes through the machine. When the list switch is wired OFF, printing occurs automatically for:

1. heading cards
2. the first card after a control change, for group indication purposes
3. program cycles, to print totals
4. overflow program cycles, to print overflow indications.

All other cards pass through the machine without printing.

When the list switch is wired OFF and neither PROGRAM START nor LAST CARD TOTAL is wired, printing takes place only by depression of the final total key. If the LAST CARD TOTAL switch is wired ON, totals are printed after the last card leaves the machine.

To select LIST OFF, wire a CYCLES impulse through a selector to the lower LIST OFF hub.

Figure 14 shows a group-printed report using the same cards used in Figure 13. It will be seen that the group-printed report eliminates printing detail items because there is only one printed line for each subledger or general ledger account, no matter how many

EXPENSE DISTRIBUTION
BY DEPARTMENT OR BRANCH

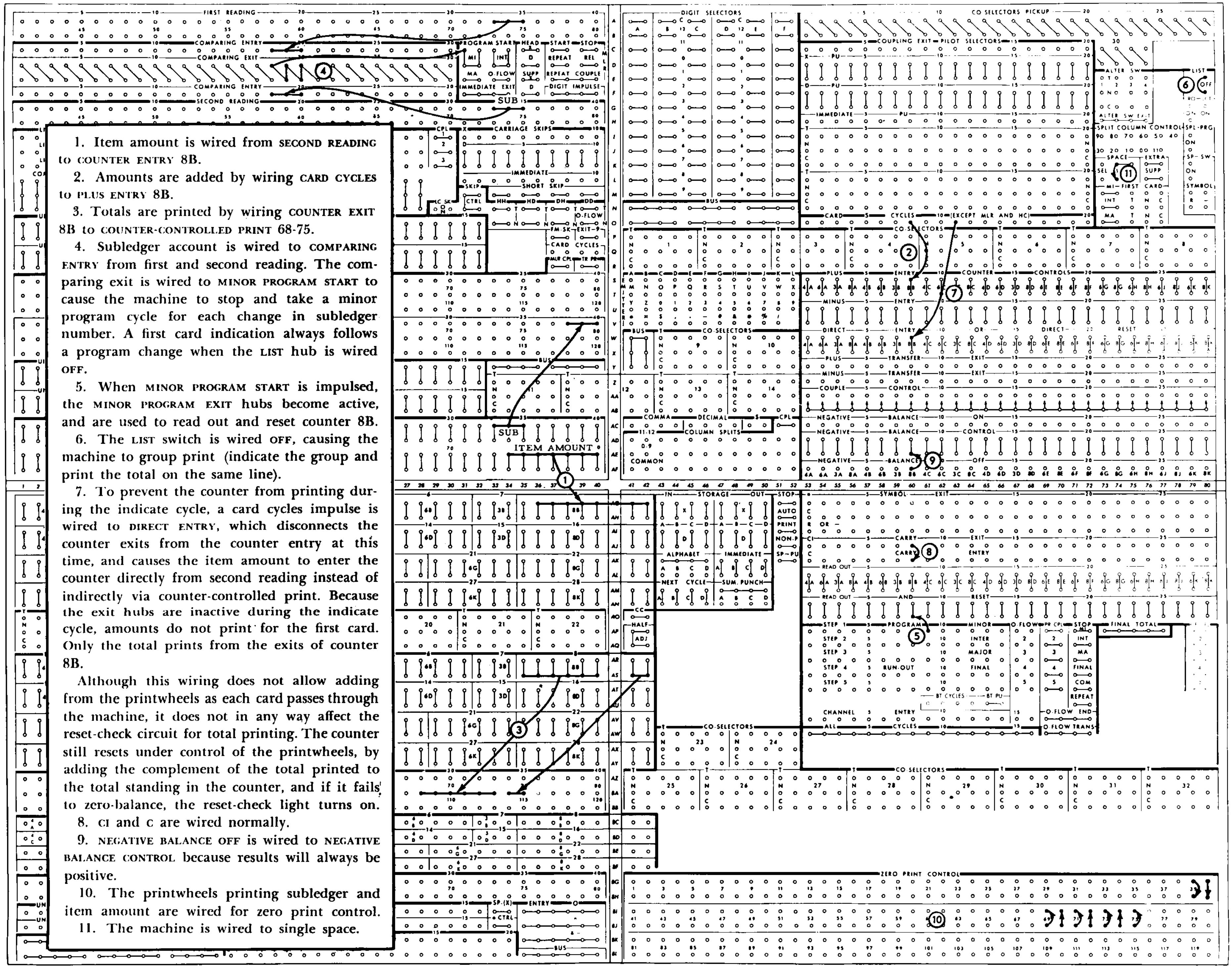
DEPT. OR BRANCH	ACCOUNT No. GEN. LEDG.	SUB. LEDG.	OUR INVOICE NUMBER	DATE MO.	DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT. OR BRANCH
82	431	112	12066	12	10	300.00		
82	431	112	12153	12	28	300.00		
						600.00*		
82	431	113	12066	12	10	150.00		
82	431	113	12066	12	10	150.00		
82	431	113	12066	12	10	125.00		
82	431	113	12153	12	28	150.00		
82	431	113	12153	12	28	150.00		
82	431	113	12153	12	28	125.00		
						850.00*		
82	431	114	12066	12	10	50.00		
82	431	114	12066	12	10	75.00		
82	431	114	12066	12	10	50.00		
82	431	114	12153	12	28	50.00		
82	431	114	12153	12	28	50.00		
82	431	114	12153	12	28	75.00		
						350.00*		
82	431	520	12149	12	28	360.43		
						360.43*		
82	431	700	12082	12	14	2.25		
						2.25*		
82	431	750	12003	12	01	100.00		
						100.00*		
82	431	810	12112	12	18	70.20		
						70.20*		
82	431	850	12043	12	07	24.75		
						24.75*		
							2357.63	
82	432	841	12151	12	28	1792.86		
						1792.86*		
							1792.86	
								4150.49

Figure 13. Detail Printed Report

EXPENSE DISTRIBUTION
BY DEPARTMENT OR BRANCH

DEPT. OR BRANCH	ACCOUNT No. GEN. LEDG.	SUB. LEDG.	OUR INVOICE NUMBER	DATE MO.	DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT. OR BRANCH
82	431	112				600.00		
82	431	113				850.00		
82	431	114				350.00		
82	431	520				360.43		
82	431	700				2.25		
82	431	750				100.00		
82	431	810				70.20		
82	431	850				24.75		
							2357.63	
82	432	841				1792.86		
							1792.86	
								4150.49

Figure 14. Group Printed Report



1. Item amount is wired from SECOND READING to COUNTER ENTRY 8B.

2. Amounts are added by wiring CARD CYCLES to PLUS ENTRY 8B.

3. Totals are printed by wiring COUNTER EXIT 8B to COUNTER-CONTROLLED PRINT 68-75.

4. Subledger account is wired to COMPARING ENTRY from first and second reading. The comparing exit is wired to MINOR PROGRAM START to cause the machine to stop and take a minor program cycle for each change in subledger number. A first card indication always follows a program change when the LIST hub is wired OFF.

5. When MINOR PROGRAM START is impulsed, the MINOR PROGRAM EXIT hubs become active, and are used to read out and reset counter 8B.

6. The LIST switch is wired OFF, causing the machine to group print (indicate the group and print the total on the same line).

7. To prevent the counter from printing during the indicate cycle, a card cycles impulse is wired to DIRECT ENTRY, which disconnects the counter exits from the counter entry at this time, and causes the item amount to enter the counter directly from second reading instead of indirectly via counter-controlled print. Because the exit hubs are inactive during the indicate cycle, amounts do not print for the first card. Only the total prints from the exits of counter 8B.

Although this wiring does not allow adding from the printwheels as each card passes through the machine, it does not in any way affect the reset-check circuit for total printing. The counter still resets under control of the printwheels, by adding the complement of the total printed to the total standing in the counter, and if it fails to zero-balance, the reset-check light turns on.

8. CI and C are wired normally.

9. NEGATIVE BALANCE OFF is wired to NEGATIVE BALANCE CONTROL because results will always be positive.

10. The printwheels printing subledger and item amount are wired for zero print control.

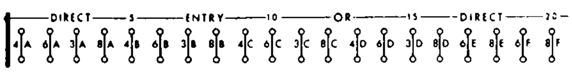
11. The machine is wired to single space.

Figure 15. Group Printing

cards are included within these groups. Moreover, the minor total prints on the same line with the indication. Intermediate totals print one line below the minor total, and major totals print one line below the intermediate totals (when the machine is set to single space). An automatic space occurs after the intermediate total, if only minor and intermediate programs are active, or after the major total if all three programs are active. An automatic space never occurs after a minor total only.

The speed for group printing, as for detail printing, is 150 cycles per minute.

Figure 15 shows wiring for group printing.



W-X, 53-80

Direct Entry. In group printing, the group total prints on the same line with the indication. Usually, information from the counter prints during the indicate cycle and during the program cycle too, resulting in overprinting. To suppress printing from the counter for the indicate cycle, a *card cycles* impulse must be wired to the DIRECT ENTRY hubs of the counter being used. This wiring disconnects the counter entries from the counter exits for the indicate cycle, forcing the information wired to COUNTER ENTRY to enter the counter directly from second reading, rather than indirectly via the printwheels. This wiring also nullifies the action of the C and R or MINUS hubs, and credit symbols do not print on the first card of a group. When more than one DIRECT ENTRY hub is wired from one impulse, the corresponding READ-OUT AND RESET hubs must be impulsed during the same program cycle. Otherwise, the DIRECT ENTRY hubs must be impulsed independently. See *Direct Entry or Direct Reset* under *Operating Rules and Suggestions.*

The DIRECT ENTRY hubs are also used for direct reset as explained under *Direct Reset.*

Consecutive Number Printing (Figure 16)

This is a simple method of printing consecutive numbers with the IBM 407 Accounting Machine. The method can be applied easily to printing serial numbers on checks or other accounting documents, since it does not interfere in any way with normal carriage controls.

The starting number is read into a counter from an X-punched leader card. NON-PRINT is impulsed at this time to prevent printing. On every cycle thereafter, the number in the counter is read out and printed, but it is also increased by 1 by a carry impulse from another counter, which is always subtracting.

Consecutive Number Control (Figure 17)

This is a simple method of consecutive number control when the printing of missing consecutive numbers is *not* required. Any break in a consecutive-number series is signalled by a special character (M) printed beside any number that starts a new series. Duplicate numbers are identified by another special character (D) printed beside each duplicate number. Examples:

Detail Printing	Group Printing
1006	1010 M
1007	1013 D
1008	etc.
1010 M	
1011	
1012	
1013	
1013 D	
1014	
etc.	

The number of selectors and counters required for this operation depends on the size of the number to be checked. For example, consecutive number control of a 5-digit number requires two co-selectors, two 6-position counters, and ten comparing positions. In all cases, four pilot selectors are required, and the file must be preceded by two blank cards.

The control number punched in the cards is read from first reading, and subtracted by direct entry into one of two counters that are controlled alternately through a pilot selector. When one counter subtracts, the other direct-resets, and vice versa. By omitting the CI to C wiring, the number subtracted in the counter is increased by 1 when converted (Negative Balance ON). Thus, the number can be read out of COUNTER PUNCH EXITS in the next cycle, and compared with the number read from the following card. Use of COUNTER PUNCH EXITS is permissible if the counter is reset directly. If the comparison is unequal (a break in the consecutive series), the comparing exit picks up a pilot selector and the letter "M" is allowed to print, in the next cycle, through the transferred side of the selector.

Another independent normal comparison between two cards (one at first reading and the other at second reading) controls printing of the letter "D" for duplicates, through the normal side of a pilot selector.

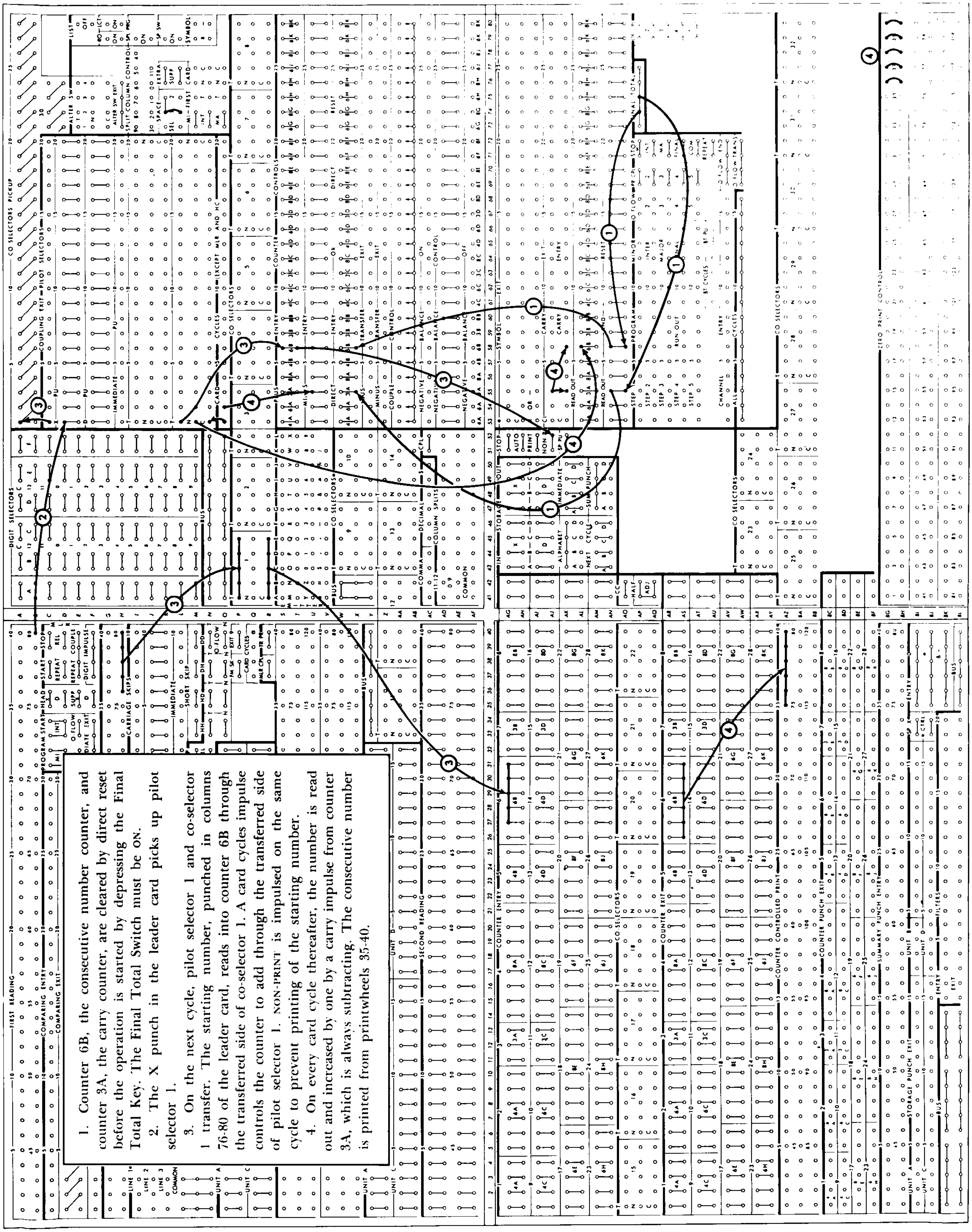
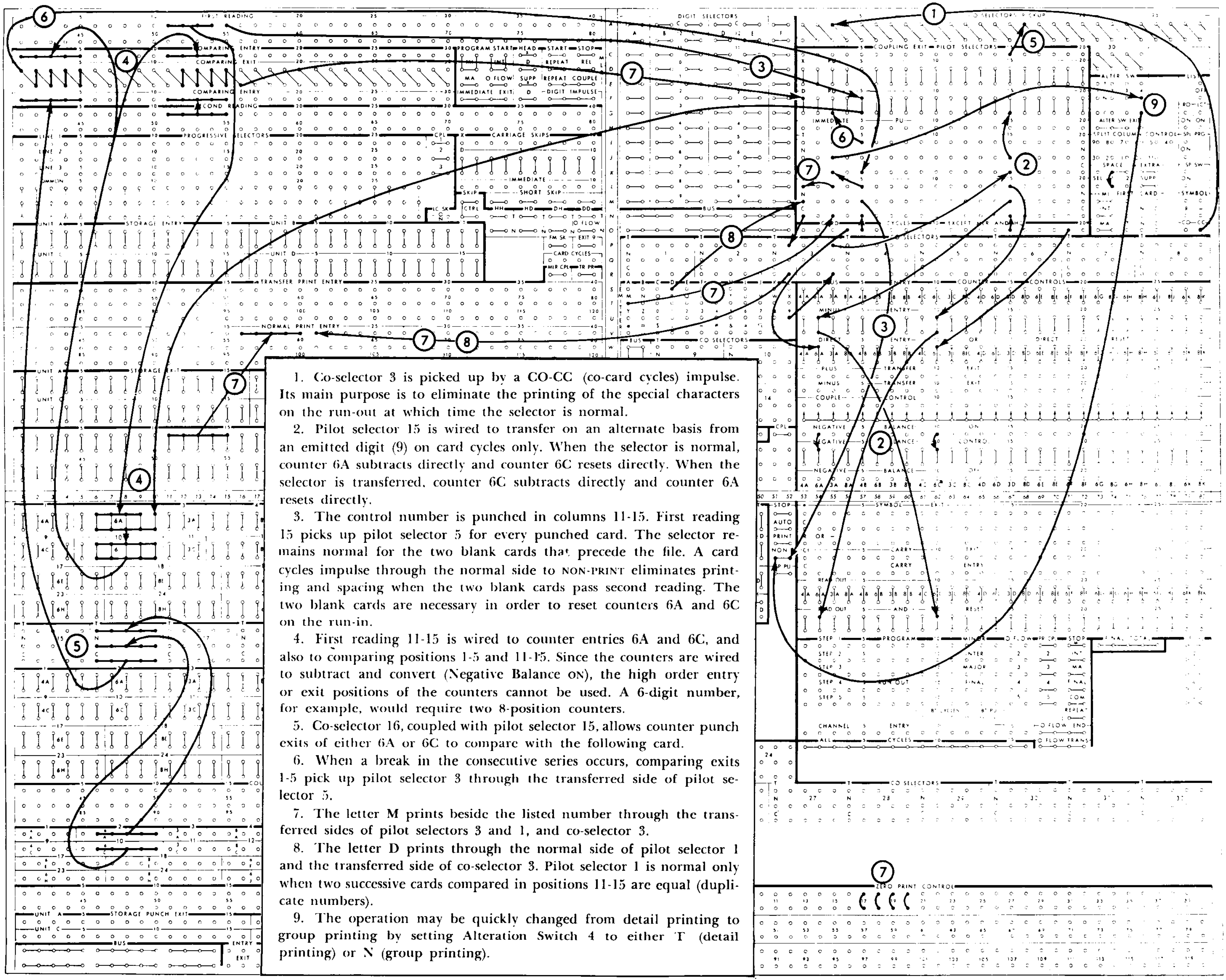


Figure 16. Consecutive-Number Printing



1. Co-selector 3 is picked up by a CO-CC (co-card cycles) impulse. Its main purpose is to eliminate the printing of the special characters on the run-out at which time the selector is normal.

2. Pilot selector 15 is wired to transfer on an alternate basis from an emitted digit (9) on card cycles only. When the selector is normal, counter 6A subtracts directly and counter 6C resets directly. When the selector is transferred, counter 6C subtracts directly and counter 6A resets directly.

3. The control number is punched in columns 11-15. First reading 15 picks up pilot selector 5 for every punched card. The selector remains normal for the two blank cards that precede the file. A card cycles impulse through the normal side to NON-PRINT eliminates printing and spacing when the two blank cards pass second reading. The two blank cards are necessary in order to reset counters 6A and 6C on the run-in.

4. First reading 11-15 is wired to counter entries 6A and 6C, and also to comparing positions 1-5 and 11-15. Since the counters are wired to subtract and convert (Negative Balance ON), the high order entry or exit positions of the counters cannot be used. A 6-digit number, for example, would require two 8-position counters.

5. Co-selector 16, coupled with pilot selector 15, allows counter punch exits of either 6A or 6C to compare with the following card.

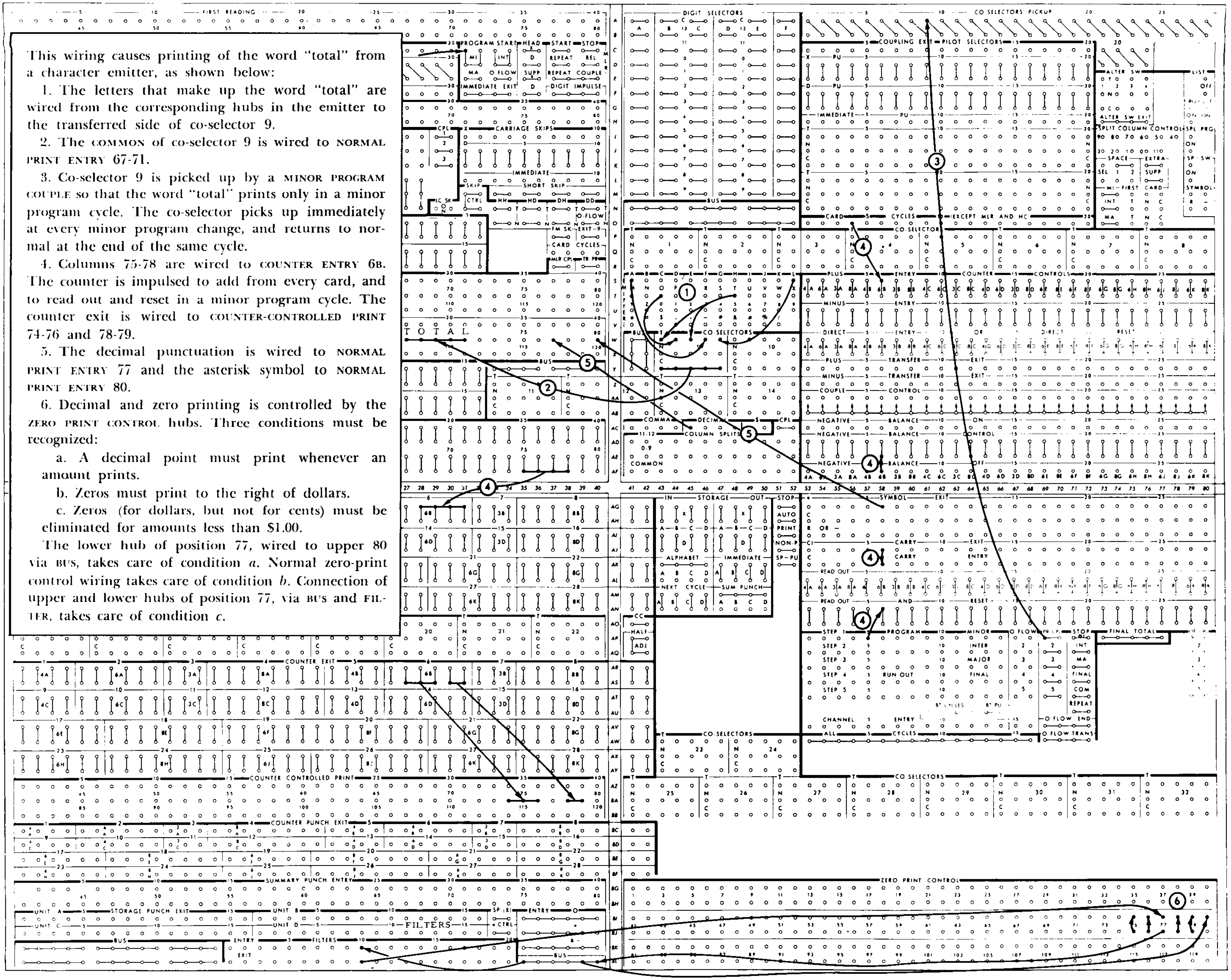
6. When a break in the consecutive series occurs, comparing exits 1-5 pick up pilot selector 3 through the transferred side of pilot selector 5.

7. The letter M prints beside the listed number through the transferred sides of pilot selectors 3 and 1, and co-selector 3.

8. The letter D prints through the normal side of pilot selector 1 and the transferred side of co-selector 3. Pilot selector 1 is normal only when two successive cards compared in positions 11-15 are equal (duplicate numbers).

9. The operation may be quickly changed from detail printing to group printing by setting Alteration Switch 4 to either T (detail printing) or N (group printing).

Figure 17. Consecutive-Number Control



This wiring causes printing of the word "total" from a character emitter, as shown below:

1. The letters that make up the word "total" are wired from the corresponding hubs in the emitter to the transferred side of co-selector 9.

2. The COMMON of co-selector 9 is wired to NORMAL PRINT ENTRY 67-71.

3. Co-selector 9 is picked up by a MINOR PROGRAM COUPLE so that the word "total" prints only in a minor program cycle. The co-selector picks up immediately at every minor program change, and returns to normal at the end of the same cycle.

4. Columns 75-78 are wired to COUNTER ENTRY 6B. The counter is impulsed to add from every card, and to read out and reset in a minor program cycle. The counter exit is wired to COUNTER-CONTROLLED PRINT 74-76 and 78-79.

5. The decimal punctuation is wired to NORMAL PRINT ENTRY 77 and the asterisk symbol to NORMAL PRINT ENTRY 80.

6. Decimal and zero printing is controlled by the ZERO PRINT CONTROL hubs. Three conditions must be recognized:

a. A decimal point must print whenever an amount prints.

b. Zeros must print to the right of dollars.

c. Zeros (for dollars, but not for cents) must be eliminated for amounts less than $1.00.

The lower hub of position 77, wired to upper 80 via BUS, takes care of condition *a*. Normal zero-print control wiring takes care of condition *b*. Connection of upper and lower hubs of position 77, via BUS and FILTER, takes care of condition *c*.

Figure 18. Character-Emitter Printing

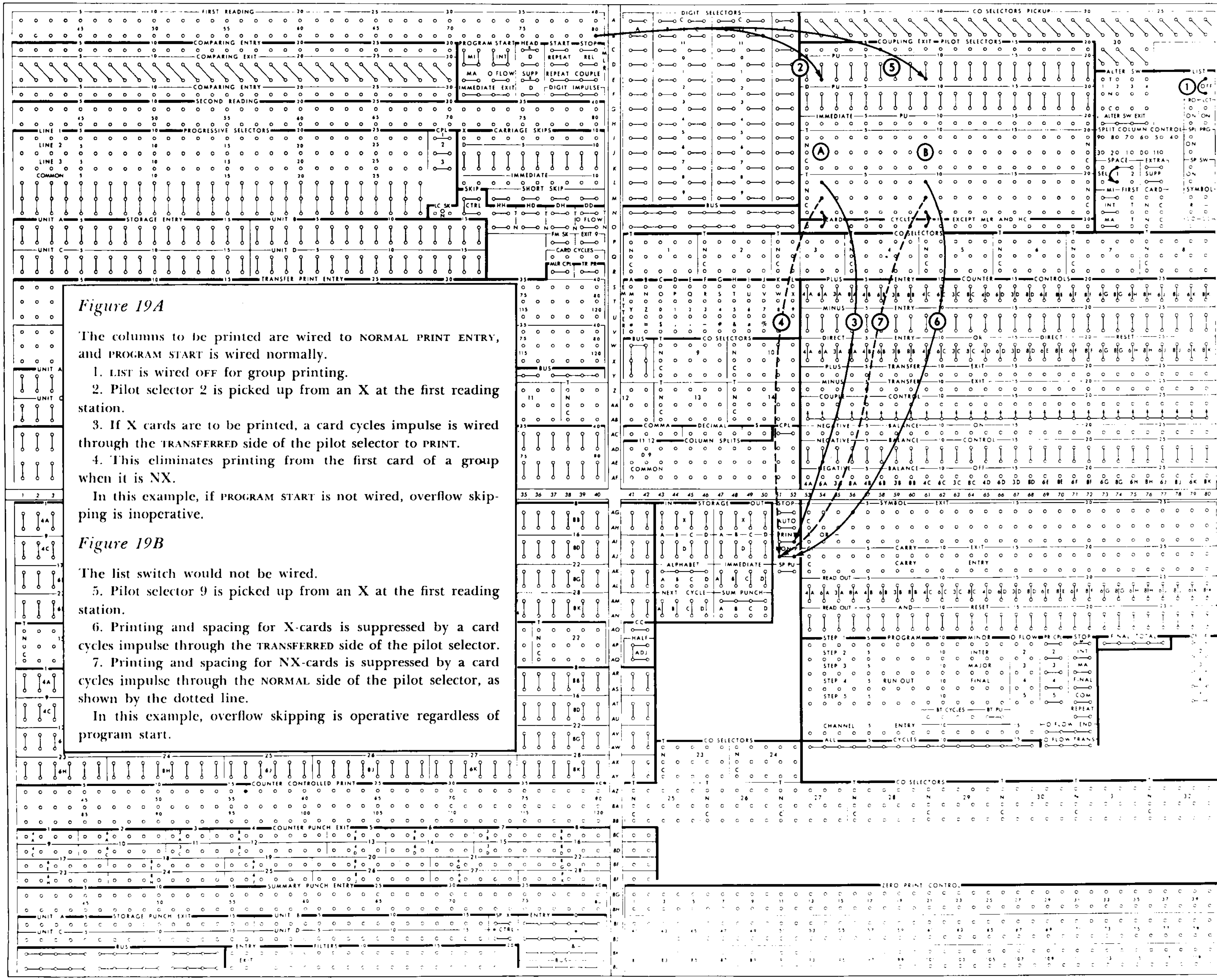


Figure 19A

The columns to be printed are wired to NORMAL PRINT ENTRY, and PROGRAM START is wired normally.

1. LIST is wired OFF for group printing.

2. Pilot selector 2 is picked up from an X at the first reading station.

3. If X cards are to be printed, a card cycles impulse is wired through the TRANSFERRED side of the pilot selector to PRINT.

4. This eliminates printing from the first card of a group when it is NX.

In this example, if PROGRAM START is not wired, overflow skipping is inoperative.

Figure 19B

The list switch would not be wired.

5. Pilot selector 9 is picked up from an X at the first reading station.

6. Printing and spacing for X-cards is suppressed by a card cycles impulse through the TRANSFERRED side of the pilot selector.

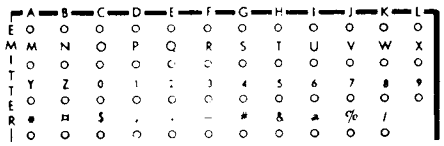
7. Printing and spacing for NX-cards is suppressed by a card cycles impulse through the NORMAL side of the pilot selector, as shown by the dotted line.

In this example, overflow skipping is operative regardless of program start.

Figure 19. A. Group Printing B. Detail Printing

Character-Emitter Printing

Digits, letters and special characters can be printed, even though not punched in the card, by the use of the *character emitter.*



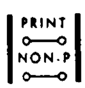
S-V, 41-52

Character Emitter. All digits, letters and special characters are emitted from the CHARACTER EMITTER hubs during every machine cycle, including run-in, run-out, and final-total cycles. For printing, they may be wired to NORMAL or TRANSFER PRINT ENTRY directly, or through selectors. For summary punching, digits may be wired to counters or SUMMARY PUNCH ENTRY, letters to storage units or SUMMARY PUNCH ENTRY, and special characters to SUMMARY PUNCH ENTRY. Special characters "&" "—" and "/" may also be wired to storage units.

Figure 18 shows wiring for emitted-character printing.

Print Selection

Detail printing and group printing in the same operation can be controlled by the use of PRINT and NON-PRINT hubs.



AI-AJ, 51-52

Print. The two common PRINT hubs accept card cycle or all cycles impulses to cause detail printing when the machine is set for group printing (LIST OFF). The cards to be detail printed must be distinguished (from those to be group printed) by an X or digit. An X or digit cannot be wired directly to the PRINT hub, but is wired from first reading to pilot selector pickup. X or digit cards are printed by a card cycles impulse through the TRANSFERRED side of a pilot selector, and NX or no digit cards through the normal side. The PRINT hubs control all 120 printwheels as a unit (Figure 19A).

Non-P (Non-Print). The two common NON-PRINT hubs accept card cycles, all cycles or program impulses to prevent the machine from printing and spacing, regardless of the wiring to the printwheels. When the machine is detail printing, cards with distinctive punching can be prevented from printing by controlling a card cycle impulse through a pilot selector to NON-PRINT. To prevent printing and spacing during a total cycle, a program exit is wired directly to NON-PRINT. To prevent printing from the first card of a group (group indicate elimination), the minor, intermediate or major first card is wired directly to NON-PRINT. The NON-PRINT hubs control all 120 printwheels as a unit (Figure 19B). An X or digit cannot be wired directly to NON-PRINT.

Offset Total Printing

It is often necessary to detail print amounts from one set of printwheels and print their total from another set of printwheels, directly beneath other printed information. In the example shown in Figure 20, the name of the insured is printed from printwheels 11-22 and the amount of insurance from printwheels 24-29.

The total amount of insurance would normally print beneath the detail amounts. The total may be offset (printwheels 14-19) as shown in the illustration by wiring the counter exit through a co-selector so that the exit impulses reach printwheels 24-29 for detail printing and printwheels 14-19 for total printing (Figure 21).

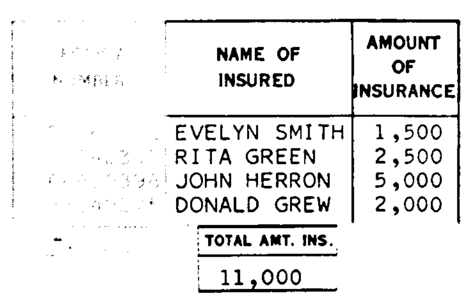


Figure 20. Offset Total

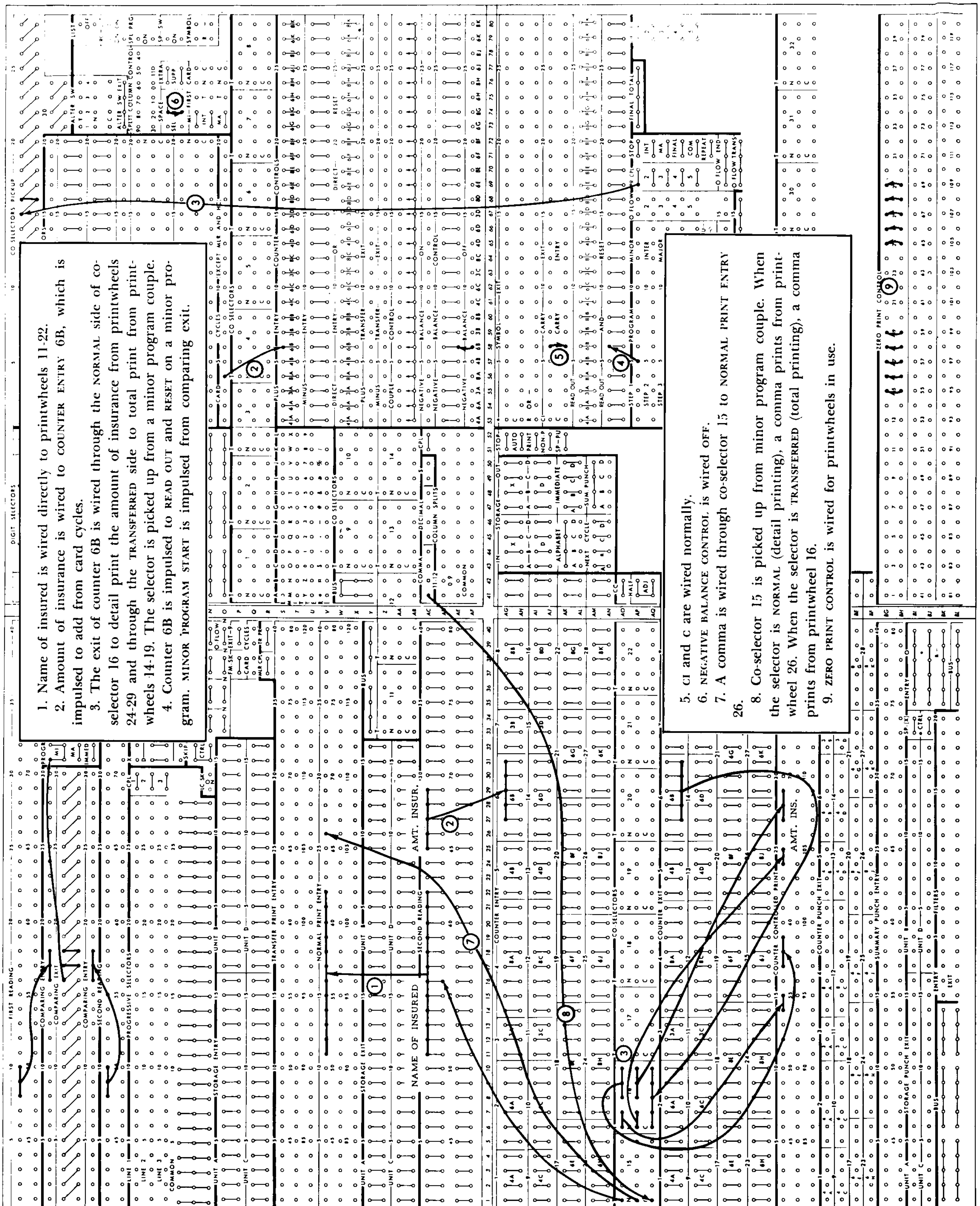


Figure 21. Offset Total Printing

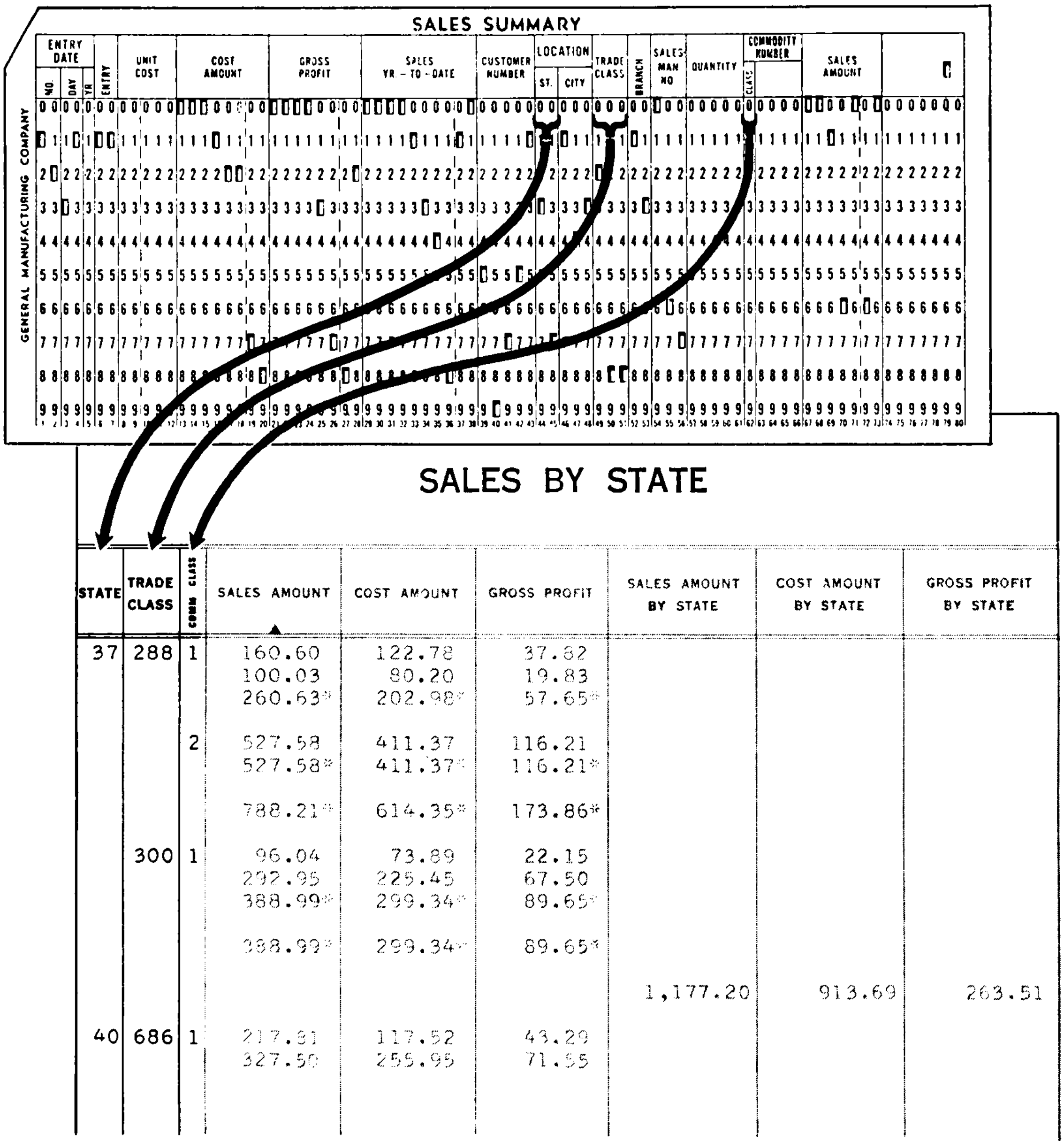
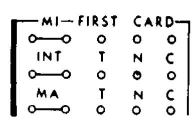


Figure 22. Group-Indicated Report

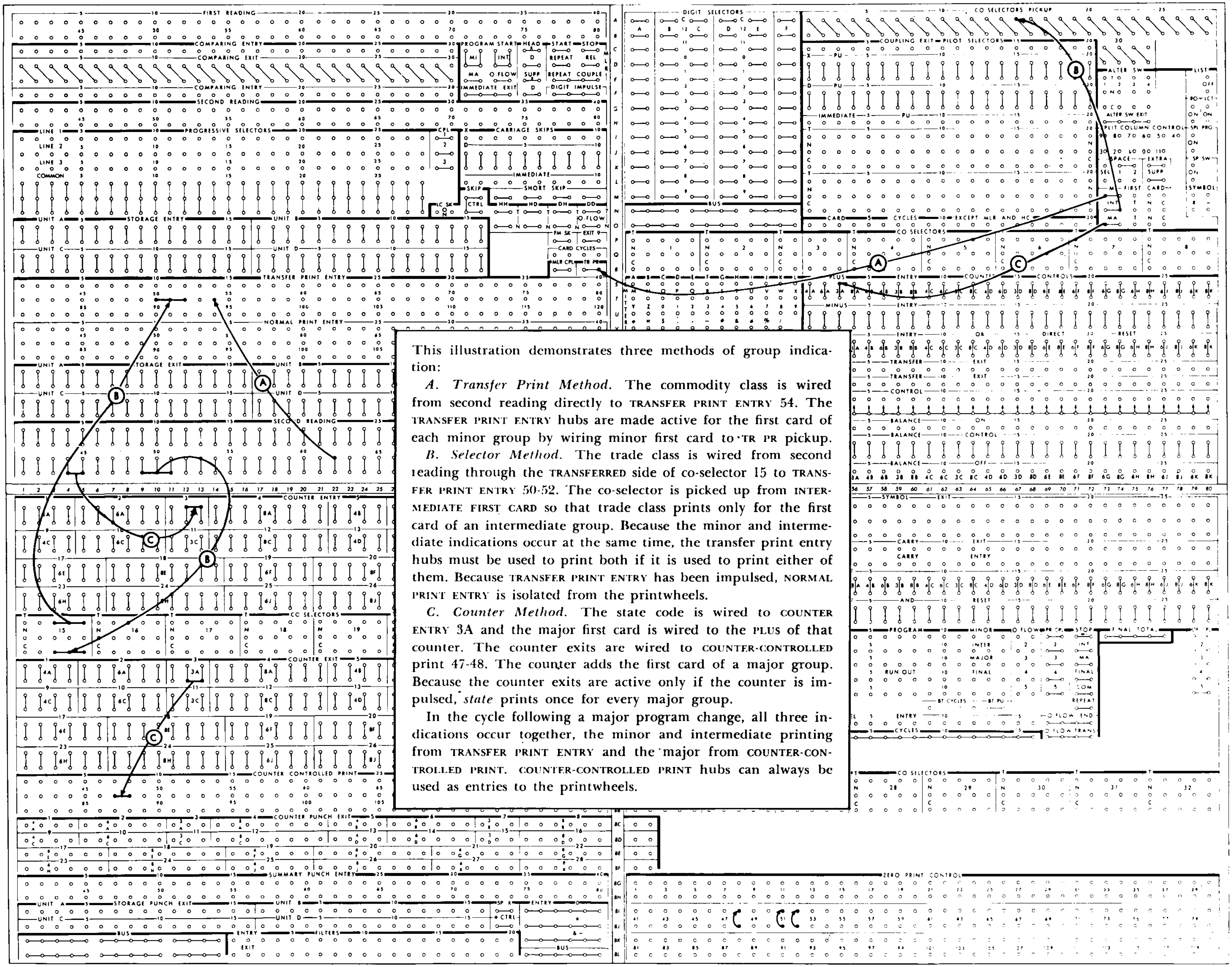
Group Indication

The printing of information from only the first card of a group as shown in Figure 22 is called group indication. In detail printing, normally the indicative information is printed repetitively from every card in the control group. In group printing, the indicative information for minor, intermediate and major prints on the first card of every group. This repetitive printing can be suppressed by selection, by use of the transfer print hubs, or by printing from counter exits. Each method is discussed in detail following the explanation of the hubs that are used for group indication (Figure 23).



M-0, 73-77

First Card Mi, Int, Ma. The MI (minor), INT (intermediate) and MA (major) FIRST CARD hubs emit cycles impulses for the print cycle of the first card of their respective program groups, regardless of whether the first card is a detail or a heading card. The minor first card also emits a cycles impulse for the first detail card following a heading card, regardless of program change. These hubs are normally wired to counter



This illustration demonstrates three methods of group indication:

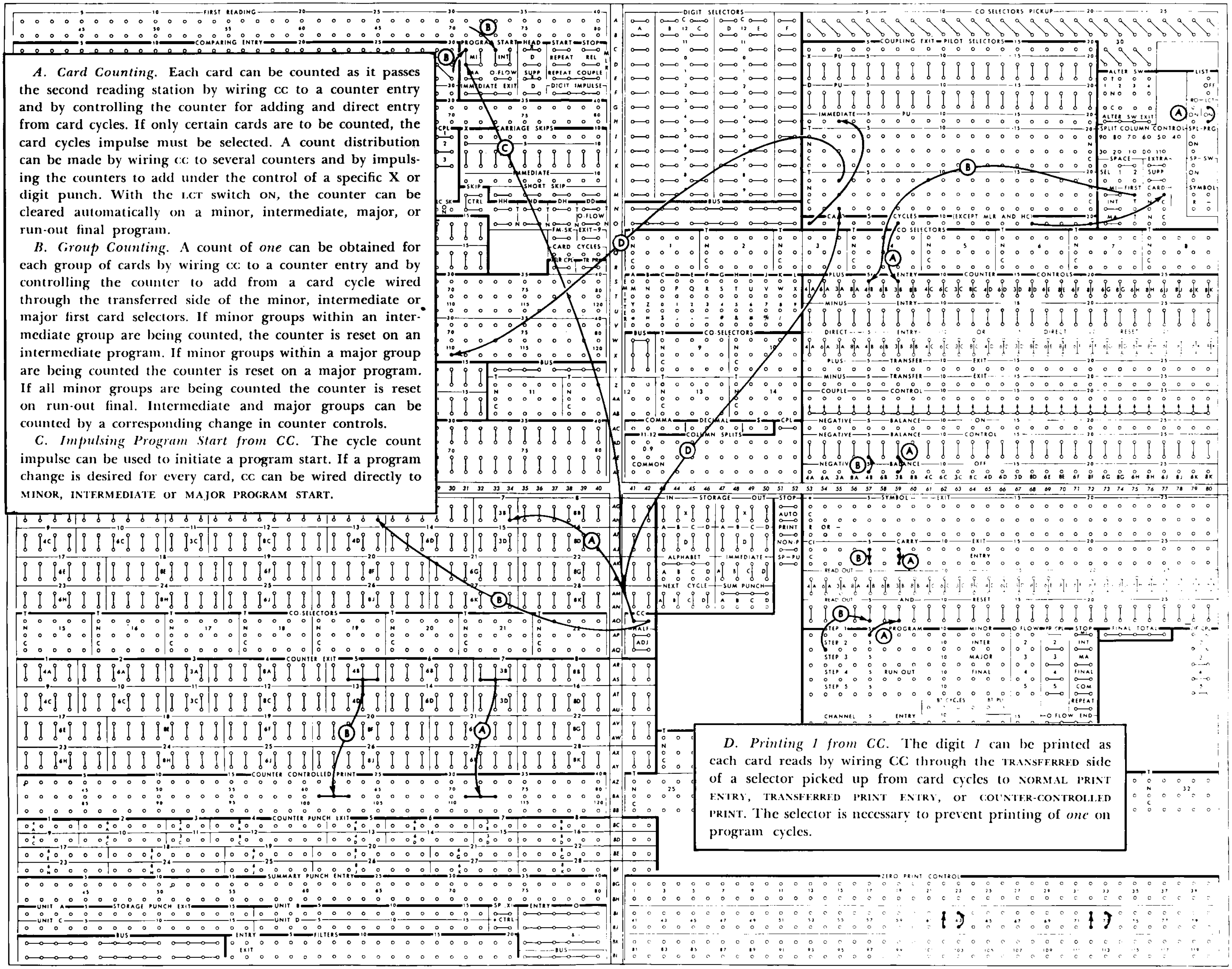
A. Transfer Print Method. The commodity class is wired from second reading directly to TRANSFER PRINT ENTRY 54. The TRANSFER PRINT ENTRY hubs are made active for the first card of each minor group by wiring minor first card to TR PR pickup.

B. Selector Method. The trade class is wired from second reading through the TRANSFERRED side of co-selector 15 to TRANSFER PRINT ENTRY 50-52. The co-selector is picked up from INTERMEDIATE FIRST CARD so that trade class prints only for the first card of an intermediate group. Because the minor and intermediate indications occur at the same time, the transfer print entry hubs must be used to print both if it is used to print either of them. Because TRANSFER PRINT ENTRY has been impulsed, NORMAL PRINT ENTRY is isolated from the printwheels.

C. Counter Method. The state code is wired to COUNTER ENTRY 3A and the major first card is wired to the PLUS of that counter. The counter exits are wired to COUNTER-CONTROLLED print 47-48. The counter adds the first card of a major group. Because the counter exits are active only if the counter is impulsed, *state* prints once for every major group.

In the cycle following a major program change, all three indications occur together, the minor and intermediate printing from TRANSFER PRINT ENTRY and the major from COUNTER-CONTROLLED PRINT. COUNTER-CONTROLLED PRINT hubs can always be used as entries to the printwheels.

Figure 23. Group Indication



A. Card Counting. Each card can be counted as it passes the second reading station by wiring CC to a counter entry and by controlling the counter for adding and direct entry from card cycles. If only certain cards are to be counted, the card cycles impulse must be selected. A count distribution can be made by wiring CC to several counters and by impulsing the counters to add under the control of a specific X or digit punch. With the LCT switch ON, the counter can be cleared automatically on a minor, intermediate, major, or run-out final program.

B. Group Counting. A count of *one* can be obtained for each group of cards by wiring CC to a counter entry and by controlling the counter to add from a card cycle wired through the transferred side of the minor, intermediate or major first card selectors. If minor groups within an intermediate group are being counted, the counter is reset on an intermediate program. If minor groups within a major group are being counted the counter is reset on a major program. If all minor groups are being counted the counter is reset on run-out final. Intermediate and major groups can be counted by a corresponding change in counter controls.

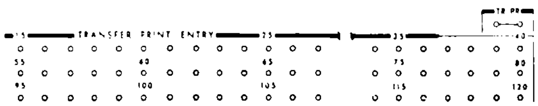
C. Impulsing Program Start from CC. The cycle count impulse can be used to initiate a program start. If a program change is desired for every card, CC can be wired directly to MINOR, INTERMEDIATE or MAJOR PROGRAM START.

D. Printing 1 from CC. The digit *1* can be printed as each card reads by wiring CC through the TRANSFERRED side of a selector picked up from card cycles to NORMAL PRINT ENTRY, TRANSFERRED PRINT ENTRY, or COUNTER-CONTROLLED PRINT. The selector is necessary to prevent printing of *one* on program cycles.

Figure 24. Cycle Count—Counting, Programming, and Printing

plus to add the first card of a group, or to the pickup of a co-selector, or the transfer print entry hubs for group indication.

There is for each program a first card selector that transfers automatically when the corresponding first card hubs are active. These selectors can be used to select card cycle impulses to control counters, card count impulses to enter counters on the first card of a group only, or single card columns to be group indicated.

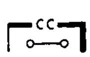


R, 39-40; S-U, 1-40

Transfer Print Entry. These hubs are another set of entries to the 120 printwheels and are active only for the duration of the impulse reaching the two common TR PR (transfer print) pickup hubs. TRANSFER PRINT ENTRY hubs are normally wired from SECOND READING through the PROGRESSIVE SELECTORS for MLR (multiple line reading) operations, or directly from SECOND READING for non-MLR operations.

TR PR (Transfer Print). These common hubs represent the pickup for the 120-position transfer print entry unit. They are impulsed from any cycles impulse, such as CARD CYCLES, FIRST CARD impulses, program exits, program couple, or a pilot selector COUPLING EXIT. The TRANSFER PRINT ENTRY hubs remain active only for the duration of the impulse wired to TR PR. Therefore, it is not practical to impulse TR PR from digit impulses (9-12). When comma, decimal, or dollar sign symbols are selected by means of TRANSFER PRINT ENTRY, the TR PR must be picked up from CARD CYCLES, COUPLING EXIT of pilot selectors, or program couple.

Counting and Programming with Cycle Count

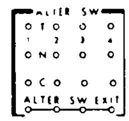


AO, 41-42

CC (Cycle Count). These hubs emit a *one* impulse during every machine cycle. They can be used to count any or all machine cycles or, when properly controlled, to count cards or groups of cards, or to initiate a program start (Figure 24).

Alteration Switches

By using the alteration switches one control panel can be used for several different reports without any change in control panel wiring.



E-H, 73-76

Alteration SW 1, 2, 3, 4. Four alteration toggle switches are located in the switch box on the top of the machine (Figure 25). Each alteration switch controls a corresponding alteration switch selector. When the switch is on T, a common connection exists between C and T; when on N, the connection is between C and N. An alteration switch selector remains transferred as long as the corresponding toggle switch is set on T. Any impulse, including the summary punch switch, can be wired through C-N or C-T.

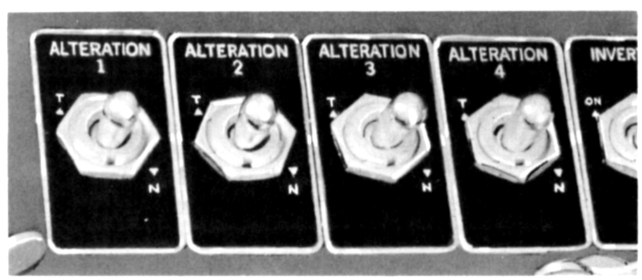


Figure 25. Alteration Switches

Pilot or co-selectors can be picked up through alteration switch selectors. In this case, one of the four alteration switch exits is wired through the normal or transferred side of an alteration switch selector (depending upon the position of the switch) to the pickup of a co-selector or *the D pickup of a pilot selector.* Co-selectors can then be used to select any impulse except the summary punch switch; pilot selectors can then be used to select any impulse except a line impulse.

Many uses for the alteration switches, like changing from detail printing to group printing with or without summary punching, programming, print selection, or counter clearing vary machine functions from one report to another.

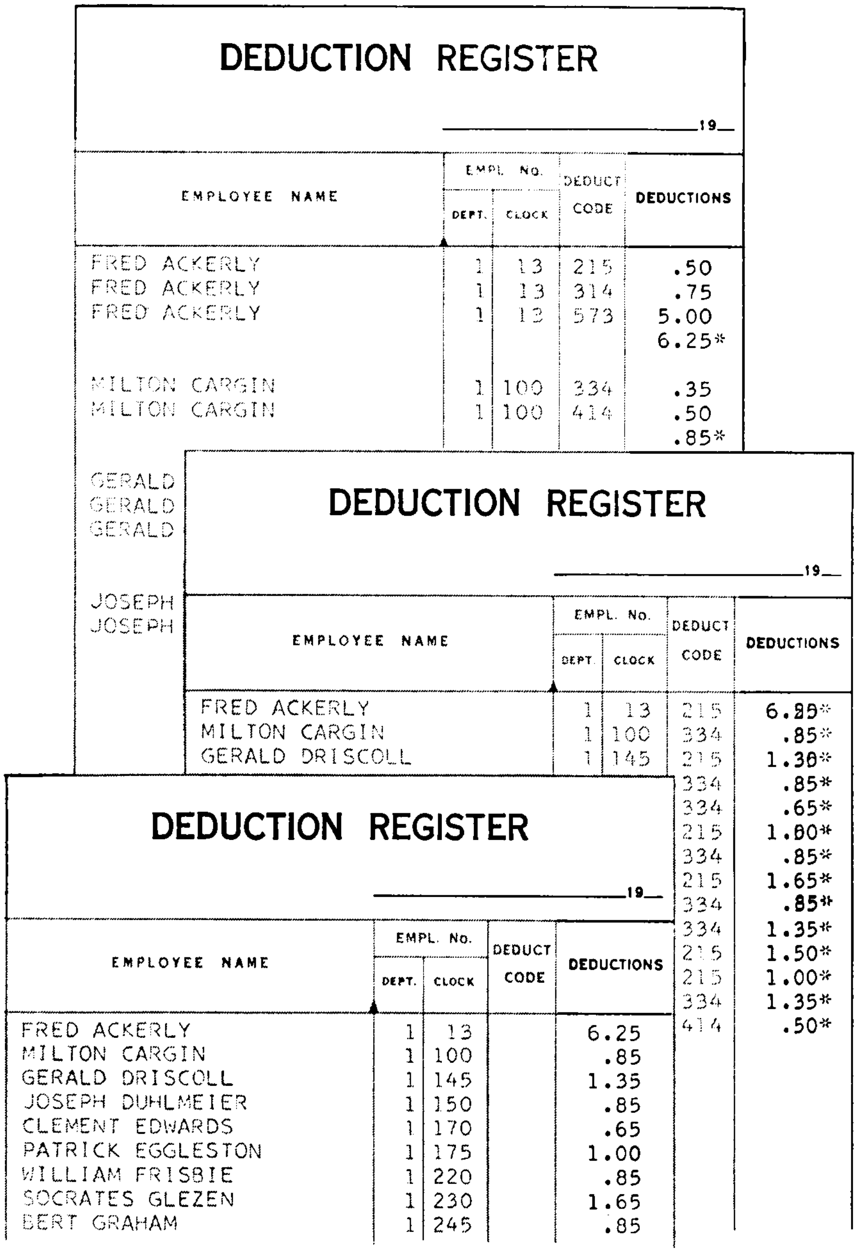


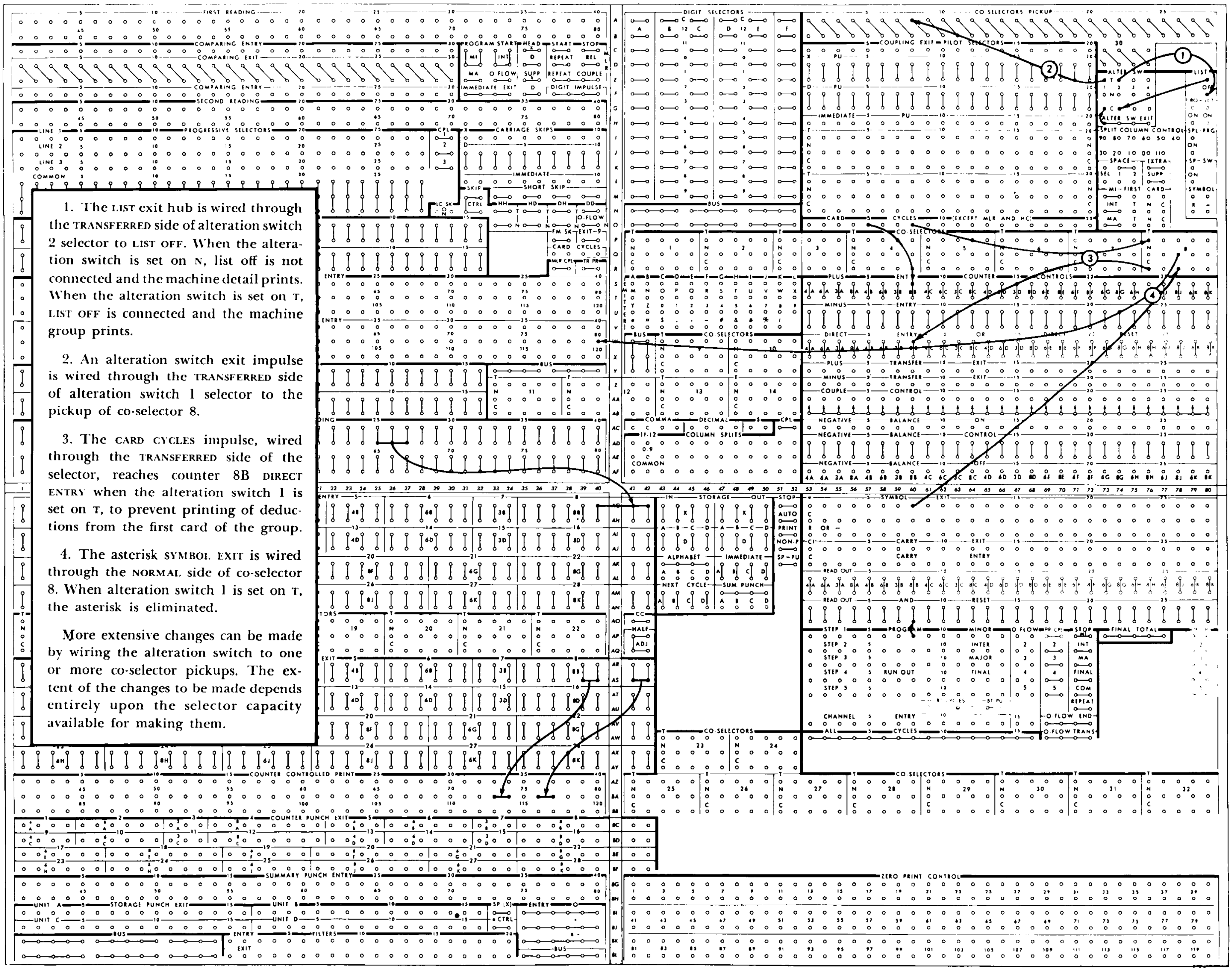
Figure 26. Detail and Group Reports, with Example of Overprinting

Changing from Detail Printing to Group Printing

In the example in Figure 26, the first report is detail printed; the second and third reports are group printed (LIST OFF). Without alteration switches, the LIST OFF hubs would have to be connected, and a card cycle impulse would have to be wired to DIRECT ENTRY of the counter being used, to eliminate overprinting as shown in the deduction column of the second report. These wiring changes can be made automatically by using the alteration switch feature of the machine (Figure 27).

Field Selection

When a choice must be made between different fields and the chosen field is to be printed from one set of printwheels or entered into one counter, field selection is necessary. Field selection can be accomplished by the use of co-selectors; transfer and normal print entry can be used under certain conditions. Co-selectors must be used when the selected information is to enter counters. Regardless of the purpose or method used, an X or a digit must identify one class of card to distinguish it from another. For printing purposes, the information may be numerical or alphabetic. For counter entry purposes, the information must be numerical. (See Figures 28 and 29 for wiring examples.)



1. The LIST exit hub is wired through the TRANSFERRED side of alteration switch 2 selector to LIST OFF. When the alteration switch is set on N, list off is not connected and the machine detail prints. When the alteration switch is set on T, LIST OFF is connected and the machine group prints.

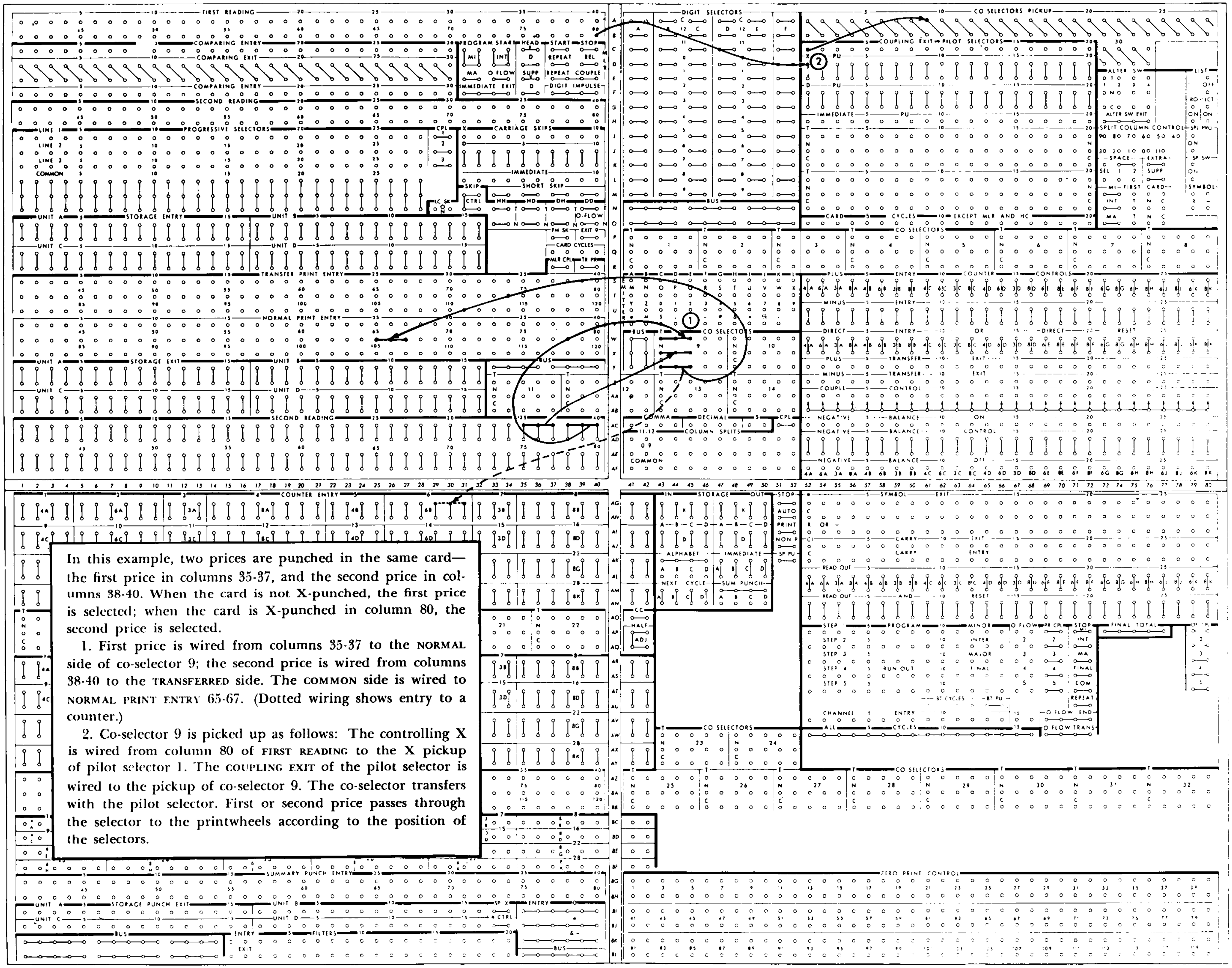
2. An alteration switch exit impulse is wired through the TRANSFERRED side of alteration switch 1 selector to the pickup of co-selector 8.

3. The CARD CYCLES impulse, wired through the TRANSFERRED side of the selector, reaches counter 8B DIRECT ENTRY when the alteration switch 1 is set on T, to prevent printing of deductions from the first card of the group.

4. The asterisk SYMBOL EXIT is wired through the NORMAL side of co-selector 8. When alteration switch 1 is set on T, the asterisk is eliminated.

More extensive changes can be made by wiring the alteration switch to one or more co-selector pickups. The extent of the changes to be made depends entirely upon the selector capacity available for making them.

Figure 27. Changing from Detail to Group Printing

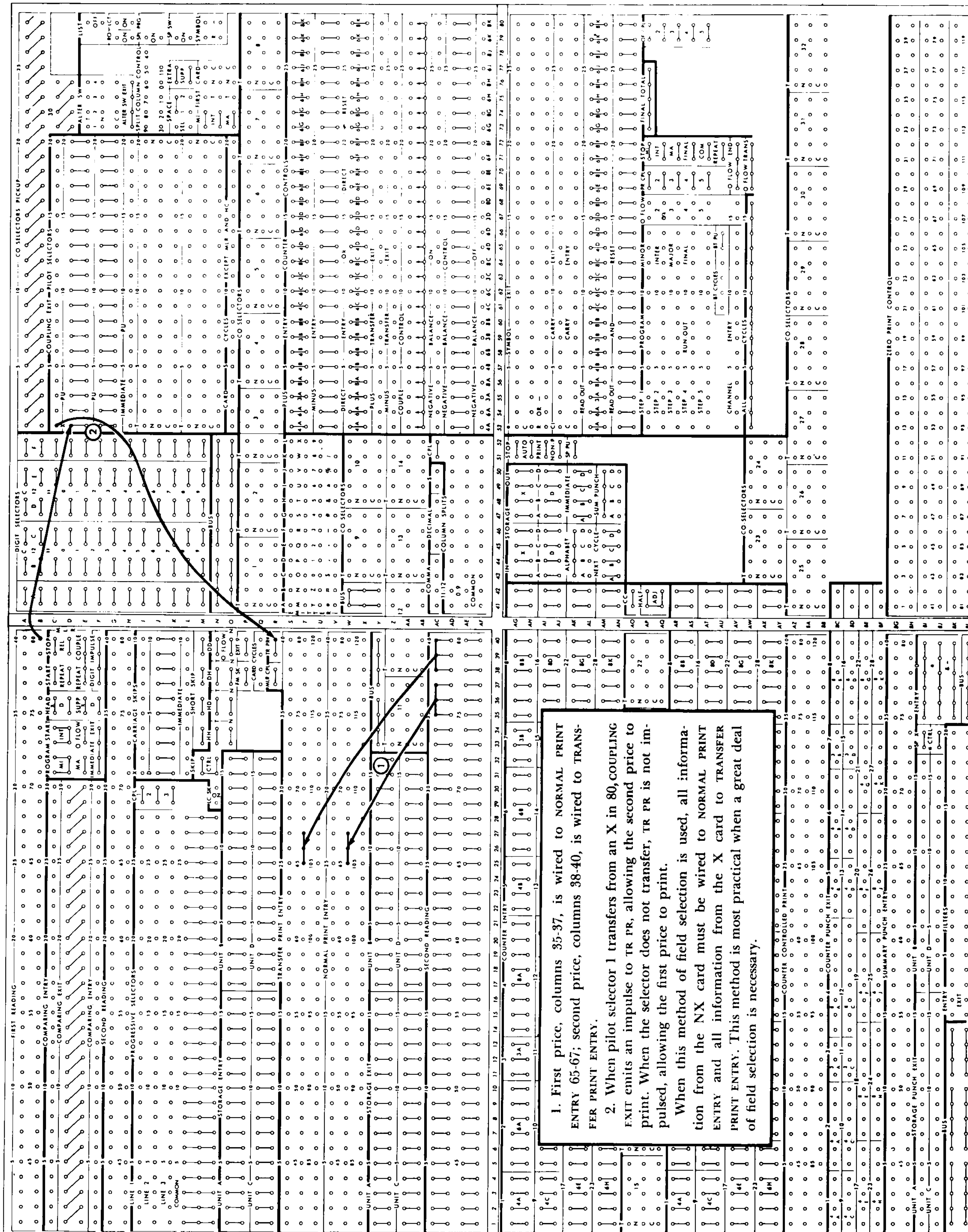


In this example, two prices are punched in the same card—the first price in columns 35-37, and the second price in columns 38-40. When the card is not X-punched, the first price is selected; when the card is X-punched in column 80, the second price is selected.

1. First price is wired from columns 35-37 to the NORMAL side of co-selector 9; the second price is wired from columns 38-40 to the TRANSFERRED side. The COMMON side is wired to NORMAL PRINT ENTRY 65-67. (Dotted wiring shows entry to a counter.)

2. Co-selector 9 is picked up as follows: The controlling X is wired from column 80 of FIRST READING to the X pickup of pilot selector 1. The COUPLING EXIT of the pilot selector is wired to the pickup of co-selector 9. The co-selector transfers with the pilot selector. First or second price passes through the selector to the printwheels according to the position of the selectors.

Figure 28. Field Selection, Co-Selector Method



1. First price, columns 35-37, is wired to NORMAL PRINT ENTRY 65-67; second price, columns 38-40, is wired to TRANSFER PRINT ENTRY.

2. When pilot selector 1 transfers from an X in 80, COUPLING EXIT emits an impulse to TR PR, allowing the second price to print. When the selector does not transfer, TR PR is not impulsed, allowing the first price to print.

When this method of field selection is used, all information from the NX card must be wired to NORMAL PRINT ENTRY and all information from the X card to TRANSFER PRINT ENTRY. This method is most practical when a great deal of field selection is necessary.

Figure 29. Field Selection, Transfer-Print Method

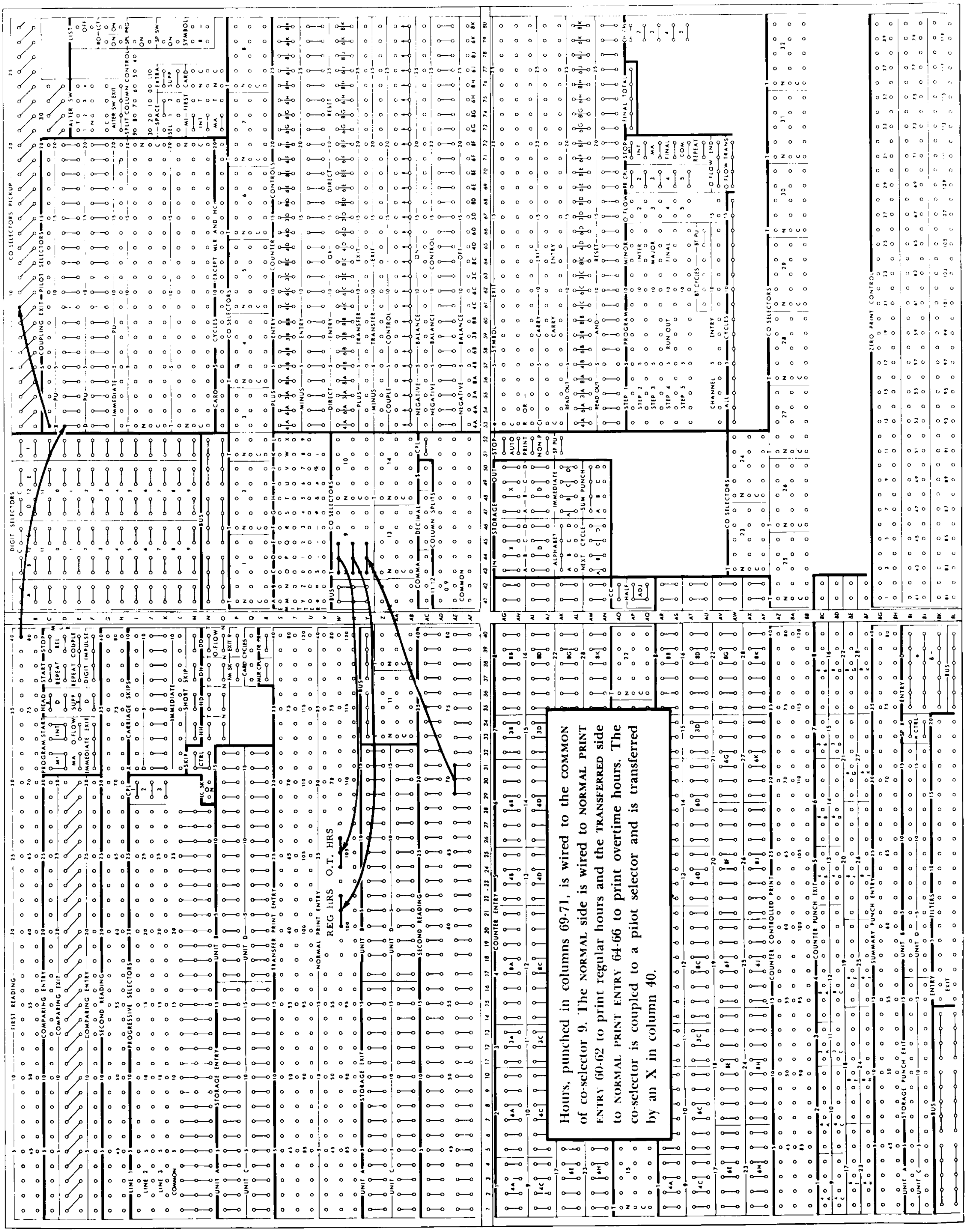
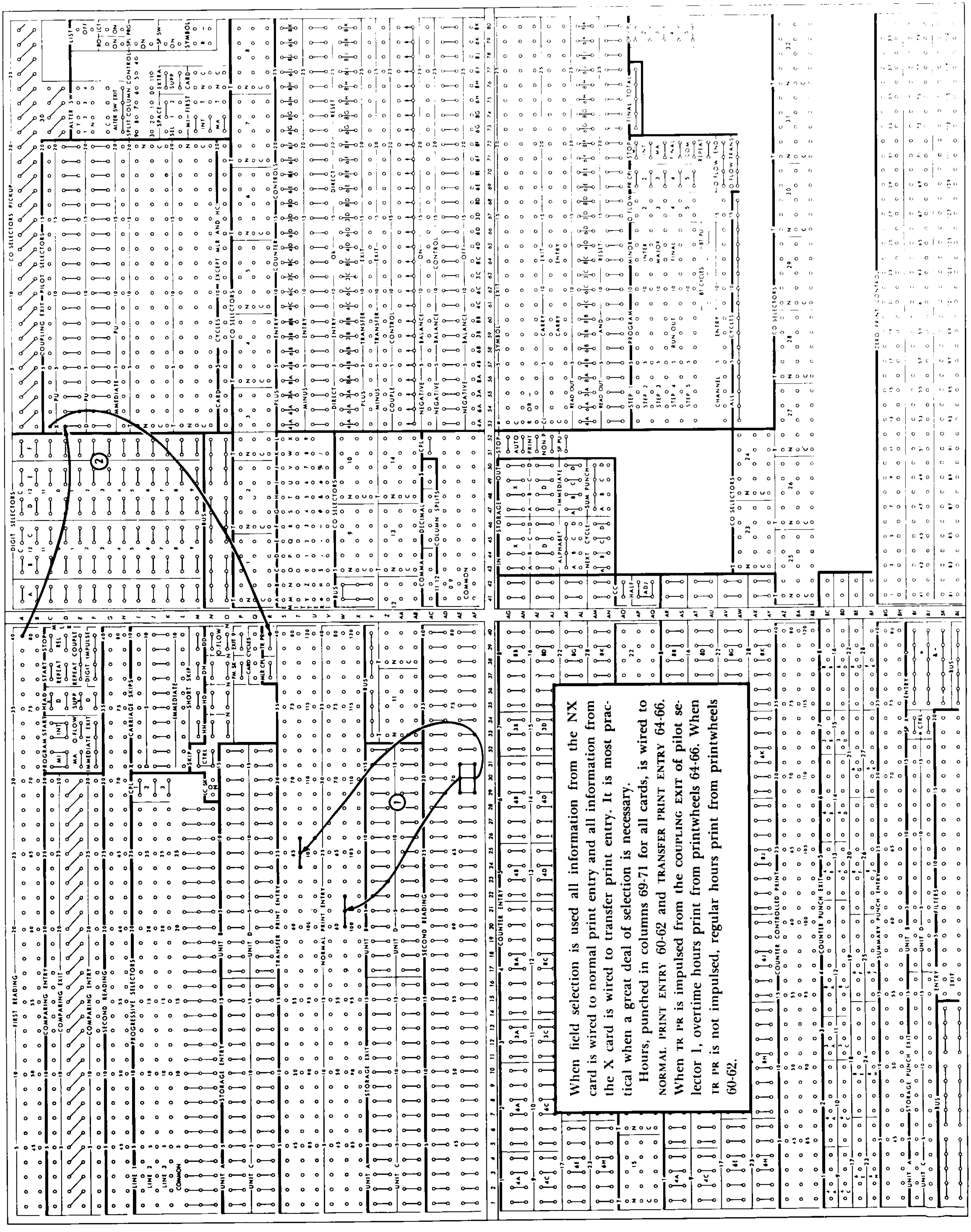


Figure 30. Class Selection, Co-Selector Method



When field selection is used all information from the NX card is wired to normal print entry and all information from the X card is wired to transfer print entry. It is most practical when a great deal of selection is necessary.

Hours, punched in columns 69-71 for all cards, is wired to NORMAL PRINT ENTRY 60-62 and TRANSFER PRINT ENTRY 64-66. When TR PR is impulsed from the COUPLING EXIT of pilot selector 1, overtime hours print from printwheels 64-66. When TR PR is not impulsed, regular hours print from printwheels 60-62.

Figure 31. Class Selection, Transfer-Print Method

Class Selection

Class selection is necessary whenever a choice must be made between several printing locations wired from the same field in different cards. The different classes of cards must be identified by X's or digits that are used to control selection.

The field to be selected is wired to the common side of a co-selector, the normal side to one set of printwheels, and the transferred side to another set of printwheels. The printing locations are selected under control of the X or digit (see Figures 30 and 31).

Symbol Selection

Symbols most frequently selected are amount punctuations, such as comma, decimal, and dollar signs, and amount identification, such as C, R or —. Selection is necessary when the symbols are to be printed under conditions described in the following examples.

Comma, Decimal, Dollar Symbol Selection

It is sometimes necessary to punctuate amounts on total cycles but not on card cycles, and *vice versa.* Often it may be necessary to punctuate amounts on certain card cycles identified by an X or digit, first card of minor, intermediate or major groups, etc.

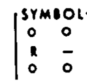
HEADING	INVOICE NO. 12345
	AMOUNT
ITEM	625.37
ITEM	23.19
ITEM	.10
ITEM	1,742.75
	$ 2,391.41

Figure 32. Amount Symbol Selection

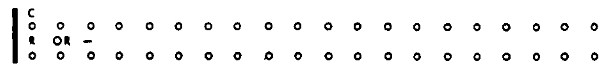
In Figure 32, punctuation is not required for invoice number printed from the heading card (X40). Decimals and commas are required to punctuate amounts in the body of the form. In addition, the dollar symbol is required on a total cycle but not on card cycles.

Figure 34 shows wiring for comma, decimal, and dollar symbol selection.

C, R or Minus Selection, Detail and Total Printing



M-N, 79-80



AH-AI, 53-80

It is possible to select the R or — switch so that the R or — exit hubs emit an R during total cycles and a minus during detail print cycles:

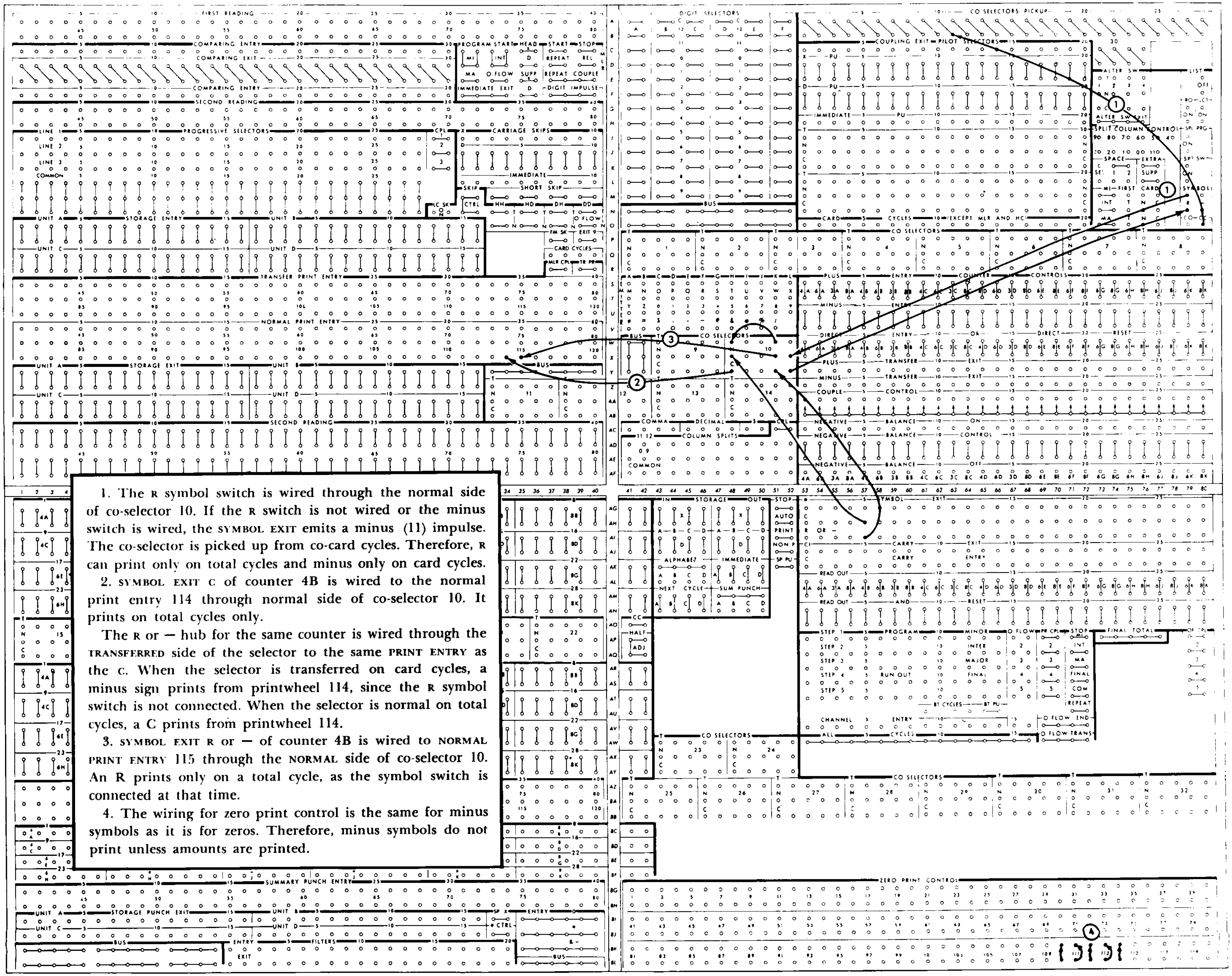
```
 123-
 147
 112-
 ----
 88CR*
```

In the example above, 123 and 112 are recognized as negative by the minus sign. The total, 88*, is recognized as negative by the CR symbols. The — and the C impulses to the same printwheel must therefore be selected (see Figure 33).

C, R or Minus Selection, Printing on One Line

Form design sometimes can dictate that several negative amounts appear on the same line of printing. It is possible to identify some negative amounts by a minus symbol, and others by a CR symbol.

When the symbol switch is not wired on the control panel, each R or (—) hub emits an X impulse (—) to identify negative amounts; when the symbol switch is wired, each hub emits both an X and a nine impulse. The combination of these two impulses causes the printing of an R. The nine impulse can be eliminated, by the use of a column split, when necessary. Symbol selection on the same cycle is explained in Figure 35.



1. The R symbol switch is wired through the normal side of co-selector 10. If the R switch is not wired or the minus switch is wired, the SYMBOL EXIT emits a minus (11) impulse. The co-selector is picked up from co-card cycles. Therefore, R can print only on total cycles and minus only on card cycles.

2. SYMBOL EXIT C of counter 4B is wired to the normal print entry 114 through normal side of co-selector 10. It prints on total cycles only.

The R or — hub for the same counter is wired through the TRANSFERRED side of the selector to the same PRINT ENTRY as the C. When the selector is transferred on card cycles, a minus sign prints from printwheel 114, since the R symbol switch is not connected. When the selector is normal on total cycles, a C prints from printwheel 114.

3. SYMBOL EXIT R or — of counter 4B is wired to NORMAL PRINT ENTRY 115 through the NORMAL side of co-selector 10. An R prints only on a total cycle, as the symbol switch is connected at that time.

4. The wiring for zero print control is the same for minus symbols as it is for zeros. Therefore, minus symbols do not print unless amounts are printed.

Figure 33. C, R, or Minus Selection, Detail and Total Printing

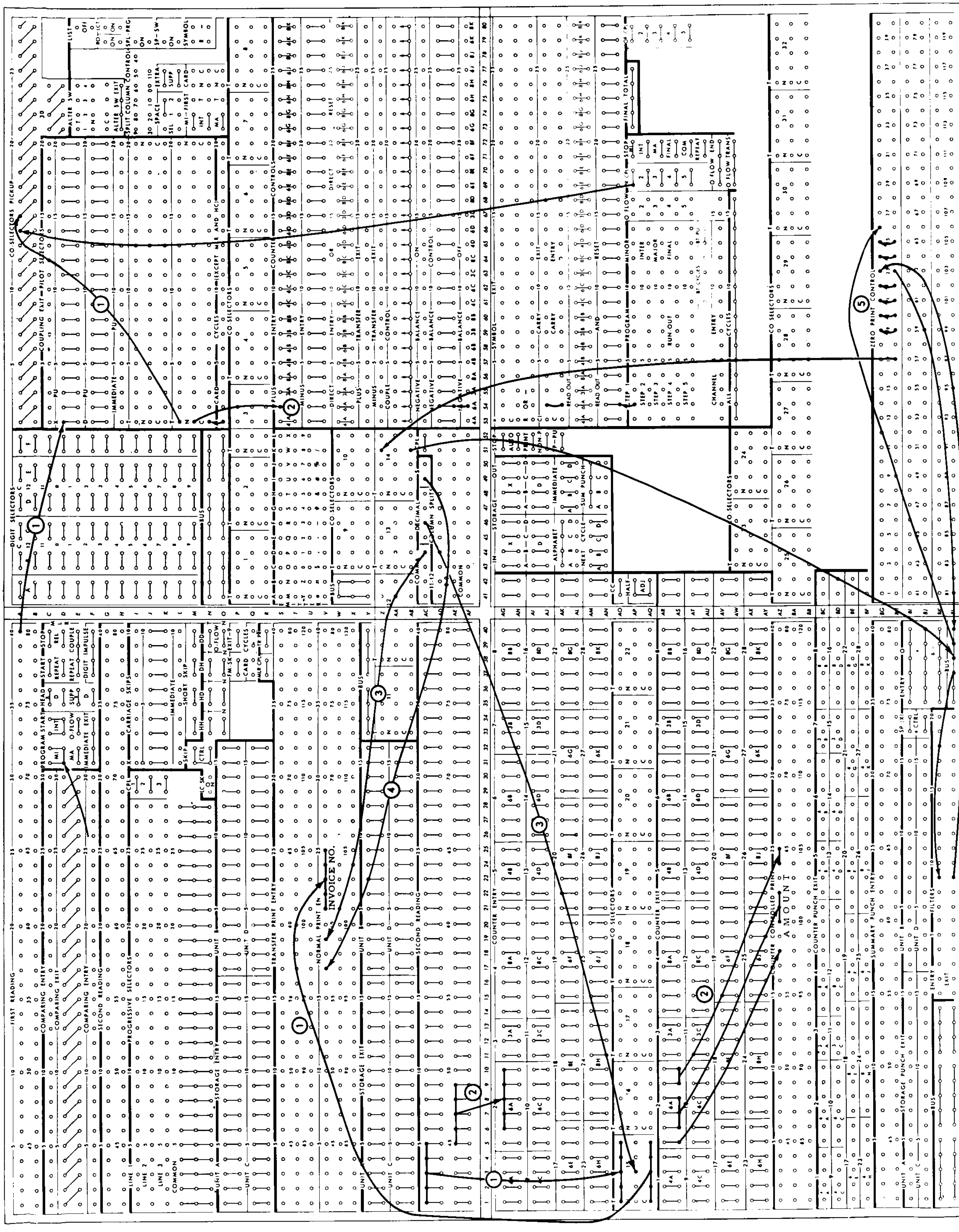


Figure 34. Comma, Decimal, Dollar Symbol Selection

1. Invoice number is wired through co-selector 15 to NORMAL PRINT ENTRY 21-25. The co-selector is picked up on X40 cards by wiring CARD CYCLES through the TRANSFERRED side of pilot selector 1 to co-selector 15 pickup. Pilot selector 1 is picked up from an X40.

2. The amount field is wired to counter 6A, controlled to add from NX40 cards. The amount is wired to COUNTER-CONTROLLED PRINT 18-25 with proper spacing for commas and decimals.

3. The decimal is wired to print on both detail and program cycles through the NORMAL side of co-selector 15. The comma is wired directly to printwheel 19 and prints only when a significant digit is printed from printwheel 18.

4. Although the dollar symbol is wired directly to NORMAL PRINT wheel 17, it is controlled to print on total cycles only, by wiring the lower hub of ZERO PRINT CONTROL 17 through the TRANSFERRED side of co-selector 14 to the upper hub of 26 via the bus. The co-selector is picked up on the minor program level, thus causing printwheel 17, which is printing the dollar symbol, to be connected back to the units position of the field only on the total cycle.

The zero print control wiring must be selected and not the dollar symbol. If the zero print control wiring was direct and the dollar symbol selected, an asterisk would print on detail print cycles through a back circuit.

5. ZERO PRINT CONTROL hubs are wired normally.

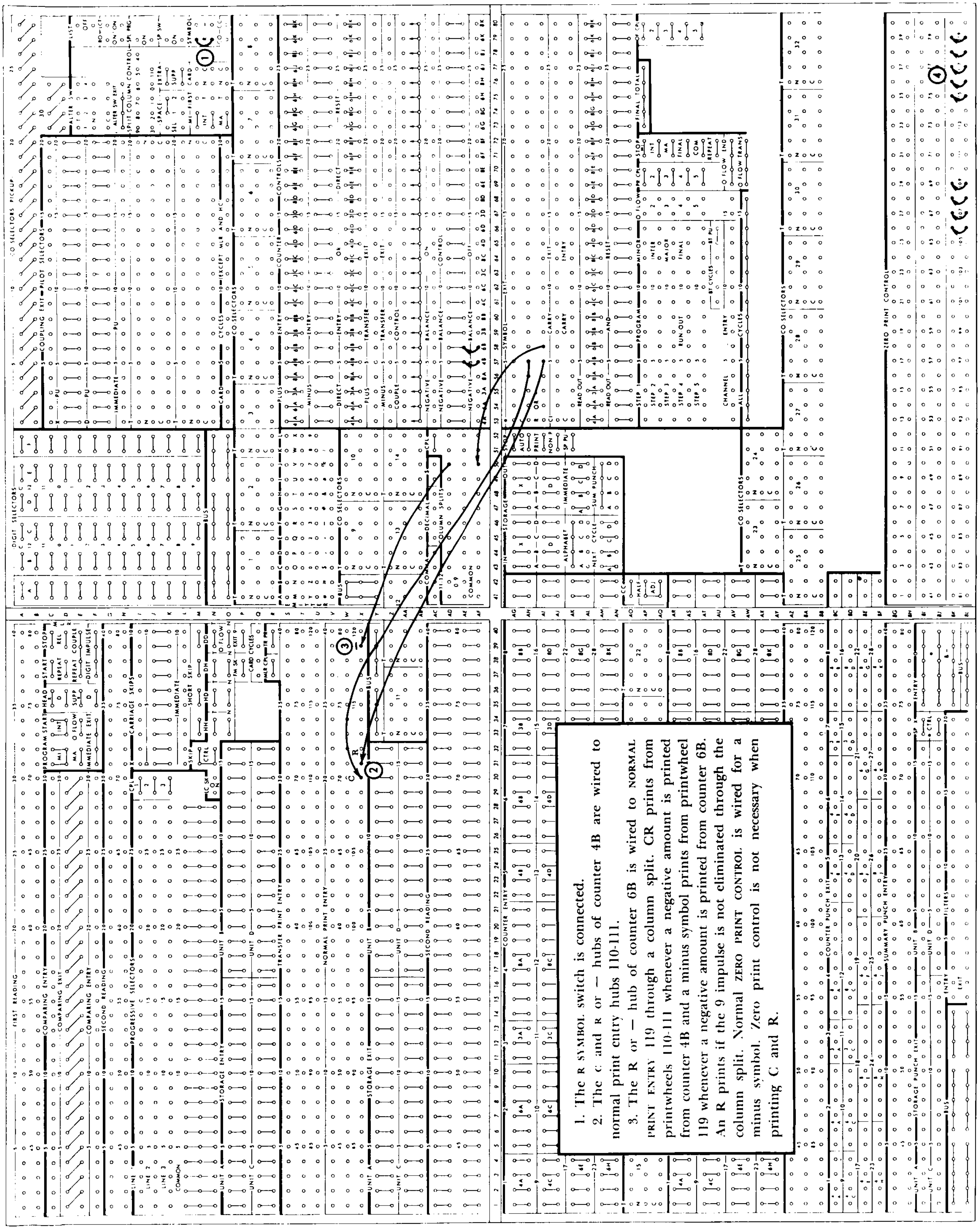


Figure 35. C, R, or Minus Selection, Printing on One Line

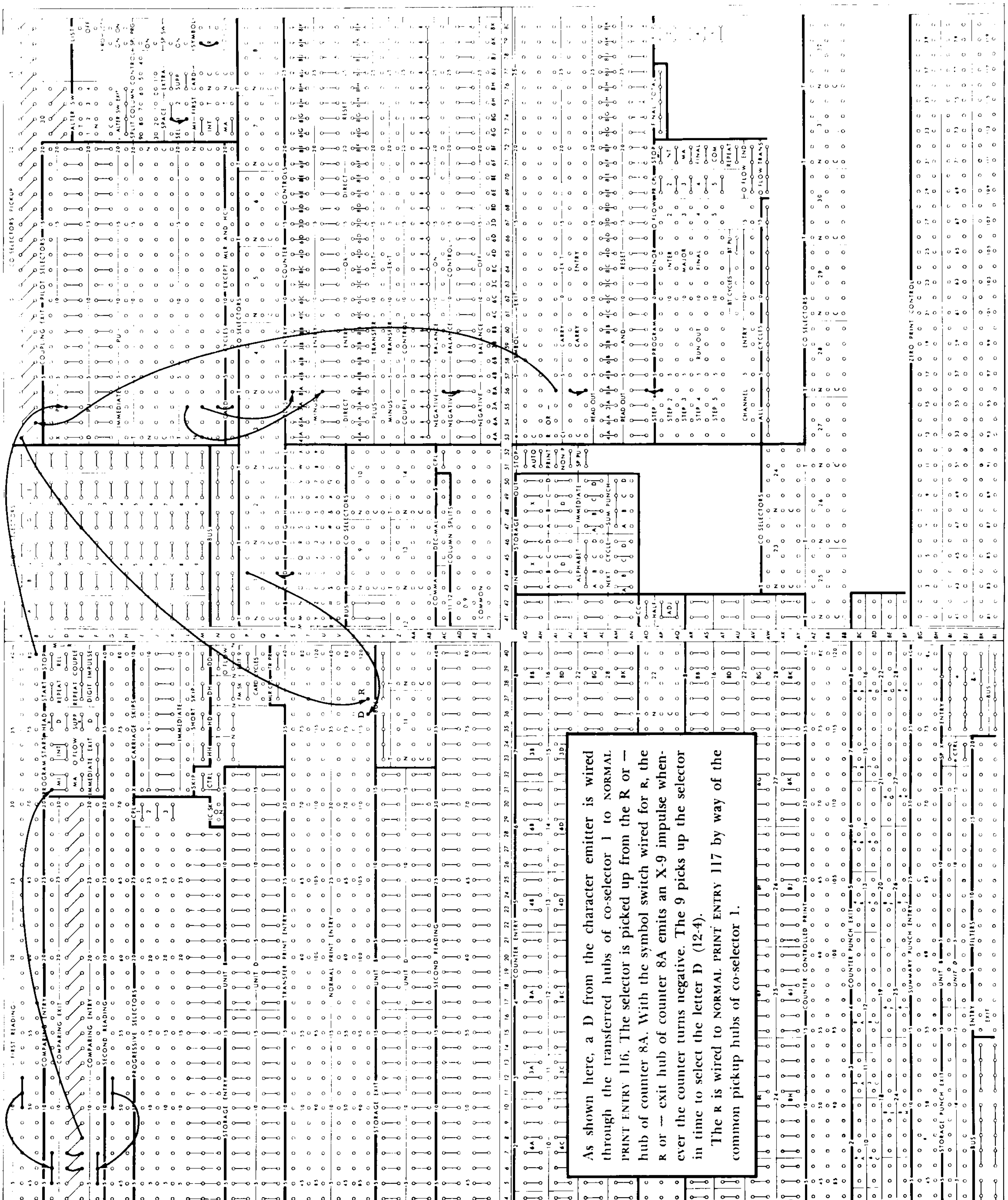
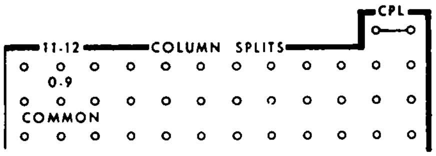


Figure 36. DR for Negative Amounts



AC, 51-52, AD-AF, 41-52

Column Split. Twelve column splits are standard, each of which has three hubs; C (common), 0-9, and 11-12. They separate 11 and 12 impulses from 0-9 impulses obtained either from punching in the card or automatic impulses on the control panel. The column splits also operate for summary punching to control X punching over specific columns.

The couple (CPL) hubs are provided to pick up co-selectors in order to obtain additional column split positions. For summary punching, however, the co-selector positions cannot be used as column splits, since the co-selectors remain transferred throughout the summary-punch cycle and no distinction can be made between 0-9 and 11-12. Couple hubs can be used to control functions during the second half of the cycle.

Printing DR Instead of CR for Negative Amounts

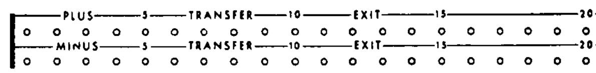
A *D* can be substituted for the *C* in the CR symbol by wiring an emitted *D* through a selector. The selector is activated by an R from the symbol exit, as diagrammed in Figure 36.

Total Transfer

Total Printing from the Same Printwheels

More than one type of total can be printed from the same printwheels without the use of selectors. This operation is sometimes referred to as total transfer, and is based upon the principle of rolling totals, as they are obtained, from one counter to another.

Each total requires a separate counter. Only the minor counter adds or subtracts from the card, however. During the minor program change, the minor total prints and rolls into the intermediate counter. During an intermediate program change, the intermediate total prints and rolls into the major counter. During a major program change, the major total prints and rolls into a final total counter. Thus, the final total is the sum of all the major totals, the major total is the sum of all the intermediate totals, and the intermediate total is the sum of all the minor totals. This method of accumulating totals is proof that if the final total is correct, the major, intermediate, and minor totals that contribute to the final total are also correct and that all totals represent the sum of the individual items as printed on the report.



Y-Z, 53-80

Transfer Exit, Plus and Minus. Each counter group has TRANSFER EXIT PLUS and MINUS hubs. The transfer exit plus hub emits an impulse whenever the counter is plus and is controlled to read out and reset. It is normally wired to the PLUS ENTRY of a receiving counter. The transfer exit minus hub emits an impulse whenever the counter is minus or contains a zero balance, and is controlled to read out and reset. It is normally wired to the MINUS ENTRY of a receiving counter. Neither the transfer plus nor the transfer minus hubs emit an impulse when the counter is controlled to read out only.

The TRANSFER PLUS or MINUS EXIT of a transmitting counter cannot be wired directly to the plus or minus hubs of a receiving counter if the receiving counter hubs are also impulsed from some other source. For example, if counter 4A is the transmitting counter and 6A is the receiving counter and 6A is wired from CARD CYCLES, the TRANSFER PLUS EXIT of 4A must be wired through a filter before reaching 6A. Direct wiring between these two hubs in this instance allows the card cycles impulse from 6A to back up into the transfer exit hub of 4A and cause 4A to subtract if it reaches TRANSFER PLUS, or to add if it reaches TRANSFER MINUS.

When totals are transferred from coupled counters, the TRANSFER EXIT of either counter can be used.

Figure 37 illustrates the printing of minor, intermediate and major totals from the same printwheels. It is a group printed report with a minor program on city, an intermediate program on county, and a major program on state. All three totals are printed from the same printwheels, the intermediate total being indicated by one asterisk, and the major total by two asterisks.

Credit Symbol Printing During Total Transfer

When a positive minor total is subtracted in an intermediate counter, CR or (—) lists from the intermediate counter on the same line as the positive minor total, if the symbols for the intermediate counter are wired directly to the printwheels. This occurs because the intermediate counter subtracts on the minor total cycle and emits a credit symbol impulse. The unwanted symbols can be eliminated by wiring the intermediate symbols through the TRANSFERRED side of a selector picked up immediately from intermediate PROGRAM COUPLE.

Total Transfer of Zero-Balance. When minor totals are transferred to an intermediate counter, CR prints for zero-balance minor totals if the CR symbols from the intermediate counter are wired directly to the printwheels. This occurs because a zero-balance minor total subtracts in the intermediate counter, causing the intermediate counter to print CR on the minor program cycle.

STATE	CO.	CITY	SALES	
1	1	1	500.00	Minor Totals
		2	200.00	
		3	50.00-	
			650.00 *	Intermediate Total
	2	1	1,082.75	Minor Totals
		2	940.50	
		3	300.00	
			2,323.25 *	Intermediate Total
			2,973.25 **	Major Total

Figure 37. Totals from Same Printwheels

The unwanted symbol printing can be eliminated by wiring the intermediate symbols through the TRANSFERRED side of a selector picked up immediately from intermediate PROGRAM CYCLE.

This problem does not arise when a minus (—) sign is used to identify negative totals (Figure 38), since the (—) symbol is under zero print control; therefore, it does not print for zero balances.

Total Printing from Different Printwheels

Minor, intermediate and major totals can be total transferred and also total printed from different printwheels. The difference between the wiring for this and the previous example is that the counter exits of the transferring counters must be wired to counter entries of receiving counters. Wiring from exit to exit would cause detail or total printing in three places from any one counter (Figure 39).

Zero and Special Symbol Control

Printwheels are designed to print normally only significant digits 1 to 9 and any letter or special character with a 1 to 9 combination.

The impulse, or impulses, wired to print entry must be able to reach the fuse to energize the print magnet and cause printing. There is an internal connection between the print magnet and the fuse at the time a digit 1 through 9 is read. However, that connection is broken after 1-time and before zero time, so that a 0, 11, and 12 cannot normally reach the fuse. A character that does not have a digit 1 to 9 does not normally reach the fuse for the same reason. Therefore zeros, whether they are read from a card or from a counter, do not normally print. For example, a number like 010050 would print as (1 5). Zero printing is controlled by use of the ZERO PRINT CONTROL hubs on the control panel. These hubs will be described first, for controlling zeros, and second, for controlling the comma, decimal, dollar sign, ampersand (&), and dash (—) symbols.

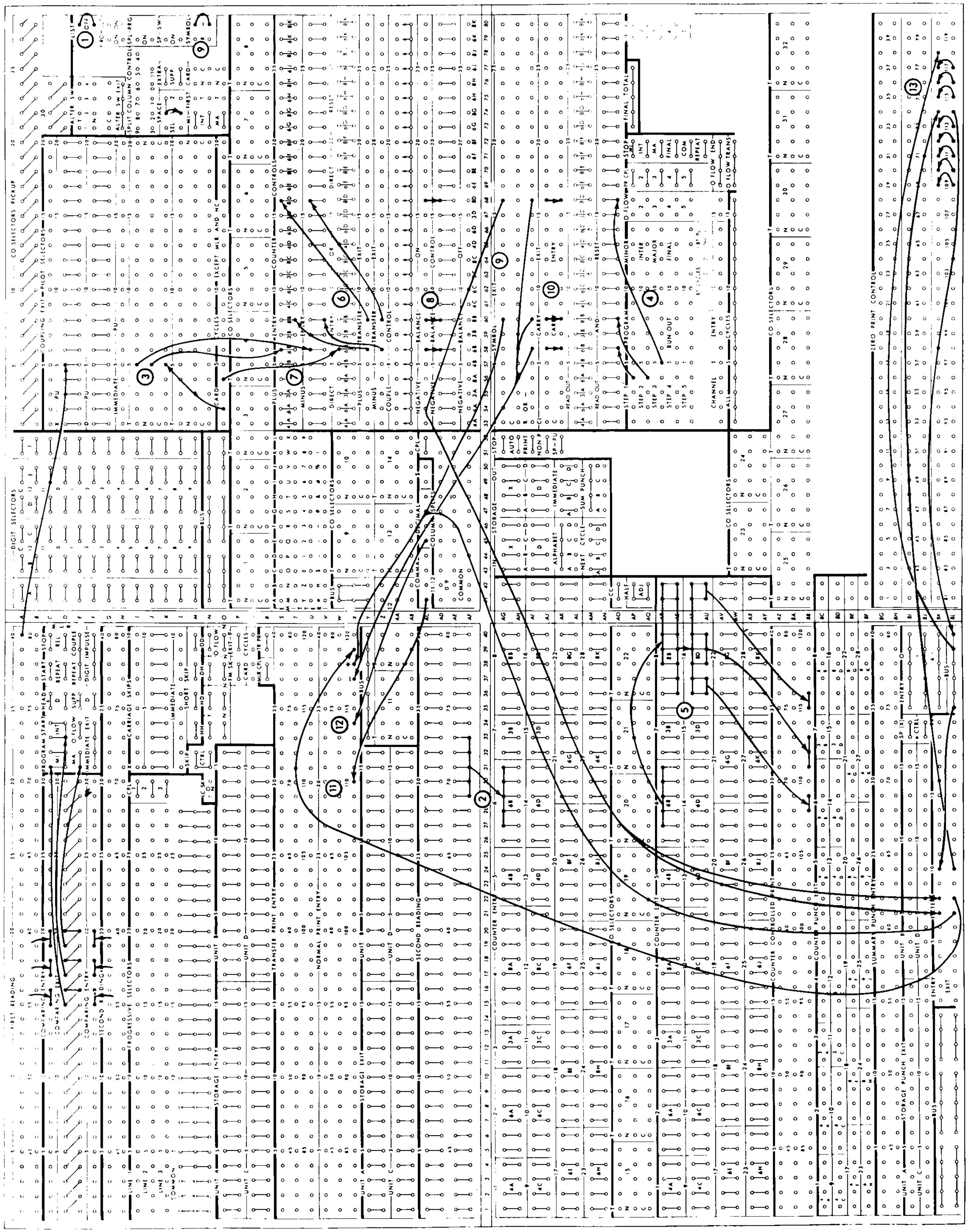


Figure 38. Total Transfer, Same Printwheels

1. Because this is a group printed report, list is wired OFF.

2. Sales amount is wired from SECOND READING to COUNTER ENTRY 6B.

3. Returns are identified by an X punch in column 40 This column is wired from FIRST READING to the X-pickup of pilot selector 5. A card cycle impulse is wired through the NORMAL side of the pilot selector to the plus of counter 6B and through the TRANSFERRED side to the minus of counter 6B.

4. Counters 6B, 8B and 8D are controlled to read out and reset on minor, intermediate and major programs, respectively.

5. The exit of counter 6B is wired to the exit of counter 8B, and the exit of 8B is wired to the exit of counter 8D. Counter exit 8D is also wired to COUNTER-CONTROLLED PRINT 108-116. Counter 6B is the only counter that adds or subtracts each individual card as it passes second reading. Counters 8B and 8D add or subtract totals only as they are transferred from one counter to the other.

In a minor program, the total prints directly from counter 6B, but it also transfers to the intermediate counter 8B where it adds or subtracts according to whether it is plus or minus. The total is always converted as it reads out, so a true figure always is transferred.

In an intermediate program, the intermediate total prints from counter 8B and transfers to the major counter 8D, where it adds or subtracts according to whether it is plus or minus.

In a major program, the major total prints from counter 8D.

Transfer between counters is made over wires connecting counter exits, when the counters are impulsed to read out and reset.

6. When minor totals are transferred from counter 6B, they are either added or subtracted into counter 8B by wiring the TRANSFER PLUS EXIT of 6B to 8B plus, and the TRANSFER MINUS EXIT of 6B to 8B minus.

When intermediate totals are transferred from counter 8B they are either added or subtracted into 8D by wiring the TRANSFER PLUS EXIT of 8B to 8D plus, and the TRANSFER MINUS EXIT of 8B to 8D minus.

7. Because the report is group printed, printing from 6B exit must be suppressed during detail print cycles. This is done by wiring a CARD CYCLES impulse to the DIRECT ENTRY of 6B, thus causing the counter exits to be disconnected from counter entry during card reading cycles. This wiring would not be necessary if the report were detail printed.

8. Negative totals of all three counters are wired for conversion.

9. A minus sign is printed from printwheel 117 for a negative minor, intermediate or major total by wiring the R or — hubs for the minor, intermediate, and major counters to NORMAL PRINT ENTRY 117, which must be wired for zero print control. These symbols do not print on the indication cycle because DIRECT ENTRY of counter 6B is wired. The R or — symbol switch is set for MINUS.

One asterisk is printed for all intermediate totals by wiring from the asterisk symbol exit of counter 8B to NORMAL PRINT ENTRY 118. Two asterisks are printed for all major totals by wiring from the asterisk symbol hub of counter 8B to NORMAL PRINT ENTRY 118. The asterisk symbol hub of counter 8D is wired through filters to NORMAL PRINT ENTRY 118 and 119. The purpose of the filters is to prevent two asterisks from printing on the intermediate cycle.

10. CI and C are wired normally.

11. A comma is wired to NORMAL PRINT ENTRY 110.

12. A decimal is wired to NORMAL PRINT ENTRY 114.

13. Zero print control is wired for 109-117. The decimal point in 114 is printed to the left as well as the right of significant digits by wiring the lower hubs of 114 through a set of bus hubs to the upper hub of 117. It is also wired to the upper hub of 113 by way of a filter.

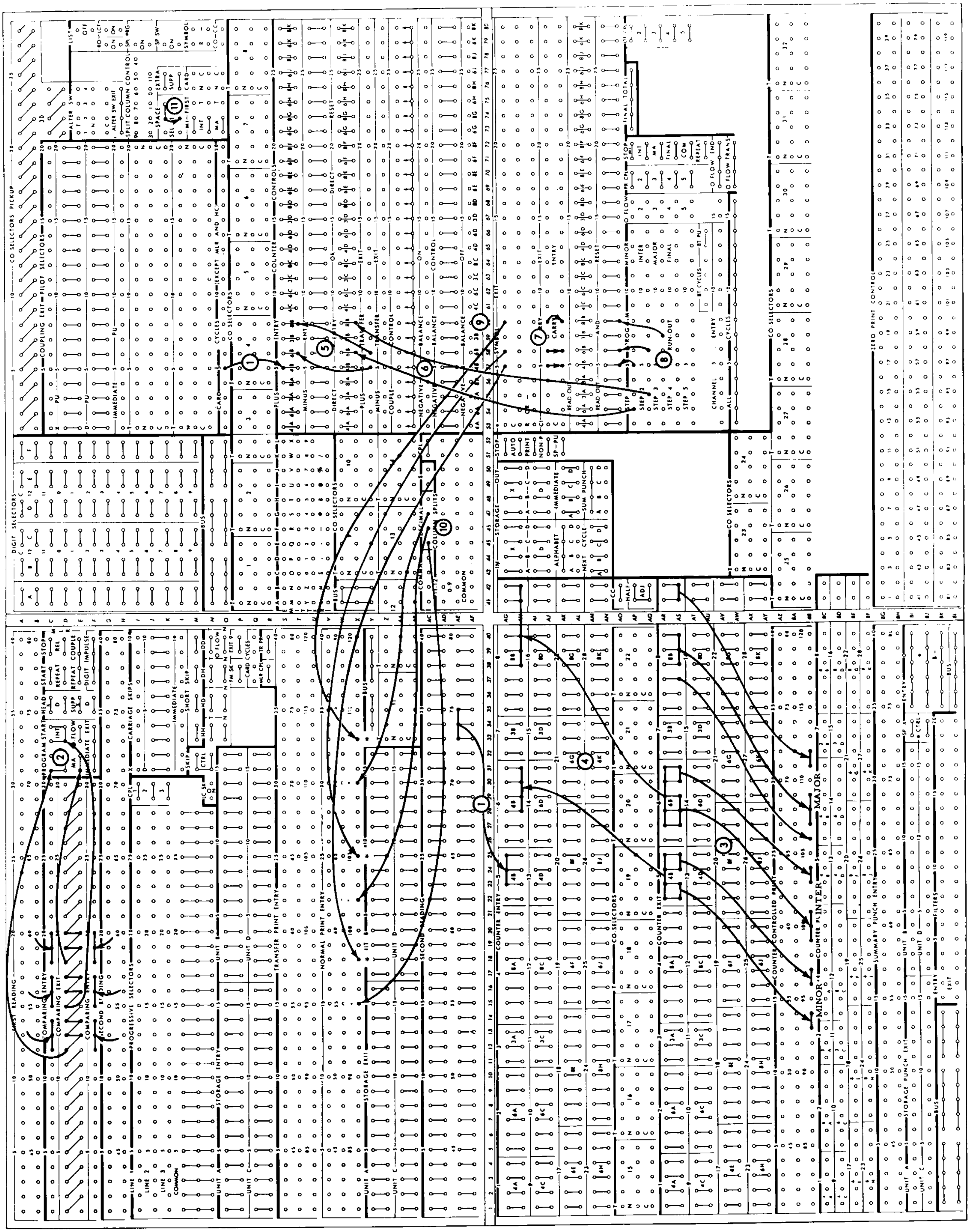


Figure 39. Total Transfer, Different Printwheels

1. The field to be added is wired to counter 4B entry and the counter is impulsed to add.

2. MINOR, INTERMEDIATE, and MAJOR PROGRAM STARTS are impulsed.

3. The minor total prints from printwheels 93-97 from COUNTER 4B EXIT. The intermediate total prints from printwheels 99-104 from COUNTER 6B EXIT. The major total prints from printwheels 106-112 from COUNTER 8B EXIT.

4. 4B exit is wired to 6B entry, so that when the minor total is read out to print, it can also add in the intermediate counter 6B. 6B exit is wired to 8B entry so the intermediate total is read out to print as it is added in the major counter 8B.

5. TRANSFER PLUS EXIT of counter 4B is wired to the plus of counter 6B so that the minor totals will be added in the intermediate counter. TRANSFER PLUS EXIT of 6B is wired to the plus of 8B so that intermediate totals may be added in the major counter.

6. To prevent the printing of minor totals from the intermediate counter exits, a MINOR PROGRAM EXIT is wired to DIRECT ENTRY of 6B. To prevent the printing of intermediate totals from the major counter exits, an INTERMEDIATE PROGRAM EXIT is wired to the DIRECT ENTRY of 8B. This wiring disconnects the exits from entries of 6B while the minor total is being added into 6B and the exits from entries of 8B while the intermediate total is being added into 8B.

7. CI and C are wired normally.

8. Counters 4B, 6B and 8B are wired to read out and reset on their respective programs.

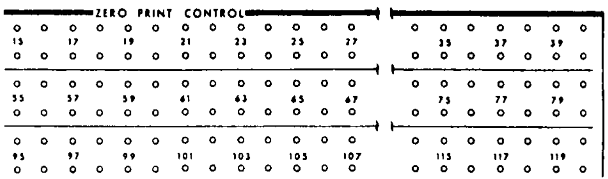
9. Asterisk symbols are wired to identify each total.

10. A decimal is wired between the tens and hundreds position of each total.

11. The single space switch is wired.

Although the zero print control wiring is not shown, it should follow the pattern previously described for the printing of zeros and decimals.

Zero Print Control for Zeros



BG-BL, 41-80

Zero Print Control. Each print entry position has a pair of zero print control hubs diagonally arranged in two rows as illustrated in Figure 40. The hubs in the lower row are numbered from 1 to 120 on the control panel to correspond to the print entry positions. The hubs in the upper row are not numbered on the control panel, but they are associated diagonally with the hubs in the lower row.

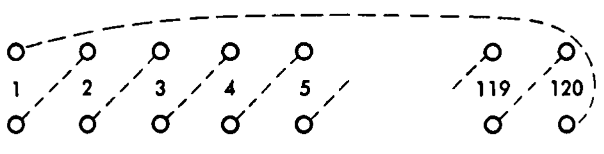


Figure 40. Zero Print Control Hub Alignment

The principle of zero print control can be explained by reference to Figure 41. Six zero print positions are shown for print wheels 41 to 46. It is assumed that card columns 1 through 6 (punched 010050) are wired from SECOND READING to NORMAL PRINT ENTRY 41 through 46. Each printwheel has a corresponding print magnet, which must be energized before a zero or a significant digit will print.

When a print entry position has been impulsed with a 9 to 1 digit (printwheels 42 and 45), the zero print contacts transfer and the connection between the two diagonal hubs is broken. The upper hub and print magnet are then connected directly to the fuse for zone time (0, 11, 12).

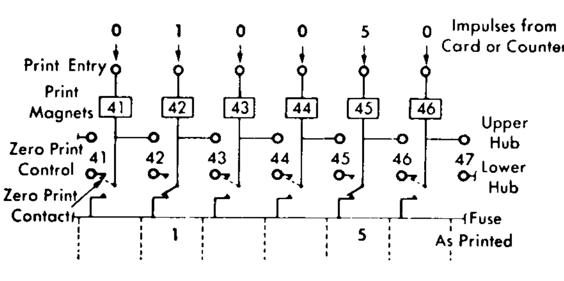


Figure 41. Zero Print Control Path to Fuse

This provides a path for a 0-, 11-, or 12-impulse to reach the fuse as in the case of an alphabetical character. In addition, the upper hub is connected to the fuse so that it could be used as an entry to the fuse. In positions that receive no significant digit (1 to 9) impulse, the zero print contacts do not transfer. A 0-, 11-, or 12-impulse entering that position would not find a path to the fuse but would be available out of the lower hub. The printing of zeros can be accomplished in the desired pattern by correctly wiring the zero print control hubs on the control panel. For example, if the lower hub of print magnet 46 is jack-plugged to the upper hub of 45, the zero impulse in position 46 would go through the normally closed zero print contact by control panel wire to the upper hub of 45, and then to the fuse. The upper hub of 45 was connected directly to the fuse because of the 5 impulse causing the zero print contact in that position to be transferred.

This arrangement affords complete flexibility in the printing of zeros. In the example above, the number may be wired to print either as 010050 or as 10050.

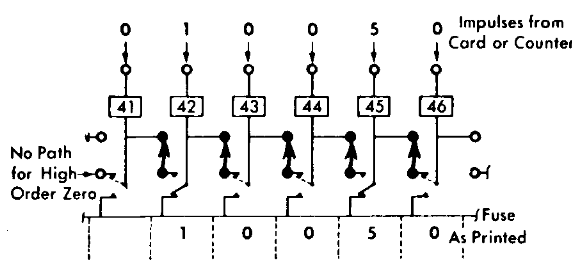


Figure 42. Zero Print Control—Zeros to Right of Significant Digit Only

If zeros are to print only to the right of the significant digits, the zero print control hubs are wired for each print wheel in use except the position of the highest order, as shown in Figure 42. The zeros from hubs 43 and 44 reach the fuse over the external wires connecting 44 and 43 and the internal connection established because of the digit 1 in printwheel 42. The high-order zero cannot reach the fuse and therefore cannot print.

Zeros may be printed to the left of significant digits as well as to the right by the wiring shown in Figure 43.

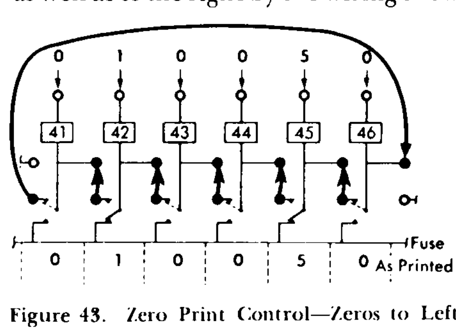


Figure 43. Zero Print Control—Zeros to Left of Significant Digit

The high-order zero prints because it reaches the fuse the same way that the zero in the units position does. All zeros punched in the card or contained in a counter print either to the left or right of a significant digit. Zeros do not print, however, unless there is a significant digit in some position.

BI, 35-40

0 Entry. These six common hubs provide a direct path to the fuse for zeros. They are normally wired from ZERO PRINT CONTROL as shown in Figure 44 to cause zeros to print regardless of significant digits. As there are no significant digits in the field, every lower zero print control hub is internally connected to its corresponding upper hub. The external wiring allows a zero anywhere in the field to reach the fuse by way of the (0) entry hubs.

ZERO PRINT CONTROL need not be wired for alphabetic fields unless interspersed numerical or special character information is to be printed. Five of the special characters (– & , . $) are controlled from zero print control.

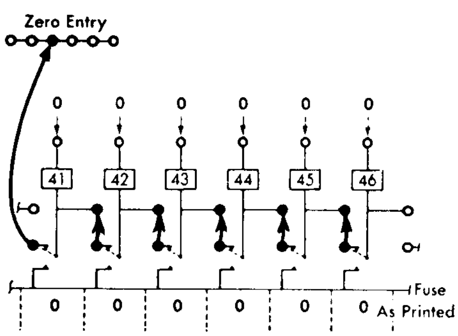


Figure 44. Zero Print Control — Zeros Regardless of Significant Digit

Zero Print Control for Dash (–) and Ampersand (&)

Because zone punches, by themselves, do not have a path to the fuse (11 for dash and 12 for ampersand) both the dash and the ampersand must be wired for zero print control and print under the same conditions in which the zero prints. In Figure 45, the dash impulse reaches the fuse because of the presence of significant digits to the left. If the field were punched with all zeros, the dash would not print.

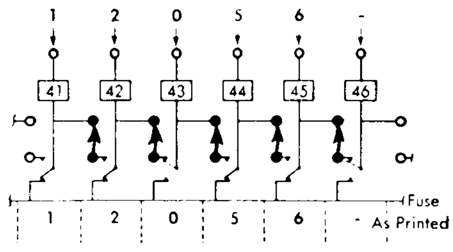


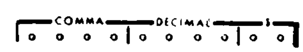
Figure 45. Zero Print Control — Dash and Ampersand

Zero Print Control — Comma, Decimal and Dollar Sign

There are three ways of printing commas, decimal points and dollar signs:

a. From the card columns in which they are punched to NORMAL OR TRANSFER PRINT ENTRY.
b. From the corresponding hubs in the character EMITTER to NORMAL OF TRANSFER PRINT ENTRY.
c. From the comma, decimal and dollar sign exits to NORMAL or TRANSFER PRINT ENTRY.

Under method *a*, the symbols print whenever they are punched, regardless of significant digits. Under method *b*, the symbols print every print cycle regardless of significant digits. Under method *c*, the symbols are controlled by zero print control.



AC, 41-50

Comma, Decimal, $. These hubs emit comma, decimal and dollar sign impulses every machine cycle. They are specially timed so that they can be printed only under control of ZERO PRINT CONTROL and in this way they differ from the comma, decimal or dollar sign impulses obtained from cards or from the emitter. They are normally wired directly to NORMAL or TRANSFER PRINT ENTRY to print the dollar sign and amount punctuation both on the detail print cycle and on the total cycle. They print with exactly the same type of control as that used for printing zeros; that is, they may be controlled to print to the right or left of significant digits by proper wiring of the zero print control hubs.

The comma, decimal and dollar sign hubs should never be split-wired directly to two or more different print entry hubs. If split-wiring is necessary each split should be wired through a filter.

Dollar Symbol

The dollar symbol is normally printed to the left of significant digits. To do this, the same ZERO PRINT CONTROL wiring must be used as that needed for printing zeros to the left of significant digits. Assuming that the $ hub is wired to NORMAL PRINT ENTRY 40 and the amount field to NORMAL PRINT ENTRY 41-46, the dollar sign prints to the left of significant digits by wiring lower ZERO PRINT CONTROL 40 to the upper hub of ZERO PRINT CONTROL 46 as shown in Figure 46. In this example, the dollar symbol reaches the fuse because of the digit *5*. The high-order zero print control hub (41) is not wired, in order to prevent the printing of zeros between the dollar sign and the high-order digit *1*.

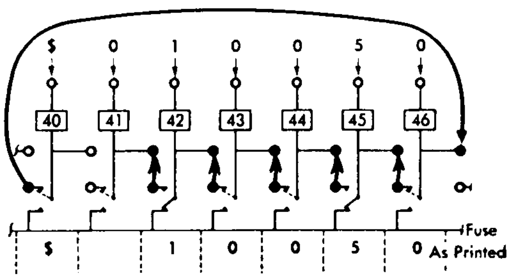


Figure 46. Zero Print Control — Dollar Symbol

Comma

The comma is normally printed to the right of significant digits. Printing of commas requires no special wiring other than that required for printing zeros. A comma impulse does not have a path to the fuse and, therefore, its printing depends upon the presence of significant digits. The comma shown in Figure 47 reaches the fuse because of the digit 2.

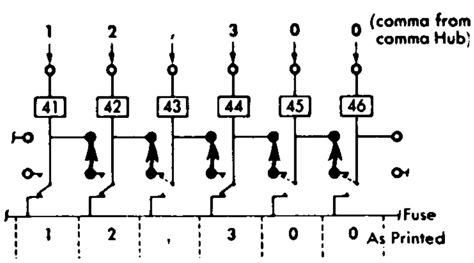


Figure 47. Zero Print Control — Comma

Decimal

There are two methods of wiring for decimal printing as illustrated in Figures 48 and 49.

The decimal point prints to the right of significant digits the same as zeros, with normal ZERO PRINT CONTROL wiring. This means that for amounts of 1.00 or

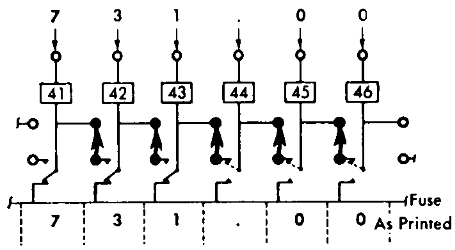


Figure 48. Zero Print Control — Decimal for Amounts of $1.00 or More

over, normal ZERO PRINT CONTROL wiring is sufficient. A decimal impulse does not have a path to the fuse and, therefore, its printing depends upon the presence of significant digits. The decimal shown in Figure 48 reaches the fuse because of the digit 1 in the hundreds position.

For amounts of 1 to 99 cents, however, normal wiring fails to print the zero and the decimal point to the left of the significant digits. This can be accomplished by wiring the lower hub of the decimal position back to the upper hub of the units position as shown in Figure 49. Both the zero and the decimal in this example print because of the presence of the digit 1. In order to print an amount such as 1.00, it would appear that lower hub 44 should be split-wired to upper hub 43. Although this wiring would cause zeros to print to the right of even dollar amounts, it would also cause zeros to print to the left of any amount under 1.00. Any zero to the left of the decimal could find its way to the fuse over the wiring originally intended to print decimals and zeros for amounts of from 1 to 99 cents. Although the connection shown by the dotted line in Figure 49 must be made, it cannot be made directly. To prevent zeros in the dollar columns from backing up and reaching the fuse by way of connections established by the units and tens positions, a filter is used.

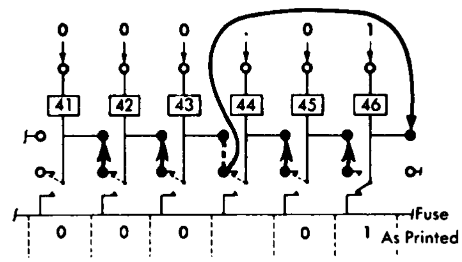
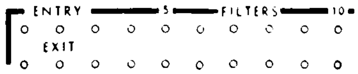


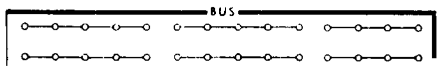
Figure 49 Zero Print Control — Decimal for Amounts Under $1.00

Filter Entry-Exit. These hubs permit the passage of an impulse in only one direction—into ENTRY and out of EXIT. When any two functions are connected by split wires or through a bus, any impulse reaching one function also reaches the other. This "back circuit"



BK-BL, 15-34

can be eliminated by a filter. Ten ENTRY and ten EXIT positions are standard. The exit of one filter should not be wired to the entry of another. Other suggestions for the use of filters may be found under *Operating Rules and Suggestions.*



N-0, 41-52; W-Y, 41-42; Y, 33-40; BL, 35-40; BK-BL, 1-14

Bus. There are 16 sets of BUS hubs; 10 sets have four common hubs, 4 sets have five common hubs, and 2 sets have six common hubs. When an impulse is entered into one of the hubs in a set, it is available out of the remaining hubs. Bus hubs are used in place of split wires.

Figure 50 shows the connection between lower 44 and upper 43 made through a filter. This allows zeros and the decimal for even dollar amounts to reach the fuse because of the presence of a significant digit anywhere to the left. It prevents zeros in 41, 42, 43 or 44 from reaching the fuse for amounts ranging from .01 to .99, since an impulse cannot pass through a filter from EXIT to ENTRY. In such operations, one filter should be used for every two positions to the right of the decimal to prevent an undue load on one filter. Refer to *Load Rating Table* under *Operating Rules and Suggestions.*

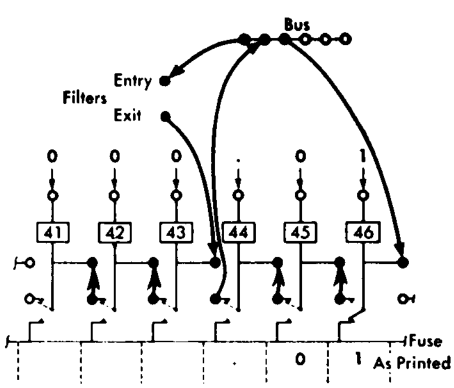


Figure 50. Zero Print Control — Decimal for all Amounts

Amount Punctuation

The correct printing of commas, decimal points, and dollar signs in amount field (Figure 51) is called *Amount Punctation.*

Expansion of Amount Punctuation Symbols

Four independent hubs are provided on the control panel for COMMAS, four for DECIMALS, and two for DOLLAR SIGNS (AC, 41-50). When amounts are punctuated by use of these hubs, it may be necessary to print more commas, decimals, or dollar symbols than there are hubs available on the control panel. If any one of these hubs is wired to two or more print entry hubs by split-wiring or through a BUS, 0-, 11-, and 12-impulses can back-circuit through ZERO PRINT CONTROL wiring and thus might cause unwanted or erroneous symbol printing.

Normally, these back-circuits can be eliminated by filters. If filters are not available, the back-circuits can be eliminated by co-selectors as shown in Figures 52-53-54.

Floating Dollar Sign and Check-Protecting Asterisk

The 407 provides two methods of check protection: the floating dollar sign and the check-protecting asterisk. A dollar sign can be made to print immediately to the left of the high-order significant digit (Figures 55 and 56). For example:

PRINT WHEELS							
6	7	8	9	10	11	12	13
$	9	2	5	4	.	9	2
	$	7	5	6	.	7	6
		$	9	2	.	4	3
			$	5	.	2	1
				$	.	1	0

Check protection can also be accomplished by printing asterisks (Figure 57) to the left of the high-order significant digit as follows:

PRINT WHEELS							
6	7	8	9	10	11	12	13
*	9	2	5	4	.	9	2
*	*	7	5	6	.	7	6
*	*	*	9	2	.	4	3
*	*	*	*	5	.	2	1
*	*	*	*	*	.	1	0

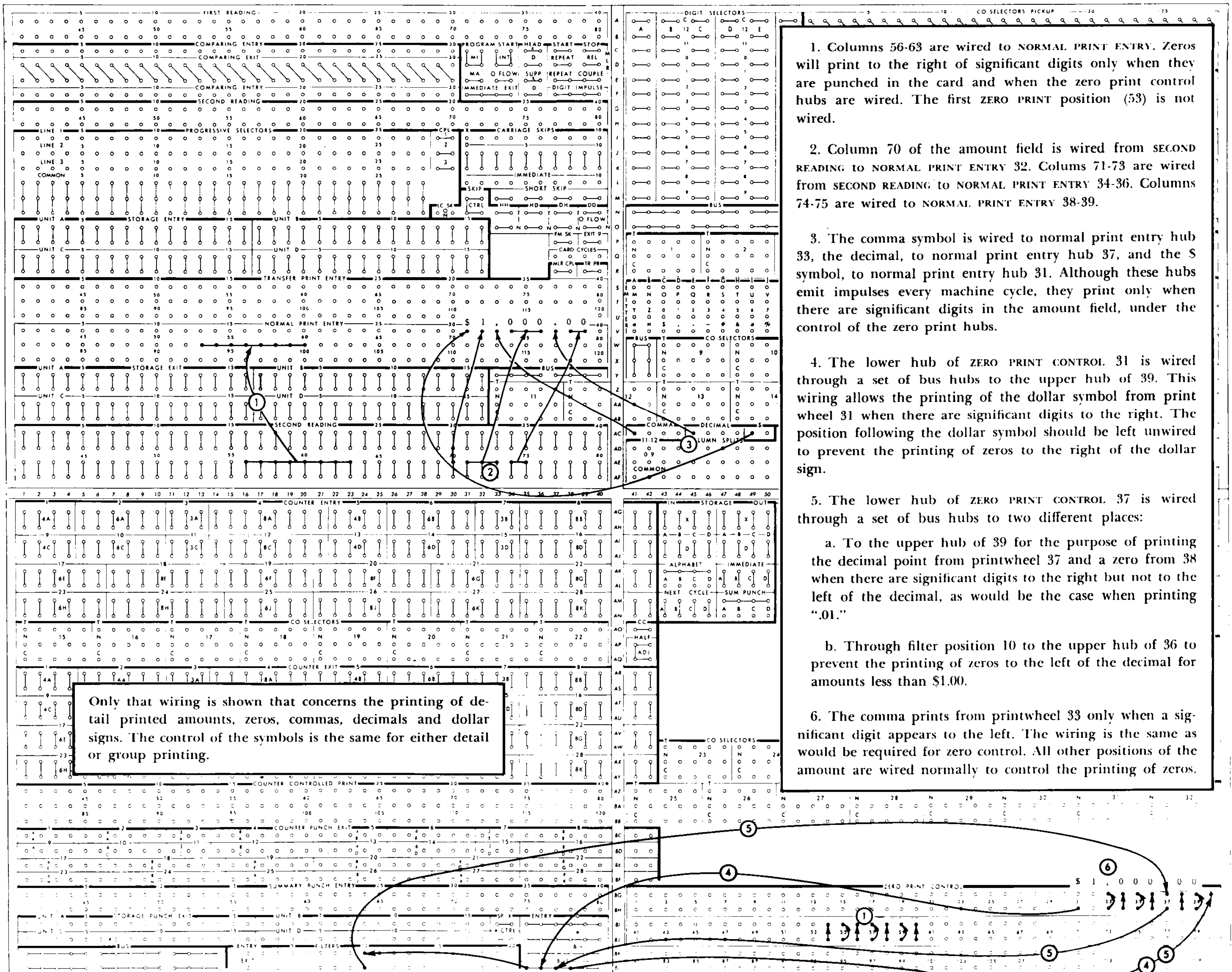
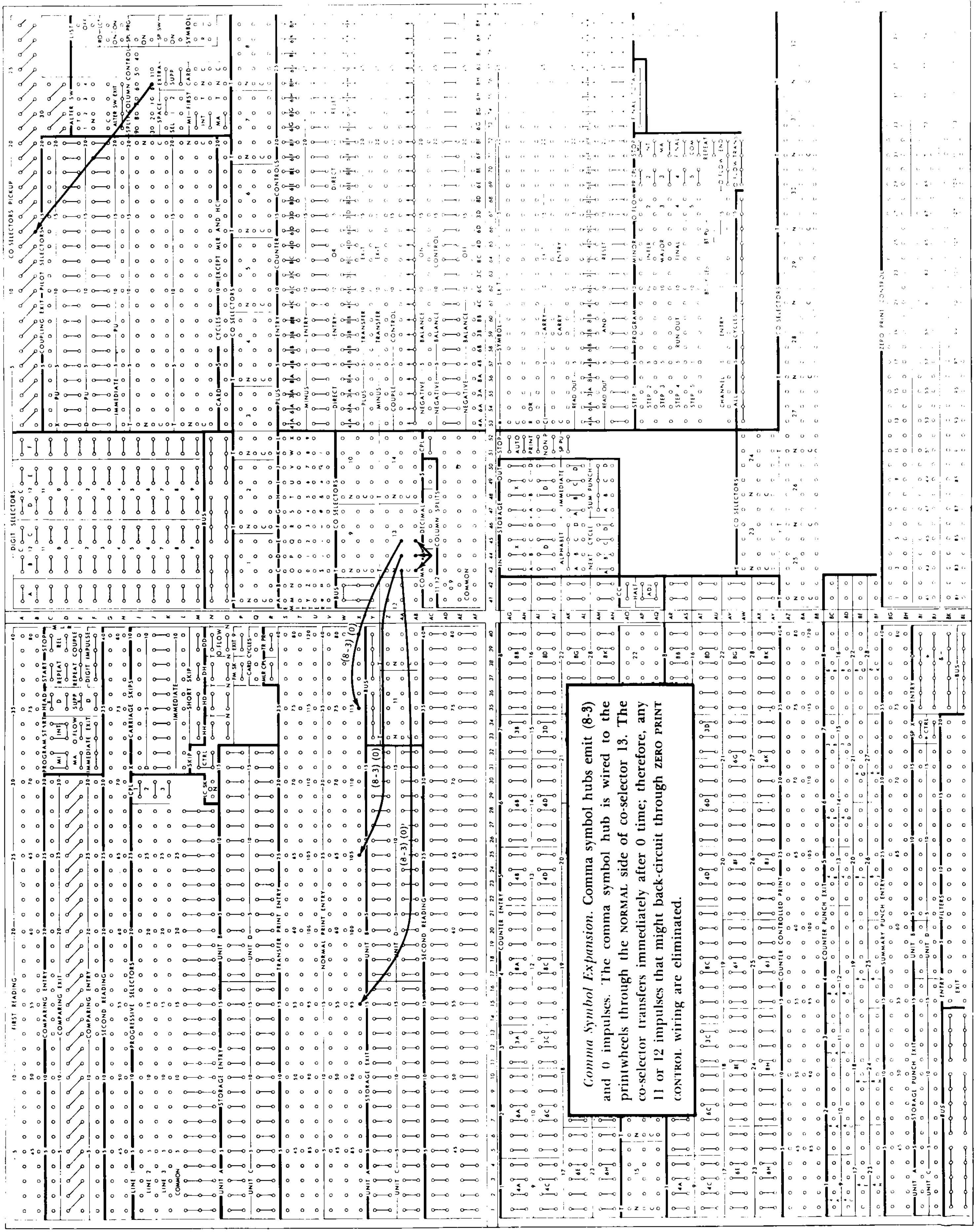


Figure 51. Amount Punctuation



Comma Symbol Expansion. Comma symbol hubs emit (8-3) and 0 impulses. The comma symbol hub is wired to the printwheels through the NORMAL side of co-selector 13. The co-selector transfers immediately after 0 time; therefore, any 11 or 12 impulses that might back-circuit through ZERO PRINT CONTROL wiring are eliminated.

Figure 52. Comma Symbol Expansion

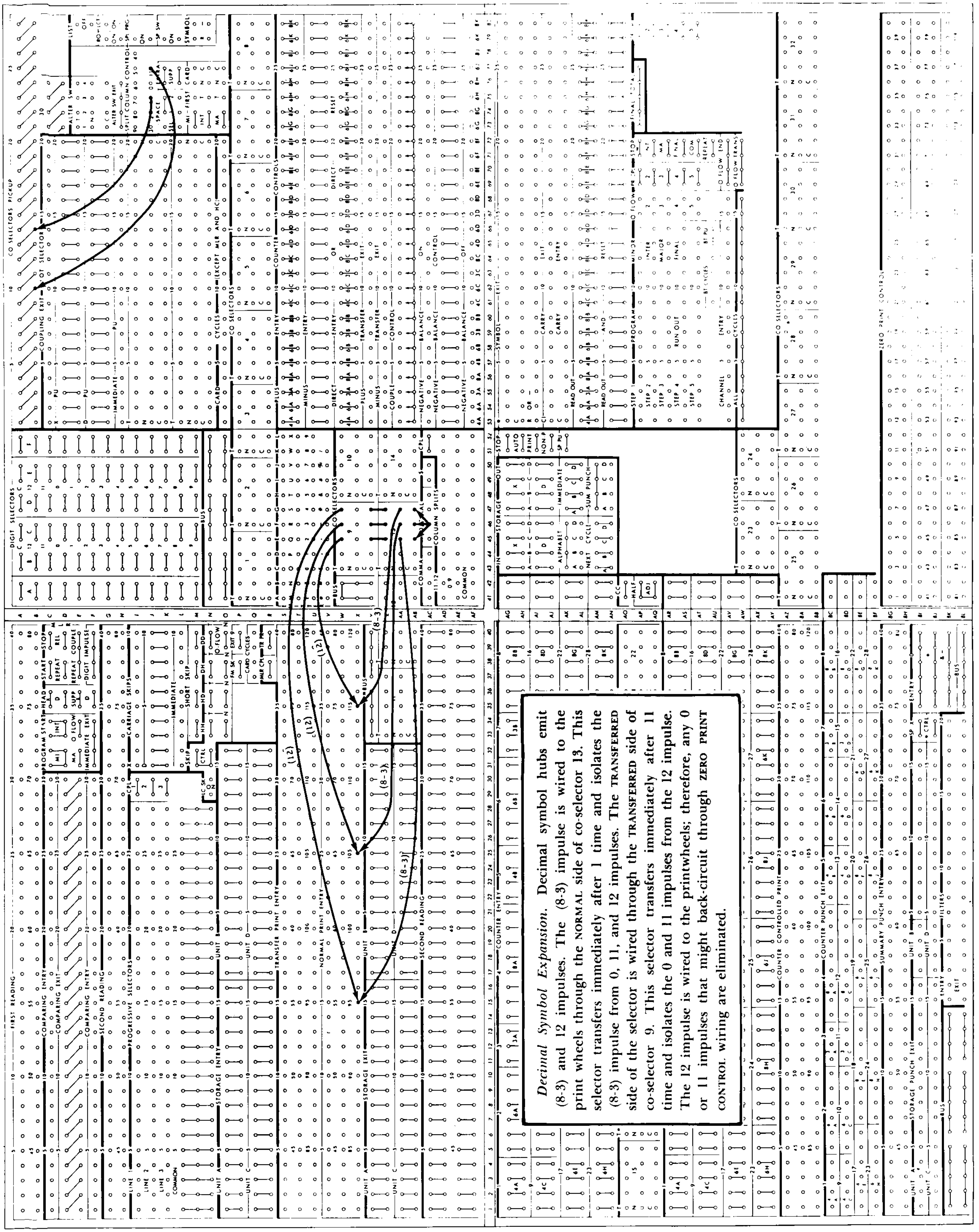


Figure 53. Decimal Symbol Expansion

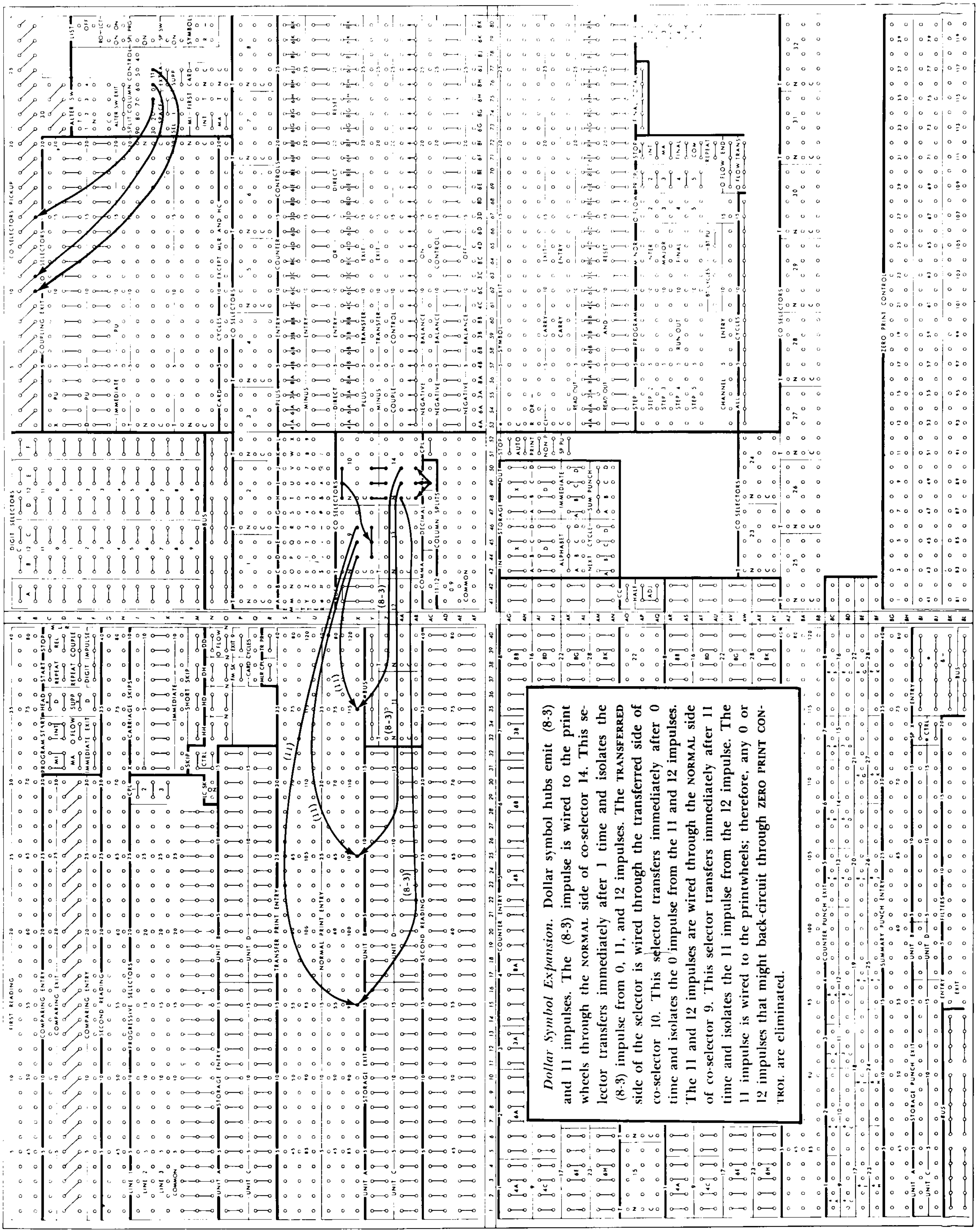
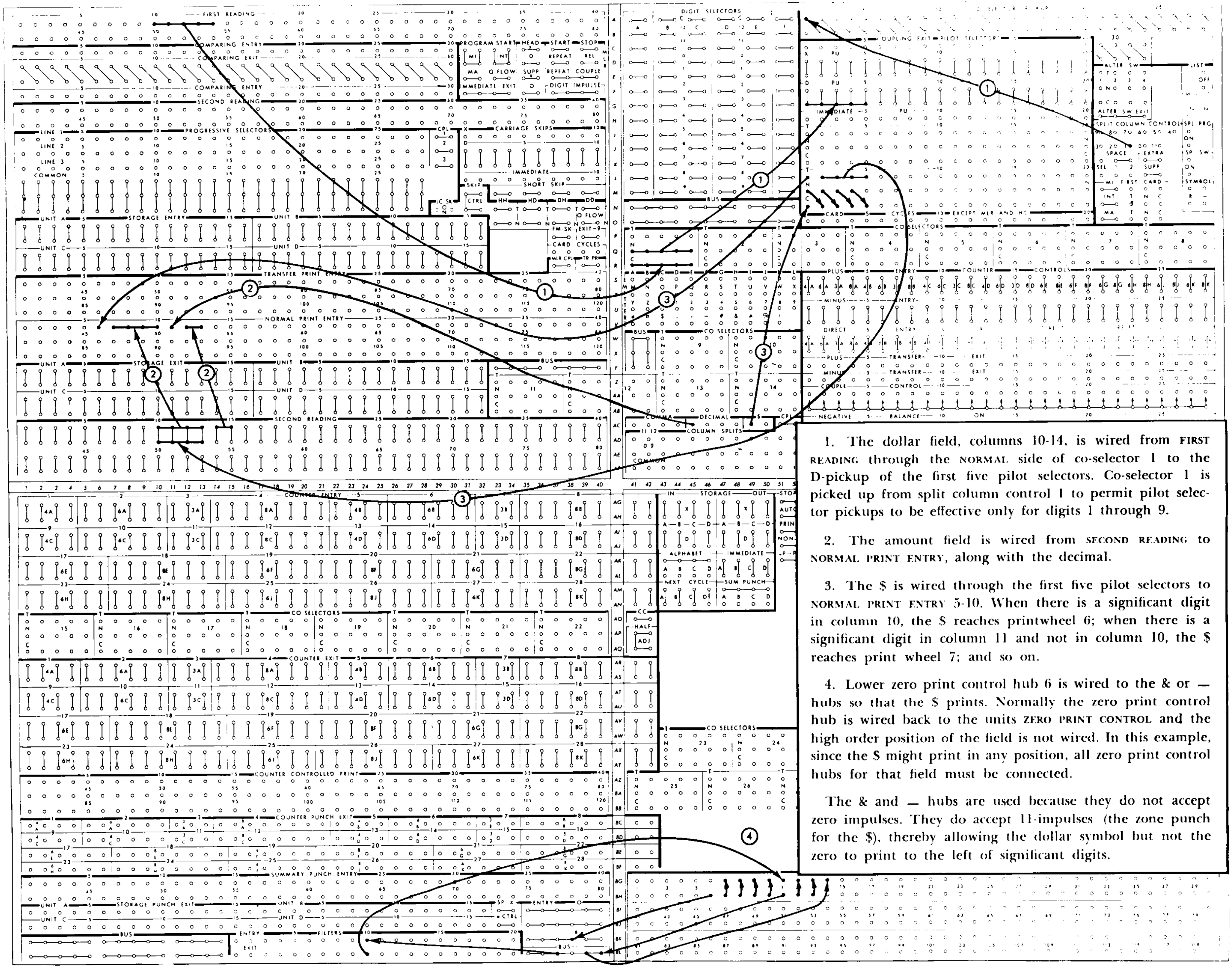


Figure 54. Dollar Symbol Expansion



1. The dollar field, columns 10-14, is wired from FIRST READING through the NORMAL side of co-selector 1 to the D-pickup of the first five pilot selectors. Co-selector 1 is picked up from split column control 1 to permit pilot selector pickups to be effective only for digits 1 through 9.

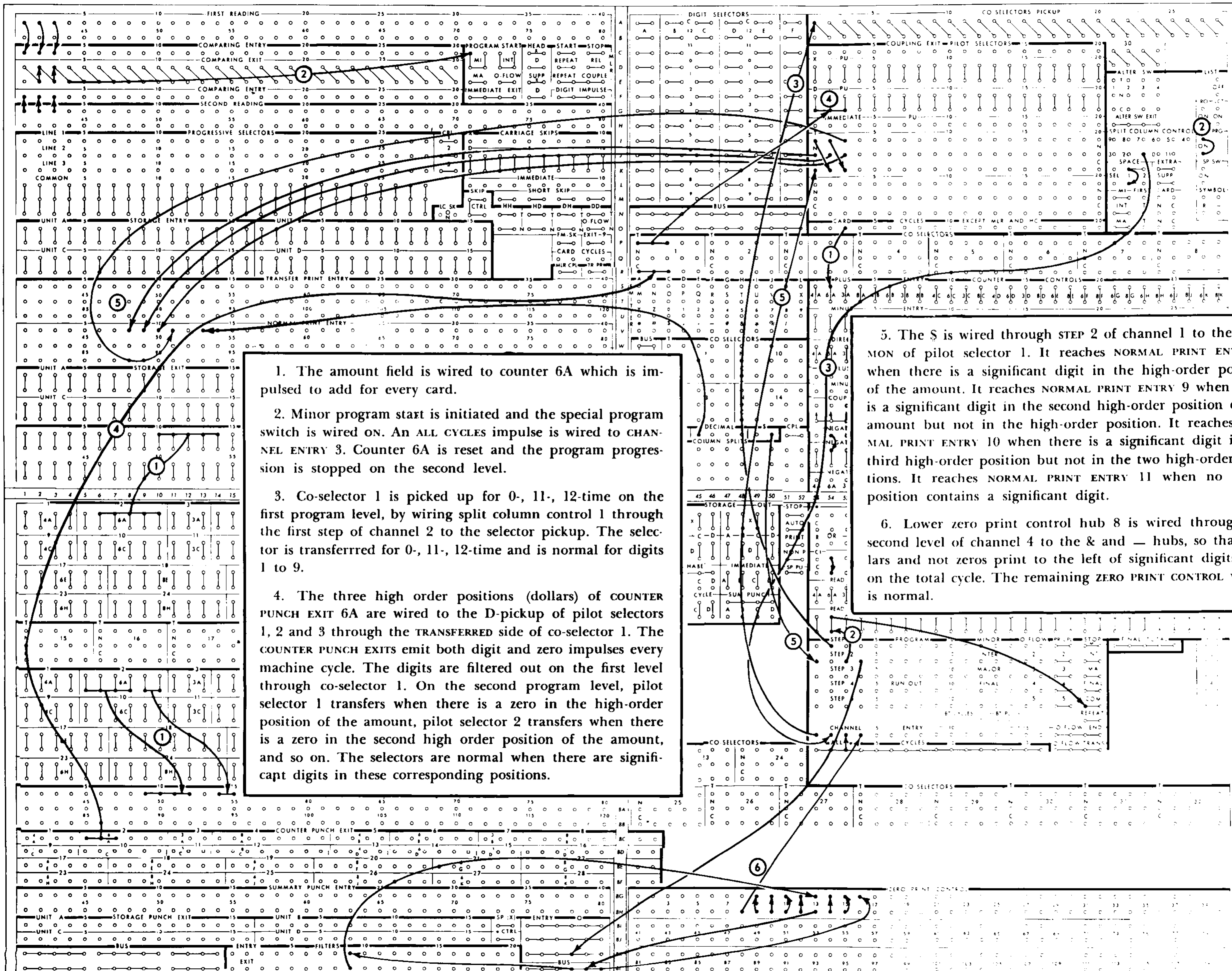
2. The amount field is wired from SECOND READING to NORMAL PRINT ENTRY, along with the decimal.

3. The $ is wired through the first five pilot selectors to NORMAL PRINT ENTRY 5-10. When there is a significant digit in column 10, the $ reaches printwheel 6; when there is a significant digit in column 11 and not in column 10, the $ reaches print wheel 7; and so on.

4. Lower zero print control hub 6 is wired to the & or — hubs so that the $ prints. Normally the zero print control hub is wired back to the units ZERO PRINT CONTROL and the high order position of the field is not wired. In this example, since the $ might print in any position, all zero print control hubs for that field must be connected.

The & and — hubs are used because they do not accept zero impulses. They do accept 11-impulses (the zone punch for the $), thereby allowing the dollar symbol but not the zero to print to the left of significant digits.

Figure 55. Floating Dollar Sign — Detail Print



1. The amount field is wired to counter 6A which is impulsed to add for every card.

2. Minor program start is initiated and the special program switch is wired ON. An ALL CYCLES impulse is wired to CHANNEL ENTRY 3. Counter 6A is reset and the program progression is stopped on the second level.

3. Co-selector 1 is picked up for 0-, 11-, 12-time on the first program level, by wiring split column control 1 through the first step of channel 2 to the selector pickup. The selector is transferrred for 0-, 11-, 12-time and is normal for digits 1 to 9.

4. The three high order positions (dollars) of COUNTER PUNCH EXIT 6A are wired to the D-pickup of pilot selectors 1, 2 and 3 through the TRANSFERRED side of co-selector 1. The COUNTER PUNCH EXITS emit both digit and zero impulses every machine cycle. The digits are filtered out on the first level through co-selector 1. On the second program level, pilot selector 1 transfers when there is a zero in the high-order position of the amount, pilot selector 2 transfers when there is a zero in the second high order position of the amount, and so on. The selectors are normal when there are significant digits in these corresponding positions.

5. The $ is wired through STEP 2 of channel 1 to the COMMON of pilot selector 1. It reaches NORMAL PRINT ENTRY 8 when there is a significant digit in the high-order position of the amount. It reaches NORMAL PRINT ENTRY 9 when there is a significant digit in the second high-order position of the amount but not in the high-order position. It reaches NORMAL PRINT ENTRY 10 when there is a significant digit in the third high-order position but not in the two high-order positions. It reaches NORMAL PRINT ENTRY 11 when no dollar position contains a significant digit.

6. Lower zero print control hub 8 is wired through the second level of channel 4 to the & and — hubs, so that dollars and not zeros print to the left of significant digits only on the total cycle. The remaining ZERO PRINT CONTROL wiring is normal.

Figure 56. Floating Dollar Sign — Total Print

BJ, 33-34

**Ctrl.* These hubs are used primarily to control the printing of check-protecting asterisks. They are always wired to the PICKUP of a co-selector. All the zero print control hubs for the positions in which the asterisks are to print are connected through the NORMAL side of the co-selector and the transferred hubs are laced from one to the other. Once a printwheel begins to turn because of the presence of a significant digit, no asterisk can print to its right. They print to the left of the high order significant digits.

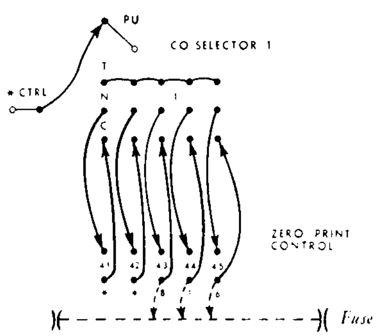
Operating principles of the asterisk control feature are described below.

1. An impulse is emitted from every lower zero print control hub at no-zone time. If the no-zone impulse can reach the fuse, a check-protecting asterisk prints.

2. When a significant digit is printed, an internal connection is made from the lower zero print control position to the fuse.

3. In the schematic shown here, the no-zone impulse from ZERO PRINT CONTROL position 42 can reach the fuse as follows:

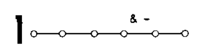
a. through the TRANSFERRED side of the selector,



b. to the TRANSFERRED selector position at the right over the crosswiring.

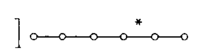
c. through the TRANSFERRED side of the selector to the lower zero print control hub for position 43, where it can reach the fuse over the internal path set up by the digit 8.

The impulse from position 41 can reach the fuse in a similar manner, by passing over two positions of the TRANSFERRED side of the selector to ZERO PRINT CONTROL position 43. The selector is picked up from *CTRL, so the lower zero print control hubs are connected at no-zone time only; at all other times they are wired to the upper hubs through the normal side of the selector.



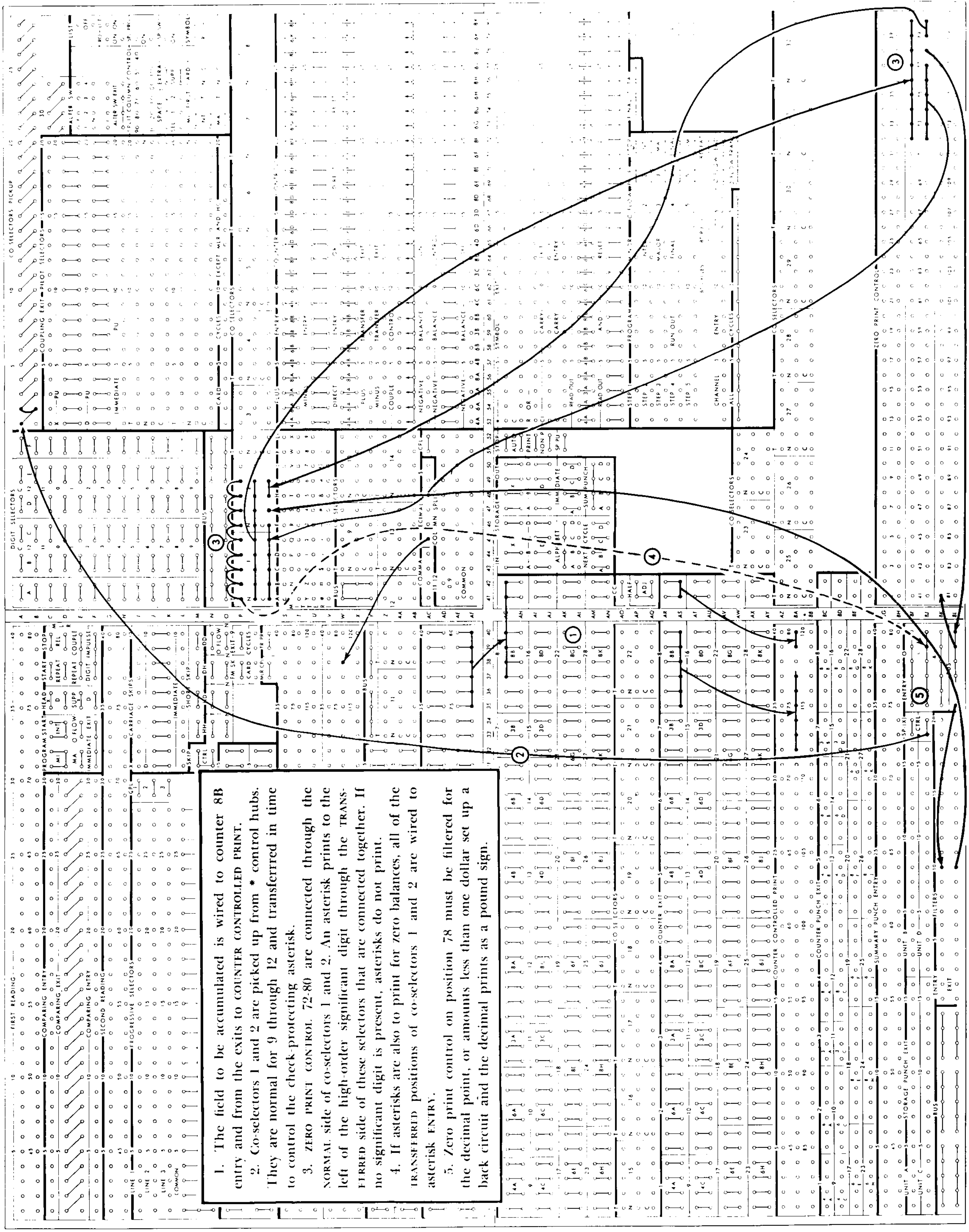
BK, 35-40

& or —. The six common & or — entry hubs are direct connections to complete the circuit for 11- or 12-impulses only. They are normally wired from zero print control hubs to control the printing of the ampersand symbol when a 12 only is sensed and a minus symbol when the 11 only is sensed by the print wheels, regardless of the presence of significant digits. They are sometimes wired to print other symbols containing an 11- or 12-impulse, when those symbols are wired to the printwheels.



BJ, 35-40

**Entry.* These hubs are wired from the zero print control hubs to print asterisks to the left of high order significant digits or to print asterisks for zero balances.



1. The field to be accumulated is wired to counter 8B entry and from the exits to COUNTER CONTROLLED PRINT.

2. Co-selectors 1 and 2 are picked up from * control hubs. They are normal for 9 through 12 and transferrred in time to control the check-protecting asterisk.

3. ZERO PRINT CONTROL 72-80 are connected through the NORMAL side of co-selectors 1 and 2. An asterisk prints to the left of the high-order significant digit through the TRANSFERRED side of these selectors that are connected together. If no significant digit is present, asterisks do not print.

4. If asterisks are also to print for zero balances, all of the TRANSFERRED positions of co-selectors 1 and 2 are wired to asterisk ENTRY.

5. Zero print control on position 78 must be filtered for the decimal point, or amounts less than one dollar set up a back circuit and the decimal prints as a pound sign.

Figure 57. Check-Protecting Asterisk

Tape-Controlled Carriage

The tape-controlled carriage controls the feeding and spacing of forms at high speed while documents or reports are being prepared on the IBM 407 Accounting Machine. The carriage is controlled by punched holes in a narrow paper tape that exactly corresponds in length to the length of one or more forms. Holes punched in the tape stop the form when it reaches any predetermined position. One of the punched holes in the tape can be used to control the accounting machine to start overflow skipping to the next form.

The carriage will accommodate continuous forms up to a maximum width of 16¾ inches, including punched margins. For the maximum length that can be accommodated, refer to Figure 73. Form length should be divisible by 4, 6, or 8, dependent upon the spacing, (4-, 6-, or 8-lines-per-inch) to be used.

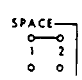
While forms of any size within the limits can be handled by the carriage, forms of standard sizes, available from the forms manufacturers, can be obtained more quickly and economically than non-standard sizes.

Forms can be designed to permit printing in practically any desired arrangement. Skipping can be controlled to ten different sections of the form.

Variable Line Spacing and Uniform Skipping

Single, double, or quadruple spacing can vary between lines as controlled by wiring on the control panel. For example, the heading section of a form may be single spaced and the body double spaced.

Any other spacing that is required must be controlled by the tape. Spaces up to two inches between lines can be skipped at the same rate of speed as normal spacing (Figure 73). This skipping is a smooth, high-speed advance of the form, allowing successive lines to be printed up to two inches apart at the rate of 150 lines per minute, the normal printing speed of the machine.



K-L, 74-75

Space 1-2. The machine single spaces (6 lines to the inch) if the hub labelled *1* is connected to either of the two common exit hubs above it. The machine double spaces (3 lines to the inch) if the hub labelled *2* is connected to either of the two common exit hubs above it. Unless the carriage is used to control spacing (SEL. SPACE), failure to connect either the 1 or 2 space hubs results in continuous skipping, since the function of these hubs is to stop a skip after either one or two spaces have been taken.

Page Totals

The overflow punch in the tape can also be used to start other operations, if desired, before ejecting the completely filled form. For example, a total may be printed at the bottom of each page before advancing to the next form.

Overflow Sheet Identification

Several lines of numerical or alphabetic identifying information can be printed on an overflow sheet. Invoice and page number can also be printed on the overflow sheets.

Predetermined Total Line

Totals can be printed on a predetermined total line, whether the form is completely filled or not. For example, although only two or three items have been printed on a form, the total of these items may be printed on a designated line of the form, instead of directly beneath the last item printed.

Overflow Skipping

When one form is completely filled, it can be ejected and the next form can advance to the first printing line or to the first body line. This "overflow skipping" is caused by sensing a punch in a specific position of the tape, that starts advancing the paper to the required line on the next form. If the last card of a group prints on the last available detail printing line, the total prints before skipping to the next form takes place.

Printing all totals on the last overflow form can be accomplished without reducing the printing space on each of the preceding forms.

Spacing Chart (Figure 58)

In the report shown in Figure 59, the order number, punched in columns 1-5 of the card, must print in the order number column of the shipping schedule. Likewise the product number, schedule date, customer number and quantity must print under their respective headings.

The best way to determine which printwheels to use to print order number in the report column set aside for it is to superimpose the report itself on a spacing chart, as shown in Figure 58. The numbers across the top and bottom of the spacing chart represent print-

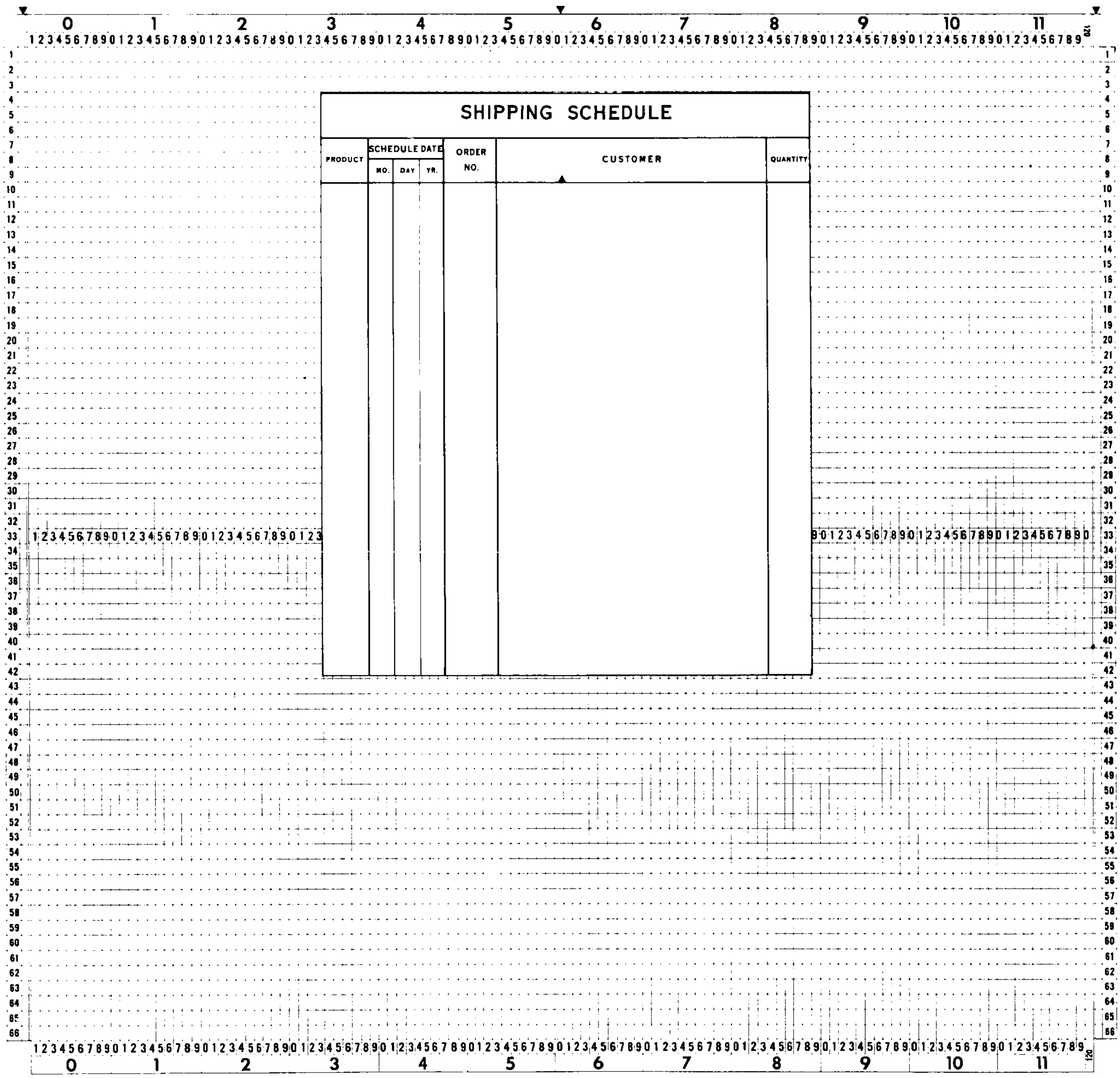


Figure 58. Report and Spacing Chart

wheel positions, which are spaced 10 to the inch or the same as standard pica typewriter spacing. The large numbers represent the tens position, and the small numbers, the units position of the printwheel number. The numbers down the sides of the spacing chart represent line numbers.

The report can be superimposed on the spacing chart without consideration for alphabetic or numerical printing, since all printwheels print all 47 characters. If the report is positioned as shown in Figure 58, then product number will be printed by printwheels 34-37, schedule date by printwheels 39-46, and order number by printwheels 48-52. In this example the report is centered, with the form alignment symbol (▲) in the center of the report lined up with printwheel 60 in the center of the spacing chart.

The printed Shipping Schedule is shown in Figure 59.

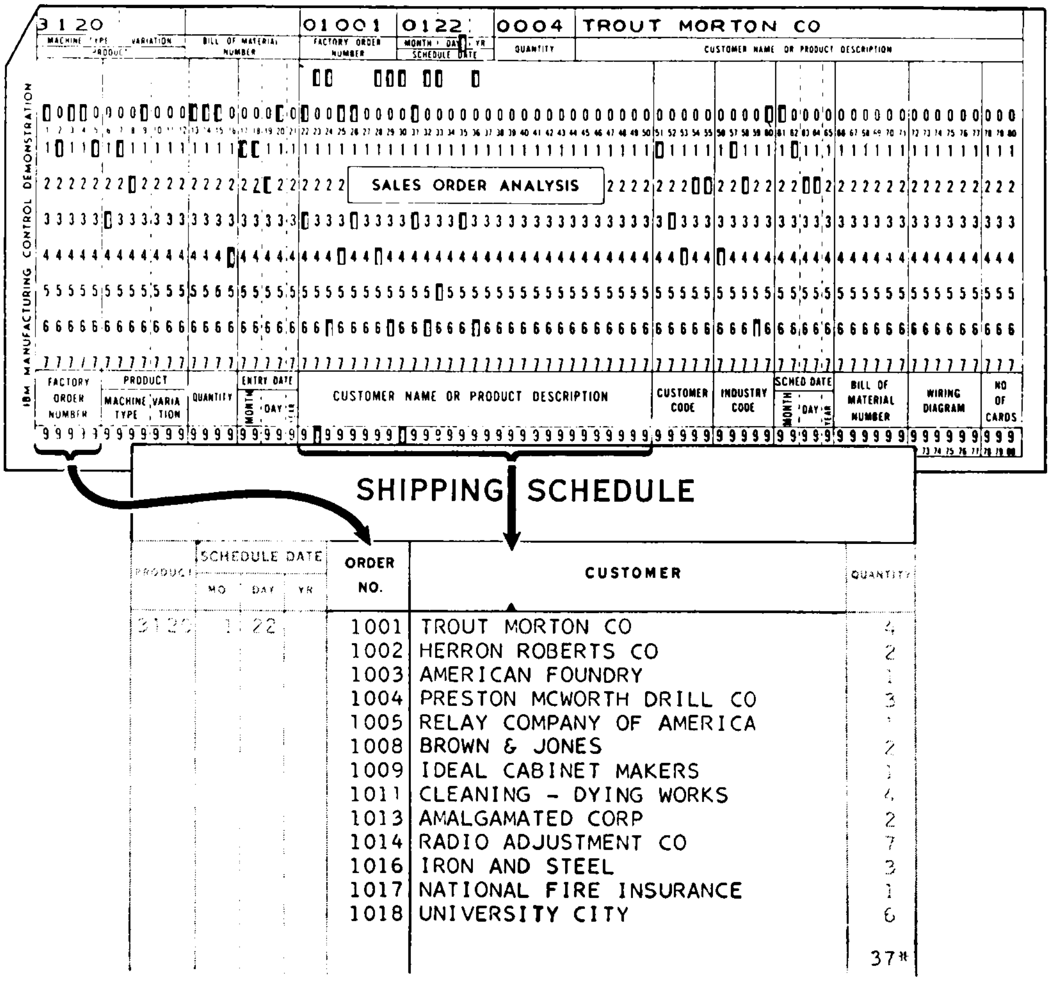


Figure 59. Shipping Schedule Prepared from IBM Cards

Space Control

All spacing on the 407 must be wired on the control panel. As previously described, single or double spacing is accomplished by connecting the SPACE 1 or 2 hubs. These hubs can be selected so that single and double spacing may be placed under the control of an X or digit. Triple spacing can be accomplished either by the use of the SEL hubs in conjunction with punching in the carriage tape, or by the special wiring shown under *Operating Rules and Suggestions.*

With the machine wired for single spacing, in detail printing there is an automatic space after each total, and in group printing there is an automatic space after intermediate and major totals when followed by minor group indication. In group printing, both the indication and the minor total print on the same line. Examples of this spacing are shown below.

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	

In detail printing, double spacing occurs after each total prints. In group printing, double spacing occurs only after intermediate or major totals when followed by minor group indication.

Results of double spacing for detail and group printing are illustrated in the following example:

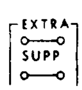
Double Spacing

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	

In detail printing, quadruple spacing occurs after each total prints. In group printing, quadruple spacing occurs after intermediate and major totals when followed by minor group indication.

Variations from this normal spacing may be obtained by the use of the space suppress (SUPP) or EXTRA hubs.



K-L, 76-77

Space Suppress. Space suppression takes precedence over all normal spacing. The space suppress hubs accept PROGRAM EXIT impulses to suppress normal spacing before a total prints and automatic spaces after a total prints. They also accept CARD CYCLE impulses through pilot selectors to suppress normal spacing for only certain cards. When spacing is to be suppressed under the control of an X or digit in a card, the selector must be picked up from first reading. Any digit from 9 through 3 can also be used to suppress spacing on the same cycle.

Extra Space. When impulsed from CARD CYCLES, these hubs cause an extra space after each card prints. If single and extra space are impulsed, the result is double spacing; if double and extra space are wired, the result is quadruple spacing. The card cycles impulse can be controlled to obtain extra spacing only for certain cards.

When impulsed from PROGRAM EXITS, these hubs cause an extra space after printing the corresponding total, except when automatic extra spaces are normal. For example, they do not cause an additional extra space after any total in detail printing, or after intermediate or major totals followed by minor group indication in group printing.

When impulsed from a first card impulse, these hubs cause an extra space after the corresponding first card prints. An X, 12, or any digit may be wired directly from FIRST READING to cause an extra space before printing, or from SECOND READING to cause an extra space after printing.

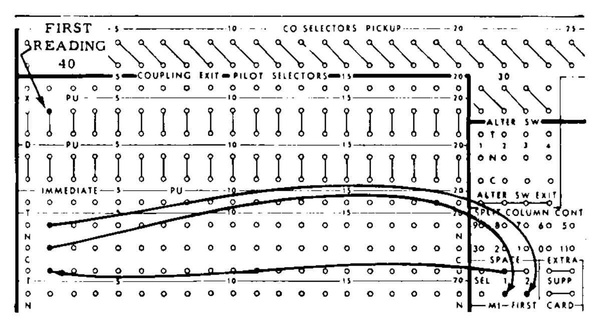


Figure 60. Single or Double Spacing Under X or Digit Control

Single or Double Spacing under X or D Control — Detail Printing

All X cards are double spaced by wiring one of the common space exit hubs through the TRANSFERRED side of a pilot selector to space hub 2. All NX cards are single spaced by wiring the NORMAL side of the same selector to space hub 1. The selector is picked up from an X at FIRST READING (Figure 60).

If digits are used to control spacing, they must be wired to the D-pickup of the pilot selector.

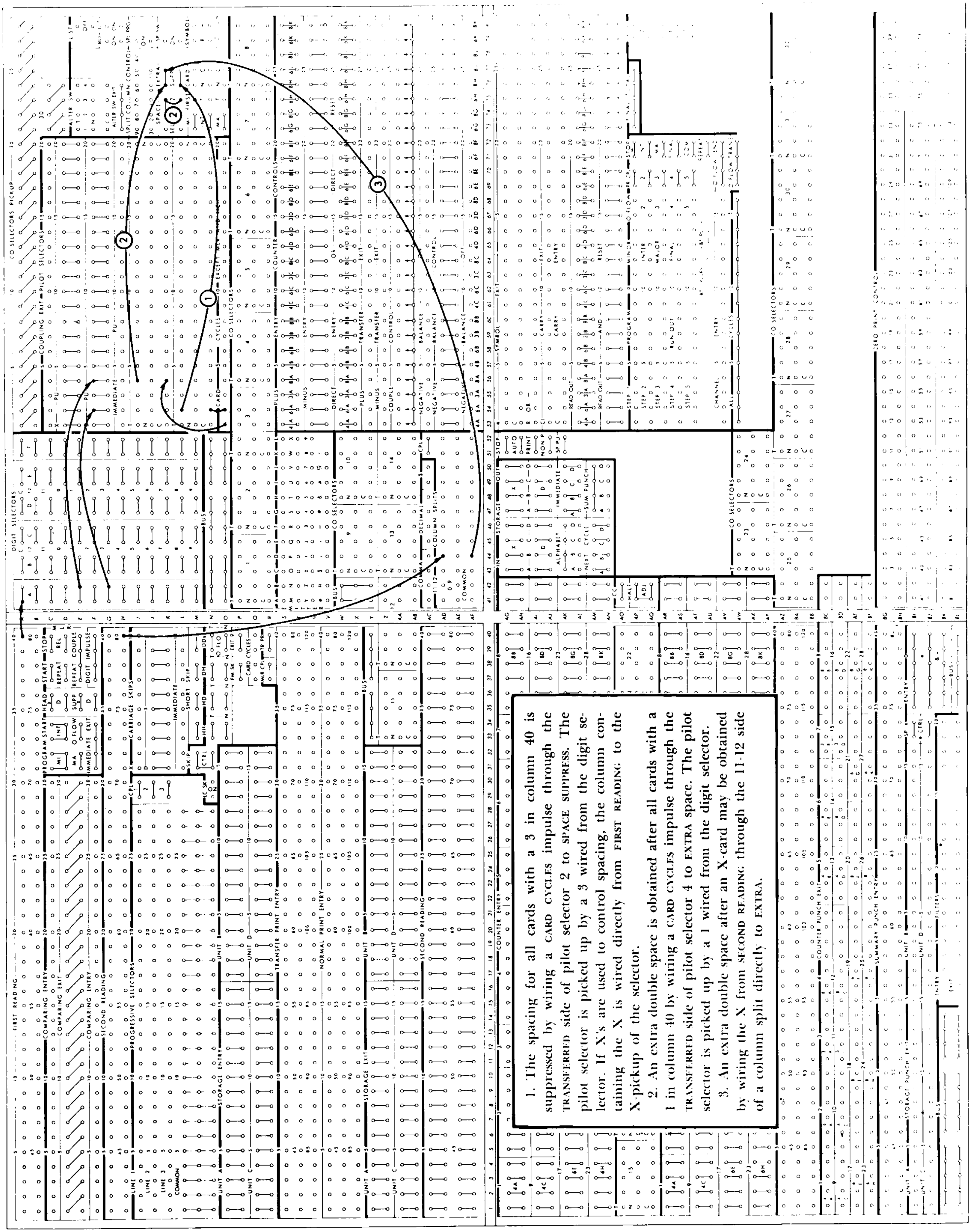


Figure 61. Space Suppression; Extra Space

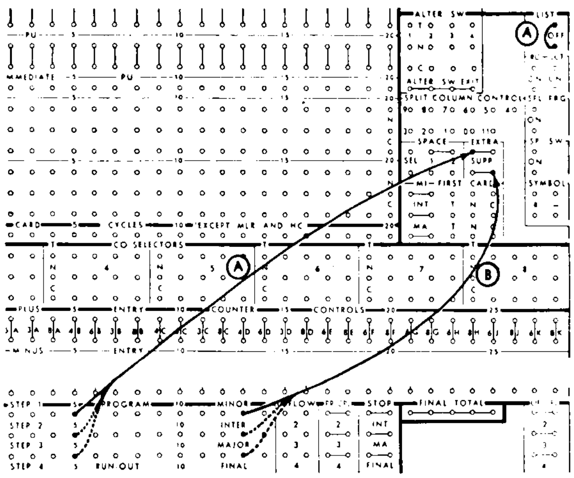


Figure 62. Wiring for: A. Extra Space; B. Space Suppression

Extra Space—Total Printing

In detail printing, with the machine wired to single space, double spacing occurs after each total prints. In group printing, double spacing occurs only after intermediate and major totals when followed by minor group indication. These extra spaces are automatic.

In detail printing, with the machine wired to double space, quadruple spacing occurs after each total prints. In group printing, quadruple spacing occurs only after intermediate and major totals when followed by minor group indication.

In group printing, an extra space can be taken after all totals (except when automatic extra spaces are normal) by wiring minor, intermediate, and major program exits to EXTRA (Figure 62A).

Two or More Totals on the Same Line in Two or More Cycles

Two or more program totals can be printed on the same line in as many cycles by wiring the corresponding PROGRAM EXITS to SUPPRESS. Spacing is suppressed before the total prints. Printing totals in this manner does not sacrifice the reset check feature of the machine or the ability to transfer totals from one counter to another (Figure 62B).

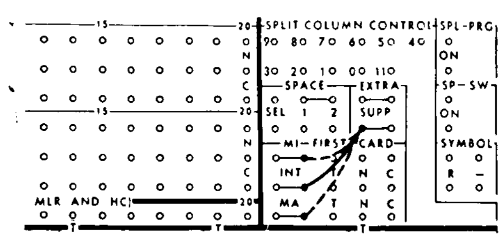


Figure 63. First Card Spacing

First Card Spacing

Minor, intermediate or major first card hubs may be wired directly to the extra or supp hub (Figure 63).

In single spacing, the normal double space after totals can be controlled to single space by wiring FIRST CARD MINOR, INTERMEDIATE, or MAJOR to SPACE SUPPRESS. For example:

NORMAL	FIRST CARD SPACE SUPPRESS
----Detail	----Detail
----Detail	----Detail
----Minor Total	-- Minor Total
----	----Detail
----Detail	

If the first card hubs were wired to EXTRA, an extra space would be taken after the corresponding first card indication.

Two or More Totals on the Same Line in One Cycle (Figure 64)

Minor, intermediate and major totals can be printed on the same line in one machine cycle by PROGRAM COUPLE wiring.

Two or more program totals can be made to print on the same line by joining their couple hubs through pilot selectors. If minor and intermediate totals are to print on the same line in one cycle, a pilot selector can be picked up from the intermediate comparing exit and couple 1 joined with couple 2 through the TRANSFERRED side of the selector. If minor, intermediate and major totals are to print on the same line in one cycle, two pilot selectors must be used, one picked up from the intermediate and major comparing exit and one from the major comparing exit only. The couple hubs would then be joined through these selectors. All minor totals are printed normally but when an intermediate program change is recognized, both the minor and the intermediate totals print in one cycle, instead of two, on the same line. By the same reasoning, minor, intermediate and major totals can be printed in one cycle and on the same line upon detection of a major program change. If the couple hubs were connected directly, intermediate and major counters would clear and print each time minor totals print.

When this method of total printing is used, it is not possible to transfer totals from one counter to another, because only one cycle is taken to print all totals. Therefore, the wiring must be from SECOND READING to the COUNTER ENTRY of each of the counters in use, instead of from SECOND READING to the COUNTER ENTRY of the minor counter and from the EXITS of the minor counter to the EXITS of the intermediate counter, and so on. The counters must be wired for DIRECT ENTRY

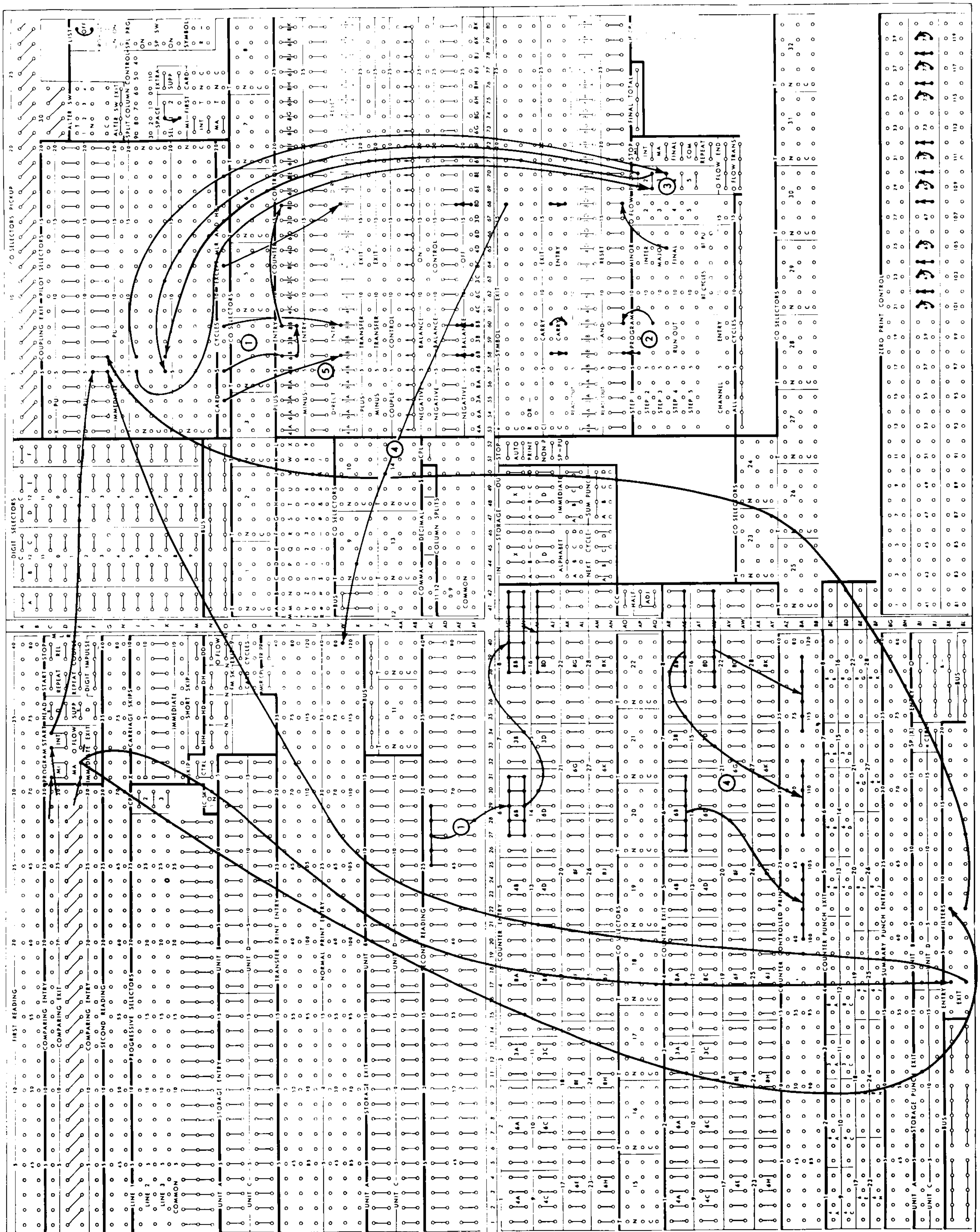


Figure 64. Printing Three Totals on Same Line in One Cycle

1. The amount to be added is wired to the entries of 6B, 8B, and 8D. All three counters are controlled to add from CARD CYCLES.

2. Counter 6B is read out and reset on a minor program change, counter 8B on an intermediate program change, and counter 8D on a major program change.

3. The couple hubs of all three levels are connected through pilot selectors as follows: COUPLE 1 and 2 are connected through the TRANSFERRED side of pilot selector 5 which is picked up directly from intermediate comparing exit. This allows intermediate totals to print on the same line as the last minor total within an intermediate group. COUPLE 2 and 3 are connected through the TRANSFERRED side of pilot selector 6, which is picked up directly from major comparing exit. This allows the major totals to print on the same line as the last intermediate total within a major group. To print the last minor total within a major group on the same line as the intermediate and major totals, it is also necessary to connect COUPLE 1 with COUPLE 2. Since pilot selector 5 does not pick up when there is a major comparing exit but not an intermediate (as in the case of 25 major, 22 intermediate comparing with 26 major, 22 intermediate), it is necessary to pick up pilot selector 5 also with a major comparing exit through a filter.

4. Minor totals are wired to COUNTER CONTROLLED PRINT 60-65. Intermediate totals are wired to COUNTER CONTROLLED PRINT 67-72. Major totals are wired to COUNTER CONTROLLED PRINT 74-79. The asterisk symbol for 8D is wired to NORMAL PRINT ENTRY 80. The asterisk prints only for major totals.

5. Detail printing from counters 6B, 8B and 8D is suppressed by wiring CARD CYCLES to the DIRECT ENTRY of those counters. The same card cycles impulse cannot be wired to all three direct entry hubs, because the three counters are being reset on separate program steps.

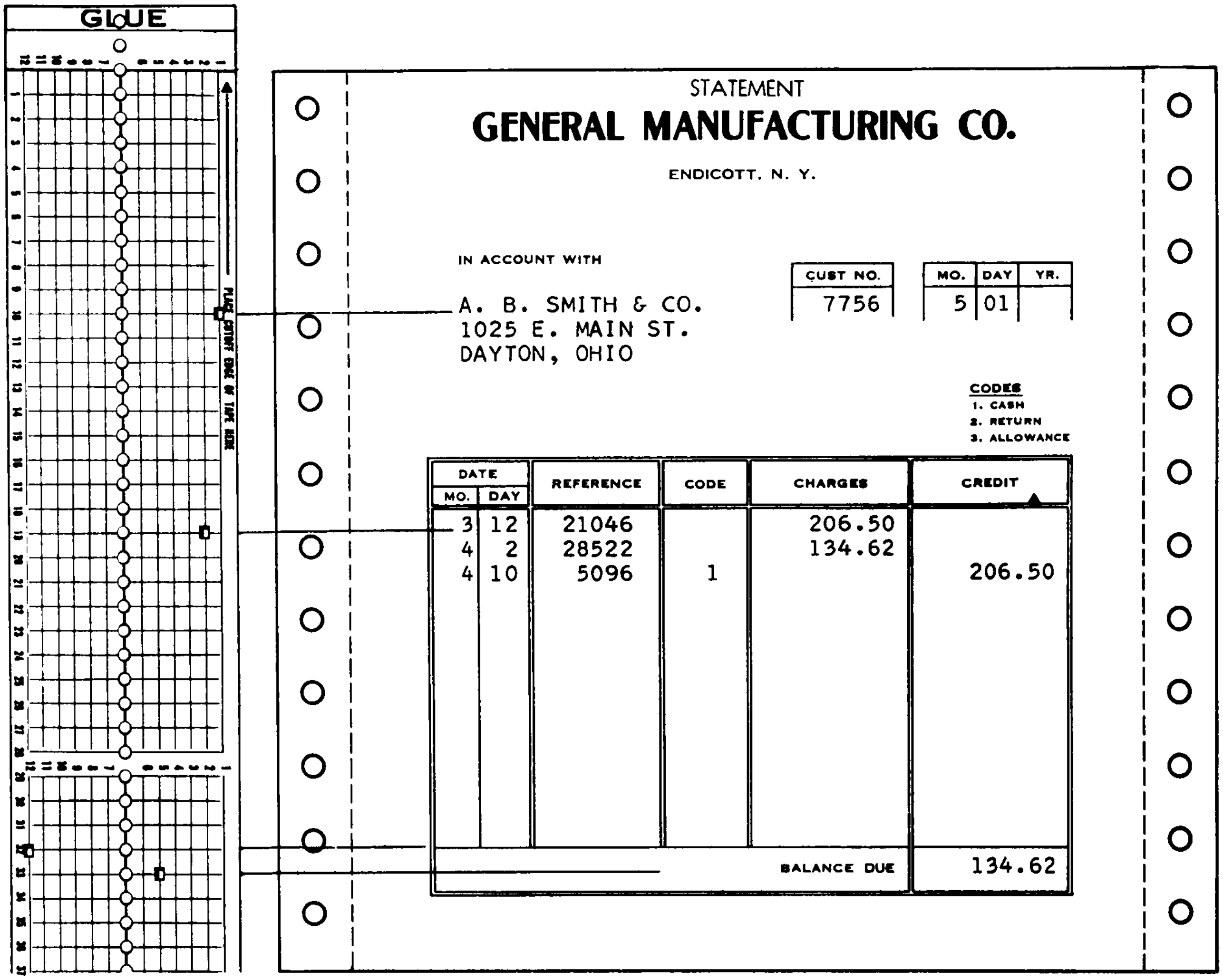


Figure 65. Control Tape Punching for Predetermined Printing Locations

and the counter plus and minus functions must be controlled on a card cycle basis. This wiring does not permit the use of additional programs beyond those that are coupled.

The wiring for printing minor, intermediate and major totals on the same line is shown in Figure 64.

Control Tape

The control tape (Figure 65) has 12 columnar positions indicated by vertical lines. These positions are called channels. A maximum of 132 lines can be used for control of a form, although for convenience the tape blanks are slightly longer. Horizontal lines are spaced 6 to the inch for the entire length of the tape. Round holes in the center of the tape are prepunched for a pin feed drive in a tape sensing mechanism that controls the carriage. The tape advances through the mechanism in synchronism with the movement of the printed form through the carriage. The effect is exactly the same as if the control holes were punched along the edge of each form.

Twelve brushes, one for each channel, are positioned over the tape for sensing the holes that are punched. As viewed from the front of the machine, they are numbered 1 through 12 from left to right. Brush 1 rests on channel 1, brush 2 on channel 2, and so on. A hole in the channel allows the brush to make contact with a metal roll and set up the necessary circuits that are normally used to stop skipping or to initiate an overflow.

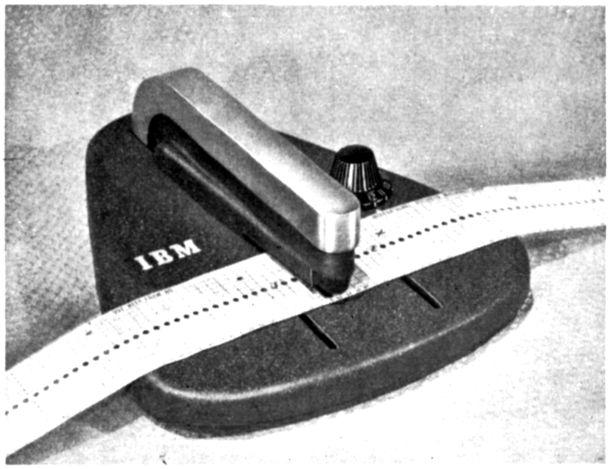


Figure 66. Tape Punch

Tape Channels

Tape channels are punched to control the following functions:

First Printing Line Stop. Channel 1 is normally punched for the first printing line of a form. This is the starting or home position.

Normal Skip Stops. Channels 2 through 10 are used to stop a form at one of nine positions including first body line. They can be used in any order or sequence. Digits, X's, comparing exits, skip control and program exits can be used to start skipping to any position of the form.

Overflow Control. The 12th channel of the tape *must* be punched in a position corresponding to the last printing line of a form. This punch is normally used to cause immediate overflow skipping but may also be used to initiate overflow programs which in turn can be used to print sheet identification information out of storage units and counters.

When head control is not wired, an overflow is made to the first printing line of the next form. When head control is wired, overflow skipping can be made to the first printing line if overflow page identification is to be printed; if not, the skip can be made directly to any stop used to locate the first body line.

Short Skip

Normally, the tape-controlled carriage stops the feeding of cards through the accounting machine during every skip regardless of its length. The feeding of cards is resumed after the skip is completed, but at least one machine cycle is lost for every skip taken. This is sometimes referred to "interlocking," and its primary purpose is to prevent printing in flight for skips longer than two inches. If a skip is two inches or less it is called a short skip and the control panel can be wired to release the interlock and thereby cause continuous operation of the accounting machine. When the distance is more than two inches, the machine is interlocked at the start of the skip. The interlock can be released, however, by impulsing SHORT SKIP whenever the remaining distance to be skipped is two inches or less.

In designing forms, distances that are to be skipped frequently should, if possible, be kept within two inches for most efficient operation. These distances may or may not be between two successive sections of a form. For example, in a billing form with a section for the heading and a section for the body, the distance from the last heading line printed to the first body line should be kept within two inches for most efficient operation.

The interlock may be released for overflow skipping if the overflow skip is two inches or less.

If skipping can occur on two successive machine cycles, and short-skip is wired, special care must be taken in short skip wiring (see *Short Skip* in *Operating Rules and Suggestions*).

Tape Punching

A small, compact punch (Figure 66) is provided for punching the tape. The tape is first marked in the channels in which the holes are to be punched. For six-lines-per-inch spacing, this can be done easily by laying the tape beside the left edge of the form that it is to control with the top line (immediately under the glue portion) even with the top edge of the form. A mark is then made in the first channel on the line that corresponds to the first printing line of the form. Additional marks are made in the appropriate channels for each of the other skip stops and the overflow signal required for the form.

The marking for one form should be repeated as many times as the usable length of the tape (see Figure 73) allows. With the tape thus serving to control several forms in one revolution through the sensing mechanism, the life of the tape is increased. Finally, the line corresponding to the bottom edge of the last form should be marked for cutting after the tape is punched.

The tape is inserted in the punch by aligning the line to be punched with the guide line on the punch and placing the center feed holes of the tape over the pins projecting from the base. The dial is then turned until the arrow points at the number of the channel to be punched. Pressing on the top of the punch, toward the back, cuts a rectangular hole at the intersection of a vertical and horizontal line in the required channel of the tape.

The tape can be punched with holes in more than one channel on the same line. This is advantageous in many cases, when several skip impulses are directed to the same skip stop. Punching two holes in one channel is necessary in some instances.

After the tape is punched, it is cut and looped into a belt. *The bottom line is glued to the top line by the use of the section marked GLUE, after the glaze has been removed by an ink eraser. If the glaze is not removed, the tape ends can come apart.* The center feed holes should coincide when the two ends of the tape are glued together.

The last hole punched in the tape should not be less than four lines from the cut edge, as approximately the last half inch of the tape overlaps the glue section when the two ends are spliced. If it is necessary to punch a hole lower than four lines from the bottom of the form, the tape should be placed with the top line (immediately under the glue portion) four lines lower than the top edge of the form before marking the channels. To compensate for the loss, the tape should then be cut four lines lower than the bottom edge of the form.

Inserting Tape in Carriage

The cover of the carriage is tilted back to gain access to the tape reading mechanism. The platen clutch is turned to a disengaged position, and the brushes are raised by moving to the left the latch located on the side of the brush holder. With the tape held *so that the printed captions can be read,* one end of the loop is placed over the pin feed drive wheel so that the pins engage the center drive holes, and the brushes are pressed down. The opposite end of the loop is placed over the nearest half-circle guide piece. The excess slack is removed from the tape by lifting the lever away from the notched bar and by moving the guide piece unit to the right. The tape should be just tight enough so that it gives slightly when the top and bottom portions of the loop are pressed together as shown in Figure 67. It should not fit too tightly or the pin feed holes will be damaged.

After the tape is in position, the cover is closed. The restore key is pressed to bring the tape to its home position and the platen clutch is turned back to its engaged position. The carriage is then ready to operate.

Tapes can be changed readily and used repeatedly over a considerable period of time.

Operating Features

Platen Clutch

When the platen clutch is positioned so that arrow below it is pointing to IN (Figure 68), the platen is engaged and can be turned manually only by the vernier knob. To disengage the platen from machine control, the platen clutch is turned to the right. The platen can then be turned manually by the platen knob.

Restore Key

The carriage is set at the start or home position (channel 1) by pressing the restore key. This is done while the platen is disengaged. Restoring is necessary because the distance which each form travels through the carriage, as it is being printed, is measured by the tape. Starting from the first printing line of one form, the tape moves in synchronism with the form, until the first printing line of the next form is reached.

Stop Key

Pressing this key stops the carriage operation immediately. It should be used to stop undesired carriage skipping. It also stops the accounting machine, but it should not be used for that purpose alone.

If space control has not been wired on the control panel, the main line switch must be turned OFF to stop carriage skipping.

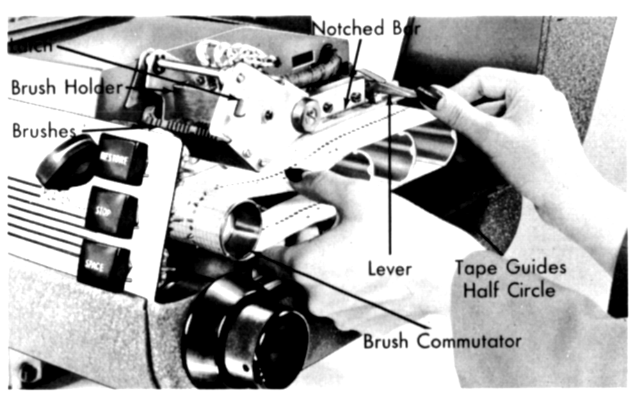


Figure 67. Inserting Tape in Carriage

Space Key

When the accounting machine is stopped, a form can be advanced by pressing the space key. With no cards in the machine, the form advances one space for each key depression, regardless of the spacing for which the space control is wired. With cards in the machine, spacing is controlled by control panel wiring. The first form can be fed into position by depressing the space key if the platen clutch is engaged, but the platen clutch should then be disengaged to permit restoring the tape without advancing the form.

Platen Knob

This knob is turned backward or forward to position the form only when the platen clutch is disengaged.

Vernier Knob

The vernier knob is used to obtain exact registrations in relation to the horizontal lines. The platen advances, thus lowering the printing on the form, when the knob is turned counterclockwise. Turning the knob in a clockwise direction causes the printing to occur higher on the form. In either case, the carriage tape is not affected and adjustments can be made while the platen is engaged and while the machine is in operation.

Form Thickness Adjustment Device

The distance between the printwheels and the platen is adjustable, for thickness of paper stock or for varying number of copies, by the use of the form thickness adjustment device (Figure 69) located on the left side of the carriage. This device contains seven positions numbered from 0 through 6. When the dial is in the 0 position the printwheels are $\frac{1}{8}$ (.125) of an inch from the platen. Each of the remaining six positions add to the $\frac{1}{8}$ inch distance by approximately the thickness of $1\frac{1}{2}$ cards. When the dial is set to 6 the distance is increased to approximately .178 of an inch. The dial should be set wherever the best results are obtained. To adjust for varying thicknesses, the dial is pulled out and is turned to increase or decrease the distance between the platen and the printwheels.

Pressure Release Lever

When the lever is pushed back, the feed rolls are released so that the paper can be moved freely around the platen. Pressure should always be released when the forms tractor for the 407 is in use. Pressure should be applied when the forms tractor is not in use.

Platen Shift Wheel

The platen can be shifted laterally a total of four inches by turning the platen shift wheel. For example, with the carriage in the extreme left position, the carriage can be moved four inches to the right. This adjustment should not be made while the machine is in operation.

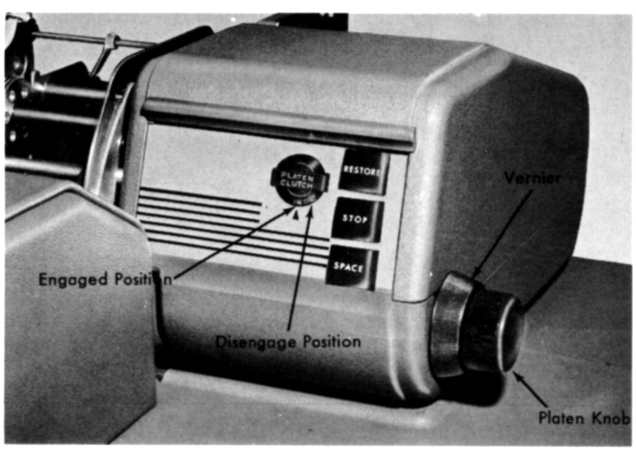


Figure 68. Carriage Features

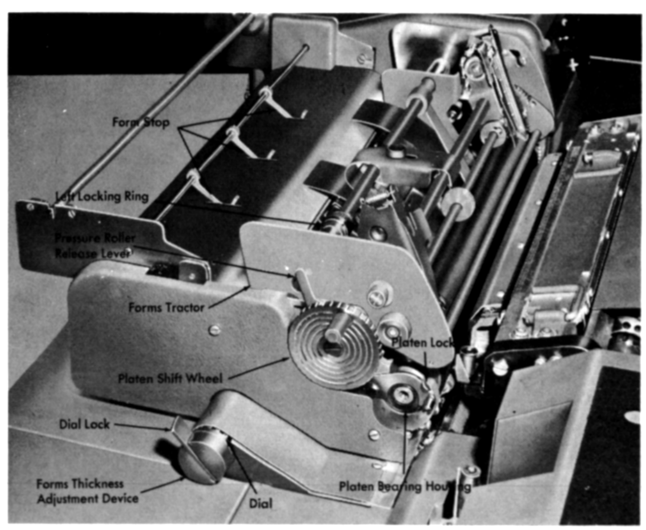


Figure 69. Left Side of Carriage

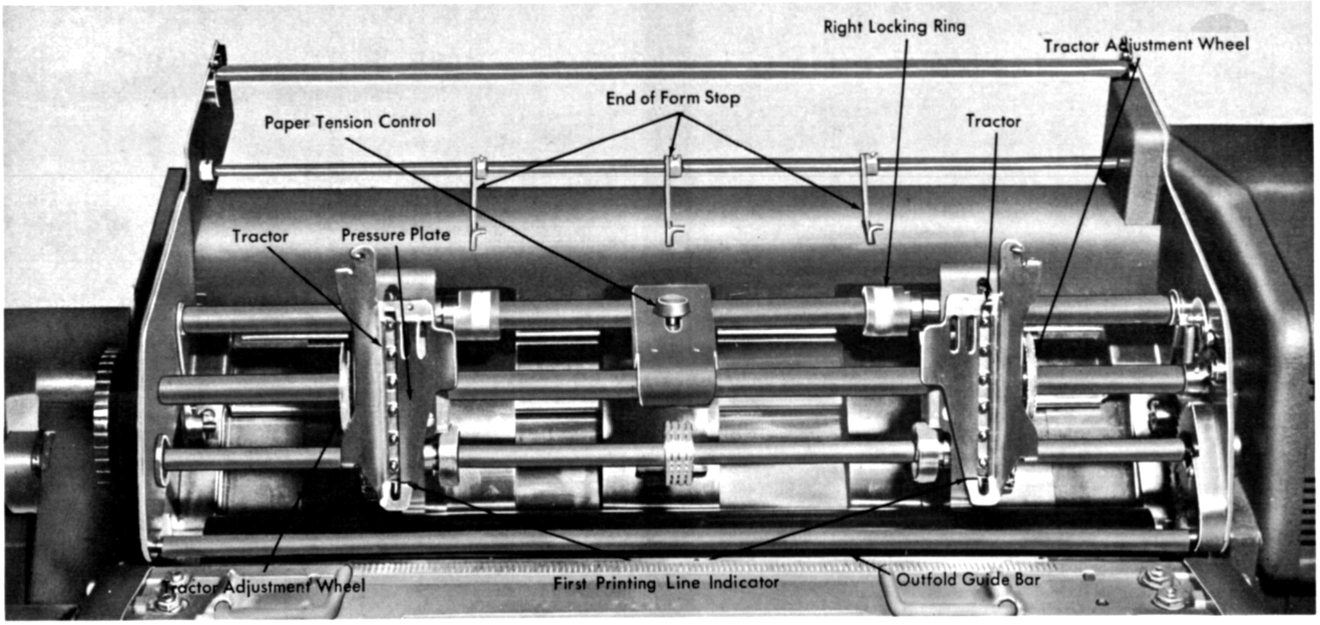


Figure 70. Front of Carriage

End-of-Form Stop

The *end-of-form stops* (Figure 70), located in the center and near either end of the carriage, stop the machine when the carriage runs out of paper, provided the form-stop toggle switch it turned on. The forms feed under the end of form stops and when the bottom edge of the last form passes them, the machine stops. The distance between the end-of-form stops and the printing line is approximately 10 inches. If the end-of-form stop is not desired, the form-stop toggle switch is turned off.

Forms Tractors

The IBM F-2 Forms Tractor—6 or 8 lines per inch spacing

The IBM F-4 Forms Tractor—6 or 4 lines per inch spacing

The F-2 (Figure 71) is standard. The F-4 may be specified in place of or in addition to the F-2. Forms tractors for machines with serial number 407-16139-LW or higher, are not interchangeable with those for machines with a lower serial number. Within these groups forms tractors are interchangeable.

Each of these devices is used for feeding marginally punched continuous forms and each has two adjustable tractor-type pin feed units, one for each side of the form. It can be freely inserted in the carriage by first positioning the carriage paper guides to the far left and right sides of the carriage, and by hooking the rear pin of the forms tractor in position and then lowering the front.

The F-2 provides the choice of 6 or 8 lines to the inch spacing, and with the F-4 the operator may choose between 6 or 4 lines to the inch spacing. On the F-2 this adjustment can be made by moving the shift cam until its pointer is positioned between the two scribed lines at either the *6* or the *8* on the side frame (Figure 72). If the pointer cannot be positioned between the scribed lines, a tooth-on-tooth condition exists between the platen gear and the forms tractor drive gear. In this case, move the shift cam to release the pressure on the 6- or 8-line drive gear and turn the platen slightly to allow the teeth to engage fully. A similar procedure should be followed when positioning for 6 or 4 lines-per-inch spacing on the F-4.

4, 6, or 8 Lines-per-inch Spacing

Regardless of the setting of the forms tractor (F-2 at 6 or 8 lines per inch, or F-4 at 6 or 4 lines per inch), the platen moves at 6 lines per inch. When the F-2 is spacing at 8 lines per inch, the platen has a tendency to move the back copies of a multicopy form faster than the original and front copies, even though the pressure release lever is disengaged. For this reason single spacing on the F-2 at 8 lines per inch is not recommended where the accuracy of line spacing is critical.

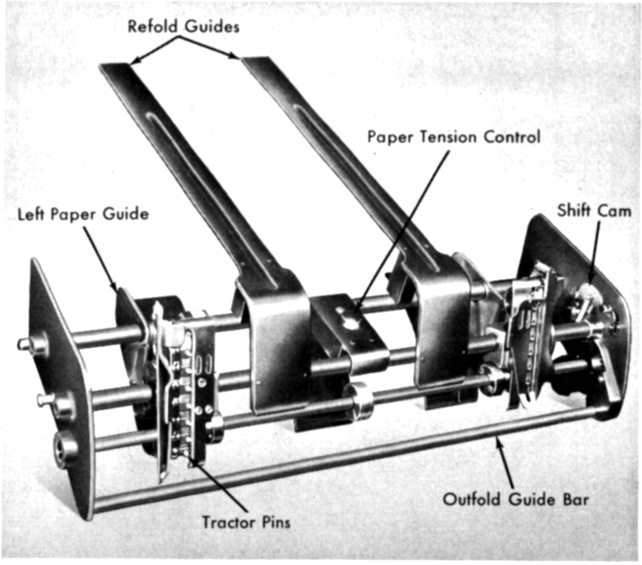


Figure 71. IBM Forms Tractor

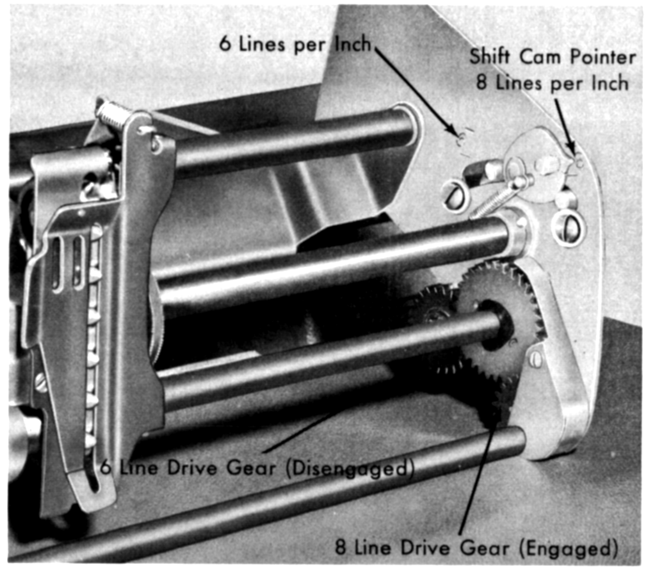


Figure 72. Forms Tractor Shift Cam Assembly

The control tape for 8 or 4 lines-per-inch spacing is punched as it would be for normal 6 lines-per-inch spacing. Each line on the tape always equals one line on the form regardless of whether the latter be 4, 6 or 8 lines per inch. In measuring a control tape for a document printed 8 lines to the inch, every $\frac{1}{8}$ inch on the form represents one line on the tape. Similarly, in 4 lines-per-inch printing, every $\frac{1}{4}$ inch on the form represents one line on the control tape.

Normal spacing is 6 lines per inch. Variations that must be considered for 8 or 4 lines-per-inch spacing are illustrated in Figure 73.

Steps in Using the Forms Tractor

1. After the forms tractor is in position, disengage the platen clutch. Make sure that the platen and the forms tractor can be moved freely by hand.
2. If the form to be used is less than 7 inches wide, the center paper guide and paper-tension device can be removed.
3. Move the left lower paper guide and tractor slightly to the left of the first printing position, place the first form between the left and right lower paper guides, and move the right guide in against the edge of the form. Allow a slight clearance so that the form

	6 LINES PER INCH		8 LINES PER INCH		4 LINES PER INCH	
	F-2 and F-4		F-2		F-4	
	Carr. Tape Lines	Distance on Form	Carr. Tape Lines	Distance on Form	Carr. Tape Lines	Distance on Form
Maximum Length of Form	132 Lines	22 Inches	132 Lines	16 1/2 Inches	132 Lines	33 Inches
Length of Form Compared with Length of Tape	———	Same	———	Form is 3/4 as long as one tape revolution	———	Form is 1 1/2 times as long as one tape revolution
Short Skip	12 Lines Maximum	2 Inches Maximum	12 Lines Maximum	1 1/2 Inches Maximum	12 Lines Maximum	3 Inches Maximum
Distance to Move First Printing Line Back from Indicator to Print	14 Lines	2 1/3 Inches	19 Lines	Approximately 2 1/3 Inches *	9 Lines	Approximately 2 1/3 Inches *

* Vernier adjustment may be necessary

Figure 73. Lines-Per-Inch Spacing Chart

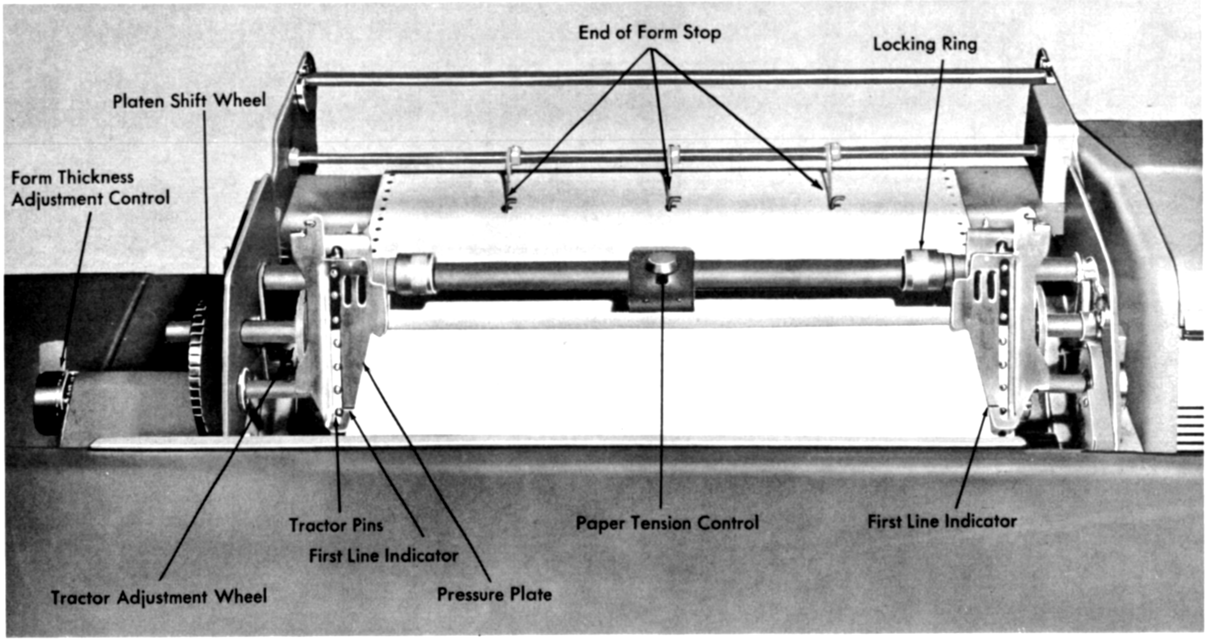


Figure 74. Carriage, Ready to Operate

slides freely between both guides. Tighten both locking rings to hold the guide assemblies in place.

4. With the pressure rolls engaged, insert the form over the forms tractor paper guides, under the round rod, and then into the pressure rolls and platen. Turn the platen by hand until the end of the form can be grasped.

5. Raise the pressure plates away from the tractor pins.

6. Release the pressure rolls and position the pinfeed holes in the tractor pins.

7. Lower the pinfeed pressure plates.

8. Set the form so that the first printing line is even with the first printing line indicator mark on the lower part of the pressure plates; then turn the form back fourteen spaces if spacing is set for 6 lines per inch, nineteen spaces if set for 8 lines per inch, and 9 spaces if set for 4 lines per inch. Finer adjustments may be achieved by use of the vernier knob.

9. Insert control tape, restore carriage, and engage the platen clutch. Figure 74 shows the carriage ready to operate.

Six or Eight Lines-to-the-inch Spacing Device

The standard carriage tapes for the IBM 922 carriage may be used for either six or eight lines-to-the-inch spacing. It must be remembered, however, that a line on the tape remains a line regardless of whether printing is for six or eight lines to the inch.

For printing six lines to the inch, the tape can be laid alongside the form, and tape punching can be easily determined line for line.

For printing eight lines to the inch, an ordinary ruler should be used. The ruler will show where to punch the holes in the tape, not by inches, but by lines. For example, if the first line is to be printed 1 6/8″ from the top of the form, the hole in the tape should be punched in channel 1, line 14, of the tape (Figure 75).

Half-inch Spacing

One method of accomplishing half-inch spacing is to engage the 6-line-per-inch drive gear on the IBM Forms Tractor and wire the control panel for triple spacing as illustrated in Figure 165.

A simpler method of accomplishing the same results is to engage the 8-line-per-inch drive gear and wire the control panel for quadruple spacing as illustrated in Figure 76.

Tractor Adjustments

Tractor adjustment wheels can be turned to provide a $1/8$ inch lateral movement of the tractors. These wheels make the tractor pins line up exactly with the center of the marginal holes in the paper after the paper guides have been set.

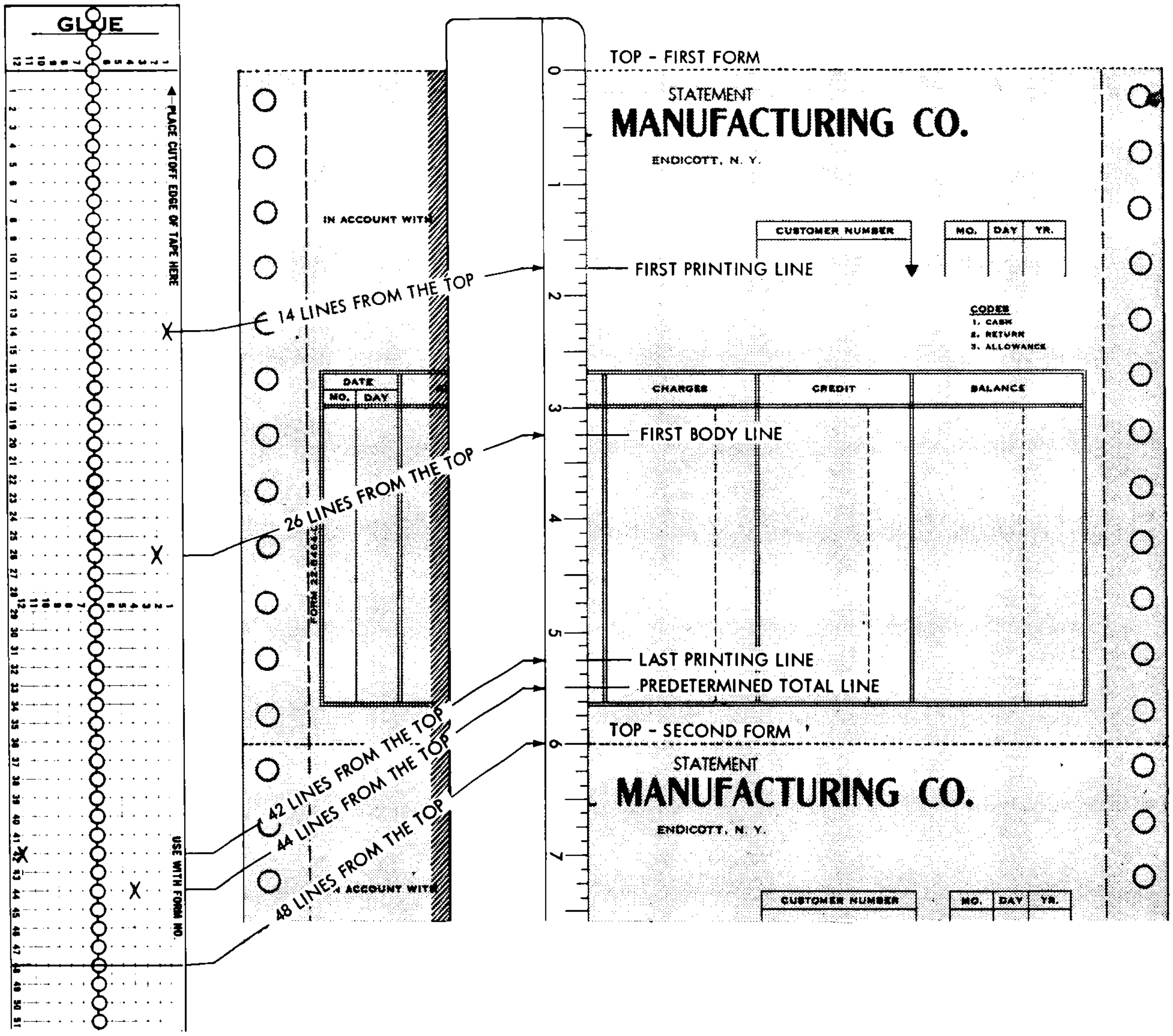


Figure 75. Method of Determining Control-Tape Punching for Eight Lines Per-Inch Spacing

Paper Tension Device

The paper tension device is adjustable and exerts a slight pressure on the paper as it feeds through the forms tractor. Earlier forms tractors have a non-adjustable paper weight for this purpose.

Outfold Guide Bar

The outfold guide bar fits across the front of the forms tractor. It is an aid in the feeding of forms. It is spring loaded and can be easily removed by the operator, if desired.

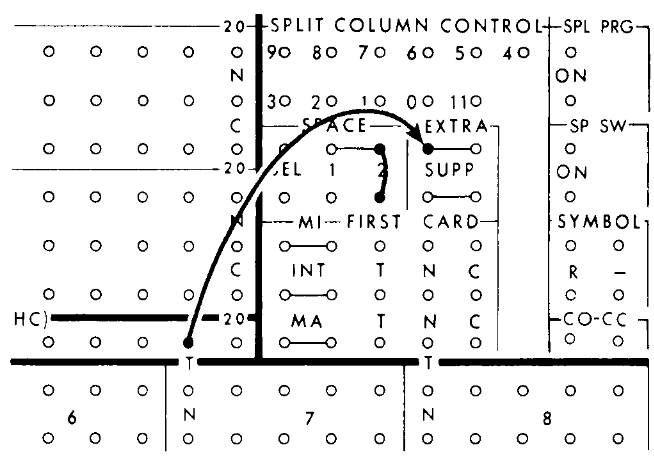


Figure 76. Half-Inch Spacing

Platen

The carriage is equipped with an easily removable solid platen as a standard feature.

Platen hardness requirements vary with the number of parts and type of paper in each form. The following platen hardnesses are recommended:

Hard platen (100 durometer), 2-part forms and over.

Medium platen (90 durometer), most single-part forms or very thin multiple-part forms.

If there is doubt as to the platen hardness required or to the quality of the carbon paper to be used, test runs should be made with sample sets of forms.

The platen can be removed by raising the platen lock on the left side and lifting the platen from the bearing housing. When the platen is inserted, the end with the gear wheel should be dropped into the platen bearing housing. The platen must then be moved to the right, turning it back and forth to fit the platen drive key into the carriage drive mechanism. The platen lock is then closed.

Figure 77 shows the platen being inserted into the carriage.

Tear Bar

The tear bar may be used in place of the forms tractor whenever feeding is under the control of the pressure rolls.

It is generally used for single-sheet operations or when roll paper is being used. It is easily inserted in the carriage by placing the ends into the forward slots on the carriage frame.

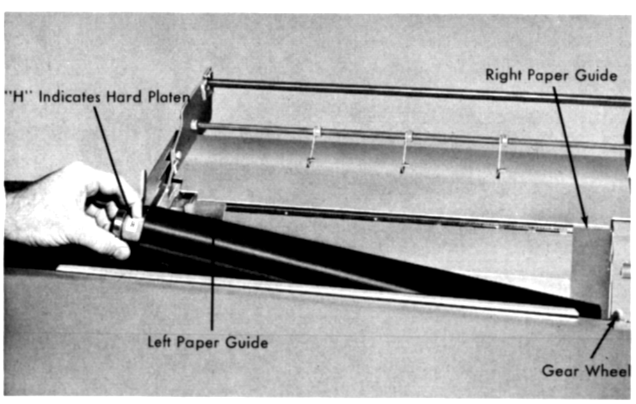


Figure 77. Platen

Form Stand and Form Guides

Form Stand (Figure 78)

There are two movable trays on the form stand. The upper tray holds the forms about to be fed into the machine and the lower tray receives the forms coming from the machine. For best operation, the upper tray should be set as high as possible and still allow ample room for the stack of forms feeding into the machine. This brings the paper close to the carriage and cuts down paper drag. The lower tray should be set at the extreme low position when feeding single-part forms and somewhat higher when feeding multiple-part forms, the exact position to be determined during actual operation.

Either tray can be moved up or down after first loosening the knob assemblies located on the side of each tray. The knobs are loosened when turned counterclockwise.

The form stand should be placed behind the 407 with the open sides of the two trays away from the machine. The top plate should fit under the rear edges of the two form guides as shown in Figure 78. The stand should then be moved as close to the machine as

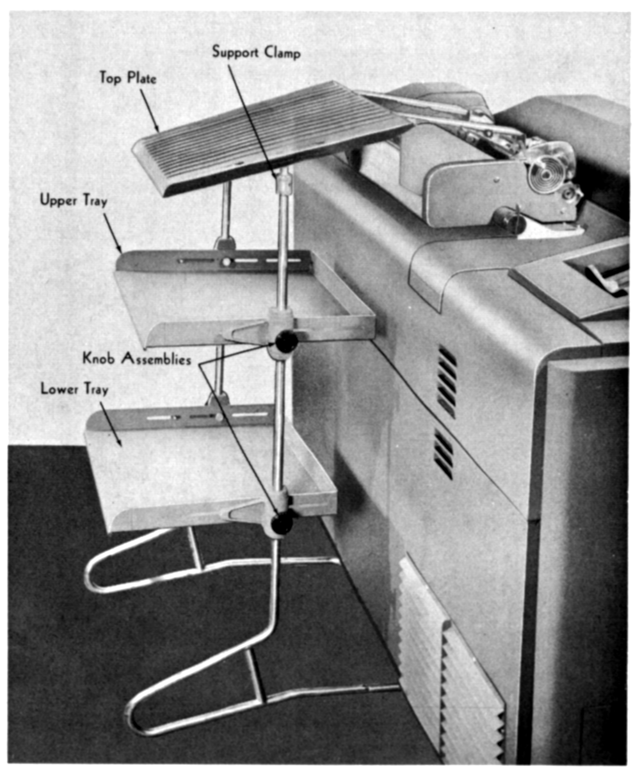


Figure 78. Form Stand and Form Guides

the form feed guides allow. The top plate can be moved up or down after first loosening the support clamps. The support clamps are loosened by turning them counterclockwise.

Form Guides

The two detachable form guides should be set equidistantly across the forms tractor. They clamp on the center tractor shaft (See Figure 71).

Locating First Printing Line (Figure 79)

To locate the first printing line, set the form so that the first printing line is even with the first printing line indicator mark. Then, depending upon the type of form feeding device used, turn back the platen as follows:

IBM Above Platen Feed Device (Model A-3) — 11 spaces.

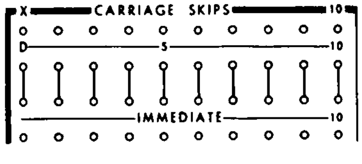
IBM Forms Tractor (Model F-2) — 14 spaces if set for six lines per inch; 19 spaces if set for eight lines per inch.

If, when designing forms, guide lines are printed in the perforated margin of continuous forms, back spacing can be eliminated entirely and thus the procedure for inserting the forms can be simplified.

Form Control

Skipping is started by wiring on the control panel and is stopped by holes in the tape. The following examples of control panel wiring show operating principles and are not necessarily the only arrangements of the channel punching that can be used.

Carriage Skips. There are 10 carriage skip positions representing the first ten channels on the carriage tape.



I-L, 31-40

Each of the 10 positions has an X, D, and IMMEDIATE SKIP hub. If an impulse is introduced into one of these hubs and a hole is punched in the tape in the corresponding channel, a skip takes place to the position where the hole is punched in the tape. For example, if hub 3 is impulsed on the control panel and a hole is punched in channel 3 of the tape, the impulse starts the skip and the hole in the tape stops it.

The X-hubs accept X, 12, or SKIP CONTROL HD, HH, DH, and DD impulses, and the D hubs, accept any impulse, (SKIP CONTROL, HD, HH, DH, DD, digit, X, 12, comparing exit, etc.) to cause skipping on the following cycle. The immediate hubs accept PROGRAM, CO-SELECTOR CARD CYCLE, CARD CYCLE, FIRST CARD, or SKIP CONTROL impulses to cause skipping on the same cycle. When the X- or D-hubs are impulsed and a total intervenes, skipping takes place after the total prints. When the I-hubs are impulsed and a total intervenes, skipping takes place before the total prints.

When the X- or D-hubs are impulsed during program or MLR (multiple line read) cycles, the skip does not become effective until after all program or MLR cycles are completed. In such cases the X- or D-skips take precedence, and any impulse wired to I of the same channel is not effective until after the X-, D-skip has been completed.

As previously described, channel 1 is normally used to identify the first printing line, and channel 12 is always used to identify overflow. All other channels identify other stops within the same form and may be used interchangeably.

Only control panel wiring that relates directly to the carriage operation is shown.

Form-to-Form Skipping

Form-to-form skipping is required whenever continuous forms are used.

Forms two inches or less in depth, requiring only one line of printing from single cards, can be prepared at the rate of 150 forms per minute. The rate of speed for preparing forms that are greater than two inches in depth depends on the number of lines to be printed on the form as well as the over-all depth of the form. About five inches can be skipped in two machine cycles.

The withholding statement shown in Figure 80 illustrates form-to-form skipping under the control of the comparing unit. A separate form is required for each employe (Figure 81).

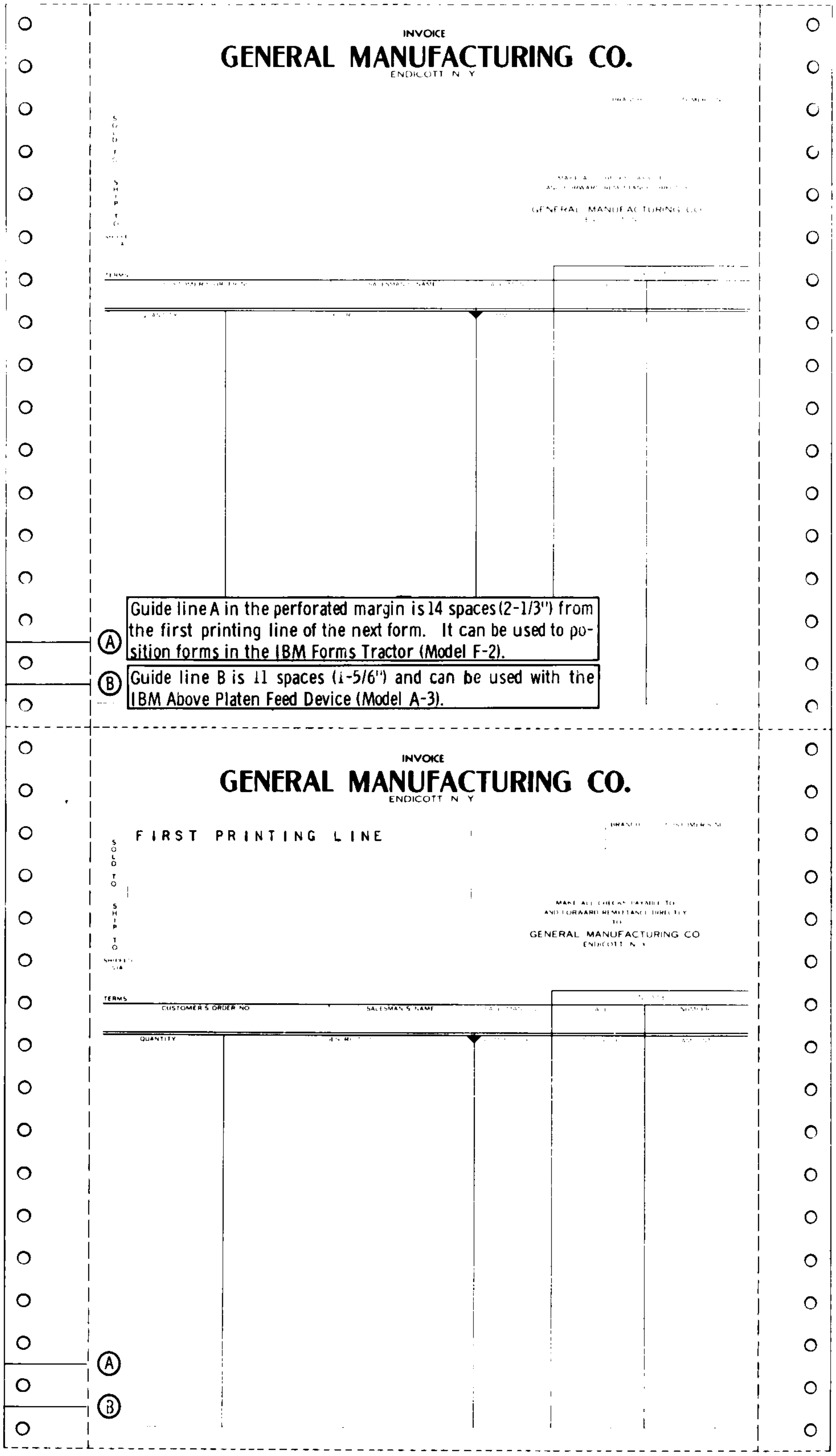


Figure 79. First Printing Line Location

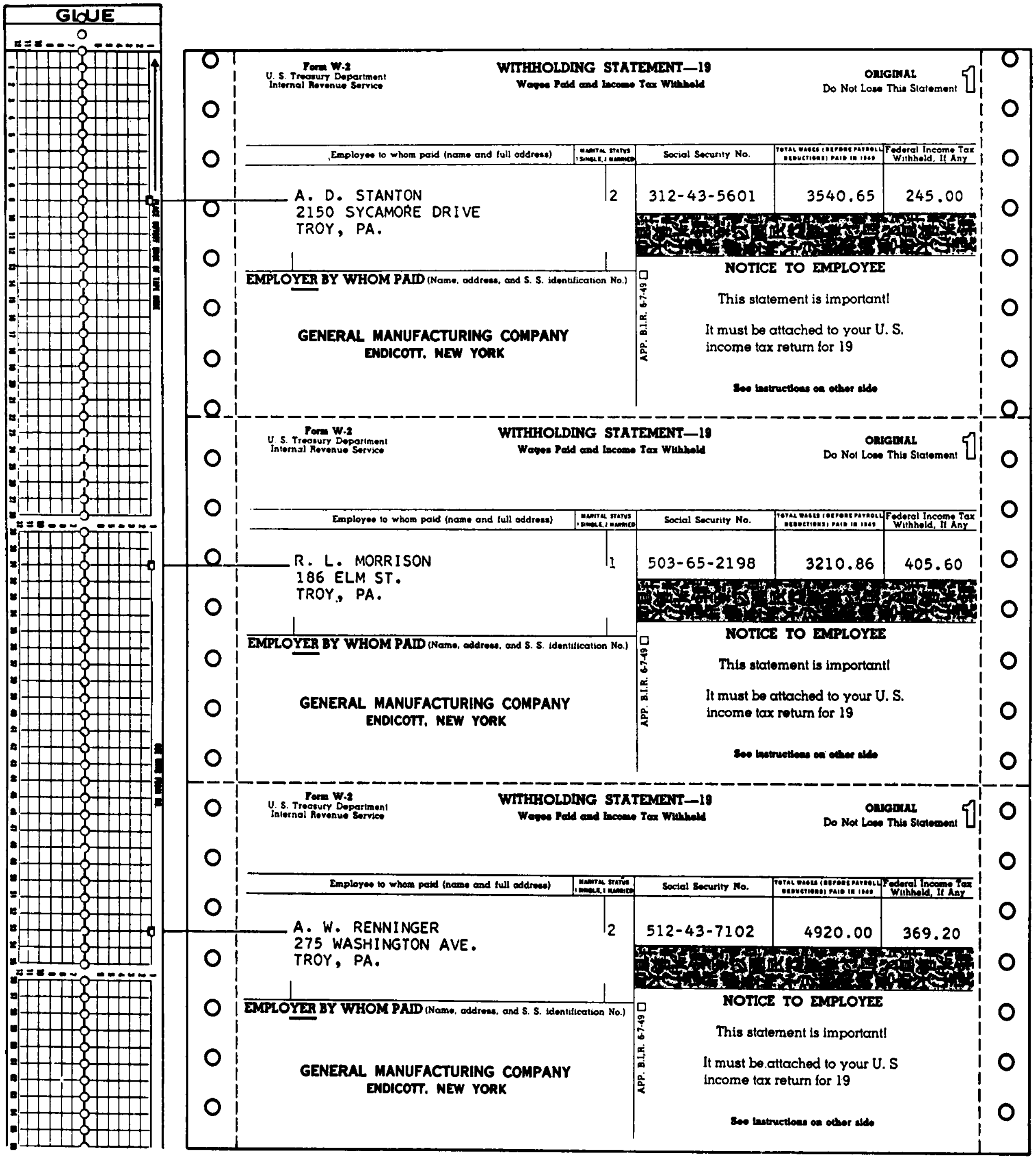


Figure 80. Form-to-Form Skipping (Note: This W-2 withholding statement design is not currently in use and is used here only to illustrate skipping.)

Social Security number is compared, and the COMPARING EXIT wired to CARRIAGE SKIP 1D. It is unnecessary to initiate a program start because totals are not required. Each new group is identified by a change in social security number and the comparing exit resulting from this change causes skipping on the following cycle or before the first card of each group. The hole in channel 1 of the tape stops the skip.

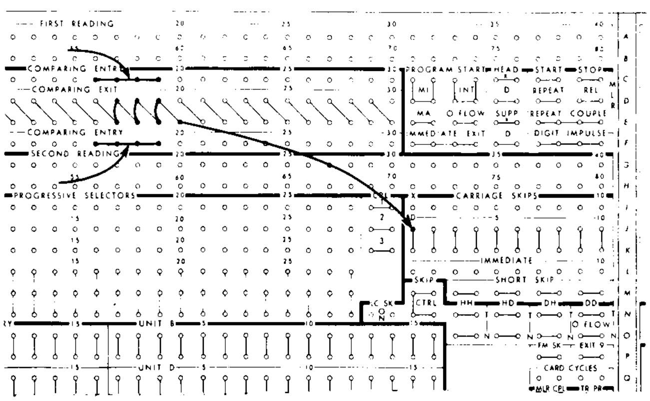


Figure 81. Wiring, Form-to-Form Skipping

Two-Part Form Skipping — Single Heading Forms

In any operation in which heading and detail cards are used (Figure 82) the machine can be controlled to print the heading cards in the heading section of the form and the detail cards in the body section, as well as provide for overflow (See Figure 84).

Head X, D. Heading cards are usually identified by a significant punch that is normally wired from FIRST READING to HEAD X or D. When an impulse is received by one of these hubs, it indicates that the next card to be read is a heading card and causes the machine to detail print during the following card feed cycle. The detail printing of heading cards takes places regardless of the setting of the list switch. These hubs also work in conjunction with skip control to control the carriage skip D and H hubs.

When HEAD CONTROL is impulsed, only the minor first card hubs are active during the print cycle of the first detail card following a heading card, regardless of program change or whether the program change is minor, intermediate or major.

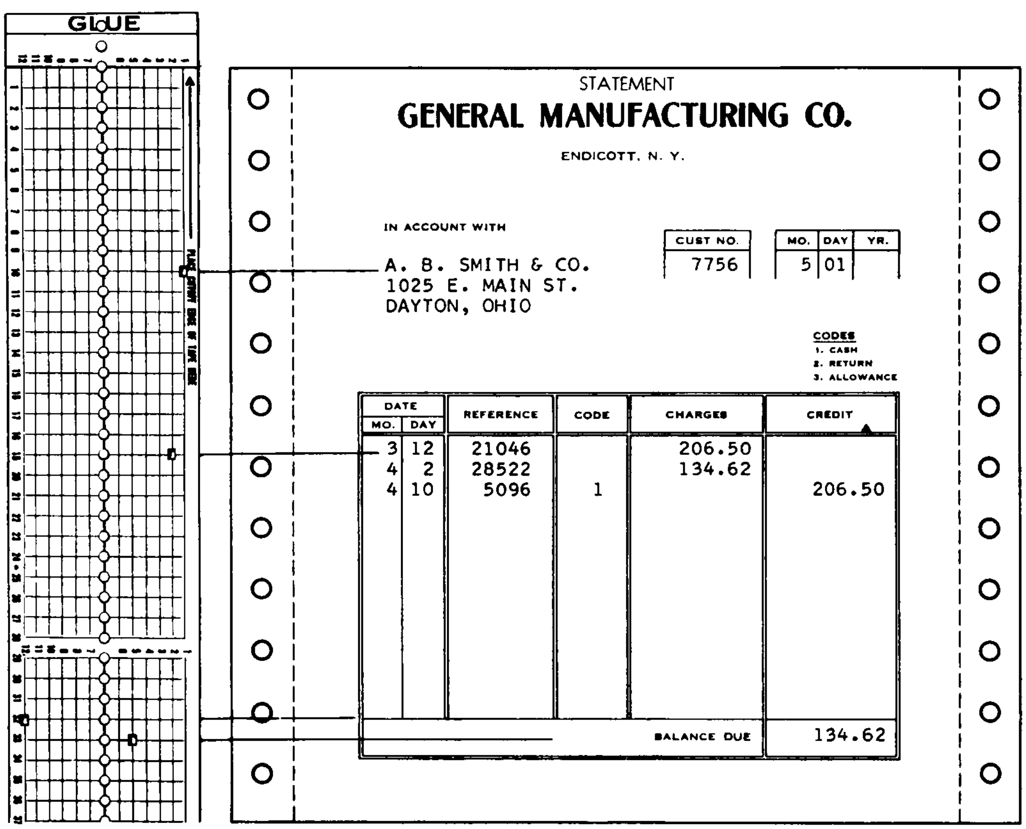
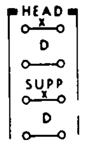


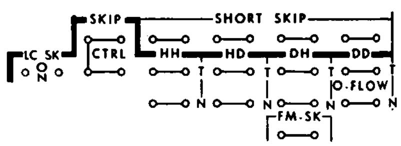
Figure 82. Identifying Printing Lines for Control-Tape Punching



C-F, 35-36

Supp X, D (Suppress X, D). An X- or D-impulse received by these hubs suppresses program control even though a change in group is recognized by the comparing unit. These hubs are normally wired from SECOND READING to suppress programming between heading and body cards or between various heading cards.

Impulsing the suppress hubs does not prevent carriage skipping, however. For example, if a change in program were recognized between heading cards that have no control field and body cards that have, the program would be suspended but the activity of the HTD (heading to detail transferred) hubs would not.



N, 29-30; M-N, 31-32; M-O, 33-40; P, 37-38

LC SK (Last Card Skip). This switch must be wired ON if it is desired to skip to channel 1 at the end of the run. If it is not wired, the form on which the last line is printed would remain in position for final totals. The final totals should be manual, rather than RO finals.

Skip Control. When these four common hubs receive an impulse from COMPARING EXIT and HEAD CONTROL is wired, an internal selector system is picked up to control the HH, HD, DH and DD as described below.

HH (Head Card to Head Card). Whenever a heading card at the second station is followed by a heading card at the first station, an impulse is emitted from the N (normal) hubs if there is no control change (skip control not impulsed) and from the T (transferred) hubs if there is a control change.

When the HH transferred hubs are active, detail cards are missing, because detail cards should always follow heading cards. These hubs normally are wired to carriage skip 1 so that the heading card always starts printing on the first line of the next form.

HD (Head Card to Detail Card). Whenever a heading card at the second station is followed by a detail card at the first station, an impulse is emitted from the N (normal) hubs if there is no control change, and from the T (transferred) hubs if there is a control change. HD NORMAL represents heading cards followed by normal cards of the same group and is normally wired to the skip reserved for the first body line. HD TRANSFERRED indicates missing detail cards of one group and missing heading cards of the following group and is usually wired to FORM SKIP (FM-SK) and to the carriage skip identifying the first body line.

DH (Detail Card to Head Card). Whenever a detail card at the second station is followed by a heading card at the first station, an impulse is emitted from the N (normal) hubs if there is no control change, and from the T (transferred) hubs if there is a control change. DH NORMAL represents cards out of sequence when conventional forms are used and should be wired to machine STOP. DH TRANSFERRED represents a change from one group to another and should be wired to carriage skip 1 so that the heading card of the new group starts printing on the first line of the next form.

DD (Detail Card to Detail Card Transferred). Detail to detail transferred emits an impulse when there is a control change between a detail card at the second station and a detail card at the first station. DD TRANSFERRED represents missing heading cards of the next group and is normally wired to skip to the first body line of the next form.

Overflow. (Detail to Detail Normal). These hubs emit an impulse as the last body line of a form is detail printed or as a total is group printed. The last body line is determined by a punch in channel 12 of the tape. If heading cards are used these hubs are normally wired to the carriage skip hub assigned to the first body line. If heading cards are not used these hubs are wired to the first line of the next form, thus causing form-to-form ejection.

Short Skip. Whenever an overflow or a regular skip occurs and the maximum distance is two inches or less (Figure 73), the interlock may be cancelled and skipping may be done without interrupting the normal printing speed of the machine. This is done by impulsing one of the four sets of short skip hubs with the skip impulse representing the skip that is within the required distance. For example, if in form-to-form skipping the distance between the last printing line of one form to the first printing line of the next form is two inches or less, overflow can be wired to SHORT SKIP as well as to channel 1; or if the skipping distance between the heading and body of a form is within two inches, HD NORMAL can be wired to short skip as well as to the channel representing the first body line.

When wiring to SHORT SKIP, care should be taken that these hubs are not tied in with any impulse other than the one desired. Unselected ALL CYCLES or CARD CYCLES should not be wired to SHORT SKIP.

FM-SK (Form Skip). A skip from the last heading line of one form to the first body line of the next form requires the carriage to skip more than one form length. The two common form skip hubs are provided

for this purpose. The function of the form skip is to delay recognition of any skip stop until the corresponding position is reached on the following form. When FORM SKIP is impulsed, the ten brushes are inactive until a 12 (overflow) hole is sensed, at which time they become active again.

The impulse most frequently wired to FORM SKIP is HD TRANSFERRED, which represents missing detail cards of the first group and missing heading cards of the second group. Thus, the body of the first form and the heading of the second form must be skipped, preventing form spoilage and allowing the manual insertion of missing data.

Analyzing a Form for Carriage Skip Wiring

Before any carriage skip wiring is attempted, the form itself should be analyzed to determine all the conditions under which skipping might occur. The form shown in Figure 83 would be analyzed as follows:

1. A skip is required between the heading and body of the same form. The carriage hub representing this condition is HD NORMAL.
2. A skip to the first printing line is required after the total prints or between the detail cards of one group and the heading cards of another. DH TRANSFERRED represents this condition.
3. When body cards are missing, a skip from the heading of one form to the heading of the next form is required. The carriage hub representing this condition is HH TRANSFERRED.
4. When heading cards are missing, a skip from the body of one form to the body of the next form is required. The carriage hub representing this condition is DD TRANSFERRED.
5. When the body cards of one form and the heading cards of the next form are missing, a skip from the heading of one form to the body of the following form is required. The hubs representing this condition are HD TRANSFERRED and are used in conjunction with FM-SK.
6. An overflow skip is required when there are more items than one form will accommodate. The hub representing this condition is OVERFLOW (DD NORMAL).
7. When heading cards follow detail cards of the same group, they are out of sequence. DH NORMAL represents this condition.

The seven conditions described in the preceding analysis provide a plan for the control of carriage skipping on the basis of heading control, that is, to form skipping and skipping to the first body line. A further skip can be initiated before total printing to permit printing of the total on a predetermined line as illustrated in Figure 82. The wiring is shown in Figure 84.

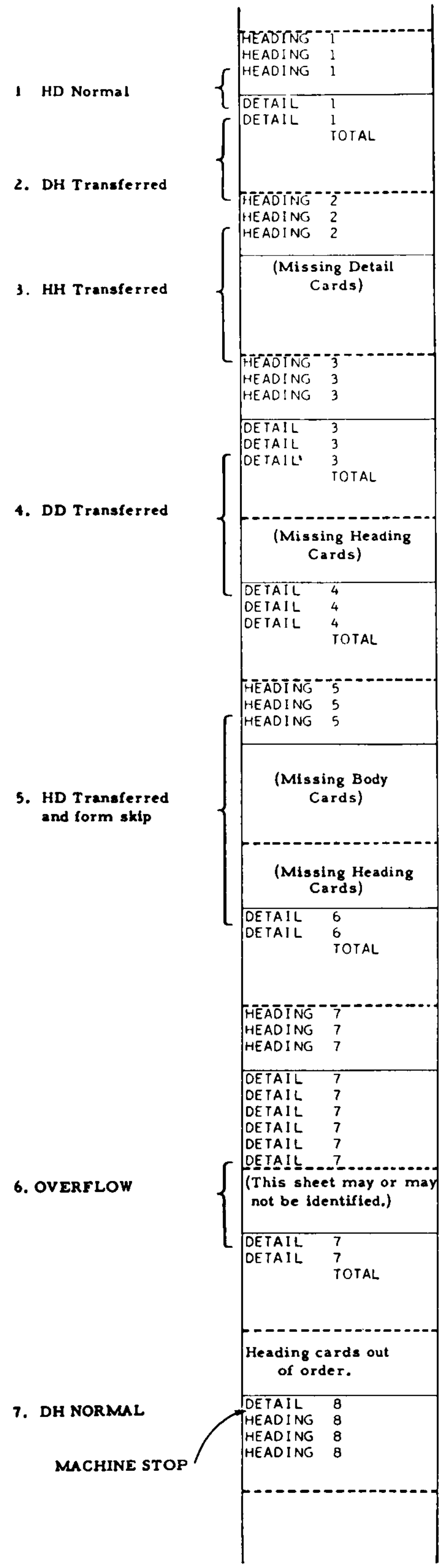
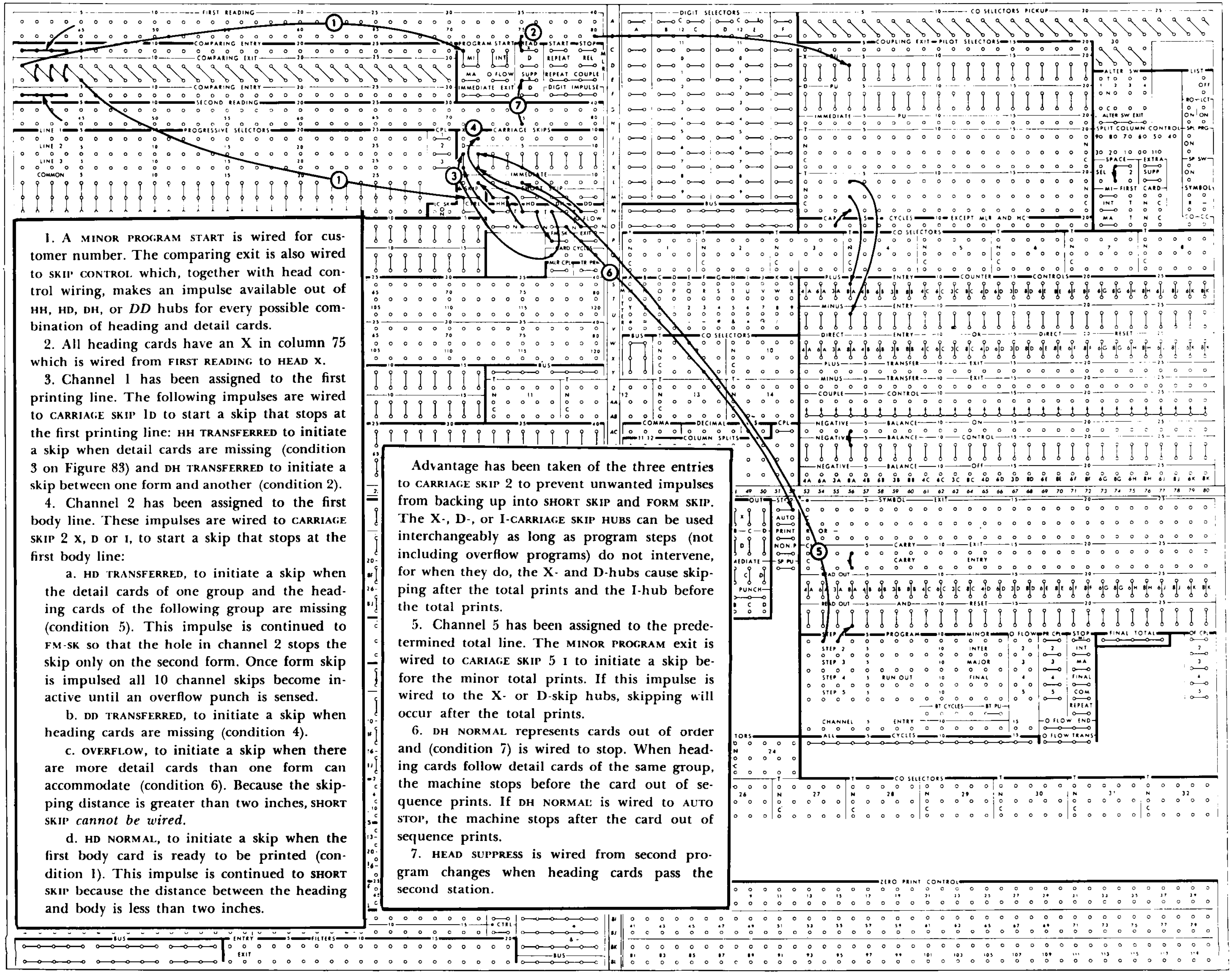


Figure 83. Form-Skip Chart



1. A MINOR PROGRAM START is wired for customer number. The comparing exit is also wired to SKIP CONTROL which, together with head control wiring, makes an impulse available out of HH, HD, DH, or *DD* hubs for every possible combination of heading and detail cards.

2. All heading cards have an X in column 75 which is wired from FIRST READING to HEAD X.

3. Channel 1 has been assigned to the first printing line. The following impulses are wired to CARRIAGE SKIP 1D to start a skip that stops at the first printing line: HH TRANSFERRED to initiate a skip when detail cards are missing (condition 3 on Figure 83) and DH TRANSFERRED to initiate a skip between one form and another (condition 2).

4. Channel 2 has been assigned to the first body line. These impulses are wired to CARRIAGE SKIP 2 X, D or I, to start a skip that stops at the first body line:

a. HD TRANSFERRED, to initiate a skip when the detail cards of one group and the heading cards of the following group are missing (condition 5). This impulse is continued to FM-SK so that the hole in channel 2 stops the skip only on the second form. Once form skip is impulsed all 10 channel skips become inactive until an overflow punch is sensed.

b. DD TRANSFERRED, to initiate a skip when heading cards are missing (condition 4).

c. OVERFLOW, to initiate a skip when there are more detail cards than one form can accommodate (condition 6). Because the skipping distance is greater than two inches, SHORT SKIP *cannot be wired.*

d. HD NORMAL, to initiate a skip when the first body card is ready to be printed (condition 1). This impulse is continued to SHORT SKIP because the distance between the heading and body is less than two inches.

Advantage has been taken of the three entries to CARRIAGE SKIP 2 to prevent unwanted impulses from backing up into SHORT SKIP and FORM SKIP. The X-, D-, or I-CARRIAGE SKIP HUBS can be used interchangeably as long as program steps (not including overflow programs) do not intervene, for when they do, the X- and D-hubs cause skipping after the total prints and the I-hub before the total prints.

5. Channel 5 has been assigned to the predetermined total line. The MINOR PROGRAM exit is wired to CARIAGE SKIP 5 I to initiate a skip before the minor total prints. If this impulse is wired to the X- or D-skip hubs, skipping will occur after the total prints.

6. DH NORMAL represents cards out of order and (condition 7) is wired to stop. When heading cards follow detail cards of the same group, the machine stops before the card out of sequence prints. If DH NORMAL is wired to AUTO STOP, the machine stops after the card out of sequence prints.

7. HEAD SUPPRESS is wired from second program changes when heading cards pass the second station.

Figure 84. Two-Part-Form Skipping

An analysis of the form should be made to determine whether the overflow and regular skips are within the two-inch limit (Figure 73). In the form shown in Figure 83, only the heading-to-detail skip is within that range and therefore can be wired to SHORT SKIP.

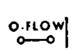
Multiple Heading Groups; Overflow Sheet Identification

The flexibility of the tape-controlled carriage for controlling skipping is illustrated in Figure 85. Provision is made on the form for five sections in the heading and two sections in the body.

The first printing line is signalled by a punch in tape channel 1. The first line of the second heading is identified by a normal skip stop in channel 2. Similarly, the first lines for shipping instructions, terms, and miscellaneous data are signalled by punches in channels 3, 4 and 5, respectively.

The first body line is signalled by a punch in tape channel 6 and the predetermined total line by a punch in tape channel 7. The cards shown in the heading may all be present, one or more may be missing. If the heading cards are identified by a common X or digit, the detail cards may be identified as NX. An X punched in the first card of each section causes skipping to the proper position of the form for printing in each section.

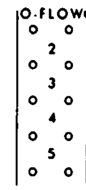
The name appearing on the first line of the first form is repeated on overflow sheets. Other information like invoice date and number, as well as page number, shown on the first line is discussed in the next problem. Several lines of identifying information can be printed on the overflow sheets. Storage units or counters can be used to store information to be printed on the overflow sheet (Figures 85 and 86).



E, 33-34

Overflow Program Start. The overflow program start hubs are wired from the overflow skip control hubs (DD NORMAL) to cause overflow programs to be initiated and impulses to be made available out of the overflow program and overflow couple hubs.

O-Flow. There are two independent overflow hubs for each program step. When OVERFLOW PROGRAM START is impulsed, the OVERFLOW programs become active in

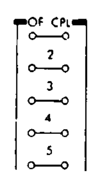


AP-AT, 67-68

turn, beginning with the first step and continuing until the fifth step is reached or until stopped by the wiring of the last step used to OVERFLOW END. These hubs are used to control the printing of overflow indication on overflow forms by wiring them to counter or storage READ OUT. They can also be used to control carriage skipping by wiring them to the carriage skip hubs for properly locating the form after the overflow indication.

When overflow program hubs are active, the regular program hubs are not active. When both the regular PROGRAM START and the OVERFLOW PROGRAM START are impulsed at the same time, the regular program exits take precedence. In such a case, the overflow programs are usually cancelled by control panel wiring.

Once the overflow program start is impulsed, progression of overflow steps continues until stopped by control panel wiring, regardless of the setting of the special program switch. If more than five overflow programs are desired, the fifth OVERFLOW step is wired to REPEAT. Although there are only two overflow program hubs for each step, they can be expanded by wiring ALL CYCLES impulses through the TRANSFERRED side of a co-selector picked up from OVERFLOW COUPLE.



AP-AT, 79-80

OF CPL (Overflow Couple). Each of these hubs emits an impulse at a specific overflow program step. Hub 1 emits for overflow program 1, hub 2 for overflow program 2, and so on. The impulses are of longer duration than the overflow programs and are normally used to pick up co-selectors for the purpose of expanding the regular overflow programs. On machines on which these hubs are inactive, overflow couple impulses are supplied by PR CPL (program couple).

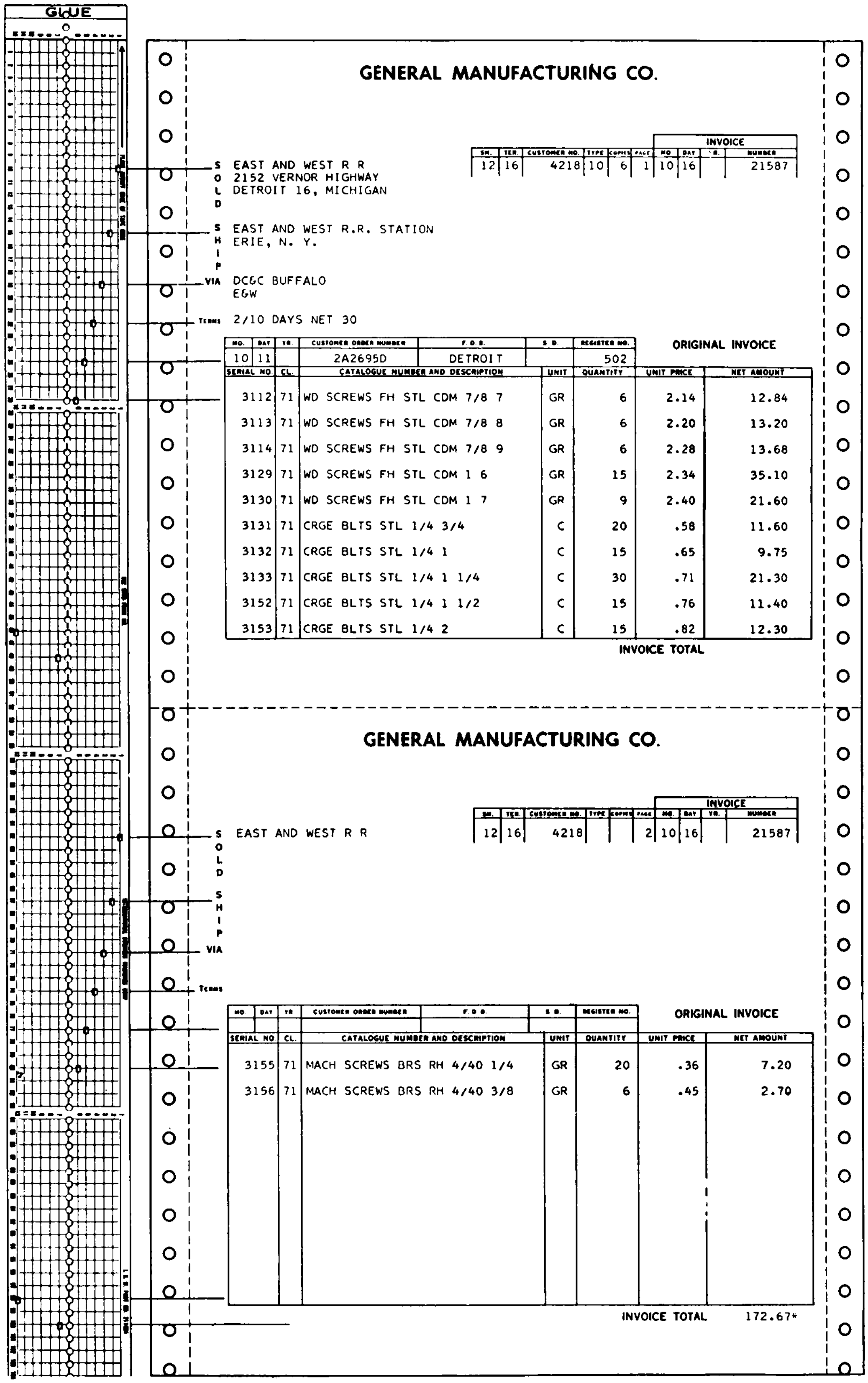


Figure 85. Control-Tape Punching for Printing-Line Identification

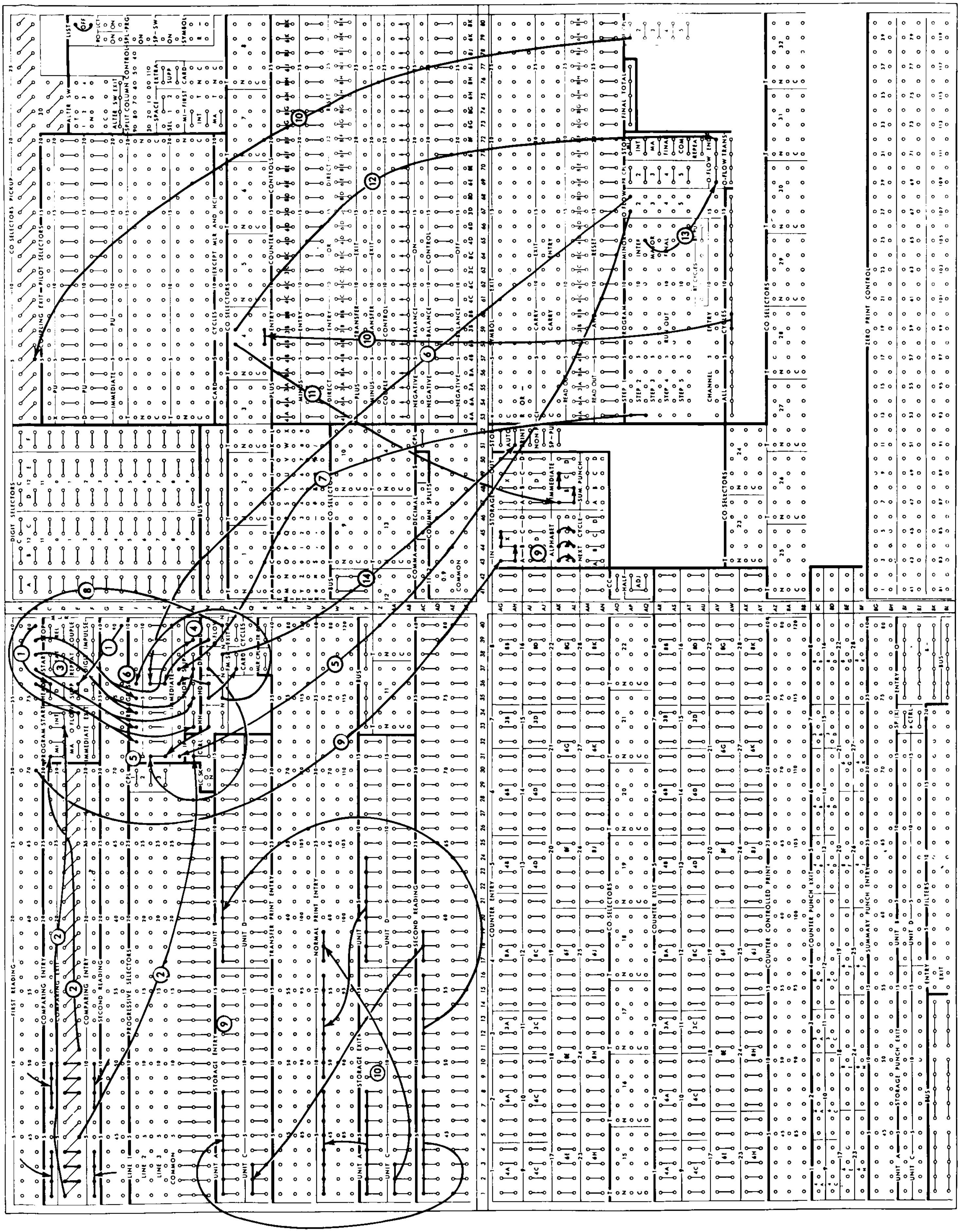


Figure 86. Multiple Heading Groups: Overflow Sheet Identification

1. All heading cards have a common X in column 80. HEAD X is wired from FIRST READING, and HEAD SUPPRESSION is wired from SECOND READING.

2. MINOR and INTERMEDIATE PROGRAM START and SKIP CONTROL are wired from COMPARING EXIT, as shown.

3. In addition to the common X for all heading cards, the first card of the shipping instruction group contains an X in column 76, the first card of *via* contains an X in column 77, the terms card contains an X in column 78, and the miscellaneous data card contains an X in column 79. These X punches are necessary to cause skipping from one section of the heading to another. A skip between *sold* and *ship* is caused by wiring X76 from FIRST READING to CARRIAGE SKIP 2X. A skip between *ship* and *via* is caused by wiring X77 from FIRST READING to CARRIAGE SKIP 3X. A skip between *via* and *terms* is caused by wiring X78 from FIRST READING to CARRIAGE SKIP 4X. A skip between *terms* and *miscellaneous data* is caused by wiring X78 from FIRST READING to CARRIAGE SKIP 5X.

4. Because the skip between one section of the heading and another is never greater than two inches, SHORT SKIP is wired from the X in the first card of each group. This prevents an idle cycle each time a skip is initiated in the heading.

5. Channel 1 has been assigned to the first printing line. These impulses are wired to CARRIAGE SKIP 1D or I to start a skip that stops at the first printing line:

a. Because the report is to group printed, OVERFLOW PROGRAM 1 is wired to SKIP TO 1 I. This causes a skip to the first printing line after the last minor total on the form has been printed and before overflow program 1 is taken. If the report were to be detail printed, overflow skip (DDN) could be wired to 1 I.

b. DH TRANSFERRED to initiate a skip to the first printing line after the intermediate total prints.

c. HH TRANSFERRED to initiate a skip to the first printing line when detail cards are missing.

6. Channel 6 has been assigned to the first body line. These impulses are wired to CARRIAGE SKIP 6X, D or I to start a skip that stops at the first body line:

a. HD NORMAL, to initiate a skip from heading to body.

b. OVERFLOW PROGRAM 1, to initiate a skip to the first body line after the sheet identification information has been printed on an overflow sheet.

c. DD TRANSFERRED to initiate a skip to the first body line when heading cards are missing.

d. HD TRANSFERRED to initiate a skip to the first body line when there are missing detail cards of one group and missing heading cards of the following group. This impulse is continued to FM-SK so that the hole in channel 6 is effective only after channel 12 has been sensed. The program control is suppressed by a heading X from second reading.

7. INTERMEDIATE PROGRAM is wired to CARRIAGE SKIP 7 I to initiate a skip to the predetermined total line before the total prints.

8. An overflow program start is initiated by wiring OVERFLOW to OVERFLOW START. This wiring makes the overflow program steps active progressively from 1 to 5, every time the hole in channel 12 is sensed.

9. The name to be printed on the overflow sheet is wired into storage units A, B, and C from SECOND READING. Because alphabetic information is being stored, only the first eight positions may be used. The storage units are impulsed to accept the information by wiring X70 (first heading card) to STORAGE IN A, B, and C. These three units are coupled for storing alphabetic information.

10. Because more than two overflow exits are needed, they are expanded by wiring ALL CYCLES impulses through the TRANSFERRED side of co-selector 4. The co-selector is picked up from OVERFLOW COUPLE 1.

11. The overflow sheet identification is read out of storage units A, B, and C by wiring overflow program 1 to IMMEDIATE READ-OUT.

12. The last overflow program (step 1) is wired to OVERFLOW END. Only one step is needed in this example to print the name on the first line of each overflow sheet.

13. INTERMEDIATE PROGRAM is wired to OVERFLOW END, so that if the intermediate program start and the overflow program start are initiated at the same time, the normal program steps are effective and the overflow program steps are cancelled.

14. DH NORMAL, which represents detail cards followed by heading cards of the same group (out of sequence), is wired to AUTO STOP.

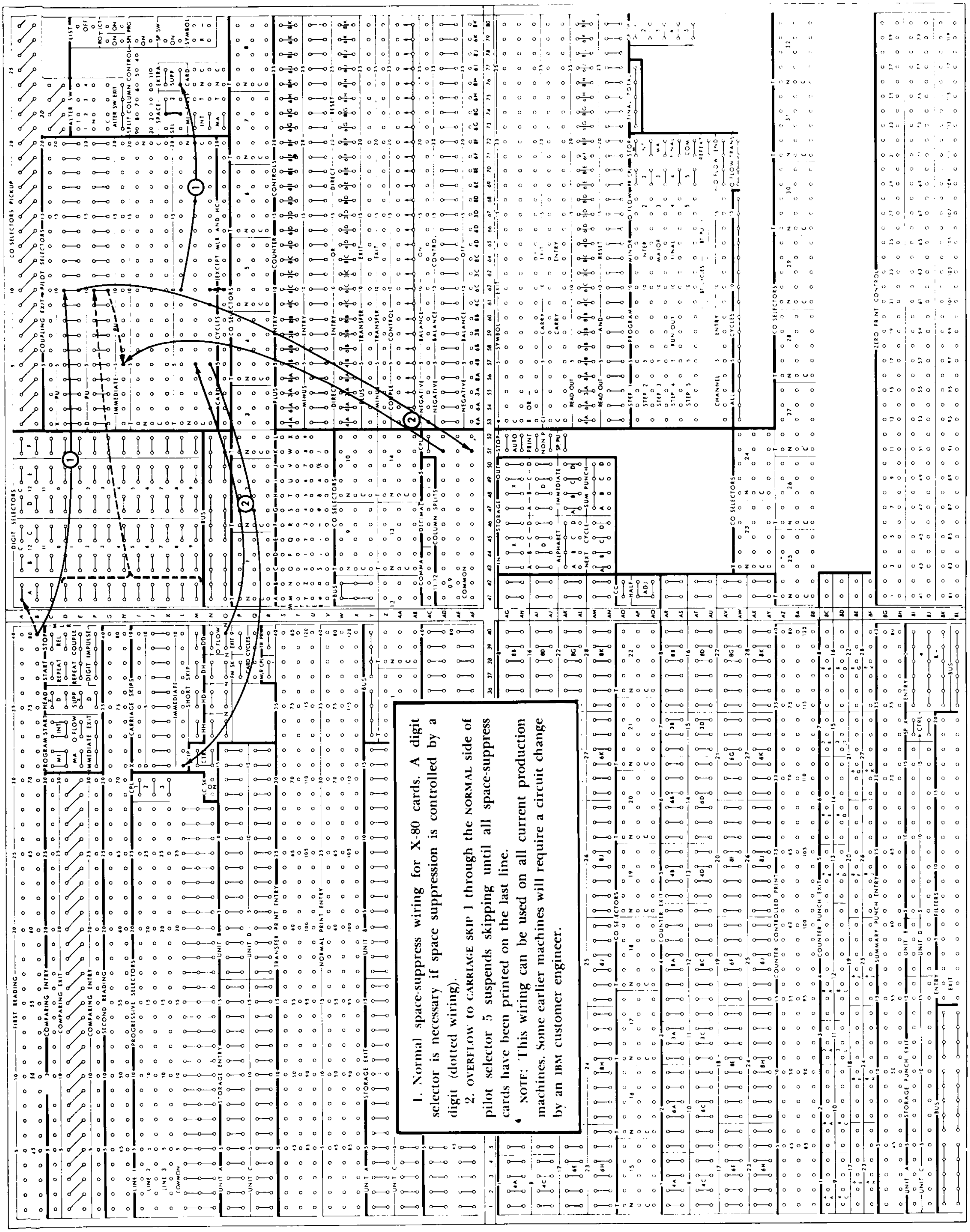
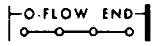


Figure 87. Space Suppression-Overflow Skipping



AV, 69-72

O-Flow End. The succession of overflow programs is stopped by wiring the last OVERFLOW program step required to OVERFLOW END. Normally, whenever an overflow program is used it is associated with either minor, intermediate or major program start. When minor program only is used, MINOR PROGRAM EXIT should be wired to OVERFLOW END along with the last overflow program. This cancels overflows steps 1 through 5, whenever both the overflow and the minor program start occur at the same time, since an overflow to the next form would not be necessary.

When overflow program is associated with intermediate program start, the INTERMEDIATE PROGRAM EXIT should be wired to OVERFLOW END along with the last overflow program. When the minor program start occurs at the same time as the overflow program start, the minor total prints, followed by a progression of overflow program steps. When the intermediate program start occurs at the same time as the overflow program start, the minor total prints, followed by the intermediate total, and all overflow programs are cancelled.

When overflow program is associated with major program start, the MAJOR PROGRAM EXIT along with the last overflow program is wired to OVERFLOW END. A minor program occurring at the same time as overflow program would be followed by overflow program steps. Intermediate programs occurring at the same time as overflow program would cause both the minor and intermediate totals to print followed by overflow program steps. When the major program start occurs at the same time as overflow program start, the minor, intermediate and major totals print and all overflow programs are cancelled. The overflow end hubs are never active unless OVERFLOW PROGRAM START has been previously impulsed. Failure to wire overflow end hubs causes the machine to stop after the fifth program step and requires that the main line switch be turned OFF before the machine can be restarted.

The possibility of an overflow program being started at the same time as a minor, intermediate, or major program can be eliminated by selecting the impulse from the overflow skip control hubs (DD NORMAL) to OVERFLOW PROGRAM START. It is taken through the NORMAL side of a selector picked up immediately from the comparing exit that initiates the program start.

Space Suppression—Overflow Skipping

Space suppression to cause printing from several cards on one line is normally accomplished by impulsing SPACE SUPPRESS from a CARD CYCLES impulse through a properly controlled selector. It must be remembered, however, that when space suppression occurs on the last line of the form, overflow skipping takes precedence if overflow is wired directly to a carriage skip hub. Thus, a card that should space-suppress and print on the last line of the form prints on the first line of the next form.

By wiring the overflow impulse through a selector as illustrated in Figure 87, overflow skipping is suspended until all space-suppress cards have been printed on the last line.

Invoice and Page Numbering

Every form passing through the machine may be identified by some number, usually an invoice number and a page number. Page numbers are usually printed consecutively to identify overflow sheets, while invoice numbers are printed repetitively for overflow sheets and consecutively for each invoice. The schematic analysis (Figure 88) shows both invoice and page number printed in the heading section of each form alongside the name.

The functions of the carriage tape channels are as follows:

- Channel 1 to locate the first printing line on which the name, invoice and page number print.
- Channel 2 to locate the first body line.
- Channel 8 to locate the predetermined total line.
- Channel 12 to locate the overflow line.

The invoice number, which may begin with 1 or any predetermined number, is entered into a counter from a leader card punched with the last invoice number used. The invoice number is printed on the first heading line of each invoice by impulsing the invoice counter to read out on the cycle following the minor program change (first card of each group). The invoice number is printed on the first heading line of each overflow sheet by impulsing the invoice counter to read out on overflow step 1.

The invoice number is increased one on every minor program change in preparation for the next invoice to follow. The invoice number counter is reset on a final total.

The page number 1 is printed on the first heading line of each invoice by impulsing the page number counter to add 1 on the cycle following the minor program change. A 1 is added in the page number

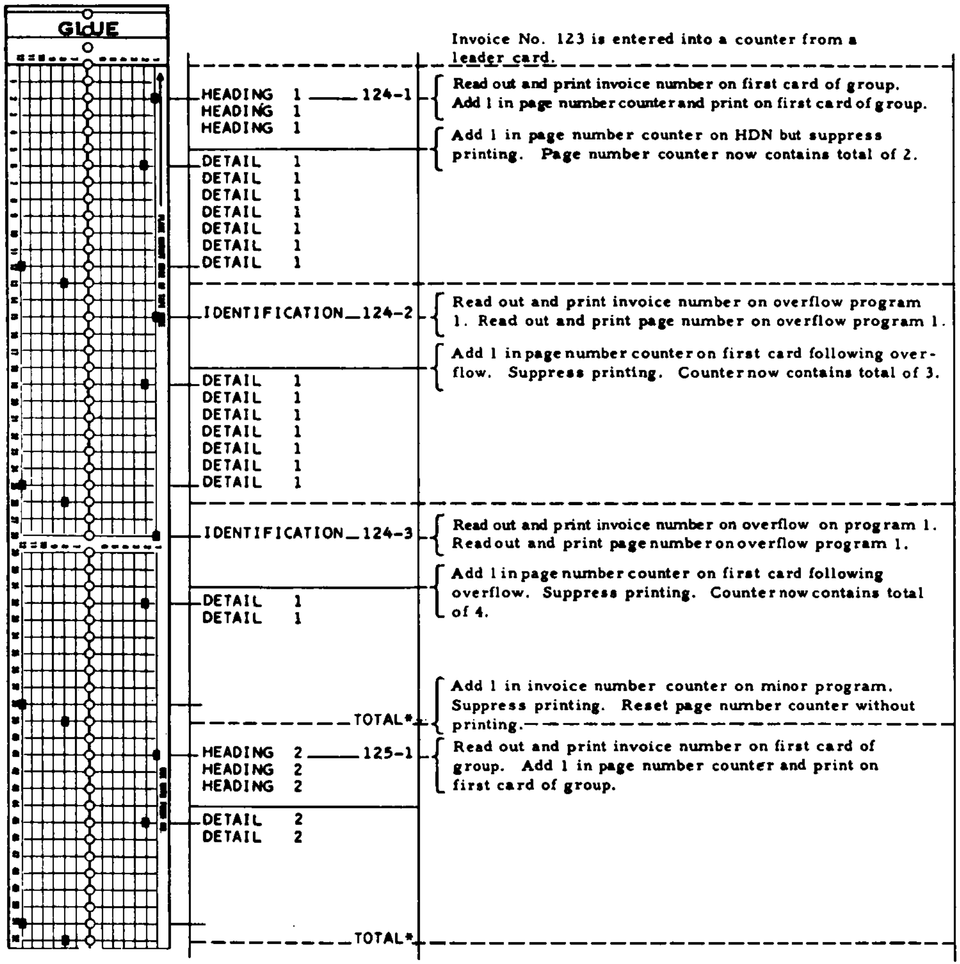


Figure 88. Invoice and Page-Numbering Control-Tape Punching

counter on a HDN condition (heading to detail normal) to increase the number to 2 in preparation for a possible overflow sheet to follow. The page number prints on the first overflow step of each overflow sheet.

A 1 is added in the page number counter on the cycle following overflow program 1, to raise the page number by 1 in preparation for a possible subsequent overflow sheet to follow. The page number counter is reset on each minor program (see Figure 90).

Identifying Overflow Sheets with More Than One Line

Overflow sheets may be identified by any number of lines within the capacity of the machine to store them. The identifying information can be alphabetic or numerical and can come from any designated card in the group or, under proper control, from the emitter.

Figure 89 shows the wiring required for printing seven overflow lines. Normally, overflow programs continue until stopped or until step 5 has been reached. If more than five overflow steps are required, special program must be ON and REPEAT must be wired.

Variable Length Overflow

Normally, when a program change and an overflow occur at the same time, an overflow skip cannot occur until all totals have been printed. In some applications, such as billing, enough space must be allowed to print the total amount of the invoice or bill, even after the overflow line has been reached. This space may vary anywhere from two to six lines and means that each form normally loses up to one inch of printing space whenever regular overflow occurs.

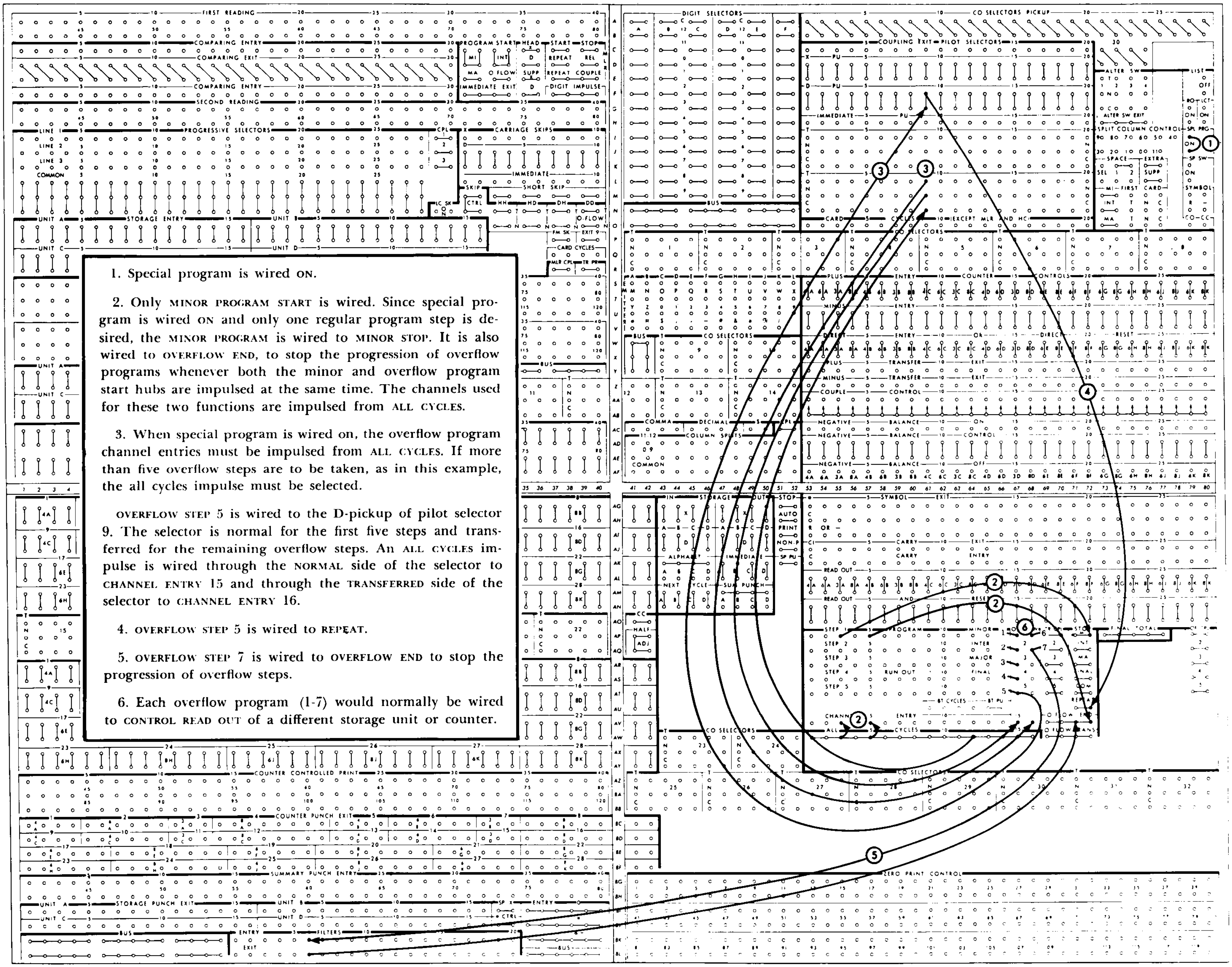


Figure 89. Seven Overflow Lines

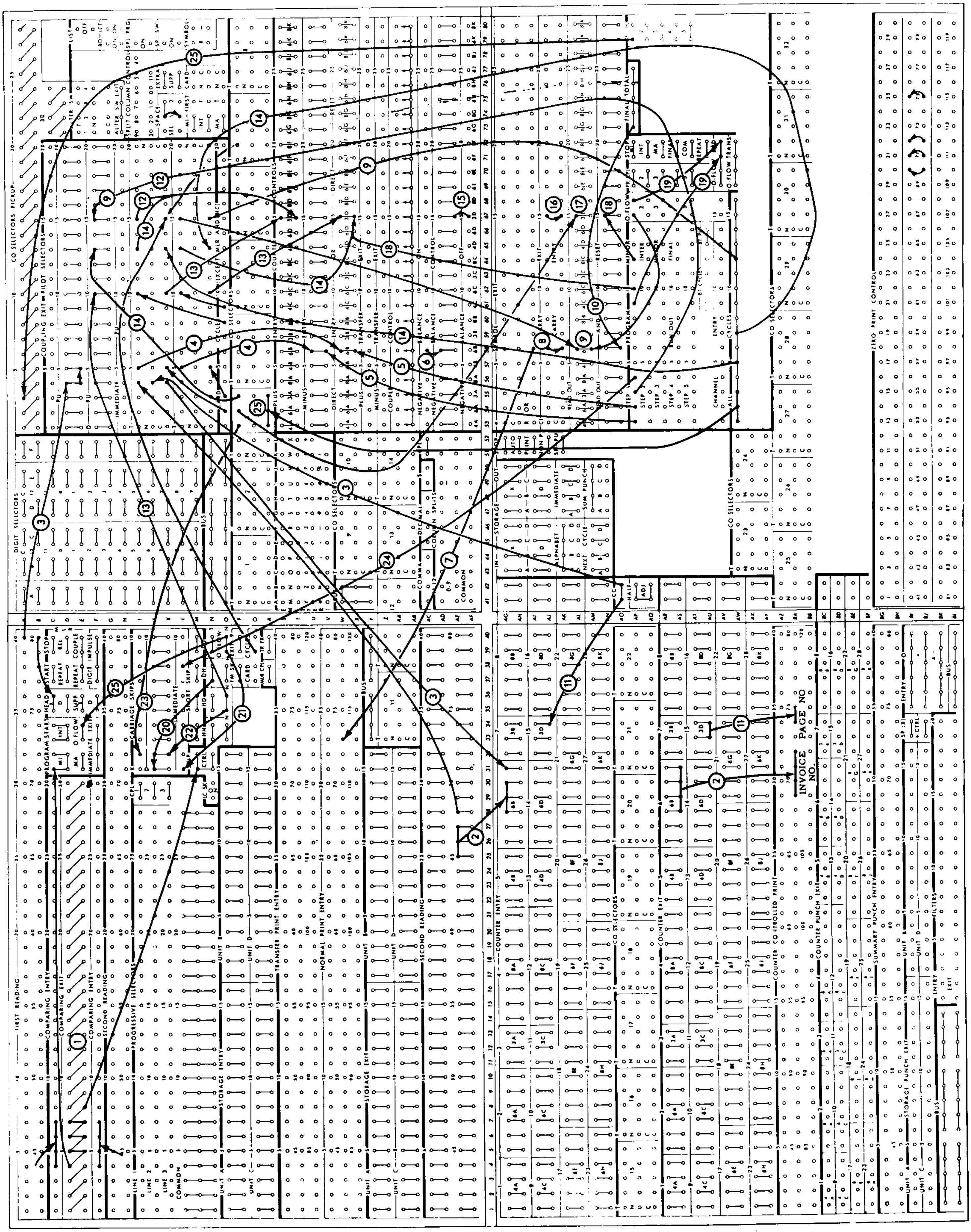


Figure 90. Invoice and Page Numbering

Explanation of the wiring in this example is divided into three parts: invoice number printing, page number printing, and carriage wiring.

A. INVOICE NUMBER PRINTING

1. The field to be compared is wired to the comparing unit, and the COMPARING EXIT is wired to MINOR PROGRAM START and SKIP CONTROL.

2. The invoice number is entered into counter 6B from a leader card (X40). The three high-order positions are wired from SECOND READING directly to COUNTER 6B ENTRY.

3. The leader-card X is wired from FIRST READING to the PICKUP of pilot selectors 4 and 5. The units position of invoice number is wired through the TRANSFERRED side of pilot selector 4 to the units position of COUNTER 6B ENTRY. A CYCLE COUNT impulse is wired through the NORMAL side of the selector to the units position of COUNTER 6B ENTRY. Thus, counter 6B is connected to column 68 for X40 (leader cards) and to the cycle count impulse on all other cycles.

4. All entries into counter 6B are subtracted so that advantage may be taken of the minus feature of the R or — hub for printing a dash between the invoice number and page number.

The number from the leader card is subtracted by wiring CARD CYCLES through the TRANSFERRED side of pilot selector 5 to COUNTER 6B MINUS. CARD CYCLES is also wired through the TRANSFERRED side of pilot selector 5 to the DIRECT ENTRY of counter 6B so that the 1 cannot print at this time.

5. The invoice number is increased 1 each time a change in account is recognized, by wiring the MINOR PROGRAM LEVEL to COUNTER 6B MINUS. The program is also wired to DIRECT ENTRY, so that the 1 will not print at this time.

6. NEGATIVE BALANCE ON is wired to NEGATIVE BALANCE CONTROL so that the complement invoice number is converted to a true figure.

7. Because the R or — symbol switch is not connected, a minus sign impulse is available out of the R or — hub of counter 6B for every print cycle. The impulse is directed to NORMAL PRINT ENTRY 73 to supply a dash between invoice and page number.

8. CI and C are connected normally.

9. The invoice number is read out of counter 6B on the cycle following the minor program change by wiring an ALL CYCLES impulse through the TRANSFERRED side of pilot selector 15 to COUNTER 6B READ OUT. Pilot selector 15 is impulsed to pick up through its D-hub from MINOR PROGRAM. The selector transfers on the following cycle. This wiring takes care of the printing of invoice number on the first sheet of each invoice. The invoice number is also read out on the first overflow program step for the purpose of printing invoice number on each overflow sheet.

10. The invoice number counter is cleared at the end of the run by depressing the final total key.

B. PAGE NUMBER PRINTING

11. The CYCLE COUNT impulse is wired to counter 3D entry. COUNTER EXIT is wired to COUNTER CONTROLLED PRINT 74 and 75.

12. A 1 is printed and added into the page number counter on the first heading card of each group by wiring a CARD CYCLES impulse through the TRANSFERRED side of pilot selector 15 to COUNTER 3D PLUS. Pilot selector 15 is picked up from MINOR PROGRAM wired to its D-hub. The selector picks up on the cycle following the minor program cycle.

13. A 1 is added by direct entry into the page number counter on the cycle following a heading to body skip by wiring CARD CYCLES through the TRANSFERRED side of pilot selector 10 to the PLUS of counter 3D. This increases the page number by 1 in preparation for printing on the first overflow sheet. CARD CYCLES is also wired through the TRANSFERRED side of pilot selector 10 to the DIRECT ENTRY of counter 3D. Pilot selector 10 is picked up by wiring HDN to the D-pickup of the selector.

14. A 1 is added by direct entry into the page number counter on the cycle following overflow program 1 by wiring ALL CYCLES through the TRANSFERRED side of pilot selector 13 to COUNTER 3D PLUS. This increases the page number by 1 in preparation for printing on a possible second overflow sheet. ALL CYCLES is also wired through the TRANSFERRED side of pilot selector 13 to the DIRECT ENTRY of counter 3D. Pilot selector 13 is picked up by wiring OVERFLOW PROGRAM 1 to the D-pickup of the selector.

15. NEGATIVE BALANCE OFF (counter 3D) is wired to NEGATIVE BALANCE CONTROL.

16. CI and C are wired normally.

17. Page number is read out of counter 3D on the first overflow step for the purpose of numbering each overflow sheet.

18. The page number counter is reset without printing (direct reset) on a minor program cycle.

19. The last OVERFLOW PROGRAM used (step 1) as well as the last regular program used (minor) is wired to OVERFLOW END.

C. CARRIAGE

20. DHT is wired to 1D to cause skipping to the first heading line of the next form, following the printing of the minor total.

21. OVERFLOW is wired to 1I to cause skipping to the heading identification line on an overflow.

22. Heading to body skipping is caused by wiring HDN to 2D.

23. OVERFLOW PROGRAM 1 is wired to 2X to cause skipping to the first body line after the overflow identification is printed.

24. A skip to the predetermined total line is obtained by wiring MINOR PROGRAM to CARRIAGE SKIP 8I.

25. Overflow programs are initiated by wiring overflow (DD NORMAL) to OVERFLOW PROGRAM START. Overflow program 1 is expanded through co-selector 3.

The sheet identification information could be stored in either the storage units or in counters. It would be read out for printing on the first overflow step.

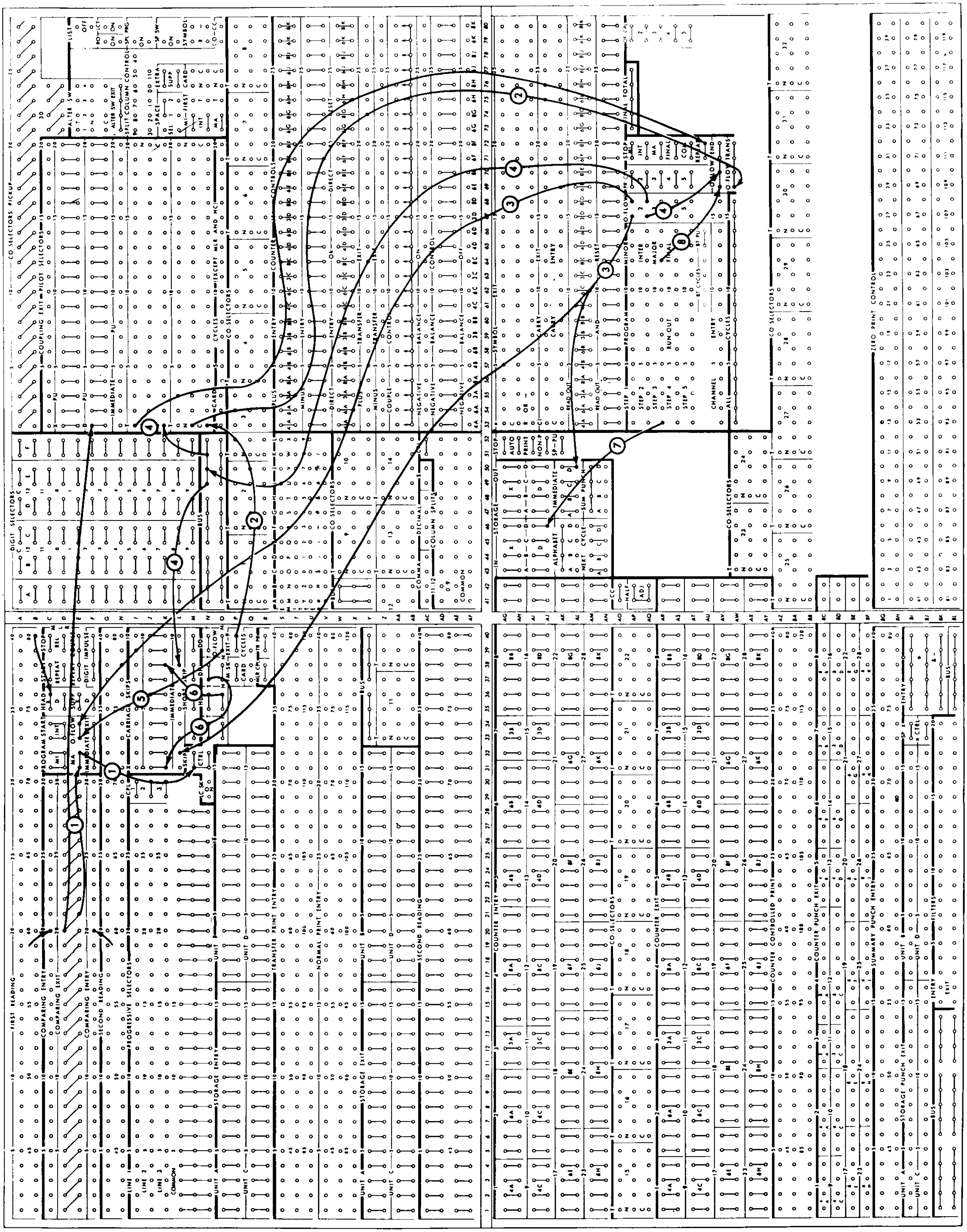


Figure 91. Variable-Length Overflow, Detail Printing

1. The major comparing exit hubs are wired to MAJOR PROGRAM START, to SKIP CONTROL, and to the D-pickup of pilot selector 1.

2. EXIT 9 is wired through the NORMAL side of pilot selector 1 to OVERFLOW TRANSFER. The overflow transfer hubs receive an impulse whenever channel 9 is sensed before or at the same time a major program change occurs.

3. If a major program change should occur any time after or at the same time that channel 9 has been sensed, the regular programs are made inactive and the overflow programs are made active. Two overflow steps are taken. Step 1 is used for these functions:

a. To cause a skip to the first printing line of the next form by wiring to CARRIAGE SKIP 2 I.

b. To cause the sheet identification information to be read out of storage unit D by wiring to the IMMEDIATE OUT of the unit.

c. To cause OVERFLOW END to be receptive to any following overflow step by impulsing OVERFLOW PROGRAM START. Normally the OVERFLOW PROGRAM START is impulsed from the carriage overflow hubs. In this instance the overflow channel (12) has not yet been read, Because the overflow end hubs are not receptive until the cycle following that from which overflow program start is impulsed, two overflow steps are required in this example.

4. Step 2 is used for the following functions:

a. To cause a skip to the first body line after the overflow sheet identification cycle by wiring to CARRIAGE SKIP 8 I.

b. To cause the regular program steps to follow the channel 9 overflow program steps by wiring to REPEAT, through the TRANSFERRED side of pilot selector 1. The selector prevents the repeat from becoming operative on regular overflow program steps.

c. To stop the progression of overflow steps by wiring to OVERFLOW END.

5. OVERFLOW PROGRAM START is wired normally.

6. DH TRANSFERRED is wired to CARRIAGE SKIP 1D to cause a skip to the first printing line whenever new heading cards are recognized, HD NORMAL is wired to CARRIAGE SKIP 8D to cause a skip to the first body line between heading and detail cards.

7. Sheet identification information is entered into storage unit D from the first card of each group by wiring MAJOR PROGRAM to STORAGE IN D.

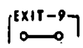
8. The last regular program used is wired to OVERFLOW END.

Two channels are used to locate the first printing line in this example. CHANNEL 1D is wired from DH TRANSFERRED and CHANNEL 2 I from OVERFLOW STEP 1. This is necessary because when the D- or X-hubs are impulsed skipping is delayed until all programs have been taken.

To isolate the two types of skips, overflow and DH transferred, two separate channels are used. In this way an immediate skip wired to CHANNEL 2 occurs regardless of how channel 1 is impulsed.

If a total occurs as the overflow line is reached, control panel wiring allows the overflow program steps to take precedence over the regular minor, intermediate and major program steps. This allows the overflow program steps to be used for sheet identification purposes before the totals print in the body of the next form. This operation requires the use of the overflow transfer and the exit 9 hubs (tape channel 9).

The wiring for variable length overflow shown in Figure 91 concerns detail printing only. The wiring for variable length overflow with group printing is shown in conjunction with the side by side "sold to, ship to" invoice printing described under *Invoice Preparation.*



P, 39-40

Exit 9. These hubs emit an impulse whenever a hole is read in channel 9. A hole is punched in this channel of the tape one line below the last position on the form that can be printed with detail information and still allow space for all totals. Information can be printed to the maximum capacity of the form, but should a control change occur at or below the position identified by a 9 punch, all totals are printed on the overflow sheet. To accomplish this, the EXIT 9 is wired to OVERFLOW TRANSFER through a properly controlled selector.

Channel 9 of the tape may also be used to save interlocking for the last two inches of a long skip under certain conditions. For example, in a skip of eleven inches, the interlocking time for the last two inches may occasionally be saved by punching a hole in channel 9 of the tape, two inches back from the next printing line, and by wiring exit 9 to short skip. The time that the hole in channel 9 is read determines whether or not a cycle is saved. If exit 9 is used for short skip to a total line, skipping to the first printing line of the next page must be less than two inches, because short skip is automatically in effect until after all program cycles.

AW, 69-72

Overflow Transfer. These hubs receive impulses from EXIT 9 to cause a transfer from regular to overflow programs whenever a hole in channel 9 has been sensed. This transfer takes place immediately but the OVERFLOW PROGRAM exits are not effective until program start is impulsed. The normal program cycles follow, provided OVERFLOW END and PROGRAM REPEAT are impulsed. Normally, the regular programs take precedence over overflow programs. When OVERFLOW TRANSFER is impulsed, however, the overflow programs take precedence over the regular programs. Once OVERFLOW TRANSFER is impulsed, it remains active until OVERFLOW END is impulsed. The overflow transfer hubs are exits during every overflow cycle.

Variable Length Overflow Analysis (Figure 92)

Channel Assignments:

1 and 2	First printing line.
8	First body line.
9	Overflow transfer line.
12	Normal overflow.

Channel 9 is punched on the same line on which the last detail item prints within the major group. Thus, if a major program change occurs at or after the channel 9 has been sensed, all totals are printed on the overflow form.

A. The first form identifies a major program change that occurred before channel 9 was sensed. Hence, all totals print on the same form that contains the last of the detail items for that group.

B. The second form identifies a major program change that occurred at or after the time channel 9 was sensed. This would mean that there was not enough room on the form to accommodate all the totals, so they are printed in the body of the overflow sheet. OVERFLOW TRANSFER is impulsed at the time channel 9 is sensed and remains active until OVERFLOW END is impulsed. This is true even though there is no program change and the regular overflow channel 12 is sensed.

Because a major program occurred at or after channel 9 was sensed, a transfer from regular to overflow programs takes place. The overflow programs are used to skip to the first printing line, where the overflow sheet is properly identified, and to skip to the first body line where the totals are printed.

To pick up again from step 1 (regular minor program) after having reached step 2 in the overflow programs, the last OVERFLOW STEP used must be wired to REPEAT.

C. The fourth shows a regular overflow condition which is not in any way affected by channel 9.

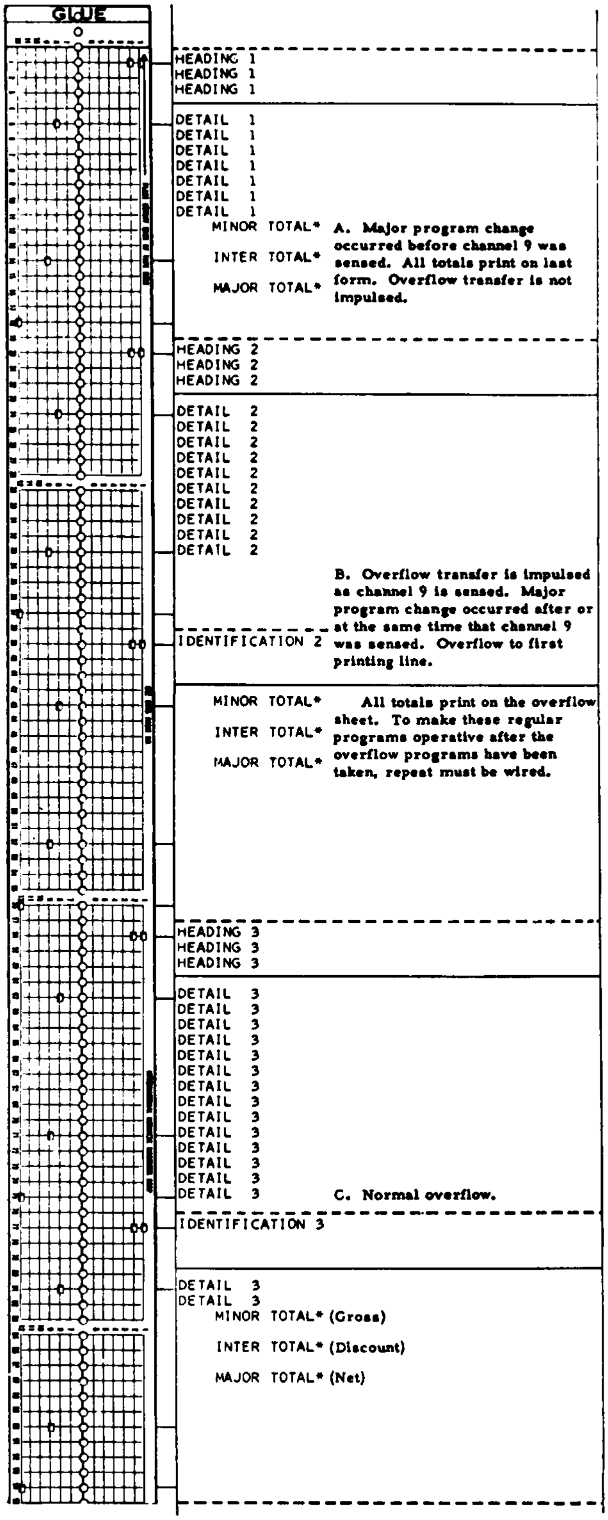


Figure 92. Control-Tape Punching for Variable-Length Overflow

Inverted-Form Operations

Voucher checks, such as the one illustrated in Figure 93, are known as inverted forms because detail cards are printed first, followed by heading cards. This type of operation is necessary when totals from the detail cards must be printed with heading information. In this example, check identification and amount are printed with an address on a check.

The tape for an inverted form is punched in the same manner as the tape for the conventional form. The first printing line, which is also the first body line, is identified by a hole in channel 1, the last printing line of the body (overflow) by a hole in channel 12. The predetermined total line and the first heading line are identified by holes in other channels.

Although the D and H identifications are the same (D for detail and H for heading) as for conventional operations, the normal and transferred skip control exits have different uses, in some instances, for inverted form operations. This is because the heading and detail cards are in reverse order. DH NORMAL indicates normal change from detail to heading cards and is wired to CHANNEL 2 (first heading line). HD TRANSFERRED indicates the end of one group and the beginning of another and is wired to CHANNEL 1 (first printing line).

The most noticeable difference lies in the form skip wiring and tape punching. DH TRANSFERRED indicates missing heading cards of one group and missing detail cards of another. The DH transferred hub would therefore be wired to CHANNEL 2 and also to pick up a selector so that FORM SKIP may be impulsed after the intermediate total prints, to insure printing the heading cards on the next form. In conventional operations, when FORM SKIP is wired, first body line channel is not operative until the overflow punch (channel 12) has been sensed. Channel 12 cannot be used in this manner when preparing inverted forms because it precedes the channel representing the first heading line of the same form. Channel 10 is used in its place and is punched on the same line as channel 1. The tape therefore has two holes punched on the first printing line, one in channel 1 and the other in channel 10.

The inverted form toggle switch works in conjunction with channel 10. When it is OFF (conventional forms) channel 10 operates as a normal stop. When the switch is ON (inverted forms) channel 10 can no longer be used as a stop. Instead, it is used to close the first 9 channel brush circuits that were previously opened by FORM SKIP. In other words, when FORM SKIP has been impulsed none of the remaining stops for that form are operative. Once channel 10 has been sensed, which takes place on the next form,

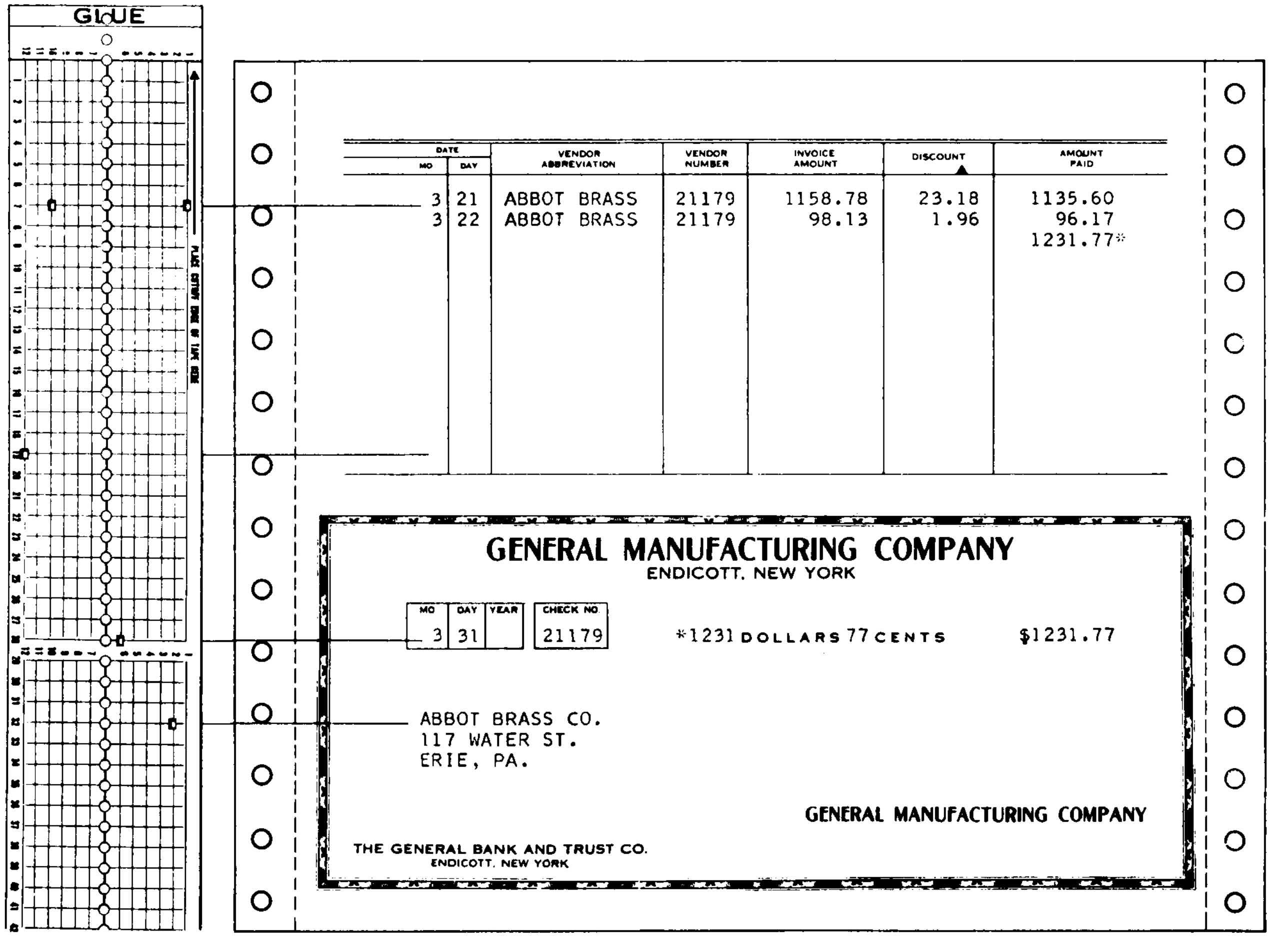


Figure 93. Control-Tape Punching for Inverted Forms

all channel stops are operative. In the case of the DH transferred conditions, (missing heading cards of one and missing detail cards of another group) a skip takes place to the first body line of the second form instead of the first form (Figure 95).

Single Sheet Form Feeding; Selective Spacing

Single sheets can be fed into the machine by placing each form on the paper guides in back of the platen. These forms must be sufficiently flexible so that they bend around the platen without catching the leading edge of the form on the ribbon. Sufficient heading space should be allowed so the tear bar can hold down the top of the form before printing is started. In this operation, the tear bar is substituted for the forms tractor. Each form is placed on the paper table, and positioned automatically at the first printing line by pressing the restore key.

As shown in Figure 94, a hole must be punched in the tape at least four lines below the bottom edge of the form. Any available channel can be used that is not already used for other purposes. The purpose of this skip stop punch is to insure ejection of the sheet from the platen upon sensing either an overflow or a program change. The tape must be cut 13 lines beyond the last hole punched, to compensate for the distance that a single sheet must travel around the platen before it can be advanced to the top edge of the form. Pressing the restore key feeds the single sheet from the paper table to the first printing line.

There are two conditions under which a single sheet form can be ejected: program change or overflow. The form shown in Figure 94 does not require overflow ejection. Whether the form is ejected because of an overflow or because of a program change, it is not only necessary to stop the skip but also to stop card feeding.

Figure 94 demonstrates also the use of selective spacing, since each card always prints in a predetermined position that varies in distance from one to seven spaces apart. For this operation the SEL hubs on the control panel and channel 11 on the carriage tape are used (Figure 96).

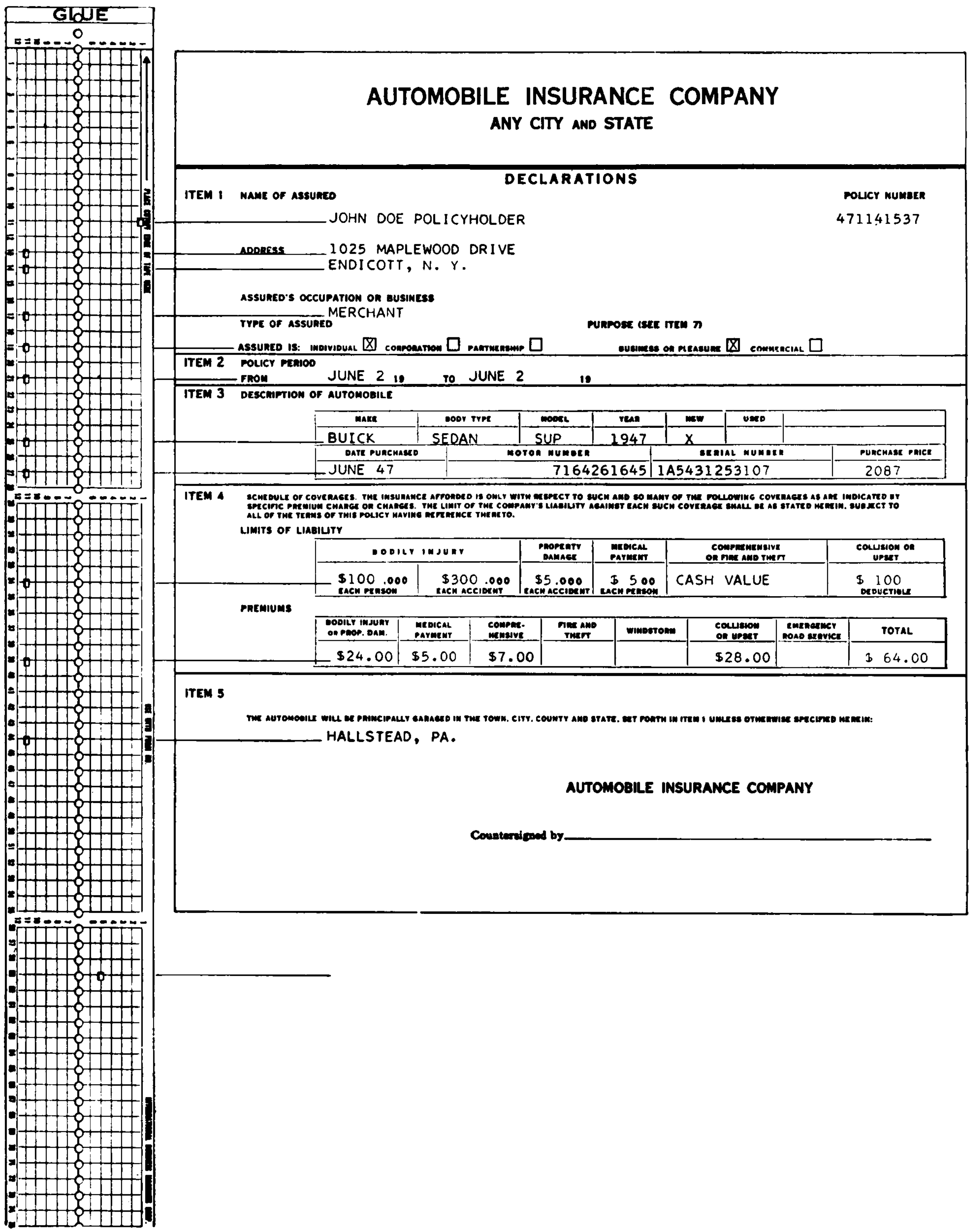


Figure 94. Control-Tape Punching for Selective Spacing; Single-Sheet Form Feeding

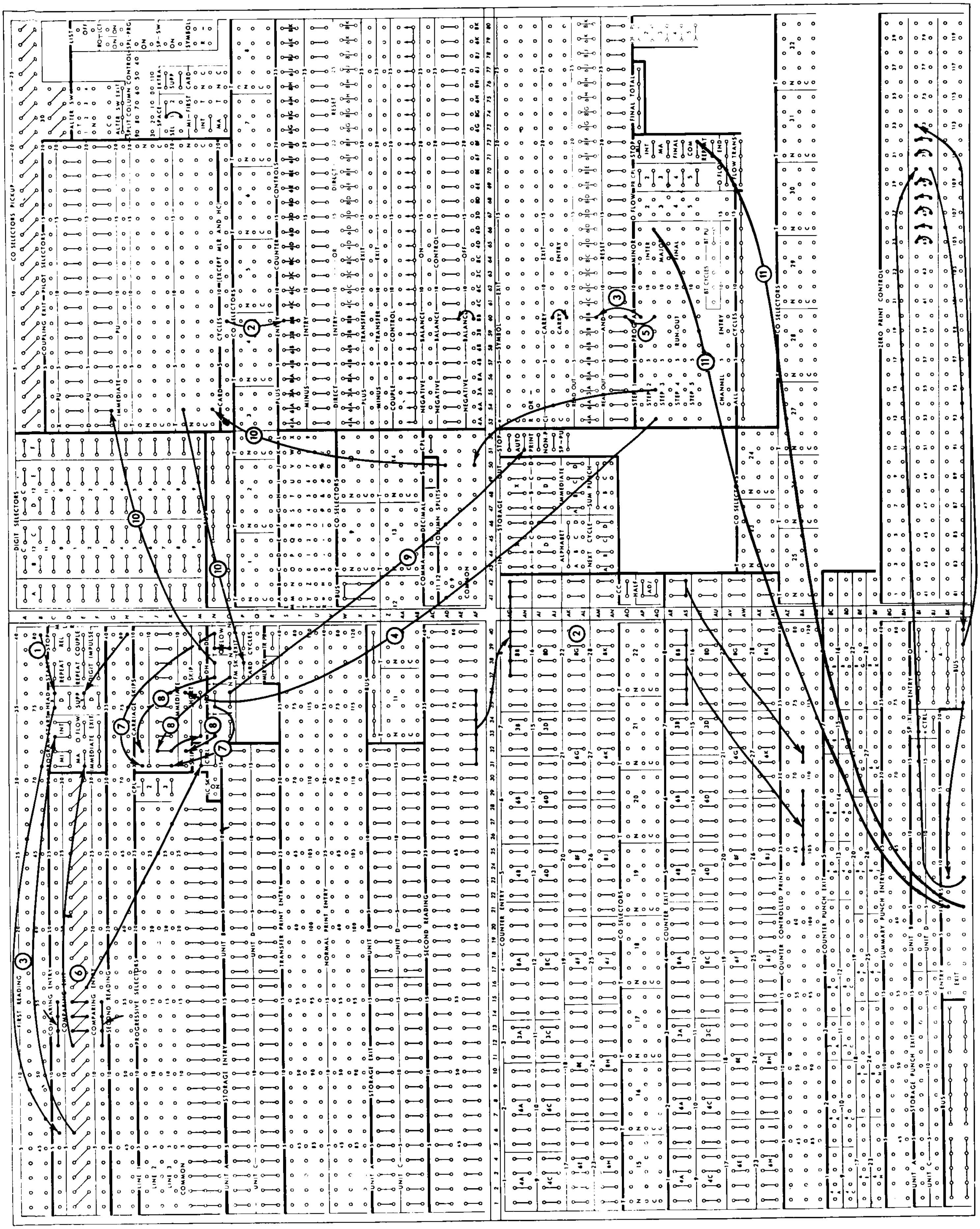


Figure 95. Inverted Form

1. All address cards have an X in column 80, which is wired from FIRST READING to HEAD X. It is also wired from SECOND READING to HEAD CONTROL SUPPRESS to suppress the program cycles on a major change.

2. The amount paid is wired from SECOND READING to counter 8B where it is detail printed. Counter 8B is impulsed to add from CARD CYCLES, which is active for body cards only.

3. A program change is recognized between body and heading cards by the X wiring to INTERMEDIATE PROGRAM START. After the last body item is printed, the INTERMEDIATE PROGRAM START is impulsed, causing a minor and an intermediate program change. On the minor program the total of the amount paid is printed in the statement portion of the form. The MINOR PROGRAM is wired to COUNTER READ-OUT so that the total remains in the counter and prints on the intermediate program. The second printing takes place on the check.

4. The INTERMEDIATE PROGRAM is wired to CARRIAGE SKIP 6I, which causes a skip to the predetermined total line (check amount) before the intermediate total is printed. The second total is identical to the first and represents the amount of the check.

5. Counter 8B is read out and reset on an intermediate program.

6. Vendor number is wired to COMPARING ENTRY and the COMPARING EXIT to MAJOR PROGRAM START and SKIP CONTROL.

7. These impulses are wired to channel 1:

a. DD TRANSFERRED—missing head cards.

b. HD TRANSFERRED—skip from one form to the other after head cards print.

c. OVERFLOW.

8. These impulses are wired to channel 2:

a. DH TRANSFERRED—missing heading cards of one group and missing detail cards of another group.

b. DH NORMAL—to cause skipping to the first heading line after the check total prints on the predetermined total line. This impulse is continued to short skip, since the distance is less than two inches.

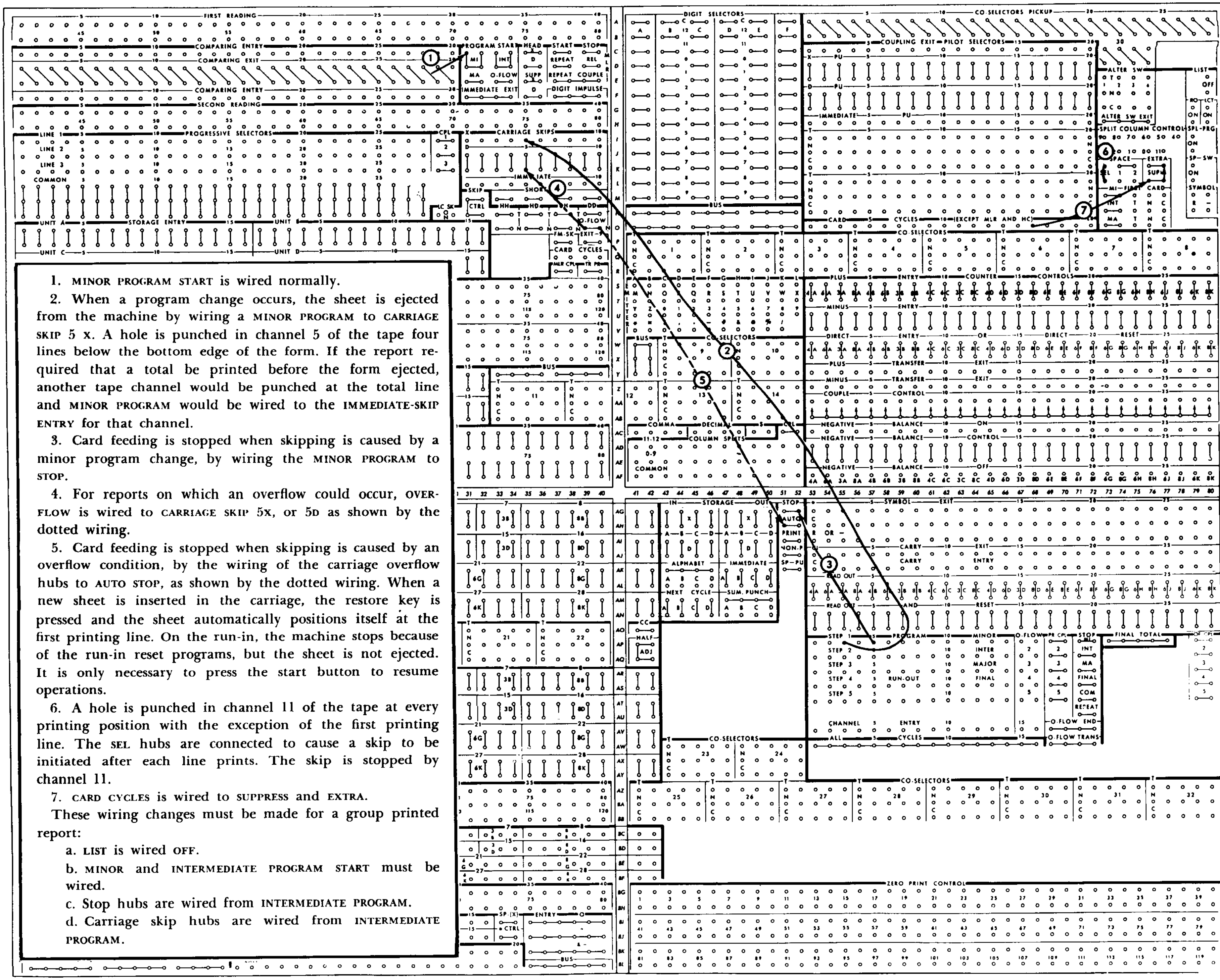
c. HH TRANSFERRED—missing detail cards. When a program change occurs between heading cards, a skip takes place to the heading of the next form.

9. HD NORMAL—cards out of sequence. This impulse is wired to stop the machine.

10. DH TRANSFERRED—missing heading cards of one group and missing body cards of the following group. This hub cannot be wired directly to form skip if the totals for the detail cards are to be printed. Both the minor and the intermediate totals are printed, in the example, before the form skip becomes operative. This is accomplished by wiring DH TRANSFERRED to the D-pickup of pilot selector 2. The INTERMEDIATE PROGRAM EXIT is then wired through the TRANSFERRED side of the selector to FORM SKIP. The INTERMEDIATE PROGRAM impulse is further conditioned through the 11-12 side of a column split to allow only the late portion of the cycle to reach the C of the selector.

The form skip therefore becomes operative after the check total prints and all channels become inoperative until both the 1 and 10 holes are sensed. The first channel 2 after 1 and 10 then stops the skip.

11. Although MAJOR PROGRAM START is impulsed, only two programs are taken because the INTERMEDIATE EXIT is wired to COMMON PROGRAM STOP. This wiring stops the progression of program steps immediately. This is possible because the major program is used exclusively to control carriage functions in this example, with no use being made of the major program level. The INTERMEDIATE EXIT is wired through a filter to COMMON PROGRAM STOP to eliminate a possible back circuit during summary punching or long carriage skips.



1. MINOR PROGRAM START is wired normally.

2. When a program change occurs, the sheet is ejected from the machine by wiring a MINOR PROGRAM to CARRIAGE SKIP 5 X. A hole is punched in channel 5 of the tape four lines below the bottom edge of the form. If the report required that a total be printed before the form ejected, another tape channel would be punched at the total line and MINOR PROGRAM would be wired to the IMMEDIATE-SKIP ENTRY for that channel.

3. Card feeding is stopped when skipping is caused by a minor program change, by wiring the MINOR PROGRAM to STOP.

4. For reports on which an overflow could occur, OVERFLOW is wired to CARRIAGE SKIP 5X, or 5D as shown by the dotted wiring.

5. Card feeding is stopped when skipping is caused by an overflow condition, by the wiring of the carriage overflow hubs to AUTO STOP, as shown by the dotted wiring. When a new sheet is inserted in the carriage, the restore key is pressed and the sheet automatically positions itself at the first printing line. On the run-in, the machine stops because of the run-in reset programs, but the sheet is not ejected. It is only necessary to press the start button to resume operations.

6. A hole is punched in channel 11 of the tape at every printing position with the exception of the first printing line. The SEL hubs are connected to cause a skip to be initiated after each line prints. The skip is stopped by channel 11.

7. CARD CYCLES is wired to SUPPRESS and EXTRA.

These wiring changes must be made for a group printed report:

a. LIST is wired OFF.

b. MINOR and INTERMEDIATE PROGRAM START must be wired.

c. Stop hubs are wired from INTERMEDIATE PROGRAM.

d. Carriage skip hubs are wired from INTERMEDIATE PROGRAM.

Figure 96. Single-Sheet Form Feeding; Selective Spacing

SPACE
SEL K-L, 73

Selective Space. All line spacing may be controlled by the SEL hubs and a hole in channel 11 of the tape. More particularly, however, these hubs and channel 11 are used to control triple spacing or selective line spacing up to a maximum of seven lines. In some operations, specific X's or digits are not available to control carriage skip; yet, the cards must be printed in a particular place on the report. In such cases, the cards must be arranged in their proper order, the SEL hubs must be connected, and the carriage tape must be punched in channel 11 for every line to be printed.

When the selective space hubs are connected, the carriage is stopped by reading a hole in channel 11. The single and double space hubs normally perform this function. The printing of every card is then under the control of the 11 punch in the tape. Whenever the desired spacing (including overflow skipping) exceeds three lines but no more than seven, both SPACE SUPPRESS and EXTRA must be impulsed from CARD CYCLES.

Triple spacing on the 407 is accomplished by connecting the SEL hubs and by punching a hole in channel 11 on every third line of the tape, including the line on which the total prints.

Form Design

Some of the rules heretofore followed for designing forms should now be reconsidered in the light of the many new features introduced by the IBM 407 Accounting Machine.

A. The print unit, containing 120 printwheels in a 12-inch width, each printwheel containing all characters.

B. Such features of the machine as character emitter, amount punctuation, overflow printing, etc.

One of the basic tools used in designing forms is the spacing chart shown in Figure 97. The numbers across the top from 0 to 11 represent the tens position of the printwheel number, and the numbers directly beneath represent the units position of the printwheel number. Printwheel 42 can be readily located by referring first to the 4 column and then to the digit 2 within the 4 column. Printwheel 9 can be located by referring to the 0 column and then to the digit 9 within that column. The form alignment symbol (▲) locates printwheel 1, 60 or 120 and should be embodied in the form design to facilitate form alignment.

A facsimile of the carriage control tape is shown at the left for marking the control punching for a specific form. Notations have been included relative to standard form widths and depths, lateral movement of the carriage, and instructions to forms manufacturers.

Form Design as Affected by the Print Unit

In view of the 120 printwheels and the 12-inch print unit, these factors should be considered when designing forms to be used on the 407:

1. The maximum form width that can be used is 16¾ inches, and the recommended minimum is 4¾ inches.

2. The maximum form length that can be used is 22 inches at six-line-per-inch spacing (Figure 73).

3. Because all printwheels contain all characters, form depth can be reduced and carbon paper eliminated by the use of side by side printing. For example, *sold to* and *ship to* names can be printed on the same line, one on the left side of the form and the other on the right.

4. Forms can be designed for printing six, eight, or four lines to the inch. Single-space eight lines per inch printing is not recommended where the registration between lines is critical.

5. Forms can be designed for variable line spacing within a form by use of single-, double-, or selective-space control.

6. It is possible to dispense with many vertical lines, since the machine can be wired to print commas, decimals, oblique lines, dashes, etc.

7. Vertical lines should *not* be printed between two adjacent printing positions because there is an over-all maximum tolerance of only .010 inch between adjacent characters.

8. The number of legible copies that can be produced depends on the weight of the paper used for each form, the carbon coating, and the hardness of the platen. Because the striking force of the printwheels is not adjustable, paper and carbon should be tested in conjunction with a platen of the recommended durometer.

9. The CR symbol prints from two printwheels, and the minus sign prints from one. For this reason the minus sign is recommended as a credit symbol in lieu of the CR symbol.

10. The dollar symbol need no longer be preprinted on a check form, because this symbol can be wired immediately to the left of significant digits.

11. The number of alphabetic positions that can be assigned in forms layout to print from storage is 32. More than 32 positions can be stored by use of counters and co-selectors in conjunction with storage as shown in Figure 147.

Form Design as Affected by Other Features

1. The character emitter, through selectors or storage control, can be used to print report headings on blank forms and to identify the first and last line of a report with such information as *brought forward* on the first line and *carried forward* on the last line.

2. Maximum utilization of the variable length overflow feature makes it unnecessary to reserve space for multiple total lines.

3. In six-lines-per-inch spacing, skips of up to two inches are possible without interrupting the normal printing speed of the machine (Figure 73). Therefore, there is an advantage to holding forms to a size that does not require skipping in excess of these limits between print cycles.

4. Zero suppression on the 407 is electrical and completely flexible. It is not mandatory, for example, to line up the right-hand digit of information printed in the heading, such as customer number, with the units digit within the columnar field, such as an amount field.

5. Total identification permits flexible positioning of totals.

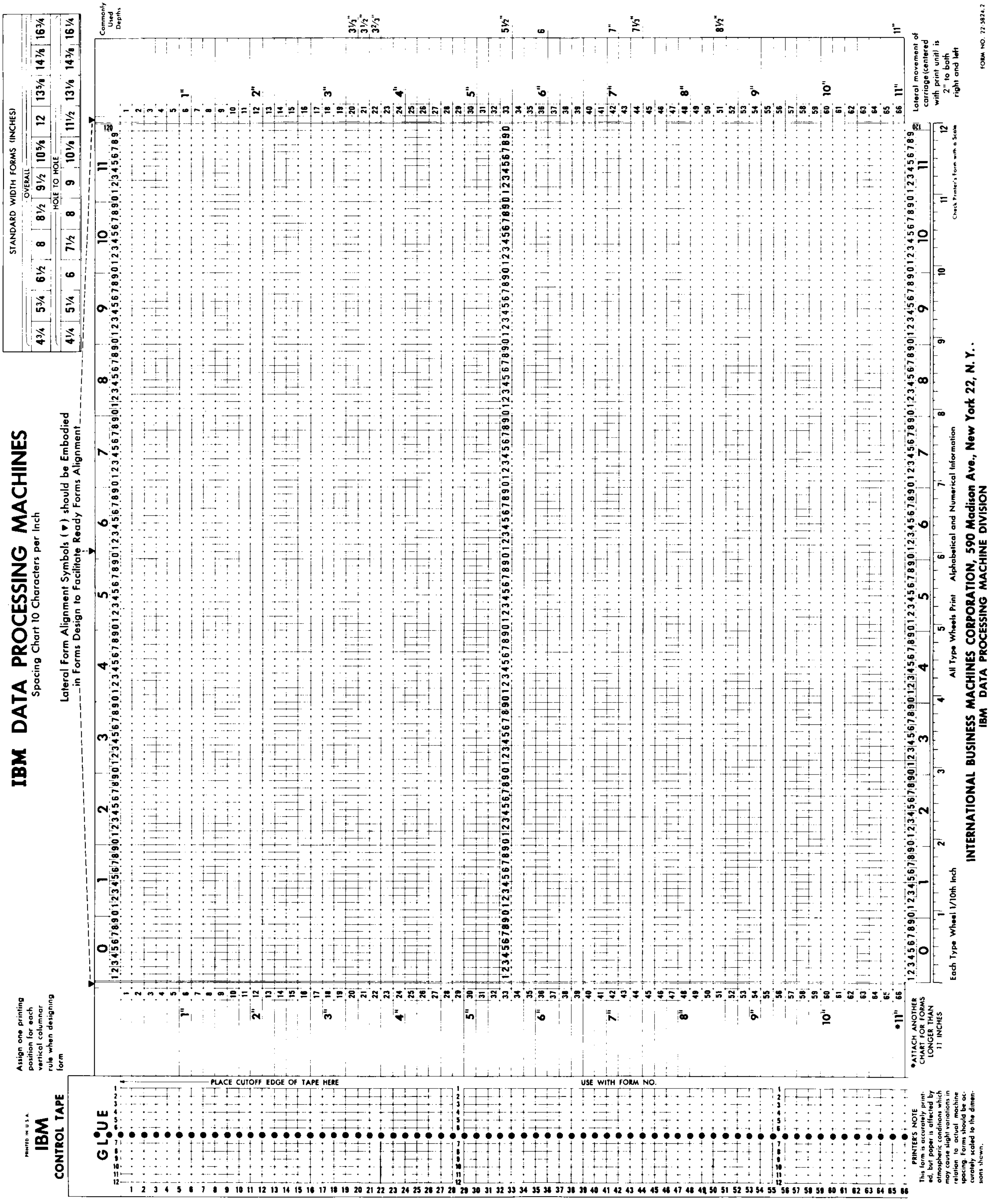


Figure 97. IBM 407 Spacing Chart

Continuous Forms

IBM has two Forms Tractors, the Model F-2 and the Model F-4, available for use in connection with its 407 Accounting Machine. These devices are designed to feed marginally punched continuous forms satisfactorily under the conditions and specifications outlined here (Figure 97A). These specifications, if followed, give maximum operating efficiency when using these devices. They are not intended to be restrictive, but rather are intended to permit customers to purchase their continuous forms from the manufacturer of their choice.

Form Specifications

Characteristics of the Paper

The paper used for continuous forms must be of sufficient weight and strength to prevent the holes from tearing out during feeding or ejecting of the form. This is particularly important when single-part forms are being used.

The paper must not be so stiff as to cause improper "wrap around" or excessive bulging, particularly at the outfold.

Paper must be as free from paper dust or lint as possible.

Perforations

Perforations must be sufficiently strong so they do not break during the feeding operation.

Multiple-Part Sets

Form length and carbon sheet length should be equal. The maximum tolerances for variations in form and carbon dimensions, due to processing and various atmospheric conditions are:

Plus .012", minus 0", per 11-inch length of form.

Marginal Punching of Forms

Forms should be punched in both right- and left-hand margins, with holes through which the paper feed pins project to hold the forms in place.

Marginal holes must be 5/32" in diameter.

Spacing between holes, center to center, must be such that the pins in the Forms Tractor, 1/8" in diameter and spaced 1/2" part, enter and leave the holes in the paper freely without tearing the paper.

Width of Forms (Figure 97A)

Maximum Width: 16 1/4", measuring from center to center of the marginal holes; tolerances ±1/64" at 50% relative humidity.

407 Minimum Width: 4 1/4", measuring from center to center of the marginal holes; tolerances ±1/64" at 50% relative humidity.

Staples

Multiple-part forms should be held together in some manner, such as by stitching, gluing, or stapling. If staples are used, the arrangement of the staples must be such as to satisfy these conditions:

Each staple must be so located as to prevent a type wheel from striking it.

Each staple must be properly crimped so as not to catch on guides, edges, staples in succeeding forms, etc.

Each staple must be secured in a manner that does not cause excessive bulging, particularly at the outfold, as forms feed through the tape-controlled carriage.

Other Important Considerations

Friction on Forms

During the feeding operation friction on marginally punched continuous forms should be eliminated by the following means:

The pressure release lever must be locked in the OFF position.

The pack of forms must be placed in back of the platen on the forms stand, in a position that eliminates any abnormal "drag" on the forms.

There must be sufficient clearance between the platen and the carriage, or any part thereof, to permit the forms to be fed by the pins freely, and without interference. This can be accomplished by proper setting of the form thickness adjustment device on the tape-controlled carriage.

Weight of Paper

The number of legible copies required, and the type of platen used (hard or medium), are factors in determining the weight of the paper to be used in a multiple-part set.

Except for the last copy, best results on multiple-copy forms require a light-weight paper of 13 lbs. or less. Again, the number of copies, the hardness of the platen, and clearance around the platen, as well as the distance of the carriage away from the typewheels (this distance can be varied by use of the form thickness adjustment device), affect the determination of paper weight.

Feeding and legibility performance can best be determined by making test runs of sample sets of forms.

Marginal Holes

Continuous forms should have holes in both right- and left-hand margins, 5/32" in diameter, spaced vertically 1/2" apart from center to center the full length of the form, and identically located on all copies of all sets throughout each pack of forms.

It is permissible, however, to use holes of any size, shape, and spacing that accomplish the equivalent feeding conditions.

Vertical lines passing through the two vertical rows of pin holes must be parallel. It is recommended that the edges of the form be 1/4" from the vertical center lines through the holes.

A horizontal line passing through the center of any two marginal holes on the same line should be at a 90° angle to either vertical center line through the marginal holes.

Not only should the marginal holes in both the paper and the carbon be cleanly punched, but the carbon paper should also be punched in the same manner as the forms.

If the forms are not fastened together, the carbon paper should be punched with marginal holes substantially larger, and approximately centered with the corresponding holes in the form.

Marginal holes in the carbon substantially larger than the corresponding holes in the forms make allowance for carbon shrinkage and provide the processing tolerance necessary for some of the commonly used form structures.

Certain form structures employ other means of carbon alignment and feeding than those described herein, thus deviating from this specification. It is permissible to use any type of form structure that accomplishes the equivalent feeding conditions, in either the carbon or the opaque sheets.

If the form structure used is different from that described herein, feeding and alignment performance can best be determined by making test runs of sample sets of forms.

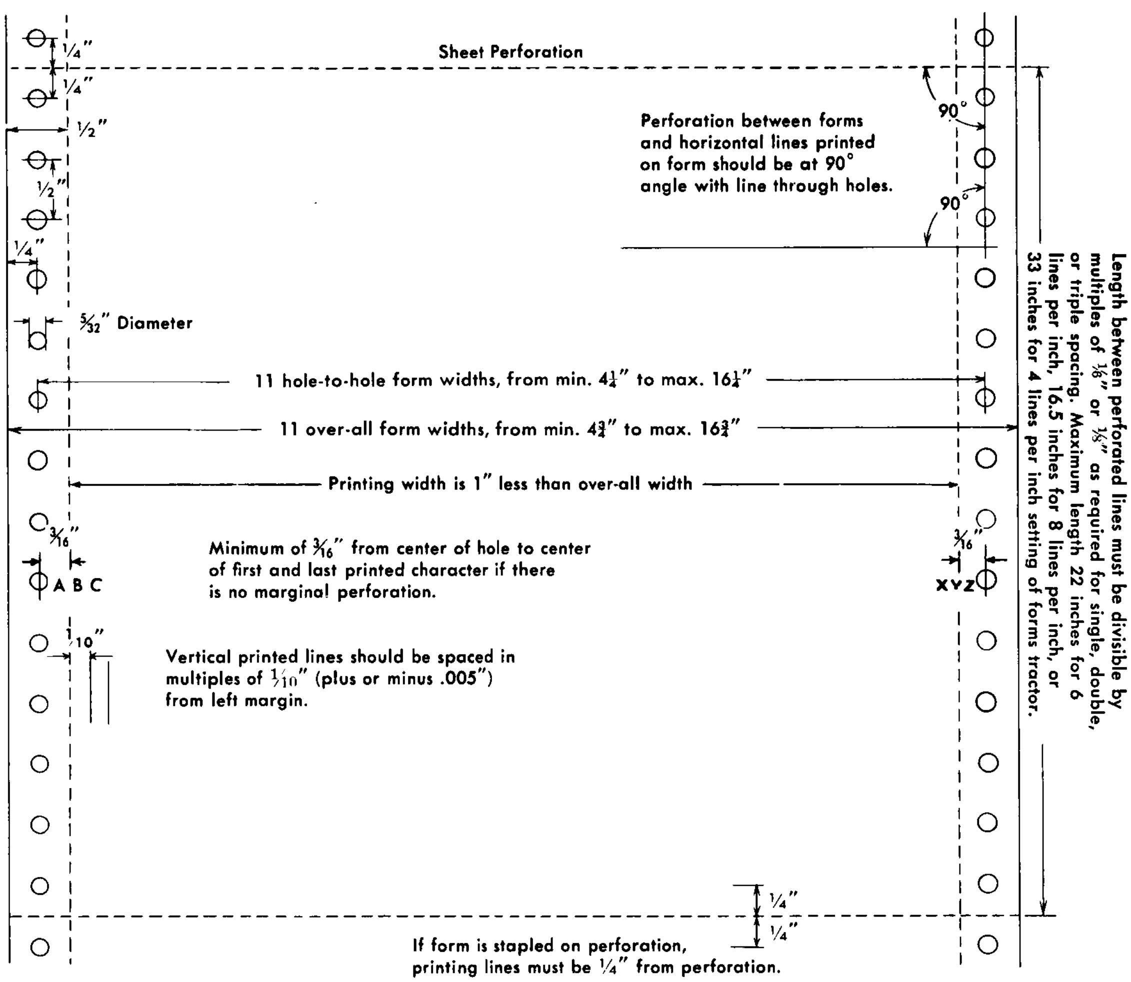


Figure 97A. Summary Diagram of Recommended Specifications for Forms

Width of Forms

While forms of any width within the limitations of the 407 can be used, it is recommended that form widths be confined to these standard sizes:

Over-all Width (inches)	Hole-to-Hole (inches)
4¾	4¼
5¾	5¼
6½	6
8	7½
8½	8
9½	9
10⅝	10⅛
12	11½
13⅝	13⅛
14⅞	14⅜
16¾	16¼

Length of Form between Perforated Lines

The 407 and 408 accommodate marginally punched continuous forms up to a maximum length of 22 inches (spacing 6 lines to the inch) or 16.5 inches (spacing 8 lines to the inch). The 407 with the F-4 Forms Tractor accommodates a maximum length of 33 inches (spacing 4 lines to the inch). It is recommended, however, that form lengths be confined to regular lengths, such as 3⅓", 3½", 3⅔", 5½", 6", 7", 7⅓", 8½", 11", 12", 14", 17", and 22".

The 407 F-2 Forms Tractor can be set by the operator for single-space printing 6 or 8 lines per inch. For 6 lines to the inch, the length of the form must be evenly divisible by ⅙ inch for single spacing, by ⅓ inch for double spacing, and by ½ inch for triple spacing. Similarly, 8 lines-to-the inch requires that the length of the form be evenly divisible by ⅛ inch for single spacing, by ¼ inch for double spacing, and by ⅜ inch for triple spacing.

The F-4 forms tractor can be set by the operator for single-space printing 4 or 6 lines per inch. For 4 lines to the inch, the length of the form must be evenly divisible by ¼ inch for single spacing, by ½ inch for double spacing, and by ¾ inch for triple spacing.

Single-space 8-lines-per-inch printing on the 407 is not recommended where the registration between lines is critical. With some forms, feeding at other than 6 lines per inch adversely affects accuracy of line-spacing because the platen does not advance at the same speed as the forms tractor.

A feature of these machines permits automatic changing of printing on a report from single to double space (and vice versa) as many times as desired within a given form length, without changing the control plugging. Whenever this feature is employed, the position (s) of printing where these specified spacing changes occur should be so indicated on the form's layout. Such spacing changes can, and often do, affect the form depth.

Perforated Lines

The perforations between forms should be sufficiently deep to permit easy separation, but not so deep as to tear in ordinary handling or feeding through the machine.

The perforated lines at the end of the form should always be located between the marginal holes and at 90° to a vertical center line through the marginal holes.

Cut and uncut portions should be uniformly accurate in length and spacing to insure proper and efficient tearing.

Vertical perforations at the margin for removal of the marginally punched strip can vary, depending upon requirements. The distance from the edge of the form to the marginal perforations is usually ½".

Multiple Copies

Multiple-copy forms consisting of more than four parts, and forms with the first part made of paper of more than 13-pound weight, should be tested under operating conditions to determine the suitability of feeding and legibility.

One-time carbon paper or carbon-backed paper can be used. The carbon paper or coating should produce the required number of legible copies without excessive smudging. This can best be determined by making test runs of sample sets of forms containing different qualities of carbon papers.

Fastening of Multiple Copy Forms

The width, length and number of copies of the form, and the type of aligning device determine the fastening requirements for satsisfactory feeding through the forms tractor.

If the construction of the form is such that the parts are of different widths, the necessity for and the method of fastening the form should be determined by the width of the parts, the depth of the form, and weight of paper.

The recommended maximum distances between fastenings are:

Form Depth (inches)	Maximum Distance between Fastenings (inches)
1 to 5	5
5⅛ to 11	11
11 to 14	7
14 to 17	8½

For forms more than 17″ deep, the maximum distance beween fastenings should be determined by actual test.

Forms of fanfold construction should be arranged so that the narrow parts, if any, are located either inside or on the face of the form — not on the back. When narrow parts are so arranged, no additional fastening is required.

When card tag or rag content paper stock is used, a test of sample sets of forms should be made to determine the exact fastening requirements to obtain best results and to determine the extent of outfolds causing displacement of normal line spacing.

The fastening may consist of any satisfactory method, such as stitching, gluing, stapling, etc., which prevents the copies from shifting. It is essential, however, that whatever fastening medium is used should not impair the feeding or printing alignment of the form.

Platen Hardness

Platen hardness requirements vary with the number of parts in each form. The following platen hardnesses are recommended:

Hard Platen (100 durometer): multiple-part forms

Medium Platen (90 durometer): single-part forms

If there is doubt about the ability of the carbon paper to provide satisfactory legibility, this can best be determined by making test runs of sample sets of forms.

Registration of Forms

The assembly of multiple-copy forms should insure that the punching and printing of all copies of the form are in absolute registration with the material printed by the 407, and with the following tolerances:

Vertical Lines. Vertical center lines of typewheels are spaced ⅒th of an inch apart; there are 50 printing spaces in 5 inches. Vertical rules printed on a form should be spaced in multiples of ⅒″ from the left margin.

The spacing of 10 characters per inch permits a plus or minus tolerance of only .005″ from true typewheel location, or a maximum over-all tolerance of .010″. From a forms viewpoint it is practically impossible to guarantee that the cumulative tolerance of printing plate shrinkage, paper shrinkage, and marginal hole perforations does not exceed .005″; this precludes the possibility of retaining satisfactory registration if vertical rules are spaced to split between typewheels.

Therefore, when designing forms layout for these machines, the practice should no longer be followed of drawing vertical lines between type positions to separate columnar fields.

Where vertical lines are required, such rules should split the respective typewheel, thereby assigning that particular position for the columnar field, or dollars and cents, etc., separation. However, in view of the fact that the 407 has among its special characters a period and comma on every typewheel, the use of these symbols as decimal points, etc., obviates vertical lines for such separations.

Vertical printed lines should be parallel to a vertical center line passing through the marginal holes.

Horizontal Lines. Horizontal printed lines on the form should be at a 90° angle to the vertical center line passing through the paper feed pin holes.

The spacing should conform to the setting of the 407 Forms Tractor — spaced 6, 3, or 2 lines to the inch; 8, 4, or 2⅔ lines to the inch; or 4, 2, or 1⅓ lines to the inch.

Single-space 8-lines-per-inch printing produces less accurate line spacing on the 407. For better legibility at 8-lines-per-inch spacing on the 407, the smaller height type (.079″) is recommended.

Horizontal lines should be so aligned that one printing line space within each ½″ is centered with a pin feed hole.

When a fastening medium is inserted in the perforation line, there should not be any printing from the accounting machine within the ¼″ space above and the ¼″ space below the perforated line.

Margins. If the margin is not perforated, the area to be printed by the accounting machine must not be closer than 3⁄16″ from the center line of the left paper feed pin hole to the center of the first character to be printed, and not closer than 3⁄16″ from the center line of the right paper feed pin hole to the center of the last character to be printed.

Ribbon Replacement

The ribbon feeds from one spool to the other approximately one inch on each print cycle. It feeds in one direction until a metal eyelet near the end of the ribbon on either spool strikes the ribbon reversing lever, and reverses the feed.

When a new ribbon is installed, it is important that the leading end of the ribbon be firmly hooked onto the empty spool. Enough ribbon should be wound on the empty spool so that the metal eyelet is somewhere between the spool and the ribbon reversing lever. The threading of the ribbon around the guide rollers is shown in Figure 98.

Silk or nylon ribbons are recommended for best results.

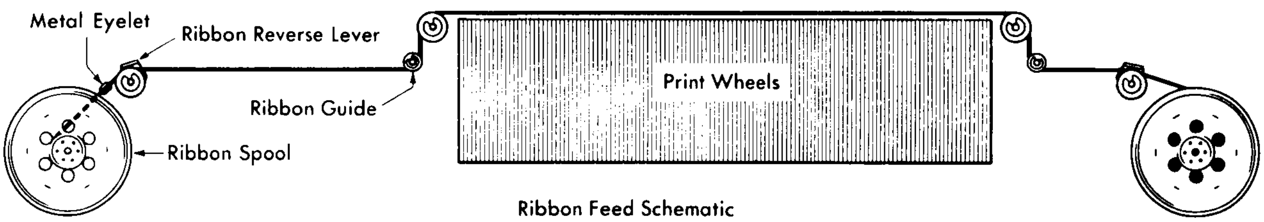


Figure 98. Ribbon-Feed Schematic

Multiple-Line Reading Operations

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 or a factor can be entered into a counter. There is no limitation to the number of times that a card can be read. It is only necessary to predetermine the number of cycles desired and, by proper control panel wiring, the card remains stationary while it is being read.

Multiple-line reading, therefore, has the advantage of printing more than one line from a single card. Figure 99 illustrates the format of a card to be used to print these lines. It is divided into three parts, part A containing the name, part B the address, and part C the city and state. Normally 28 columns are allowed for each, but these may be expanded as explained under *Progressive Selector Expansion*.

At least one column of the card must be set aside, first, to identify the card as an MLR card, and second, to determine the number of lines to be printed from that card. This is accomplished by punching the letter A for one-line printing, B for two-line printing, and C for three-line printing. In each instance the 12-punch (zone for A, B, C is used to start MLR operations, and the 1, 2, or 3 (lower punch for A, B, C) is used to stop MLR operation after one, two or three lines, respectively, have been printed. More than three lines can be printed by making use of the repeat feature, discussed under *MLR repeat*.

An MLR operation alters other functions to provide for correct MLR operation. The operations affected are: pilot selector pickup, programming, storage read-out, skipping, and card-cycles impulses.

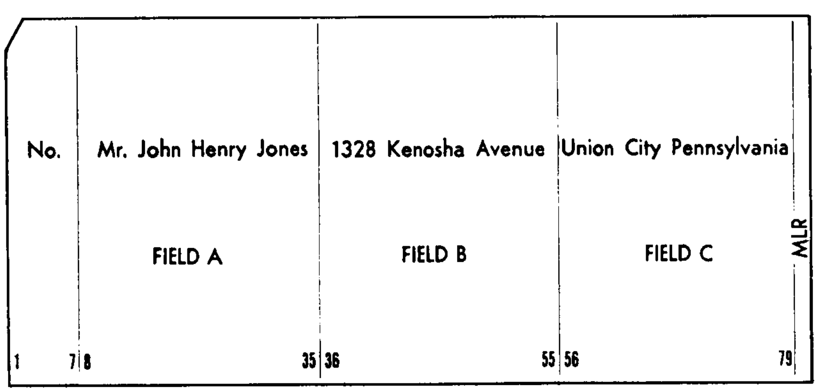
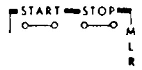


Figure 99. MLR Fields on IBM Card



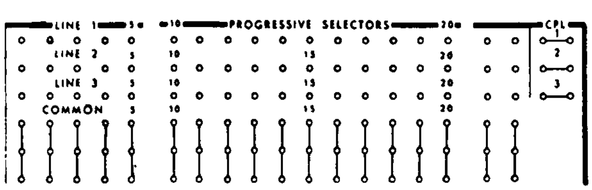
C, 37-40

MLR Start. These hubs accept a 12-impulse to stop card feeding and start a series of cycles for the repeated reading of a card. The 12-impulse is normally the zone part of the letters A, B or C, although it could be an independent 12-impulse. MLR START is wired from FIRST READING so that the repeated reading operations may begin when the MLR card reaches the second reading station. At the same time, the progressive selectors become operative.

MLR Stop. The MLR stop hubs accept a 1, 2 or 3 impulse to stop MLR operations after 1, 2 or 3 lines have been printed and to resume card feeding. The 1, 2 or 3 punches normally represent the lower punching for the letters A, B or C although they could be punched in a separate card column. MLR STOP is wired from second reading.

R, 37-38

MLR CPL. These common multiple-line read couple hubs are active on every MLR cycle. They are normally wired to TR PR to make the transfer print entry hubs active during MLR operations. Thus, TRANSFER PRINT ENTRY can be used for printing on MLR cycles, and NORMAL PRINT ENTRY can be used for printing on non-MLR cycles. If MLR is not wired to TR PR, NORMAL PRINT ENTRY can be used to print from MLR cards..



I-N, 1-30

Progressive Selectors. The progressive selectors consist of six rows, each row having 28 positions. The hubs labelled line 1, 2 and 3 are the transfer hubs. The line 1 hubs are internally connected to the three rows of common hubs on the first cycle after MLR START is impulsed. The line 2 hubs are internally connected to the common hubs on the second cycle after MLR START is impulsed. The line 3 hubs are internally connected to the common hubs on the third cycle after MLR START is impulsed. Only one line is active at a time. When line 2 is active, lines 1 and 3 are not active. Likewise, when line 3 is active, lines 1 and 2 are not active.

An impulse entered into the line 1, 2 and 3 hubs is available out of COMMON on successive cycles. Also, an impulse entered into COMMON is available out of the corresponding line 1, 2 and 3 hubs on successive cycles.

The line 1, 2 and 3 hubs are normally wired from SECOND READING when MLR cards are being read. The line 1 hubs are wired from the card columns representing the first printing line, such as name, the line 2 hubs from the card columns representing the second printing line, such as address, and the line 3 hubs from the card columns representing the third printing line, such as city and state. The common may be wired to either TRANSFER OF NORMAL PRINT ENTRY. If wired to TRANSFER PRINT ENTRY, MLR CPL must be connected to TR PR.

Progressive Selector Couple. There are two common couple hubs for each line. These hubs are exits during MLR operations and are normally used to pick up co-selectors for the purpose of expanding any line beyond 28 positions. They are entry hubs, when MLR is not being used, and can be wired from a CARD CYCLE or ALL CYCLES impulse to cause the corresponding line to be connected to the common hubs for that cycle. This gives the effect of three 28-position selectors, because each line can be independently controlled when MLR is not in operation.

Each line of the progressive selector accommodates 28 columns of the card. If more than 28 positions are desired, each line of the progressive selector can be expanded by impulsing co-selectors from the corresponding LINE COUPLE. The selected data must be wired to print through the TRANSFER side of the selector.

Address Printing

The printing of one, two or three lines of alphabetic information from a single card is illustrated in Figure 100. Each card has a 12 punched in column 80 along with a 1, 2 or 3 punch, depending on whether 1, 2 or 3 lines are to be printed. Digits 4 through 9 in the MLR control column do not affect MLR operation. Figure 101 illustrates control-panel wiring for address-printing.

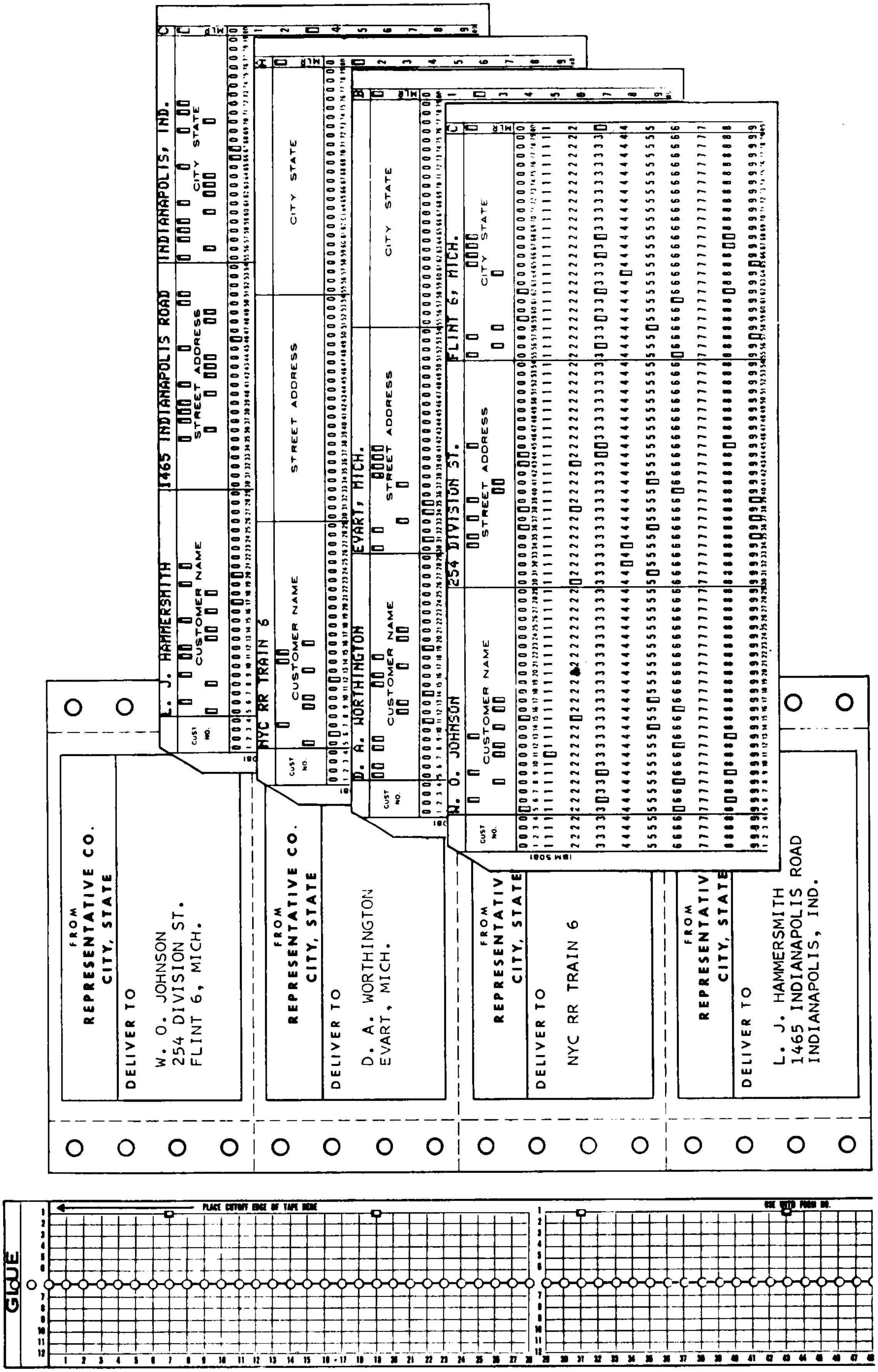


Figure 100. Address Printing Using MLR; Control-Tape Punching

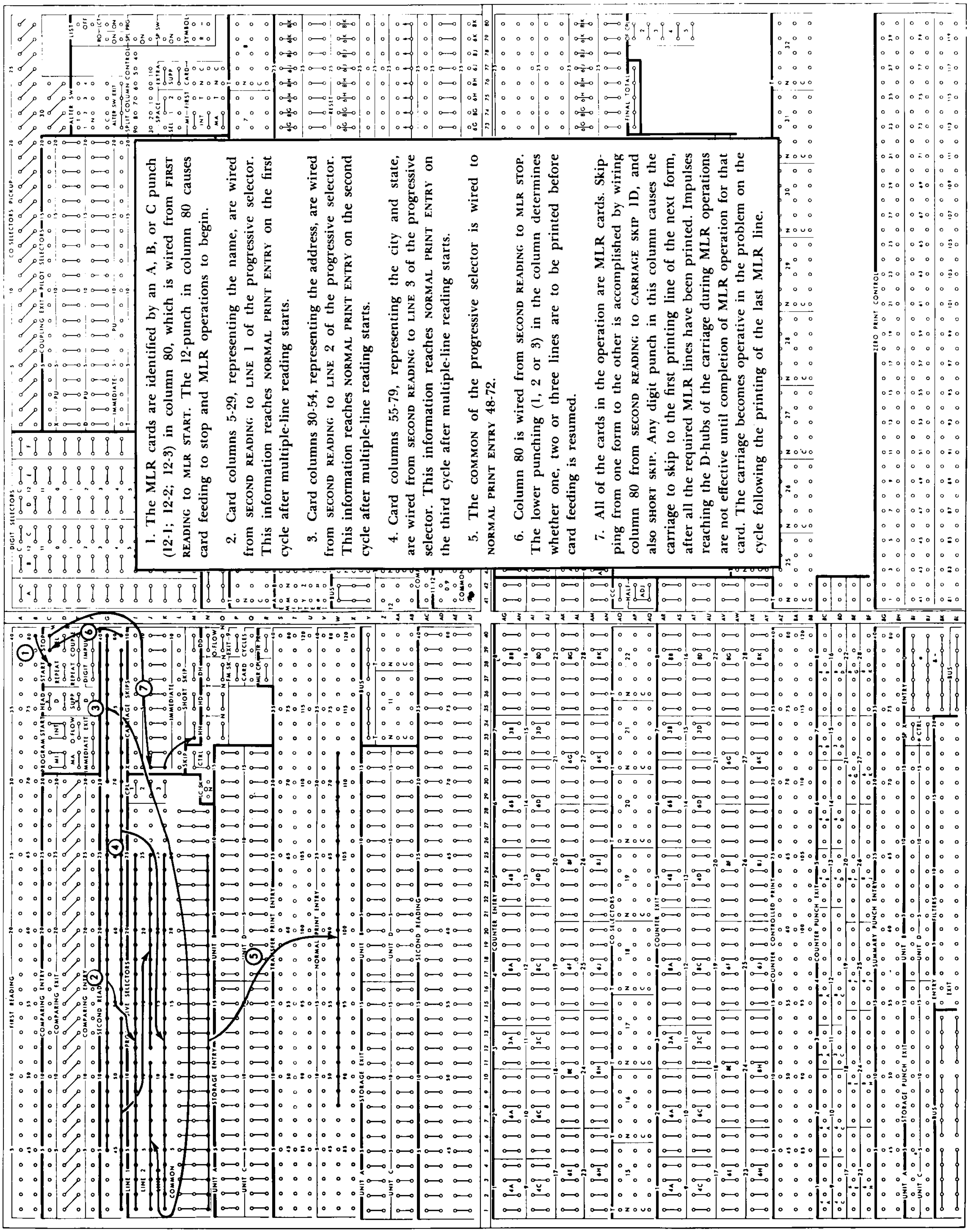


Figure 101. Wiring—Address Printing, MLR Operation

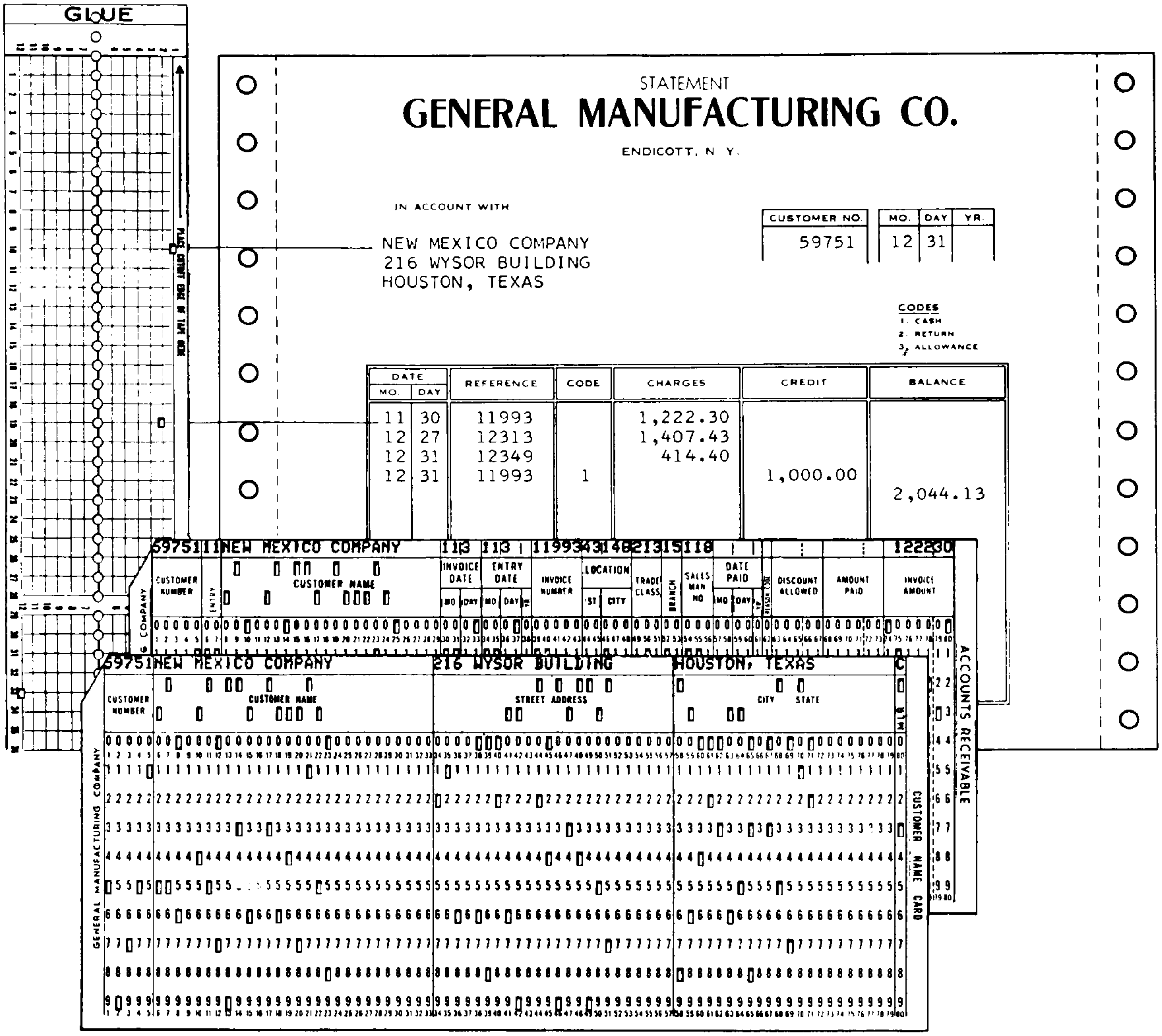


Figure 102. Heading Using MLR; Control-Tape Punching

MLR Heading Cards

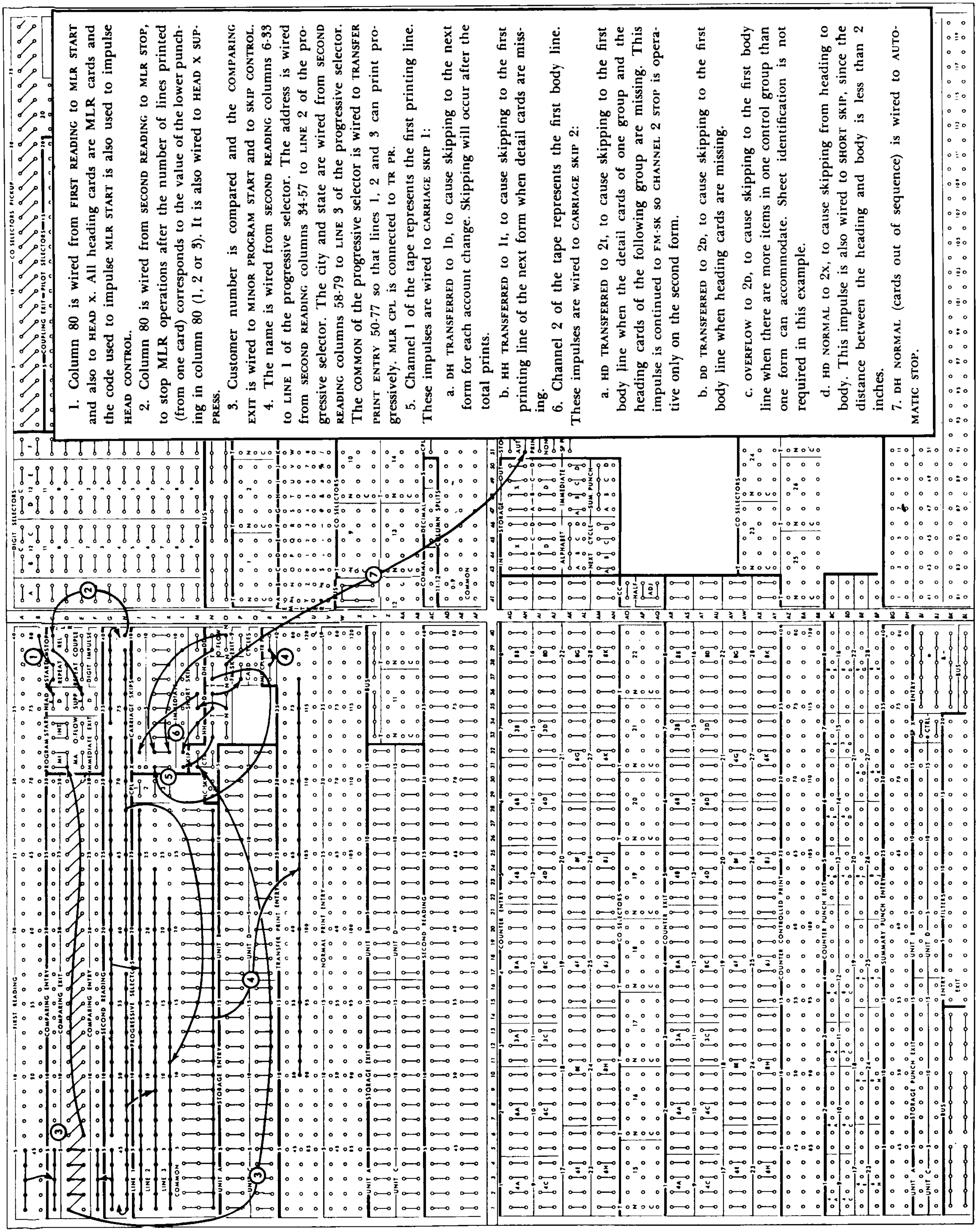
Figure 102 illustrates a statement prepared by using both MLR and normal or non-MLR cards. The MLR cards are the address cards and appear in the heading of the form. They are followed by normal cards, which appear in the body of the form.

When all heading cards including single line cards are MLR cards, the MLR code is used to control the heading operations. The heading can consist of both MLR and normal cards, but in such cases a special X must be punched in all the heading cards and that X must be wired to HEAD CONTROL. This would also be necessary in cases where the body contained both MLR and normal cards (Figure 103).

Printing More Than Three Lines from One Card

More than three lines of information can be printed from one card as shown below. This is made possible because the progressive selectors can be made to repeat their operation as often as required. The repeating process may be done after any line, regardless of the punching in the MLR column, by impulsing the repeat hub.

R. C. DOYLE
C/O BROADMORE INC.
150 FRONT ST.
DECATUR, ILL.



1. Column 80 is wired from FIRST READING to MLR START and also to HEAD X. All heading cards are MLR cards and the code used to impulse MLR START is also used to impulse HEAD CONTROL.

2. Column 80 is wired from SECOND READING to MLR STOP, to stop MLR operations after the number of lines printed (from one card) corresponds to the value of the lower punching in column 80 (1, 2 or 3). It is also wired to HEAD X SUPPRESS.

3. Customer number is compared and the COMPARING EXIT is wired to MINOR PROGRAM START and to SKIP CONTROL.

4. The name is wired from SECOND READING columns 6-33 to LINE 1 of the progressive selector. The address is wired from SECOND READING columns 34-57 to LINE 2 of the progressive selector. The city and state are wired from SECOND READING columns 58-79 to LINE 3 of the progressive selector. The COMMON of the progressive selector is wired to TRANSFER PRINT ENTRY 50-77 so that lines 1, 2 and 3 can print progressively. MLR CPL is connected to TR PR.

5. Channel 1 of the tape represents the first printing line. These impulses are wired to CARRIAGE SKIP 1:

a. DH TRANSFERRED to 1D, to cause skipping to the next form for each account change. Skipping will occur after the total prints.

b. HH TRANSFERRED to 1I, to cause skipping to the first printing line of the next form when detail cards are missing.

6. Channel 2 of the tape represents the first body line. These impulses are wired to CARRIAGE SKIP 2:

a. HD TRANSFERRED to 2I, to cause skipping to the first body line when the detail cards of one group and the heading cards of the following group are missing. This impulse is continued to FM-SK so CHANNEL 2 STOP is operative only on the second form.

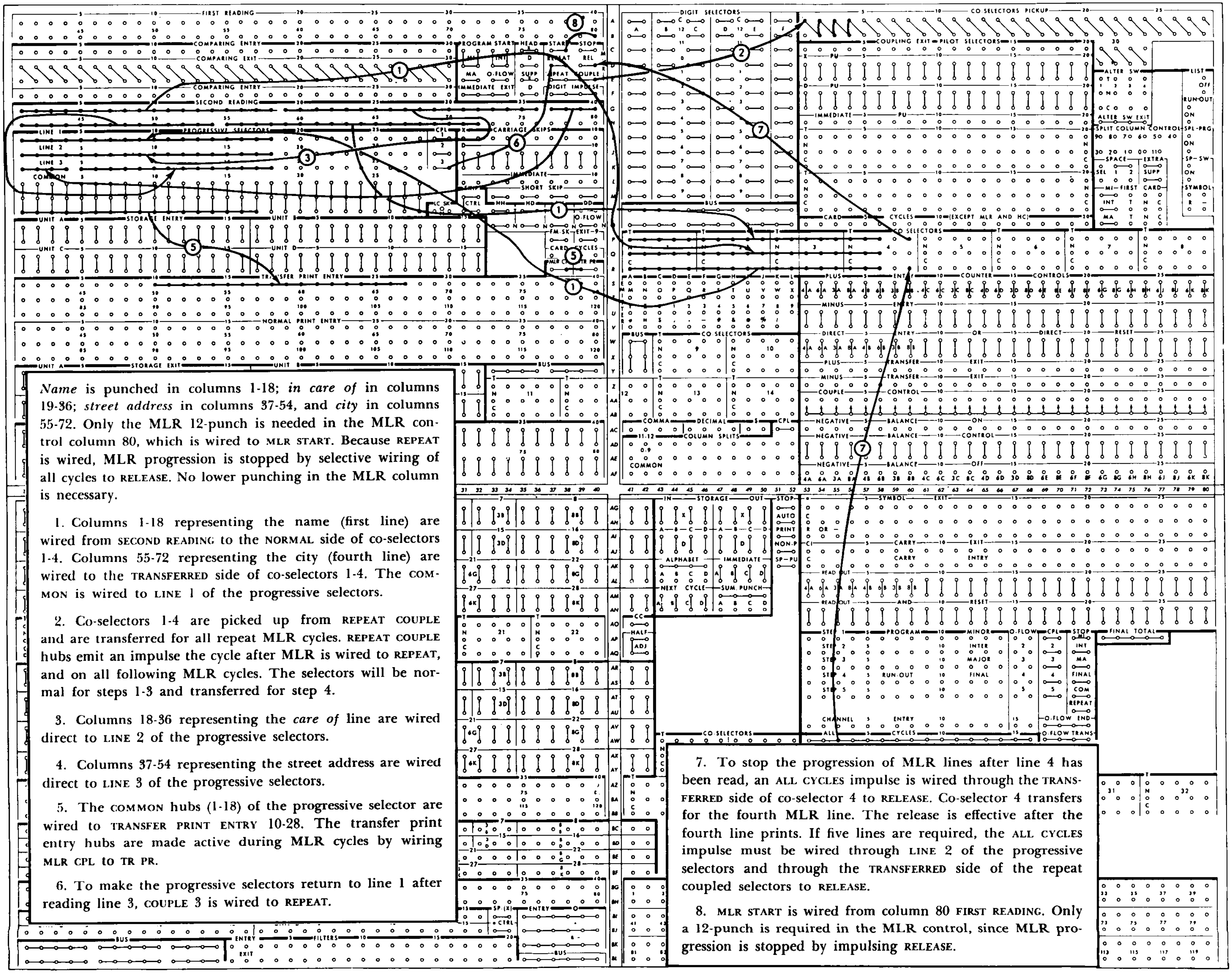
b. DD TRANSFERRED to 2D, to cause skipping to the first body line when heading cards are missing.

c. OVERFLOW to 2D, to cause skipping to the first body line when there are more items in one control group than one form can accommodate. Sheet identification is not required in this example.

d. HD NORMAL to 2X, to cause skipping from heading to body. This impulse is also wired to SHORT SKIP, since the distance between the heading and body is less than 2 inches.

7. DH NORMAL (cards out of sequence) is wired to AUTOMATIC STOP.

Figure 103. Wiring—MLR Heading Cards



Name is punched in columns 1-18; *in care of* in columns 19-36; *street address* in columns 37-54, and *city* in columns 55-72. Only the MLR 12-punch is needed in the MLR control column 80, which is wired to MLR START. Because REPEAT is wired, MLR progression is stopped by selective wiring of all cycles to RELEASE. No lower punching in the MLR column is necessary.

1. Columns 1-18 representing the name (first line) are wired from SECOND READING to the NORMAL side of co-selectors 1-4. Columns 55-72 representing the city (fourth line) are wired to the TRANSFERRED side of co-selectors 1-4. The COMMON is wired to LINE 1 of the progressive selectors.

2. Co-selectors 1-4 are picked up from REPEAT COUPLE and are transferred for all repeat MLR cycles. REPEAT COUPLE hubs emit an impulse the cycle after MLR is wired to REPEAT, and on all following MLR cycles. The selectors will be normal for steps 1-3 and transferred for step 4.

3. Columns 18-36 representing the *care of* line are wired direct to LINE 2 of the progressive selectors.

4. Columns 37-54 representing the street address are wired direct to LINE 3 of the progressive selectors.

5. The COMMON hubs (1-18) of the progressive selector are wired to TRANSFER PRINT ENTRY 10-28. The transfer print entry hubs are made active during MLR cycles by wiring MLR CPL to TR PR.

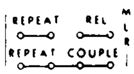
6. To make the progressive selectors return to line 1 after reading line 3, COUPLE 3 is wired to REPEAT.

7. To stop the progression of MLR lines after line 4 has been read, an ALL CYCLES impulse is wired through the TRANSFERRED side of co-selector 4 to RELEASE. Co-selector 4 transfers for the fourth MLR line. The release is effective after the fourth line prints. If five lines are required, the ALL CYCLES impulse must be wired through LINE 2 of the progressive selectors and through the TRANSFERRED side of the repeat coupled selectors to RELEASE.

8. MLR START is wired from column 80 FIRST READING. Only a 12-punch is required in the MLR control, since MLR progression is stopped by impulsing RELEASE.

Figure 104. Wiring—Printing Four Lines from One Card

The information that is to be printed on more than three lines may be repetitive or may vary from one line to the next. If the information is repetitive, no selection is required. If the information varies from one line to the next, co-selectors must be used. A separate set of co-selectors is needed for each additional line beyond three. The number of positions in each set of selectors depends on the number of card columns being used. For example, if four lines are to be printed from one card and the first and fourth lines each contain 18 positions, 4 co-selectors are necessary. The selectors are controlled in such a way that they are normal for steps 1, 2, and 3 and transferred for step 4 (repeat cycle). The first line is wired through the NORMAL and the fourth line through the TRANSFERRED side of the selectors to LINE 1 of the progressive selector (Figure 104).



D-E. 37-40

Repeat. Normally, the progression of the MLR selector is stopped after 1, 2, or 3 lines depending on the lower punching in the MLR control column. Lines may be repeated, if desired, by impulsing the repeat hub with any impulse effective at 12-time. This is done by wiring an ALL CYCLES impulse through that step of the progressive selector after which the repeating operation is to take place. Repeat printing always starts with line 1. If more than three lines are to be printed through the progressive selector, an ALL CYCLES impulse is wired through LINE 3 of the progressive selector to REPEAT. If the first line is to be repeated, an ALL CYCLES impulse is wired through LINE 1 of the progressive selector to REPEAT. When REPEAT is wired, progression is stopped by impulsing RELEASE.

Release. Normally, MLR progression is stopped from a punch in the card (MLR control column). Progression may be stopped before the indicated number of lines has been printed by impulsing RELEASE. This is done by wiring a digit (9-1) or any cycles impulse to the COMMON of any unused progressive selector position and out of the proper LINE (1, 2, 3) to release. Then, if a C were punched in the MLR control column (3 lines) the progressive selector could be stopped after the first line by wiring ALL CYCLES through line 1 to RELEASE.

When REPEAT is wired, RELEASE must also be wired to stop the progressive selector after the desired line. Thus, if four lines are to be printed from one card, each one different from the other, RELEASE must be impulsed from the fourth step. This is done by wiring ALL CYCLES through the TRANSFERRED side of the co-selector (picked up from repeat couple) to RELEASE. The release hub receives the impulse to stop the progressive selectors after the fourth line has been printed.

When printing four lines from one card, and the distance skipped between the third and fourth lines is over two inches, MLR stop should be used instead of MLR release.

Repeat Couple. Whenever REPEAT is impulsed, the repeat couple hubs emit an impulse on all following cycles until the end of the cycle during which RELEASE is impulsed. When more than three MLR cycles are required, these hubs can be used to control a co-selector for the fourth and all following MLR cycles. The NORMAL side of the selector is used to control the printing of lines 1, 2 or 3 and the TRANSFERRED side to control the printing of the repeat lines 4, 5, 6, etc.

The arithmetic operations on the 407 are performed by counters controlled to add or subtract. Many combinations of adding and subtracting are utilized through the grouping of counters and the control of the information to the counters.

Addition

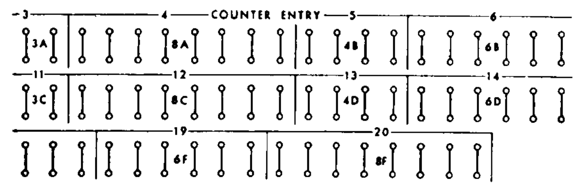
The control-panel wiring needed to perform addition in the 407 is illustrated in Figure 105.

Counters. The 407 machine has 112 individual accumulators, each of which can add up to 9. Fifty-six additional accumulators are optional. These single-position accumulators are grouped into units called counters, which vary in size from a 3-position counter to an 8-position counter. Within each counter, a single-position adds up to 9 and then carries over to the next position to its left. These two counter positions in turn add up to 99 and carry over into the third position, and so on. The carry-over within each counter is automatic.

Each counter has a serial number for general identification and a number and a letter for specific identification, the number in the latter case, indicating how many positions the counter contains, and the letter, its grouping. For example, counter 7 is also labelled 3B, meaning that it is a 3-position counter in the B group. There are 20 separate counters grouped as follows:

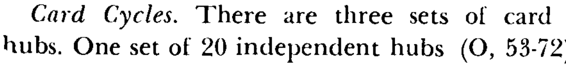
Group	A	B	C	D	E	F
Positions	4 6 3 8	4 6 3 8	4 6 3 8	4 6 3 8	6 8	6 8
Numbers	1 2 3 4	5 6 7 8	9 10 11 12	13 14 15 16	17 18	19 20

The counters can be coupled in any desired arrangement. A 6-position counter can be coupled with a 3-position counter to form a 9-position counter. An 8-position counter can be coupled with a 6-position counter to form a 14-position counter.



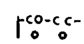
AG-AN, 1-42

Counter Entry. The counter entry hubs accept information to be added or subtracted. Each counter position contains a pair of common entry hubs that are normally wired from SECOND READING. They can also be wired from other counter EXITS, HALF ADJUSTMENT, CYCLE COUNT or from a DIGIT SELECTOR used as an emitter. The counters are identified by numbers from 1 to 20 and by numbers and letters to represent size and grouping.



O, 53-72

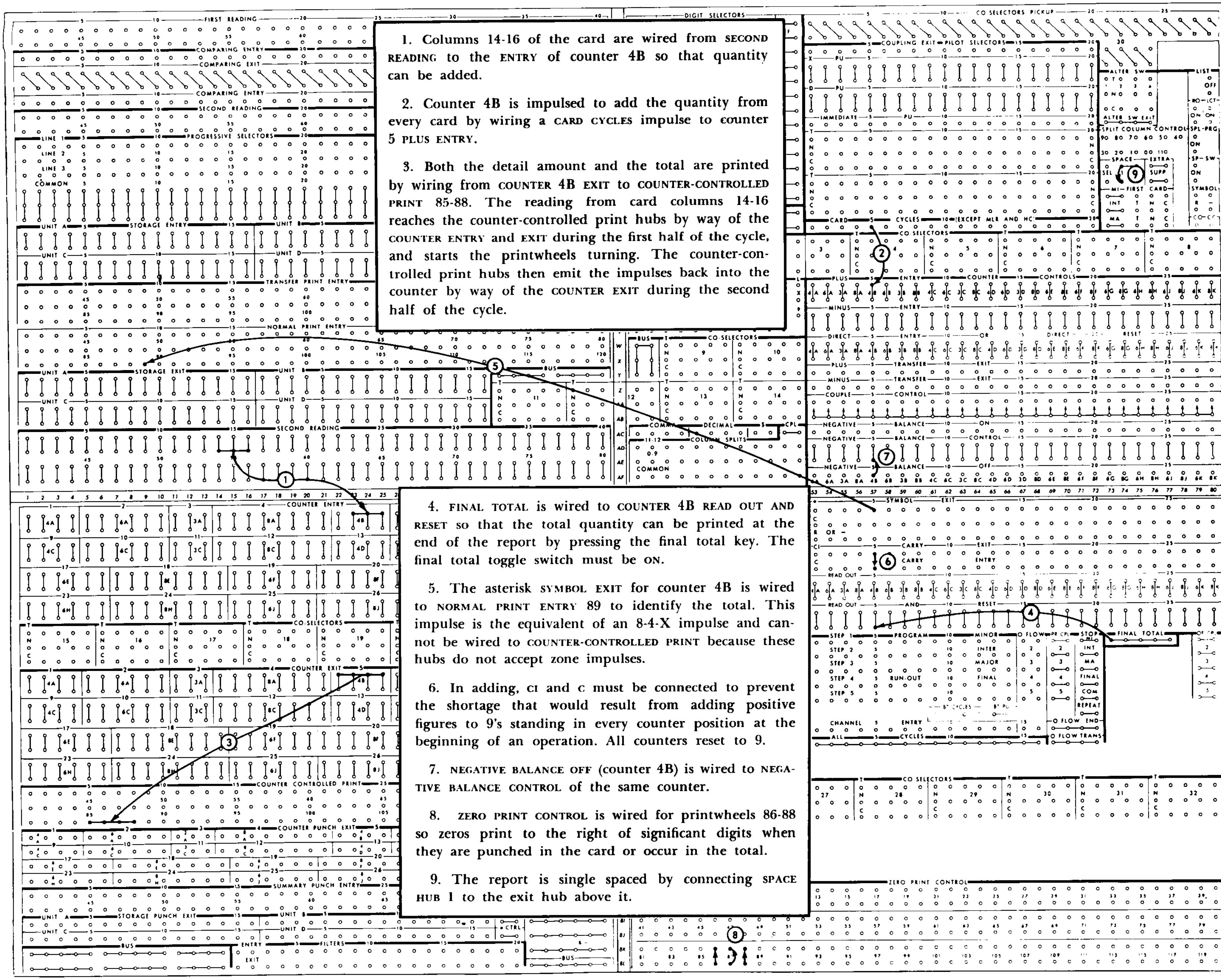
Q, 37-40



O, *79-80*

Card Cycles. There are three sets of card cycles hubs. One set of 20 independent hubs (O, 53-72) emit impulses as each detail card, except heading and MLR cards, is read at the second reading station. Another set of four independent hubs (Q, 37-40) emit impulses as each card, including heading and MLR cards, is read at the second reading station. They are normally wired to COUNTER PLUS or MINUS to cause addition or subtraction, or to DIRECT ENTRY to suppress the counter exits.

A third set of two independent hubs (O, 79-80) emit impulses for all detail cards except heading and MLR, but the impulse is short and comes early in the cycle. Co-selectors to be transferred during card cycles should be picked up by wiring from these hubs.



1. Columns 14-16 of the card are wired from SECOND READING to the ENTRY of counter 4B so that quantity can be added.

2. Counter 4B is impulsed to add the quantity from every card by wiring a CARD CYCLES impulse to counter 5 PLUS ENTRY.

3. Both the detail amount and the total are printed by wiring from COUNTER 4B EXIT to COUNTER-CONTROLLED PRINT 85-88. The reading from card columns 14-16 reaches the counter-controlled print hubs by way of the COUNTER ENTRY and EXIT during the first half of the cycle, and starts the printwheels turning. The counter-controlled print hubs then emit the impulses back into the counter by way of the COUNTER EXIT during the second half of the cycle.

4. FINAL TOTAL is wired to COUNTER 4B READ OUT AND RESET so that the total quantity can be printed at the end of the report by pressing the final total key. The final total toggle switch must be ON.

5. The asterisk SYMBOL EXIT for counter 4B is wired to NORMAL PRINT ENTRY 89 to identify the total. This impulse is the equivalent of an 8-4-X impulse and cannot be wired to COUNTER-CONTROLLED PRINT because these hubs do not accept zone impulses.

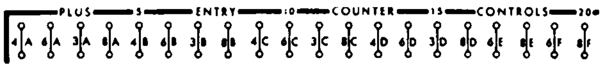
6. In adding, CI and C must be connected to prevent the shortage that would result from adding positive figures to 9's standing in every counter position at the beginning of an operation. All counters reset to 9.

7. NEGATIVE BALANCE OFF (counter 4B) is wired to NEGATIVE BALANCE CONTROL of the same counter.

8. ZERO PRINT CONTROL is wired for printwheels 86-88 so zeros print to the right of significant digits when they are punched in the card or occur in the total.

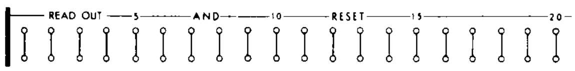
9. The report is single spaced by connecting SPACE HUB 1 to the exit hub above it.

Figure 105. Addition



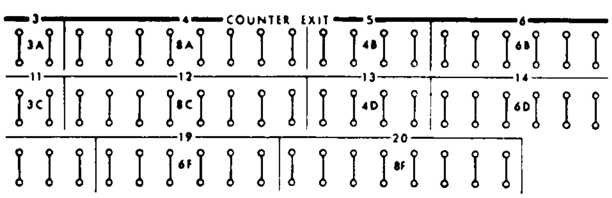
S-T, 53-80

Counter Control Plus. Each counter has a corresponding PLUS ENTRY that must be impulsed to cause the counter to add as the card is read at the second station. If a counter is to add from every card, a CARD CYCLES impulse is wired to the plus hubs of that counter. If only certain cards are to be added, the CARD CYCLES impulse must be selected to reach the counter plus hubs only for the particular cards to be added.



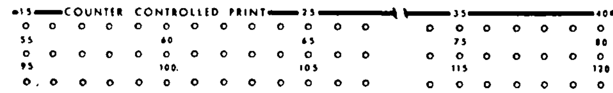
AN-AO, 53-80

Read Out and Reset. Each counter has a pair of common read out and reset hubs. They cause the counter to read out (print the total) and reset (clear) in the same cycle. The time at which the total prints depends upon the type of impulse wired to the read out and reset hubs. Normally they are wired from PROGRAM or FINAL TOTAL. They may also be wired from CARD CYCLES to cause the counter to read out and reset for every card, or from FIRST CARD MINOR, INTERMEDIATE or MAJOR to cause the counter to read out and reset for the first card of every minor, intermediate or major group. A counter on the 407 always resets either by adding the 9's complement of the number standing in the counter when resetting without printing, or the 9's complement of the number printed. A counter always resets to 9 rather than zero, thus leaving 9's standing in every counter position after reset.



AR-AY, 1-42

Counter Exit. Each counter has a corresponding COUNTER EXIT from which all counter detail and total printing is obtained. These hubs must be wired to COUNTER-CONTROLLED PRINT if the total is to be printed and the counter is to reset at the same time. They may be wired to either NORMAL or TRANSFER PRINT ENTRY if the counter is to be read out only. The COUNTER EXITS are internally tied to the corresponding COUNTER ENTRY hubs except when the DIRECT ENTRY or DIRECT RESET controls for that counter are impulsed. The exit hubs may be used as entries, as they frequently are when transferring totals from one counter to another.



AZ-BB, 1-40

Counter-Controlled Print. Each printwheel has a corresponding counter-controlled print hub on the control panel, which is internally connected to either TRANSFER or NORMAL PRINT ENTRY, whichever is active. The difference between these hubs and the normal print entry hubs discussed earlier is that the counter-controlled print hubs are also exits for all amounts printed by the printwheels. A cycle on the 407 is divided into two parts, referred to as the first half and the second half of the cycle, as shown in Figure 106. Information read from the card reaches the counter-controlled print hubs from the COUNTER EXIT in the first half of the cycle, and sets up the printwheels for printing. The information that the wheel prints is emitted from the counter-controlled print hubs in the second half of the cycle, and returns to the COUNTER EXIT from which it started and to any other COUNTER EXITS connected together. These are sometimes referred to as "echo" impulses.

Counters that are controlled to add, add data returned from the printwheels through the COUNTER EXITS. Counters which are controlled to reset, add or subtract the returned information. Counters are then checked for a zero balance.

COUNTER EXITS must be wired to COUNTER-CONTROLLED PRINT when a total is to be read out and reset; the only way a counter can be reset on the cycle in which it is read out is by subtracting the total, if it is plus, or by adding it, if it is minus. This is done on the second half of the total cycle by impulses received from the counter-controlled print hubs.

All counter positions being used must have the COUNTER EXITS wired to COUNTER-CONTROLLED PRINT to insure that all positions return to a zero balance during a reset operation. If a counter fails to balance to zero, the reset check light turns on.

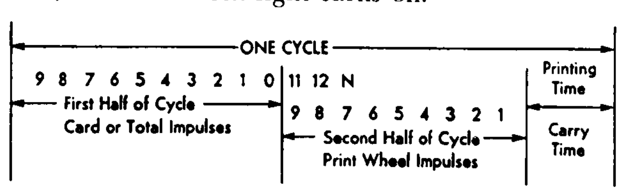
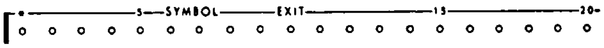


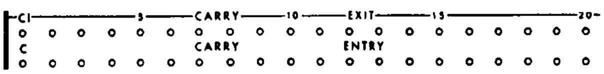
Figure 106. Cycle Schematic

Counter-controlled print hubs can be wired directly from SECOND READING to print numerical information, provided the same information is not wired for comparing. Alphabetic or special character information cannot be wired to COUNTER-CONTROLLED PRINT because these hubs do not accept 11 and 12 impulses.



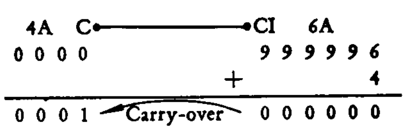
AG, 53-80

* *Symbol Exit.* Each counter has a corresponding asterisk symbol exit hub that emits the equivalent of an 8-4-X impulse whenever the counter is impulsed to read out or to read out and reset. This is usually wired to any normal print entry hub to identify totals, or to the TRANSFER PRINT ENTRY when those hubs are active. Symbol exit cannot be wired to COUNTER-CONTROLLED PRINT because these hubs do not accept zone impulses, which in the case of the asterisk is the X impulse.



AJ-AK, 53-80

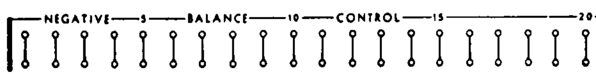
CI Carry Exit, C Carry Entry. These hubs have two functions, counter coupling and carry-back. If two or more counters are joined together to increase capacity, they must be coupled by wiring the CI of the counter containing the units position to the C of the coupled counter. A 10-position counter is obtained by coupling a 6-position counter with a 4-position counter. If 4A is to be coupled with 6A, and 6A contains the units position, the CI of 6A is wired to the C of 4A. The example below shows how counter coupling functions when 4 is added to 999996 in a 10-position counter.



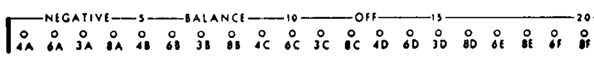
The CI and C hubs are also used to carry back from the left position of a counter to the units position of the same counter, or from CI to C. This is necessary whether a counter is impulsed to add or to subtract, to compensate for shortages that would result because all counters reset to 9 instead of zero, and also because of the use of the 9's complement method of subtraction.

Positive Result: Problem	Positive Result: Counter Action	Negative Result: Problem	Negative Result: Counter Action
	999999		999999
+175	000175	-175	999824
	(1)000174 → 1		(1)999823 → 1
	000175		999824
-96	999903	+96	000096
	(1)000078 → 1		999920
		+102	000102
	000079		(1)000022 → 1
-102	999897		
	999976		000023
+75	000075	-75	999924
+52	(1)000051 → 1	-52	999947
	000052		(9's complement of 52)

In each of the examples above, the carry-back is added back into the units position because CI is wired to C of the same counter. If the carry-back wiring is omitted, positive totals would be short, and negative totals would be over, after being converted.



AD-AE, 53-80



AF, 53-80

Negative Balance Off; Negative Balance Control. Each counter group has a corresponding negative balance off hub which emits an impulse at the end of the cycle during which the counter zero-balances, and for every cycle thereafter as long as the counter remains at zero. It has two uses: to pick up selectors so that certain machine operations can be conditioned by a zero balance, and to impulse the negative balance control hubs of the same counter so that a zero balance does not print as 9's.

When counters are coupled, the negative balance control hubs must also be coupled, and when positive totals are accumulated, only the NEGATIVE BALANCE OFF of the low-order counter is wired to NEGATIVE BALANCE CONTROL. This wiring works in conjunction with COUPLE CONTROL to test all positions of the coupled counter for a zero balance.

In general, the NEGATIVE BALANCE OFF should be wired to NEGATIVE BALANCE CONTROL whenever a total to be printed from the counter is always positive.

The same card and report form for detail printing are now reconsidered for the purpose of adding quantity, as shown in Figure 107.

SHIPPING SCHEDULE						
PRODUCT	SCHEDULE DATE NO.	DAY	YR.	ORDER NO.	CUSTOMER	QUANTITY
3120	1	22		1001	TROUT MORTON CO	4
				1002	HERRON ROBERTS CO	2
				1003	AMERICAN FOUNDRY	1
				1004	PRESTON MCWORTH DRILL CO	3
				1005	RELAY COMPANY OF AMERICA	1
				1008	BROWN & JONES	2
				1009	IDEAL CABINET MAKERS	1
				1011	CLEANING - DYING WORKS	4
				1013	AMALGAMATED CORP	2
				1014	RADIO ADJUSTMENT CO	7
				1016	IRON AND STEEL	3
				1017	NATIONAL FIRE INSURANCE	1
				1018	UNIVERSITY CITY	6
						37*

Figure 107. Detail-Printed Report

Subtraction

Subtraction on the IBM 407 (Figures 108 and 109) is accomplished by adding the 9's complement of the number. Complement results are usually converted to true figures before they are printed. Conversion of complements is done in the same cycle during which printing takes place and therefore does not require additional time. Either a CR or a minus symbol can be printed beside the converted total as well as beside each subtracted amount.

As in addition, in detail printing a counter receives the amount to be subtracted from the counter wheel, thus assuring that the counter subtracts the same figure that prints. When total printing a negative result,

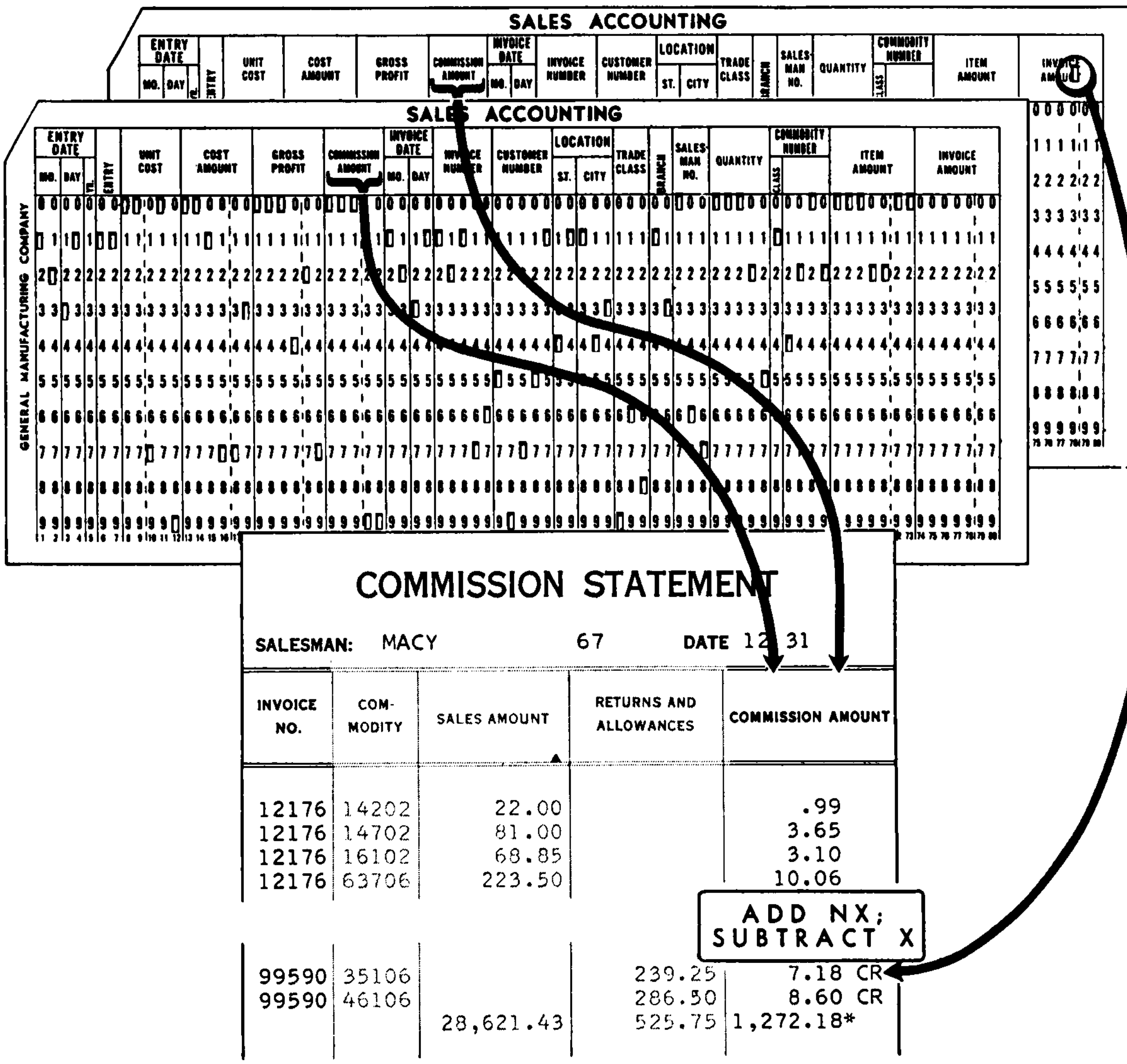


Figure 108. Subtraction from Cards

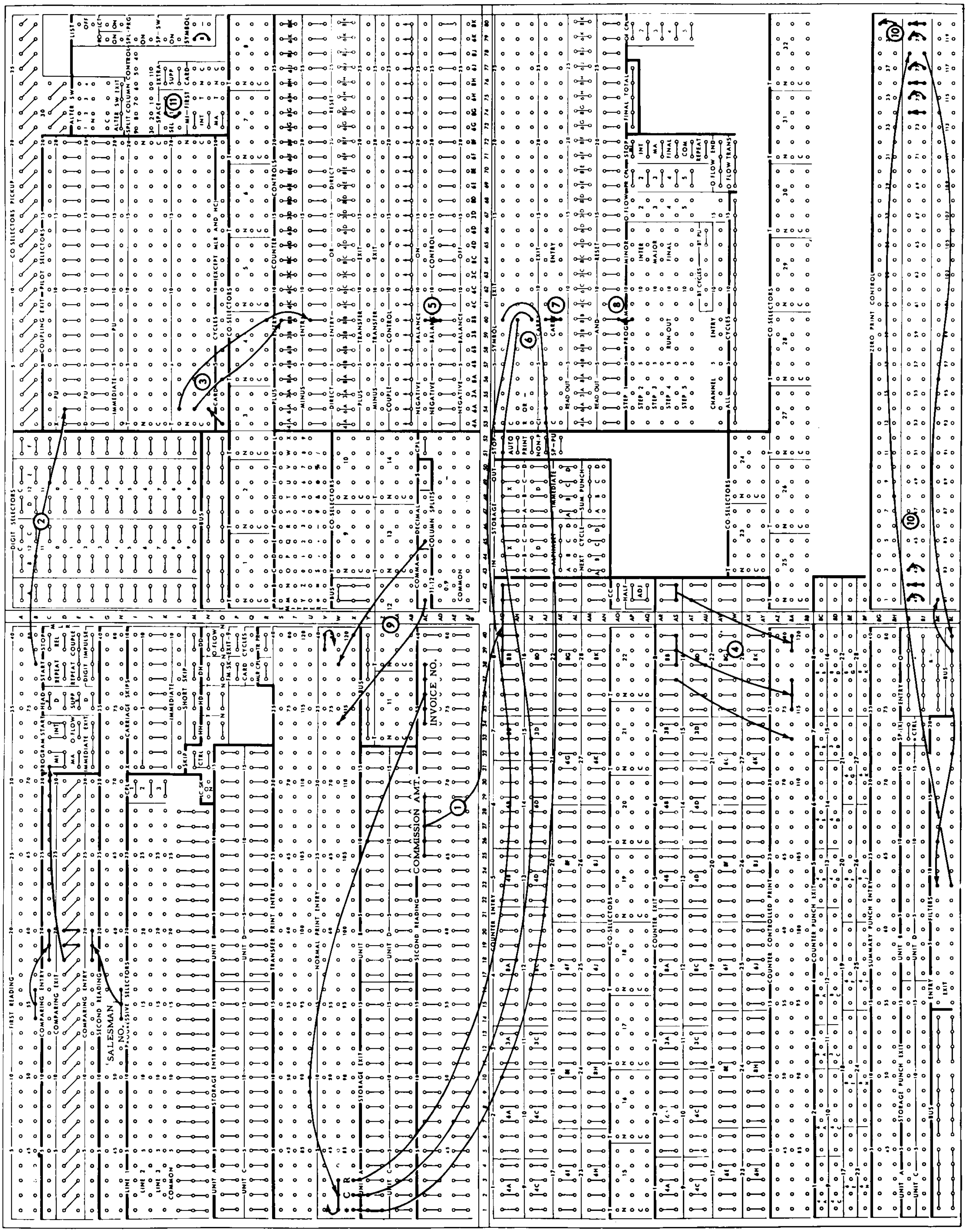


Figure 109. Subtraction

Wiring for the shaded area shown in Figure 108 is not shown in this example. This is a detail printed report.

1. The commission amount is wired from SECOND READING to COUNTER 8B ENTRY.

2. The X in column 78, identifying credit cards, is wired from the first reading station to the X-pickup of pilot selector 2. The X must be read from the first station so that the pilot selector is transferred by the time the card reaches the second station.

3. A CARD CYCLES impulse is wired to the COMMON of the pilot selector. An X in the card transfers the selector, and the CARD CYCLES impulse controls counter 8B to subtract. The NX-card does not transfer the selector and the CARD CYCLES impulse controls counter 8B to add.

4. Both detail and total amounts are printed by wiring from COUNTER 8B EXIT to COUNTER-CONTROLLED PRINT 73-80, allowing one position for comma and one for demical printing.

5. NEGATIVE BALANCE ON of counter 8B is wired to NEGATIVE BALANCE CONTROL of the same counter. NEGATIVE BALANCE ON emits an impulse whenever a 9 stands in the high-order position of counter 8B, indicating a negative balance. NEGATIVE BALANCE CONTROL accepts the impulse on the total cycle to convert the complement standing in the counter to a true figure.

6. A CR symbol is printed alongside each credit item, as well as alongside a credit total, by wiring the C symbol exit hub for counter 8B to NORMAL PRINT ENTRY 82 and the R or minus exit hub for counter 8B to NORMAL PRINT ENTRY 83. The symbol switch is wired for printing R instead of minus.

An asterisk is printed beside every total, whether it be debit or credit, by wiring the asterisk symbol exit hub for counter 8B to NORMAL PRINT ENTRY 81. SYMBOL EXIT impulses cannot be wired to COUNTER-CONTROLLED PRINT, because these hubs do not accept zone impulses.

7. CI and C are wired normally.

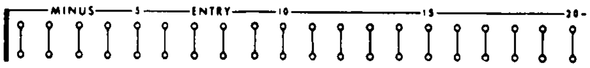
8. MINOR PROGRAM EXIT is wired to counter 8B READ OUT AND RESET. The program is initiated by an impulse from the COMPARING EXIT, resulting from a change in salesman number.

9. The comma is wired to NORMAL PRINT ENTRY 74 and the decimal to NORMAL PRINT ENTRY 78. With these symbols under zero print control, they print only when significant digits are present.

10. The wheels printing commission amount and invoice number are wired for zero print control. To make the decimal print when there are significant digits in the amount, the lower hub of ZERO PRINT CONTROL 78 is wired through a set of bus hubs to the top hub of 81 and through a filter to the top of 78.

11. The machine is wired to single space.

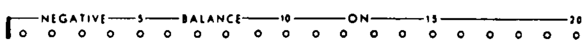
the counter resets by adding the true figure as printed to the complement standing in the counter. For example, a −4 would be represented in a 3-position counter as 995. When the counter is reset, +4 is added to 995, resulting in 999, which is the 9's complement of a zero balance.



U-V, 53-80

Counter Control Minus. Each counter has two common minus hubs which, when wired from a CARD CYCLES impulse, cause the counter to subtract, or in other words, to add the 9's complement of the figure to be subtracted. It also makes available a C, and R or minus, symbol from the corresponding hubs for the purpose of identifying credit items.

If a CARD CYCLES impulse were wired directly to MINUS, all cards would subtract. If only certain cards are to subtract, the CARD CYCLES impulse must be selected.



AC, 53-80

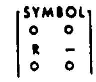
Negative Balance ON; Negative Balance Control. Each counter group has a corresponding negative balance on hub which emits an impulse at the end of the cycle during which the counter turns negative and for every cycle thereafter as long as the counter remains negative. It has two uses, one to pick up selectors so that certain machine operations can be conditioned on a negative balance, and the other to impulse the negative balance control hubs of the same counter so that complement totals will print as true figures.

A negative balance is signalled by a 9 in the high-order position of a counter and, therefore, that position must not be used for accumulating purposes. It is the 9 in this position of the counter that causes the NEGATIVE BALANCE ON hub to emit an impulse.

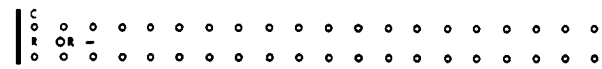
The NEGATIVE BALANCE ON wired to NEGATIVE BALANCE CONTROL converts complement totals to true figures and also causes a C and R or − to be emitted from the corresponding symbol exit hubs for identifying credit balances. This wiring also supplies X-0 impulses from the high-order counter punch exit hubs, which can be used to identify credit balances punched in summary cards.

When counters are coupled, the common negative balance control hubs must also be coupled. Only the high-order counter is wired for NEGATIVE BALANCE ON to control the negative balancing operations.

If NEGATIVE BALANCE ON is not wired, a negative total prints, and summary punch as a 9's complement.



M-N, 79-80



AH-AI, 53-80

Symbol Switch; C, R or Minus Symbol Exits. The CR symbol must print from two printwheels, the C from one and the R from another. Each counter has a corresponding C hub and a corresponding R or minus hub. Both hubs emit impulses under two conditions:

a. When the minus hub of the counter they represent receives an impulse.
b. When the counter they represent receives an impulse to READ OUT or READ OUT AND RESET a converted negative total. This does not include zero balances.

The R or minus symbol exit hubs are further conditioned by the setting of the symbol R (minus) switch. If the switch is wired for R, the exit hubs emit an R (X and 9) impulse. If the switch is not wired for R, the exit hubs emit a minus (−) impulse. The two minus hubs of the switch are inactive. The advantage of printing a minus sign for credit items is that it prints from a single printwheel.

If both an R and a minus are to be printed on the same line, the symbol switch should be set at R and the SYMBOL EXIT impulse should be wired directly to a printwheel to print the R, and through a column split (to eliminate the 9) to the printwheel that is to print the minus sign. It is also possible to select the symbol switch so that minus signs print for negative detail items and R, together with C from the C hubs, for negative totals.

When DIRECT ENTRY is impulsed, the C and R or minus symbol hubs do not emit impulses.

Symbol exit hubs can never be wired to COUNTER-CONTROLLED PRINT because these hubs do not accept 11- or 12-zone impulses

If the symbol exits of more than one counter are used on a total cycle, and one can have a zero balance while others are negative, the symbol exits should be filtered.

Counter Coupling

Counter groups are arranged in the following sequence: 4, 6, 3, 8; 4, 6, 3, 8; etc. This arrangement permits convenient coupling of adjacent counters to form counters of larger capacity. For example, larger capacity counters can be coupled as follows:

COUNTER CAPACITY	COUNTER COUPLING
9 positions	6 and 3
10 "	4 and 6
11 "	3 and 8
12 "	8 and 4
13 "	4, 6 and 3
14 "	6 and 8
15 "	3, 8 and 4
17 "	6, 3 and 8
18 "	8, 4 and 6

Sixteen-position counter capacity requires coupling of counters that are not adjacent. For best operation, no more than 20 counter positions should be coupled.

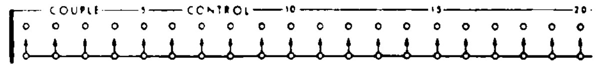
The wiring required for counter coupling is illustrated in Figure 110.

CI and C for Counter Coupling

Whenever a counter is used, CI and C must be connected. When counters are coupled, the CI of the high order counter must be wired to the C of the low order counter and the remaining CI and C hubs must be connected. The purpose of wiring from CI of the high order counter to C of the low order counter is to carry back a 1 to the units position when adding, subtracting or group indicating. The purpose of wiring the remaining CI and C hubs is to provide a path for *carry* from one counter to another.

Negative Balance On-Off for Counter Coupling

When conversion of complements to true figures is required, the NEGATIVE BALANCE ON of only the high order counter is wired to NEGATIVE BALANCE CONTROL of all coupled counters, because only the high-order 9 can signal a credit total. When only positive totals are being printed, the NEGATIVE BALANCE OFF of the low order counter must be wired to NEGATIVE BALANCE CONTROL. This wiring works in conjunction with COUPLE CONTROL to cause a zero test to be made in every coupled counter to keep the counters from printing 9's when nothing is added into the counters.



AA-AB, 53-80

Couple Control. Each counter has a couple control entry hub that can be connected to any one of the common hubs below it. When counters are coupled, the couple control hubs of all except the high-order counter must be connected. COUPLE CONTROL has three main functions:

1. to insure a zero test in each coupled counter, rather than just the low-order counter, when NEGATIVE BALANCE OFF is wired. This test is necessary so that 9's will not print for zero balances.
2. to eliminate the summary punching of credit X's from the coupled low-order counters when amounts are negative. Unless COUPLE CONTROL is wired, an X will summary punch from the high-order position of each coupled counter, when it should punch from the high-order counter only.
3. to make the corresponding NEGATIVE BALANCE ON hub inactive. Wiring NEGATIVE BALANCE ON of coupled counters would be nullified.

Crossfooting

$$\pm A \pm B \pm C = \pm R$$

Crossfooting can be done on the IBM 407 either from individual cards or from a group of cards by rolling factors or totals from one counter to another on separate program steps. If special program is not used, three program steps are available for crossfooting. With special programming, as many steps as desired may be taken for each of the three program levels.

Three fields can be crossfooted from each card by entering the fields into three different counters as the card is read at the second reading station. The minor program is used for crossfooting the first two fields, and the intermediate program, for crossfooting the total of the first two fields with the third field. The major program is used to print the result.

By impulsing MAJOR PROGRAM START with a CYCLE COUNT, all three levels are operative for every card. Although the counters are cleared as the totals are rolled from one to another, printing from all except the major counter is suppressed by the use of NON-PRINT.

Fields to be crossfooted can always be added into the receiving counter, always subtracted, or sometimes added and sometimes subtracted, under the control of a designating X or digit. Figure 111 shows three-field crossfooting, always adding two factors and always subtracting a third $(A + B - C = R)$.

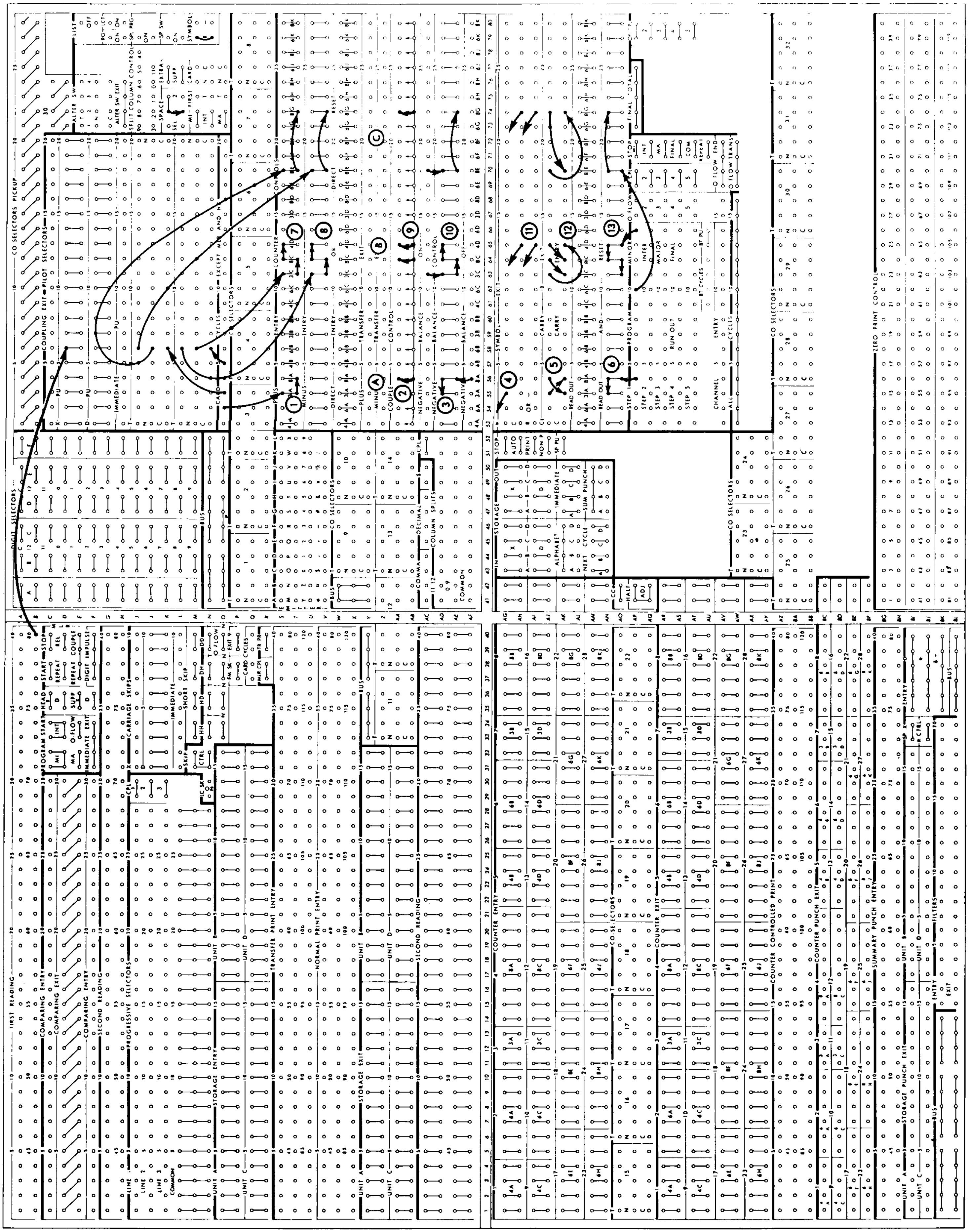


Figure 110. Counter-Coupling Wiring

The section of the diagram labelled A shows the wiring for coupling two adjacent counters, adding only; B shows the wiring for coupling three adjacent counters, adding and subtracting; and C shows the wiring for coupling two non-adjacent counters, adding and subtracting.

A. COUNTER 3A COUPLED TO COUNTER 8A
TO FORM AN 11-POSITION COUNTER

1. A CARD CYCLES impulse is wired to PLUS of both counters.

2. COUPLE CONTROL is connected for the low-order counter 8A. The purpose of this wire is to insure a zero test in both counters 3A and 8A.

3. The negative balance control hubs for 3A and 8A are connected. NEGATIVE BALANCE OFF of the low-order counter 8A is connected to NEGATIVE BALANCE CONTROL. This wiring works in conjunction with the COUPLE CONTROL to zero test the whole counter.

When a counter zero balances, all positions stand at 9. With NEGATIVE BALANCE OFF wired, conversion of 9's to zeros takes place. If counter 8A COUPLE CONTROL were not wired, in this example, and counter 8A contained all 9's, the 9's in counter 8A would be converted to zeros, but because the NEGATIVE BALANCE CONTROL of 3A is also connected, whatever amount stands in that counter would also be converted. COUPLE CONTROL prevents this from happening by allowing the test to begin with the high-order position of the coupled counter and work to the low-order position. It passes from one counter to another by way of the CI and C connections, so these hubs must also be wired.

4. The ASTERISK SYMBOL exit of the high-order counter is wired to print. The exit from the low-order counter could be used.

5. When counters are coupled, the CI of the high-order counter must be wired to the C of the low-order counter. The remaining CI and C hubs are then connected starting from the right and working to the left.

6. Minor program is wired to the READ OUT AND RESET controls of counters 3A and 8A. It is assumed that MINOR PROGRAM START has been initiated or that the LCT switch is ON.

B. COUNTERS 3C, 8C AND 4D COUPLED
TO FORM A 15-POSITION COUNTER

7. The counter control plus hubs are impulsed to add NX cards.

8. The counter control minus hubs are impulsed to subtract X cards.

9. The couple control hubs of counters 8C and 4D (low-order counters) are connected.

10. The negative balance on hub of the high-order counter is wired to NEGATIVE BALANCE CONTROL of all three counters to convert complement totals to true figures, including zero balances. This wiring works in conjunction with COUPLE CONTROL wiring to prevent the summary punching of X's from the high-order positions of counters 8C and 4D when a negative result is converted. If couple control wiring were omitted, three X's would be summary punched, one from each high-order position of the coupled counters. The only one needed is from the high-order counter. This is more fully discussed under *Summary Punching*.

11. The C and R or — symbol exits of the low-order counter are wired to print. The low-order counter must be used because the test for zero balance or negative balance starts with the high-order position of the high-order counter and progresses through the low order counter. Therefore, all counters coupled should be tested from high order to low order before the symbol is allowed to print. If the symbol exit were wired from the high-order counter, the only time the symbols would print would be when the high-order counter contained a negative result. Because it is possible for the high-order counter to contain a zero result (all 9's) and the low-order counter to be negative, the resulting negative total would not be identified.

12. The CI of the high-order counter is wired to the C of the low-order counter. The remaining CI and C hubs are connected, starting from the right and working to the left.

13. MINOR PROGRAM is wired to the READ OUT AND RESET of counters 3C, 8C and 4D. It is assumed that MINOR PROGRAM START has been initiated or that the LCT switch is ON.

C. COUNTERS 8E AND 8G COUPLED
TO FORM A 16-POSITION COUNTER

Wiring principles are the same as described for wiring *B*.

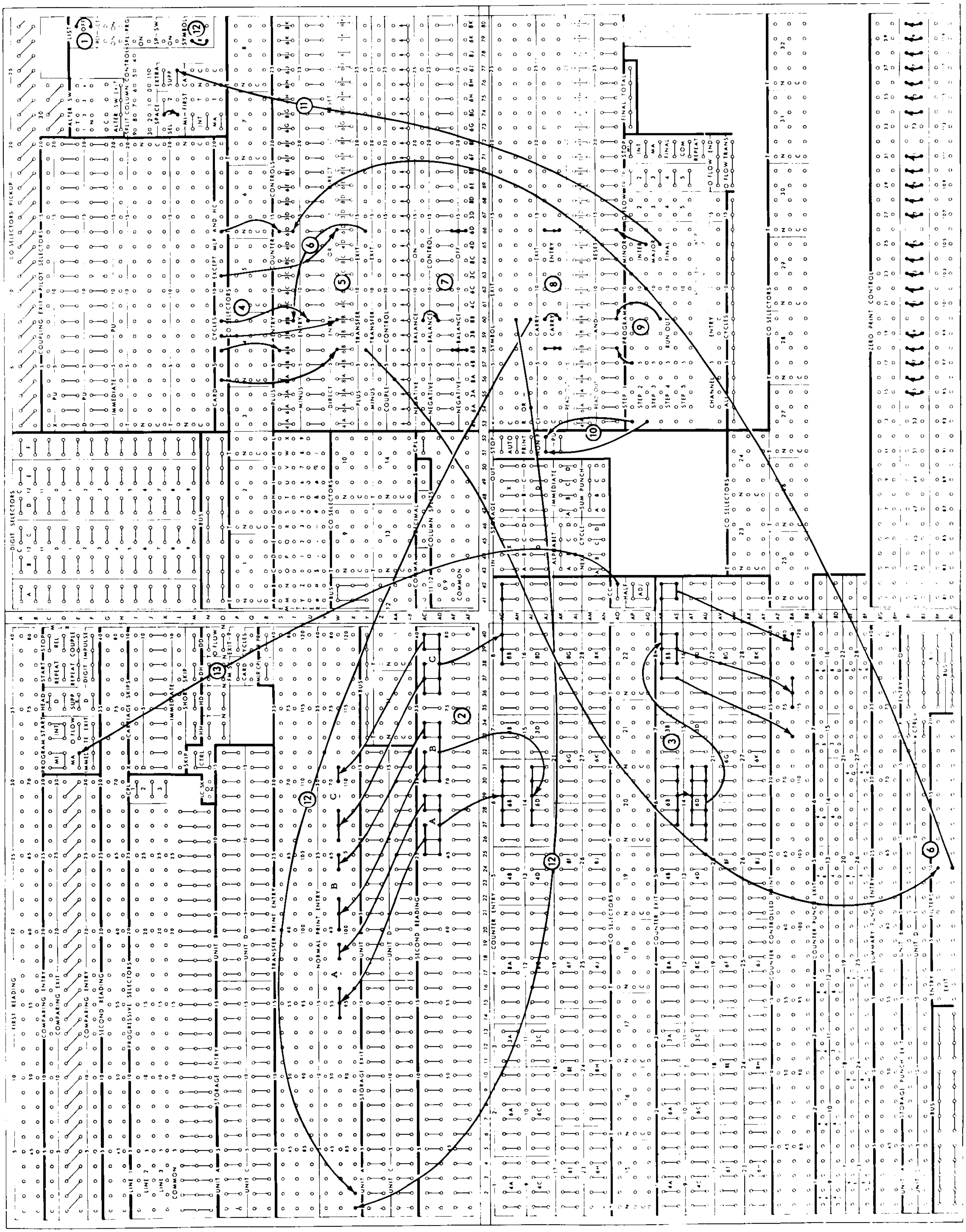


Figure 111. Three-Field Crossfooting

1. This is a group printed report, therefore list is wired OFF.

2. Field A is entered into counter 6B, field B into counter 6D, and field C into counter 8B. These three fields are also wired from SECOND READING to NORMAL PRINT ENTRY with spaces left for decimal printing. The decimal wiring is not shown in this example.

3. All three COUNTER EXITS are connected to provide a path for rolling counters from one to the other. The exit of counter 8B is wired to print the result, allowing a space for decimal printing.

4. A CARD CYCLES impulse is wired to the PLUS of 6B and 6D and to the MINUS of 8B.

5. Detail printing from all counters is prevented by wiring independent CARD CYCLE impulses to the DIRECT ENTRY of each counter. The same CARD CYCLE impulse cannot be wired to all three DIRECT ENTRY hubs, because the three counters are being reset on different program steps.

6. The TRANSFER PLUS EXIT of 6B is wired to the PLUS of 6D. It must be wired through a filter, however, since CARD CYCLES impulse is already wired to 6D PLUS. If the TRANSFER PLUS 6B were wired directly to 6D, the CARD CYCLES impulse of 6D would back into the TRANSFER PLUS of counter 6B, and counter 6B would attempt to add and subtract simultaneously. The filter prevents this back-circuit. TRANSFER PLUS EXITS emit an impulse when the counter is plus at the time the counter is read out and reset. Because 6B is read out and reset on a minor program, factor A will read out of 6B and add in 6D.

The TRANSFER PLUS EXIT of 6D is wired to the PLUS of 8B. Because 8B is read out and reset on an intermediate program, the sum of A and B reads out of 6D and adds to the minus figure in 8B.

7. Because the result in counter 8B could be minus, NEGATIVE BALANCE ON is wired to NEGATIVE BALANCE CONTROL for the purpose of converting complements to true figures. NEGATIVE BALANCE OFF is wired to 6B and 6D NEGATIVE BALANCE CONTROL to prevent the printing of 9's for possible zero balances.

8. CI and C are wired normally.

9. Counter 6B is read out and reset on a minor program, 6D on an intermediate program, and 8B on a major program.

10. Both printing and spacing for the minor and intermedite pogram levels are suppressed by wiring the corresponding program exit hubs to NON-PRINT.

11. The major program is used to print the result from 6D. To print the total on the same line as the indication, MAJOR PROGRAM EXIT is wired to space suppress. Normally, in group printing, the minor total prints on the same line as the indication, the intermediate total one line below the indication, and the major total two lines below the indication. Because the spacing for the intermediate transfer is suppressed in this example, the crossfooted total normally prints one line below the indication.

12. Negative crossfooted totals are identified by CR symbols.

13. The CYCLE COUNT impulse is wired to MAJOR PROGRAM START. This wiring forces all three programs to be taken for each card, because a major program start forces both a minor and intermediate program.

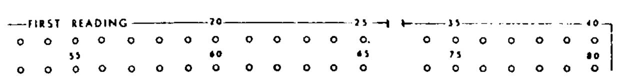
Crossfooting three totals at the end of a group may be done by wiring a COMPARING EXIT impulse to MAJOR PROGRAM START.

Program Control

Program control enables the machine to distinguish the cards of one classification from those of another. The cards in a single classification are referred to as a program group.

The machine can read simultaneously, by means of the first and second reading stations, the holes punched in two successive cards. Thus, each card passing through the machine is compared twice, once with the card ahead of it and once with the card following it. If the fields are the same, thus indicating that the cards are of the same program group, the machine continues to feed cards. When the punching in one card does not compare with the punching in the card preceding it, and the control panel is properly wired, the machine automatically starts a total program cycle.

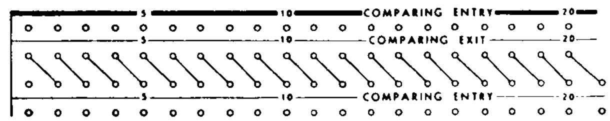
Three types of totals are possible on the 407: minor, intermediate, and major. They are also known as program levels 1, 2, and 3. A minor program is used for the classification representing the smallest group, intermediate program for the next group, and major program for the largest group. If totals of sales amount were to be printed by state, by city, and by customer number, customer number would be considered a minor group, city an intermediate group and state a major group. When the proper programs are used for these groups, the machine automatically stops at the end of each group and does not start until the required number of program cycles is taken. For a minor program change only one total program cycle is required, for an intermediate program change two total program cycles are required, and for a major change, three total program cycles are required (see Figure 115).



A-B, 1-40

First Reading. The 80 first reading hubs represent the 80 columns of the card and are used for reading information from the card as it stands at the first reading station. They are wired principally to COMPARING ENTRY and to the controlling hubs of selectors, MLR, storage units and the carriage.

Comparing Unit. Twenty positions of comparing are standard on the 407 and ten more are optional. Each position consists of two comparing entry hubs and two comparing exit hubs. The two common comparing exit hubs are diagonally arranged to facilitate wiring.



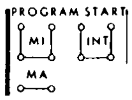
C-F, 1-30

Comparison is accomplished by wiring the field from FIRST READING to one row of COMPARING ENTRIES, and from SECOND READING to the other row of COMPARING ENTRIES. Either row of COMPARING ENTRIES can be wired from either set of brushes, and the wiring is the same for alphabetic or numerical information. Although any hubs within a COMPARING ENTRY row can be used, the corresponding hubs in the other COMPARING ENTRY row must be wired. It is not possible, for example, to wire FIRST READING to COMPARING ENTRIES 1 through 5 and SECOND READING to COMPARING ENTRIES 6 through 10. The hubs used in both sets of entries must line up with each other.

During each card cycle, the readings to both sides of the comparing entries are compared. If the two readings for any comparing position are not identical, a comparing exit impulse is available in the two common comparing exit hubs. If the two comparing positions are identical, a comparing exit impulse is not available. The two cards shown in Figure 112 are fed to their respective reading stations at the same time. Because they are read 9's first, the 3 hole at the second reading station is read before the 2 hole at the first reading station. Therefore, the 3 impulse reaches the comparing unit before the 2 impulse setting up an unequal condition in the unit and making an impulse available at the COMPARING EXIT. The impulse can be used to stop the feeding of cards and start programming.

If a column contains more than numeric punch (1-9), the comparing unit recognizes only the first digit read. For example, if a 6 and a 3 are read from FIRST READING to a COMPARING ENTRY and a 6 only is read from SECOND READING to the corresponding COMPARING ENTRY, there is no impulse from the COMPARING EXIT. If the card at second reading contained a 3 instead of a 6, there would be an impulse from the comparing exit.

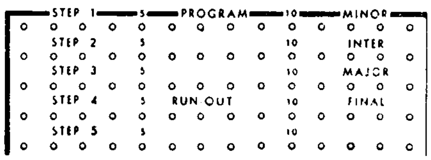
Program Start Minor, Inter., Major. The minor intermediate and major program start hubs receive COMPARING EXIT impulses from the comparing exit hubs to stop card feeding and start programming, one for minor, two for intermediate, and three for major. If



C-D, 30-33; E, 30-31

INTERMEDIATE PROGRAM START only were wired, a minor total cycle would be forced before the intermediate total cycle. If MAJOR PROGRAM START alone were wired, both a minor and an intermediate total cycle would be forced before the major total cycle.

A CYCLE COUNT or a DIGIT impulse may also be wired to PROGRAM START to cause a program start on every card.



AP-AT, 53-66

Program Exit Minor, Inter., Major, Run-Out Final. Each program step has fourteen exit hubs that emit all-cycle impulses whenever the corresponding PROGRAM START is impulsed. Only the minor program exit hubs become active when MINOR PROGRAM START is impulsed; minor and intermediate program exits become active in succession when INTERMEDIATE PROGRAM START is impulsed; MINOR, INTERMEDIATE and MAJOR PROGRAM EXITS become active in succession when major program start is impulsed.

The run-out final total hubs differ from the regular final total hubs discussed earlier in that they do not depend in any way on the final total key. When they are wired directly to the READ OUT or READ OUT AND RESET of a counter, the total in the counter clears out automatically as a final total, provided these conditions are satisfied:

a. The last card has passed through the machine.
b. The final total toggle switch is on.
c. The MAJOR PROGRAM START is impulsed. Without a program start, all four program steps become active in turn when the LCT switch is on, as discussed later.

Each row of hubs is completely independent of the other row of hubs and only one row is active at a time.

Counters normally read out or read out and reset under the control of the program exits, after which the machine restarts automatically for the following group. Program exit hubs can also be wired to control storage units and carriage operations as described under those headings.

The fifth step shown on the diagram is described under *Special Program*.

Expanding the Program Exits

There are 14 exits for each program level. The number of exits may be increased by controlling a co-selector from a COUPLE EXIT and by wiring ALL CYCLES impulses through its transferred hubs (Figure 113). If one co-selector is used, the exits are expanded from 14 to 19.

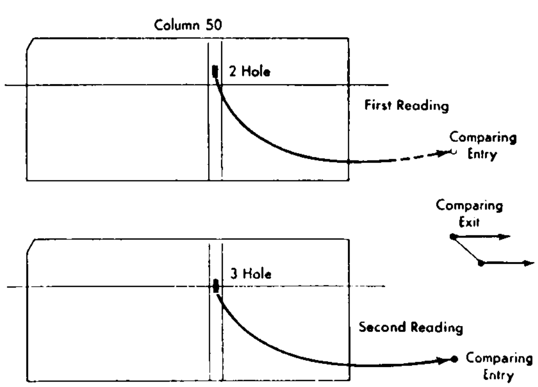


Figure 112. Comparing

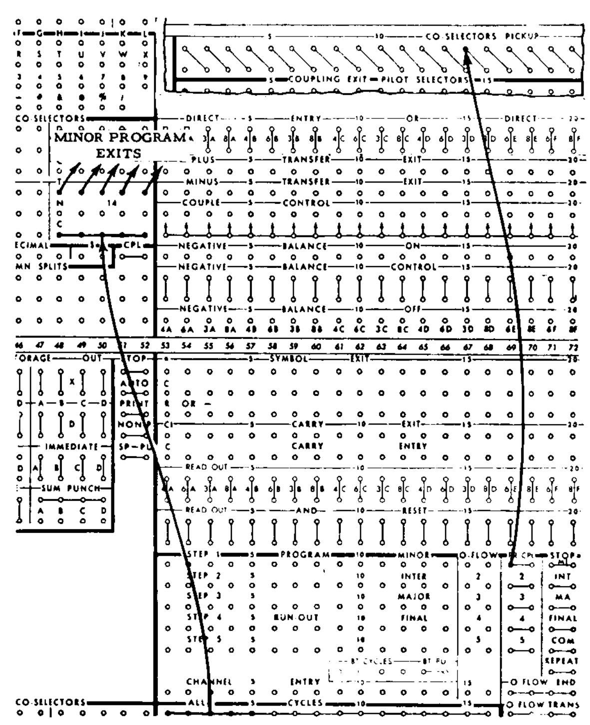
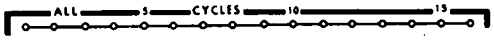
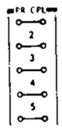


Figure 113. Expanding Program Exits



AW, 53-68

All Cycles. Sixteen common all cycles hubs emit cycle control impulses on every machine cycle. They are normally wired to CHANNEL ENTRY to provide program exits when special program is wired, or when properly controlled, as a substitute for CARD CYCLES or PROGRAM EXITS. ALL CYCLES are not active during summary punch cycles or during long carriage skips.



AP-AT, 69-70

PR CPL (Program Couple). Each of these hubs emits an impulse on a specific program step. Hub 1 emits an impulse on the minor step, hub 2 on the intermediate step, hub 3 on the major step, hub 4 on the run-out final or fourth step, and hub 5 on the fifth step when SPECIAL PROGRAM is wired. These impulses are of slightly longer duration than the PROGRAM EXITS themselves, beginning earlier and ending later. On machines that have OF CPL (overflow couple) these hubs emit on regular programs only. On machines that do not have OF CPL, they emit on overflow programs as well as on regular programs.

AP, 73-77

Final Total. The five common final total hubs emit an impulse that can be used to read out and reset counters whenever the final total key is pressed, provided these conditions have been satisfied:

a. The final total toggle switch is ON.
b. The last card has been run out of the machine.
c. The machine is idling.

When the last card leaves the hopper, the machine stops. The start key must then be pressed to run out the cards remaining in the machine. The final total key is then pressed to print the total. If the final total toggle switch is OFF, the total cannot be cleared even though all other conditions have been satisfied; this prevents accidental clearing of the counter.

When the final total key is pressed, the carriage is restored to its home position before the total prints if the LC SK (last card skip) switch is wired ON. If there is no tape in the carriage, this restoration accounts for one space. Another space is taken before the total prints, thus causing a final total to print two spaces below the last printed item.

Run-in Reset

As the first card is fed into the machine, all programs wired are initiated, provided significant digits are punched in the control fields. Only those counters wired from normal program steps are cleared. No printing of any kind, such as totals left standing in the machine or counter symbols, takes place on the run-in reset. This automatic feature assures that the counters to be used in an operation are cleared before the operation starts.

Final total counters must be reset manually, that is, by turning the final total toggle switch on and by pressing the final total key.

If the LCT (last card total) switch is wired ON, the three normal program steps are taken on the run-in whether or not control fields are wired. If the final total switch is also ON, the 4th step or run-out final also occurs on the run-in.

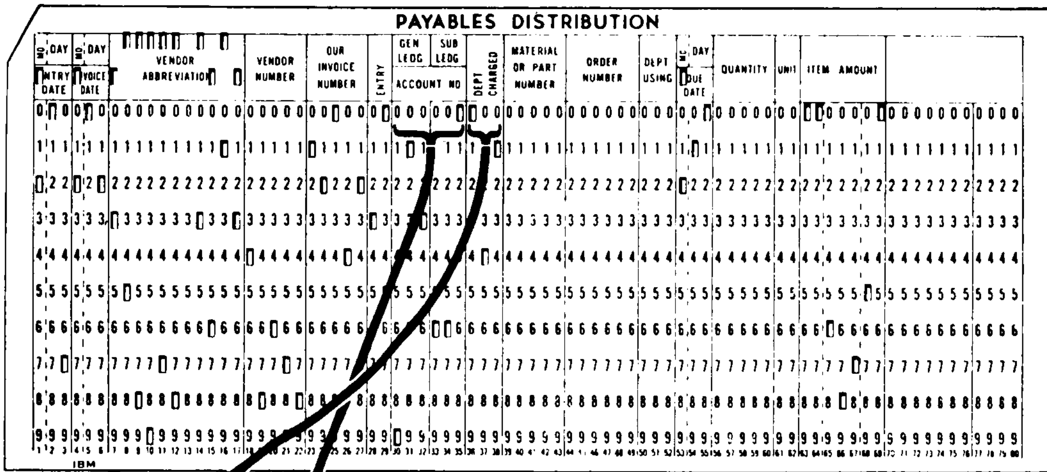
Detail Printing: Minor, Intermediate, and Major Program

The expense distribution shown in Figure 114 is a detail printed report. The smallest group on this report is subledger number and is therefore referred to as the minor group. The largest group is department and is referred to as the major group. The group in between is general ledger and is referred to as the intermediate group.

For each of the three groups mentioned, there is a corresponding total. The first minor total, $1,409.42, was printed from one counter when the machine recognized a change from 660 to 700 in subledger number. The first intermediate total, $2,085.37, was printed from another counter when the machine recognized a change from 913 to 915 in general ledger number. The first major total, $4,204.87, was printed from a third counter when the machine recognized a change from 41 to 43 in department number.

Just as the three groups are known as the minor, intermediate, and major groups, the totals are known as minor, intermediate and major totals. If desired, a fourth total (run-out final) could be added and would print automatically following the last major total.

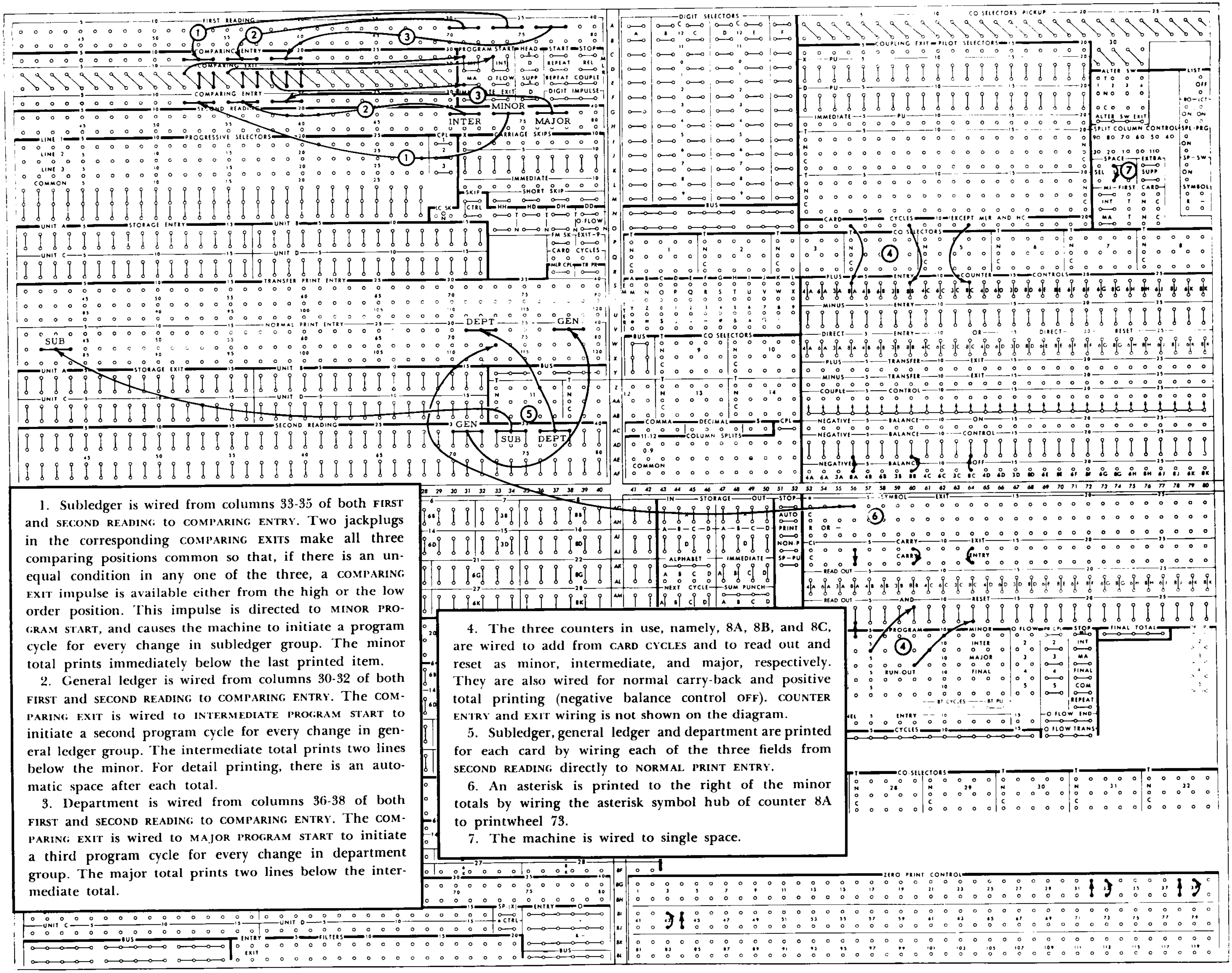
Wiring a control panel for a detail-printed report is illustrated in Figure 115.



EXPENSE DISTRIBUTION
BY DEPARTMENT OR BRANCH

DEPT. OR BRANCH	ACCOUNT No. GEN. LEDG.	ACCOUNT No. SUB. LEDG.	OUR INVOICE NUMBER	DATE MO.	DATE DAY	AMOUNT	AMOUNT BY ACCOUNT	AMOUNT BY DEPT. OR BRANCH
41	913	660	12042	12	07	687.50		
41	913	660	12084	12	14	721.92		
						1409.42*		
41	913	700	12125	12	23	675.95		
						675.95*		
							2085.37	
41	915	760	12086	12	15	2119.50		
						2119.50*		
							2119.50	
								4204.87
43	913	730	12171	12	31	47.40		
						47.40*		
43	913	740	12164	12	31	611.93		
						611.93*		
43	913	750	12089	12	15	200.00		
						200.00*		

Figure 114. Detail-Printed Report



1. Subledger is wired from columns 33-35 of both FIRST and SECOND READING to COMPARING ENTRY. Two jackplugs in the corresponding COMPARING EXITS make all three comparing positions common so that, if there is an unequal condition in any one of the three, a COMPARING EXIT impulse is available either from the high or the low order position. This impulse is directed to MINOR PROGRAM START, and causes the machine to initiate a program cycle for every change in subledger group. The minor total prints immediately below the last printed item.

2. General ledger is wired from columns 30-32 of both FIRST and SECOND READING to COMPARING ENTRY. The COMPARING EXIT is wired to INTERMEDIATE PROGRAM START to initiate a second program cycle for every change in general ledger group. The intermediate total prints two lines below the minor. For detail printing, there is an automatic space after each total.

3. Department is wired from columns 36-38 of both FIRST and SECOND READING to COMPARING ENTRY. The COMPARING EXIT is wired to MAJOR PROGRAM START to initiate a third program cycle for every change in department group. The major total prints two lines below the intermediate total.

4. The three counters in use, namely, 8A, 8B, and 8C, are wired to add from CARD CYCLES and to read out and reset as minor, intermediate, and major, respectively. They are also wired for normal carry-back and positive total printing (negative balance control OFF). COUNTER ENTRY and EXIT wiring is not shown on the diagram.

5. Subledger, general ledger and department are printed for each card by wiring each of the three fields from SECOND READING directly to NORMAL PRINT ENTRY.

6. An asterisk is printed to the right of the minor totals by wiring the asterisk symbol hub of counter 8A to printwheel 73.

7. The machine is wired to single space.

Figure 115. Programming

Automatic Last Card Totals

Programs can be initiated at the end of the run to clear out final totals automatically by the use of the last-card total switch. When used, the switch provides four program cycles at the end of the run (Figure 116).

The run-out switch is wired ON to cause the last card to run into the stacker automatically. The LCT switch is wired ON to cause four program cycles on the run-out: minor, intermediate, major and run-out final.

The counter is cleared automatically after the last card runs out of the machine by wiring MINOR PROGRAM to counter READ OUT AND RESET. No PROGRAM START wiring is necessary. Other counters are cleared on intermediate, major, and run-out final program levels, as shown by the dotted wiring in Figure 116.

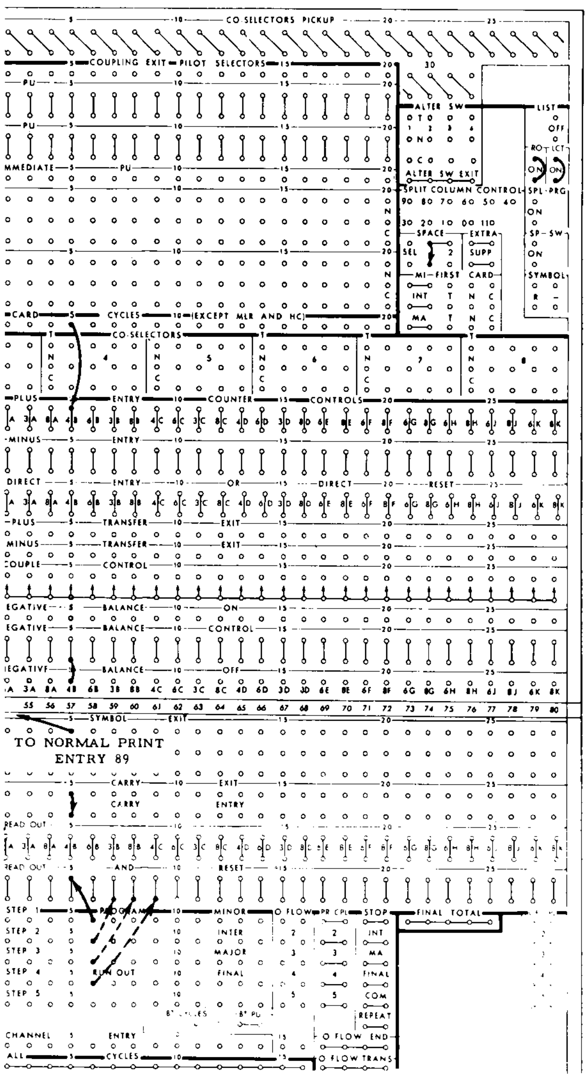
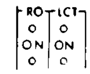


Figure 116. Last-Card Totals



G-H, 79-80

RO (Run Out) ON. Normally, the machine stops when the last card leaves the hopper. Therefore, the start key must be pressed to run the cards remaining in the machine into the stacker. When the RO switch is ON, these cards run into the stacker automatically.

LCT (Last Card Total) ON. When the LCT switch is ON, three programs are taken in succession on the run-in and as the last card is run out to the stacker. If the final total toggle switch is also ON, a fourth program step (Run-Out Final) is taken. The programs occur even though PROGRAM START is not impulsed. If PROGRAMMING is wired, it is not affected by wiring LCT ON. The main purpose of both the RO and LCT switches is to allow the printing of final totals automatically at the end of small batches of cards when it is not practical to initiate a program change for each batch.

Minor Program Cycle Elimination

Elimination of minor program cycles can be accomplished by control-panel wiring (Figure 117). The basic principles, with minor changes, can be applied to many types of applications.

The indicative information for each group is stored in two sets of storage units from the first card of the group. Amounts are accumulated in two counters. The printing from both the storage units and the counters is alternated so that the indication and the total for group 1 print on the minor group indication cycle for group 2; the indication and total for group 2 print on the minor group indication cycle for group 3; and so on. The last minor group within each intermediate group prints on a minor program cycle. The net effect of this operation is that minor program cycles are eliminated for all minor groups except the last, thus saving the time normally consumed by minor program cycles.

Multiplication

Multiplication can be accomplished on the 407 by repeated addition, as wired in Figure 118.

The group multiplier is limited to two digits because of the number of digit selectors and comparing positions on the standard machine. For each position of the multiplier, one digit selector and eight comparing positions are required. This method provides for the X-punched group multiplier card to be the last card

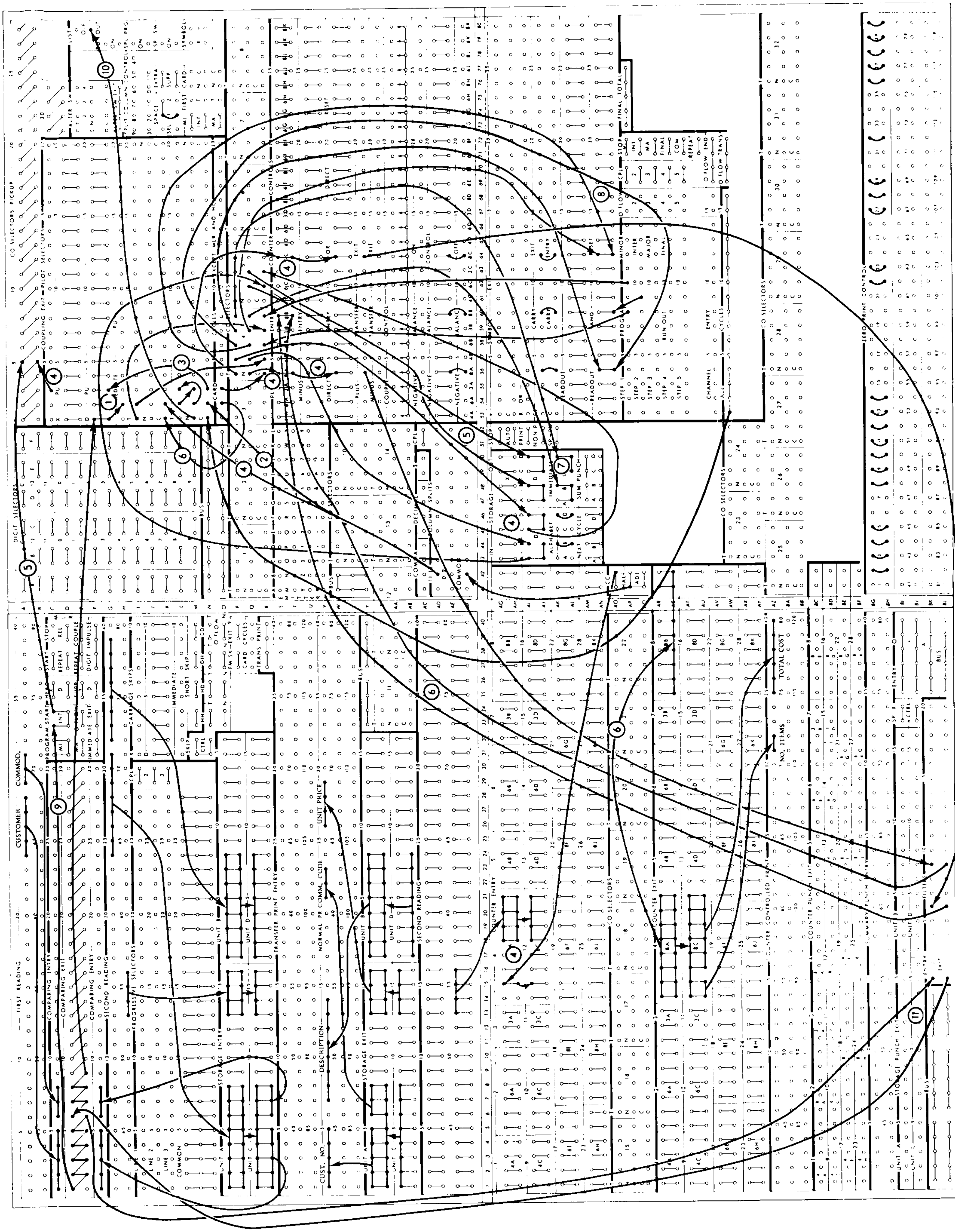


Figure 117. Minor-Program-Cycle Elimination

1. Pilot selector 2 picks up immediately whenever a change in commodity number occurs.

2. A HALF-ADJUST impulse is wired through a column split, to make it available only during the second half of the cycle, to C of pilot selector 2.

3. On a change in commodity number, HALF-ADJUST continues through the TRANSFERRED side of pilot selector 2 and the NORMAL side of pilot selector 3 to the D-pickup of pilot selector 3. This wiring causes pilot selector 3 to transfer during the first card cycle of every odd-numbered group.

Pilot selector 2 returns to normal on the first card cycle of the group. Wiring from N of selector 2 to T of selector 3 causes selector 3 to remain transferred to the end of that group.

As the second commodity group is detected, selector 2 again transfers, breaking the succession of impulses to the D-pickup of pilot selector 3, thus causing the selector to be normal for all even-numbered groups.

Pilot selector 3 is normal for all even-numbered groups and transferred for all odd-numbered groups. Other machine functions are controlled from this alternating selector action.

4. Co-selector 4 transfers with pilot selector 3 for odd-numbered groups and, therefore, is normal for even-numbered groups. Indicative information for all even-numbered commodity groups is stored in storage units A and B. This is done by wiring HALF ADJUST through the TRANSFERRED side of pilot selector 2 and the NORMAL side of co-selector 4 to the D IN of the respective storage units. The TRANSFERRED side of co-selector 4 is wired to the D IN of storage units C and D and allows indicative information for all odd-numbered groups to be stored in these units.

Total cost and number of items add in counter 4 for even-numbered groups and in counter 12 for odd-numbered groups. Both counters add by direct entry.

5. The indicative information for group 1 prints on the indication cycle of group 2. The indicative information for group 2 prints on the indication cycle of group 3, etc. While storage units A and B are reading in, units C and D are reading out. While storage units C and D are reading in, units A and B are reading out. This is accomplished by continuing the impulse from A and B IN to C and D OUT, and from C and D IN to A and B OUT. The impulses are wired through the NORMAL side of co-selector 5 to suppress the read-out on the first card of a new customer group.

6. On every change in commodity, a CARD CYCLES impulse reads out and resets counter 4 (even-numbered groups) or counter 12 (odd-numbered groups). In this way, totals print on card cycles rather than on program cycles. As each total prints, it is transferred into counter 8 to be accumulated for a customer total (intermediate).

7. Special provision has been made to read out the last minor total within each intermediate at the conclusion of the intermediate group. MINOR PROGRAM is wired through the normal side of co-selector 4 to the IMMEDIATE READ-OUT of storage units A and B and through the TRANSFERRED side of co-selector 4 to the IMMEDIATE READ-OUT of storage units C and D. Thus, if the last minor group is even, the indicative information is read out of storage units A and B. If the last minor group is odd, the indicative information reads out of storage units C and D.

8. The totals for the last minor group read out of either counter 4 or counter 12 by wiring the MINOR PROGRAM through co-selector 4 to the READ-OUT AND RESET hubs of these two counters. The minor program is forced by an intermediate change.

9. An intermediate program change is initiated by a change in customer number. Counter 8 is read out and reset at this time.

For any one customer group, only two total cycles are required. The total for the last commodity group prints on a minor program, and the customer total prints on the intermediate program. All other totals print from card cycles, thus saving the time normally required for total printing.

10. The machine is wired for group printing except on the cycle following a change in commodity number (group indication).

11. This wiring takes care of cases where intermediate control changes but minor control does not.

Cust. No.	Prod. Desc.	Comm. Code	Unit Price	Qty.	Total
1023	ITEM 1	318	780	1	780
1023	ITEM 2	476	620	1	620
1023	ITEM 3	2578	340	1	340
1023	ITEM 4	3196	375	1	375
1023	ITEM 5	3374	410	1	410
1023	ITEM 6	3376	370	1	370
1023	ITEM 7	3378	345	1	345
1023	ITEM 8	3839	1235	2	2470
1023	ITEM 9	3841	1220	2	2440
1023	ITEM 10	4044	1525	1	1525
1023	ITEM 11	4073	360	1	360
1023	ITEM 12	4215	1025	3	3075
1023	ITEM 13	5650	960	1	960
1023	ITEM 14	7152	921	1	921
1023	ITEM 15	7472	185	2	370
				20	15361
1024	ITEM 1	1555	775	2	1550
1024	ITEM 2	1560	1000	1	1000
				3	2550

Item 1 prints on indicate cycle for item 2.
Item 2 prints on indicate cycle for item 3.
Item 15 prints on minor program, forced by inter. change.
Customer total prints on intermediate cycle.
No total cycles taken until a change in customer number occurs.
Last commodity group prints on change in customer number.

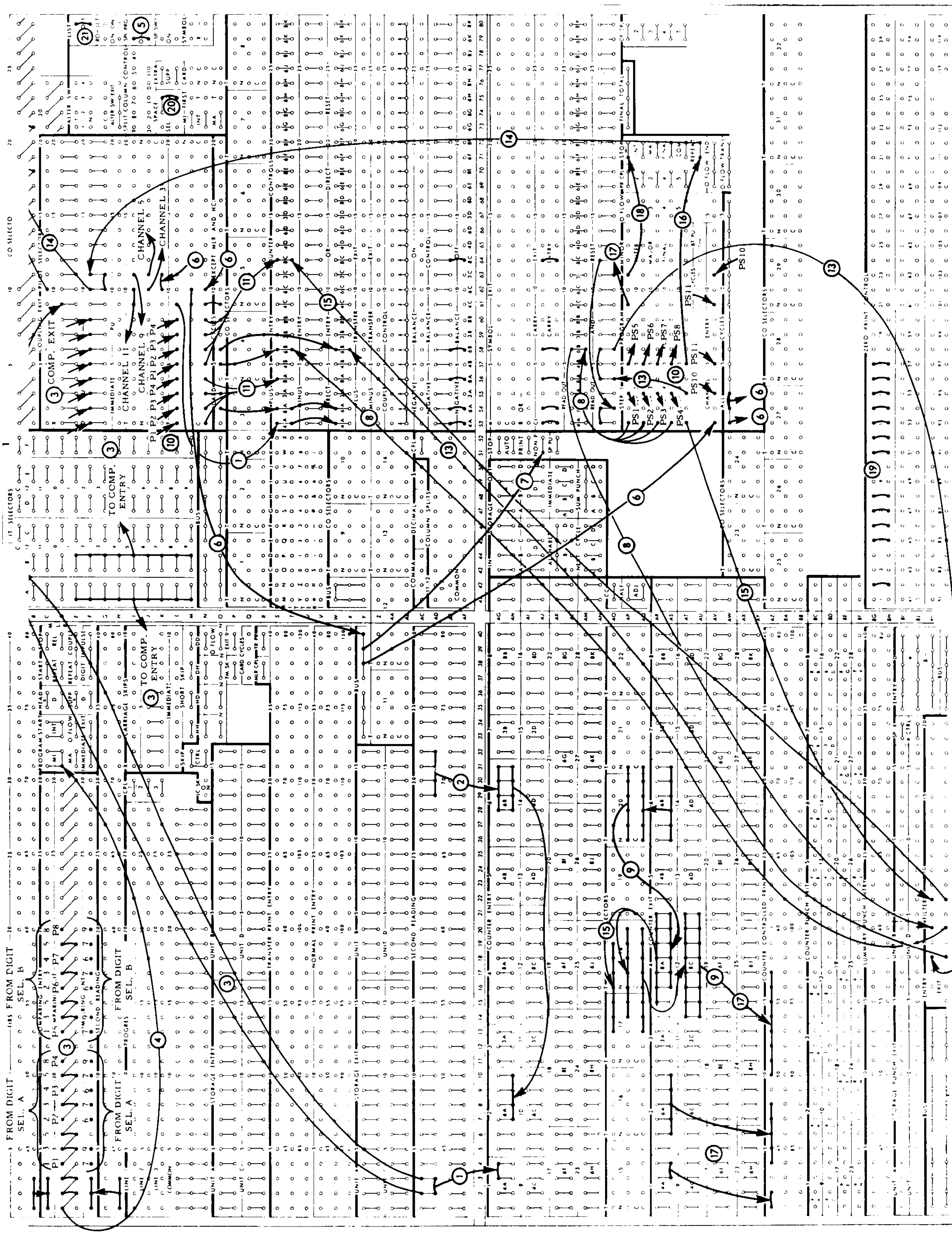


Figure 118. Multiplication

1. Counter 4A is impulsed to add the multiplier from an X40 group multiplier card. This is stored for group indication printing. DIRECT ENTRY is wired to prevent printing from this counter at this time.

2. Counters 6A and 6B are impulsed to accumulate the multiplicand on card cycles. Counter 6A is used for printing the multiplicand, and 6B is used for doubling the multiplicand.

3. The multiplier is read at second read and wired to digit selectors A and B. The EXITS of each digit selector are wired to COMPARING ENTRIES as shown. The comparing unit is used to create selector pickup impulses for specific combinations of digits. The COMPARING EXITS are wired to the PICKUPS of pilot selectors 1 through 8. The units digit controls selectors 5 through 8, and the tens digit controls selectors 1 through 4. The following chart shows the selectors picked by each digit in each position of the multiplier. As these selectors are picked on the last card of the group, they remain transferred during programming.

Units Mlpr Digit	Selector Transferred	Tens Mlpr Digit	Selector Transferred
1	5	1	1
2	6	2	2
3	5 & 6	3	1 & 2
4	7	4	3
5	5 & 7	5	1 & 3
6	6 & 7	6	2 & 3
7	5 & 6 & 7	7	1 & 2 & 3
8	8	8	4
9	5 & 8	9	1 & 4

4. MINOR PROGRAM START is impulsed when the control field changes.

5. Special programming is wired ON.

6. ALL CYCLES impulses are wired to the COMMON of pilot selectors 10 and 11. The ALL CYCLES impulses from the NORMAL sides are wired to CHANNEL ENTRIES 1, 3, and 5.

7. The ALL CYCLES impulses to CHANNEL ENTRY 1 are wired to NON-PRINT to prevent printing during the first five program steps.

8. During the first four program steps, counter 6B (multiplicand) is wired to read out and add. The filter is necessary to prevent the card cycles impulses from the plus hub from back-circuiting to the read-out hub.

9. The amount in 6B is read out through co-selectors 17, 18, 20, and 21 to COUNTER CONTROLLED PRINT. The echo impulses from the printwheels are then added into 6B back through the same path. As a result, the amount in 6B is doubled on each of the first four program steps.

These co-selectors are not on the standard machine but are used here to make the control panel diagram easier to follow.

10. The EXITS of program step 1 (channels 3 and 5) are wired to the TRANSFERRED sides of pilot selectors 1 and 5, program step 2 to selectors 2 and 6, program step 3 to selectors 3 and 7, and program step 4 to selectors 4 and 8.

11. The COMMON sides of selectors 1 through 4 are wired to 8A PLUS, and the COMMON sides of 5 through 8 are wired to 8C PLUS.

12. Assume a multiplier of 53. Pilot selectors 5 and 6 are transferred because of the 3 in the units position of the multiplier. Through the TRANSFERRED sides of pilot selectors 5 and 6, counter 8C is impulsed to add on program steps 1 and 2; therefore, counter 8C accumulates 1 times the multiplicand and 2 times the multiplicand, resulting in a total of 3 times the multiplicand. Pilot selectors 1 and 3 transfer because of the 5 in the tens position of the multiplicand. Through the transferred sides of pilot selectors 1 and 3, counter 8A is impulsed to add on program steps 1 and 3; therefore, counter 8A accumulates 1 times the multiplicand and 4 times the multiplicand, resulting in a total of 5 times the multiplicand.

13. On program step 5, counter 6B and 8A are impulsed to READ OUT AND RESET. Counter 6B is wired to DIRECT RESET.

14. On program step 5, co-selectors 17 and 18 are picked.

15. The amount being read out of 8A is wired through the TRANSFERRED side of co-selectors 17 and 18 to counter 8C. On program step 5, counter 8C is impulsed to add. The units position of 8A enters the tens position of 8C, etc.; therefore, at the end of step 5, the amount in 8C is 1875 (3 times the multiplicand) plus 31250 (50 times the multiplicand). The total of this is 33125, the product of 53 times 625.

16. Program step 5 is wired to REPEAT to permit programming to continue. Pilot selectors 10 and 11 are impulsed to transfer the ALL CYCLES impulses from channel entries 3 and 5 to channel entries 9 and 11.

17. The next program step (6) impulses, therefore, are available from step 1 hubs of channels 9 and 11. Counters 4A, 6A, and 8C are impulsed to READ OUT AND RESET to print the multiplier, multiplicand, and product.

18. Programming is wired to stop at the end of step 6.

19. ZERO PRINT CONTROL is wired to print zeros to the right of significant digits.

20. The report is double-spaced.

21. The list switch is wired OFF.

	Multiplicand Counter	Tens Product Counter	Units Product Counter
	625		
Program step 1	RO & + 625 (1×625)	+ 625	+ 625
Program step 2	RO & +1250 (2×625)		+1250
Program step 3	RO & +2500 (4×625)	+2500	
Program step 4	RO & +5000 (8×625)		
		3125 (5×625)	1875 (3×625)
Program step 5	R & R	R & R	+3125
			33125 (53×625)
Program step 6			R & R Total Print

of the group. Programming may be started by a program change in any control field.

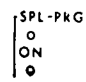
Six program steps for each group are required regardless of the multiplier. During the first four program steps, the multiplicand (accumulated in a counter) is impulsed to read out and add at the same time. As a result, the amount in the multiplicand counter is doubled on each program step.

Each multiplier digit has its own product counter, thus permitting simultaneous multiplication by both digits of the multiplier. By controlling the product counters to add from the multiplicand counter during the first four program steps, each of the product counters can accumulate from 1 to 9 times the multiplicand. The tens product counter is transferred to the units product counter on step 5. The result is printed on program step 6 from the units product counter; for example: 53 × 625 = 33125 is calculated as above.

Special Program

Four program cycles have thus far been discussed: minor, intermediate, major and run-out final. Normally, when the minor program start is impulsed, only one program cycle is taken; when the intermediate program start is impulsed, two program cycles are taken; and when the major program start is impulsed three program cycles are taken. The run-out final program occurs only on the last card to go through the machine.

By means of special programming, any number of program cycles can be initiated for any one program start. For example, five program cycles can be initiated by a minor start for the purpose of crossfooting five minor totals or printing them one underneath the other (Figure 119).



I-J, 79

Spl. Prg. (Special Program). When these two hubs are connected, these changes in machine functions take place:

1. The normal minor, intermediate, major and run-out final programs lose their identity and become instead program steps 1, 2, 3, 4.
2. A fifth program step becomes available so that whenever any program start is initiated program steps 1, 2, 3, 4 and 5 are taken in succession.
3. Neither the regular nor the overflow program hubs emit impulses unless CHANNEL ENTRY is wired.
4. Automatic total spacing for both detail and group printing is altered. Instead, for each program step taken, the platen advances uniformly, single or double spaced as wired.
5. Program steps 1, 2, 3, 4 and 5 are internally connected to the channel entry in successsion each time a PROGRAM START is initiated.

AV, 53-68

Channel Entry. Each vertical row of total program hubs has a corresponding channel entry hub. They are called CHANNEL ENTRIES because they accept impulses to control the activity of the hubs immediately above them. Unless the channel entry hub is impulsed, the program exit hubs above them are inactive. When SPECIAL PROGRAM is not wired, each channel entry hub is internally connected with an ALL CYCLES impulse, making available PROGRAM EXIT impulses at each of

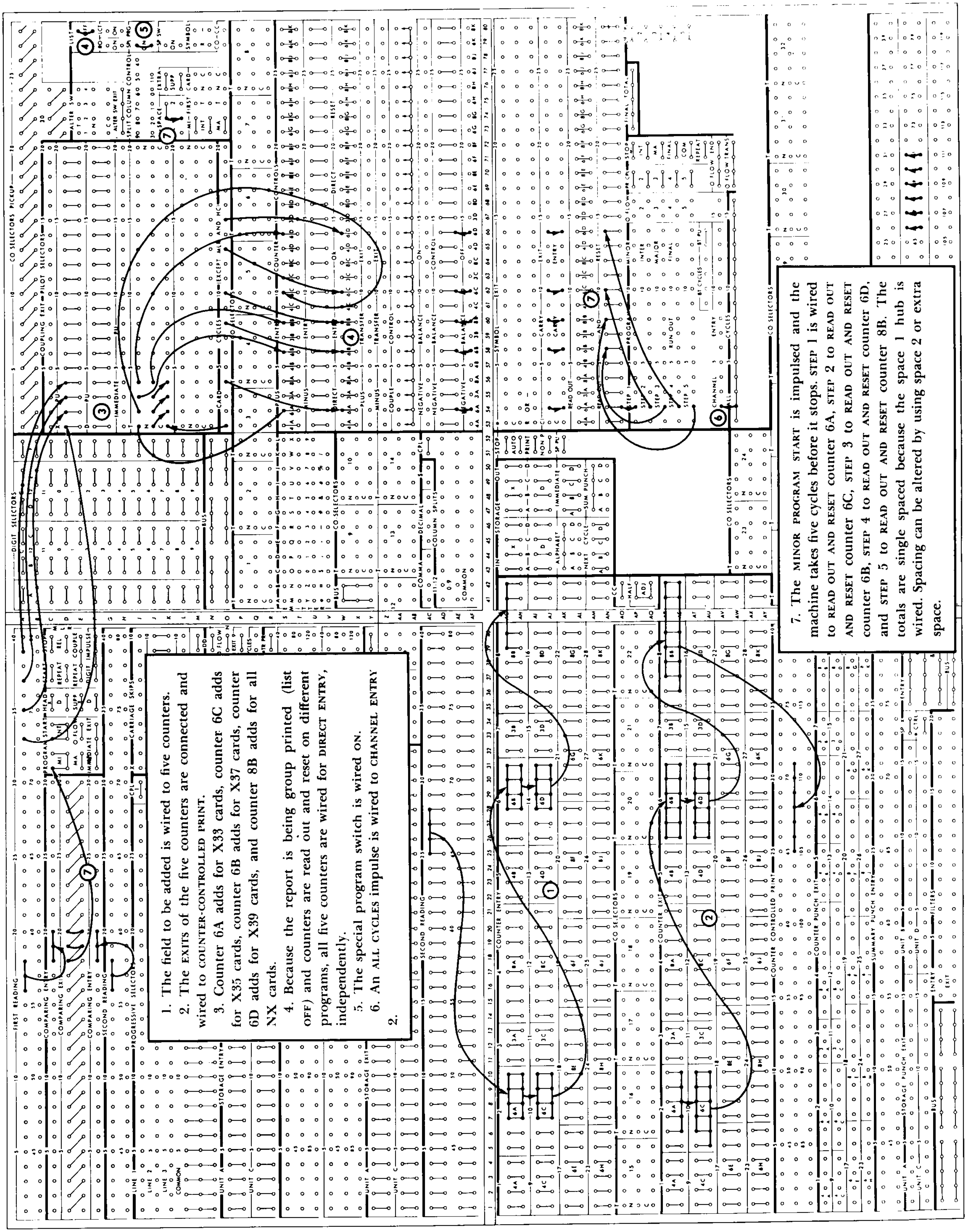


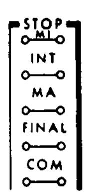
Figure 119. Printing Five Minor Totals from Same Printwheels

the program levels. When SPECIAL PROGRAM is wired, this internal connection is broken so the CHANNEL ENTRY does not receive an impulse unless externally wired from all cycles. This arrangement permits selection of one channel for the first five steps, another channel for the second five steps, a third channel for the next five steps, and so on.

The channel entry hubs can also be used as the common points of a selector with the five rows of program levels serving as five transferred points. After a program start has been initiated, the five program levels are connected internally to the channel entry hubs in succession, so data can be introduced either into the channel entry or the various program level hubs for selection.

AU, 71-72

Repeat. When special program is wired ON and a program start is initiated, the program successsion is stopped after five program steps have been taken. If more program steps are desired, step 5 is wired to REPEAT, causing step 1 to be initiated on the cycle following step 5, and the automatic progression to be repeated. Any program step other than 5 can be wired to repeat and the succession of program steps starts over on the following cycle.



AP-AT, 71-72

Stop Minor, Intermediate, Major, Final, Common. When card feeding is to be resumed following a program level other than 5, the stop hubs must be impulsed. If three steps are desired for the minor program, then step 3 is wired to MINOR STOP. Only the INTERMEDIATE STOP is active on the intermediate change in program, even though a preceding step is wired to MINOR STOP. By the same reasoning, only a MAJOR STOP is active on a major change in program even though preceding steps are wired to MINOR and INTERMEDIATE STOPS.

Any number of extra program steps can be taken from any one program start, and only one program need be taken for the other two. For example, if five programs are desired for minor program start and one each for intermediate and major, two channels would be necessary, one for minor and the other for intermediate and major. The first channel would provide the five minor program steps. Steps 1 and 2 of the second channel would provide the intermediate and major program step. Thus, on a major program start, seven program cycles would occur, the first five for minor, the sixth for intermediate, and the seventh for major. The minor program would be stopped from step 5, the intermediate from step 6, and the major from step 7. Steps 6 and 7 are the first and second hubs of the second channel. If only five steps are desired, no stop is necessary because the machine stops automatically after the fifth step if repeat is not wired. Card feeding would then be resumed.

The common stop hub is both an entry and an exit when SPECIAL PROGRAM is not wired. When SPECIAL PROGRAM is wired, it is an entry and not an exit. As an entry, any program step wired to it causes the program progression to stop at the end of the cycle on which it receives the impulse, regardless of other controls. As an exit, it emits an ALL CYCLES impulse during the last program step of each group. When the common stop hub is used as an exit, it should be wired so that it does not make or break a circuit. It can be wired to perform special functions, such as extra spacing after the last total of each group.

The final stop is used when special program is ON, the LCT switch is ON, and the final total toggle switch is ON to stop the progression of program steps on the run-in and as the last card is run out to the stacker. The final stop hubs can also be wired from the step following the last program step used. This extra step can be used to control a run-out final total.

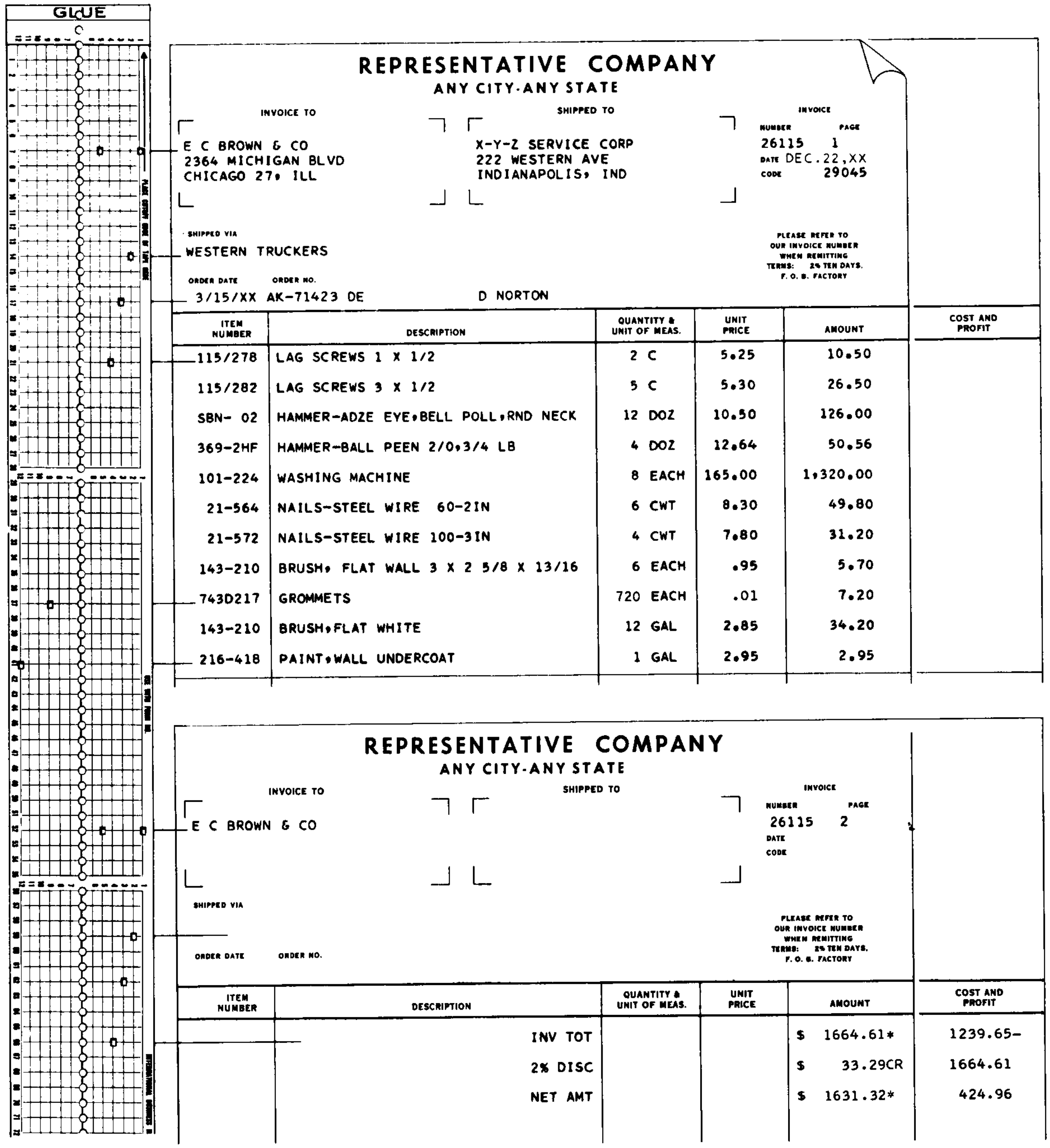
Printing Total Identifications from Channel Entry

When special program is wired ON, the channel entry hubs can be used as the common points of a selector with the five rows of program levels serving as five transferred points. Information wired into any or all five rows is available out of channel entry in turn, that is, the first row on step 1, the second row on step 2, etc.

One of the uses for this type of selection would be the identification of totals as shown in Figure 120. The first total is identified as an invoice total, the second as a 2% discount total and the third as net amount. The wiring for total identification shown in this figure is illustrated in Figure 121.

Discount Calculation by Repeated Addition

Multiplication by repeated addition can be performed with special programming. This feature often provides a practical method of performing calculations. Careful consideration should be given to each problem of this



REPRESENTATIVE COMPANY
ANY CITY-ANY STATE

INVOICE TO: E C BROWN & CO, 2364 MICHIGAN BLVD, CHICAGO 27, ILL

SHIPPED TO: X-Y-Z SERVICE CORP, 222 WESTERN AVE, INDIANAPOLIS, IND

INVOICE NUMBER 26115 PAGE 1
DATE DEC.22,XX
CODE 29045

SHIPPED VIA: WESTERN TRUCKERS

PLEASE REFER TO OUR INVOICE NUMBER WHEN REMITTING
TERMS: 2% TEN DAYS.
F. O. B. FACTORY

ORDER DATE 3/15/XX ORDER NO. AK-71423 DE D NORTON

ITEM NUMBER	DESCRIPTION	QUANTITY & UNIT OF MEAS.	UNIT PRICE	AMOUNT	COST AND PROFIT
115/278	LAG SCREWS 1 X 1/2	2 C	5.25	10.50	
115/282	LAG SCREWS 3 X 1/2	5 C	5.30	26.50	
SBN- 02	HAMMER-ADZE EYE,BELL POLL,RND NECK	12 DOZ	10.50	126.00	
369-2HF	HAMMER-BALL PEEN 2/0,3/4 LB	4 DOZ	12.64	50.56	
101-224	WASHING MACHINE	8 EACH	165.00	1,320.00	
21-564	NAILS-STEEL WIRE 60-2IN	6 CWT	8.30	49.80	
21-572	NAILS-STEEL WIRE 100-3IN	4 CWT	7.80	31.20	
143-210	BRUSH, FLAT WALL 3 X 2 5/8 X 13/16	6 EACH	.95	5.70	
743D217	GROMMETS	720 EACH	.01	7.20	
143-210	BRUSH,FLAT WHITE	12 GAL	2.85	34.20	
216-418	PAINT,WALL UNDERCOAT	1 GAL	2.95	2.95	

REPRESENTATIVE COMPANY
ANY CITY-ANY STATE

INVOICE TO: E C BROWN & CO

SHIPPED TO

INVOICE NUMBER 26115 PAGE 2
DATE
CODE

SHIPPED VIA

PLEASE REFER TO OUR INVOICE NUMBER WHEN REMITTING
TERMS: 2% TEN DAYS.
F. O. B. FACTORY

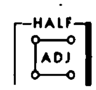
ORDER DATE ORDER NO.

ITEM NUMBER	DESCRIPTION	QUANTITY & UNIT OF MEAS.	UNIT PRICE	AMOUNT	COST AND PROFIT
	INV TOT			$ 1664.61*	1239.65-
	2% DISC			$ 33.29CR	1664.61
	NET AMT			$ 1631.32*	424.96

Figure 120. Total Identification; Control-Tape Punching

type to determine whether this method is to be preferred over other methods of calculating. In the example shown (Figure 122) two discounts are computed, one for 10% and the other for 20%. The result of each calculation is adjusted for dropped decimals and subtracted from the invoice totals. The planning chart (Figure 123) illustrates this principle.

Control-panel wiring for discount calculation is shown in Figure 124.



AP-AQ, 41-42

Half Adj. (Half Adjust). These hubs emit a 5 impulse every machine cycle. They are normally wired to counters under selector control to adjust totals to the nearest cent. A separate program step is required for half adjusting totals.

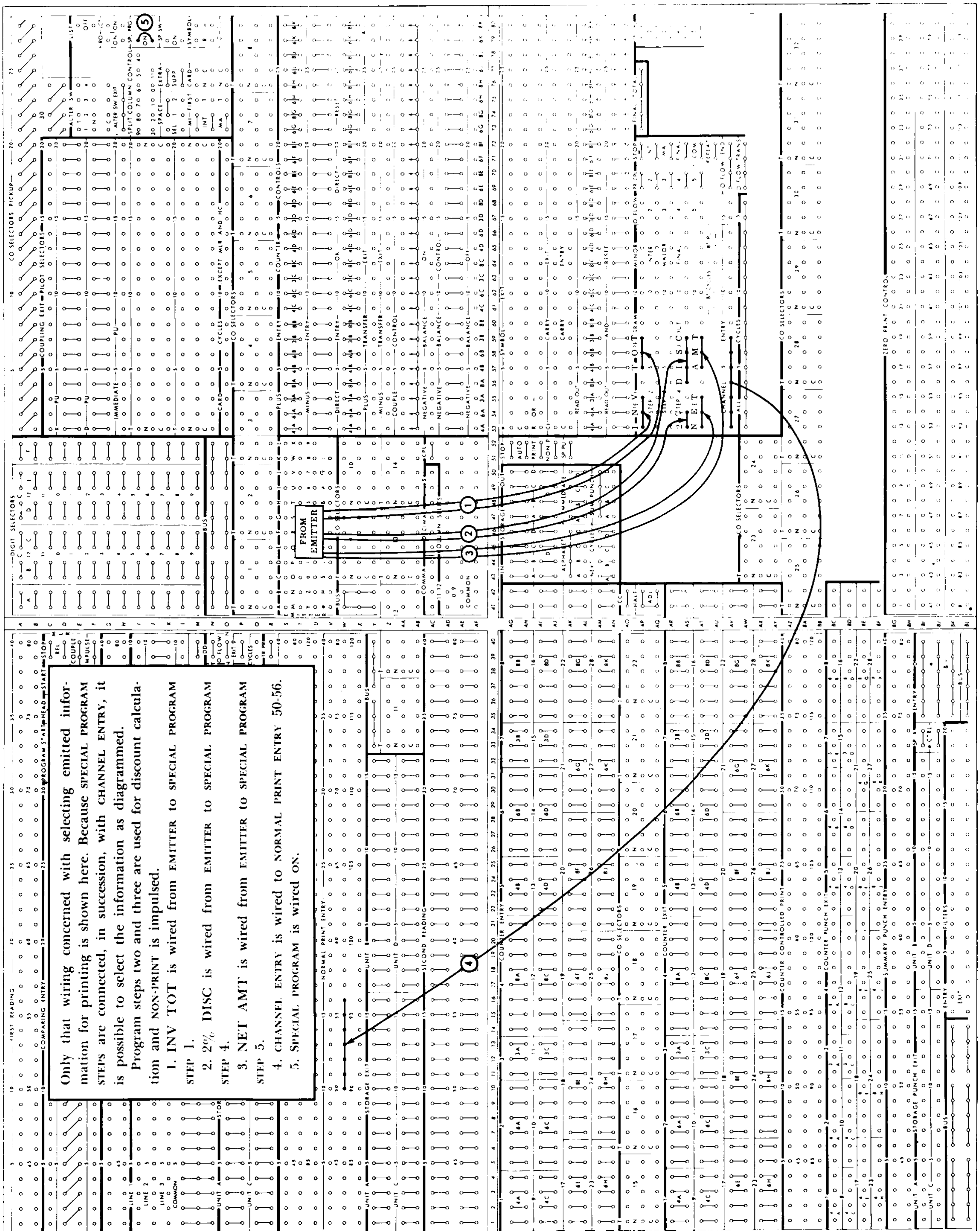


Figure 121. Wiring—Total Identification

REPRESENTATIVE COMPANY

CITY, STATE

INVOICE

INVOICE NO.
51-02

SOLD TO

GENERAL RADIO COMPANY
1019 MAIN AVENUE
ENDICOTT, NEW YORK

SHIP TO

INVOICE DATE		
MO.	DAY	YEAR

SHIPPING INSTRUCTIONS	TERMS	SALESMAN	CUST. ORDER NO.	CUST. ORDER DATE

QUANTITY	UNIT	DESCRIPTION	STOCK NO.	PRICE	AMOUNT
1		CABINET	T-44	56.00	56.00
1		CONSOLE	TAN	129.00	129.00
1		COMBINATION	F-118	523.50	523.50
			GROSS		$708.50 ¤
			- 10%		70.85
					637.65
			- 20%		127.53
			NET		510.12

Figure 122. Discount Calculation

PROGRAM STEP	COUNTER 8A (NET)	COUNTER 8B (DISCOUNT)	FUNCTIONS
1.	19,053.75 RO	+1,905.375	Print accumulated total from 8A. Transfer total to 8B by direct entry.
2. Non-print		5 1,905.380	½ adjust units position by direct entry.
3.	−1,905.38	RO	Print 10% discount from 8B, dropping units position. Transfer 10% discount to 8A and subtract.
4. Non-print		Direct reset*	Direct reset 8B.
5.	17,148.37 RO	1,714.837	Print first net from 8A. Transfer total to 8B by direct entry.
6. Non-print	RO	1,714.837 3,429.674	Transfer total to 8B by direct entry.
7. Non-print		5 3,429.679	½ adjust units position by direct entry.
8.	−3,429.67	RO	Print 20% discount from 8B, dropping units position. Transfer 20% discount to 8A and subtract.
9.	13,718.70 RO and reset	Direct reset*	Print final net from 8A. Direct reset 8B.

*Direct reset is necessary because the units position is not wired to counter-controlled print.

Figure 123. Discount Calculation Planning Chart

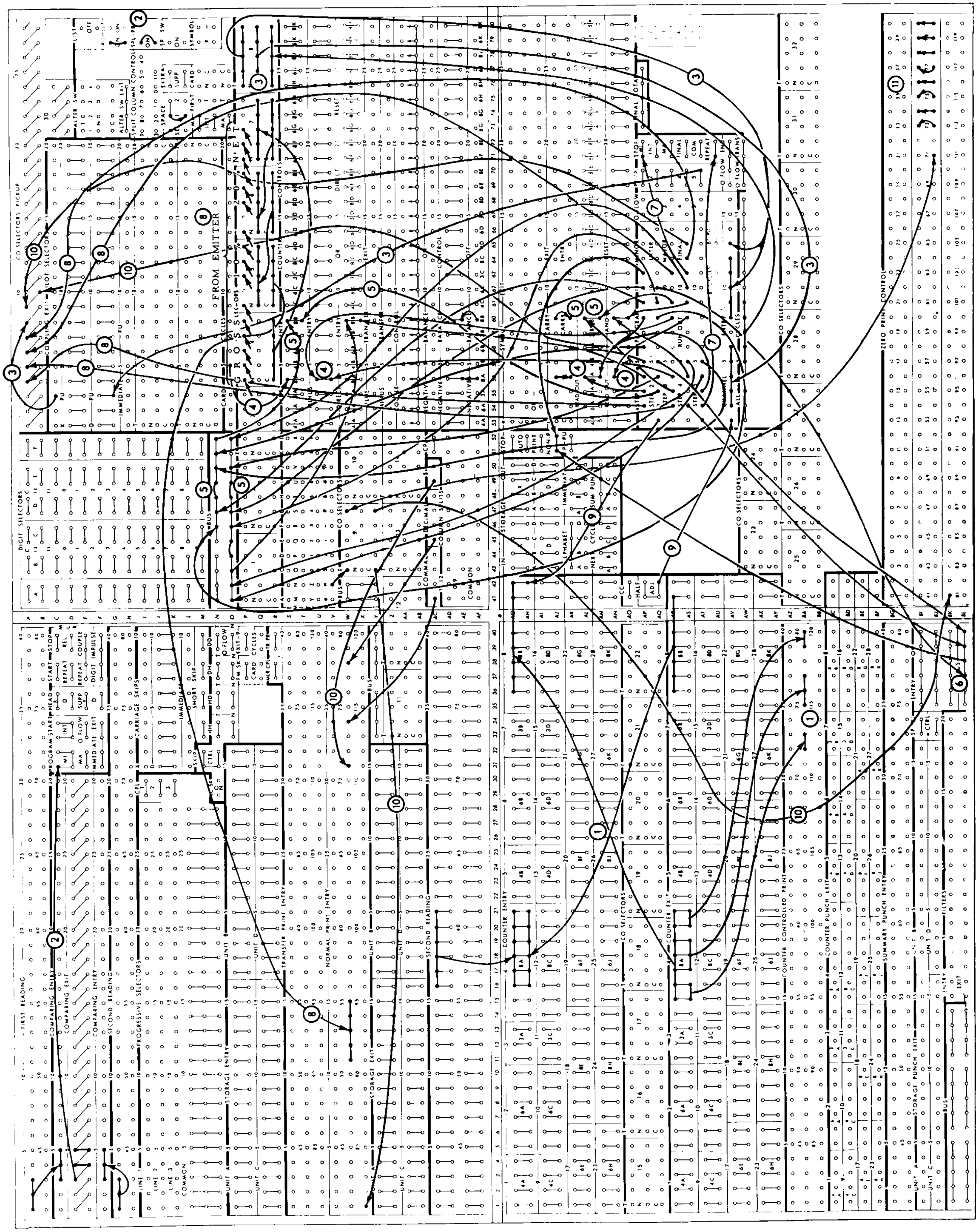


Figure 124. Wiring—Total Identification

The wiring for this example can best be understood by reference to the planning chart (Figure 123) as each step is explained.

1. Counter 8A is the net counter, and 8B, the discount counter. The field to be accumulated is wired to 8A ENTRY. The EXIT of 8A is wired to COUNTER-CONTROLLED PRINT and also to the ENTRY of 8B. The EXIT of 8B is wired to the ENTRY of 8A. This wiring facilitates the transferring of totals back and forth from one counter to another.

2. Special program is wired ON, because more than three steps are required for every minor program change.

3. Channels 2, 3, 4, 5 and 6 are made active for the first five steps by wiring ALL CYCLES through the NORMAL side of co-selector 8 to CHANNEL ENTRY. Channels 8, 9, 10, 11, 12 and 13 are made active for the next five steps by wiring ALL CYCLES through the TRANSFERRED side of co-selector 8 to CHANNEL ENTRY.

Co-selector 8 is picked up from the COUPLE EXIT of pilot selector 3 which is picked up from the fifth program level. Both selectors are normal for steps 1-5 and transferred for all remaining program steps through the first card of the following group.

4. The counter controls for 8A are wired as follows:

COUNTER PLUS:
- CARD CYCLES to add from every card.

COUNTER MINUS:
- Step 3 to subtract 10% discount.
- Step 8 to subtract 20% discount.

NEG. BAL. OFF:
- To NEGATIVE BALANCE CONTROL.

CI and C:
- CI to C.

READ OUT:
- Step 1 to read out gross for printing and for transmitting to 8B.
- Step 5 to read out first net for printing and for transmitting to 8B.
- Step 6 to read out for transmitting to 8B.

READ OUT AND RESET:
- Step 9 to read out and reset for printing net total.

5. The counter controls for 8B are wired as follows:

COUNTER PLUS:
- Step 1 to add gross from 8A.
- Step 2 to add half adjustment.
- Step 5 to add first net from 8A. } 20% disc.
- Step 6 to add first net from 8A. } 20% disc.
- Step 7 to add half adjustment.

DIRECT ENTRY:
- Step 1 to direct enter gross.
- Step 2 to direct enter half adjustment.
- Step 5 to direct enter first net. } 20% disc.
- Step 6 to direct enter first net. } 20% disc.
- Step 7 to direct enter half adjustment.

NEG. BAL. OFF:
- To NEGATIVE BALANCE CONTROL.

CI and C:
- CI to C.

READ OUT:
- Step 3 to read out 10% discount into 8A.
- Step 8 to read out 20% discount into 8A.

READ OUT AND RESET:
- Step 4 to direct reset and to read out and reset 10% Disc.
- Step 9 to direct reset and to read out and reset 20% Disc.

6. NON PRINT is wired to suppress printing and spacing on the following program steps:
- Step 2 when 10% discount is half adjusted.
- Step 4 when counter 8B is direct reset.
- Step 6 when 10% is added in 8B.
- Step 7 when another 10% is added in 8B.

7. REPEAT is wired from step 5, and MINOR STOP from the last program used, step 9.

8. Total identification is wired from the emitter as follows:
- The word *net* is wired to the TRANSFERRED side of co-selector 7. The selector is picked up from step 9.
- —20% (discount) is wired to the TRANSFERRED side of co-selector 6. The selector is picked up from step 8.
- —10% (discount) is wired to the TRANSFERRED side of co-selector 5. The selector is picked up from step 3.
- The word *gross* is wired to the TRANSFERRED side of co-selector 4. The selector is picked up from step 1.

Total identification prints from printwheels 51-55.

9. Half adjustments for 10% and 20% discounts: Because both half adjustments occur at the second level (steps 2 and 7) the HALF ADJUST is wired to CHANNEL ENTRY 1 and out of level 2 to the units position of COUNTER 8B ENTRY.

10. The dollar sign and total symbol (¤) are wired to print only for gross and net totals as follows:
- The dollar symbol is wired to NORMAL PRINT ENTRY 71.
- The total symbol is wired from the character EMITTER through co-selector 9.
- Zero print control hub 71 is wired through the TRANSFERRED side of co-selector 9 to the upper hub of 80. The selector is picked up from step 1 (gross) and step 9 (net).

11. The comma and decimal are wired to NORMAL PRINT ENTRY 74 and 78 and are controlled by normal ZERO PRINT CONTROL wiring.

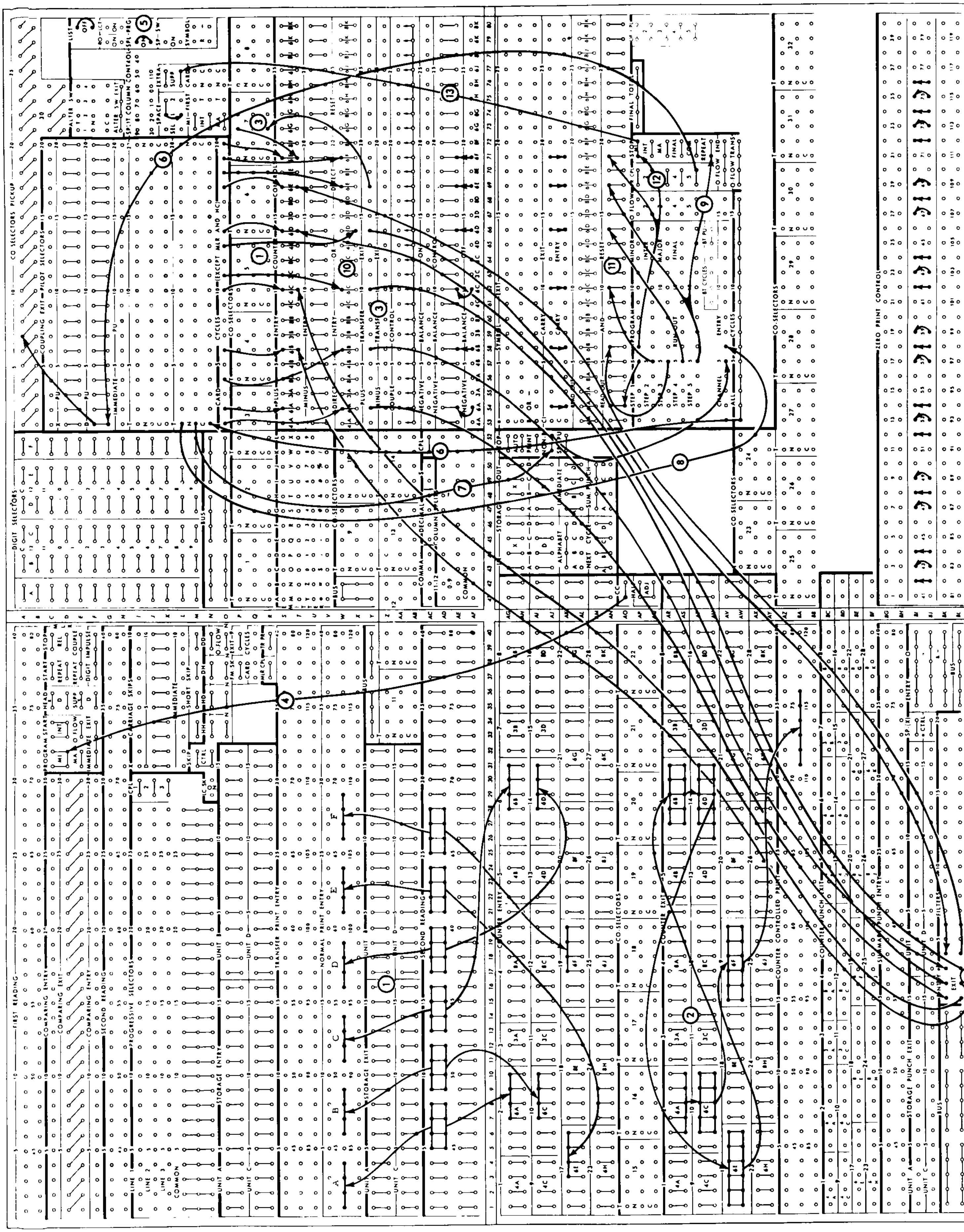


Figure 125. Six-Field Crossfooting

1. The six fields are wired to counters as shown. They are also wired to NORMAL PRINT ENTRY.

2. A reads out of counter 6A and rolls into counter 6C to add to B. A+B reads out of counter 6C and rolls into counter 6B to add to C. A+B+C reads out of counter 6B and rolls into counter 6D to add to D. A+B+C+D reads out of counter 6D and rolls into counter 6E to add to E. A+B+C+D+E reads out of counter 6E and rolls into counter 6F to add to F. The total reads out of counter 6F to COUNTER-CONTROLLED PRINT.

3. All of the receiving counter plus hubs are impulsed from CARD CYCLES; therefore, TRANSFER CONTROL PLUS of the transmitting counters cannot be wired directly to the PLUS of a receiving counter. If it is, the CARD CYCLES impulse backs up into the TRANSFER PLUS EXIT and causes the transmitting counter to subtract.

To prevent the interference, the transfer plus exit hubs of counters 6A, 6C, 6B and 6D are wired through filters to the plus hubs of receiving counters 6C, 6B, 6D and 6E. The TRANSFER PLUS EXIT of 6E is wired through the TRANSFERRED side of co-selector 7 to COUNTER 6F PLUS. The selector is picked up from program couple 5 and represents another method of preventing the CARD CYCLES impulse from reaching TRANSFER PLUS.

4. CYCLE COUNT is wired to MINOR PROGRAM START.

5. The special program is wired ON; therefore, once the PROGRAM START is impulsed, the program levels begin stepping off until either the fifth level is reached or a stop hub is impulsed.

6. An ALL CYCLES impulse must be wired to the channel entry hub corresponding to the vertical row of program hubs to be used. If five or less cycles are desired, the ALL CYCLES impulse can be wired directly to the CHANNEL ENTRY hub. If more than five cycles are required, as in this problem, a pilot selector must be used to select the ALL CYCLES impulse so that it reaches one channel on the first five steps and another channel on the second five steps. To do this, the couple hub of the fifth level is wired to the D-pickup of a pilot selector. When the fifth minor program step is reached, the pilot selector is impulsed and transfers for the sixth cycle and through the next card feed cycle.

NOTE: If special programming is used when summary punching and more than five program levels are required, a program exit impulse should be used instead of program couple to pick the pilot selector that shifts the ALL CYCLES impulse to a different channel entry. This is required only if SP PU is impulsed on the last program step before the shift in the ALL CYCLES impulse takes place.

7. The pilot selector is normal for the first five steps. An ALL CYCLES impulse wired through the NORMAL side to NON-PRINT eliminates printing and spacing during crossfooting cycles. The ALL CYCLES impulse is also wired to the fifth CHANNEL ENTRY. The hubs immediately above this channel entry are active at their respective levels on the first round, or for steps 1 through 5.

8. The pilot selector is transferred for the sixth step and the ALL CYCLES impulse is directed to the sixth channel. The hubs immediately above this channel entry are active for their respective levels on the second round, or for steps 6 through 10.

9. Normally, programming stops and card feeding is resumed after the fifth step, if the preceding steps are not wired to STOP. In the example, six steps are desired, and therefore step 5 is wired to REPEAT. The program steps then begin again at 1 and continue until stopped or until the 10th step is reached.

10. Because the report is being group printed and counters are read out and reset on different programs, all counters are wired for DIRECT ENTRY independently.

11. Counter 6A reads out and clears on step 1, counter 6C on step 2, counter 6B on step 3, counter 6D on step 4, counter 6E on step 5 and counter 6F on step 6.

12. Step 6, the last step used, is wired to MINOR STOP. The MINOR STOP is used because the MINOR PROGRAM START initiated programming. Only the MINOR STOP is active on a minor change in program.

13. The sixth program step is wired to SPACE SUPPRESS to permit the crossfooted total to print on the same line as the indication.

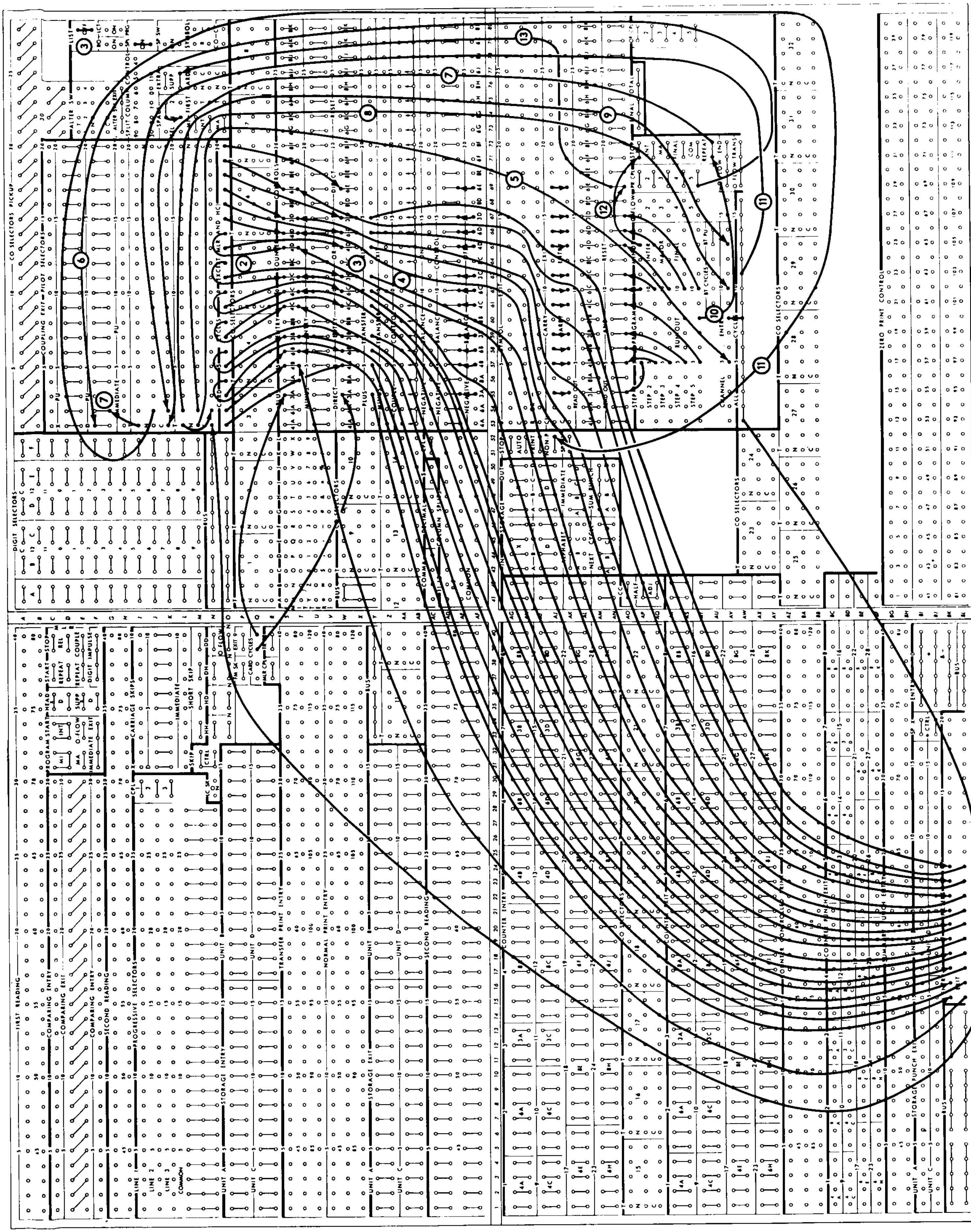


Figure 126. Crossfooting Eleven Totals

1. MINOR PROGRAM START is wired.

2. Eleven counters are impulsed to add from CARD CYCLES.

3. CARD CYCLES are wired independently to the DIRECT ENTRY hubs of each counter to suppress the printing from counters on the group indicate cycle.

4. Receiving counters are impulsed to add transferred totals by wiring the transfer control plus hubs of the transmitting counters through filters, to the plus hubs of the receiving counters. The filters are necessary to prevent the card cycles impulse from backing up into the transfer exit hubs and thereby cause the transmitting counter to subtract erroneously.

5. An ALL CYCLES impulse is wired through the NORMAL hubs of pilot selector 1 to CHANNEL 5. This channel is operative for steps 1 through 5.

6. Pilot selector 1 is picked up from the COUPLE of step 5. The selector is normal for the first five steps and transferred for the remaining program steps through the first card of the following group. NOTE: See Figure 120, item 6.

7. An ALL CYCLES impulse from step 5 is wired through the TRANSFERRED side of pilot selector 1 to the D-pickup of pilot selector 2. On the tenth step the ALL CYCLES impulse reaches the selector pickup and transfers the selector for step 11 and all remaining program steps through the first card of the following group.

8. An ALL CYCLES impulse is wired through the TRANSFERRED side of pilot selector 1, and then through the NORMAL side of pilot selector 2 to channel entry 10. This channel is operative for steps 6 through 10.

9. An ALL CYCLES impulse is wired through the TRANSFERRED hubs of pilot selectors 1 and 2 to CHANNEL ENTRY 13. Pilot selector 1 is picked up for step 6 and remains transferred for all remaining program cycles. Pilot selector 2 is picked up for step 11 and remains transferred for all remaining program cycles. Channel 13 is operative starting with step 11.

10. Because programming starts automatically after every five steps, repeat is required after steps 5 and 10. To accomplish this, an ALL CYCLES impulse is wired to CHANNEL ENTRY 8 and the fifth step is wired to REPEAT. This hub is active on every fifth program step.

11. Pilot selector 2 transfers for the eleventh and all remaining program steps through the first card of the following group. The ALL CYCLES impulse wired through the NORMAL side impulses NON-PRINT for steps 1 through 10, thus allowing printing only for the group indication cycle and the total print cycle.

12. The eleven counters are impulsed to read out and reset on specific program steps as shown. The last program step used (step 11) is wired to MINOR STOP.

13. Program step 11 is also wired to SUPP so that the crossfooted total prints on the same line as the indication.

NOTE: This wiring should not be used when summary punching.

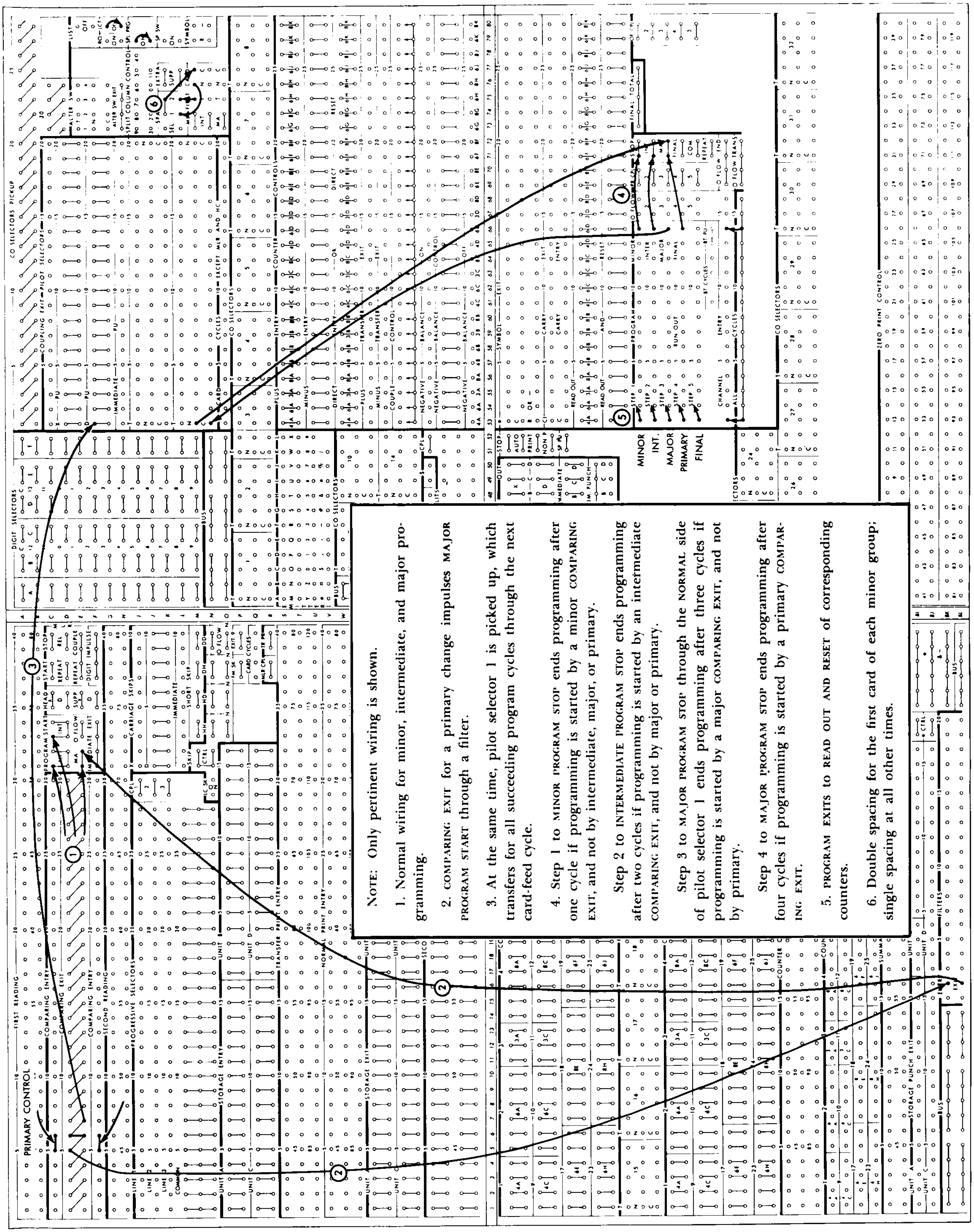


Figure 127. Four Classes of Totals, Using Special Program

Six-Field Crossfooting

Six or more fields can be crossfooted from a single card by the use of special program. The crossfooted factors may be added or subtracted.

Figure 125 demonstrates how extra cycles beyond five may be taken for minor program start. Although a CYCLE COUNT is wired to MINOR PROGRAM START so that the steps are taken for every card, a comparing impulse can be used so that the steps can be taken for a group of cards. Thus, crossfooting can be done for every card or for a group of cards.

Crossfooting Eleven Totals

For every five programs taken during a special program operation, a separate channel is required. An ALL CYCLES impulse must be wired to each channel used. It can be wired directly to CHANNEL ENTRY if only five steps are required. For every additional five steps, a pilot selector is required to select the ALL CYCLES impulses to the channel entries in turn. When eleven cycles are required, two pilot selectors are necessary, one to control steps 6 through 10 and the other to control step 11.

The wiring shown in Figure 126 is for an 11-field group printed report. Whenever a minor program change is recognized, the totals of all eleven fields crossfoot on ten cycles and the grand total prints on the eleventh cycle before continuing with the following group. COUNTER ENTRY and EXIT wiring are not shown, because they are the same as in Figure 125. On any crossfooting or total transfer operation, however, the number of cycles can be reduced by transferring more than one counter on each step, but COUNTER EXIT selection is necessary to eliminate interference.

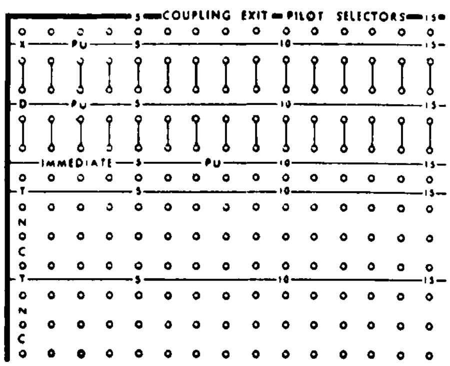
Four Classes of Totals Using Special Program

The four control fields (minor, intermediate, major, and primary) are wired to the comparing unit in the normal manner. Minor, intermediate, and major COMPARING EXITS are wired to their corresponding PROGRAM START hubs. The primary COMPARING EXIT is wired directly to the D-pickup of a pilot selector and also to MAJOR PROGRAM START through a filter.

The required number of special program cycles (one for minor, two for intermediate, three for major, and four for primary) is then controlled as diagrammed in Figure 127.

Selectors

Selectors are provided on the IBM 407 as a medium of control for the basic features. Selectors add flexibility to many functions of the IBM 407.



C-N, 53-72

Pilot Selectors. Fifteen 2-position pilot selectors are standard and five are optional. They can be used independently, or in conjunction with other selectors (co-selectors) on the control panel. The guiding function they perform when used with co-selectors gives them the name "pilot selectors."

The two positions in each selector are vertically arranged. Each position has a C (common), an N (normal) and a T (transferred) hub, and three pickup hubs: X, DIGIT and IMMEDIATE. These pickup hubs are used to control the selectors which, in turn, are used to control various machine functions, such as adding amounts from certain cards and subtracting amounts from other cards.

One of the most common methods of distinguishing one card from another is by an X-punch in some column of the card. If some cards have an X-punch and other cards do not, the machine can be controlled

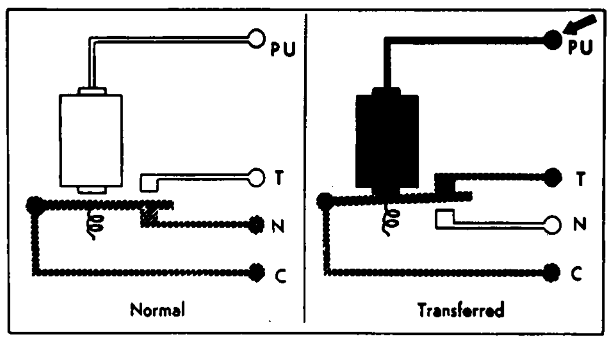


Figure 128. Schematic Diagram of a Selector

to do certain things with X-cards and certain other things with cards having no X-punch (NX-card). If the column of the card containing the distinguishing X-punch is wired to the X-pickup of a pilot selector, a card cycles impulse introduced into the C hub of that selector is available at the T hub at the beginning of the next machine cycle. By the same token, an impulse introduced into the T hub is available on the next cycle at the C hub. If there is no X in the card, a card cycles impulse introduced into the C hub of a selector is available at the N (normal) hub. Likewise, an impulse introduced into the N hub is available at the C hub on the next cycle. When a selector is not impulsed, C and N are always connected as shown by Figure 128 (normal). When a selector pickup is impulsed, C and T are temporarily connected (transferred).

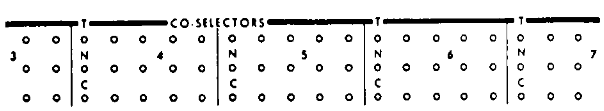
A digit can also be used as a distinguishing punch to pick up a pilot selector. The column in which it is punched is wired to the digit pickup hub. If more than one digit is punched in the column wired to the D-pickup, a digit selector must be used to separate the distinguishing digit from all the others. Once the digit impulse has reached the pilot selector pickup, the action of the selector is identical to that of one picked

up by an X-punch. The difference between the two pickups is that a D-pickup accepts any impulse, whereas an X-pickup accepts only X- or 12-impulses.

Whenever the X or D hub of a selector is impulsed, the selector transfers on the following cycle and remains transferred until the controlling card has been read at second reading. Thus, if card feeding is interrupted for any reason, such as for total printing, the selector would be transferred during the total printing cycle and the following card cycle.

The immediate pickup hubs for each selector accept any impulse and transfer the selector immediately instead of on the next cycle. If the immediate pickup is impulsed during a card cycle, the selector remains transferred only until the end of the same cycle. If the immediate pickup is impulsed during a program cycle, it remains transferred through the following card feed cycle.

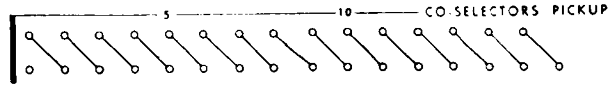
Each pilot selector has a coupling exit hub, located immediately above the X pickup. This hub emits an impulse when the corresponding pilot selector is transferred and emits this impulse once each cycle thereafter, if the selector remains transferred. These hubs are normally connected to a co-selector pickup for the purpose of expanding the pilot selector beyond two positions. Although the co-selector to which the COUPLING EXIT is wired transfers a little later than the pilot selector, the two selectors function alike for all practical purposes. This difference in transfer time need be considered only when selecting CI and C. In such cases, CI and C can be selected through the pilot selector but not through the coupled co-selector.



P-R, 41-80; W-Y, 43-52; Z-AB, 33-52; AO-AQ, 1-40; AW-AY, 43-52; AZ-BB, 41-80

Co-Selectors. There are 16 standard and 16 optional co-selectors. Co-selectors are so named because they often operate in conjunction with pilot selectors. Each selector has five positions, each position having a C (common), N (normal) and a T (transferred) hub. In principle they function like pilot selectors. When they are transferred, there is a common connection between C and T; and when they are not transferred, there is a common connection between C and N.

Each selector has two common pickup hubs, that are diagonally arranged for convenience in jackplugging. When these hubs are impulsed, the selector transfers immediately and holds for the remainder of the cycle.



A-B, 53-80; C-D, 73, 76

When these hubs are wired from the COUPLING EXIT of a pilot selector, they transfer with the pilot selector and hold for the same length of time as the pilot selector. In other words, when a co-selector is picked up from the COUPLING EXIT of a pilot selector, the number of positions available for selection is increased from 2 to 7.

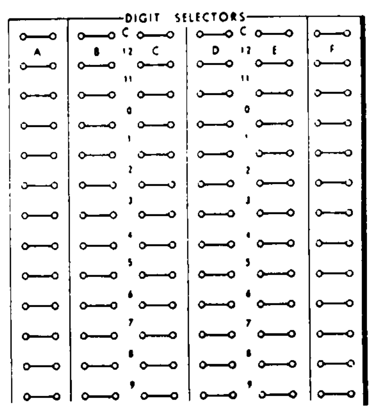
X Selection

Amounts for different types of transactions can be added in separate counters, even though the amounts are punched in the same field of the card. This is done by means of X or digit selection. In the example shown in Figure 129, the item amount field represents sales on NX-cards and returns and allowances on X-cards.

Figure 130 shows control-panel wiring to select amounts from one field of a card for printing into two fields of a report, under control of an X in the card.

Digit Selection

Digit punching, as well as X-punching, can be used to control pilot selectors. If the presence of any digit in a card column is sufficient to identify a transaction, then the column containing the digit can be wired directly to the D-pickup of a pilot selector. If a particular type of transaction is identified by a specific digit (Figure 131), then a digit selector is necessary.



A-M, 41-52

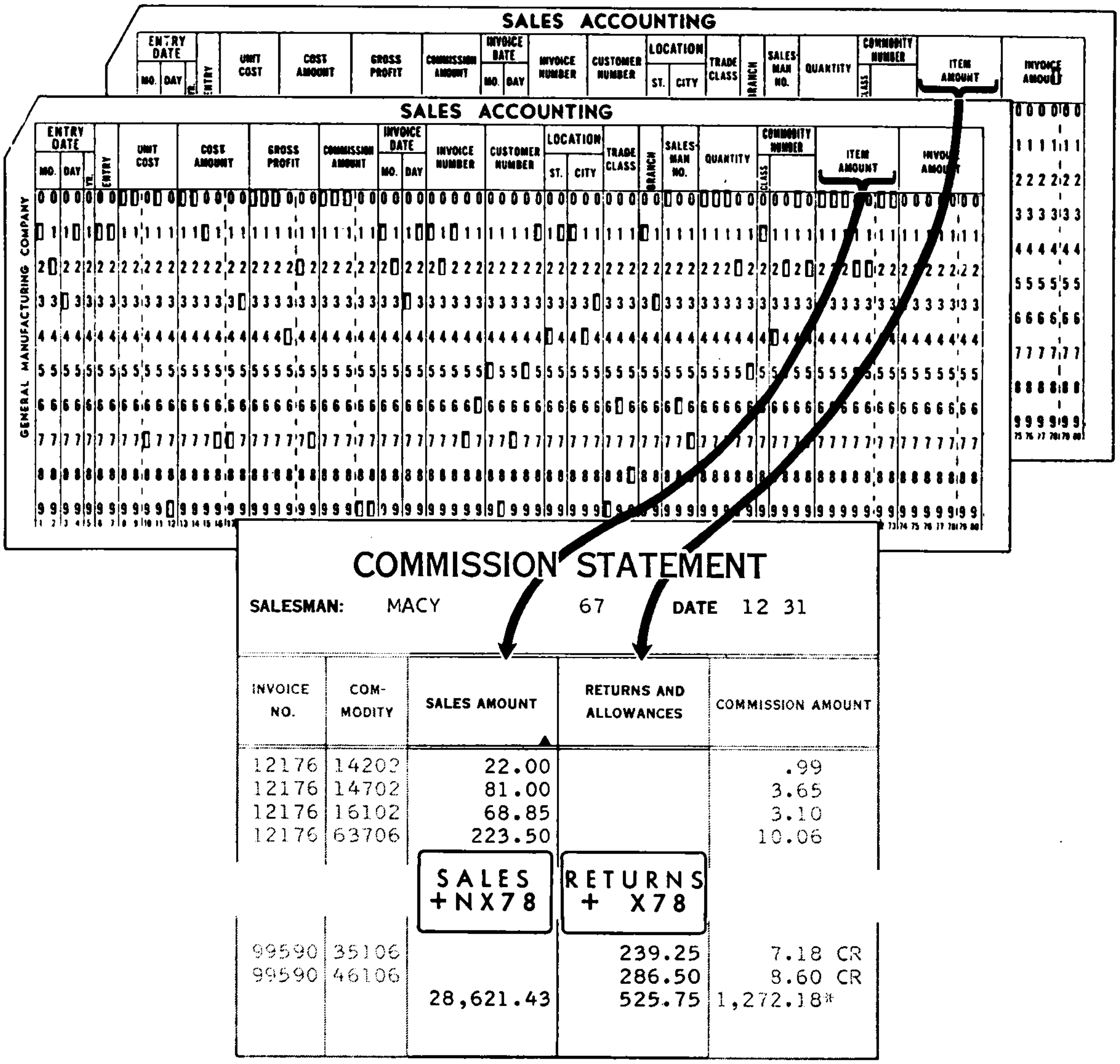
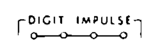


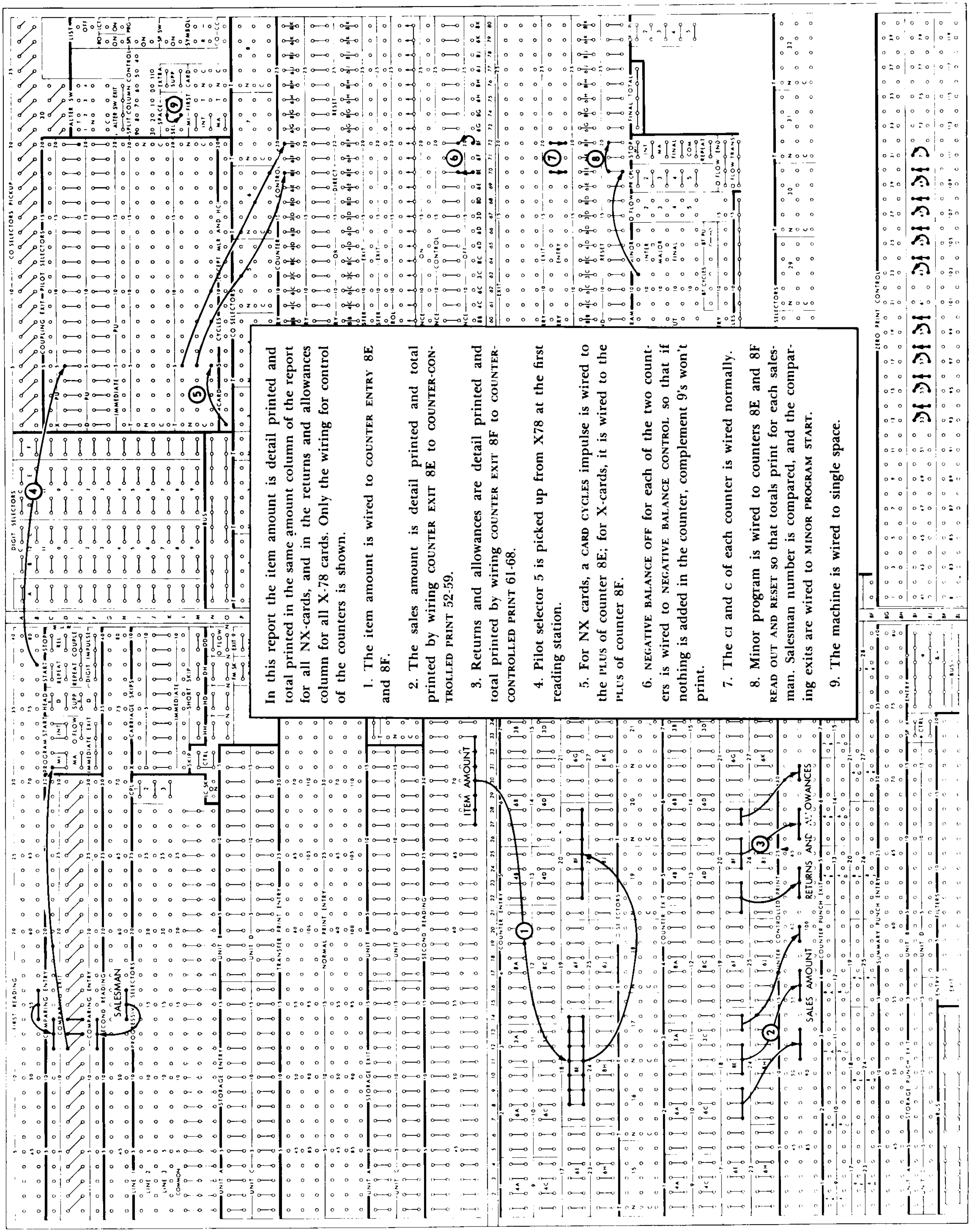
Figure 129. Selection, Under Control of X-Punch

Digit Selectors. Two digit selectors are standard (selectors A and B) and four are optional (selectors C, D, E and F). Each digit selector consists of a pair of C (common) hubs and twelve pairs of hubs labelled for the 12 punching positions in a column of the card. On every machine cycle, the C hub is internally connected successively to the 9, 8, 7 . . . . 12 hubs. When a column is connected to the C hub, a specific punching position can be read from the corresponding hub of the digit selector. Thus, digits can be used to pick up pilot selectors or to operate functions of the machine that can be digit controlled, such as head control, carriage skip, and many others.



F, 37-40

Digit Impulse. These hubs emit digit impulses on every machine cycle. When a DIGIT IMPULSE is wired to the C of a digit selector, the digit selector becomes a digit emitter and can be used to print numbers, letters, or special characters under proper control.



In this report the item amount is detail printed and total printed in the same amount column of the report for all NX-cards, and in the returns and allowances column for all X-78 cards. Only the wiring for control of the counters is shown.

1. The item amount is wired to COUNTER ENTRY 8E and 8F.

2. The sales amount is detail printed and total printed by wiring COUNTER EXIT 8E to COUNTER-CONTROLLED PRINT 52-59.

3. Returns and allowances are detail printed and total printed by wiring COUNTER EXIT 8F to COUNTER-CONTROLLED PRINT 61-68.

4. Pilot selector 5 is picked up from X78 at the first reading station.

5. For NX cards, a CARD CYCLES impulse is wired to the PLUS of counter 8E; for X-cards, it is wired to the PLUS of counter 8F.

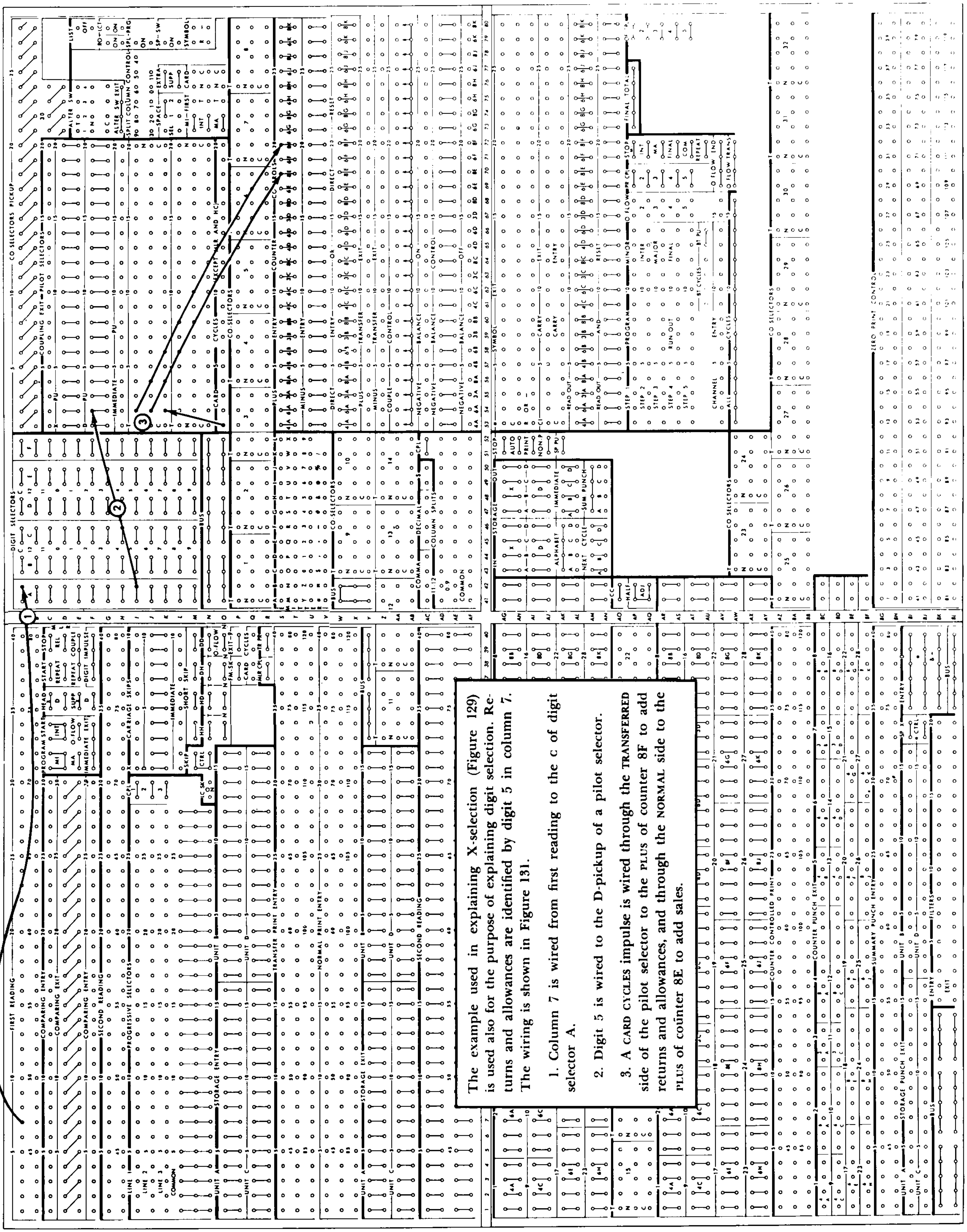
6. NEGATIVE BALANCE OFF for each of the two counters is wired to NEGATIVE BALANCE CONTROL so that if nothing is added in the counter, complement 9's won't print.

7. The CI and C of each counter is wired normally.

8. Minor program is wired to counters 8E and 8F READ OUT AND RESET so that totals print for each salesman. Salesman number is compared, and the comparing exits are wired to MINOR PROGRAM START.

9. The machine is wired to single space.

Figure 130. X Selection



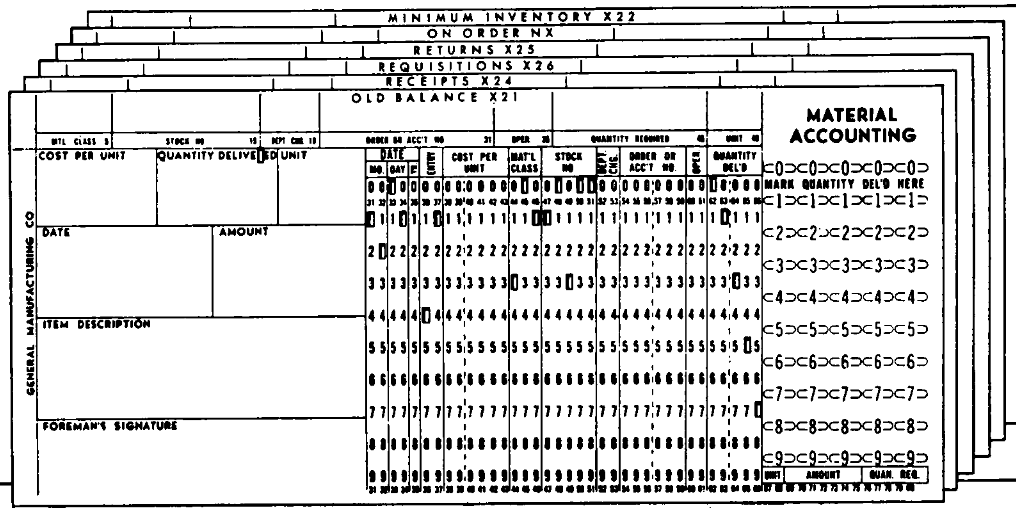
The example used in explaining X-selection (Figure 129) is used also for the purpose of explaining digit selection. Returns and allowances are identified by digit 5 in column 7. The wiring is shown in Figure 131.

1. Column 7 is wired from first reading to the C of digit selector A.

2. Digit 5 is wired to the D-pickup of a pilot selector.

3. A CARD CYCLES impulse is wired through the TRANSFERRED side of the pilot selector to the PLUS of counter 8F to add returns and allowances, and through the NORMAL side to the PLUS of counter 8E to add sales.

Figure 131. Digit Selection



STOCK STATUS SUMMARY

MAT'L	STOCK No.	DESCRIPTION	OLD BALANCE	RECEIPTS	REQUISITIONS	ON HAND	ON ORDER	MINIMUM INVENTORY	AVAILABLE
301	10300	BRASS ROD	1,357	345	967	735	3,000	3,100	635
301	20400	SOFT BRASS ROD	1,130	66	786	410		760	350CR
301	29648	C D BRASS	637		13	624		81	543
301	30623	H H CLOCK BRASS	60	100	66	94		73	21
301	35369	BRASS DISC	186			186	250	215	221
301	38942	BRASS TUBING	923		500	423		37	386
301	40732	HARD SPRING BRASS	+X21	+X24	+X26 −X25	+X21 +X24 +X25 −X26	+NX	+X22	−X22 −X26 +ALL OTHERS
301	41693	BRASS PINION							
301	50800	EXTRUDED BRASS							
301	52634	BERYLLIUM COPPER	475					225	
301	60900	BRONZ TUBING	270	500	341			274	
305	10005	ALUMINUM CASTING	4,210		60			295	
305	20012	ALUMINUM ALLOY CAST	455	5,340	710			322	
305	20023	BRASS CASTING		2,000	373	1,627		32	1,595
305	30023	BRONZ ALLOY CASTING	243	81	15	309	500	400	409

Figure 132. Selection, Under Multiple-X Control

Multiple X or Digit Selection

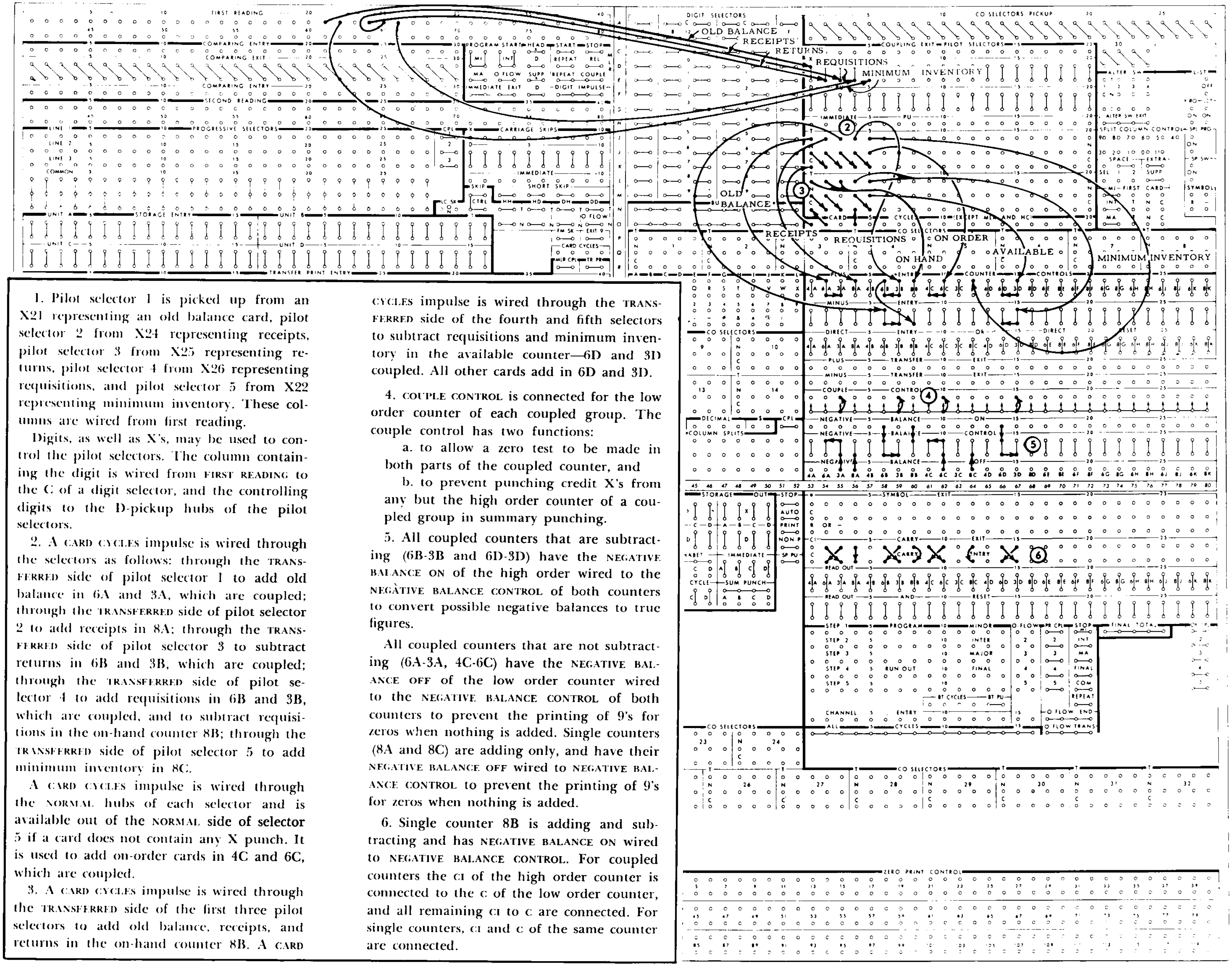
When a single card field is used for punching amounts or other quantitative data for different types of transactions, each transaction must be distinguished from the others by an identifying punch. In Figure 132, quantities for six different transactions are punched in the same field of the card. Five transactions are identified by significant X-punches; the sixth is identified by NX. These X-punches are used to control the plus or minus functions of seven counters (Figure 133).

A counter is required for each quantitative column on the report. Each counter adds or subtracts according to the requirements of the report columns. For example, the on-hand total is determined by adding the previous balance, receipts, and returns and by subtracting requisitions. Only the X distribution and the counter coupling wiring is shown.

Recognizing Negative and Zero Balances

The negative balance ON hubs have been described previously as emitting an impulse at the end of the cycle during which the counter goes negative and for every cycle thereafter as long as the counter remains negative. The negative balance OFF hubs emit an impulse at the end of the cycle during which the counter reaches a zero balance and for every cycle thereafter as long as the counter remains at zero.

Both the ON and the OFF hubs are timed exactly alike. The ON hub is normally wired to NEGATIVE BALANCE CONTROL to cause conversion of a complement figure. The OFF hub is normally wired to NEGATIVE BALANCE CONTROL to cause a zero balance to read out



1. Pilot selector 1 is picked up from an X21 representing an old balance card, pilot selector 2 from X24 representing receipts, pilot selector 3 from X25 representing returns, pilot selector 4 from X26 representing requisitions, and pilot selector 5 from X22 representing minimum inventory. These columns are wired from first reading.

Digits, as well as X's, may be used to control the pilot selectors. The column containing the digit is wired from FIRST READING to the C of a digit selector, and the controlling digits to the D-pickup hubs of the pilot selectors.

2. A CARD CYCLES impulse is wired through the selectors as follows: through the TRANSFERRED side of pilot selector 1 to add old balance in 6A and 3A, which are coupled; through the TRANSFERRED side of pilot selector 2 to add receipts in 8A; through the TRANSFERRED side of pilot selector 3 to subtract returns in 6B and 3B, which are coupled; through the TRANSFERRED side of pilot selector 4 to add requisitions in 6B and 3B, which are coupled, and to subtract requisitions in the on-hand counter 8B; through the TRANSFERRED side of pilot selector 5 to add minimum inventory in 8C.

A CARD CYCLES impulse is wired through the NORMAL hubs of each selector and is available out of the NORMAL side of selector 5 if a card does not contain any X punch. It is used to add on-order cards in 4C and 6C, which are coupled.

3. A CARD CYCLES impulse is wired through the TRANSFERRED side of the first three pilot selectors to add old balance, receipts, and returns in the on-hand counter 8B. A CARD CYCLES impulse is wired through the TRANSFERRED side of the fourth and fifth selectors to subtract requisitions and minimum inventory in the available counter—6D and 3D coupled. All other cards add in 6D and 3D.

4. COUPLE CONTROL is connected for the low order counter of each coupled group. The couple control has two functions:

a. to allow a zero test to be made in both parts of the coupled counter, and

b. to prevent punching credit X's from any but the high order counter of a coupled group in summary punching.

5. All coupled counters that are subtracting (6B-3B and 6D-3D) have the NEGATIVE BALANCE ON of the high order wired to the NEGATIVE BALANCE CONTROL of both counters to convert possible negative balances to true figures.

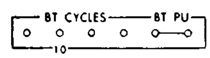
All coupled counters that are not subtracting (6A-3A, 4C-6C) have the NEGATIVE BALANCE OFF of the low order counter wired to the NEGATIVE BALANCE CONTROL of both counters to prevent the printing of 9's for zeros when nothing is added. Single counters (8A and 8C) are adding only, and have their NEGATIVE BALANCE OFF wired to NEGATIVE BALANCE CONTROL to prevent the printing of 9's for zeros when nothing is added.

6. Single counter 8B is adding and subtracting and has NEGATIVE BALANCE ON wired to NEGATIVE BALANCE CONTROL. For coupled counters the CI of the high order counter is connected to the C of the low order counter, and all remaining CI to C are connected. For single counters, CI and C of the same counter are connected.

Figure 133. Multiple-X Distribution

as zero instead of 9's. These hubs may also be used to control such functions as:

1. changing from detail print to group print whenever a counter changes from positive to negative or when it zero balances
2. changing from group print to detail print whenever a counter changes from positive to negative or when it zero balances
3. stopping the machine one cycle after a counter turns negative or zero balances
4. causing a program to be initiated one cycle after a counter turns negative or zero balances
5. causing information to be read out of storage when a counter turns negative or zero balances.



AU, 61-66

BT (Balance Test) CYCLES — BT-PU. A cycles impulse, such as CARD CYCLES, ALL CYCLES, PROGRAM EXITS, etc., wired through a selector picked up from NEGATIVE BALANCE OFF or ON damages the selector. This may be avoided by the use of BT (balance test) CYCLES impulses. The four independent BT cycles hubs are made active only when BT-PU is impulsed. If an all cycles impulse is wired to BT-PU, the BT cycles hubs emit an all cycles impulse suitable for selection. If a PROGRAM EXIT is wired to BT-PU, the BT cycles hubs emit a corresponding program cycles impulse suitable for selection.

Any digit, X or 12 can be wired to BT-PU in which case the BT cycles begin shortly after BT-PU is impulsed and continue for the duration of an all cycles impulse. Thus if the digit 6 were wired to BT-PU, the BT cycle would begin shortly after 6 time and continue through the second half of the cycle.

Changing from Detail to Group Print on Zero Balance

The machine can be wired to change from detail print to group print on the cycle following the detection of either a negative or a zero balance (Figure 134).

The negative balance OFF hub of a counter is wired to the I-pickup of a pilot selector. Normally, when a pilot selector is controlled from its I-hub, it picks up immediately and drops out at the end of the same cycle. The negative balance ON and OFF impulses come so late in the cycle that the selector picks up for the following cycle and drops out at the end of that same cycle. The D-pickup hubs cannot be wired from NEGATIVE BALANCE ON or OFF because the selector would pick up and drop toward the end of the same cycle and therefore would be of no use in controlling machine functions.

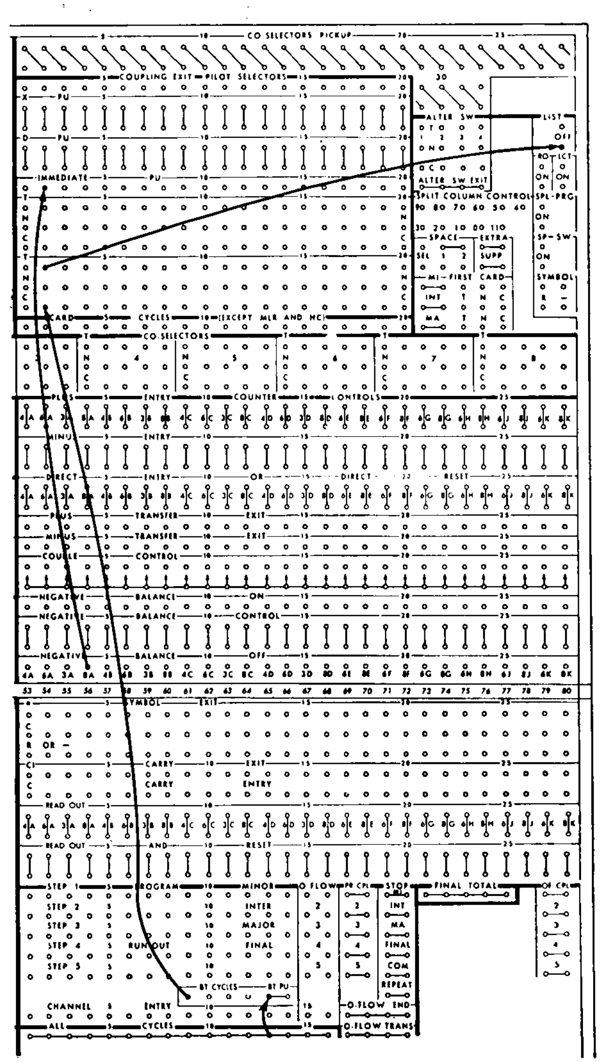
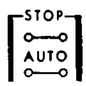


Figure 134. Changing from Detail to Group Print on a Zero Balance

The lower list OFF (entry) hub is impulsed from BT CYCLES through the TRANSFERRED side of the pilot selector so that the machine, which normally detail prints, group prints as long as the counter remains negative. The BT-PU is wired from ALL CYCLES. It is only necessary to wire from the NORMAL side of the pilot selector to change from group print to detail print on a zero balance. The upper list OFF (exit) hub should not be used because it is not a properly timed impulse for selector use.

Stop and Automatic Stop

The IBM 407 can be wired to stop for two different predetermined conditions during the same run of the cards by means of control panel wiring. One of the stops can be identified by a stop light.



AG-AH, 51-52

Stop. The two common stop hubs receive card cycles, all cycles, comparing exit, digit, X, 12, program exit, first card impulses and skip control exits, such as HH, HD, etc., to stop all machine operation at the end of the cycle during which the impulse is received. When they receive negative balance on or off impulses, the machine stops at the end of the following cycle. The machine is restarted by pressing the start key.

Auto Stop. These hubs are essentially the same as the stop hubs except that an automatic stop light turns on when the machine stops. Another exception is that when IMMEDIATE EXIT or SKIP CONTROL EXIT, such as HH, HD, etc., is wired to AUTO stop, the machine stops at the end of the following cycle and not at the end of the cycle during which the impulse is received. The purpose of the light is to distinguish one stop from the other when two stops are used. The machine is restarted and the light extinguished by pressing the start key.

Stopping from an X or Digit Punch

If an X or digit is wired to STOP or AUTO stop, the machine stops before the card prints if wired from first reading, after the card prints if wired from second reading. This would normally be done through column splits or digit selectors. When AUTO stop is wired (Figure 135), the automatic stop light turns on. The machine can be restarted by pressing the start key.

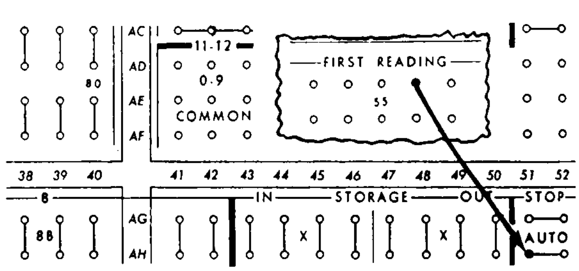


Figure 135. Stopping from X- or Digit-Punch

Stopping from Zero Balance (Figure 136)

Because a zero balance is determined by the presence of 9's in all positions of the counter being tested, the NEGATIVE BALANCE OFF of counter 4B is wired through the NORMAL side of pilot selector 6 to AUTO stop. The selector is transferred by a minor program wired to its D-pickup. This prevents the NEGATIVE BALANCE OFF from reaching AUTO stop on all zero conditions resulting from counter reset on a minor, intermediate, or major program, except on the run-in.

Stopping from Negative Balance

A negative balance is recognized by a 9 in the high order position of a counter. Because a zero balance also contains a 9 in the high order position, the negative balance ON hub cannot be wired to AUTO stop directly. If it were, the machine would stop both for a negative balance and for a zero balance.

Therefore, two selectors are used to recognize a negative-balance condition in the counter, as illustrated in Figure 137.

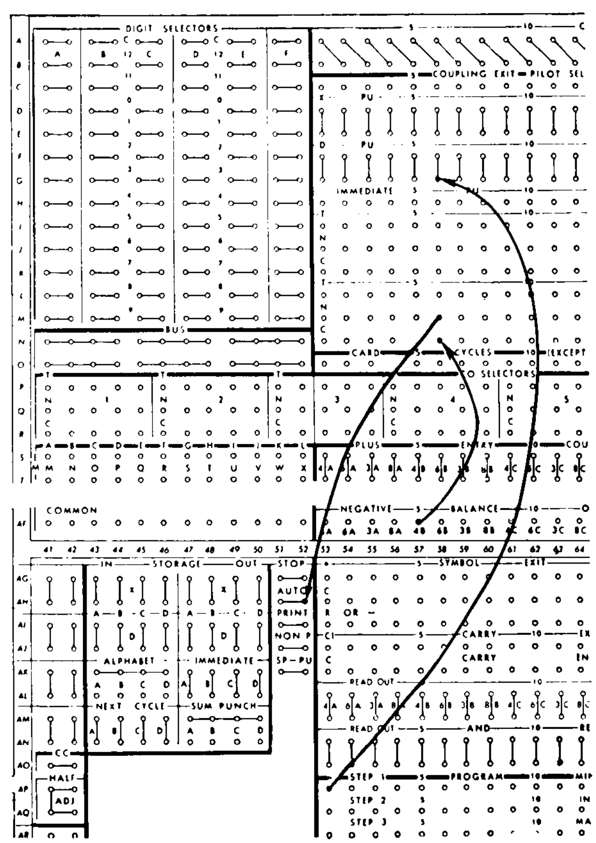


Figure 136. Stopping from Zero Balance

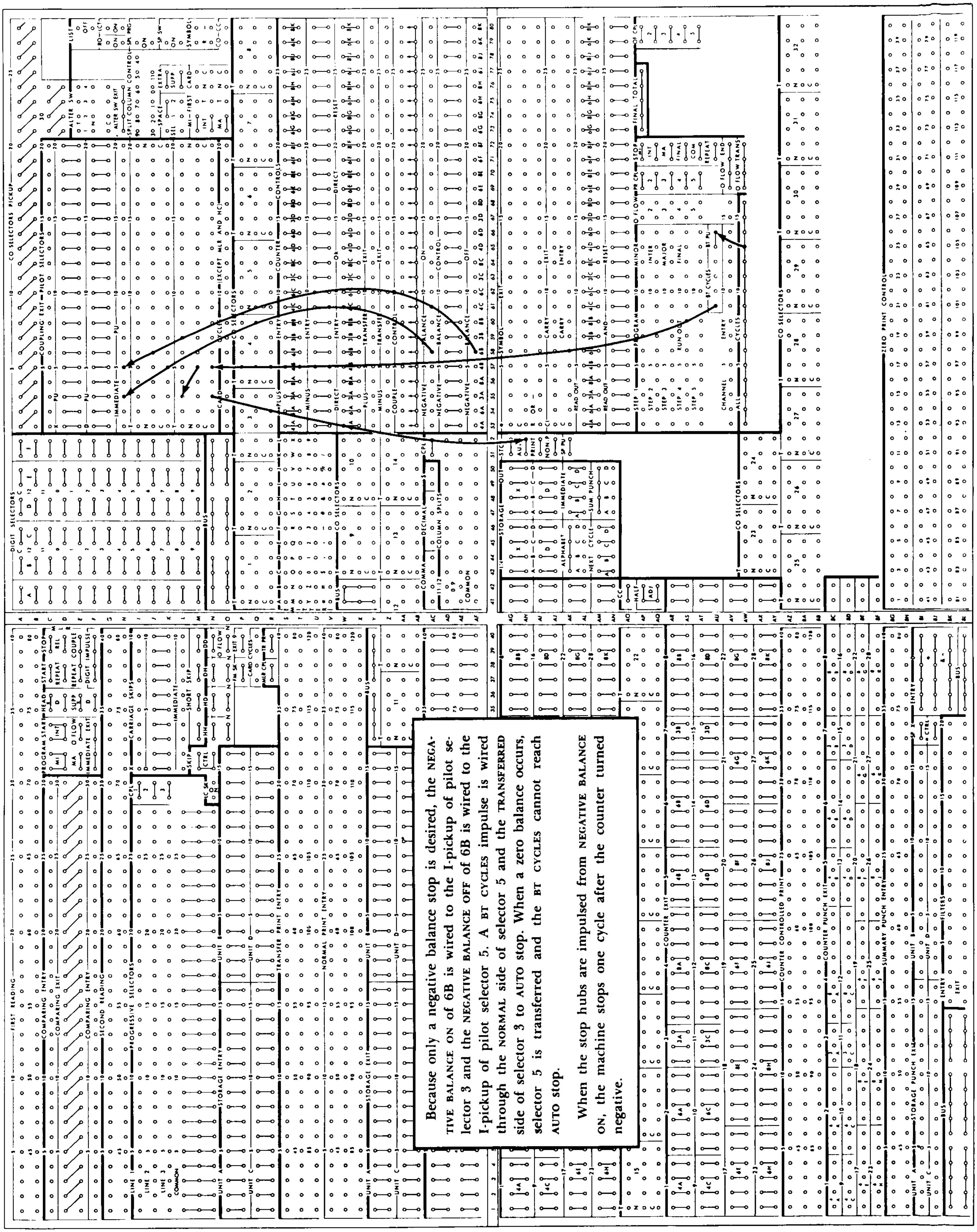
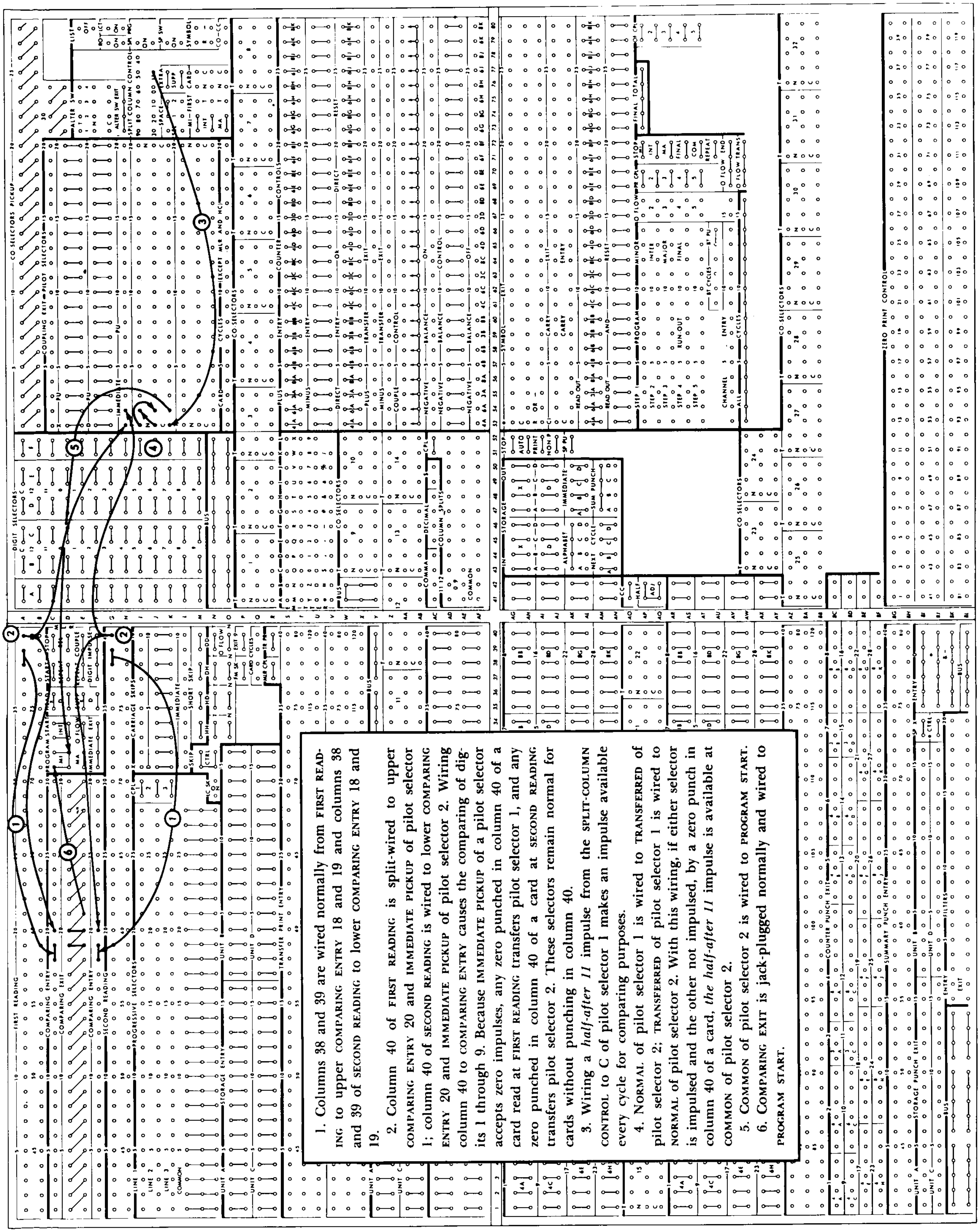


Figure 137. Stopping from Negative Balance



1. Columns 38 and 39 are wired normally from FIRST READING to upper COMPARING ENTRY 18 and 19 and columns 38 and 39 of SECOND READING to lower COMPARING ENTRY 18 and 19.

2. Column 40 of FIRST READING is split-wired to upper COMPARING ENTRY 20 and IMMEDIATE PICKUP of pilot selector 1; column 40 of SECOND READING is wired to lower COMPARING ENTRY 20 and IMMEDIATE PICKUP of pilot selector 2. Wiring column 40 to COMPARING ENTRY causes the comparing of digits 1 through 9. Because IMMEDIATE PICKUP of a pilot selector accepts zero impulses, any zero punched in column 40 of a card read at FIRST READING transfers pilot selector 1, and any zero punched in column 40 of a card at SECOND READING transfers pilot selector 2. These selectors remain normal for cards without punching in column 40.

3. Wiring a *half-after 11* impulse from the SPLIT-COLUMN CONTROL to C of pilot selector 1 makes an impulse available every cycle for comparing purposes.

4. NORMAL of pilot selector 1 is wired to TRANSFERRED of pilot selector 2; TRANSFERRED of pilot selector 1 is wired to NORMAL of pilot selector 2. With this wiring, if either selector is impulsed and the other not impulsed, by a zero punch in column 40 of a card, *the half-after 11* impulse is available at COMMON of pilot selector 2.

5. COMMON of pilot selector 2 is wired to PROGRAM START.

6. COMPARING EXIT is jack-plugged normally and wired to PROGRAM START.

Figure 138. Zero and Blank-Column Control

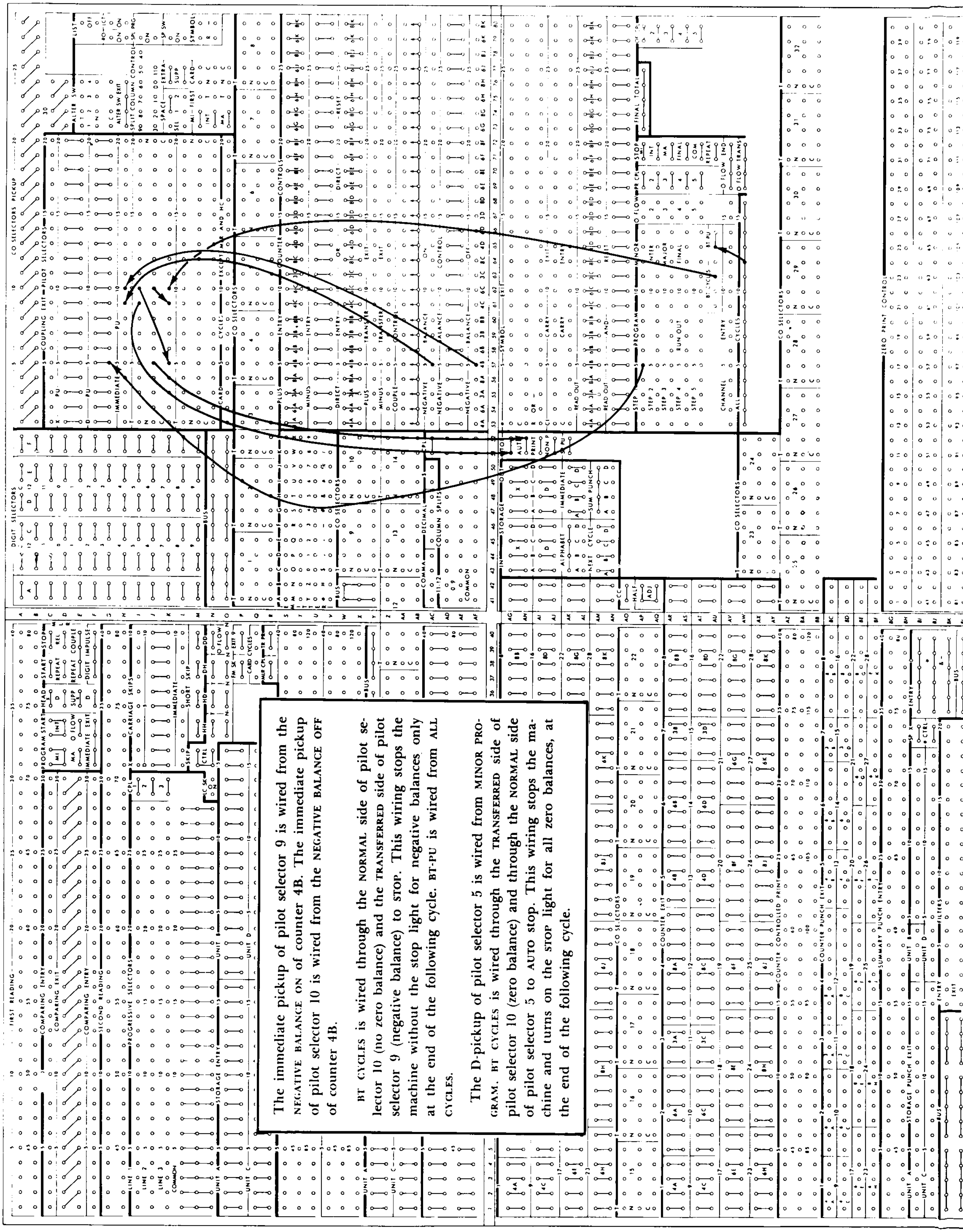


Figure 139. Regular Stop for Negative Balance; Auto Stop for Zero Balance

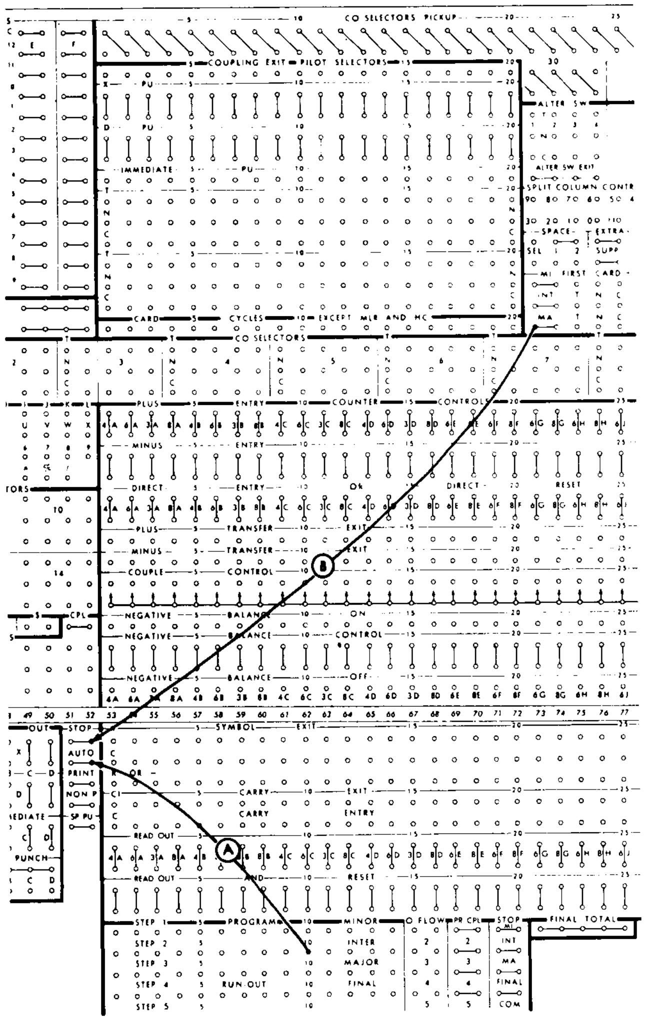


Figure 140. Stopping from: A. Program Exit; B. First Card

Zero and Blank Column Control

It is often necessary to differentiate between a zero-punched column and a blank column in a control field; a condition that is not normally recognized by the comparing unit. The condition can be recognized by use of two co-selectors, or pilot selectors as illustrated in Figure 138.

Regular Stop for Negative Balances and Auto Stop for Zero Balances

The control panel can be wired to stop the 407 when a zero-balance or negative-balance condition occurs. To enable the operator to recognize the type of balance that exists, the impulse selected for a negative-balance is wired to regular stop and the impulse selected for a zero balance is wired to auto stop (Figure 139). Because a regular stop is operative without a light, but auto stop is operative with an indicating light, visual recognition of the balance condition is possible.

Stopping from a Program Exit (Figure 140A)

When a PROGRAM EXIT is wired to either STOP or AUTO stop, the machine stops *after* the corresponding total prints. In the example shown, INTERMEDIATE PROGRAM EXIT is wired to AUTO stop. When an intermediate program change occurs, the machine stops after the intermediate total prints, and the automatic stop light turns ON.

When a skip and a stop are initiated from the same program step, and short skip is not wired, the auto stop hub must be used. If the stop hub is wired for this application, the program will not be completed.

Stopping from a First Card Impulse (Figure 140B)

MINOR, INTERMEDIATE, or MAJOR FIRST CARD can be wired directly to STOP or AUTO stop. In the example shown, MAJOR FIRST CARD is wired to STOP, causing the machine to stop after the first card of a major group prints.

Split Column Control

With SPLIT COLUMN CONTROL (Figures 141-142), multiple punching in one column can be split between any two punching positions. It differs from normal column split (which is always between 0 and X) in that the split may be between 9 and 8, 0 and X, etc. There is a hub for all the digits 9 through 0 and for 11. They emit impulses at half after the number indicated. For example, 9 emits an impulse between 9 and 8; 0 emits an impulse between 0 and 11.

The split column control hubs are normally wired

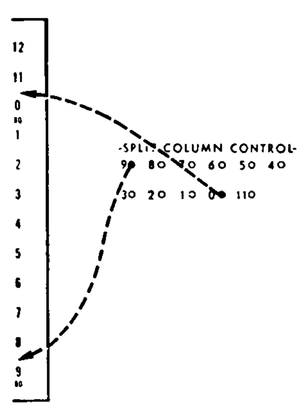


Figure 141. Split-Column Control

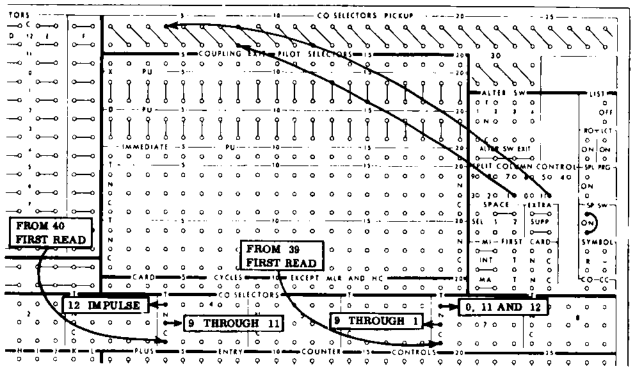


Figure 142. Wiring—Split-Column Control

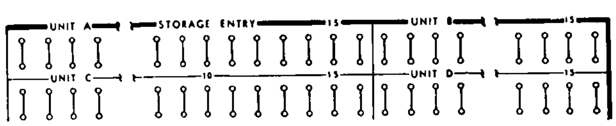
to a co-selector pickup, making the selector operate the same as a column split device. For example, if a 1 is wired to a co-selector pickup, the C and N hubs of the selector are common from 9 through 1, and the C and T hubs are common from 0 through 12. Thus, zone impulses can be separated from digit impulses punched in the same column. If the 0 is wired to the co-selector pickup, the C and N hubs are common from 9 through 0 and the C and T hubs are common for 11 and 12. This arrangement is the same as a normal column split. A column can be split between 11 and 12 by using the 11 hub as a pickup for the selector.

Storage Units

The 407 provides four 16-position storage units, (A, B, C, D). They store up to 64 positions of numerical or 32 positions of alphabetic information from the card, from the emitter, or from a counter. Data can be read into or out of the storage units at will, under the control of a digit, an X-punch, a card cycles impulse, a program exit, and certain types of carriage impulses. Each group may store letters, digits, and three of the special characters: minus (–), ampersand (&), and diagonal (/). The remaining 8 special characters include combination codes (8-3, 8-4) and, therefore, cannot be wired directly to storage units.

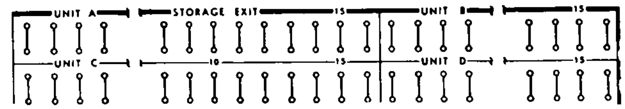
The storage units are used for such functions as:

a. storing information to be printed on sheet headings after an overflow, in order to duplicate the name and address on all subsequent forms.
b. increasing usable card columns for detail information by storing name, city and state that can be printed at will.
c. storing alphabetic or numerical information to be simultaneously read out and printed line by line with the detail information from the card.
d. storing information to be summary punched.
e. storing information to be group indicated.
f. storing columnar heading information so blank unruled forms can be headed by reading out of storage for each new sheet.



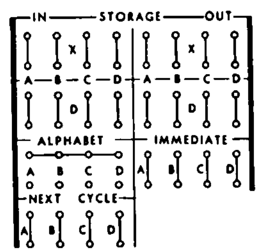
O-R, 1-32

Storage Entry. These hubs are the entries to the four storage units, A, B, C, and D. Each unit has 16 positions. Information can be stored from the card, a counter, or character emitter. Storage units accept information only during the first part of the cycle. Each storage unit can store 16 positions of numerical information or 8 positions of alphabetic information. Alphabetic information is always wired to the left-hand 8 positions of a storage unit. The digit impulses are stored in the first 8 positions and the zone impulses are stored in the last 8 positions.



Y-AB, 1-32

Storage Exit. Each STORAGE ENTRY position has a corresponding storage exit hub. Information from the storage units may be printed from NORMAL PRINT ENTRY or the TRANSFER PRINT ENTRY by wiring from STORAGE EXIT. STORAGE EXITS should not be wired to COUNTER-CONTROLLED PRINT, because the counter-controlled print hubs emit impulses during the second half of the cycle. Information from storage units can be entered into counters by wiring from STORAGE EXIT to COUNTER ENTRY. When alphabetic information is read out of storage, only the first 8 storage exit positions can be wired.



AG-AN, 43-46;
AG-AL, 47-50

Storage In, X and D. There two common X and two common D IN hubs for each of the four storage units. An X or digit impulse reaching these hubs causes the storage units to accept information on the following *card feed cycle.* If the X- or D- were wired from a card at first reading, information would be accepted by the storage unit as the same card is read at the second station, whether that information be from the emitter, a counter, or from the card itself.

The D hub may also be wired from CARD CYCLES, ALL CYCLES, CARRIAGE EXIT, or PROGRAM EXIT to operate the unit on the following card feed cycle. The X hubs should be wired to accept only X, 12, or carriage exit impulses. All storage units restore during the last half of the cycle in which they are impulsed. If the cycle is a program cycle, the storage unit restores on the last half of the last program cycle in that series. By wiring the X or D impulses from first reading, the units have time to restore before accepting new information at the second reading station.

If these hubs are impulsed from the first reading station while an MLR card is at second reading, data enters storage from the MLR card.

Storage In, Next Cycle. There are two common hubs for each storage unit that accepts digit, CARD CYCLES, ALL CYCLES or PROGRAM EXIT impulses to cause the storage units to accept information on the following *machine cycle.* The difference between these hubs and the IN D hubs is that they cause the storage units to operate on the following *machine cycle* rather than the following *card feed cycle.* For this reason, they cannot be used if the next cycle is a summary punch or a long carriage skip cycle. They are normally wired from PROGRAM EXITS to perform the following functions:

a. Read in information from the first card of a group for overflow sheet identification.

b. Read in factors to be crossfooted, to save counters.

Storage Out, X and D. There are two common X and two common D OUT hubs for each of the four storage units. An X- or digit impulse reaching these hubs causes the storage units to read out on the following *card feed cycle.* If the X or D is wired from a card at first reading, the storage unit would read out as the same card is read at second reading, provided it is not an MLR card. Besides digits, the D hubs also accept CARD CYCLES, ALL CYCLES, CARRIAGE EXIT, or PROGRAM EXIT impulses to cause a read-out on the following card feed cycle. The X hubs also accept 12 or CARRIAGE EXIT impulses. The storage units are not cleared on a read-out, and therefore information stored in them can be read out as often as, and whenever, desired. Storage units clear only upon entry.

Storage Out, Immediate. There are two common immediate hubs for each storage unit. They accept any impulse to cause the storage units to read out immediately. They are normally wired from PROGRAM EXITS or CARD CYCLES to cause the storage unit to read out on the same cycle. One example of their use would be to identify minor, intermediate and major totals with some descriptive information by reading this information out of the storage units on minor, intermediate, and major programs. BT CYCLE impulses can be controlled through the NORMAL side of a pilot selector to IMMEDIATE OUT so the storage unit does not read out for zero or negative balances. The selector is picked up immediately from NEGATIVE BALANCE OFF or ON. If STORAGE READ-IN X or D is used, STORAGE OUT IMMEDIATE must be wired from BT CYCLE to enable read-in to take precedence over read-out whenever they occur in the same cycle.

DATE ______

NET PAY	CHECK NUMBER	EARNINGS TO-DATE	NOTES
4939	12208	61806	
6619	12209	76930	MAIL
5556	12210	69520	
4795	12211	40540	
8254	12212	110206	MAIL
4837	12213	70215	HOLD
5505	12214	69120	
5003	12215	49650	
6058	12216	91642	MAIL

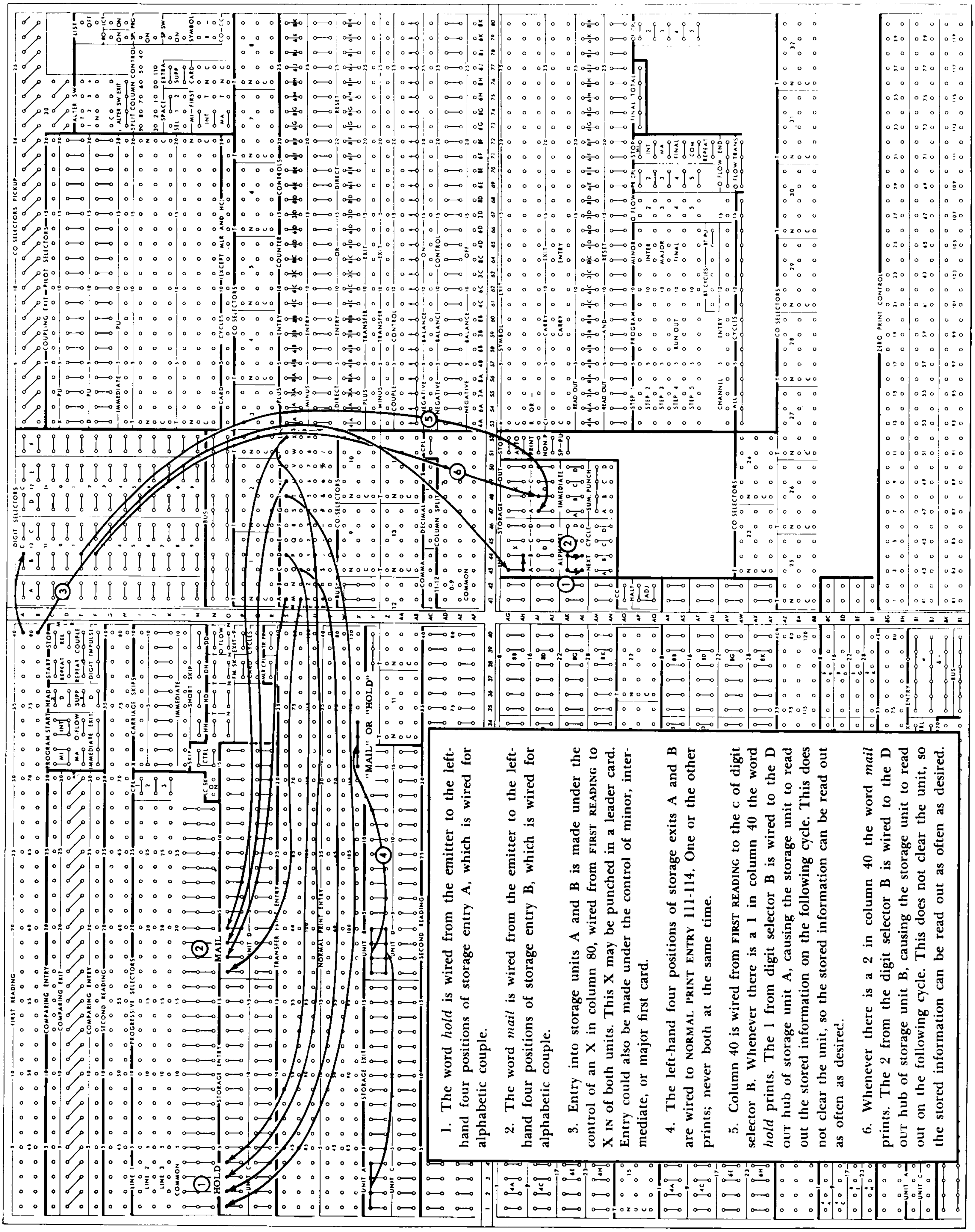
Figure 143. Information Printed from Storage

Storage, Alphabet. Whenever alphabetic information is to be stored in a storage unit, the corresponding couple entry hub (lower) must be connected to one of the four common exit hubs above it. The exit hubs emit an impulse from 0 to 12 time.

Whenever the alphabet couple hubs of a storage unit are connected, the capacity of that unit is reduced from 16 numerical positions to 8 alphabetic positions. Wiring into or out of the storage unit must then be confined to the left-hand eight positions. The right-hand positions are internally connected to accept the zone impulses directed to them by the left-hand eight positions.

Reading into and out of Storage under Control of an X or Digit

In the payroll register shown in Figure 143, some employees have special notes indicating what disposal is to be made of their pay checks. These notes are not punched in the employee's payroll card and therefore must be printed from some other source. One source is from the character emitter properly controlled through the co-selectors. Another source is the emitter properly controlled through the storage units. Only two notations are shown, *mail* and *hold.* The word *mail* is stored in one storage unit, and the word *hold,* in another. A significant X or digit for each is punched in the employee's payroll card to cause one or the other of the storage units to read out (Figure 144).



1. The word *hold* is wired from the emitter to the left-hand four positions of storage entry A, which is wired for alphabetic couple.

2. The word *mail* is wired from the emitter to the left-hand four positions of storage entry B, which is wired for alphabetic couple.

3. Entry into storage units A and B is made under the control of an X in column 80, wired from FIRST READING to X IN of both units. This X may be punched in a leader card. Entry could also be made under the control of minor, intermediate, or major first card.

4. The left-hand four positions of storage exits A and B are wired to NORMAL PRINT ENTRY 111-114. One or the other prints; never both at the same time.

5. Column 40 is wired from FIRST READING to the C of digit selector B. Whenever there is a 1 in column 40 the word *hold* prints. The 1 from digit selector B is wired to the D OUT hub of storage unit A, causing the storage unit to read out the stored information on the following cycle. This does not clear the unit, so the stored information can be read out as often as desired.

6. Whenever there is a 2 in column 40 the word *mail* prints. The 2 from the digit selector B is wired to the D OUT hub of storage unit B, causing the storage unit to read out on the following cycle. This does not clear the unit, so the stored information can be read out as often as desired.

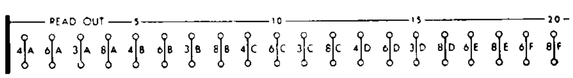
Figure 144. Storage Entry and Read-Out

Storage Units as a Substitute for Counters

Although storage units can neither add nor subtract, storage can be used as a substitute for a counter by storing a total that the counter has accumulated along with the sign of that total. The counter can then reset and accumulate another total, to which is added the previous total in the storage unit. The sum of the two totals, along with its sign, is then transferred back to storage and the process is repeated (Figures 145 and 146).

To demonstrate the principle of this operation, one counter and one storage unit are used to print both minor and final totals. Normally two counters are required. Every minor program change requires three cycles, one cycle to print the minor total, one cycle to transfer the accumulated minor totals from storage into the counter so that the two can add, and one cycle to transfer the sum of the minor totals back to storage. At the end of the run, the final total is printed from the storage unit.

Because this method of storing totals requires more cycles than the normal two-counter method, it is normally used only when counters are not available. Although only two classes of totals are shown, minor and final, the same principle is used when printing minor, intermediate and major from two counters and one storage unit, or minor, intermediate, major, and final from three counters and one storage unit. Both of these operations, however, require special program wiring, because more than three cycles is required in each case.



AL-AM, 53-80

Counter Control Read Out. Each counter has a pair of common read out hubs that accept CARD CYCLE, PROGRAM or ALL CYCLE impulses to read out a counter without resetting. These hubs are normally used for progressive total printing.

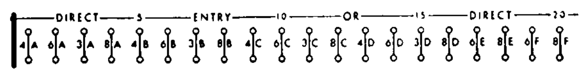
Storing 16 Positions of Alphabetic Information Using One Storage Unit

Normally only the left-hand eight positions of a storage unit may be used to store alphabetic information because half of the unit is needed to store the digits, and the other half, to store the zones.

By using counters to store the digits, all positions of the storage unit can be used to store the zones. Because a storage unit accepts the first digit or zone read into it, the alphabetic field must first be wired through a selector so the zones enter the storage unit and the digits enter the counter. Selectors are not necessary when the information is read out to print.

It is possible to store 64 positions of alphabetic information at one time by using all four storage units to store the zones, 64-counter positions to store the digits and 64 co-selector positions for selection of the information upon entry.

Figure 147 illustrates the printing of 16 alphabetic positions on a minor total cycle. The information printed is stored from the first card of each intermediate group. The alphabetic information prints on each succeeding minor total cycle.



W-X, 53-80

Direct Reset. The hubs used for direct entry are also used for direct reset. When they are impulsed at the same time as the corresponding read out and reset hubs, the counter resets without printing. DIRECT RESET does not allow information in the counter to reach the COUNTER EXITS, and, therefore, could not be used when performing such operations as total transfer or crossfooting. It is normally used to reset counters used for such operations as summary punching or page numbering where the information in the counter should neither print nor transfer to other counters. DIRECT RESET is not effective unless READ OUT and RESET is also wired. When more than one direct reset hub is wired from one impulse, the corresponding PLUS and MINUS must be impulsed at the same time from the same source. Otherwise, the direct reset hub must be impulsed independently. (See Direct Entry or Direct Reset under *Operating Rules and Suggestions.)*

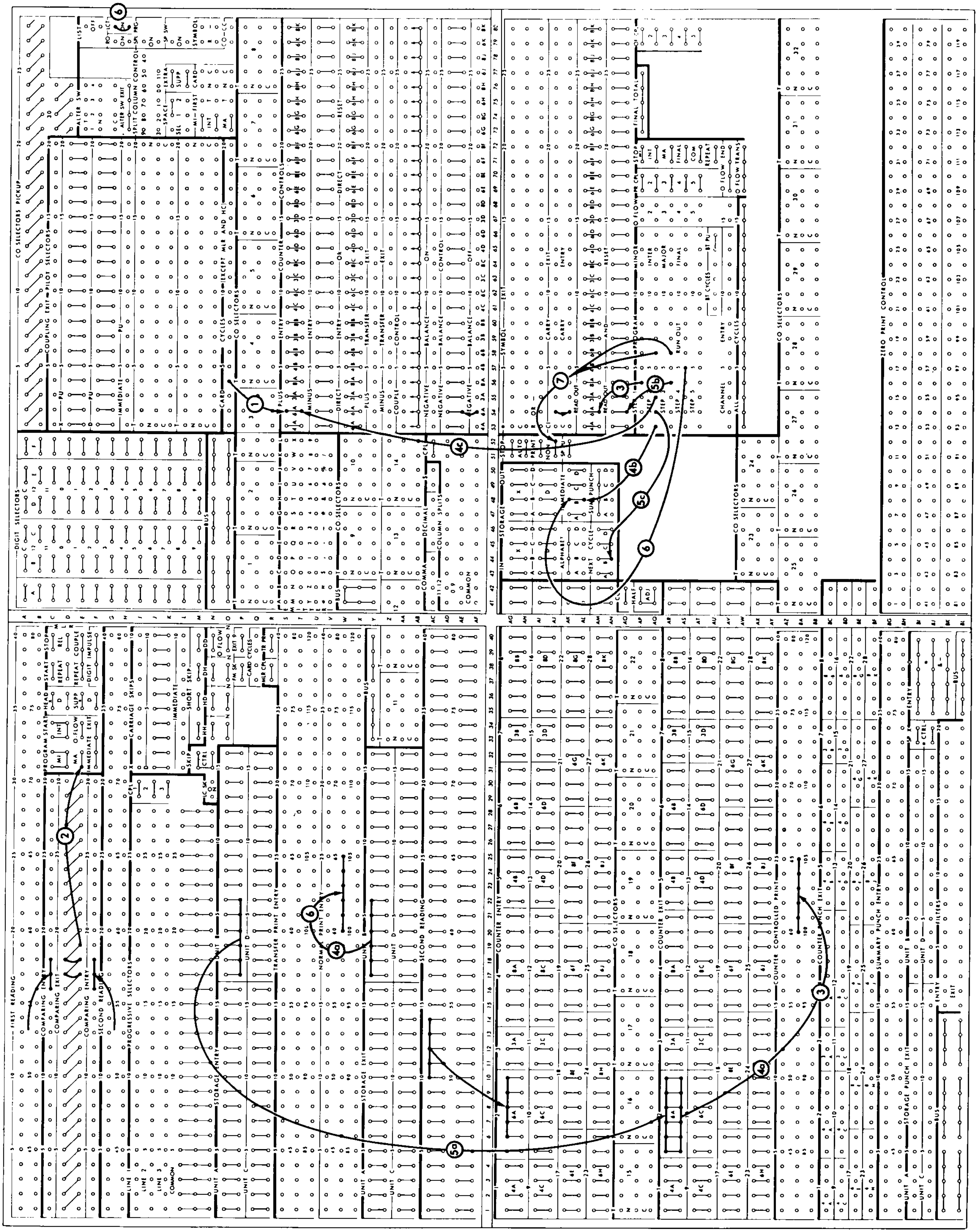


Figure 145. Storage Unit used as a Substitute for Counter, Adding only

To better understand the wiring necessary to print minor and final totals by using one counter and one storage unit, the following requirements must be kept in mind:

Minor Program Cycle—Read out the minor total from the counter and print.

Intermediate Program Cycle—Read out the accumulated minor totals from storage and add into the counter.

Major Program Cycle—Read out and reset the new total from the counter to storage.

Run-Out Final Cycle—Read out the final total from storage and print.

1. The field to be added is wired to COUNTER ENTRY 6A and the counter is impulsed to add every card.

2. The COMPARING EXIT of the field being compared is wired to MAJOR PROGRAM START. This causes all three program steps to be taken for every change in comparison.

3. The total is read out of counter 6A without resetting, on the first of the three programs, by wiring MINOR PROGRAM EXIT to 6A READ OUT. The COUNTER EXITS of 6A are wired to COUNTER-CONTROLLED PRINT.

4. The sum of the accumulated minor totals, standing in storage unit B, is read out and added to the last minor total standing in the counter by the following wiring:

a. STORAGE EXIT B to COUNTER ENTRY 6A by way of NORMAL and COUNTER-CONTROLLED PRINT ENTRY. NORMAL and COUNTER-CONTROLLED PRINT are connnected internally.

b. INTERMEDIATE PROGRAM EXIT to IMMEDIATE READ OUT of storage unit B.

c. INTERMEDIATE PROGRAM EXIT to the PLUS of counter 6A.

5. The accumulated minor total is read out of the counter back into storage by the following wiring:

a. The COUNTER EXIT of 6A is wired to STORAGE ENTRY B.

b. The counter is read out and reset on the major program.

c. INTERMEDIATE PROGRAM EXIT to NEXT CYCLE IN of storage unit B.

Although program 2 is wired to both the IMMEDIATE READ OUT and the NEXT CYCLE IN of storage unit B, there is no interference in the wiring because the read-in occurs on the following (major) program cycle.

6. The final total is printed from storage unit B by wiring the STORAGE EXIT to NORMAL PRINT ENTRY and by impulsing IMMEDIATE READ OUT of B from RUN-OUT FINAL PROGRAM. Because the last card total switch is ON, the run-out final program is automatic on the run-out.

7. The storage unit is wired to READ OUT on step 2 and the counter is read out and reset on step 3. No printing on either of these steps is desired. The non-print hubs are therefore wired from PROGRAM STEPS 2 and 3. This wiring also suppresses spacing on these cycles.

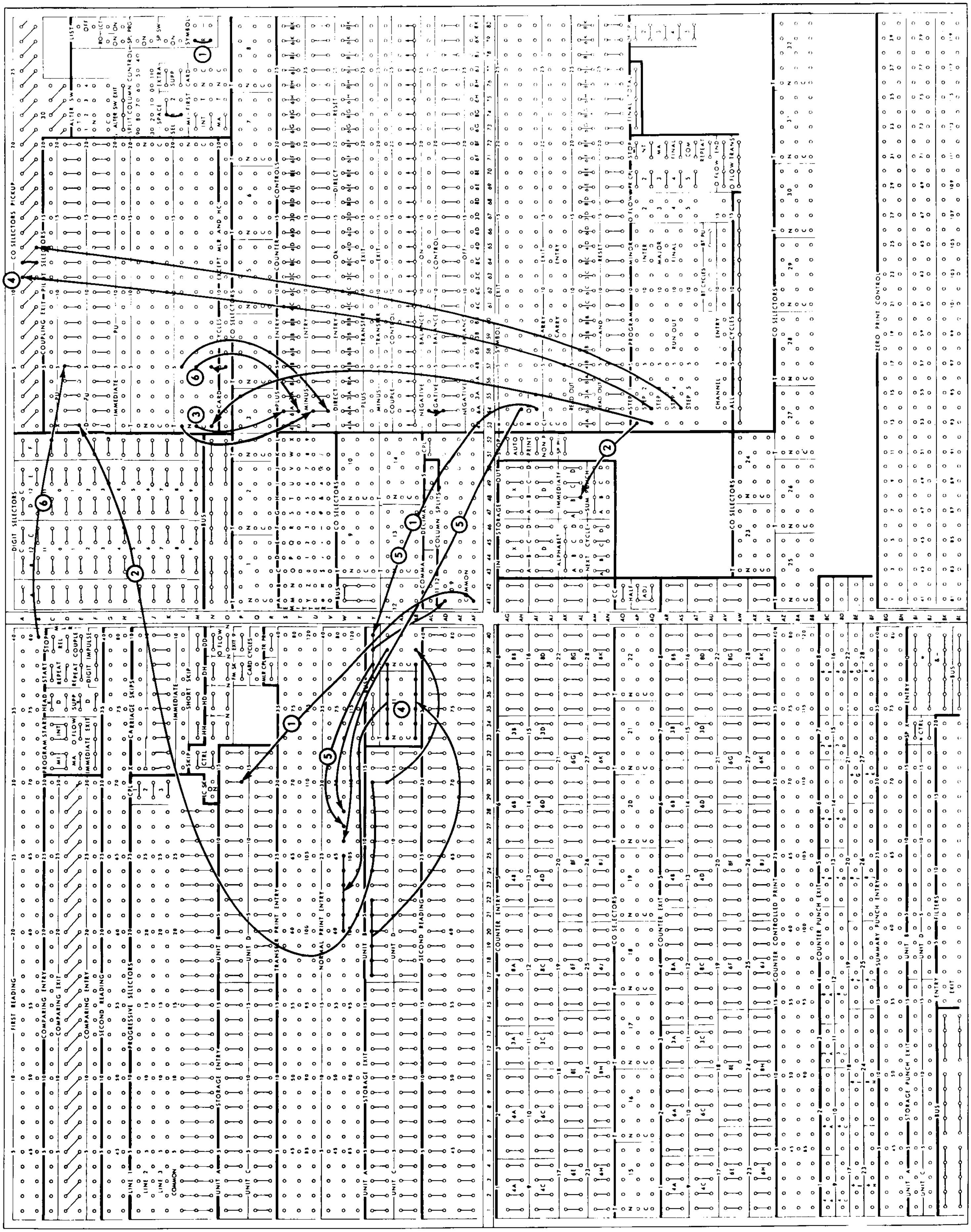


Figure 146. Storage Unit used as a Substitute for Counter, Adding and Subtracting

When subtraction is to be included in the preceding example, it is necessary to carry the sign of the total into the storage unit on every transfer from counter to storage. One method of accomplishing this is to wire the R or — hub of the counter being used to a separate position of the storage unit. With the symbol switch set for R, the R or — hub emits an X-9 impulse whenever the counter is impulsed to subtract or whenever the counter is negative and is impulsed to read out. The X impulse is separated from the 9 impulse through a column split.

The purpose of storing the sign of the total is to control properly the addition or subtraction of the stored total when it is transferred into the counter, and to identify a negative final total with a minus (—) symbol on the run-out final total cycle.

The wiring shown is in addition to that demonstrated in the preceding example, with the exception of the intermediate program wiring to counter 6A plus, which is changed.

1. The R or — symbol switch is wired to R. The R OR — for counter 6A is wired through a column split to any available position in storage entry B. The X impulse (part of X9 for R) reaches the storage unit whenever the counter is negative, and the storage unit is impulsed to READ IN.

2. The corresponding position of STORAGE EXIT is wired to the PICKUP of pilot selector 1. The storage unit is impulsed to READ OUT on a minor program so that the credit signal (X) picks up pilot selector 1 in time to select the intermediate program impulse. Co-selectors 11 and 12 prevent the total in storage unit B from printing on the minor program cycle.

3. Because the transfer from storage to counter takes place on step 2, INTERMEDIATE PROGRAM is wired through pilot selector 1 to add or subtract in counter 6A. Pilot selector 1 is normal when the total in storage is plus (no X in position 14), and transferred when the total in storage is minus (X in position 14).

4. The total in storage prints on the run-out final through the TRANSFERRED sides of co-selectors 11 and 12. If the final total is minus, the X impulse in position 14 of the storage unit prints a minus (—) symbol from printwheel 68.

5. The CR symbols for credit minor totals are wired normally.

6. Normal counter control wiring to add NX80 and subtract X80 on card cycles.

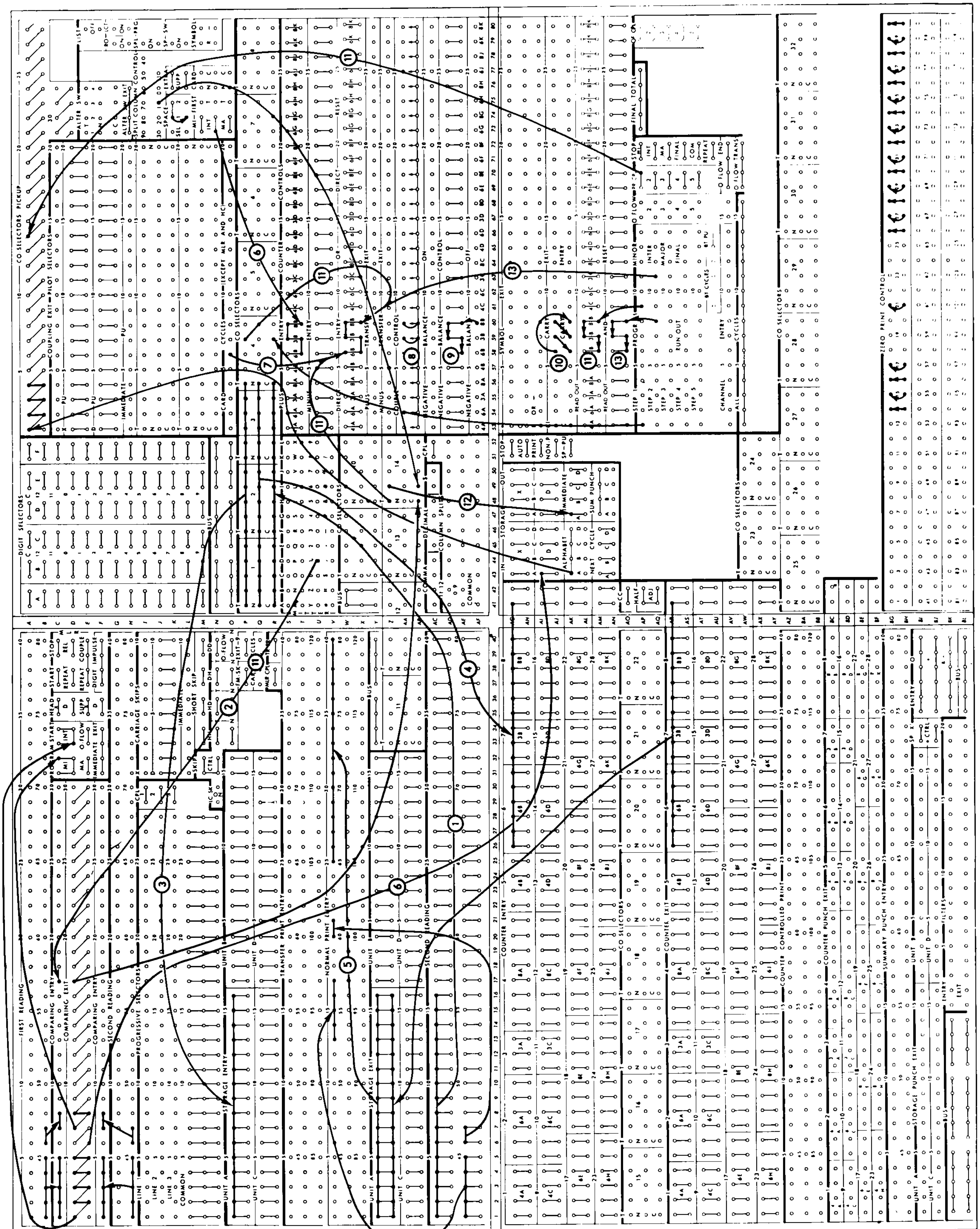


Figure 147. Storing 16 Alphabetic Characters using One Storage Unit

1. Information to be stored is wired to the COMMON of co-selectors 1, 2, 3 and 4.

2. Co-selectors 1, 2, 3 and 4 are transferred for the reading of zones and is normal for the reading of digits by picking them up from a storage alphabet hub.

3. The zone impulses for the field to be stored are wired to STORAGE A ENTRY from the TRANSFERRED side of co-selectors 1, 2, 3 and 4. These selectors are transferred for the reading of 0, 11 and 12 impulses.

4. The digit impulses for the field to be stored are wired to COUNTER ENTRIES 6B, 3B and 8B from the NORMAL side of co-selectors 1, 2, 3 and 4. These selectors are normal for the reading of 1 through 9 impulses.

5. Both the zones and the digits are wired from STORAGE EXIT A and COUNTER EXITS 6B, 3B and 8B to NORMAL PRINT ENTRY 25-40.

6. Because the information to be stored is to be read from the first card of each intermediate group, the intermediate first card hub is wired to the PLUS of counters 6B, 3B, and 8B, and the intermediate comparing exit hubs are wired to storage A READ IN D. The information is accepted by the storage unit on the following card feed cycle.

7. A card cycles impulse is wired to DIRECT ENTRY of 6B, 3B and 8B so that the digit impulses can enter the counter directly in the first half of the cycle. This is necessary because the COUNTER EXITS are not wired to COUNTER-CONTROLLED PRINT and because the information to be stored should not print on the indicate cycle.

8. The couple control hubs for counter 3B and 8B are connected. The high order counter is never wired for COUPLE CONTROL.

9. NEGATIVE BALANCE OFF of the low counter 8B is wired to NEGATIVE BALANCE CONTROL of all three counters.

10. CI of the high order counter is wired to the C of the low order counter. All remaining CI and C hubs are connected beginning at the right.

11. The counters are impulsed to read out on a minor program cycle. Only the digits 1-9 are wanted. To keep zeros from reading out and interfering with corresponding storage exits, a HALF AFTER 1 impulse, made by comparing a character emitted 1, is wired to the DIRECT ENTRY of counters 6B, 3B and 8B through the TRANSFERRED side of co-selector 14. Co-selector 14 is picked up from MINOR PROGRAM COUPLE. This suppresses the reading out of zeros on the minor program cycle.

Because the direct entry hubs hold only for the duration of the impulse wired to them, the HALF AFTER 1 is supplemented by wiring MINOR PROGRAM through the TRANSFERRED side of co-selector 4 to DIRECT ENTRY. Co-selector 4 is picked up at half after 1.

12. The storage unit is impulsed to read out zone impulses only on a minor program by wiring SPLIT COLUMN CONTROL 1 through the TRANSFERRED side of co-selector 14 to immediate OUT. This wiring prevents interference during the read out of 9-1 digits from the counters.

13. Counters 6B, 3B and 8B are wired for DIRECT RESET on the intermediate program. Direct resetting is necessary because the COUNTER EXITS are not wired to COUNTER-CONTROLLED PRINT.

Summary Punching

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

Summary cards are generally punched during the preparation of detail reports by a summary punch machine connected to the accounting machine by a cable, as shown in Figure 148.

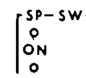
Summary-punch machines—IBM 514, 519, 523, and 528—can be used with the 407 Accounting Machine. The summary punch has a cable that must be connected to the receptacle provided for it on the lower left side of the accounting machine. This cable must be disconnected when either machine is used independently.

Up to 80 columns of information may be summary punched at one time. The only wiring required on the summary punch panel is the connecting of 80 COUNTER EXITS to the 80 PUNCH POSITIONS. No selectors are required on the summary punch, because all selected wiring is accomplished on the 407 control panel. All selectors that are available on the accounting machine, as well as storage units, emitters and counters, can be used for summary punch purposes.

Alphabetic, as well as numerical information, can be summary punched either from the storage unit or from the emitter. Special character information can also be summary punched when wired from the emitter.

All 80 COUNTER EXIT positions on the summary punch should be wired position for position to the 80 punch magnet hubs. No further wiring is necessary on the summary punch control panel.

Only the summary-punch wiring is explained in Figure 149, which illustrates control-panel wiring for summary-punching minor totals.



K-L, 79

SP-SW (Summary Punch Switch). This switch must be wired ON whenever cards are summary punched. The switch provides an interlock that delays the accounting machine while summary cards are being punched, and stops both machines when the last card leaves the hopper of either machine. Whenever the summary punch switch is turned OFF or ON for different operations, SP-SW must be wired directly through an alteration switch selector. Co-selectors or pilot selectors cannot be used.

When used as a summary punch, the 523 differs in operation from the 514, 519, and 528. If the summary punch switch is disconnected in any way, such as by opening the 407 control panel door or by use of an alteration switch, the 523 START key must be pressed again to resume operation.

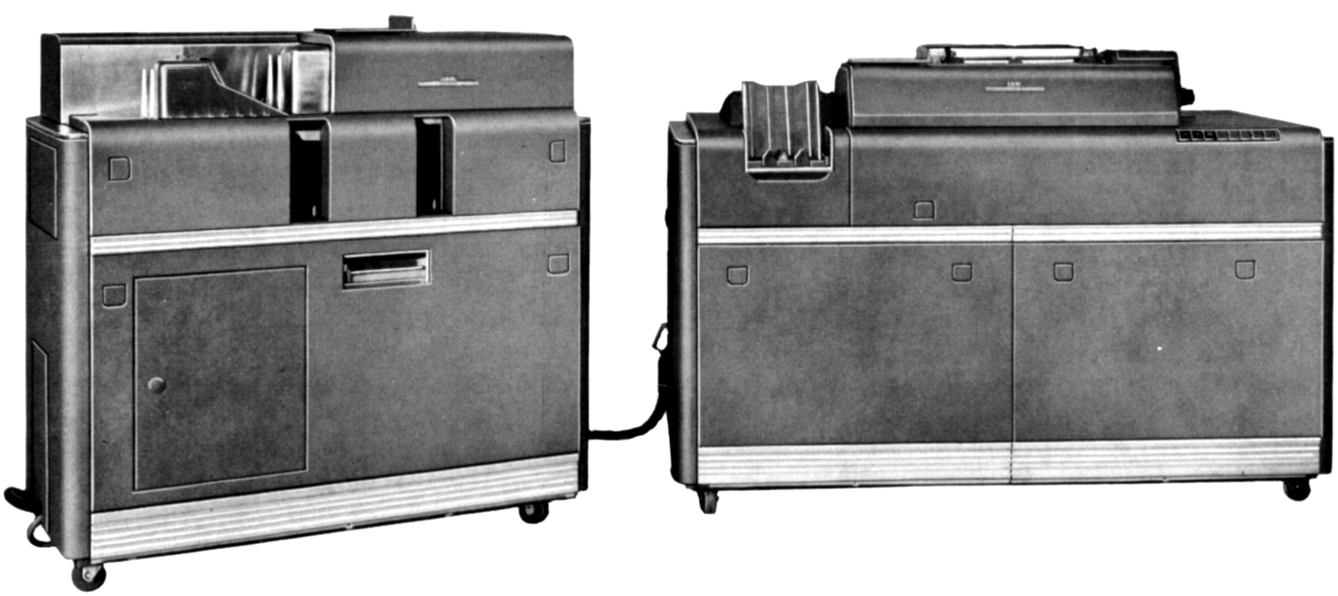


Figure 148. IBM 407 Accounting Machine Attached to IBM 514 Summary Punch

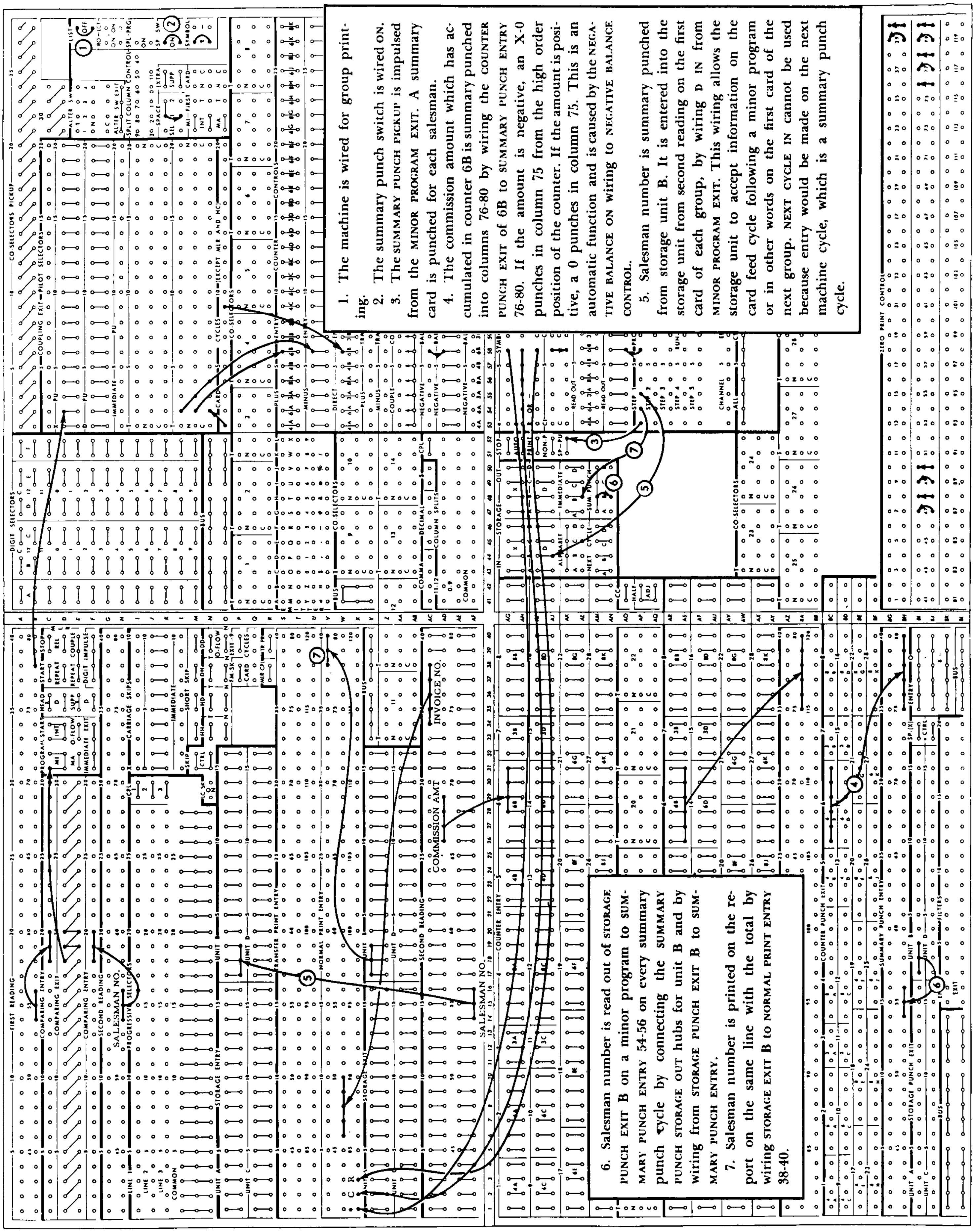
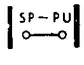
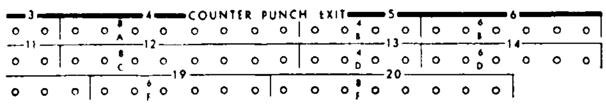


Figure 149. Summary Punching Minor Totals



AK- 51-52

SP-PU (Summary Punch Pickup). Summary punching may be initiated on any program change by impulsing SP-PU. If a PROGRAM EXIT is wired to the pickup, summary punching takes place just before the total prints. More than one type of total can be summary punched in the same run. When summary punching is initiated, the advancement of the program is delayed until summary punching is completed, at which time programming continues and totals print.

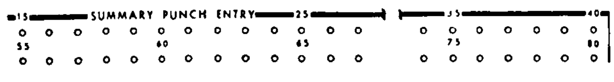


BC-BF, 1-42

Counter Punch Exit. For each counter position there is a corresponding counter punch exit hub. COUNTER PUNCH EXITS read out automatically during the first half of the cycle whatever data stood in the counter on the preceding cycle. They are normally wired to SUMMARY PUNCH ENTRY, which accepts information from them only when the SUMMARY PUNCH PICKUP is impulsed. When NEGATIVE BALANCE ON is wired, an X is emitted from the high-order position of each COUNTER PUNCH EXIT whenever that counter contains a converted negative figure to be used to identify credit summary cards. The X may be punched in any column of the card by the use of the column splits. When NEGATIVE BALANCE ON or OFF is wired, an X is emitted from the high order position of each counter for zero balances.

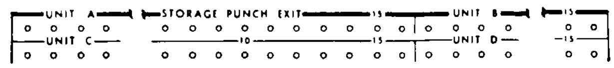
COUNTER PUNCH EXITS can also be wired either to TRANSFER PRINT ENTRY, NORMAL PRINT ENTRY, STORAGE ENTRY, or other COUNTER ENTRIES, even though the machine is not wired for summary punching. However, COUNTER PUNCH EXITS wired to these hubs must be selected so that they are available only when the counter is inactive, i.e., not adding, subtracting, or resetting. The only exception to this is if the counter is direct reset; then these hubs may be used.

Summary Punch Entry. The 80 SUMMARY PUNCH ENTRY positions represent the 80 columns of the card.



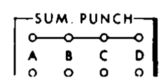
BG-BH, 1-40

Information to be summary punched must be wired to these hubs from the COUNTER PUNCH EXITS, STORAGE PUNCH EXITS, or from the EMITTER. Because the summary punch entry hubs are located on the accounting machine, full use can be made of the character emitter, counters and storage units.



BI-BJ, 1-32

Storage Punch Exit. Each storage unit has a corresponding set of storage punch exit hubs. They are used for summary punching either alphabetic or numerical information from the storage units. Each unit may be individually controlled to read out on a specific summary punch cycle. They offer the only means of summary punching alphabetic information from the card. Because only the left-hand eight positions of a storage unit can be used for storing letters of the alphabet, only the left-hand eight positions of STORAGE PUNCH EXIT can be used for summary punching them. All sixteen positions can be used for numerical information. These hubs are common with storage exit hubs.



AM-AN, 47-50

Summary Punch—Storage Out. Each storage unit has an independent summary-punch read-out hub, which, when connected to any hub immediately above it, causes the storage unit to read out on every summary-punch cycle. If a storage unit is read out only on specific summary-punch cycles, the lower hub must be impulsed from a corresponding PROGRAM COUPLE.

Eliminating Zero Balance Summary Punching

Zero balance summary punching can be eliminated by controlling the impulse wired to SP-PU through the NORMAL side of a pilot selector picked up from NEGATIVE BALANCE OFF. It is necessary, however, to advance the program on which summary punching is to take place one step. In other words, if the minor program would be normally used to cause summary punching, it must be changed to intermediate if zero balances are to be eliminated. All counter and storage units

must read out on the program used to impulse summary punching.

Figure 150 shows only the wiring necessary to impulse summary-punching on a zero-balance condition.

An additional step is required because the negative balance off hub, which is used to pick up a pilot selector through which the summary punching is controlled, emits an impulse later in the cycle than the programs it is attempting to select. Unless the pilot selector is picked up one step in advance of the program used to impulse SP-PU, the program impulse reaches SP-PU before the selector transfers and zero balance summary punching would not be eliminated.

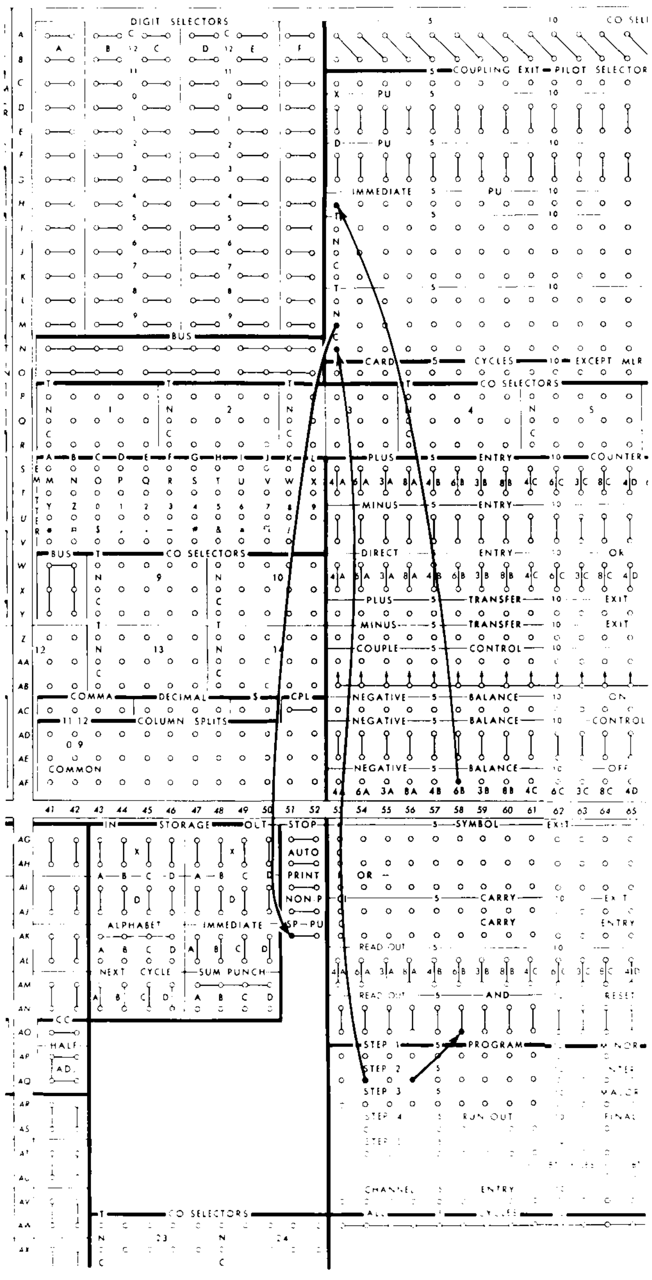
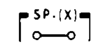


Figure 150. Eliminating Zero Balance Summary Punching

Because of the additional step required for this operation, three cycles (one to pick up the selector, one for summary punching, and one for total printing) instead of two are taken every time a card is summary punched. Good judgment dictates a study of the problem to determine whether the added time required offsets the advantage gained by zero balance summary-punch elimination.



BI, 33-34

SP-X (Summary Punch X). These hubs emit an X-impulse every machine cycle, including all summary punch cycles. When properly controlled, through selectors, they are normally used to distinguish one type of summary card from another, such as minor from intermediate, to identify debit or credit totals punched from storage. All summary cards can be X-punched by wiring SP-X directly to SUMMARY PUNCH ENTRY.

Eliminating X Punching for Zero Balances

The credit X punches from the high order position of the counter punch exit for zero balances as well as for negative balances. If the X is not desired for zero balances, it can be eliminated by the wiring shown in Figure 151.

Punching a Credit X over the Amount Field

The credit X punches from the counter's high-order position, which must normally be reserved for detection of a negative balance. For a negative balance, this position of the counter emits an X and 0 impulse; for a positive balance, it emits a 0 impulse. The 0 can be eliminated and the X punched anywhere in the card or over any position of the amount field by use of column splits (Figure 152).

Punching X's for Debit Balances

An X may be punched to identify debit balances instead of credit balances by the use of a pilot selector. A column split is also required if the X is to be punched over a digit (Figure 153).

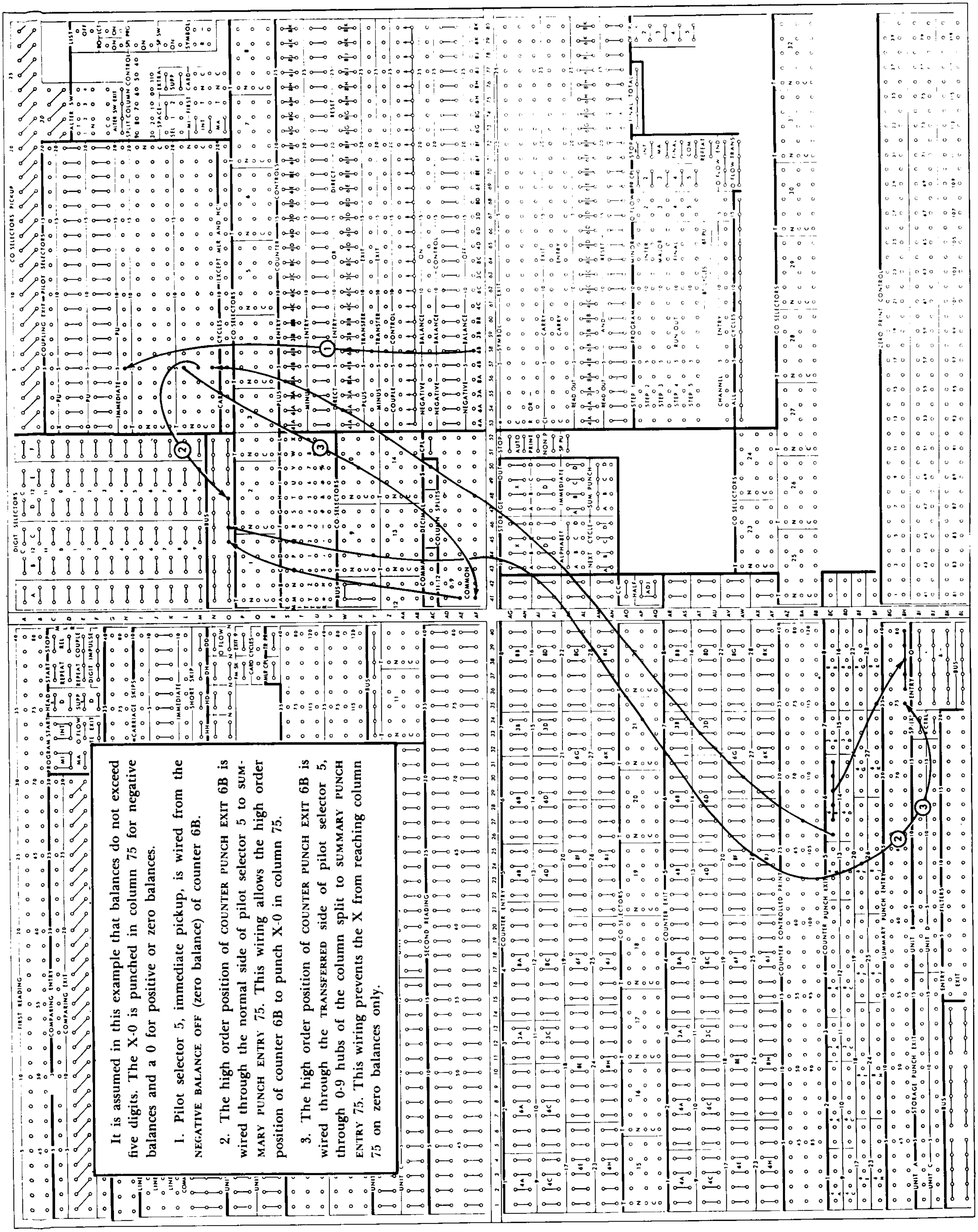


Figure 151. Eliminating X-Punching for Zero Balances

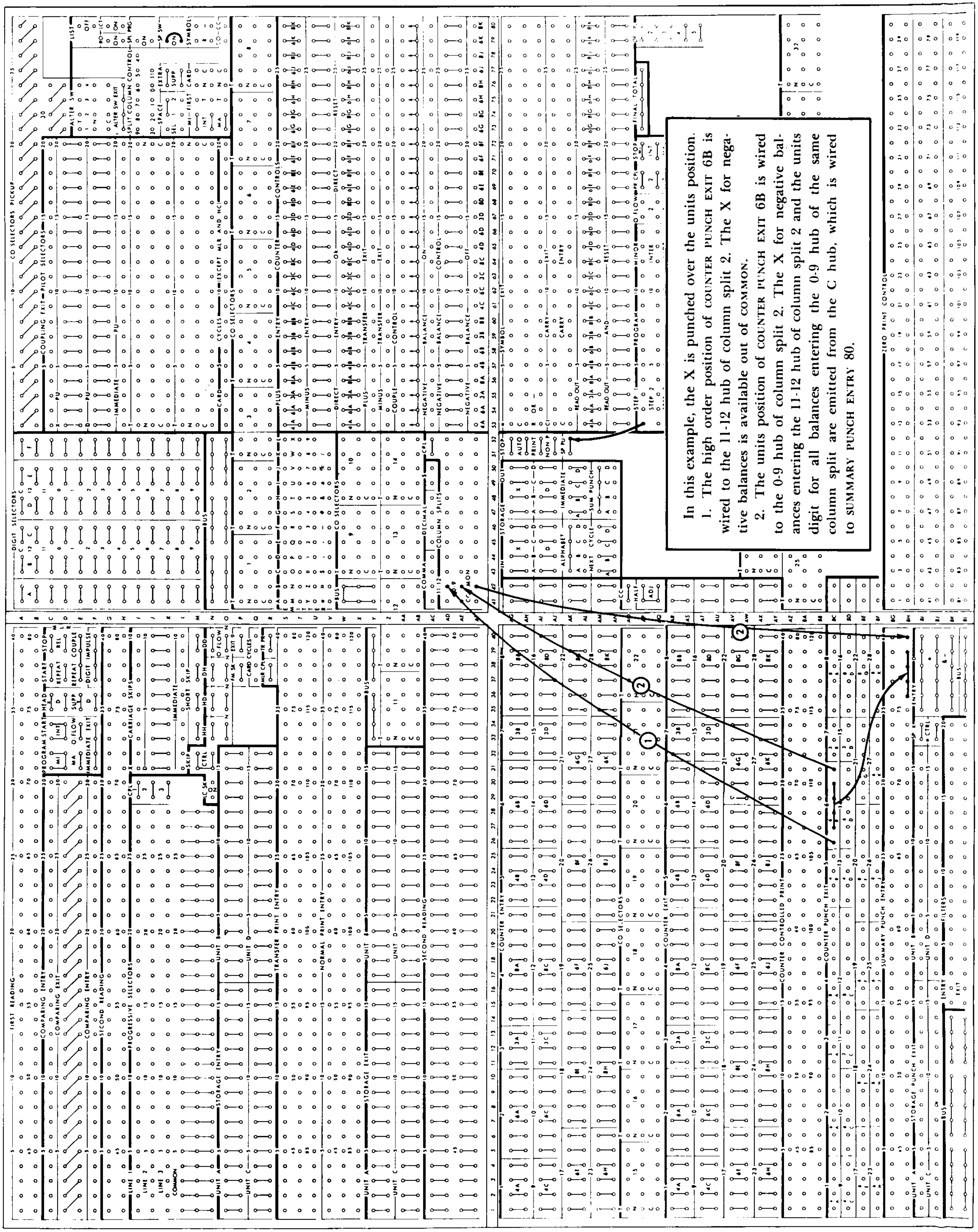


Figure 152. Punching a Credit X Over the Amount Field

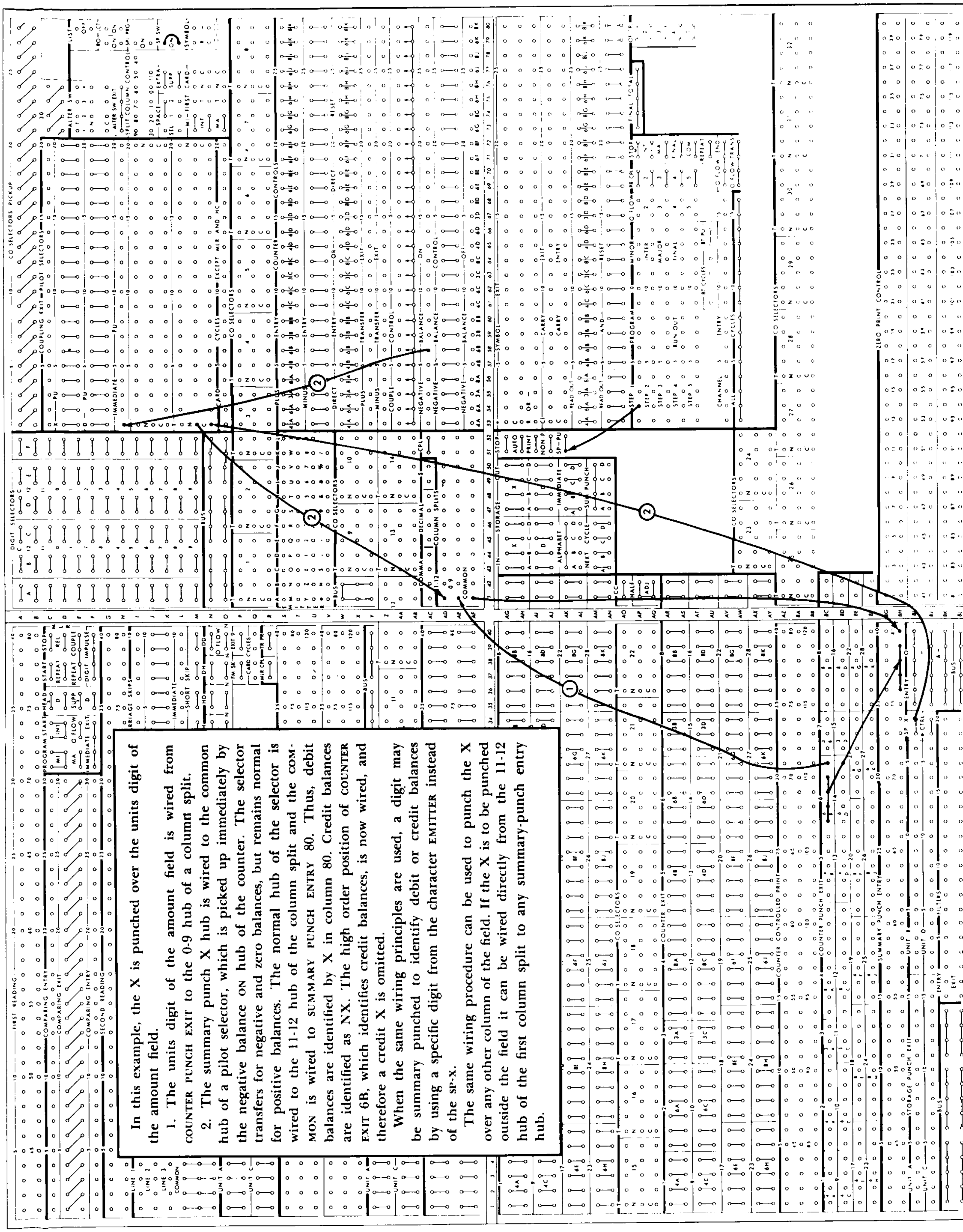


Figure 153. Punching X's for Debit Balances

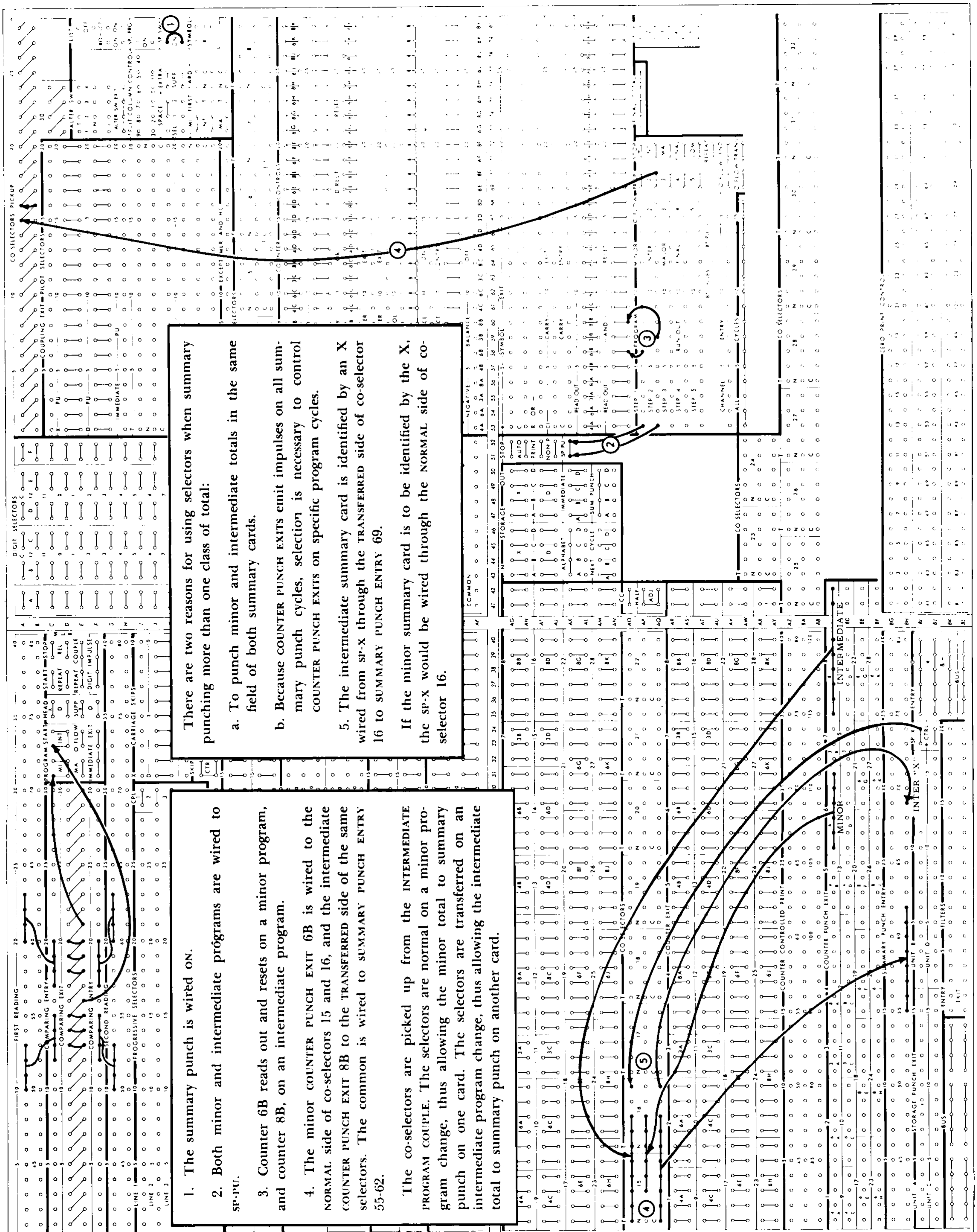


Figure 154. Summary Punching Minor and Intermediate Totals

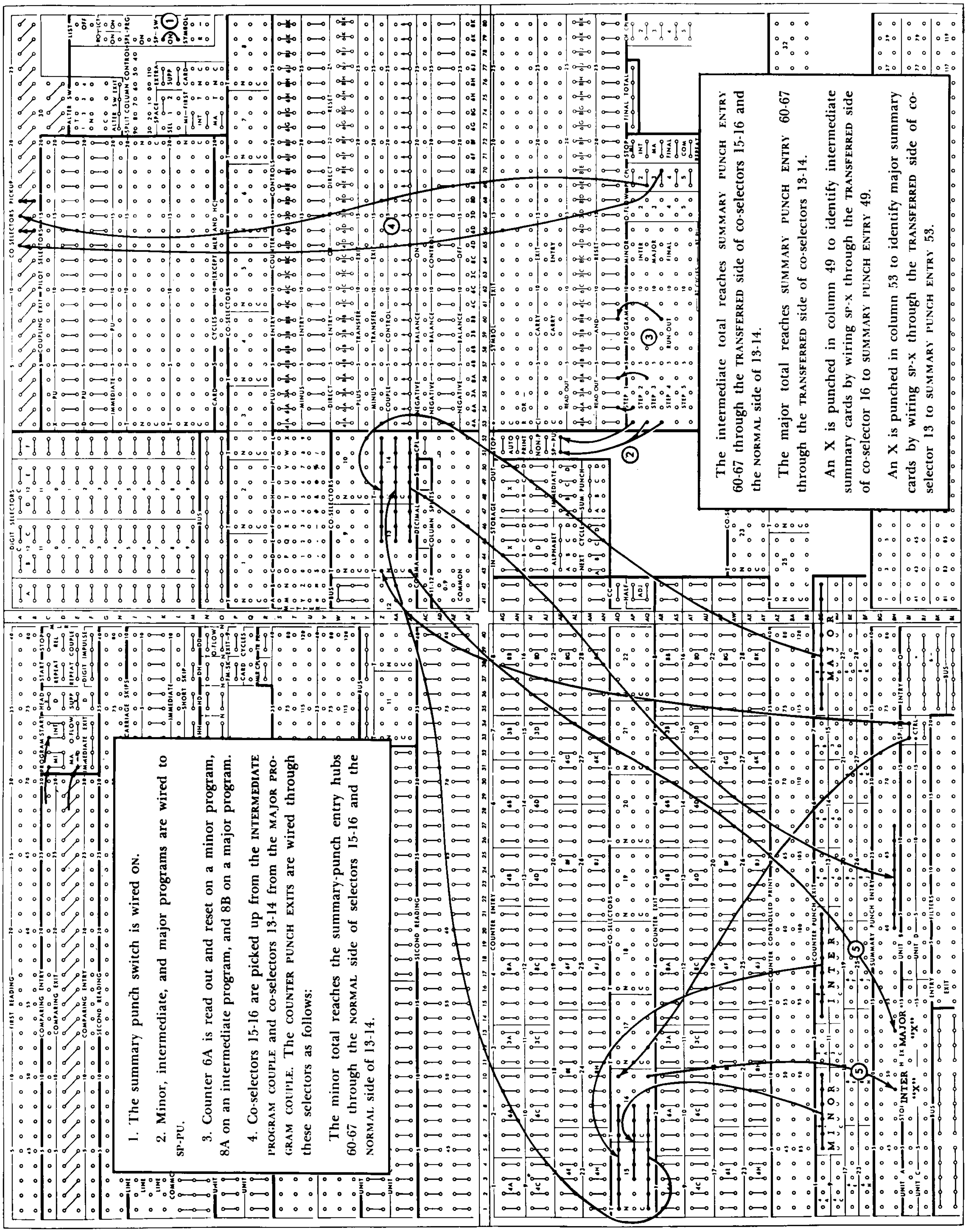
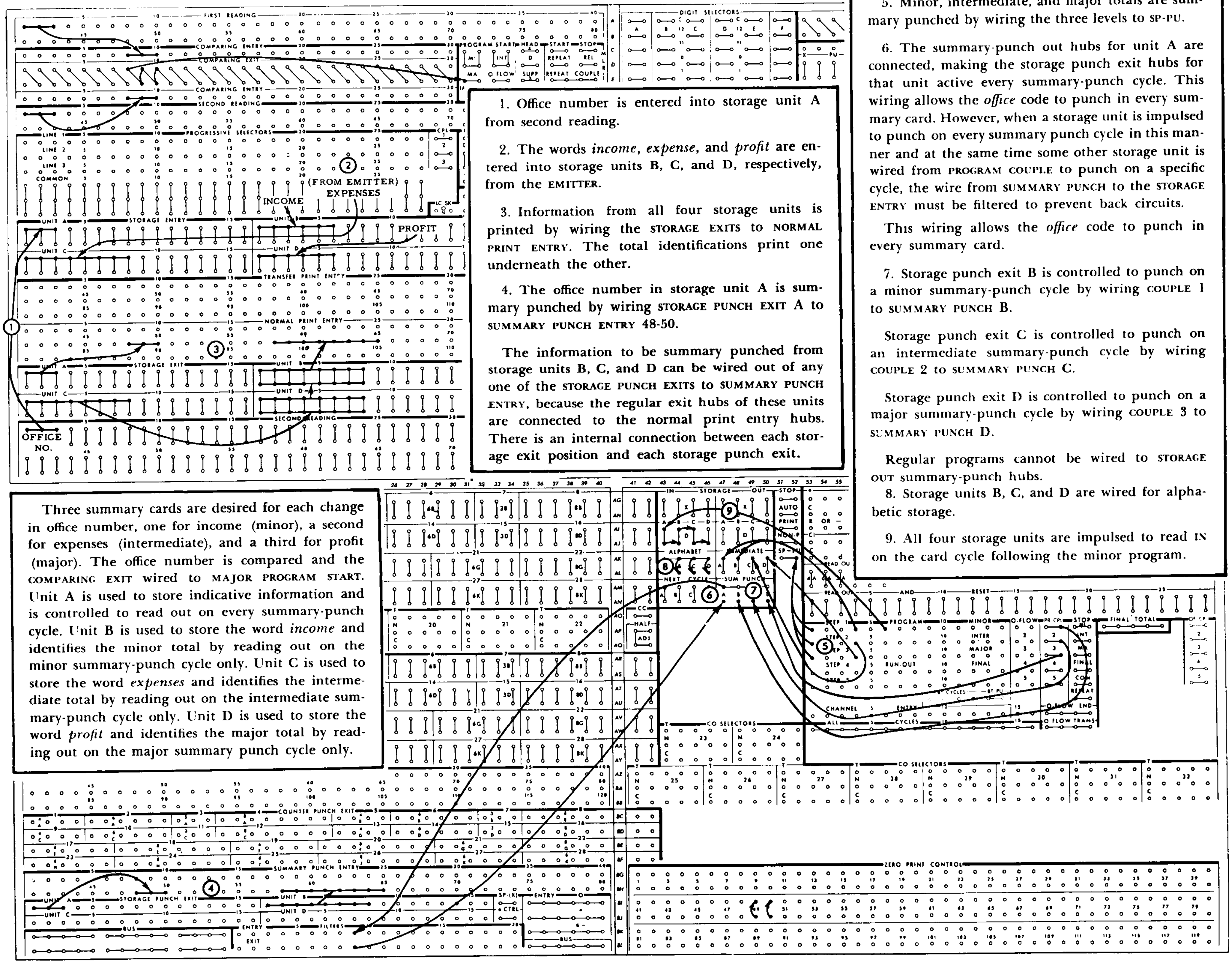


Figure 155. Summary Punching Minor, Intermediate, and Major Totals



1. Office number is entered into storage unit A from second reading.

2. The words *income*, *expense*, and *profit* are entered into storage units B, C, and D, respectively, from the EMITTER.

3. Information from all four storage units is printed by wiring the STORAGE EXITS to NORMAL PRINT ENTRY. The total identifications print one underneath the other.

4. The office number in storage unit A is summary punched by wiring STORAGE PUNCH EXIT A to SUMMARY PUNCH ENTRY 48-50.

The information to be summary punched from storage units B, C, and D can be wired out of any one of the STORAGE PUNCH EXITS to SUMMARY PUNCH ENTRY, because the regular exit hubs of these units are connected to the normal print entry hubs. There is an internal connection between each storage exit position and each storage punch exit.

5. Minor, intermediate, and major totals are summary punched by wiring the three levels to SP-PU.

6. The summary-punch out hubs for unit A are connected, making the storage punch exit hubs for that unit active every summary-punch cycle. This wiring allows the *office* code to punch in every summary card. However, when a storage unit is impulsed to punch on every summary punch cycle in this manner and at the same time some other storage unit is wired from PROGRAM COUPLE to punch on a specific cycle, the wire from SUMMARY PUNCH to the STORAGE ENTRY must be filtered to prevent back circuits.

This wiring allows the *office* code to punch in every summary card.

7. Storage punch exit B is controlled to punch on a minor summary-punch cycle by wiring COUPLE 1 to SUMMARY PUNCH B.

Storage punch exit C is controlled to punch on an intermediate summary-punch cycle by wiring COUPLE 2 to SUMMARY PUNCH C.

Storage punch exit D is controlled to punch on a major summary-punch cycle by wiring COUPLE 3 to SUMMARY PUNCH D.

Regular programs cannot be wired to STORAGE OUT summary-punch hubs.

8. Storage units B, C, and D are wired for alphabetic storage.

9. All four storage units are impulsed to read IN on the card cycle following the minor program.

Three summary cards are desired for each change in office number, one for income (minor), a second for expenses (intermediate), and a third for profit (major). The office number is compared and the COMPARING EXIT wired to MAJOR PROGRAM START. Unit A is used to store indicative information and is controlled to read out on every summary-punch cycle. Unit B is used to store the word *income* and identifies the minor total by reading out on the minor summary-punch cycle only. Unit C is used to store the word *expenses* and identifies the intermediate total by reading out on the intermediate summary-punch cycle only. Unit D is used to store the word *profit* and identifies the major total by reading out on the major summary punch cycle only.

Figure 156. Summary Punching with Variable-Storage Read-Out

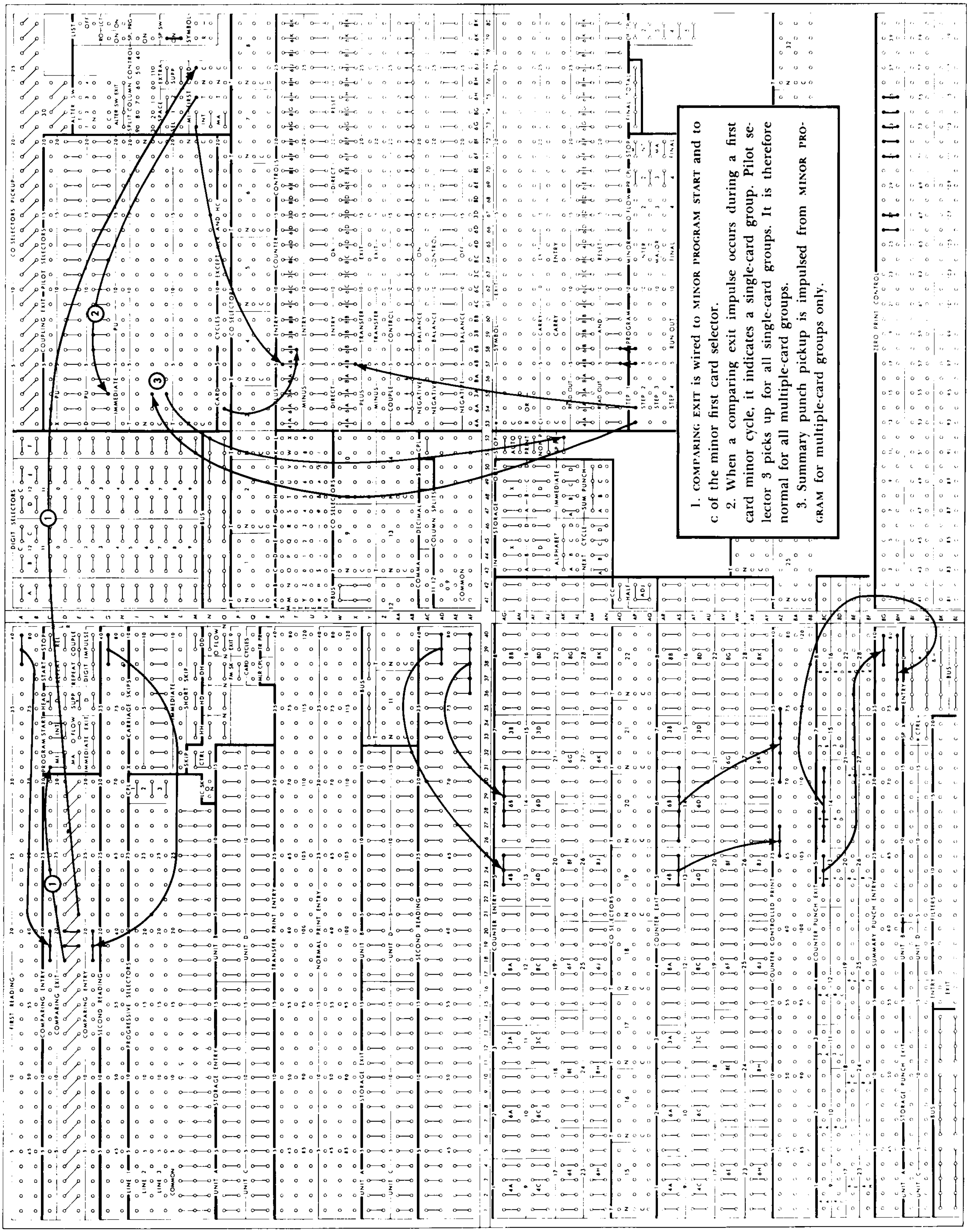


Figure 157. Summary-Punch Elimination for Single-Card Groups

Summary Punching More Than One Class of Total

More than one class of total can be summary punched on separate cards during the same operation. The totals to be summary punched must be selected so that they punch in turn, that is, minor first, intermediate second, and major third. Otherwise, all three totals are punched whenever anyone of them is punched. The selection is done on the IBM 407 control panel as shown in Figures 154 and 155.

Summary Punching with Variable Storage Unit Read Out

Figure 156 demonstrates the use of all four storage units in a summary punch operation, each one reading out information to be punched, independently of the others.

Summary Punch Elimination for Single-Card Groups

The elimination of summary punching for single-card groups is often desirable, particularly when single-card groups constitute a large percentage of a machine run or when card consumption is excessive. The summary punch is then controlled to operate for intermediate groups. Summary punching for single-card groups is eliminated.

On the IBM 407, summary-punch elimination for single-card groups is controlled by selection of the summary-punch pickup impulse as illustrated in Figure 157.

Operating Rules and Suggestions

Before a feature or a control-panel hub was used in this manual, it was described. Because of the wide flexibility in use of hubs, however, it was not always possible to present some of the corrective measures that must be taken when a feature or a control-panel hub is used in a somewhat unusual way, without complicating the basic instruction. Some of the measures are described here.

Immediate Pick Up of Selectors

An impulse to the pickup of a co-selector or to the immediate pick-up of a pilot selector must come before any impulse that can go through the transferred points of the selector. There should be a timing interval of at least 7 degrees (see timing charts, Figures 177 and 178) between the immediate pick-up of a selector and any impulses to or from its transferred hubs.

Proper Use of Filters

It is generally assumed that a filter allows current to go in only one direction—from ENTRY to EXIT—and thus can be used to eliminate back circuits. Filters, however, do not entirely eliminate back circuits. A little current passes in the opposite direction—from EXIT to ENTRY—but so little that the reverse current cannot operate any feature of the machine. Also, as current passes through a filter, there is a slight loss of power.

Filters were originally installed to permit flexibility in the control of zero printing and amount punctuation as well as for the control of special character printing, such as minus, ampersand, and dollar signs. To eliminate back circuits for purposes other than those for which filters were originally intended, selectors should be used whenever possible. Improper use of filters not only causes improper machine operation but can also damage the filters.

Quite often one or more comparing positions can be used to avoid using filters; for example, digits 1 and 3 can be used to pick up two pilot selectors independently. They can also be used in combination to pick up a third selector. If digits 1 and 3 are wired to the upper and lower hub of the same comparing position, the comparing exit becomes the pickup impulse for either digit. The comparing exit impulse comes from a completely independent source and, therefore, cannot in any way interfere with the proper control of the other two selectors.

Under certain conditions, filters can be used for purposes other than those for which they were originally intended; however, special consideration must be given to the following rules when filters are so used:

1. If a given impulse must pass through a filter to operate any feature in combination with another impulse, that same impulse must pass through another filter to operate any other feature. This is shown in Figure 158, where impulse A controls pilot selectors 2 and 4, and impulse B controls selector 4. Impulse A must be wired through a filter to each of the pilot selector pickup hubs.

2. An impulse must not pass through more than one filter in series to control a feature; in other words, the exit of one filter must not be wired to the entry of another filter (Figure 159).

3. Split-wiring through filters should not be used when such wiring creates reverse current paths for two or more different impulses at the same time, because the combination of both reverse currents can be sufficient to operate a machine feature erroneously. In Figure 160, if the impulses at first reading 15 and 19 occur at the same time, the reverse current through filters 2 and 8 combined might be sufficient to pick up selector 2.

4. A filter is built to take a certain load of electricity which, if exceeded, damages the filter and can cause the machine to operate improperly. Therefore, if one filter exit is used to control several similar or different features, reference must be made to a load rating table (Figure 162) to insure that the combined load rating does not exceed 4. For example, one filter exit can be used to pick up two co-selectors (combined rating 4) but cannot be used to pick up four co-selectors (combined rating 8) (Figure 161).

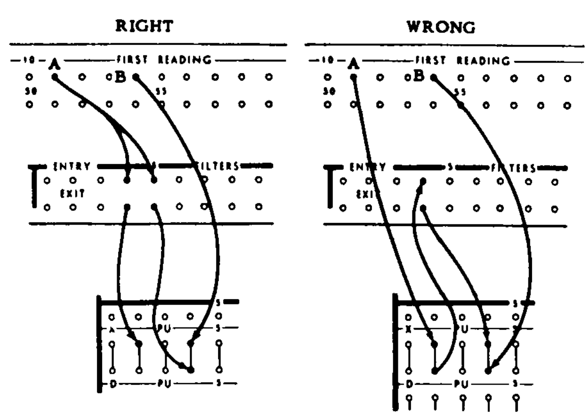


Figure 158. Filtering of Split Wires

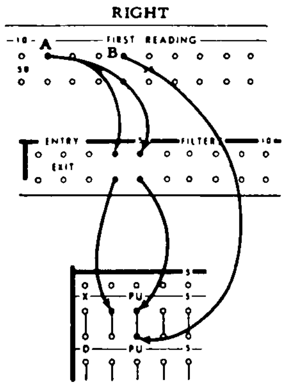


Figure 159. Proper Filtering of Wiring in Series

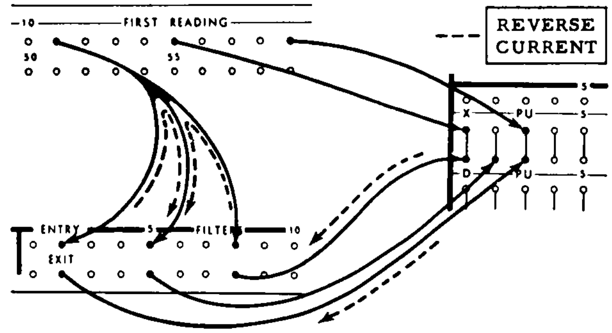


Figure 160. Reverse Current Picking Up Selector Erroneously

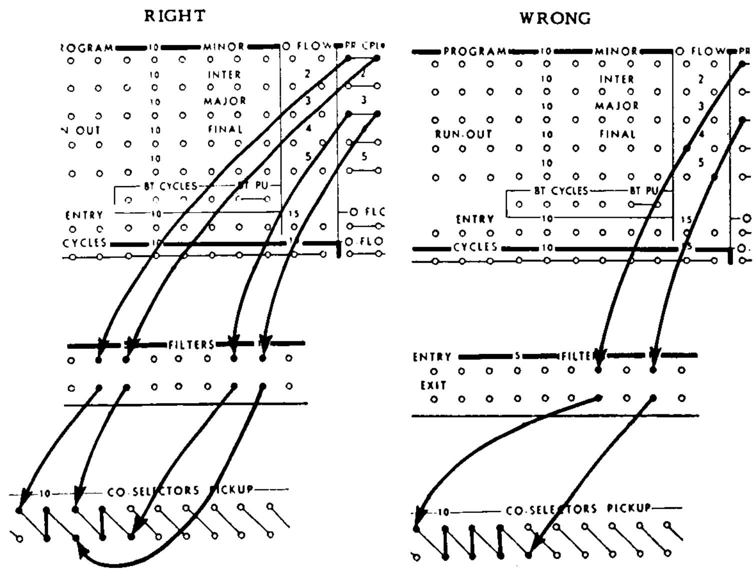


Figure 161. Load Capacity Limits

CONTROL PANEL ENTRY HUB	LOAD RATING	CONTROL PANEL ENTRY HUB	LOAD RATING	CONTROL PANEL ENTRY HUB	LOAD RATING
Auto Stop	1	Head Supp, X, D	3	Runout Switch	1
BT PU	1	Head X, D	3	Short Skip	2
Carriage Skips X, D, I	1	LC SK	*	Skip Control	3
Carry Entry	*	LCT	1	Space 1, 2, Extra, Sel.	3
Column Split Cpl	*	List Off	1	Space Supp.	3
Comparing Entry	1	MLR Release	1	Spl. Prg.	2
Co-Selector Pickup	2	MLR Repeat	1	Stop	2
Counter Control (plus, minus, read out)	1	MLR Start	1	Storage Entry	2
Counter Controlled Print	3	MLR Stop	2	Storage (Sp) — Immediate	1
Ctr Control (RO and RE)	2	Neg. Bal. Control	1	Storage — In-Out, X, D, Next Cycle, Alpha.	1
Counter Couple Control	1	Non-Print	3	Storage — Summary Punch	3
Counter Entry and Exit	3	Normal Print Entry	3	Summary Punch Entry	3
Cpl Progressive Selector	*	Overflow End	2	Summary Punch Pickup	4
Dir Entry or Dir Reset	1	Overflow Trans.	2	Summary Punch Switch ON	1
FM-SK	3	Pilot Sel I, X, D Pickup	1	TR PR	*
		Program Repeat	2	Transfer Print Entry	3
		Program Start	1	Zero Print Control	#2
		Program Stop (Mi, Int, Ma, Final, Com.)	4		

* Must not be wired through filters.

When filters are necessary for zero print control, one filter must be used for every two positions to the right of the decimal.

Figure 162. Load-Rating Table

Direct Entry or Direct Reset (Figure 163)

When lacing DIRECT ENTRY or DIRECT RESET from one counter group to another, the following rules must be kept in mind:

1. The direct entry hubs of up to five counter groups can be laced, provided that they are all added at the same time, subtracted at the same time, and reset at the same time. Example B is wrong because the three counter groups are cleared on different program cycles. The wiring can be corrected by impulsing each DIRECT ENTRY position from three independent CARD CYCLES.

2. PROGRAM EXITS can be laced from one DIRECT RESET to another up to a maximum of five counter groups, provided that the corresponding counter groups add or subtract at the same time. Example D is wrong, because the three counter groups are impulsed to add at different times. The wiring can be corrected by impulsing each direct reset position from three independent MINOR PROGRAM EXITS.

NOTE: DIRECT ENTRY should not be coupled to the plus or minus hubs.

Counter Coupling

When counters are coupled and only some of them need to be reset directly, impulses to the plus and minus hubs of the coupled counters must be isolated and not laced from one counter to the other.

In example A (Figure 164), counter 6A is used to accumulate dollar amounts, and counter 3A, to accumulate cents. The cents are not to be printed, so counter 3A is cleared on a minor program by DIRECT RESET. When there is a positive balance in the two counters, counter 6A is reset normally, that is, by subtracting in the second half of the cycle to reach a zero balance. The minus impulse travels over the external wiring to counter 3A minus and cause that counter to subtract also. However, because counter 3A is cleared by DIRECT RESET, the plus hubs have already been impulsed internally. Thus, counter 3A adds, subtracts, reads out, and resets, all at the same time. This causes faulty counter operation in the entire machine and could give erroneous results.

To correct this condition, the minus and plus hubs of the two counters are isolated by wiring independent

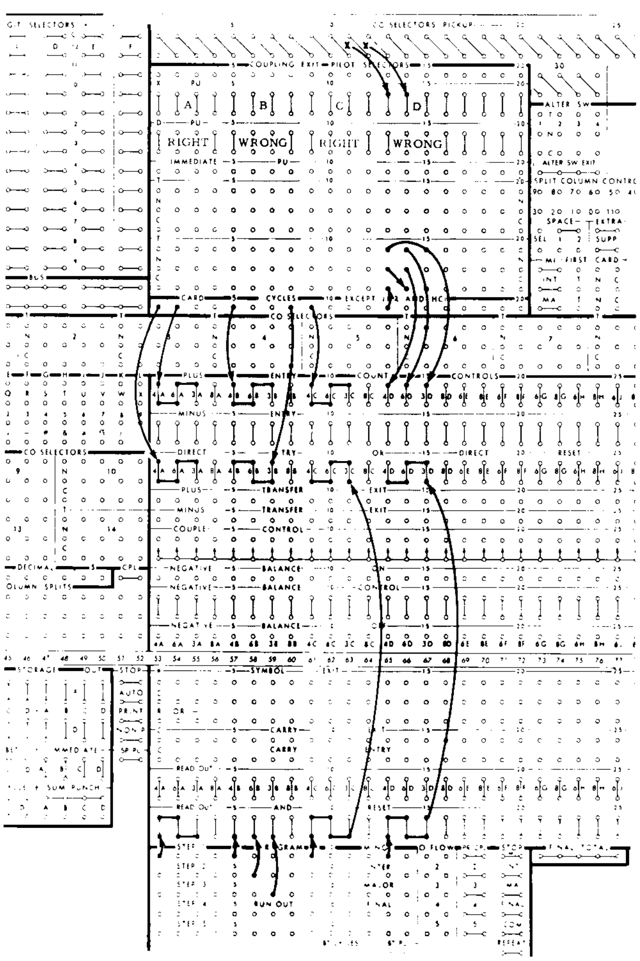


Figure 163. Direct Entry or Direct Reset

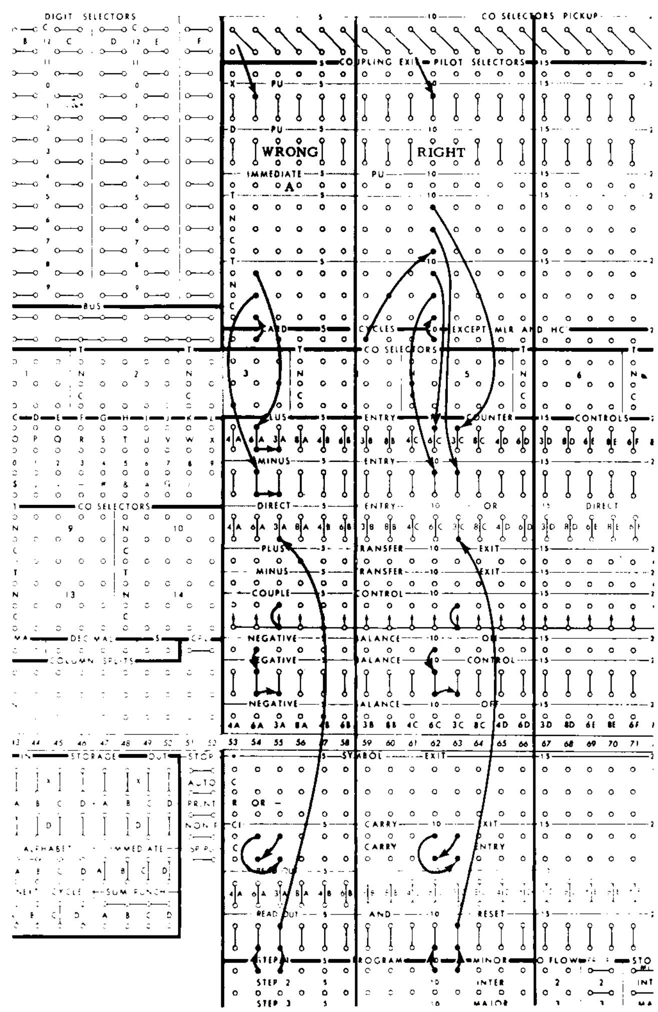


Figure 164. Counter Coupling

CARD CYCLES to the plus and minus hubs of each counter as shown in Example B (Figure 164). This prevents the internal minus impulse out of counter 6C minus hubs from reaching the minus hubs of counter 3C on the total cycle, because there is no common connection between the two.

Wiring of X's or 12's to Comparing and to Print Entry

When NORMAL OR TRANSFER PRINT ENTRY is wired directly from SECOND READING, X or 12 punches in otherwise numerical fields cause alphabetic printing. Zoning of the printwheel can be eliminated by wiring the column in which the X or 12 is punched through the 0-9 hubs of a column split.

When the control is on a numerical field in which an X or 12 is also punched for other purposes, the first and second reading positions must be wired through column splits to eliminate the X or 12 before wiring to COMPARING ENTRY. Otherwise, the extraneous X or 12 punch breaks control twice, the first time when the X or 12 is read by the first reading brush and the second time when the X or 12 is read by the second reading brush. An alternative method would be to wire the COMPARING EXIT to PROGRAM START through the 0-9 hubs of a column split.

When the X or 12 is punched in each card of a group in an otherwise blank numerical control field and the X or 12 is used to function as normal control, the X or 12 cannot, of course, be eliminated. However, the column in which the X or 12 is punched must be wired to the NORMAL OR TRANSFER PRINT ENTRY through the 0-9 hubs of a column split to prevent the X or 12 from spreading across the whole field through the ZERO PRINT CONTROL wiring. If the X or 12 to the printwheel is not eliminated, the X or 12 back-circuits as follows:

Internally through the ZERO PRINT CONTROL wiring to the adjacent PRINT ENTRY positions;

Externally from PRINT ENTRY to SECOND READING;

Internally from the lower set of second reading positions (AC-AF, 1-40) to the upper set (G-H, 1-40);

Externally from the upper set of SECOND READING positions to one side of the COMPARING ENTRIES.

Thus, each card in the group punched X or 12 breaks control as follows:

	Comparing Entry			
First Reading	X			
Second Reading	X	(X)	(X)	(X)

Example 1 below shows results obtained when the column containing the X or 12 is wired from SECOND READING to NORMAL OR TRANSFER PRINT ENTRY through a column split. Example 2 shows results obtained when the SECOND READING position is wired directly to NORMAL OR TRANSFER PRINT ENTRY.

Example 1		*Example 2*	
Control	*Amounts*	*Control*	*Amounts*
12345	25	12345	25
12345	50	12345	50
12345	25	12345	25
	100*		100*
(X)	75	(X)	75
(X)	25		75*
(X)	50	(X)	25
	150*		25*
12346	75	(X)	50
12346	125		50*
	200*	12346	75
		12346	125
			200*

(X) would not normally print in either example.

Note in example 2 that the three X-punched cards in the same group cause three control breaks for the reasons stated.

Because an X- or 12-punch in an otherwise blank field back-circuits to the adjacent SECOND READING positions when wired directly to NORMAL OR TRANSFER PRINT ENTRY, it is obvious that any feature controlled by an X- or 12-punch from any SECOND READING position within that field will operate erroneously.

The rule, therefore, is that any X- or 12- wired to comparing and to print but not intended for alphabetic or character printing should not be wired directly to normal or transfer print entry but should be eliminated through a column split.

Negative Balance On-Off

If a cycles impulse is allowed to back up into NEGATIVE BALANCE ON or OFF, the corresponding counter action could be affected, and an incorrect result obtained. Extreme care must be taken to prevent this back circuit. ON and OFF hubs controlling pilot selectors should be filtered.

Counter Punch Exits

COUNTER PUNCH EXITS were primarily intended for summary punching purposes and are normally wired to the SUMMARY PUNCH ENTRY. They cannot be wired directly to any other set of entries, such as to the pickup hubs of pilot selectors. They must be first selected so that they reach the entries at a time when the corresponding counter is not adding, subtracting, or resetting. There is one exception: COUNTER PUNCH EXIT impulses can reach entry hubs during a direct reset

operation. Although the COUNTER PUNCH EXITS can function when wired directly, considerable damage is done to the machine internally.

Maximum Number of Entries from One Source

One source hub (such as card cycles) can be split-wired to several entry hubs. However, for safe operation one source hub should not be wired to more than five entries. For example, one card-cycles hub should not be wired to more than five COUNTER-CONTROL PLUS entries, nor should one pilot selector COUPLE EXIT be wired to pick up more than five co-selectors.

Co-Selector Expansion

It might be necessary to select fields beyond the machine's capacity of co-selectors. Selection of printing can be accomplished with TRANSFER PRINT. Fields can also be selected through the PROGRESSIVE SELECTORS, provided that MLR is not used. Note that there are a set of common hubs and three sets of transferred hubs in the progressive selectors. There are no normal hubs.

Numeric fields can be selected through counters by using two counter groups and selecting a cycle impulse to control the addition. The field that is controlled to add is selected to print. A "hash" total is accumulated in each counter, and these should be cleared at the end of the run. This method allows printing of the letters S through Z as well.

Resetting a Counter on Successive Cycles

If a counter group is wired to reset on successive cycles, a false reset check may occur, even though the counter resets correctly. The successive reset of a counter group can be avoided by selection.

Overflow Program Concurrent with Run-Out Final

A problem exists when an overflow program is started at the same time as a run-out final program. The impulse from the last overflow program step to OVERFLOW END prevents the run-out final from taking place. This can be avoided by picking up a selector at last card time by wiring the LCT switch to the digit pickup of a pilot selector. The pulse to OVERFLOW END is wired from the COMMON. The last step in the overflow program is wired to NORMAL and a RUN-OUT FINAL is wired to TRANSFERRED.

Maximum Number of Zeros with Zero Print Control

Any number of adjacent zero-print positions can be wired, but one significant digit cannot be expected to provide a circuit for more than eight zeros to print.

Triple Spacing

Triple spacing can be accomplished without the use of the sel hubs by combination wiring of space hubs 1, 2, and extra. The principle is explained by Figure 165.

Program Couple Hubs and Overflow Couple Exits

The use of these hubs should be planned carefully. The wiring of more than one program couple hub or overflow couple hub to a common set of hubs results in backcircuits and, consequently, machine malfunction during program cycles.

Locating Counters Causing Reset Check Light

When the reset check light turns on during the testing of a control panel, it is usually caused by improper counter wiring. Specifically, the light turns on when a counter or group of counters, wired to reset, fails to reset to 9's (zero) for one reason or another.

A false reset check may occur on summary punch operations if the carriage overflow hub and the program step hub are wired to the same skip hub, with counters wired to read out and reset on the same program step. Wiring the program step hub through a filter to the skip hub corrects this condition.

RESET CHECK INDICATING LIGHTS

Late model machines are equipped with reset check indicator lights that are physically located on the left end of the machine near the feed.

The operation of the reset check indicator lights is controlled by each counter group. When an individual counter group is impulsed to reset and the function fails or is interrupted, the indicator light comes ON. When resetting is completed in a normal manner, the light is OFF.

These indicator lights can be very helpful in debugging control-panel wiring and in determining the counter location of intermittent reset check lights.

The most common causes, illustrated in Figure 166, are:

1. When coupled counters are wired to add only, and CI is not wired to C.

   This is because the normal path for the test impulse is through the CI to C wiring. If the proper connections are not made, the test impulse is not allowed to pass from the high-order counter to the low-order counter.

2. When COUNTER EXIT positions are erroneously wired to NORMAL or TRANSFER PRINT ENTRY instead of to COUNTER-CONTROLLED PRINT.

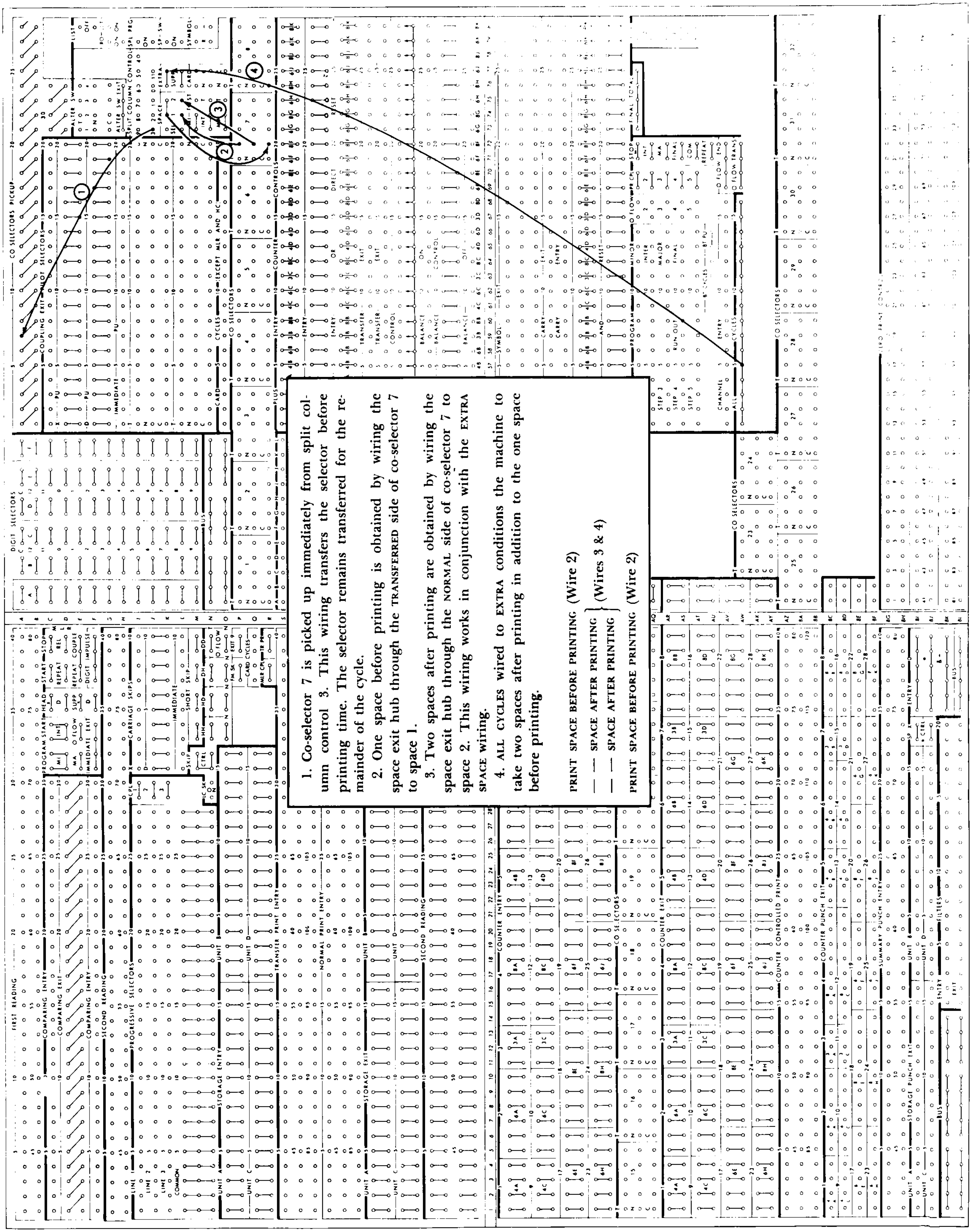


Figure 165. Triple Spacing

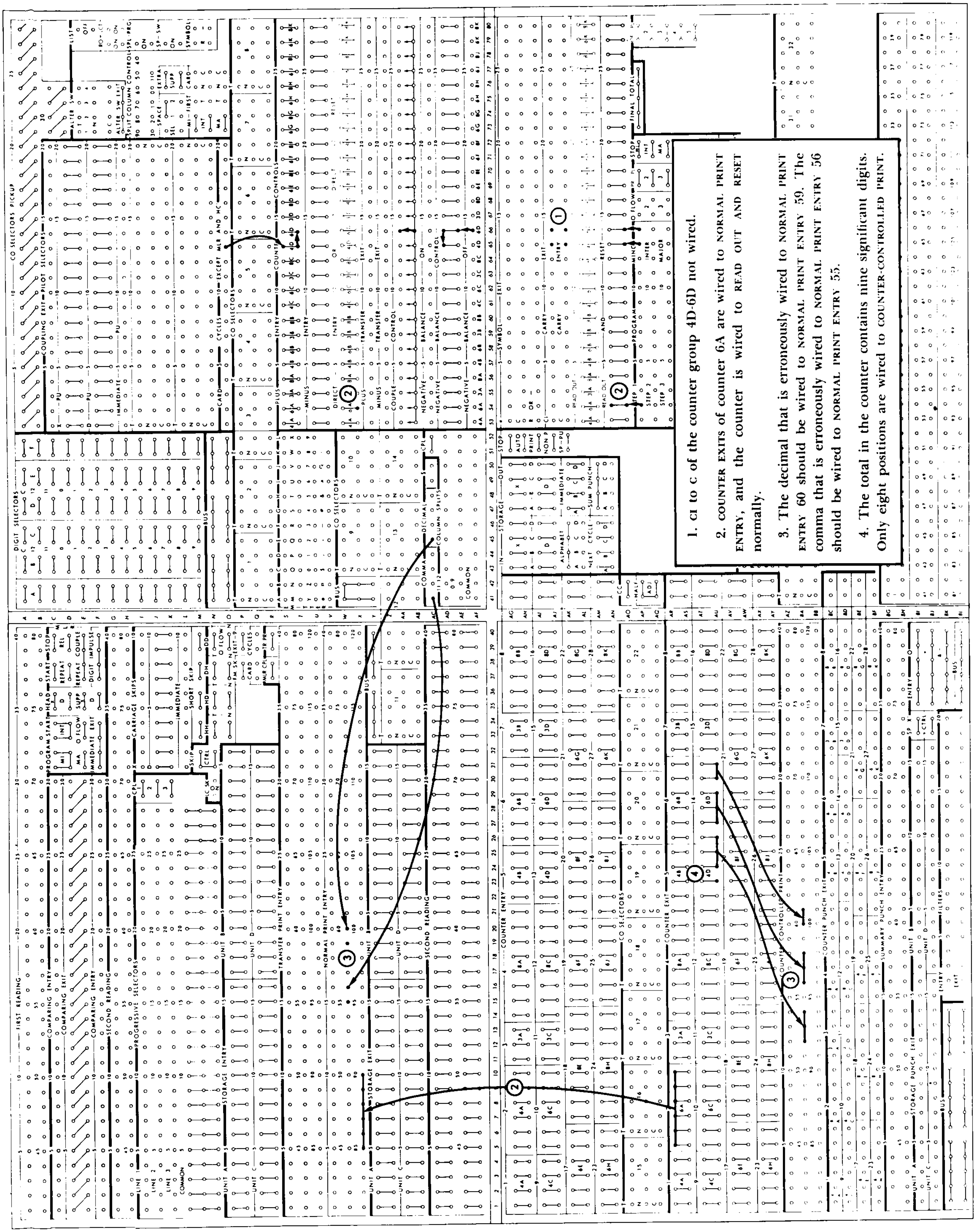


Figure 166. Counters Causing Reset Check Light

When COUNTER EXITS are wired to NORMAL or TRANSFER PRINT ENTRY, the only way that the counter can clear is by direct reset.

3. When emitted impulses, such as dollar, decimal, comma, and special characters, overlap positions wired from COUNTER EXIT to COUNTER-CONTROLLED PRINT.

For example, a decimal is wired to NORMAL or TRANSFER PRINT ENTRY 60, and a COUNTER EXIT POSITION is wired to counter-controlled print 60. In such cases, the symbol impulse back-circuits to the counter exit position in the second half of the reset cycle and prevents the counter from resetting to 9's.

4. When the total in a counter exceeds the number of positions wired from COUNTER EXIT to COUNTER-CONTROLLED PRINT.

This condition can be described as *total overflow* and is more apt to occur during the preparation of a report than during the initial testing of the control panel.

When only one counter is cleared on a given program step, and the reset check light turns ON, it is a simple matter to locate the counter in error and check the counter wiring for the error conditions just described.

When several counters are cleared and the reset check light turns ON, the specific counter in error can be located by proceeding as follows:

1. Empty the hopper.
2. Press the start key to run out the cards.
3. Press the stop key to turn off the reset check light.
4. Remove the reset wire from one of the counters.
5. Run the test deck through the machine a second time. If the reset check light does not turn ON, that counter is in error.
6. If the reset check light does turn ON, remove the reset wiring from each remaining counter group in turn and repeat steps 1 through 5 until the machine does not indicate a reset failure. The last counter group disconnected has the faulty counter wiring.
7. If all counter wiring is correct and the reset check light turns ON, the machine is malfunctioning.

Printing in Flight

Printing that occurs while the paper is moving vertically is referred to as *printing in flight*.

Printing in flight occurs if:

1. space hubs are not wired.
2. carriage skipping is impulsed and the carriage brushes are not in position.
3. SHORT SKIP is improperly wired. (Refer to sections on SHORT SKIP in *Operating Rules and Suggestions* and *Control Tape*.)

Short Skip

Whenever two skipping operations can occur on successive cycles, and the first skip is wired for SHORT SKIP, the impulse wired to SHORT SKIP must be selected if the second skip exceeds two inches.

SHORT SKIP must never be wired for an X-skip or a D-skip if the X- or D-skip can be followed by an *immediate skip* on the next machine cycle. If SHORT SKIP is wired under these conditions, and the *immediate skip* exceeds two inches, printing in flight occurs.

If wiring is correct, and printing in flight continues, rewire skipping to eliminate short-skip wiring.

Transfer Print

When comma, decimal, or dollar sign symbols are selected by means of TRANSFER PRINT ENTRY, the TR PR must be picked up from CARD CYCLES, COUPLING EXIT of pilot selectors, or PROGRAM COUPLE. *Do not wire* ALL CYCLES *to* TR PR. ALL CYCLES wired to TR PR will cause other special symbols to print in place of digits when comma, decimal, or dollar sign symbols are wired to NORMAL PRINT.

Co-Selectors

To prevent damage to co-selector relay coils, CO-SELECTOR PICKUP should not be wired by a LINE IMPULSE, CARD CYCLES, ALL CYCLES, or any other long duration impulse. CO-CC hubs are available and should be used, whenever possible, to pick up co-selectors.

Comma, Decimal, and Dollar Sign

The comma, decimal, and dollar sign hubs should not be split-wired to two or more print entries without filtering each entry. Extraneous printing of symbols in a zero balance field may occur when this rule is not observed.

Zeros Printing from Blank Positions of Storage

Zeros may print from blank positions of a storage unit, or numerical figures may print as zero-zone characters, because of a back circuit through the storage unit blank-position emitter-bar. The storage unit must be wired to accept alphabetic information and must contain a combination of blank positions, numerical, and/or alphabetic information. This problem can be overcome by using control panel filters in positions that are blank.

Optional Features

The optional features available for the IBM 407 Accounting Machine are divided into two groups—those that add to the capacity of the basic machine functions, and those that provide additional functions.

Additional Capacity:

Digit Selectors:
- Model A-2 Two additional units maximum
- Model A-3 Three additional units maximum

Filters—in groups of ten:
- Model A-1 Two additional groups maximum
- Model A-2 One additional group maximum
- Model A-3 One additional group maximum

Pilot Selectors—in groups of five, 2-position, to a maximum total of 40.

Co-Selectors—in groups of four, 5-position, to a maximum of 44.

Alteration Switches—in multiples of two, to a maximum of 12.

Automatic Control—in groups of five, to a maximum of 40.

Special Devices:

Alphabetic Device (for use with IBM 650 Data Processing System)

Auxiliary Card Counter—maximum of two:
- A 5-position counter which can be wired to count all cards, count cards of a single classification, or count control groups.

Special Character Device (for use with IBM 650)

407 Synchronizer (for use with IBM 650)

Tape Data Selector Control (for use with IBM 774 Tape Data Selector)

Toggle Switches—maximum number governed by available space on the control panel:
- These switches allow a single control panel to be used for several reports, without changes in control panel wiring.

Typewheels, Special—120 maximum (Only single-character special characters can be furnished. Typewheels are not demountable):
- For deviation from standard type arrangement; special characters available.

Zero and Special Character Control—in groups of five positions; four groups maximum:
- Permits comparing to differentiate between zeros and blank positions; permits comparing recognition of all special characters, in addition to all digits and alphabetic characters.

Address-Writing Feature (explanation follows)

Ribbon-Inking Device (explanation follows)

Single-Card-Total-Elimination Device (explanation follows)

Twelfth Counter (explanation follows)—in multiples of two:
- Model A-1 20 positions maximum
- Model A-2 22 positions maximum

Address-Writing Feature

Address labels are normally printed by the IBM 407 Accounting Machine on continuous forms. Interspersed three- and four-line addresses are produced at rates that vary between 1800 and 3000 labels per hour. Specially designed forms, permitting multiple-label printing side by side, increase production proportionately. The labels are then separated and attached to the material to be mailed. This method is adequate for a relatively low-volume application.

The IBM Address-Writing Feature prints three-line addresses at the rate of 9000 per hour (150 per minute). Interspersed three- and four-line addresses are produced at rates between 4500 and 9000 per hour.

Addresses are printed on a 7/8-inch tape (Figure 167) from IBM 403 MLP cards or IBM 407 MLR cards. Over 7000 carbon masters or 8000 labels can be produced from a roll of tape. The carbon masters that are used in commercial heat-transfer addressing machines have a reverse carbon image printed on the back of the tape. The labels are processed by automatic mailing machines that cut and affix them to material for mailing.

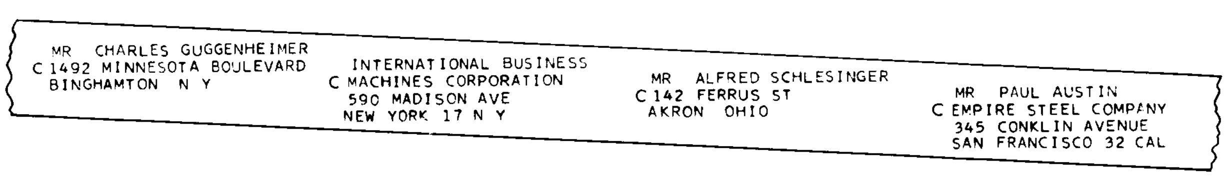


Figure 167. Printed-Tape Section

Functional Principles

The tape is fed from a supply reel on the right — down to the platen — between the platen and printwheels and is rewound tightly on a reel on the left (Figure 168). Because the tape travels across the platen at an angle, four different lines of four separate addresses can be printed at the same time. The continuous-form carbon paper passes face-forward between the platen and the tape.

Printing is done from four fixed groups of printwheels. The right group prints the first line; the second group prints the second line; the third group prints the third line. The fourth group at the extreme left prints only when a fourth line is required.

Three-line addresses are punched in one card; four line addresses require two cards that must be punched according to any one of the following patterns:

Three lines on the first card — one line on the second (3-1 system)

Two lines on the first card — two lines on the second (2-2 system)

One line on the first card — three lines on the second (1-3 system)

A standard carriage tape, punched in channel 1 at two-inch (12-line) intervals, is used to control the movement of the tape (2.805 inches) from right to left between proper print cycles.

Because the information must be printed from four different sources at the same time, the first line (24 characters) is printed from the first reading station, the second line (24 characters), from the second reading station, and the third and fourth lines (22 characters), from counters and storage units.

A perforation is automatically cut in the tape between each address as the tape passes from the platen to the rewind reel. These $\frac{1}{8}$-inch chadless holes serve to keep the tape in proper registration when it is processed by an automatic mailing machine.

Detail information is available in Manual of Operation A24-1023.

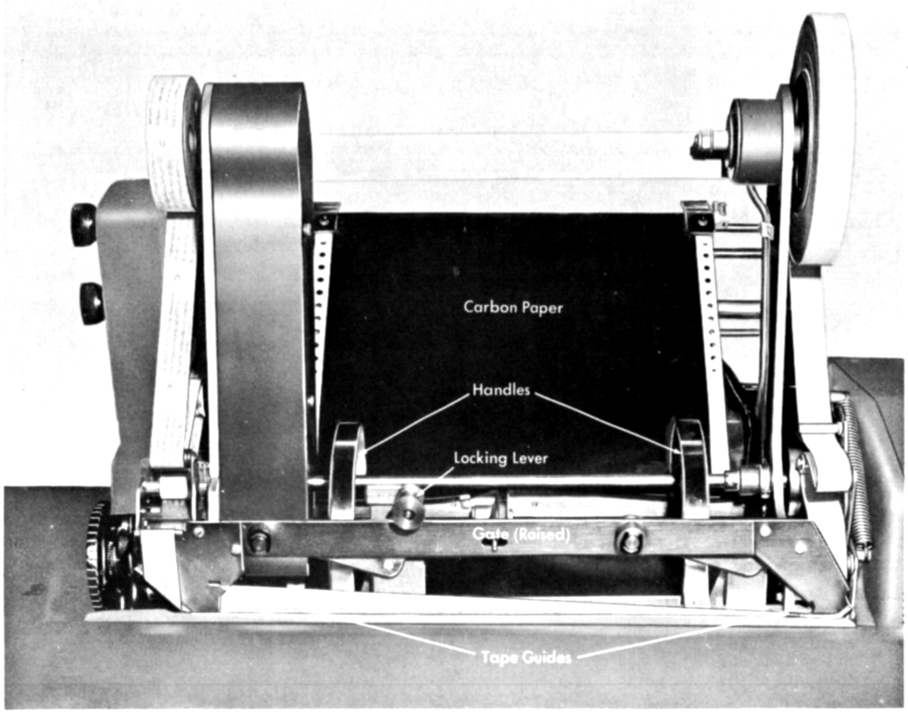


Figure 168. Address-Writing Feature

IBM Ribbon-Inking Device

The IBM Ribbon-Inking Device permits re-inking of ribbons for uniformity of character impression.

This device uses a simple, clean, quick method of replenishing the ink on the ribbon by a disposable plastic ink capsule. The replacement of the capsule is simple and requires only minor adjustments by the operator (Figure 169).

The typewheels are kept clean by a protective tape that feeds automatically between the ribbon and the typewheels (Figure 170).

The ribbon is positioned as illustrated in the ribbon feed schematic (Figure 171).

This device cannot be used on 407's equipped with the IBM Address-Writing Feature.

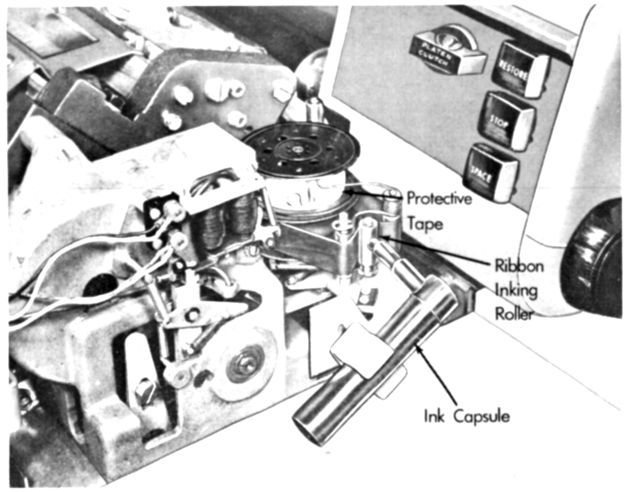


Figure 169. Ink Capsule Position

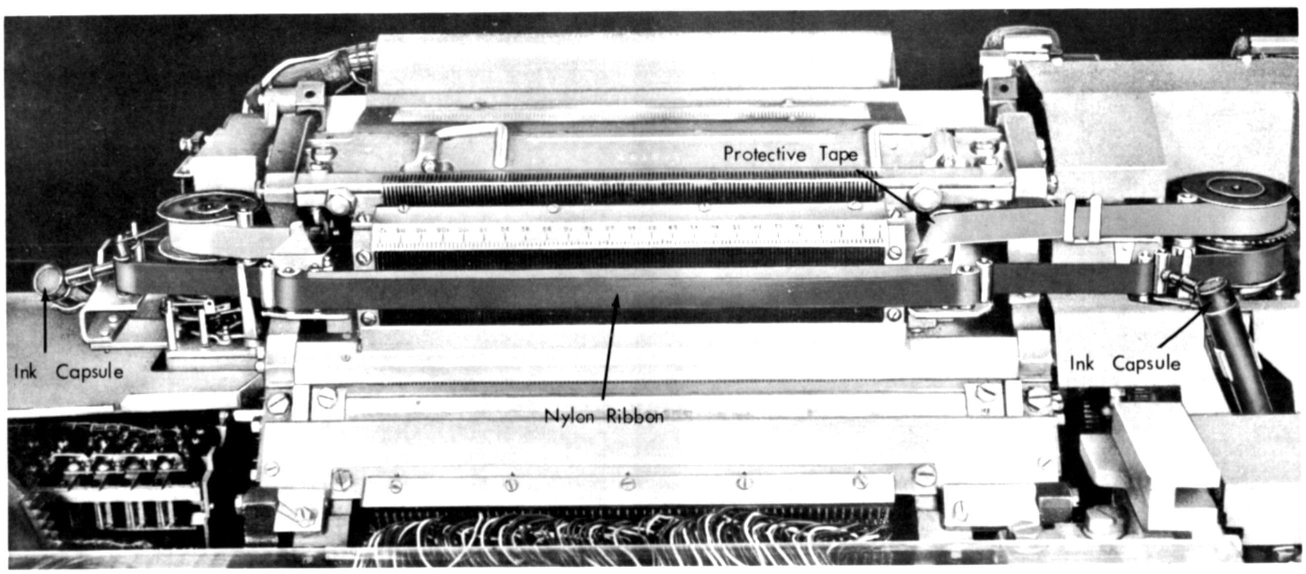


Figure 170. Ribbon and Protective Tape

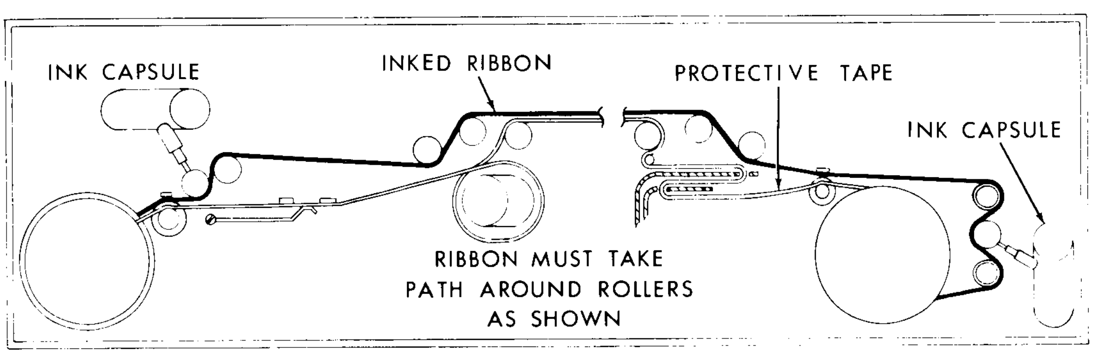


Figure 171. Ribbon Feed Schematic

Single-Card-Total Elimination Device

Minor total cycles for single-card groups can be eliminated by a standard 407 as explained in the section headed *Program Control* (see Figure 117). However, the single-card-total elimination device eliminates the minor total cycles from single-card groups without using selectors or storage units.

When this device is used, group control is limited to numerical information because the comparing exits must emit before zero time.

The minor totals must print from the printwheels (up to eleven positions) specified for this device.

For group-print operations, the device controls machine operations during a minor first-card cycle:

1. For single-card groups, the specified printwheels print the total from the card, and this amount adds into the intermediate counter group only.

2. For multiple-card groups, printing is suspended for the specified printwheels, and the amount adds into the minor counter group only. A control change, with a single-card group at the second reading station, has this effect:

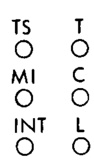
   a. A minor control change does not start programming, but the first card of the following group prints a group-indication.

   b. An intermediate control change starts programming for only one cycle—program step two is active; step one is inactive.

   c. A major control change starts programming for only two cycles—program steps two and three are active; step one is inactive.

Control Panel Hubs

Six control panel hubs are provided:



BD-BF, 43-44

TS. This hub is wired from MINOR FIRST CARD. When TS and PROGRAM START are impulsed during the same cycle, the device recognizes a single-card group.

MI. This hub emits an impulse for the duration of *echo* time when a single-card group has been recognized. It is wired to DIRECT ENTRY of the minor counter to prevent entry of the echo impulses for single-card groups.

INT. This hub emits an impulse for the duration of echo time during the first card cycle of a multiple-card group. It is wired to DIRECT ENTRY of the intermediate counter to prevent entry of the echo impulses for multiple-card groups.

T; C; L. For group-print operations, C is wired from T. For detail-print operations, C is wired from L. It is possible to control these hubs selectively for specific applications, such as selective listing while group printing.

When this device is not wired, the machine functions normally. Wiring the 407 to use the Single-Card-Total-Elimination Device is illustrated in Figure 172.

Twelfths Counters

Normal counters in the 407 use a base number of ten. When a base number of ten is used, each counter position can accumulate up to a maximum of nine, and a carry-over occurs as the counter position goes from nine to zero (ten). Fraction counters operate with a base number other than ten, and differ from the normal counters in that a carry-over occurs when the sum accumulated in the counter exceeds the highest numerator value. For example, a twelfths counter carries over as the sum in the counter goes from 11/12 to 0/12 (12/12).

The units position of any counter group in the 407 can be equipped to add twelfths instead of whole numbers. Twelfths fractions are punched in one card column, with the digits 0 through 9 (for 0/12 through 9/12), an 11 punch for 10/12, and a 12 punch for 11/12. Fractions 0/12 through 9/12 are printed from one printwheel, but 10/12 and 11/12 require two printwheels and print as 10 and 11. However, the 0 and 1 in the units position of the 10 and 11 are not the normal 0 and 1 on the printwheel. Each printwheel is, therefore, provided with a special 0 and 1 in place of the normal # and @ characters, respectively. The labels of the two character-emitter hubs are changed to correspond to the change in the printwheels.

A counter equipped for twelfths accumulation performs all normal functions such as adding, subtracting, negative balance control, summary punching, etc. When NEGATIVE BALANCE ON is wired to NEGATIVE BALANCE CONTROL, negative twelfths print as true figures; otherwise, they print as an eleven complement.

The methods of wiring twelfths counters are illustrated in Figures 173, 174, and 175.

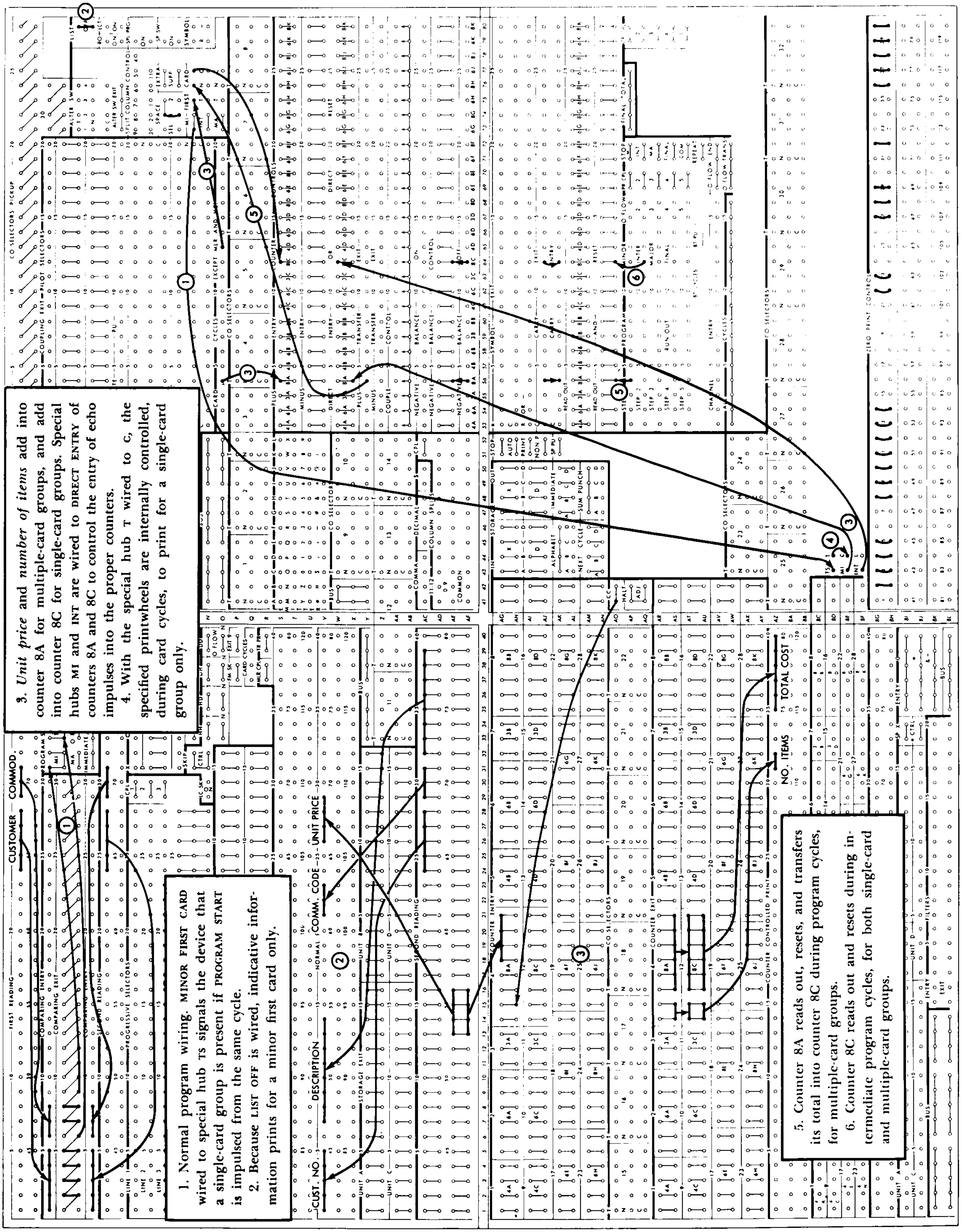


Figure 172. Single-Card-Total Elimination

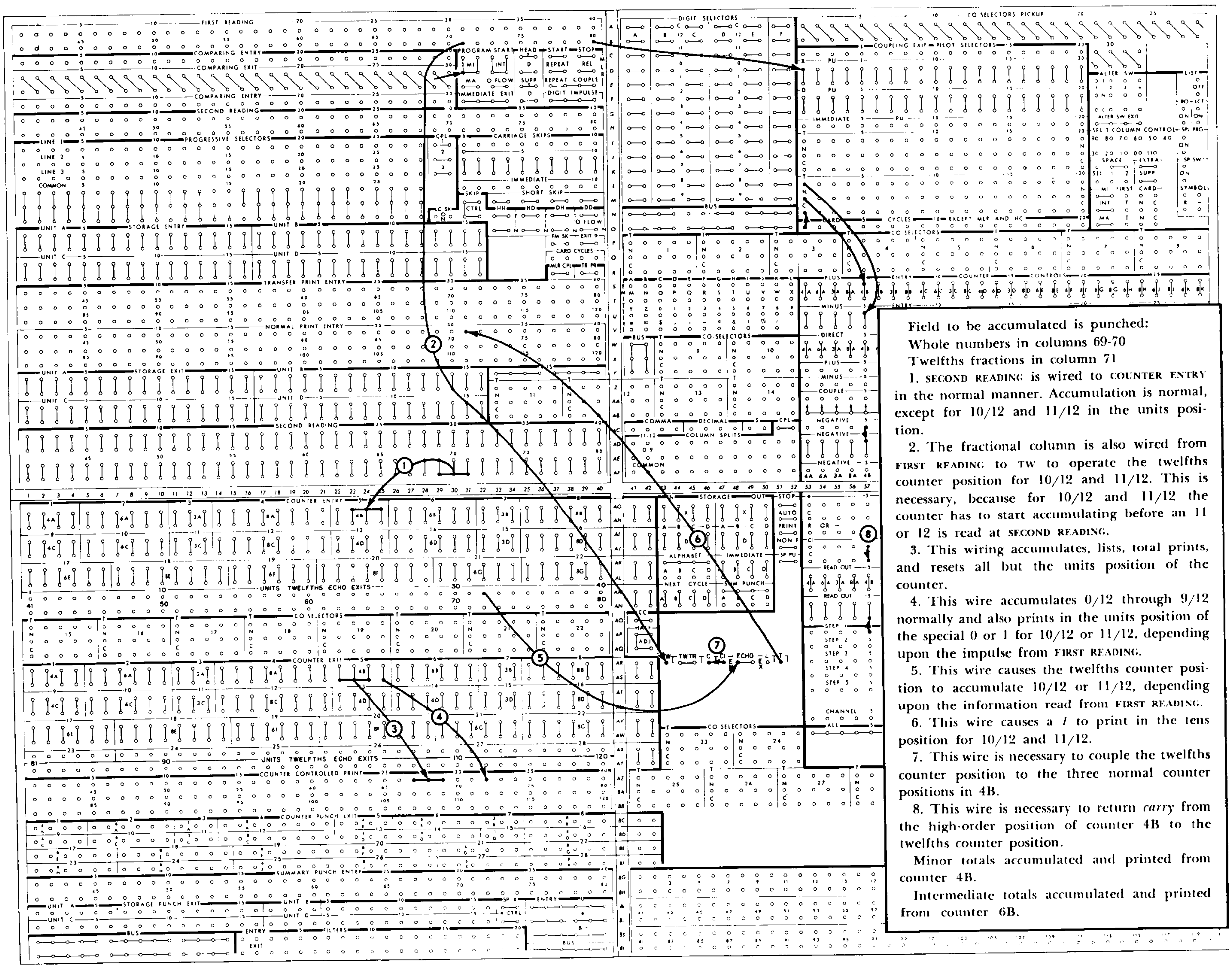
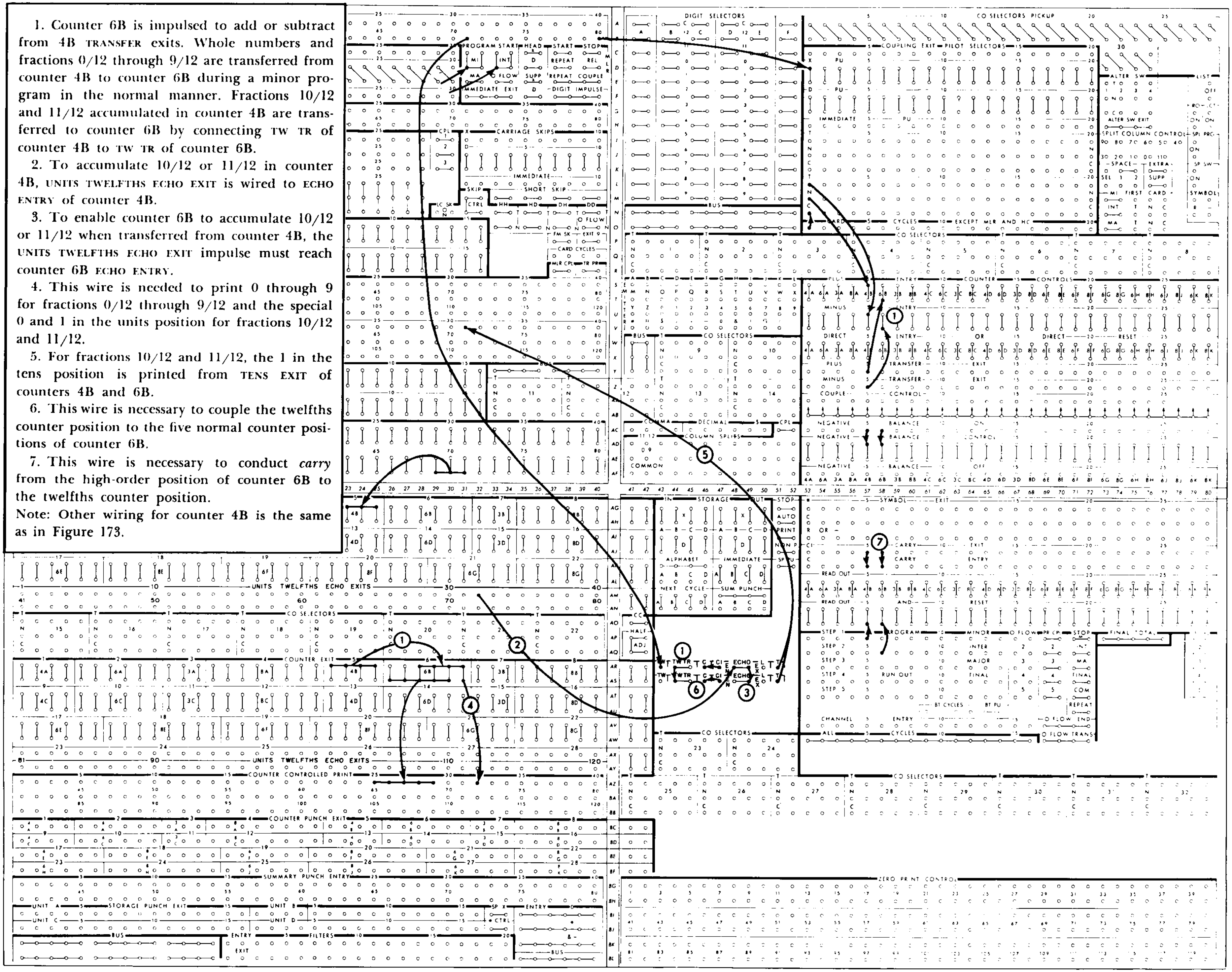


Figure 173. Twelfths-Fraction Accumulation in Counter 4B



1. Counter 6B is impulsed to add or subtract from 4B TRANSFER exits. Whole numbers and fractions 0/12 through 9/12 are transferred from counter 4B to counter 6B during a minor program in the normal manner. Fractions 10/12 and 11/12 accumulated in counter 4B are transferred to counter 6B by connecting TW TR of counter 4B to TW TR of counter 6B.

2. To accumulate 10/12 or 11/12 in counter 4B, UNITS TWELFTHS ECHO EXIT is wired to ECHO ENTRY of counter 4B.

3. To enable counter 6B to accumulate 10/12 or 11/12 when transferred from counter 4B, the UNITS TWELFTHS ECHO EXIT impulse must reach counter 6B ECHO ENTRY.

4. This wire is needed to print 0 through 9 for fractions 0/12 through 9/12 and the special 0 and 1 in the units position for fractions 10/12 and 11/12.

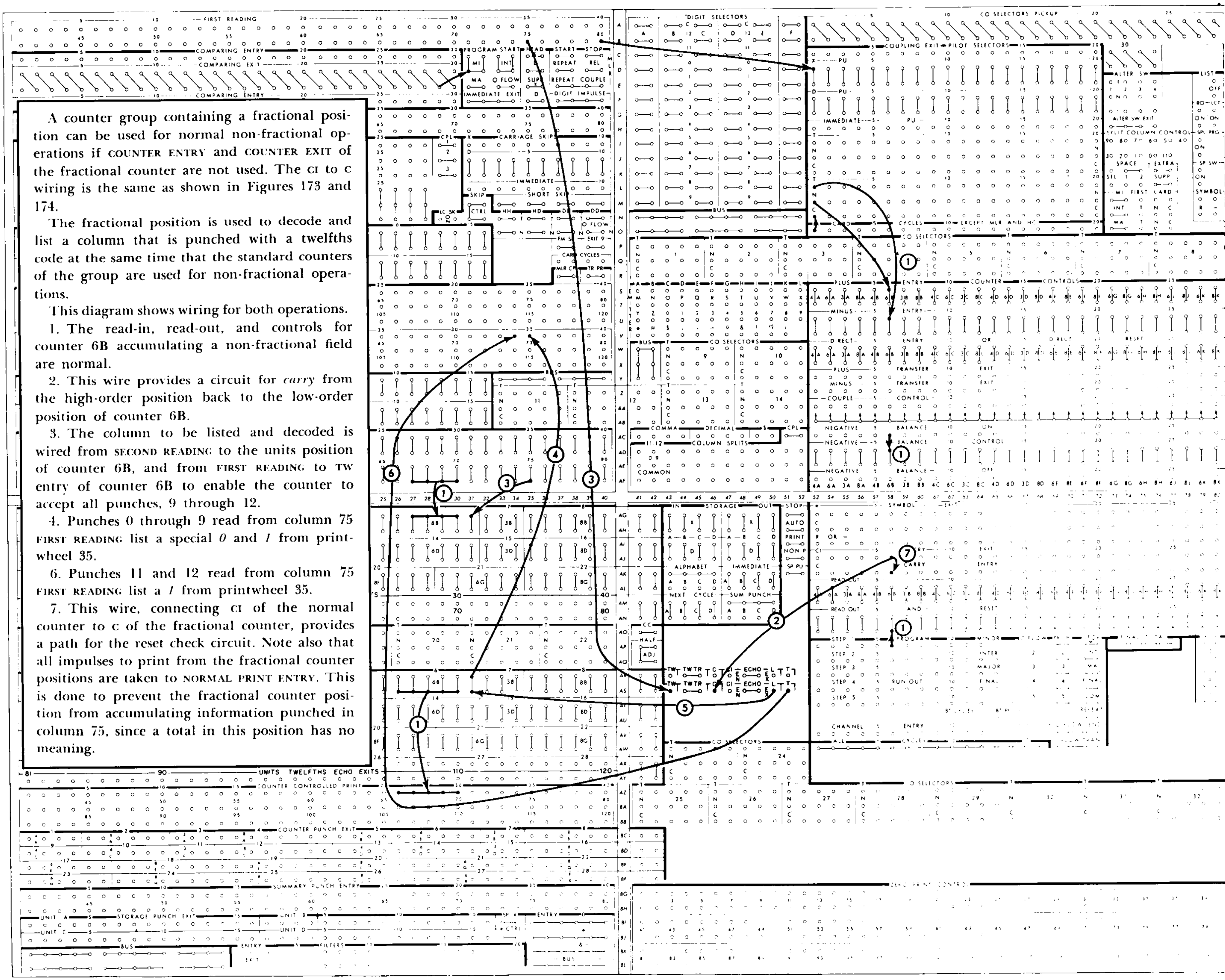
5. For fractions 10/12 and 11/12, the 1 in the tens position is printed from TENS EXIT of counters 4B and 6B.

6. This wire is necessary to couple the twelfths counter position to the five normal counter positions of counter 6B.

7. This wire is necessary to conduct *carry* from the high-order position of counter 6B to the twelfths counter position.

Note: Other wiring for counter 4B is the same as in Figure 173.

Figure 174. Twelfths-Fraction Accumulation with Total Transfer



A counter group containing a fractional position can be used for normal non-fractional operations if COUNTER ENTRY and COUNTER EXIT of the fractional counter are not used. The CI to C wiring is the same as shown in Figures 173 and 174.

The fractional position is used to decode and list a column that is punched with a twelfths code at the same time that the standard counters of the group are used for non-fractional operations.

This diagram shows wiring for both operations.

1. The read-in, read-out, and controls for counter 6B accumulating a non-fractional field are normal.

2. This wire provides a circuit for *carry* from the high-order position back to the low-order position of counter 6B.

3. The column to be listed and decoded is wired from SECOND READING to the units position of counter 6B, and from FIRST READING to TW entry of counter 6B to enable the counter to accept all punches, 9 through 12.

4. Punches 0 through 9 read from column 75 FIRST READING list a special *0* and *1* from printwheel 35.

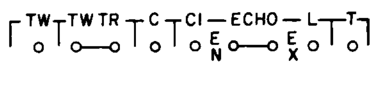
6. Punches 11 and 12 read from column 75 FIRST READING list a *1* from printwheel 35.

7. This wire, connecting CI of the normal counter to C of the fractional counter, provides a path for the reset check circuit. Note also that all impulses to print from the fractional counter positions are taken to NORMAL PRINT ENTRY. This is done to prevent the fractional counter position from accumulating information punched in column 75, since a total in this position has no meaning.

Figure 175. Fractional Counter Group Used for Normal Operating and Decoding

Control Panel Hubs

Because the operation of a counter group containing a 1/12th accumulating position differs from that of a normal counter group, additional hubs are provided in the control panel. For each counter group specified for twelfths accumulation, nine special hubs are provided in the control panel.



Each set of hubs is associated with a specified counter group and can be installed anywhere in the control panel not occupied by other standard features or special devices. The preferred location is above coselectors 23 and 24.

In addition to the above, 120 special UNITS TWELFTHS ECHO EXITS are installed in locations AM-AN, 1-40 and AY, 1-40.

TW (Twelfths). This hub is an entry for the 11 or 12 punching in the fractional column and is normally wired from FIRST READING.

Units Twelfths Echo Exits. Each printwheel has a special UNITS TWELFTHS ECHO EXIT hub to provide an echo impulse for the units position for 10/12 and 11/12, because COUNTER CONTROLLED PRINT ENTRY only handles 0 through 9 impulses. The hub corresponding to the printwheel printing the units position is wired to ECHO ENTRY.

Echo Entry. These two common hubs are normally wired from UNITS TWELFTHS ECHO EXITS to receive the 10/12 and 11/12 echo impulse.

C; CI. These two hubs are normally connected to handle *carry* from the twelfths fractional counter position to the normal counter positions in the same group. (The standard CI is the *carry exit* of the high-order position of the normal counter; the standard C is the *carry entry* of the twelfths fractional counter.)

L (List Exit). This hub is used to decode and list a twelfths fractional column that is not to be accumulated in a twelfths counter. At the same time the normal positions of the counter can be used to accumulate a normal field. This hub must be wired to TWELFTHS COUNTER EXIT and NORMAL PRINT ENTRY.

T (Tens Exit). This hub emits a normal *1* impulse when the fractional counter accumulates or total prints 10/12 or 11/12. It is wired to NORMAL PRINT ENTRY of the tens position to print *1*. NORMAL PRINT ENTRY is used to prevent an unwanted echo impulse from getting into the TENS EXIT hubs.

TW TR (Twelfths Transfer). These two common hubs are used to transfer twelfths accumulations from one fractional counter to another.

Fractional Counter Used for Increased Capacity in Normal Operations

The twelfths counter position can be used to increase the normal capacity of the 407 if it is coupled as the high-order position counter. The CI to C wiring is the same as in Figures 172 and 173; however, nothing should be wired to read into the fractional counter position. It should only accumulate carry impulses from the high-order position of the normal counter. A counter group with only four positions coupled with the fractional counter can then accumulate up to 11999.

The counter can be wired for addition and subtraction, but negative results cannot be converted, since NEGATIVE BALANCE ON does not correctly identify a negative total. In fact, NEGATIVE BALANCE CONTROL for this counter should not be used at all, because NEGATIVE BALANCE OFF does not correctly identify a zero total. Negative balances print an eleven complement from the fractional counter and a nine complement from the remaining counter positions.

Rules for Counter Wiring on an IBM 407 Equipped With Twelfths Counters

1. Normal counters used normally

All exit positions must be wired to COUNTER CONTROLLED PRINT to reset counters.

2. Twelfths counter used as a tenths accumulator (no twelfths):

The twelfths positions of the counter must remain unwired from the entries and exits.

Wire: Regular CI split to special C and regular C

3. Twelfths counter used to accumulate 12ths:

Use counter wiring shown.

Wire: Regular CI split to regular C
Special CI to special C

4. Normal counter coupled to normal counter to accumulate tenths (no 12ths):

Wire: Regular (high-order) CI to regular (low-order) C
Regular (low-order) CI to regular (high-order) C

5. Twelfths counter coupled to twelfths counter to accumulate 12ths:

Wire: Low-order counter wired as shown in wiring diagrams
12ths position of high-order counter not wired
Regular (high-order) CI to regular (low-order) C

Regular (low-order) CI split to regular (high-order) C and special (high-order) C

Special (low-order) CI to special (low-order) C

6. Twelfths counter to twelfths counter used to accumulate 10s (no 12ths):

Wire: No wires necessary to 12ths position exit or entry

Regular (high-order) CI split to regular (low-order) C and special (low-order) C

Regular (low-order) CI split to regular (high-order) C and special (high-order) C

7. Twelfths counter (high-order) coupled to normal counter (low-order) used normally (no 12ths):

Wire: No wires necessary to 12ths position exit or entry

Regular (high-order) CI to regular (low-order) C

Regular (low-order) CI split to regular (high-order) C and special (high-order) C

8. Normal counter (high-order) coupled to twelfths counter (low-order) used normally:

Wire: No wires necessary to 12ths position exit or entry

Regular (high-order) CI split to regular (low-order) C and special (low-order) C

Regular (low-order) CI to regular (high-order) C

9. Normal counter (high-order) coupled to twelfths counter (low-order) to accumulate twelfths:

Wire: Twelfths counter exits and entries wired as if they were not coupled

Regular (high-order) CI to regular (low-order) C

Regular (low-order) CI to regular (high-order) C

Special (low-order) CI to special (low-order) C

Control-Panel Summary

Each section of the control panel (Figure 176) is assigned a number under which the hubs are briefly described.

1. *First Reading.* These hubs represent the 80 brushes that read the card at the first station. They are wired principally to COMPARING ENTRY, MLR START, X or D storage controls, digit selectors, pilot and co-selector pickups, X or D carriage skips and heading control.

2. *Comparing Unit.* There are 20 positions of comparing on the standard machine. The COMPARING ENTRY hubs are wired from FIRST and SECOND READING, so that classifications in two cards may be compared to determine whether or not they are alike in both cards. If the punching is alike, the cards belong to the same group; if it is unlike, the cards belong to different groups. Three different classifications can be compared at the same time to print totals for each classification.

Each vertical pair of ENTRY hubs has a corresponding pair of common COMPARING EXIT hubs, which are diagonally arranged for convenience in jackplugging. Whenever a reading at one station does not compare with the reading at the other station, the COMPARING EXITS emit an impulse which is normally wired to PROGRAM START and CARRIAGE SKIP CONTROL.

If a column contains more than one numerical punch (1-9), only the first punch read, the higher number, will be recognized by the comparing unit.

3. *Second Reading.* These hubs represent the 80 brushes that read the card at the second station. They appear at two locations on the control panel for convenience in wiring. The upper set of hubs is normally wired to COMPARING ENTRY or to PROGRESSIVE SELECTORS for multiple-line reading. The lower set of hubs is normally wired to COUNTER ENTRY, STORAGE ENTRY, NORMAL or TRANSFER PRINT ENTRY, HEADING CONTROL SUPPRESSION and MLR STOP CONTROL.

4. *Progressive Selectors.* There are 28 progressive selector positions each consisting of three common and three transfer hubs. The transfer hubs labelled 1, 2, 3 are successively connected internally to the COMMON hub during MLR operations. Information for three lines of printing can then be wired from SECOND READING to the hubs for each line and from the COMMON hubs to TRANSFER PRINT ENTRY.

5. *Progressive Selector Couple.* Each line has a pair of COUPLE hubs, which are exits during MLR operations and normally are used to pick up co-selectors for the purpose of expanding any line beyond 28 positions. They are also entry hubs when MLR lines are not being printed, and may be wired from any cycle impulse to cause the corresponding line to be connected to the COMMON hubs for that cycle. This gives the effect of three 28-position selectors, because each line can be independently controlled when MLR is not in operation.

6. *Storage Entry.* These are the entries to the four storage units. Normally they are wired from SECOND READING to store information read from a card, or from COUNTER EXITS to store information accumulated in counters. Numerical information, including 11 and 12 punching, can be stored in all 16 positions. Alphabetic information must be read into the left-hand eight positions of each unit. Storage units clear when corresponding STORAGE IN hubs are impulsed.

7. *Transfer Print Entry.* The 120 TRANSFER PRINT ENTRY hubs are one of three sets of entries to the print-wheels. Like the transferred hubs of a selector, these hubs accept impulses only when they are made active by a cycle control impulse reaching TR PR.

8. *Normal Print Entry.* The 120 NORMAL PRINT ENTRY hubs are one of three sets of entries to the print wheels. Normally they are wired from SECOND READING or from STORAGE EXITS to print either numerical or alphabetic information.

9. *Storage Exit.* These are the exits from the four storage units. They are normally wired to NORMAL or TRANSFER PRINT ENTRY or to COUNTER ENTRIES. The storage exits are active any time the corresponding storage unit is impulsed to read out.

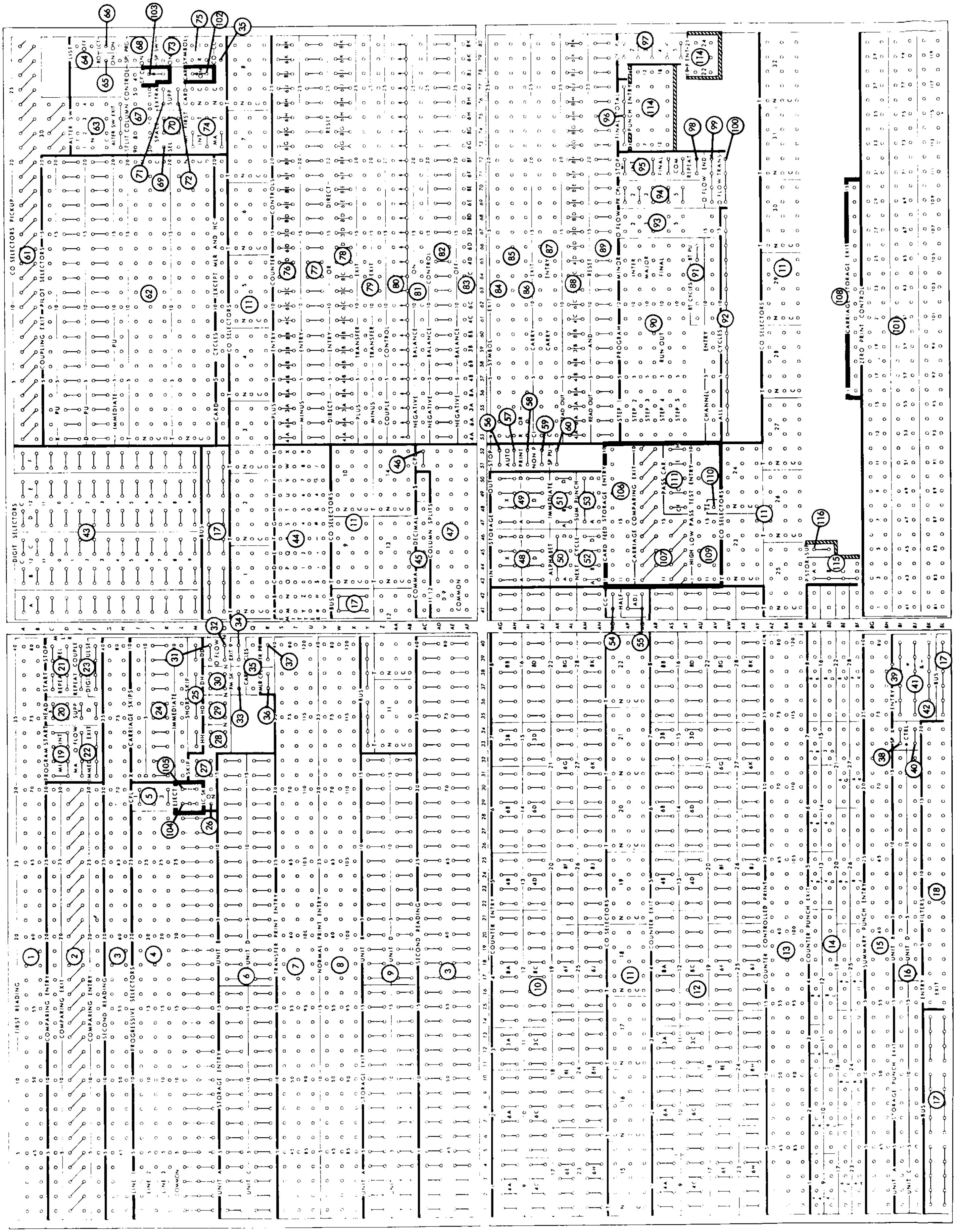


Figure 176. Control-Panel Summary

10. *Counter Entry.* There are 112 counter positions arranged in convenient groups of 4, 6, 3 and 8 positions. COUNTER ENTRIES are normally wired from SECOND READING for the purpose of adding, subtracting or group-indicating information read from the card. The entry of every counter group is internally connected to the corresponding COUNTER EXIT positions unless DIRECT ENTRY for that counter group is wired. These hubs are receptive on the first half of the cycle only.

11. *Co-selectors.* Sixteen co-selectors are standard. Each selector has five positions. When the PICKUP hubs are impulsed, the selector picks up immediately and holds to the end of the same cycle.

12. *Counter Exits.* Counter exits emit impulses for information that is detail- or total-printed from the counter. To detail-print, the counter must be impulsed to add or subtract, at which time COUNTER ENTRIES are internally connected to COUNTER EXITS. To total-print, the counter must be read out and reset, and the exits must be wired to COUNTER-CONTROLLED PRINT. COUNTER EXITS do not emit impulses when the counter is impulsed to DIRECT ENTRY, at which time they are internally disconnected from COUNTER ENTRY. Also, COUNTER EXITS do not emit impulses when DIRECT RESET is wired. Refer to paragraphs 13 and 78.

13. *Counter-Controlled Print.* These hubs are one of three sets of entries to the printwheels, the other two being NORMAL and TRANSFER PRINT ENTRY. Normally they are wired from COUNTER EXITS, receiving the information from the counter during the first half of the cycle and returning it to the counter during the second half of the cycle. The printwheels are set up for printing during the first half of the cycle. If the counter is wired to reset, the returned information during the second half of the cycle either adds or subtracts in the counter to reach a zero balance, thus affording a check between the amounts printed on a report and the amount accumulated in the counter.

These hubs provide the only means by which a counter may be reset as the total is printed, because counter clearing is done in the second half of the cycle. Counter exit positions containing significant digits must be wired to COUNTER-CONTROLLED PRINT in order to reset.

Alphabetic or special character information cannot be wired to COUNTER-CONTROLLED PRINT, because these hubs do not accept zone impulses.

14. *Counter Punch Exit.* The COUNTER PUNCH EXITS are active on every machine cycle, emitting whatever stands in the corresponding counter. Normally they are wired to SUMMARY PUNCH ENTRY during summary-punching operations, so that accumulated amounts or group-indicated information may be punched in a summary card. If wired to other hubs, they must be selected. The high-order position of each COUNTER PUNCH EXIT emits a 0-X impulse whenever a converted negative figure or a zero balance is being punched.

15. *Summary Punch Entry.* These hubs represent the 80 punch magnets on the summary punch. Normally they are wired from COUNTER PUNCH EXITS, the character emitter, or STORAGE PUNCH EXITS for summary punching.

16. *Storage Punch Exit.* These hubs are normally wired to SUMMARY PUNCH ENTRY when information in the storage units is to be summary punched. They are under the control of the STORAGE OUT SUMMARY PUNCH hubs, which can be impulsed during any summary punch cycle. The units are independently controlled.

17. *Bus.* These hubs are located in convenient sections of the control panel and are used to expand either exits or entries, thereby eliminating the need for split wires.

18. *Filters.* 10 Filters are standard, each with an ENTRY and an EXIT hub. They allow an impulse to travel in only one direction (into ENTRY, out of EXIT) and are used to control a circuit in one direction only.

19. *Program Start.* The PROGRAM START hubs are identified as MI (minor), INT (intermediate), MA (major), and O-FLOW (overflow). MI, INT, and MA are normally wired from the comparing exit to cause a program change for every group or from CC (cycle count) to cause a program change for every card. The MI, INT, and MA hubs accept impulses to activate the minor, intermediate, and major programs.

The overflow entry is used in conjunction with the carriage and is normally wired from the overflow carriage hub to cause overflow programs to be initiated for overflow sheet identification.

An impulse into any of these PROGRAM START hubs causes card feeding to stop and a series of one or more program cycles to start unless this occurs on an MLR operation, in which case programming will be suspended until after the MLR operation is completed.

20. *Head X, D; Supp X, D.* HEAD X or D hubs are usually wired from FIRST READING to cause heading cards to detail print regardless of the setting of the LIST switch. When wired, they work in conjunction with skip control for controlling the function of the D and H carriage skip hubs.

SUPP X or D hubs normally are wired from SECOND READING to suspend control between heading cards or between heading and body cards. They do not suspend carriage skipping.

21. *MLR Start, Stop, Repeat, Rel; Repeat Couple.* The MLR START hubs accept a 12 impulse from FIRST READING to stop card feeding and start a series of cycles for the repeated reading of a card. The PROGRESSIVE

SELECTORS operate during this series of repeated cycles.

The MLR STOP hubs accept a 1, 2, or 3 impulse from SECOND READING to stop the progressive selection after 1, 2, or 3 lines have been printed. Card feeding then resumes.

The MLR REPEAT hubs accept the equivalent of a 12 from an ALL CYCLES impulse after an MLR operation has been started. This causes the PROGRESSIVE SELECTORS to operate again starting with line 1.

The MLR REL (release) hubs must be wired whenever REPEAT is wired. These hubs accept the equivalent of 9 to 1 of an ALL CYCLES impulse to stop any series of MLR cycles at the end of the cycle during which release is impulsed.

REPEAT COUPLE hubs emit an impulse on every repeat MLR cycle, and normally are wired to co-selectors so that a distinction can be made between regular MLR cycles and repeat MLR cycles.

22. *Immediate Exit.* These hubs emit a short impulse during the second half of each machine cycle. Normally it is selected to control operations during the second half of the cycle, such as machine stop, for a negative balance in a counter, or to control program start.

23. *Digit Impulse.* These hubs emit impulses corresponding to the 12 punching positions in a column of the card. Normally they are wired to the C hub of DIGIT SELECTORS so that any required impulse can be read from the exits during one or more cycles.

24. *Carriage Skips, X, D, and Immediate.* These hubs correspond to channels 1 to 10 on the tape. They receive impulses to initiate skips that are to be stopped by holes in the corresponding channels of the tape. The X hubs accept 11, 12, or skip control impulses and the D hubs accept any impulse to cause skipping on the following cycle. The I hubs accept CYCLE or skip control (SKIP CTRL) impulses to cause skipping on the same cycle.

When the X or D hubs are impulsed and a total intervenes, skipping takes place after the total prints. When the I hubs are impulsed and a total intervenes, skipping takes place before the total prints. When the X or D hubs are impulsed during program or MLR cycles, the skip will not become effective until after all program or MLR cycles are completed.

Channel 1 must be used to identify the first printing line, and channel 12, the overflow line.

25. *Short Skip.* These hubs are entries and normally are wired from the skip control hubs (SKIP CTRL), when the skip does not exceed two inches. When impulsed, they suppress the normal internal interlock that occurs whenever a skip is initiated, and allow the skip to take place without loss of time.

26. *LC SK (Last Card Skip).* When the switch is wired on, the carriage will skip to channel 1 at the end of a run. If it is not wired, a final total may be printed on the last form.

27. *Skip Control.* The four common skip control (SKIP CTRL) hubs normally are wired from the COMPARING EXITS and operate in conjunction with HEAD X or D to pick up an internal selector for controlling HH, HD, DH, and DD hubs.

28. *HH — Head Card to Head Card.* Whenever a heading card at the second station is followed by a heading card at the first station, an impulse is emitted from N (normal) if there is no control change and from T (transferred) if there is a control change.

When the HH T hubs are active, detail cards are missing. These hubs would normally be wired to channel 1.

29. *HD — Head Card to Detail Card.* Whenever a heading card at the second station is followed by a detail card at the first station, an impulse is emitted from HD N if there is no control change, and from HD T if there is a control change. HD N identifies heading cards followed by normal cards of the same group and usually is wired to the channel reserved for the first body line. HD T identifies missing detail cards of one group and missing heading cards of another group and normally is wired to the first body line channel and to FM-SK.

30. *DH — Detail Card to Head Card.* Whenever a detail card at the second station is followed by a heading card at the first station, an impulse is emitted from DH N if there is no control change and from DH T if there is a control change. DH N identifies cards out of sequence on a conventional form and normally is wired to stop. DH T identifies a change from one group to another on a conventional form and should be wired to CARRIAGE SKIP 1.

For inverted forms, DH N is wired to the carriage skip identifying the first body line and DH T to FM-SK and to the first body line carriage skip.

31. *DD T—Detail Card to Detail Card Transferred.* These hubs emit an impulse whenever two detail cards follow each other and a control change occurs. They identify missing heading cards and normally are wired to the first body line carriage skip.

32. *O-FLOW — Detail to Detail Normal.* These hubs emit an impulse as the last body line of a form is printed. The last body line of a form is determined by a punch in channel 12 of the tape. If heading cards are used, these hubs normally are wired to the first body line carriage skip hub. Without heading cards, these hubs are wired to skip to the first line of the next form.

33. *FM-SK.* When impulsed, the form skip hubs suspend the action of all skip stops until after the overflow punch has been sensed for conventional forms or a punch in channel 10 has been sensed for inverted forms. Normally it is wired from HD T for conventional forms and from DH T for inverted forms.

34. *Exit 9.* These hubs emit an impulse whenever a punch in channel 9 of the tape is sensed. They normally are wired through selectors to overflow transfer (O-FLOW T) for variable-length overflow operations. They are also wired to SHORT SKIP to release the interlock on the last two inches of a long skip.

35. *Card Cycles.* These hubs emit a cycle control impulse on card feed cycles for controlling entry into and printing from counters. This impulse starts before the 9 position in the card is read, and it continues until all adding into counters has been completed. These hubs are not active for MLR, heading card, and program cycles. The four CARD CYCLE hubs (Q, 37-40) are active on every card feed cycle, including MLR and head card cycles. The two CO-CC hubs (79-80) are active on every card cycle except HC and MLR and are short impulses to be used to pick up co-selectors.

36. *MLR CPL.* These two common hubs are active on every MLR cycle. They are normally wired to TR PR to make the transfer print entry hubs active on every MLR cycle.

37. *TR PR (Transfer Print).* These common hubs represent the pickup for the 120-position TRANSFER PRINT ENTRY unit. They are normally wired from MLR CPL. These hubs may also be wired from cycles impulses. The transfer print unit remains transferred only for the duration of the impulse wired to TR PR.

38. *SP-X (Summary Punch X).* These hubs emit an X impulse on every summary punch cycle and are normally wired through selectors to SUMMARY PUNCH ENTRY to identify different types of summary cards, such as minor and intermediate summary cards. They are also used to identify debit balance summary cards when an NX is used to represent a credit balance summary card.

39. *0 Entry.* The 0 ENTRY hubs are direct connections to complete a circuit from any lower ZERO PRINT CONTROL hub wired to them. Normally, they are wired from ZERO PRINT CONTROL hubs to print zeros for zero balances. However, more than eight zeros should not be printed in this manner.

40. **Ctrl (Asterisk Control).* These hubs emit an impulse for asterisk control and are wired to CO-SELECTOR PICKUP hubs to control ZERO PRINT CONTROL hubs when check-protecting asterisks are being printed. They differ from the regular asterisk in that they print from the check-protecting asterisk impulse rather than an 8-4-11 impulse.

41. **Entry.* The asterisk entry hubs are direct connections to complete the circuit for printing check-protecting asterisks (N impulse). They are normally wired from ZERO PRINT CONTROL.

42. *& – Entry.* The ampersand and minus entry hubs are direct connections to complete the circuit for printing an ampersand (12 only) or a minus (11 only). They are normally wired from ZERO PRINT CONTROL.

43. *Digit Selectors.* Two DIGIT SELECTORS, A and B, are standard. These selectors are used to select specific digits from a card column or to emit digits on every machine cycle. The C hub is impulsed from a reading station if a specific digit is to be selected, or from DIGIT IMPULSE if the selector is to be used as an emitter.

44. *Character Emitter.* All letters, digits, and special characters are emitted from the character EMITTER on each machine cycle. Usually they are wired through selectors to NORMAL or TRANSFER PRINT ENTRY, to COUNTER ENTRY (numbers only), to storage units, or to SUMMARY PUNCH ENTRY.

45. *Comma, Decimal, Dollar Symbol.* These symbols are emitted on every machine cycle. They differ from the same hubs in the character EMITTER in that they can be controlled by ZERO PRINT CONTROL wiring. They are normally wired directly to NORMAL or TRANSFER PRINT ENTRY.

46. *Column Split Cpl.* The COLUMN SPLIT CPL (couple) hubs are normally used to pick up selectors for the purpose of expanding column splits. They are also used as exit hubs during the second half of the cycle.

47. *Column Splits.* Twelve COLUMN SPLITS are standard. Each one has a C (common), *0-9,* and *11-12* hub. They are used to separate 11-12 punches from 0-9 punches in a card column. By wiring a cycle impulse into C and out of *11-12,* the second half of the cycle can be separated from the first half.

48. *Storage In, X-D.* Each storage unit has its own STORAGE IN X and D hubs. They accept impulses to condition the storage units to accept information on the following *card feed cycle.* The X hubs accept 11, 12, or carriage exit impulses and are normally wired from FIRST READING. The D hubs accept digits, 11, 12, carriage exit, or cycle impulses and are normally wired from FIRST READING or any hub emitting a cycle impulse. When the IN hubs receive an impulse, storage units clear before the next machine cycle.

49. *Storage Out, X-D.* Each storage unit has its own STORAGE OUT X and D hubs. They accept impulses to cause the storage units to read out on the following card feed cycle, provided the pickup is not from an MLR card. The X hubs accept 11, 12, or carriage exit impulses. The D hubs accept digit 11, 12, carriage exit, or cycle impulses.

50. *Storage Alphabet.* Each storage unit has its own ALPHABET couple hubs which must be connected when alphabetic information is being stored. The common hubs above are exits and emit the equivalent of a 0-11-12 impulse. The lower hubs are entries. When the ALPHABET couple hub for a storage unit is connected, all numbers enter the left eight positions of the unit and all zones enter the right-hand eight positions. It is necessary to wire only the left side of the storage unit when storing alphabetic information.

51. *Storage Out, Immediate.* Each storage unit has two common IMMEDIATE OUT hubs. They accept any impulse to cause the storage units to read out immediately.

52. *Storage In, Next Cycle.* Each storage unit has two common NEXT CYCLE hubs, which, when impulsed, condition the storage units to accept information on the next *machine cycle.* They are normally wired from program exits to cause the storage units to be conditioned, either for the first card of the next group or for the following program step. These hubs cannot be used if the next machine cycle is a summary punch or a long carriage skip cycle.

53. *Storage, Sum Punch.* Summary punching out of each storage unit is controlled by the SUMMARY PUNCH hubs. The lower hubs are entries and are independent one from the other. The top hubs are common. When the lower hubs are connected to any of the top hubs, the STORAGE PUNCH exits will emit on every summary-punch cycle. Summary punching out of a particular storage unit may be done on a specific program by wiring the program couple (PR CPL) hub to the lower SUMMARY PUNCH hub.

54. *CC (Cycle Count).* The CC hub emits a 1 impulse during the first and second half of every machine cycle. Normally it is wired to COUNTER ENTRY to count cards or groups of cards, or to PROGRAM START to cause one or more programs to be initiated for every card.

55. *Half Adj.* The HALF ADJUST hubs are exits for a 5 impulse during the first and second half of every machine cycle. These hubs normally are wired to COUNTER ENTRY for decimal adjusting purposes.

56. *Stop.* These hubs accept CARD CYCLE, ALL CYCLE, FIRST CARD, digits, 11, 12, COMPARING EXIT impulses or skip control (SKIP CTRL) exits, such as HH, HD, etc., to stop the machine at the end of the same cycle. They receive NEGATIVE BALANCE ON, or NEGATIVE BALANCE OFF impulses to stop the machine at the end of the following cycle. The machine is restarted by pressing the start button.

57. *Auto.* These hubs are the same as the STOP hubs except that they also cause the automatic stop light to turn on. When immediate exits or skip control exits, such as HH, HD, etc., are wired to these hubs, the machine stops at the end of the following cycle and not at the end of the same cycle.

58. *Print.* These hubs accept CARD CYCLES or ALL CYCLES impulses to cause the machine to detail print when the LIST switch is wired off.

59. *Non-Print.* These hubs accept CARD CYCLE or ALL CYCLES impulses to prevent printing and spacing for the cycle during which NON-PRINT is impulsed.

60. *SP-PU.* The summary-punch pickup hubs accept any cycle impulse to cause the machine to summary punch. They are normally wired from program levels.

61. *Co-Selector Pickup.* These are the pickup hubs for the co-selectors. When impulsed, they cause the co-selector to transfer immediately. They are normally wired from PILOT SELECTOR COUPLING EXIT or from program steps.

62. *Pilot Selectors.* Fifteen pilot selectors are standard. Each selector has two positions arranged vertically, and an X, D, and IMMEDIATE pickup. When the X or D hubs are impulsed, the selector transfers on the following card or program cycle unless there is an MLR card at the second reading. When pilot selector X or D hubs are impulsed from an MLR card at first reading, the selector will transfer on the following cycle and remain transferred through all MLR cycles of that card, provided there is not an MLR card at second reading. If the X or D hubs are impulsed while an MLR card is at second reading, the selector transfers after all MLR lines of the card at second reading have been printed. When X or D hubs are impulsed during a program cycle, the selector transfers on the following cycle and remains transferred for all remaining program cycles through the first card of the following group.

When the I hubs are impulsed, the selector transfers immediately. When I is impulsed during a program cycle, the selector transfers immediately and remains transferred for all program cycles and through the first card of the following group. If the I hubs are impulsed while an MLR card is being read, the selector transfers immediately and remains transferred for all MLR cycles. Each selector also has a COUPLING EXIT, which emits an impulse when the selector transfers, and continues to emit as long as the selector remains transferred. It is normally wired to a CO-SELECTOR PICKUP.

63. *Alter. Sw.* There are four ALTERATION switch selectors on the control panel that correspond to the four ALTERATION toggle switches on the machine. When the ALTERATION toggle switches are turned on, the corresponding selector transfers. The selectors may be used independently or in conjunction with pilot or co-selectors to change machine funtions under the control of a toggle switch.

64. *List.* When the switch is off, the machine group prints. When the switch is not wired, the machine detail prints. The lower hub may be impulsed by a cycle impulse wired through selectors to control detail and group printing.

65. *RO (Run Out).* When the run-out switch is on, the last card in the machine runs out automatically into the stacker. When the switch is not wired, the last card must be run out into the stacker by pressing the start key.

66. *LCT (Last Card Total).* When this switch is on, three programs (minor, intermediate, and major) will be taken in succession on the run-in and as the last card is run out to the stacker. When the switch is not wired, the programs are under the control of the PROGRAM START hubs. The fourth step (run-out final) is active only if the FINAL TOTAL toggle switch is on. Normal programming is not affected by wiring LCT on.

67. *Split Column Control.* These are off-time emitter hubs that emit an impulse at half after the number they represent. They are normally wired to pick up selectors which are then used as column splits.

68. *Spl. Prg.* When the special program switch is on, a program change causes card feeding to stop and a series of program cycles to start. The cycles will continue until 5 steps have been taken (unless REPEAT is wired), after which time card feeding resumes. Special program on also disconnects the internal all cycles impulse from the channel entries, permitting control-panel entry to each channel. These impulses may be selected, however, so that channel 1 represents program steps 1 through 5, channel 2 program steps 6 through 10, etc.

When the special program switch is not wired, programming is normal.

69. *Sel Space.* When these hubs are connected, all spacing is under the control of channel 11 in the carriage control tape. Every space initiated after printing is stopped by a hole in channel 11, thus allowing variable spacing within any section of the form. The select space hubs and the punching in channel 11 of the control tape must be used for triple spacing.

70. *Space 1-2.* SPACE 1 hubs are connected for single spacing, and SPACE 2 hubs, for double spacing. These hubs stop rather than cause spacing, for an automatic space is initiated before each line prints. These hubs may be selected so that single or double spacing may be placed under the control of a specific punch in the card.

71. *Extra.* These hubs accept cycle impulses to cause single or double space after printing, depending on how SPACE 1 or 2 is wired. These impulses may be selected.

72. *Supp.* These hubs accept program impulses to suppress normal spacing before a total prints, or a CARD CYCLES impulse to suppress normal spacing for every card. These impulses may be selected. Space suppression takes precedence over all normal spacing but does not suppress extra spacing.

73. *SP-SW.* The summary-punch switch must be on for summary punching. Its function is to provide an interlock, which delays the accounting machine while summary cards are being punched and to stop accounting machine operation when the last card leaves the summary punch hopper. This switch may be selected only through an alteration switch selector.

74. *First Card.* The MI, INT, and MA first card hubs emit a cycle impulse for the first detail card read after a minor, intermediate, or major program change. The minor first card hubs are always active for the first detail card following a heading card. They are normally wired to COUNTER PLUS to add the first card of a group, to the pickup hubs of a co-selector, or to the TRANSFER PRINT CONTROL hubs.

Each first card hub has a corresponding single-position selector, which transfers during the time the first card impulse is available.

75. *Symbol.* When the symbol switch is set for R, the R or – hubs for each counter emit an R (11-9) impulse when the counter is negative. When the switch is set for minus or is not wired, the R or – hubs emit a minus (11) impulse when the counter is negative. The R symbol switch can be selected so that the R prints on detail print cycles and the minus on group print cycles, or *vice versa.*

76. *Counter Control Plus.* A CARD CYCLE, ALL CYCLES, PROGRAM, or FIRST CARD impulse introduced into these hubs will cause the corresponding counter to add. TRANSFER EXIT PLUS is also wired to COUNTER CONTROL PLUS, when positive information is being transferred from another counter.

77. *Counter Control Minus.* A CARD CYCLE, ALL CYCLES, PROGRAM, or FIRST CARD impulse introduced into these hubs will cause the corresponding counter to subtract. TRANSFER EXIT MINUS is also wired to COUNTER CONTROL MINUS, when minus information is being transferred from another counter. When the minus hubs are impulsed, both the C and R or – hubs for the corresponding counter are active.

78. *Direct Entry or Direct Reset.* These are DIRECT ENTRY hubs, when the same impulse is wired to them that is also wired to the corresponding PLUS or MINUS hubs. An impulse to DIRECT ENTRY separates the COUNTER ENTRY from the COUNTER EXIT. The information wired to the COUNTER ENTRY hubs will enter the counter directly from the card rather than from the COUNTER-CONTROLLED PRINT hubs. When DIRECT ENTRY

is wired, no printing occurs. It is normally used during group printing operations to prevent overprinting and when transferring from another counter information that is not to be printed.

These are DIRECT RESET hubs when the same impulse is wired to them that is also wired to the corresponding READ-OUT and RESET hubs. An impulse to DIRECT RESET causes the total to clear out of the counter without reading out of the COUNTER EXIT hubs. A counter is normally wired for DIRECT RESET whenever the counter is to be cleared without printing the total. Totals cannot be transferred from one counter to another when DIRECT RESET is wired.

79. *Transfer Plus-Minus Exit.* The TRANSFER PLUS EXIT hubs emit an impulse when the corresponding counter READ-OUT and RESET hubs are impulsed and the counter is plus. They are wired to the PLUS ENTRY of another (receiving) counter.

The TRANSFER MINUS EXIT hubs emit an impulse when the corresponding counter READ-OUT and RESET hubs are impulsed and the counter is minus or zero. They are wired to the MINUS ENTRY of another (receiving) counter.

80. *Couple Control.* Whenever counters are coupled, the COUPLE CONTROL hubs of all but the high-order counter must be connected. This wiring insures that a zero test will be made in every coupled counter when NEGATIVE BALANCE is wired off, and prevents the punching of credit X's from any but the high-order counter during summary-punch operations.

81. *Negative Balance On.* These hubs emit an impulse at the end of the cycle during which the corresponding counter turns negative and for every cycle thereafter as long as the counter remains negative. Normally they are wired to NEGATIVE BALANCE CONTROL to convert complement figures or to the pickup of a selector to control other functions of the machine.

82. *Negative Balance Control.* These are entry hubs wired either from NEGATIVE BALANCE ON to convert complementary results or from NEGATIVE BALACE OFF to convert zero balance 9's to zeros.

83. *Negative Balance Off.* These hubs emit an impulse at the end of the cycle during which the corresponding counter zero balances. They are wired to NEGATIVE BALANCE CONTROL to convert zero balance 9's to zeros or to selector pickup hubs to control other functions of the machine.

84. * *Symbol Exit.* These hubs emit the equivalent of an 8-4-11 impulse whenever the corresponding counter is impulsed to READ OUT or READ OUT and RESET. They are wired to NORMAL or TRANSFER PRINT ENTRY for the printing of asterisk symbols for totals. They cannot be wired to COUNTER-CONTROLLED PRINT because these hubs do not accept zone impulses.

85. *C Symbol Exit.* These hubs emit a C (12-3) impulse whenever the corresponding counter is impulsed to subtract. They also emit a C impulse whenever the corresponding counter is negative and is impulsed to READ OUT or READ OUT and RESET. They are wired to NORMAL or TRANSFER PRINT ENTRY in conjunction with the R hub to identify a credit item or a credit total. They cannot be wired to COUNTER-CONTROLLED PRINT.

86. *R or — Symbol Exit.* If the R or — switch is wired for R, these hubs emit an R (11-9) impulse whenever the corresponding counter is impulsed to subtract or whenever that counter is impulsed to READ OUT or READ OUT and RESET a converted negative total. If the R switch is not wired or is wired for minus, these hubs emit a minus (11) impulse under the same condition as the R hubs. The R or — hubs are wired to NORMAL or TRANSFER PRINT ENTRY to identify credit items or credit totals. They cannot be wired to COUNTER-CONTROLLED PRINT.

87. *Carry Exit — Carry Entry.* The CI and C hubs must always be connected whenever a counter is in use. This is necessary because all counters reset to 9's. When counters are coupled, the CI of the high-order counter is wired to the C of the low order counter and the remaining CI and C hubs of the group are connected from right to left.

88. *Read Out.* These hubs accept cycle impulses to cause a counter to read out without resetting. They are normally used for progressive totalling.

89. *Read Out and Reset.* These hubs accept cycle impulses to cause a counter to read out and reset.

90. *Program.* These hubs are exits for cycle control impulses which are wired to control counters, selectors, storage units and the carriage, during program steps. Normally the first row of hubs (minor) becomes active as exits when the MINOR START hub receives an impulse; first and second (intermediate) rows become active in succession when the INTERMEDIATE START receives an impulse; first, second and third (major) rows become active in succession when the MAJOR START receives an impulse. The RUN-OUT FINAL row is active when the LCT switch is wired on, and the FINAL TOTAL toggle switch is ON.

When the special program switch is not wired on, each channel entry is connected internally to an all cycles impulse. When the switch is on, this connection is broken and must be made by external wiring. With the switch on, any start impulse causes the program steps to become active in succession from 1 through 5, at which point they stop unless REPEAT is wired.

91. *BT Cycles — BT PU.* When BT PU (balance test pickup) is wired from a cycles impulse, the BT CYCLES hubs emit impulses that begin slightly later and are suitable for selection through selectors picked

up immediately from NEG. BAL. ON or OFF. When BT PU is impulsed from a digit, BT CYCLES will emit an impulse that begins slightly after the digit and continues to the end of the cycle.

92. *All Cycles.* These common hubs emit all cycles impulses on every machine cycle except summary-punch cycles or long carriage skips. They are normally used as a substitute for other cycle impulses when properly controlled, or to provide program exit impulses when special program is wired on.

93. *O-Flow.* There are two independent overflow hubs for each program level. When OVERFLOW PROGRAM start is impulsed, the OVERFLOW PROGRAM hubs become active in turn, beginning with the first level and continuing until the fifth level is reached or until stopped by impulsing OVERFLOW END. They are normally used to control counters, storage units, and carriage operations for overflow sheet identification purposes. When overflow programs are active, the regular programs are inactive.

94. *PR CPL.* Each program step has a pair of common couple hubs. They emit impulses that begin sooner and last longer than the regular programs and are normally used to pick up selectors for the purpose of expanding the program exits. On machines that have OF CPL, these hubs emit on regular programs only. On machines that do not have OF CPL they emit on overflow programs as well as on regular programs.

95. *Stop Mi. Int, Ma. Final, Com.* When special program (SPL PRG) is wired on, the automatic stops are cancelled and the PROGRAM STOP must be wired. Normally the last program used is wired to STOP MINOR, INTERMEDIATE, or MAJOR, depending on what program start initiated the progression. The FINAL STOP is used when special program is ON, and both the RUN-OUT switch and the FINAL TOTAL toggle switch are on, to stop the progression of program steps after the last card runs out of the machine.

When the COMMON STOP hub is impulsed, the progression of steps will stop at the end of the same cycle, regardless of other controls. It is also an exit hub, and as such, emits an all cycles impulse during the last program step of each group.

96. *Final Total.* These hubs are normally wired to counter READ-OUT and RESET when final totals are desired. They emit an impulse whenever the final total key is pressed, provided the FINAL TOTAL toggle switch is on, the machine is idling, and there are no cards at the first and second reading stations.

97. *OF CPL (Overflow Couple).* These hubs emit impulses on their corresponding overflow program steps. The impulses begin sooner and last longer than the regular overflow programs and are normally used to pick up co-selectors for expanding overflow programs beyond two positions.

98. *Repeat.* When special program is wired on and a program start is initiated, if more than five steps are desired, step 5 is wired to REPEAT. This causes the automatic progression to be repeated. Any program step other than 5 can be wired to REPEAT, and the progression of steps will start over again on the following cycle.

99. *O-Flow End.* The succession of overflow program steps is stopped by wiring the last overflow program used to OVERFLOW END. The highest program level used (MINOR, INTERMEDIATE, or MAJOR) is also wired to OVERFLOW END along with the last overflow program, to cancel the overflow steps when both the overflow and the program change occur at the same time.

100. *O-Flow Trans.* These hubs are normally wired from EXIT 9 through a selector to cause a transfer from regular to overflow programs whenever a program change occurs after the hole in channel 9 has been sensed. They are used in variable length overflow operations.

101. *Zero Print Control.* Each printwheel has a pair of ZERO PRINT CONTROL hubs. They are jack-plugged to print zeros to the right of significant digits. The high-order position of a field is always left unplugged. To print zeros, zero impulses must be received by the printwheel either from a card, from a counter, or from an emitter. A maximum of eight zeros may be controlled to print to the left or right (or four on each side) of a significant digit, or for zero balances. The ZERO PRINT CONTROL hubs also control the printing of commas, decimals, and dollar signs as they do zeros, when these symbols are wired to PRINT ENTRY from the COMMA, DECIMAL, and DOLLAR hubs located immediately above the column splits.

102 through 113. *408-409 Control Panel Hubs.* These hubs are used only with the IBM 408 and IBM 409 Accounting Machines.

114 through 116. *409 Control Panel Hubs.* These hubs are used only with the 409.

Timing Charts

The main purpose of timing charts (Figures 177 and 178) is to assist in determining whether or not doubtful control-panel wiring functions properly. A good working knowledge of the machine is necessary before timing charts can be used effectively. The timing charts should be used in conjunction with the control-panel summary.

A cycle is a period of time required for a given series of events at the completion of which the series is repeated. Because the 407 operates at a speed of 150 cycles per minute, one cycle requires two-fifths of a second. Each cycle is divided into 24 equal parts called points, and each point of a cycle is further divided into 15 degrees. There are 360 degrees from one given point of a cycle to the same point of the next cycle. A cycle is usually measured from 0 to 0 (0 being the same as 360). Because the functional cycle on the 407, 408 begins at 322 degrees, the timing charts show a range from 322 degrees to 322 degrees.

Each cycle is also divided into two parts referred to as the first and second half of the cycle. Generally, the first half of the cycle (0 degrees to 180 degrees) is used for card reading and the second half (150 degrees to 285 degrees) for accumulating, although the latter may be done in the first half of the cycle by direct entry. Printwheels are set up from card reading or counter exits in the first half of the cycle and "echo" back to the counter in the second half.

The transfer time of pilot selectors when picked up with X or D is from approximately 292 degrees of one card cycle to 285 degrees of the next card cycle. Thus, pilot selectors remain transferred for intervening program cycles. The 7-degree break is necessary to allow time for a transferred selector to drop back to normal between one card cycle and another. When pilot selector immediate (I) is impulsed, selectors transfer immediately and drop at 285 degrees of the same cycle. If programs intervene, the selector will hold through the next card feed cycle.

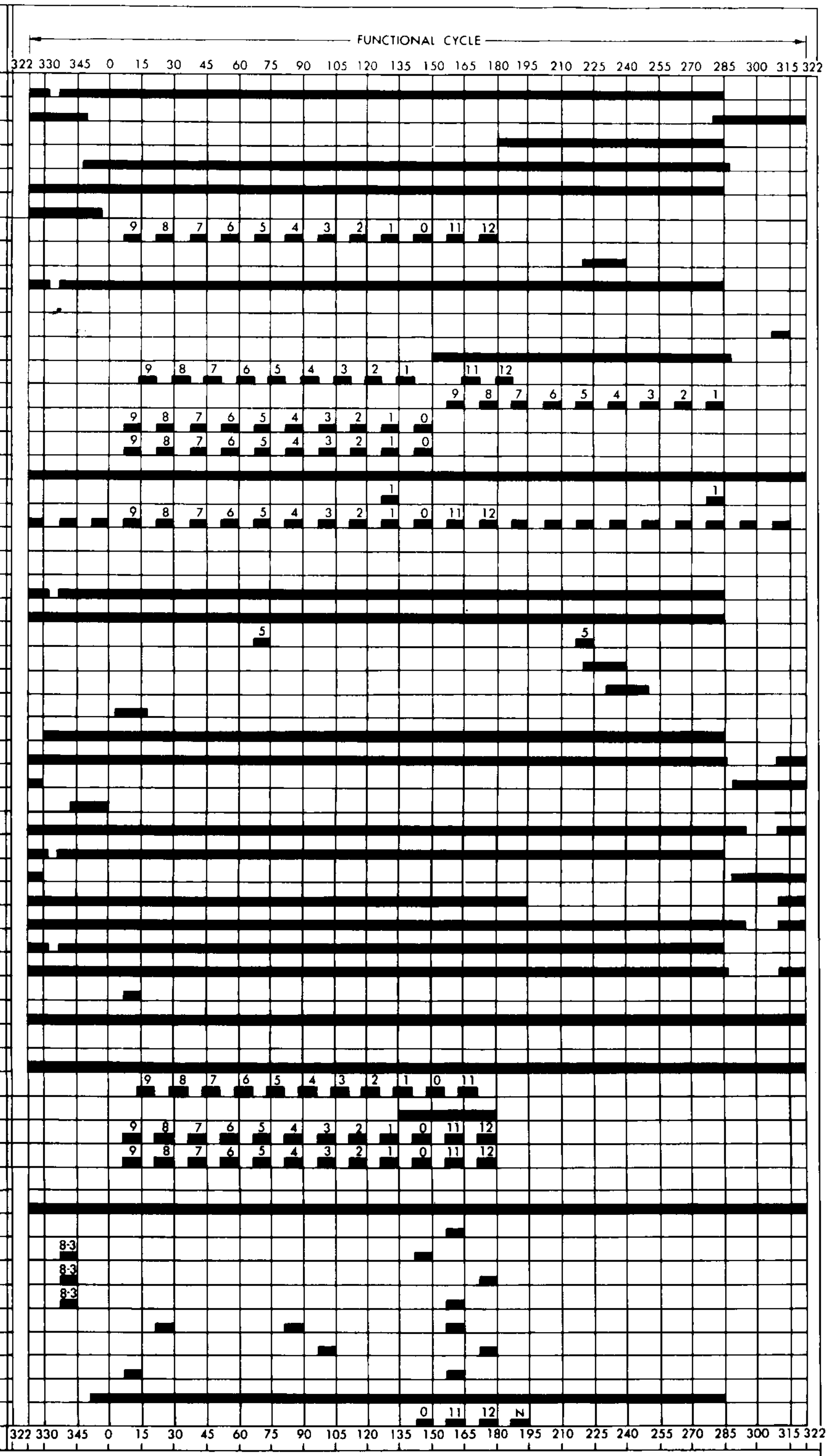
Co-selectors transfer immediately and return to normal at 285 degrees of the same cycle. When a co-selector is transferred with a coupling exit of a pilot selector, the co-selector transfers during carry (CI) time (307 degrees to 315 degrees), and for this reason pilot selectors (X or D pickup) instead of co-selectors should be used to select carry impulses.

As a general rule, an allowance of 7 degrees should be made between the immediate pickup impulse and the impulse to be selected because of the variable lag in the actual transfer of selectors. Impulses that are active during pickup time should not be selected. For example, the chart will show that selecting an all cycles impulse through a selector picked up immediately from NEGATIVE BALANCE OFF or ON will arc the selector points. On the other hand, the chart also shows that the same result can be accomplished by selecting the balance test cycle instead of ALL CYCLES without damaging the selector points.

The timing shown applies to all 407 machines that are internally wired to wiring diagram number 123165A.

EXITS ▬

CONTROL PANEL HUBS	LOCATION	MACH CYCLE	NOTES
All Cycles	AW, 53-68	A	
Alter. SW Exit	H, 73-76	A	
Asterisk Control	BJ, 33-34	A	
Bal. Test Cycle	AU, 61-64	A	1
Card Cycles	O, 53-72; Q, 37-40	C	2
Card Cycles (CO,CC)	O, 79-80	C	2
Card Reading Impulses		CM	
Carriage HH, HD, DH, DD, O'flow	N-O, 33-40	A	31
Channel Entry	AV, 53-68	A	4
Character Emitter	S-V, 41-52	AS	5
CI Carry Exit	AJ, 53-80	A	
Column Split CPL	AC, 51-52	AS	
Comparing Exit	D-E, 1-30	A	
Counter-Controlled Print (Echo Impulses)	AZ-BB, 1-40	A	6
Counter Exit	AR-AY, 1-42	A	7
Counter Punch Exits	BC-BF, 1-42	AS	
Couple Control (Lower)	AB, 53-80	AS	3
Cycle Count	AO, 41-42	A	
Digit Impulse	F, 37-40	A	
Exit 9	P, 39-40		8
Filter Exit	BL, 15-34		9
Final Total	AP, 73-77	F	
First Card (Mi, Int, Maj)	M-O, 73-74		10
Half Adjust	AP-AQ, 41-42	A	
Immediate Exit	F, 31-34	A	
Last Card Skip	N, 29-30	A	
Last Card Total (Upper)	G, 80	CF	11
List Off (Upper)	E, 80	AS	11
MLR Couple	R, 37-38	M	
MLR Repeat CPL	E, 37-40		12
Negative Bal. On-Off	AC, 53-80; AF, 53-80	A	
Overflow Couple	AP-AT, 79-80	O	
Overflow Programs	AP-AT, 67-68	O	
Overflow Transfer	AW, 69-72	O	
Pilot Sel. Couple Exit	C, 53-72		
Program Couple	AP-AT, 69-70	PS	
Program (Exit)	AP-AT, 53-66	P	
Progressive Couple 1, 2, 3	I-K, 29-30	M	13
R or — Switch (Upper)	M, 79	A	
Runout On (Upper)	G, 79	A	3, 11
Space 1, 2 Sel.	K, 73-75		8
Special Program On (Upper)	I, 79	AS	3, 11
Split Column Control	I-J, 73-78	A	
Storage Alphabet	AK, 43-46	AS	
Storage Exit	Y-AB, 1-32	AS	
Storage Punch Exit	BI-BJ, 1-32	AS	
Storage Sum Punch	AM, 47-50	S	
Summary Punch Switch	K-L, 79	AS	3, 11
Summary Punch X	BI, 33-34	AS	
Symbols—Comma	AC, 41-44	A	
Decimal	AC, 45-48	A	
Dollar Sign	AC, 49-50	A	
* Symbol	AG, 53-80	A	
C Symbol	AH, 53-80	A	
R or Symbol	AI, 53-80	A	
Transfer Exit Plus-Minus	Y-Z, 53-80	A	14
Zero Print Ctrl. (Lower)	BH, 41-80; BJ, 41-80; BL, 41-80		15



MACHINE CYCLES CODE

- A All machine cycles, except summary punch and long carriage skip cycles
- C Card cycles
- F Final total cycle
- M MLR cycles
- O Overflow programs
- P Program cycles
- S Summary punch cycle; timing under control of summary punch

NOTES

1. Should not be used for counter crossfooting
2. Q, 37-40 active on all card cycles; O, 53-72 and O, 79-80 except HC and MLR cycles
3. Line impulse
4. Except special program
5. Emits impulses as designated on control panel
6. All cycles if impulsed
7. Except on direct entry or direct reset
8. Under control of carriage
9. Emits whatever is entered
10. Minor also active on first body card
11. Wire only to lower hub
12. All MLR cycles after repeat is impulsed. First repeat cycle good only from 310-350°
13. Timing shown for MLR only. When used as entries, timing depends on pickup impulse
14. Only when counter is impulsed to read out and reset
15. Print cycles only; N internal no-zone impulse
16. Immediate transfer at time impulsed
17. Minus must be impulsed not later than 351°
18. Counter-controlled print internally common with either normal or transfer print entry on first half of cycle
19. Must be impulsed not later than 336°
20. Except when release is impulsed on the same cycle
21. Including last MLR cycle
22. Accepts 3 on line 3, 2 on line 2, 1 on line 1
23. Accepts only after overflow program start has been impulsed
24. Except overflow programs
25. Transfer time on X or D pickup
26. Com. accepts any program; Mi, Int, Maj accept when corresponding program start is impulsed; Final accepts when runout final is active
27. Except cycle preceding summary punch cycle
28. Read in effective on next card feed cycle or next MLR cycle; Read out effective on same card feed cycle if impulsed between 322 and 335°
29. Read in effective on next card feed cycle or next MLR cycle
30. Any impulse from 5 to 110 degrees (including digits 9 through 3) will suppress spacing before and after printing. Any impulse on a program cycle from 135 to 260 degrees will suppress any automatic spacing that may occur after total printing
31. In MLR, emits only on the last cycle

Figure 177. Timing Chart

ENTRIES: Normal / Available but not normally used

CONTROL PANEL HUBS	LOCATION	MACH.	NOTES
Alter. SW Sel. (Trans.)	E-G, 73-76	A	
Ampersand, Minus Entry	BK, 35-40	A	
Asterisk Entry	BJ, 35-40	A	
Auto Stop	AH, 51-52	A	
Bal. Test P. U.	AU, 65-66	A	
C Carry Entry	AK, 53-80	A	
Carriage · Form Skip	P, 37-38	A	
Immediate Skip	L, 31-40	A	
Short Skip	M, 33-40	A	
Skip Control	M-N, 31-32	A	
Skip D	J-K, 31-40	A	
Skip X	I, 31-40	A	
Channel Entry (Spec Prog On)	AV, 53-68	A	
Column Split 0-9	AE, 41-52	AS	
Column Split 11-12	AF, 41-52	AS	
Comparing Entry	C-F, 1-42	A	
Co-selector P. U.	A-B, 53-80; C-D, 73-76	AS	
Co-selector (Transferred)		AS	16
Counter Control Plus-Minus	S-T, 53-80; U-V, 53-80	A	17
Counter-Controlled Print	AZ-BB, 1-40	A	18
Counter Entry	AG-AN, 1-42	A	
Counter Exit	AR-AY, 1-42	A	
Counter Readout & Readout Reset	AL-AO, 53-80	A	
Couple Control (Upper)	AA, 53-80	A	
Digit Selector C	A, 41-52	A	
Direct Entry or Reset	W-X, 53-80	A	19
Extra Space	K, 76-77	A	
Filter Entry	BK, 15-34	A	
First Card Selectors (Trans.)	M-O, 75-77	CM	10
Head D or Head D Suppr.	D, 35-36; F, 35-36	A	
Head X or Head X Suppr.	C, 35-36; E, 35-36	A	
MLR-Lines 1, 2, 3 (Progressive Sel. Trans.)	I-K, 1-30	A	13
Release	D, 39-40	A	
Repeat	D, 37-38	M	20
Start	C, 37-38	C	21
Stop	C, 39-40	M	22
Neg. Bal. Control	AD-AE, 53-80	A	
Non Print	AJ, 51-52	A	
Normal Print Entry	V-X, 1-40	A	18
Overflow End	AV, 69-72	OP	23
Overflow Prog. Start	E, 33-34	A	24
Overflow Transfer	AW, 69-72	A	
Pilot Selector — D P.U.	F-G, 53-72	A	
I P.U.	H, 53-72	A	
X P.U.	D-E, 53-72	A	
Pilot Selectors (Trans.)		A	25
Print	AI, 51-52	A	
Program Repeat	AU, 71-72	P	
Program Start (Mi, Int, Maj)	C-D, 30-33; E, 30-31	C	21
Prog. Stop (Mi, Int, Maj, Final, Com)	AP-AT, 71-72	P	26
R or — Switch (Lower)	N, 79	A	
Space 1, 2, Sel.	L, 73-75	A	8
Space Suppress	L, 76-77	A	30
Stop	AG, 51-52	A	
Storage-Alphabet SW	AL, 43-46	AS	
Entry	O-R, 1-32	A	
Immediate Out	AK-AL, 47-50	A	
Next Cycle In	AM-AN, 43-46	A	27
Read In, Out D	AI-AJ, 43-50	A	28
Read In, Out X	AG-AH, 43-50	A	29
Summary Punch	AN, 47-50	S	
Summary Punch Entry	BG-BH, 1-40	S	
Summary Punch P. U.	AK, 51-52	OP	
Transfer Print (TR PR)	R, 39-40	A	
Transfer Print Entry	S-U, 1-40	A	18
Zero Entry	BI, 35-40	A	
Zero Print Ctrl. (Upper)	BG, 41-80; BI, 41-80; BK, 41-80	A	

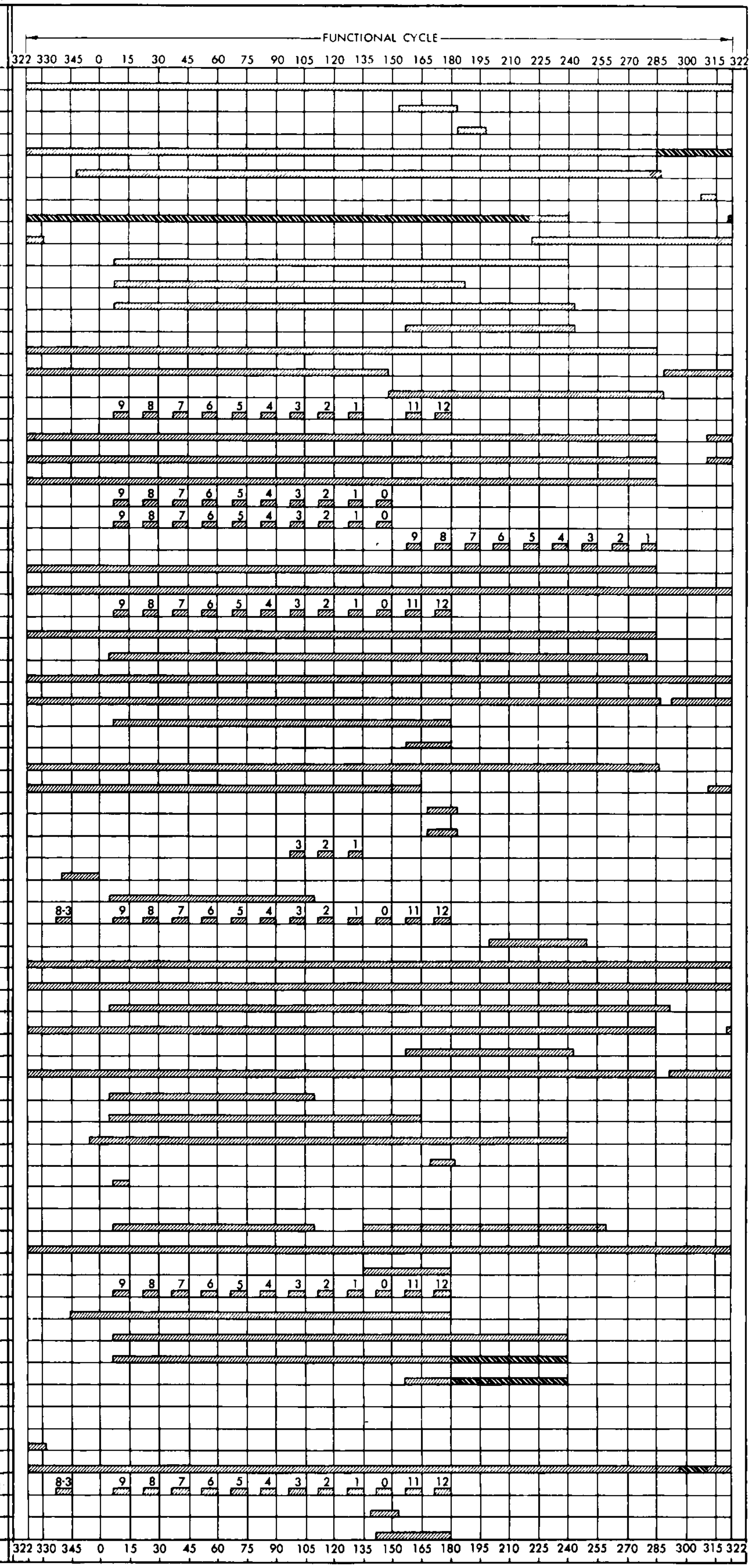


Figure 178. Timing Chart

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