RESEARCH COMPUTER LABORATORY

IBM

650 DATA PROCESSING SYSTEM BULLETIN

533 CARD READ PUNCH, 537 CARD READ PUNCH, 407 ACCOUNTING MACHINE

This bulletin is one of a series of three bulletins on the 650 Card System. The other bulletin Form numbers are G24-5000 and G24-5002. These three bulletins obsolete the 650 Manual of Operation, Form 22-6060. In addition, the information in this bulletin obsoletes:

1. 537 Manual of Operation, Form 22-6315
2. 650 Additional Features Manual of Operation, Form 22-6265 (407 Section)
3. 650 Bulletin 4, Form 32-7989
4. 650 Bulletin 10, Form 32-7884, pp. 67 and 68
5. 650 Bulletin 15, Form 31-0410, pp. 119, 120, 121, and 125

Input and Output Synchronizers

The IBM 650 Data Processing System can be equipped with three input-output synchronizers. Each of these synchronizers can accommodate any of the three input-output units.

The purpose of a synchronizer is to achieve maximum efficiency in the electronic portions of the system while maintaining the flexibility of the mechanical input-output device. Because of the synchronizers, it is *not* necessary to stop 650 program execution for the entire mechanical cycle of the input-output device. A further function of the synchronizer is that of language translation. It translates the language of the input device to that of the 650 and translates 650 language to that of the output device.

Attachment of any input-output device (533, 537, 407) to any synchronizer is by means of cable receptacles located on the 655 Power Unit (Figure 1). There are two cable receptacles associated with each input-output synchronizer. One of them serves as a connection to the input area and the other as a connection to the output area. However, a single input-output device cannot be split between two synchronizers (for instance, 533 input to synchronizer 1 and output to synchronizer 2).

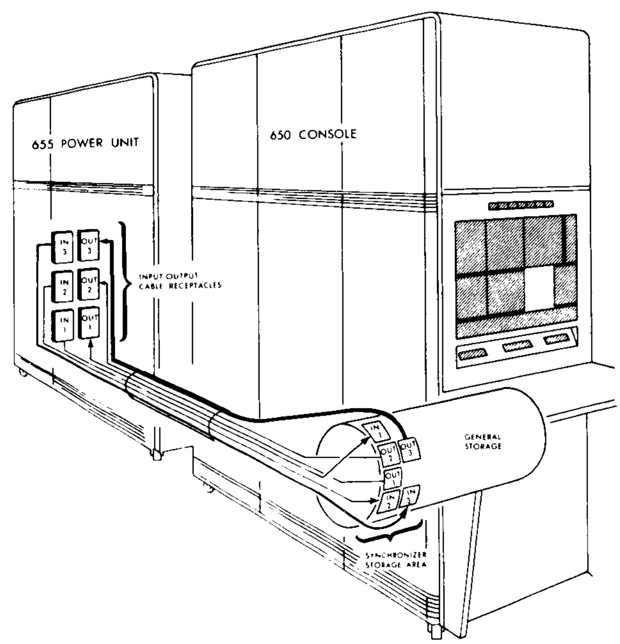


Figure 1. Synchronizer Cable Connections

The synchronizers are physically located on the drum but are *not* part of general storage and therefore, are not addressable. Each synchronizer area has the capacity for storing up to 10 words (100 digits) of information. The physical placement of the synchronizers with respect to the general storage area (Figure 2) is important because it determines which words in general storage are accessible to each synchronizer.

An individual synchronizer does not have direct access to the entire 2000 words of the drum. Rather, its access is limited to those words directly opposite the individual synchronizer area. Input synchronizer 1 is opposite words 0001-0010, 0051-0060, etc. (These are the words to which it has direct access.) Output synchonizer 1 is opposite words 0027-0036, 0077-0086, etc. Thus input synchronizer 1 has access to 400 general storage words (10 words in each of the 40 bands). Output synchronizer 1 also has access to 400 words of general storage (10 words in each band). Synchronizers 2 and 3 have access to the same areas of general storage (Figure 2). Each has access to 400 words on input and 400 words on output.

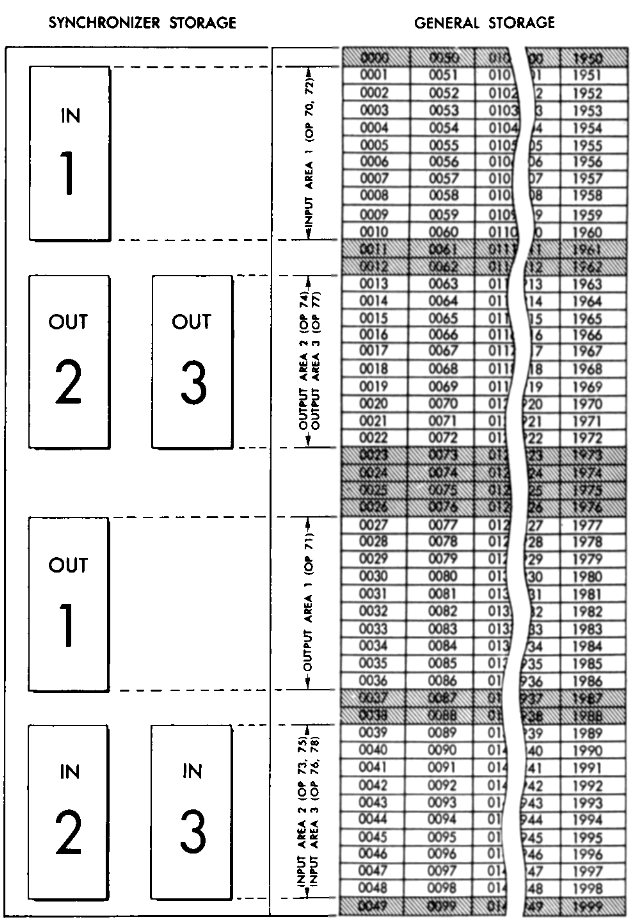


Figure 2. Physical Location of the Synchronizers

At the beginning of a 650 operation, cards are placed in the hopper of the input unit. The operator then presses the Start key on the input-output unit. This results in an automatic operation that stops when the information in the first card has been entered into the appropriate synchronizer storage area. At this point, further operation of the input unit is placed under control of the 650 program. Before the program begins, the information from the first card is already present in the input synchronizer area.

This is the starting point for the following discussion of the input-output operation codes. Only those codes associated with synchronizer 1 are discussed in detail. The codes associated with synchronizers 2 and 3 are identical in operation to the synchronizer 1 codes, with the exception of the areas in general storage to which the synchronizers have access and which cable receptacles are active.

Input-Output Operation Codes

70 RD1 (Read, Input Area 1). This is specifically associated with input synchronizer 1. This code initiates a two-step operation (Figure 3):

1. The contents of the synchronizer storage area are transferred to general storage. This information may or may not be validity checked during the transfer (see Control Panel section-RVC). The specific band in general storage is determined by the D-address of the instruction. NOTE: the D-address determines only which band of general storage will receive the transfer. The specific words in the band are fixed by the physical placement of the synchronizer area with respect to the general storage area. For synchronizer 1, these will be words 0001-0010, 0051-0060, etc.
2. The input unit is given a signal telling it to feed and read another card. Reading this card will not begin until the present contents of the synchronizer are completely transferred to general storage. When the transfer is completed, and the mechanical feeding of the next card is begun, the 650 is free to continue program execution. The short time that program execution is interrupted is called *interlock-time.* The exact amount of interlock time depends on the input unit being used (see Bulletin 6, 328-7990). The mechanical action of the input unit now refills the synchronizer with the information from the next card while the information from the previous card is being processed. During the transfer from the input unit to the synchronizer, the language of the input card is translated to that of the 650.

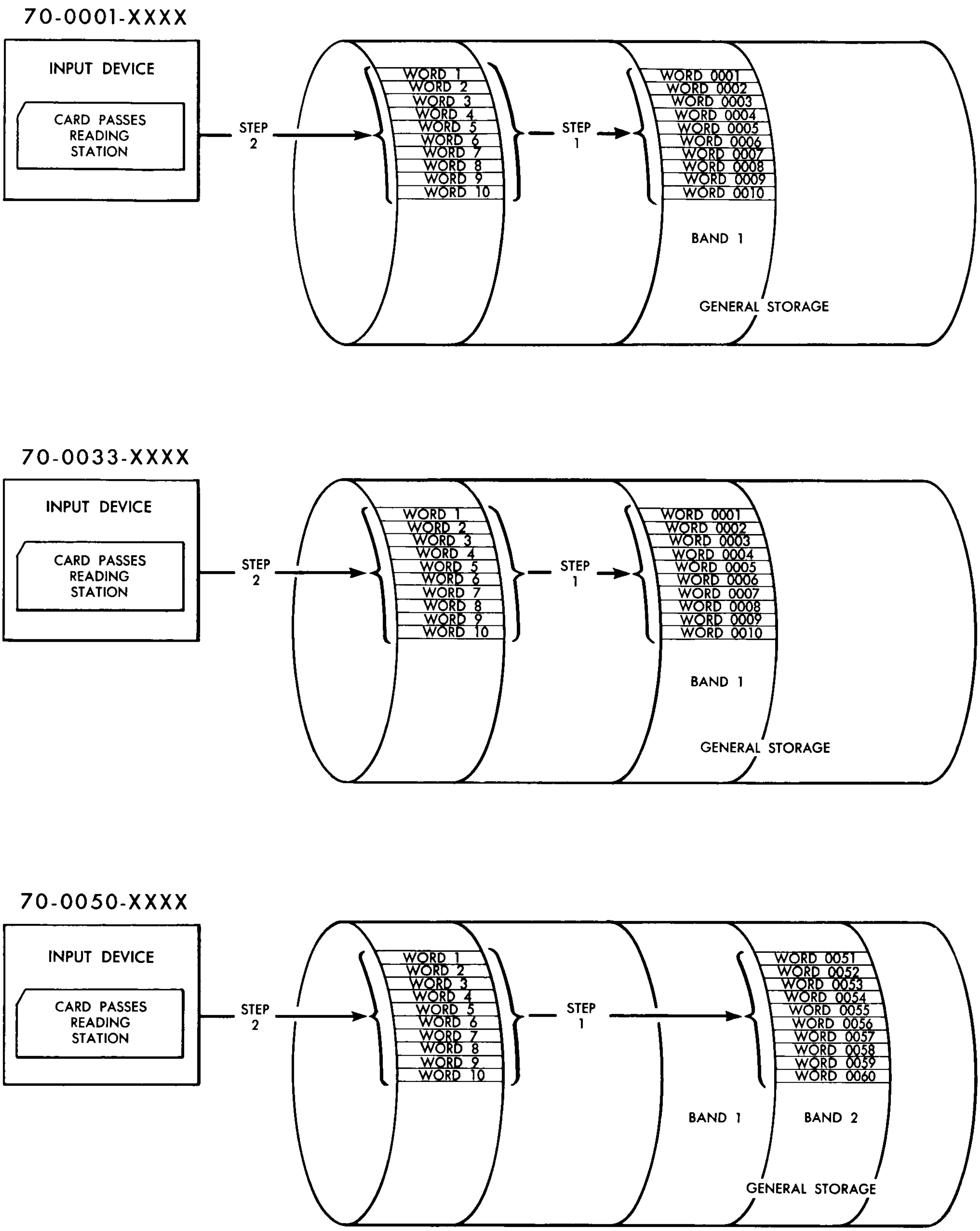


Figure 3. 70 RD1 Operation

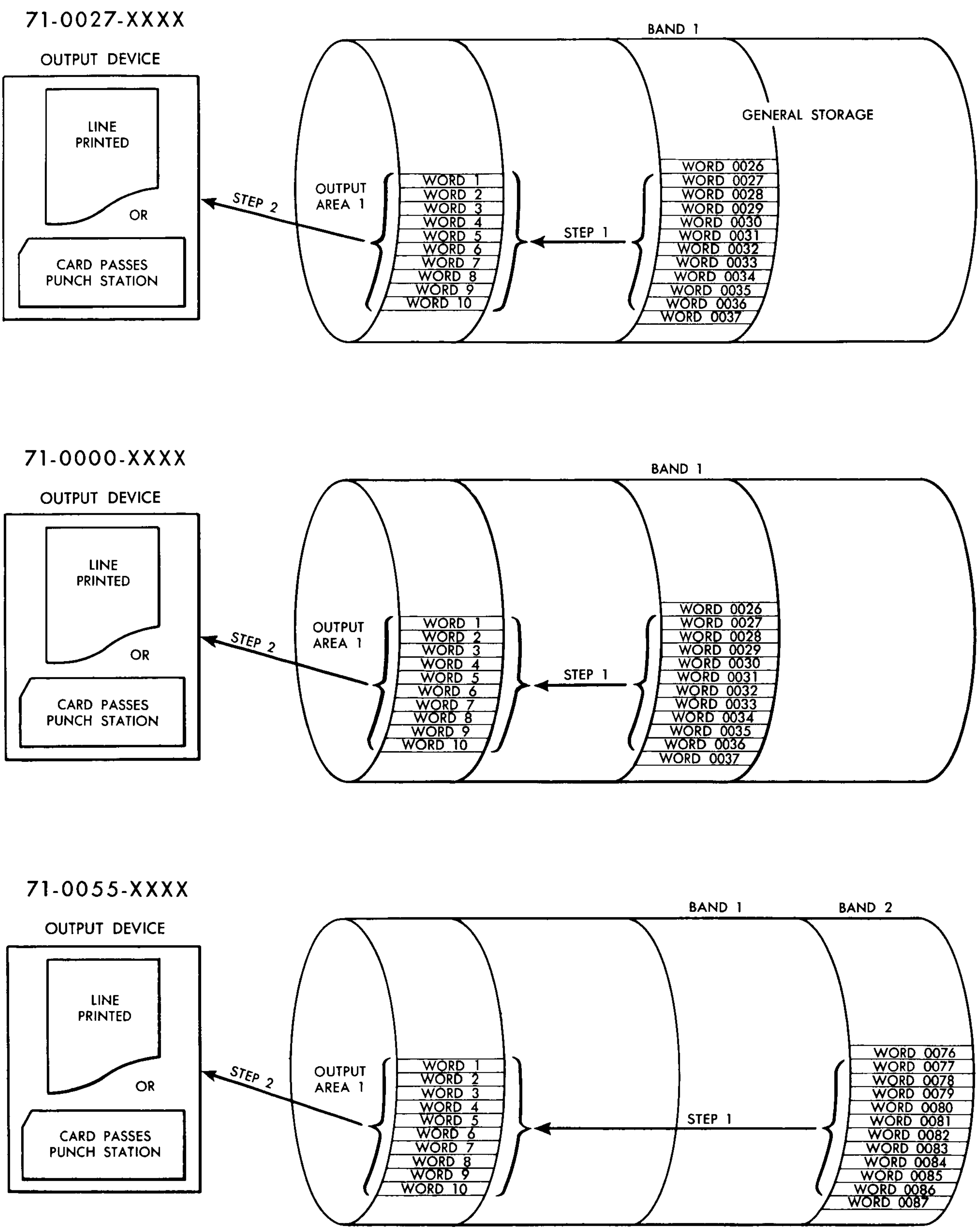


Figure 4. 71 WR1 Operation

71 WR1 (Write, Output Area 1). This is specifically associated with output synchronizer 1. This code initiates a two-step operation (Figure 4):

1. The contents of ten words of a general storage band are transferred to output synchronizer area 1. The specific band is determined by the D-address of the instruction. NOTE: The D-addres does not determine which 10 words of the band are transferred. The specific words transferred are fixed by the physical relationship of the output synchronizer 1 to the general storage area. These words are 0027-0036, 0077-0086, etc.
2. A signal is sent to the output unit telling it to begin its mechanical output operation. This operation will not begin until the entire 10 words from the general storage band are transferred to the output synchronizer. The contents of the output synchronizer are then transferred to the output unit control panel. During this transfer, the information may or may not be validity checked (see control panel section-PVC). Also, the language of the 650 is translated to that of the output unit. As in the 70 RD1 code, 650 program execution is interlocked for only the short period of time necessary to assure that the mechanical operation is begun.

NOTE: The 71 WR1 code can result in the mechanical operation of the input unit (407 only) connected to synchronizer 1, if the 71 code is preceded in the program by a 72 RC1 instruction.

72 RC1 (Read Conditional, Input Area 1). This is specifically associated with input synchronizer 1. It can be used only with a 537 or 407. If it is used with a 533, program execution will stop.

This code is very similar to the 70 RD1 code. The major difference is that the 72 RC1 code does not initiate any mechanical action of the input unit. The 72 RC1 code:

1. Transfers the contents of the input synchronizer to the band of general storage specified by the D-address of the instruction; and
2. Conditions the input unit so that it will operate to refill the synchronizer when the next 71 WR1 instruction is executed.

This conditioning of the input unit to operate only when the WR instruction is executed, allows both read and write operations to take place simultaneously (Figure 5).

The 72 RC1 code must be used in conjunction with the 71 WR1 code. The 72 code must be followed by a 71 code before another input code (associated with synchronizer 1) is executed.

LOCATION OF INSTRUCTION	INSTRUCTION			OPERATION ABBREV.
	OP	DATA	INSTRUCTION	
0051	72	0000	0052	RC1 ①
0052	71	0027	XXXX	WR1 ②③

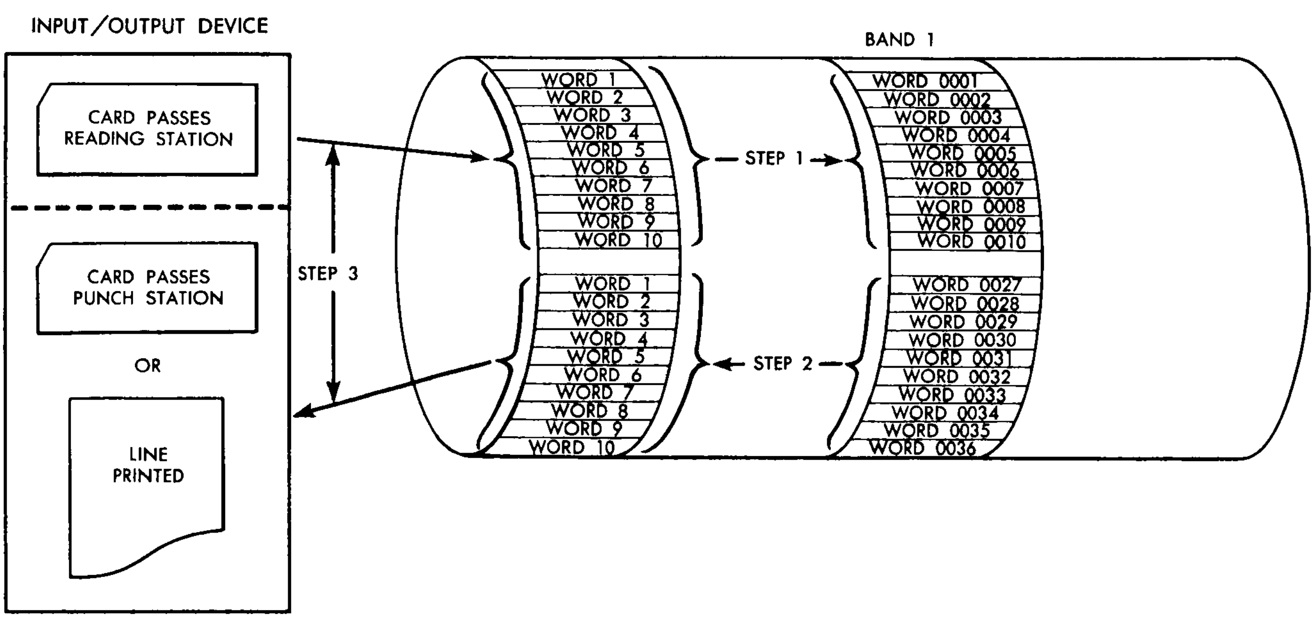


Figure 5. 72 RC1 Operation

73 RD2 (Read, Input Area 2). This is specifically associated with input synchronizer 2. This code functions similar to the 70 RD1 command, except which words in general storage are used and which cable receptacle is active. Input synchronizer 2 has access to general storage words 0039-0048, 0089-0098, etc.

74 WR2 (Write, Output Area 2). This is specifically associated with output synchronizer 2. This code functions similar to the 71 WR1 command, except which words in general storage are used and which cable receptacle is active. Output synchronizer 2 has access to general storage words 0013-0022, 0063-0072, etc.

75 RC2 (Read Conditional, Input Area 2). This is specifically associated with input synchronizer 2. This code functions similar to the 72 RC1 command, except which words in general storage are used and which cable receptacle is active.

76 RD3 (Read, Input Area 3). This is specifically associated with input synchronizer 3. Except for the cable receptacle used, it functions the same as the 73 RD2 command.

77 WR3 (Write, Output Area 3). This is specifically associated with output synchronizer 3. Except for the cable receptacle used, it functions the same as the 74 WR2 command.

78 RC3 (Read Conditional, Input Area 3). This is specifically associated with input synchronizer 3. Except for the cable receptacle used, it functions the same as the 75 RC2 command.

IBM 533 Card Read Punch

This machine provides input and output for the 650. It can be considered as two separate machines on one base (Figure 6). The input (read) unit has a maximum rate of 200 cards (16,000 digits) per minute. The output (punch) unit has a maximum rate of 100 cards (8000 digits) per minute. Operations on one of the units does not affect the other. Because the two feeds are entirely independent, it is not possible to punch information directly from the card being read. Any information being read from the card must pass through the input synchronizer, the general storage area, and the output synchronizer before it can be punched.

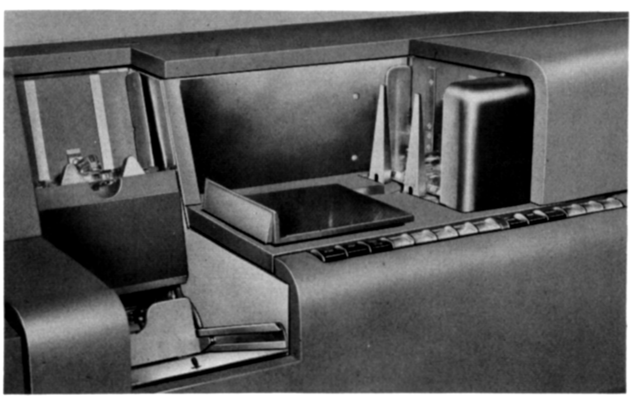


Figure 6. 533 Read Feed (Left) and Punch Feed (Right)

Main-Line Switch

This switch controls the application of power to the 533. It is located on the right end of the machine.

Power Light

This light (Figure 7) goes on when the main-line switch is turned on. It remains on as long as the power is applied.

Fuse Light

This light (Figure 7) goes on when a fuse blows in the 533.

Input Keys and Lights (Figure 7)

The input cards are placed into the read hopper face down, 12-edge first. All 80 columns of the card can be read into the input synchronizer, which has a capacity of 100 digits. The card reader (Figure 8) has two stations at which cards can be read. Normally, cards are read at the second reading station. The first reading station usually reads control information such as man number, card indentification, etc. Group control is performed by internal programming in the 650.

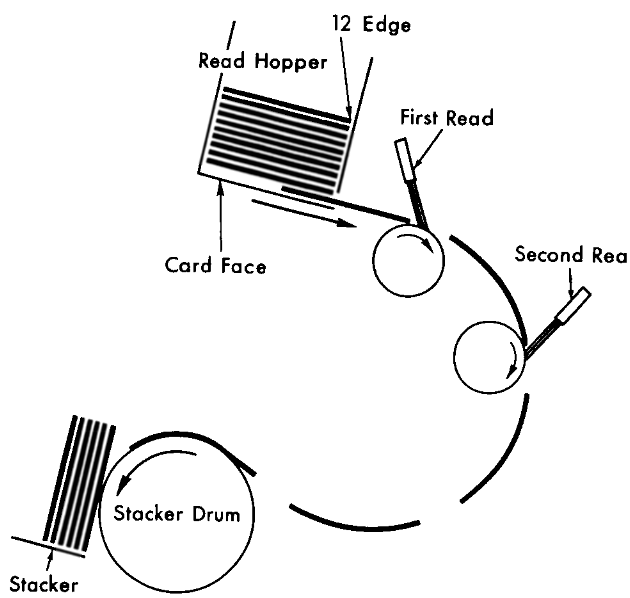


Figure 8. 533 Read Feed Schematic

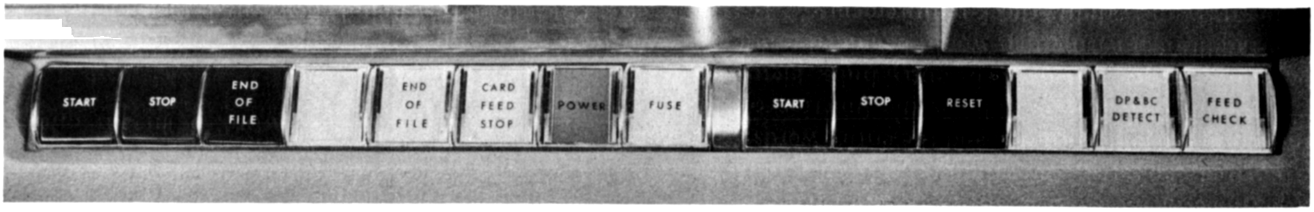


Figure 7. 533 Control Keys and Indicator Lights

Read-Start Key

The major function of this key is to initially place the input cards into position so that further feeding and reading is under control of the stored program.

If four or more cards are placed into the read hopper, a single momentary depression of the read-start key results in three cards being fed (Figure 9). At the end of the third feed cycle the machine stops, and further feeding and reading is placed under control of the stored program. During the third feed cycle, the first card passes the second reading station and the information from this card is transferred to the input synchronizer area. Pressing the read-start key again will have no effect while cards remain in the hopper.

The action of the stored program will eventually result in the last card leaving the hopper. When this occurs, the machine stops with three cards still unprocessed (Figure 10). Further feeding, under control of the stored program, is now contingent on some action by the operator. The action taken by the operator will depend upon the job status. There are three possible conditions:

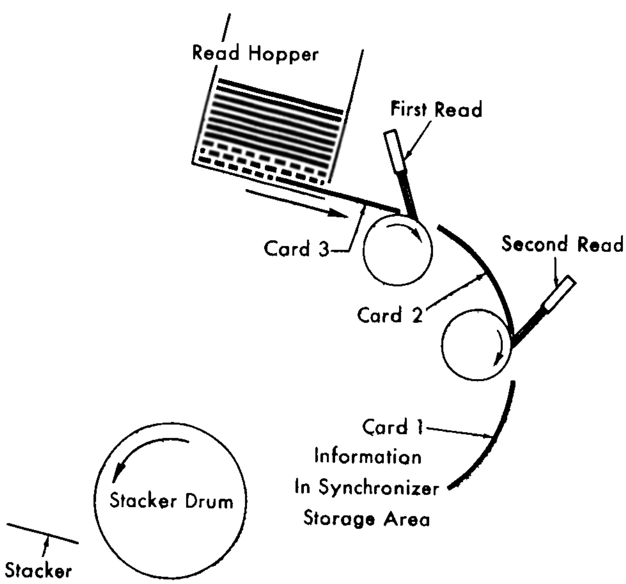


Figure 9. 533 Run-In—4 or more Cards

1. *There are more cards to be processed* – refill the read hopper and press the read-start key. Processing will resume immediately.
2. *There are no more cards to be processed except the three remaining in the feed* – press the END-OF-FILE key. The stored program resumes control of the feeding until the last card is processed (Figure 11). The read-start key is then used to run the cards into the stacker.
3. *The three remaining cards in the feed are not to be processed* – hold the read-start key down until the last card is in the stacker. In this case, the function was non-calculate run-out.

If fewer than four cards are initially placed into the read hopper, special attention must be given to the action of the read-start and end-of-file keys. This special case is covered in the section headed *Processing Fewer than Four Cards.*

End-of-File Key

The function of this key is to allow the 650 to process those cards remaining in the feed after the last card has left the hopper (Figures 10 and 11). This key is not effective while cards remain in the hopper.

Read-Stop Key

The function of this key is to suspend card feeding. Pressing this key stops feeding in either or both feeds. However, program execution continues until a RD or WR instruction is called for.

With both feeds in use, card feeding can be stopped by pressing either the READ-STOP or PUNCH-STOP key. To resume operation, press both the read-start and punch-start keys.

With only one feed in use, card feeding can be stopped with either stop key. However, the start key associated with the feed in use is pressed to resume operation.

Card-Feed-Stop Light

This light comes on when an improper card feed occurs in the read feed. Program execution stops when the next RD instruction is sensed (see section on Restart Procedures).

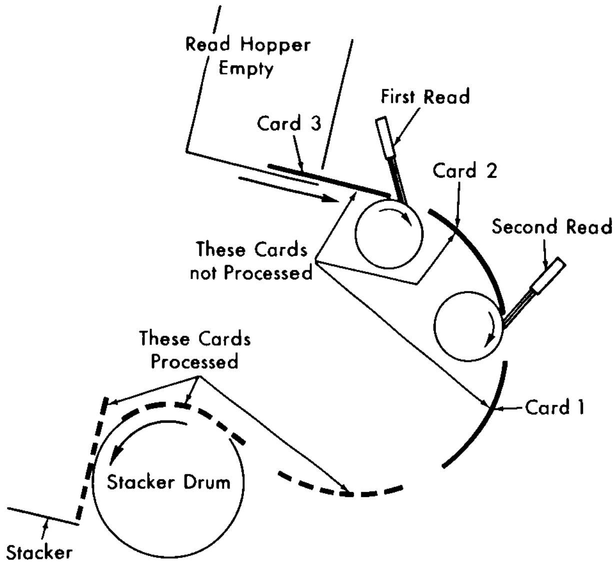


Figure 10. 533 Hopper Stop Condition

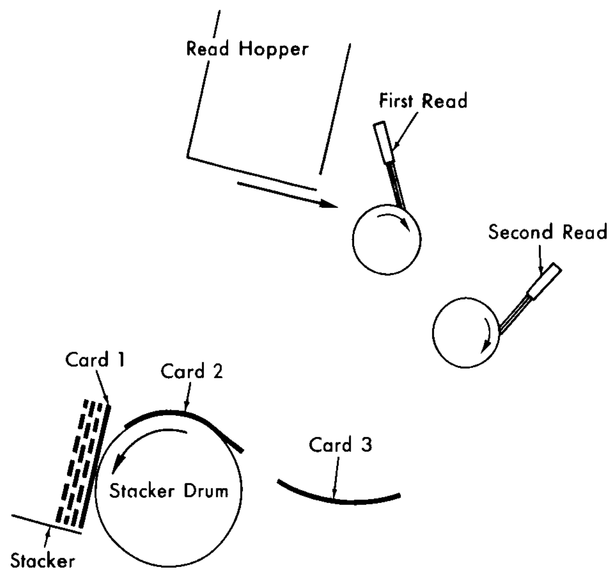


Figure 11. 533 End-of-File Complete—All Cards Processed

Unlabeled Light-Left

This light is on whenever the read feed is not in use. On the run-in, it goes out after the third card feed cycle and remains out until any one of these conditions occurs:

1. Stop key is pressed.
2. Last card leaves the hopper.
3. Cards are manually removed from the hopper.
4. Card-feed-stop is activated.

End-of-File Light

This light comes on when the end-of-file key is pressed and remains on until the information from the last card is entered into general storage. If the stop key is pressed while the machine is processing the last three cards, the end-of-file light will go out and the unlabeled light comes on. The end-of-file key must be pressed again to resume processing.

Feed-Check Light

This light comes on when either feed unit has mechanical cycles in excess of those called for by the program. Program execution is not stopped until it refers again to the unit that had the extra feed.

To determine which unit causes the feed-check, look at the op register display lights on the control console. If a RD code (70, 73, 76) is displayed, the read unit caused the feed-check. If a WR code (71, 74, 77) is displayed, the punch unit caused the feed-check (see section on Restart Procedures).

Output Keys and Lights (Figure 7)

Output cards are placed into the punch hopper, face down, 12-edge first. The punch feed (Figure 12) contains a punching station and a punch-brush station. The output results from the 650 are recorded in the card at the punching station. The main use of the punch brushes is to detect double-punched or blank columns in the output card. Normal gangpunching from the punch brushes can be done. It is *not* possible to read into a synchronizer area from the punch brushes.

Punch-Start Key

This key positions cards in the punch feed so that further feeding is under control of the stored program. A single momentary depression of this key will cause two punch-feed cycles (Figure 12). After the second cycle, feeding stops and control is transferred to the program. Further action of this key will have no effect while cards remain in the hopper. To run cards out of the punch unit, empty the hopper before pressing the punch-start key.

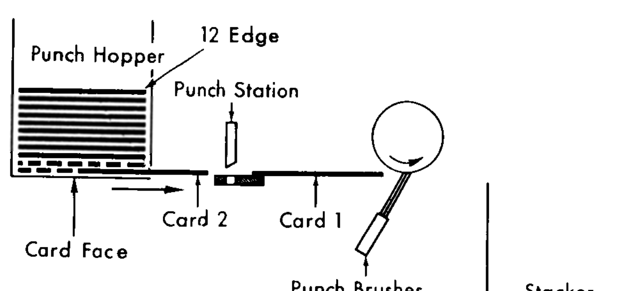


Figure 12. 533 Punch Feed Schematic

Punch-Stop Key

This key is identical in operation to the read-stop key. If the punch-start key and punch-stop key are pressed at the same time, in an attempt to single-cycle the run-in of the cards, the machine will lock-up after feeding one card. It is now necessary to remove the cards from the punch hopper and run the card out of the feed before operations can be resumed.

Reset Key

This key resets the double-punch and blank-column stop circuit. It also turns off the DPBC light.

DPBC Light (Double-Punch, Blank-Column)

This light comes on when a double-punch or blank-column error is detected by control-panel wiring.

Unlabeled Light-Right

This light is on when the punch feed is not in use. On the run-in, this light goes out after the second feed cycle and remains out until one of these conditions occurs:

1. Either stop key is pressed.
2. The last card leaves the hopper.
3. Cards are manually removed from the hopper.
4. Card-feed-stop is activated.

Restart Procedures

Restart after Read Feed-Check

To restart:

1. Remove cards from read hopper.
2. Hold read-start key down until all cards in the feed are in the stacker and the feed-check light is out.
3. Remove the last four cards in the stacker and place in front of the cards that were removed from the hopper. Replace cards in hopper.
4. Press read-start key – program execution begins automatically.

Restart after Punch Feed-Check

To restart:

1. Remove cards from the punch hopper.
2. Hold punch-start key down until all cards in the feed are in the stacker and the feed-check light is out.
3. Take the last correctly punched card from the stacker and place it in front of the cards removed from the hopper.
4. Replace the cards in the hopper and press the punch-start key – program execution begins automatically.

Restart after Card-Feed-Stop

To restart:

1. Remove cards from read hopper.
2. Hold read-start key down to clear the feed.
3. Repair the damaged card.
4. Remove the last two cards from the stacker and place them in front of the group removed from the hopper.
5. Replace cards in hopper and press read-start key.

A card-feed-stop on the first card of the run-in requires only pressing the read-stop key to turn off the card-feed-stop light.

Restart after RVC

To restart:

1. Remove cards from read hopper.
2. Hold read-start key down to clear feed.
3. Remove last four cards from the stacker.
4. Correct error card (first card of the four removed).
5. Press error reset key on the control console.
6. Place the corrected card, and three other cards removed from stacker, in front of the group removed from the hopper and replace them in hopper.
7. Press read-start key.
8. Press program start key on control console.

Restart after PVC

To restart:

1. Remove cards from punch stacker.
2. Press error reset key on control console.
3. Press program start key on control console.

The error card is the second card fed into the punch stacker.

Processing Fewer Than Four Cards

To process fewer than four cards in the 533:

1. Press computer reset or program reset key on control console.
2. Place card(s) in read hopper.
3. Press read-start key and end-of-file key together. Hold them down until end-of-file light comes on.
4. Press program start key on control console.

Control Panel

The 533 Control Panel, which provides for flexibility of input and output, is mounted on the right end of the machine. Although the control panel is used basically for flexibility of input-output, its use can have a great effect on programming. For this reason, it is most important to plan the control-panel layout as the programming is being done.

Figure 13 shows the control-panel layout. The shaded areas represent additional capacity and optional devices. In the description of the control-panel hubs, the number following the hub name indicates the area in which it is located on the panel.

The timing chart of the control panel impulses is shown in Figure 14.

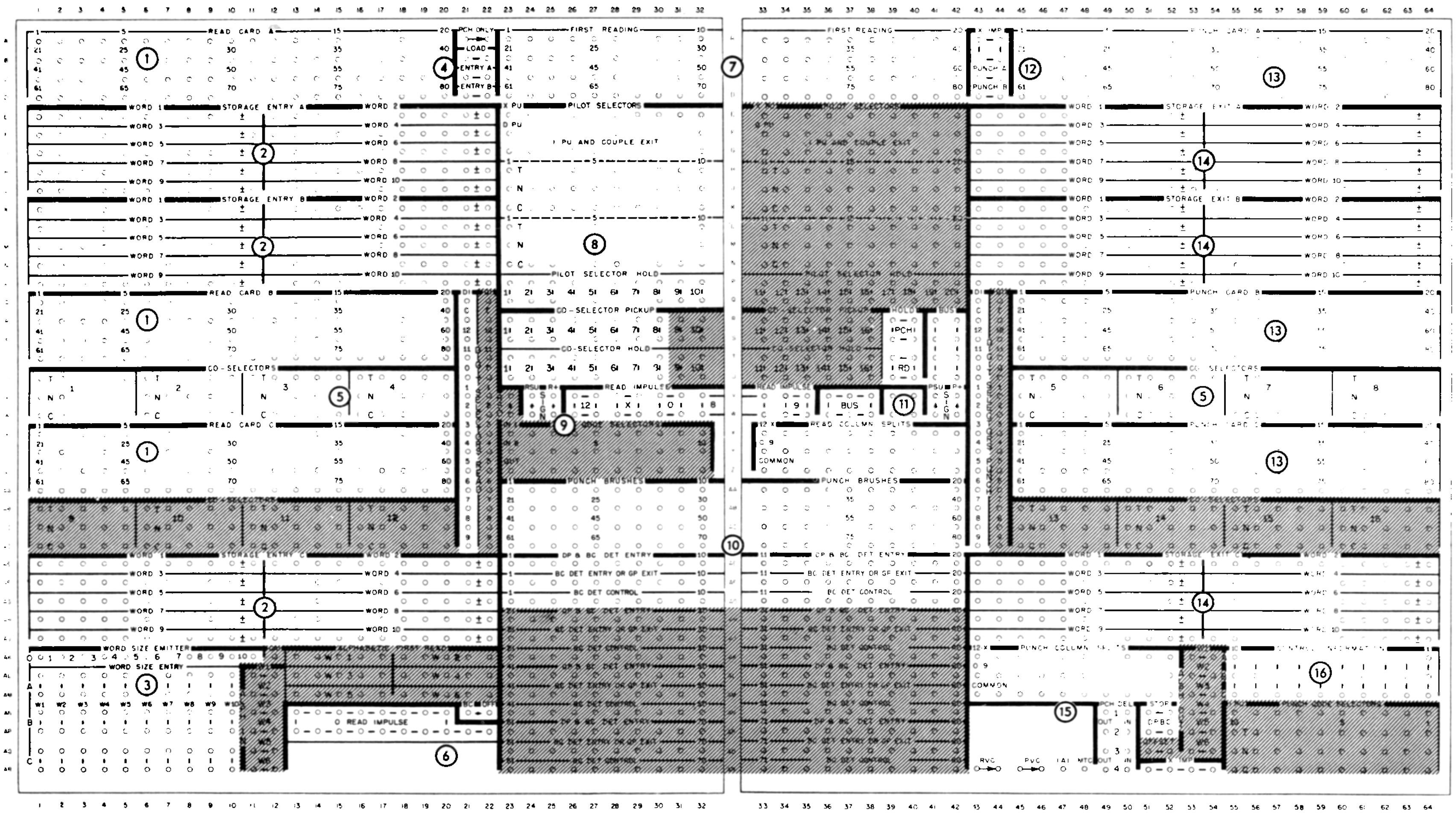


Figure 13. 533-537 Control-Panel Diagram (Form X24-6207)

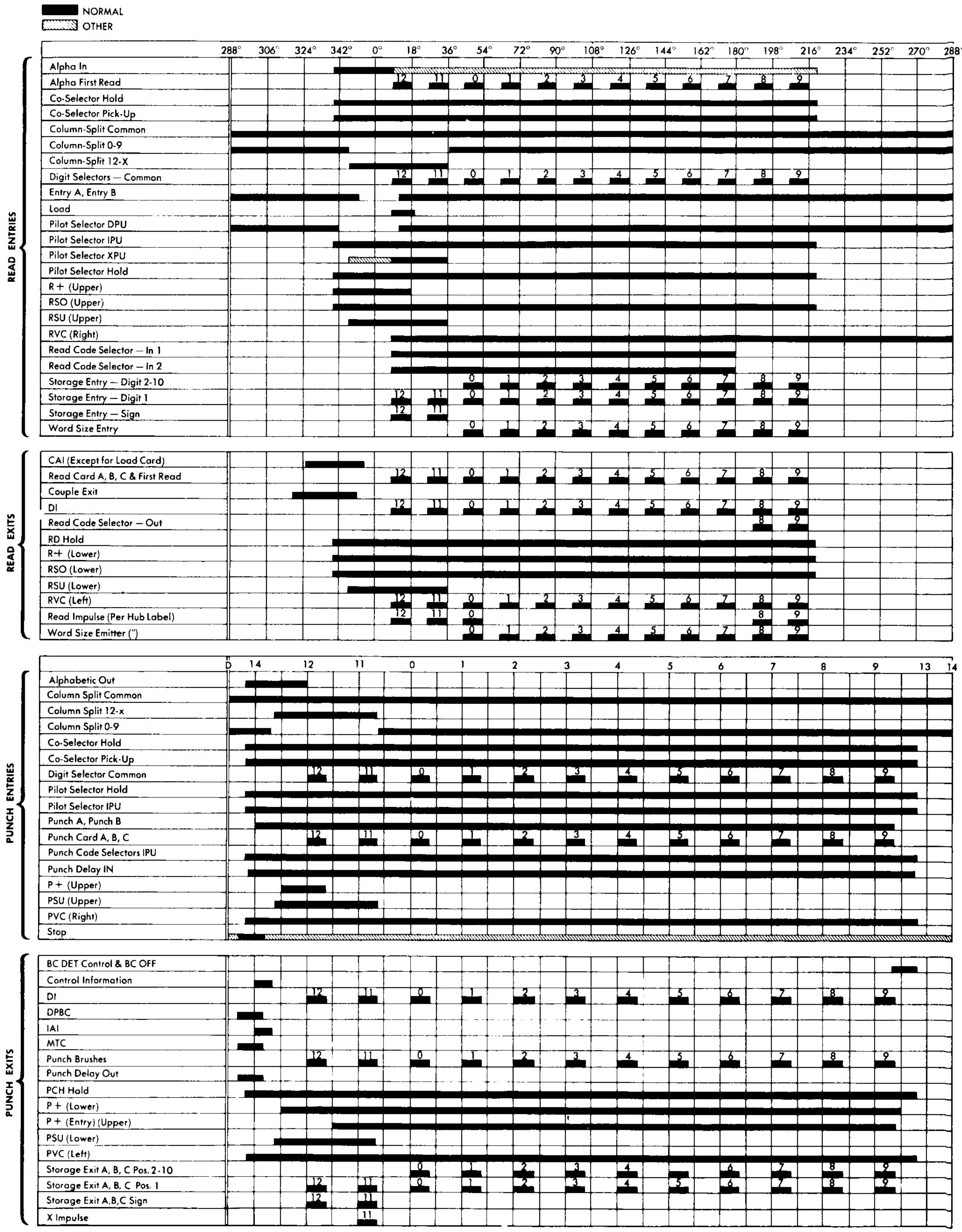


Figure 14. 533 Timing Chart (Wiring Diagram 254490B)

Input

The control-panel hubs and wiring necessary for the basic entry of information into the system are covered in this section. Entry of data is usually accomplished by connecting the second reading station to the input synchronizer. This is done by control-panel wiring. Thus the information from any column of the card can be entered into any position of any storage entry word. Multiple exits from the second reading station, and multiple entries to the input synchronizer, are provided for ease of wiring.

As information is transferred from the input synchronizer to general storage, it may or may not be checked for valid data. If the check is made, every digit and sign position of all 10 input words is checked for the presence of valid information. Invalid information will cause the machine to stop, and the STORAGE SELECTION light on the console will be lighted.

RVC (15). This switch is wired when it is desired to make the input validity check *inactive*. The wiring of this switch can be selected with pilot and co-selectors. The read-validity check can also be made inactive by impulsing the LOAD hubs.

Read Card A, B, C (1). These three sets of hubs provide exits for the information read from the card at the second reading station. The three groups are common and are numbered to correspond with the card column from which the information is read. The information being read from card column 1 is available simultaneously at the hubs labeled 1 in A, B, and C. Information being read from card column 2 is available simultaneously at the second hubs in A, B, and C, etc. This arrangement is for wiring convenience.

Storage Entry A, B, C (2). These three sets of hubs provide entry to an input synchronizer storage area. (The particular input area is determined by the cable connection used at the 655 Power Unit). Each set is independent of the other two. Only one can be active during any one card cycle. Storage-entry C is normally active. Storage-entry A is made active by impulsing entry A (Figure 13-4) on the previous cycle. Storage-entry B is made active by impulsing entry B (Figure 13-4) on the previous cycle. If both storage-entry A and B are made active on the same cycle, only storage-entry A accepts impulses.

Note that each storage-entry word has eleven positions. The extreme right-hand position of each storage-entry word is the SIGN position (labeled $\pm$). This position will accept only 11-impulses for minus, or 12-impulses for plus. It must be wired if the RSU switch (Figure 13-9) is *not* wired.

The units position of each storage-entry word will accept all read-digit impulses (12-9). The 12- and 11-impulses entering this position will cause sign identification if the RSU hubs (Figure 13-9) are wired. Positions 2-10 of each storage-entry word will accept only read digit impulses 0-9.

Entry A, B (4). These hubs are entries that will accept all read-digit impulses 12-9. They are normally wired from first reading (Figure 13-7). An impulse to these hubs will cause either storage-entry A or storage-entry B to become active on the following feed cycle. If both entry A and entry B are impulsed simultaneously, only storage-entry A is active.

First Reading (7). These hubs are exits for information read from the card at the first reading station. The hubs are numbered to correspond with the card columns being read. The information being read from the card at the first reading station is normally used for control purposes. As a card passes the first reading station; control-panel wiring controls the direction and flow of its information, as the same card passes the second reading station.

Wiring Example (Figure 15). This example illustrates the use of the control-panel hubs already described.

There are three types of cards to be entered into the system. Card 1 is identified by an X in column 28. Card 2 is identified by an X in column 30. Card 3 is identified by the absence of X's in both 28 and 30. From card 1 the information comes from columns 21-26. From card 2 the information comes from columns 9-15, and from card 3 the information comes from columns 43-50.

1. The wire from first reading-28 to entry A detects any cards with punching in column 28 and identifies them as type 1 cards. This conditions storage-entry A to accept information as this card passes the second reading station. Card type 2 and 3 cannot have any punching in column 28 if this wire is to be effective.
2. The wire from first reading 30 to entry B detects any cards punched in column 30. Because only type 2 cards are punched in column 30, this conditions storage-entry B to accept information on the cycle following that during which the X in 30 is read at the first reading station.

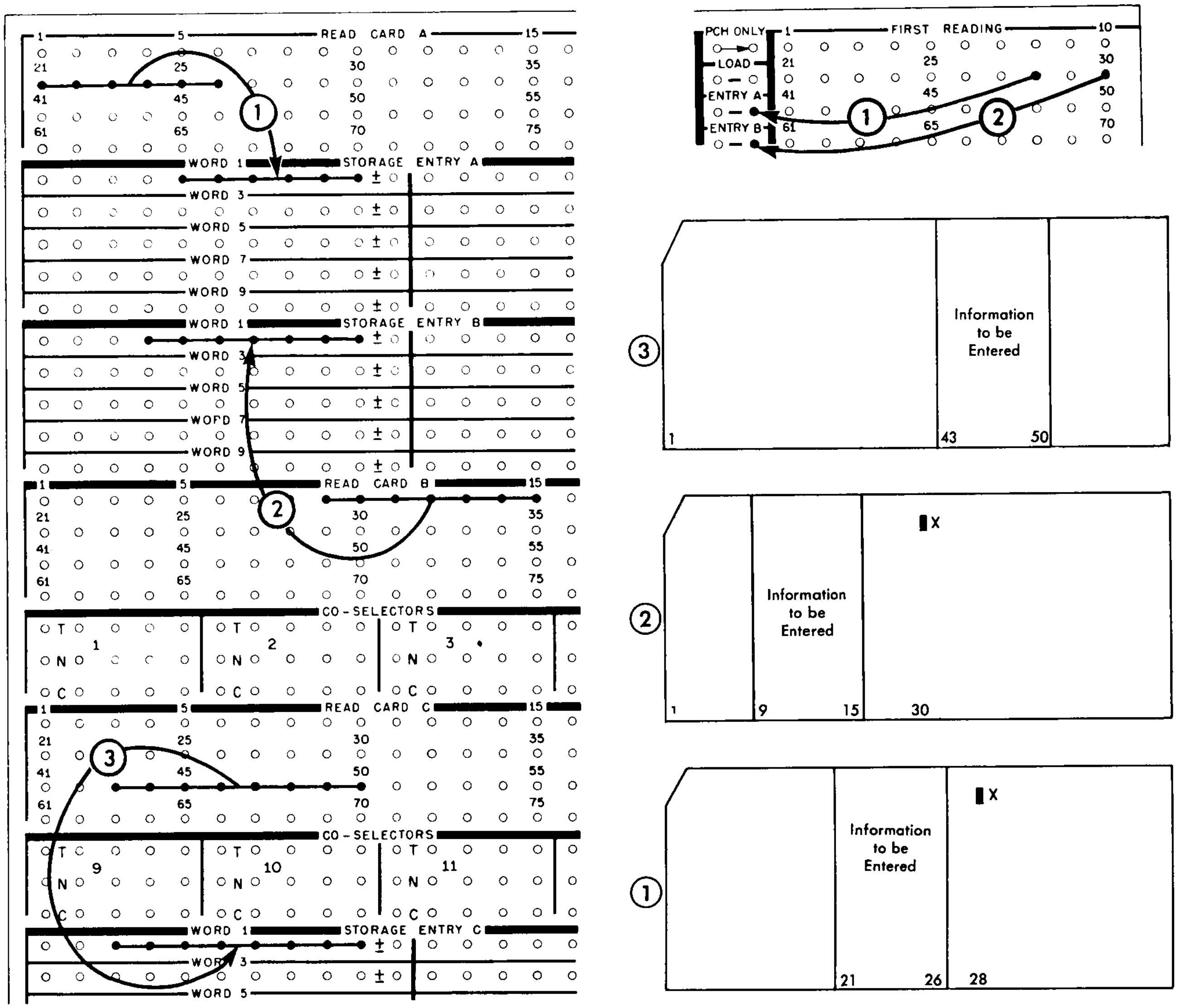


Figure 15. Reading Three Types of Cards

3. As a type 3 card passes first reading, nothing is read from either columns 28 or 30. Therefore, when the type 3 card passes the second reading station, storage-entry C accepts the information read from columns 46-50.

Because READ CARD A, B, and C are all common, the wiring to the storage-entry A, B, and C could all have been made from READ CARD C. By providing 3 separate sets of exit hubs, wiring is facilitated.

If the validity-check circuits of the 650 are to be satisfied, each storage-entry position must receive valid information. In the previous example, the unwired storage-entry positions of word 1 would receive blanks. Therefore, if RVC is not wired, a validity error is detected as these words are transferred from the synchronizer to general storage, because blanks are an invalid characterization. Likewise, entry words 2-10 are blank, and are detected by the validity-check circuits. A way to fill zeros into what would otherwise be blank positions is needed. This is the function of the word-size-emitter and word-size-entry.

Word-Size-Emitter (3). These hubs, labeled 0-10, are used to fill in zeros to the left of the last storage-entry word position wired from the second reading station, (assuming that every card column wired to storage entry is punched).

The labeling on the hubs corresponds to the number of card columns wired to the storage-entry positions. Therefore, word-size-emitter 7 puts zeros into the 3 high-order positions of the word; word-size-emitter 6 puts zeros into the 4 high-order positions of a word, etc.

When all 10 positions of a storage-entry word are wired, word-size-emitter 10 must be used. Word-size-emitter 0 is used to put zeros into an entire storage-entry word. It is possible to select the word-size-emitter impulses by using a pilot selector or co-selector.

It is important when wiring the control panel to know the number of digits being read into each storage-entry word. Using a word-size-emitter less than the actual number of digits will cause zeros to be superimposed over the actual digits read from the card. Using a word-size-emitter greater than the actual number of digits will cause a blank digit-position in the word. In both cases, this results in invalid information that is detected by the validity-check circuits.

Word-Size-Entry (3). These hubs are entries for the impulses from the word-size-emitter. The three sets of independent hubs (A, B, C) are active only when the corresponding storage-entry (A, B, C) are active.

All hubs within a group (A, B, C) must be wired to a word-size-emitter if the corresponding group of storage-entry words is being used. If any group of storage-entry words is not being used, no wiring is necessary to the corresponding word-size-entry. If the read-validity-check feature is being used, all unused storage-entry words should be wired to word-size-zero, and the sign entry must be impulsed if R+ is wired. This will enter zeros into all unused words and satisfy the input validity-check feature of the machine.

Wiring Example (Figure 16). In Figure 15 note that storage-entry A, word 1, is not completely wired. Also, storage-entry B and C, word 1, are not completely wired. Also, none of the storage entries (A, B, C) have words 2-10 wired. To satisfy the validity-check, zeros must be entered to the left in word 1, and the entire words 2-10, must be filled with zeros. This is the function of the word-size emitter and word-size-entry hubs. Figure 16 is the additional wiring that would be added to Figure 15 to satisfy the validity-check requirements:

1. This wiring fills all unused words in each storage-entry group with zeros.
2. This wire fills in zeros in the four unwired positions of storage-entry A, word 1.
3. This wire fills in the three unwired positions of storage-entry B, word 1.
4. This wire fills in the two unwired positions of storage-entry C, word 1.

Sign Entry

A further requirement of the validity-checking features of the 650 is that all words entered into the machine must have either a plus or minus sign. There are three possible ways to enter signs into the machine:

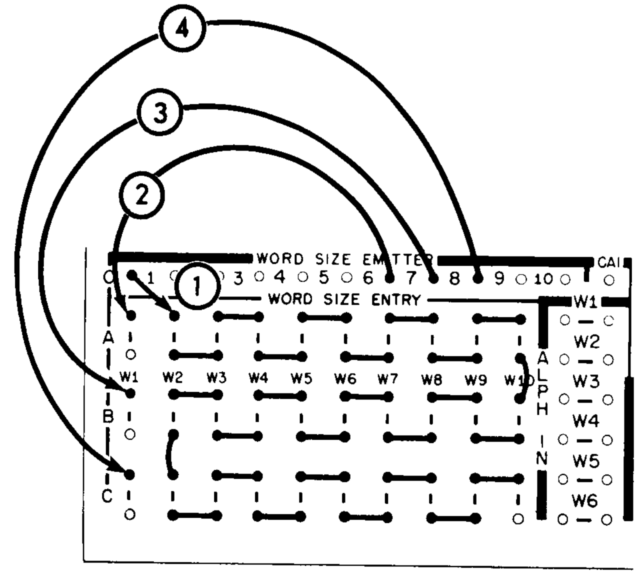


Figure 16. Word Size Control

1. Either the plus or minus sign can be entered from punching in the card. When punching in the card is used to indicate one or the other, the plus sign is indicated by a 12-punch, and the minus sign by an 11-punch.
2. Only the minus sign is entered directly from the card. In this case an 11-punch indicates a minus sign, and the absence of an 11-punch tells the machine to supply the plus sign automatically.
3. On machines equipped with the ALPHA-SPECIAL CHARACTER device, the machine automatically enters a plus sign with any words that are entered by means of this device.

In items 1 and 2, the sign-punching can be over the units position of its associated word, or in any other column of the card.

RSU (Read Sign over Units; 9). This pair of vertically adjacent hubs is a switch. When wired, the sign punch in the card must be over the units position of the storage-entry word. The units position of every storage-entry word is conditioned to accept both the digit punching (0-9) and the sign punching (11-12).

When this switch is not wired, the storage-entry sign position must be wired. This wiring can be from any column of the card. The sign-entry accepts only 11- or 12-punches.

The RSU switch can be selected with pilot and co-selectors and is independent of the R+ switch.

R+ (Read Plus Sign; 9). This pair of vertically-adjacent hubs is a switch. When wired, a plus sign must be indicated by a 12-punch in the card for all words, including those wired to word-size 0. When not wired, the machine will automatically supply a plus sign on any words that do not have the minus sign indicated by an 11-punch. The R+ switch can be selected with pilot or co-selectors.

Wiring Example (Figure 17). This example shows the four possible combinations of the RSU and R+ switches.

1. RSU wired indicates to the machine that all sign punching is over the units position of the field. This conditions the units storage-entry position to accept both digit punching and sign punching. The unwired R+ switch indicates that the machine will supply a plus sign if no 11-punch is read in the card.
2. Information read from card columns 31-38 at the second reading station is entered into storage-entry C, word 2. The units position of word 2 accepts the 5 impulse from the card and routes it to the units position of the synchronizer storage area for word 2 and also accepts the 11-punch from column 38 of the card and routes it to the sign position of input synchronizer word 2.
3. With neither the RSU or R+ switch wired, this indicates to the machine that the sign punching is in some position other than the units, and makes it mandatory that the sign position of the storage-entry word be wired. The absence of wiring of the R+ switch indicates the same thing as in the previous example.
4. The wire from read card C-35 goes to the sign position and to position 4 of storage-entry, word 2. Position 4 can accept only digit impulses 0-9; therefore, the 11-punch is ignored at this position. The sign position cannot accept the digit pulses; therefore, only the sign indication is recognized at this hub.
5. When RSU is not wired it indicates to the machine that the sign is in other than the units position. The R+ switch wired indicates to the machine that it must receive a 12-impulse from the card to indicate a positive sign. The machine will not automatically supply a plus sign on the absence of an 11-impulse.
6. The wire from read card C-36 goes to the third position and to the sign position of storage-entry, word 2. Position 3 can accept only digit impulses 0-9; therefore, the 12-impulse is ignored. The sign position cannot accept the digit pulses; it only accepts an 11- or 12-impulse. If the sign position does not receive either an 11- or 12-impulse, no sign is entered with this word. Therefore, an error is indicated by the validity-check circuits.
7. The RSU switch is wired to indicate to the machine that the sign will be read over the units position of the word, and that the sign position of the storage entry need not be wired. The R+ switch wired indicates to the machine that it must receive a 12-impulse to indicate a positive sign.
8. The information from card columns 31-38 is wired from read card C to storage-entry C, word 2. The units position of word 2 receives the 5-impulse and directs it to the units position of the synchronizer storage word 2, and also receives the 12-impulse and directs it to the sign position of word 2.

This completes basic wiring necessary to enter information into the system from the 533 Card Read Punch.

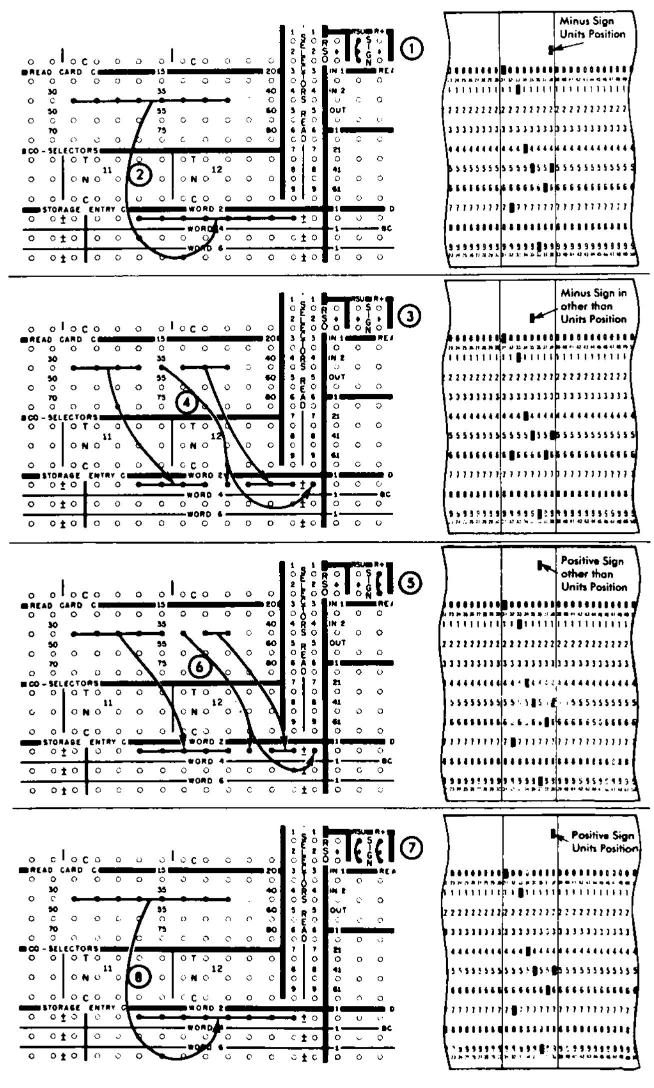


Figure 17. Sign Entry

Loading

Another input from the second reading station to the input-synchronizer is available. This method bypasses the control panel and sets up a direct internal connection between the second reading station and the input-synchronizer. This direct connection is normally used when transferring the program instructions from punched cards to general storage. This internal connection is under control of the LOAD hub.

Load (4). These hubs accept read-12-impulses. The internal connection between the second reading station and the synchronizer storage area is set up one cycle after LOAD is impulsed. Therefore, it is normally wired from first reading. The internal wiring automatically reads card columns 1-80 into synchronizer storage words 1-8. Card column 1 goes to the high-order position of word 1. Card column 2 goes to position 9 of word 1. Card column 3 goes to position 8 of word 1, etc. Storage-entry words 9 and 10 automatically receive zeros and plus signs.

Impulsing LOAD activates the branching function of the RD code on the cycle that the load-card information is transferred from the input-synchronizer to general storage. The instruction following the RD is specified by the D-address of the RD instruction.

During the cycle when the load-card information is transferred from the input-synchronizer storage area to general storage, validity checking is made inactive.

Selection

Pilot and co-selectors are provided to increase the flexibility of format on both input and output. Each individual position of a selector is a switch composed of three hubs labeled T, N, C. The C (common) hub is always connected to either the N (normal) or T (transferred) hub, but never to both (Figure 18). Thus, impulses entering C are selectively available at either N or T, depending upon whether the pickup hubs have received an impulse. Conversely, impulses entering either N or T are available at C under control of the impulses to the pickup hubs.

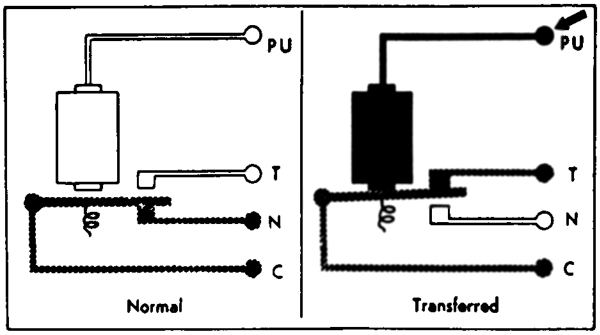


Figure 18. Schematic of Selector Operation

Pilot selectors have multiple pickup hubs to meet varying needs. They may be impulsed on one cycle to transfer on the following cycle, or they may be impulsed and transferred on the same cycle. Co-selectors have only one pickup and transfer immediately upon being impulsed. If more flexible operation is desired, they can be coupled to the pilot selectors by using the IPU and couple exit of the pilot selector, wired to the pickup of a co-selector. In this way, a co-selector is used to increase the size of the pilot selector.

Both pilot and co-selectors have hold hubs on the control panel. They must be wired to either read- or punch-hold for proper operation of the selectors.

Pilot Selector Pickups (8). Three types of pilot selector pickups are provided:

1. XPU. These hubs accept any 12- or 11-read impulse, to cause the corresponding selector to transfer on the *next read cycle*. Because there is a one-cycle delay in the transfer of the pilot selector (under automatic control of the read feed) these hubs should not be activated by an impulse timed to the punch feed. The pilot-selector hold hubs must be wired from read-hold when using XPU.
2. DPU. These hubs accept any read-digit impulse (12-9) to cause the corresponding selector to transfer on the next read-feed cycle. The same precaution for hold-wiring as is indicated for XPU, applies when DPU is impulsed.
3. IPU and Couple Exit. These hubs can be either an entry or an exit. As an entry, they accept impulses timed to either the read feed or the punch feed. Impulses timed to the punch feed must be wired to these hubs. An impulse entering one of these hubs causes the associated pilot selector to transfer immediately.

   These hubs become exits when either XPU or DPU is impulsed. The impulse from these hubs is available at the beginning of the read-cycle following the impulsing of the corresponding XPU or DPU. This impulse is usually used to control co-selectors or other pilot selectors.

Caution should be observed when using both XPU and IPU of the same selector as pickups. If both receive impulses during the same cycle, it may cause other pilot selectors, receiving impulses into XPU or DPU during the same cycle, to transfer one cycle early. The same precaution must be observed if both DPU and IPU of the same selectors are used as inputs.

Pilot Selectors (8). Ten selectors are standard on the 533. Additional pilot selectors are available in groups of 5. Each pilot selector has two switching positions.

Pilot Selector Hold (8). These are entires for impulses that determine how long a pilot selector remains transferred. Because pilot selectors can be used with either the read or punch feed, no automatic hold is provided. The hold impulse is provided by control-panel wiring from either RD-HOLD or PCH-HOLD, depending upon which feed controls the action of the selector.

Read Hold (11). These hubs emit an impulse which, when wired to co-selector hold or pilot selector hold, causes the wired selector to remain transferred for the duration of the read-feed cycle during which the original transfer took place.

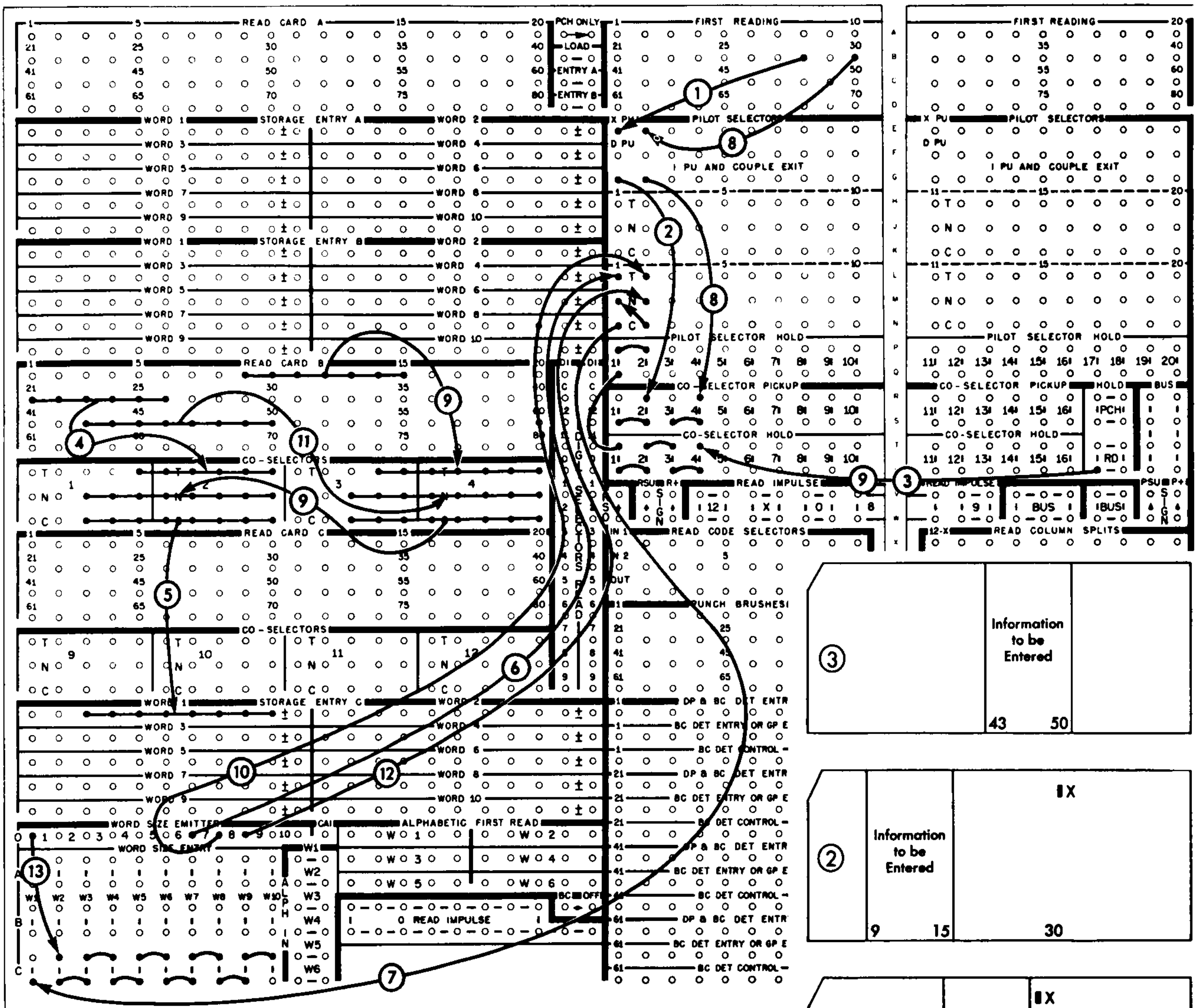
Co-Selector Pickup (8). These hubs accept impulses timed to either the read feed or the punch feed. The associated selector transfers immediately upon receipt of an impulse to either one of these common hubs.

Co-Selectors (5). Eight co-selectors are standard in the 533. Additional co-selectors are available in groups of 4. Each co-selector has 5 switching positions.

Co-Selector Hold (8). These hubs are entries for impulses that determine how long the co-selector will remain transferred. Because the co-selector can be used with either the read feed or punch feed, no automatic hold is provided. The hold impulse is provided by control-panel wiring from either RD-HOLD or PCH-HOLD, depending upon which feed controls the action of the selector.

Wiring Example (Figure 19). This example illustrates the basic use of pilot and co-selectors. The same three cards used in Figure 15 are entered into the system without using entry A or entry B.

1. Pilot selector 1 is impulsed by an X in column 28 from the first reading station. This identifies the type 1 card. Pilot selector 1 transfers on the following cycle, as the type 1 card passes the second reading station.
2. Co-selectors 1 and 2 are transferred, during the same cycle that pilot selector 1 is transferred, by an impulse from the couple exit of pilot selector 1.
3. Co-selectors 1, 2, 3, and 4 and pilot selectors 1 and 2 remain transferred for one read cycle by the wiring to RD-HOLD. This hold wiring is effective only after an impulse to the pickup.
4. The information from card columns 21-26 is wired to the transferred side of co-selectors 1 and 2. This wiring is taken from read card B for convenience only. Because read card A, B, and C are common exits for the same information, this wiring could have come from any one of them.
5. The common side of co-selectors 1 and 2 is wired to storage-entry C, word 1. Because at this time co-selectors 1 and 2 are transferred, the information from card columns 21-26 is entered into word 1.
6. Word-size-emitter 6 is wired to the transferred side of pilot selector 1. This pilot selector is transferred at the time the X28 card passes the second reading station.
7. The common side of pilot selector 1 is wired to word-size-entry C, word 1. This fills in zeros to the left of the high-order position for a type 1 card. Storage-entry C is used because it is normally active when entry A and entry B are not impulsed.
8. An X in column 30, of a card passing the first reading station, impulses pilot selector 2. This causes this pilot selector to transfer one cycle later as the card passes the second reading station. The impulse from the couple exit of pilot selector 2 is used to pick up co-selectors 3 and 4. Co-selectors 3 and 4 are picked up on the cycle during which the X30 card passes the second reading station.
9. The hold wiring results in co-selectors 3 and 4 and pilot selector 2 remaining transferred for one read cycle. The information from card columns 9-15 is wired to the transferred side of co-selectors 3 and 4. With co-selectors 3 and 4 transferred, this information is available at the common side of these co-selectors, and it is taken to the normal side of co-selectors 1 and 2. Co-selectors 1 and 2 should be normal when co-selectors 3 and 4 are transferred. This makes the information from card columns 9-15 available at the common side of co-selectors 1 and 2. This information goes to storage-entry C, word 1.
10. Word-size-emitter 7 is wired to the transferred side of pilot selector 2. When pilot selector 2 is transferred, by an X in column 30, this impulse is available at the common of pilot selector 2. It is wired from the common to the normal side of pilot selector 1 where it will be available at the common of pilot selector 1. It then is wired to word-size-entry C, word 1.
11. The information from card columns 43-50 is wired to the normal side of co-selectors 3 and 4. When a card that is neither X28 nor X30 passes the second reading station, this information passes from columns 43-50, through co-selectors 3 and 4 normal, to co-selectors 1 and 2 normal, to storage-entry C, word 1.
12. Word-size-emitter 8 is wired to the normal side of pilot selector 2. With both pilot selectors 1 and 2 normal, this impulse is routed to word-size-entry C, word 1.



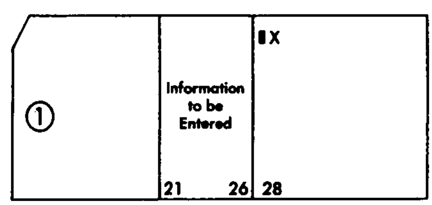


Figure 19. Pilot & Co-selector Operation

13. Word-size-emitter 0 is wired to the unused words of word-size-entry C to satisfy the validity-checking requirements of the system.

The word-size-emitter wiring using pilot selectors 1 and 2 could have been wired through the unused positions of co-selectors 1 and 3.

Digit Selection

The three cards shown in Figures 15 and 19 can be identified by different digit punching in the same card column. These digits can serve the same function that the separate X-punching did. The individual digits could be selected by using a digit selector.

Digit Selectors – Read (9). One read-digit selector is standard on the 533. One additional read-digit selector or half-time emitter can be obtained. Digit selectors can be used to select specific digits from a card column, or to emit digits on read cycles. When a card column is wired to C (common), a specific digit impulse can be read from the corresponding hub of the digit selector. Thus, each digit that is punched is available for control purposes. If the DI hub is wired to C, specific digit impulses are available from each of the exit hubs on each read cycle. With this wiring, the digit selector is acting as a digit emitter.

Wiring Example (Figure 20). In this example the card types are identical to those used in Figures 15 and 19. The only difference in the cards is the identifying punching. For this example, card 1 is identified by a 3 in column 65, card 2 by a 4 in column 65, and card 3 by the absence of both 3 and 4 punches. All other conditions of Figures 15 and 19 remain the same. Therefore, only the necessary selection wiring is shown.

1. The information from card column 65 is wired from first reading to C of the digit selector.
2. Any 3-punch read in column 65 at first reading is available from this hub. If the basic wiring were the same as Figure 15, the wire from digit selector 3 would go to entry A. If the basic wiring were that of Figure 19, the wire would go to the DPU of pilot selector 1.
3. Any 4-punch read in column 65 at first reading is available at this hub. The 4-impulse would be directed to entry B if the wiring were like Figure 15, or to the DPU of pilot selector 2 if the wiring were like Figure 19.

EMITTED IMPULSES (READ)

Data can be supplied by the control panel for entry into the system. These emitted factors can be used for filling in zeros to the right of fields, supplying sign impulses, or converting control punching to 8 or 9 for interrogation by the program. Emitted impulses can come from the hubs labeled *Read Impulse* or the digit selector wired as a digit emitter.

Read Impulse (6, 9). These hubs emit read-digit impulses 12, X (11), 0, 8, and 9.

Wiring Example (Figure 21). This example shows the emission and selection of information from either the read impulse or digit emitter. All cards with an X in column 24 are to enter an 8 in the units position of entry word 2. Those cards that do not have an X in column 24 are to enter a 9 into the units position of entry word 2.

1. The X from card column 24 is used to control the first pilot selector.
2. An 8-impulse can be supplied to the transferred side of pilot selector 1 from either the read impulse or the digit emitter.
3. A 9-impulse can be supplied to the normal side of the pilot selector from either the read impulse or the digit emitter.
4. The common of the pilot selector is wired to the units position of storage-entry word 2.
5. All digit impulses are supplied to the digit selector from the DI hub.

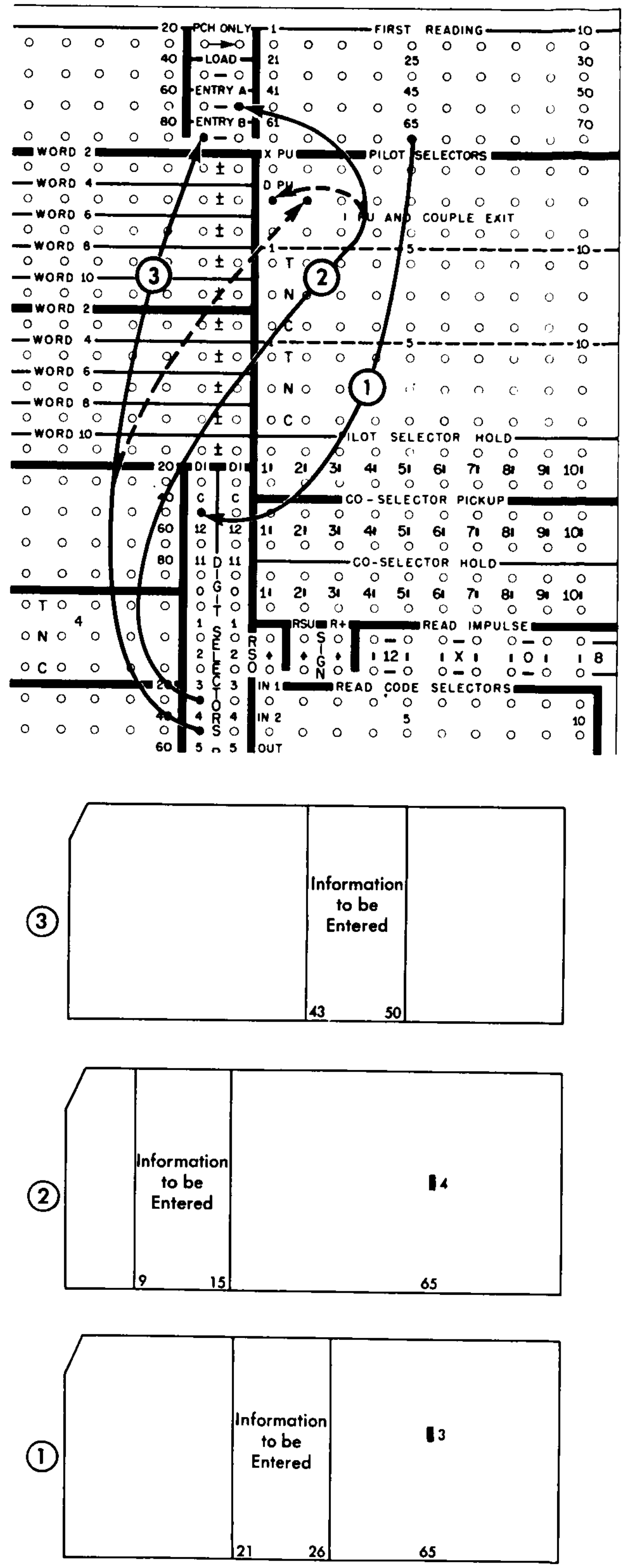


Figure 20. Digit Selection

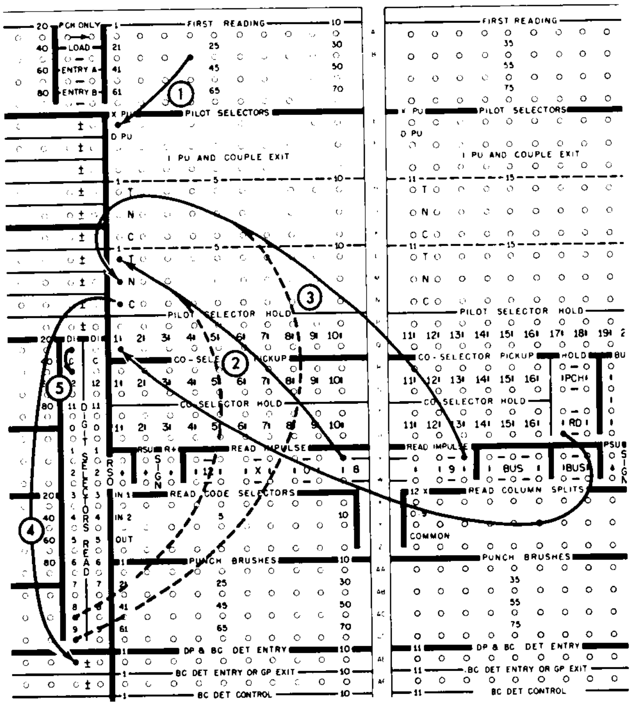


Figure 21. Emitting Information

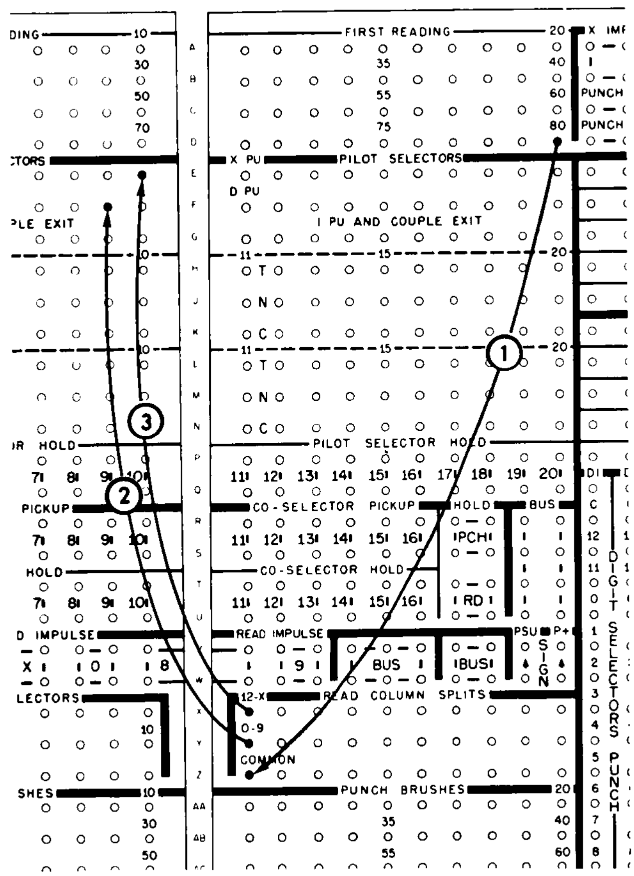


Figure 22. Column Splitting

Read Column Splits (11). This device is used to separate 12 and 11 impulses from 0-9 impulses, read from a card at the first or second reading station. During the time that the 12 and 11 are being read from the card, the 12-X and C hubs of this device are connected. During the time that the 0-9 are being read from the card, the 0-9 and C hubs are connected.

Wiring Example (Figure 22)

1. All impulses from column 80 are read at the first reading station, and are directed to the common of the column split.
2. Any digit pulses (0-9) from column 80 are directed to the DPU of pilot selector 9.
3. Any 12 or 11 impulses from column 80 are directed to the XPU of pilot selector 10.

Output

The control-panel hubs and wiring necessary for the basic output of information from the system are covered in this section. Output of data is usually accomplished by connecting the output-synchronizer to the punching station. By control-panel wiring, the information in any position of any storage-exit word may be punched in any column of the card. Multiple exits from the output-synchronizer and multiple entries to the punching station are provided for ease of wiring.

As information is transferred from the output-synchronizer storage area to the 533, it may or may not be checked for valid data. If the check is made, every digit and sign position of all ten output words is checked for the presence of valid information. The presence of invalid information causes the machine to stop the next time the 533 output unit is called upon. Also, the storage-selection light on the console is lighted.

PVC (15). This switch is wired when it is desired to make the output validity-check inactive for all output cards. If checking is to be on a selective basis, it is made inactive by wiring a control information impulse to the OFF hub (right-hand hub).

Storage Exit A, B, C (14). These three sets of hubs provide exits for the information from the output-synchronizer. They are numbered to correspond to the words and digit positions of the output-synchronizer storage area. Because the three sets are common, information from the output-synchronizer storage area is available simultaneously at all three sets. This arrangement is for wiring convenience.

Each word has eleven exit positions, one for each digit of the word, and one for the sign. The action of the sign exit and units-position is under control of the

PSU (punch sign over units) and the P+ (punch plus) switch.

Control Information (16). These hubs emit an impulse, prior to punching time, if there is a digit 8 in the corresponding position of storage-exit, word 10. If there is any digit other than 8 in a particular position, no impulse is emitted. Remember, the emitted impulse does not occur at 8-punching time, but prior to 12-punching time for control purposes.

Punch Card A, B, C (13). These three sets of hubs provide entry to the punching station. They are numbered to correspond to the card columns being punched. Each group is independent of the other two. Only one can be active during any one punching cycle. Punch card C is normally active. Punch card A is made active by impulsing PUNCH A (Figure 13-13). PUNCH CARD B is made active by impulsing punch B (Figure 13-13). If both punch card A and B are made active on the same cycle, only punch card A accepts impulses.

Punch A, B (12). An impulse to these hubs causes the corresponding punch card A or B to be active on the same cycle. These hubs are normally impulsed from control information. If punch A and B are impulsed on the same cycle, only punch card A accepts information.

Wiring Example (Figure 23). This example shows the punching of three different card formats under the direction of control information. If there is an 8 in position 9 of output word-10, card columns 21-26 are punched from output word-1. If there is an 8 in position 10 of output word-10, card columns 1-6 are punched from output word-1. If neither position 9 nor 10 of output word-10 contains an 8, card columns 61-66 are punched from output word-1.

1. An 8 in position 9 of output word-10 causes position 9 of control information to impulse PUNCH A. Storage exit A, word 1 is wired to punch card A, which accepts the impulses and punches in column 21-26.
2. An 8 in position 10 of output word-10 causes position 10 of control information to impulse PUNCH B. Storage exit B is wired to punch card B which accepts the impulses from exit word 1.
3. When neither position 9 nor 10 of output word-10 contains an 8, punch card C is active and accepts the impulses from storage-exit, word 1 for punching in columns 61-66.

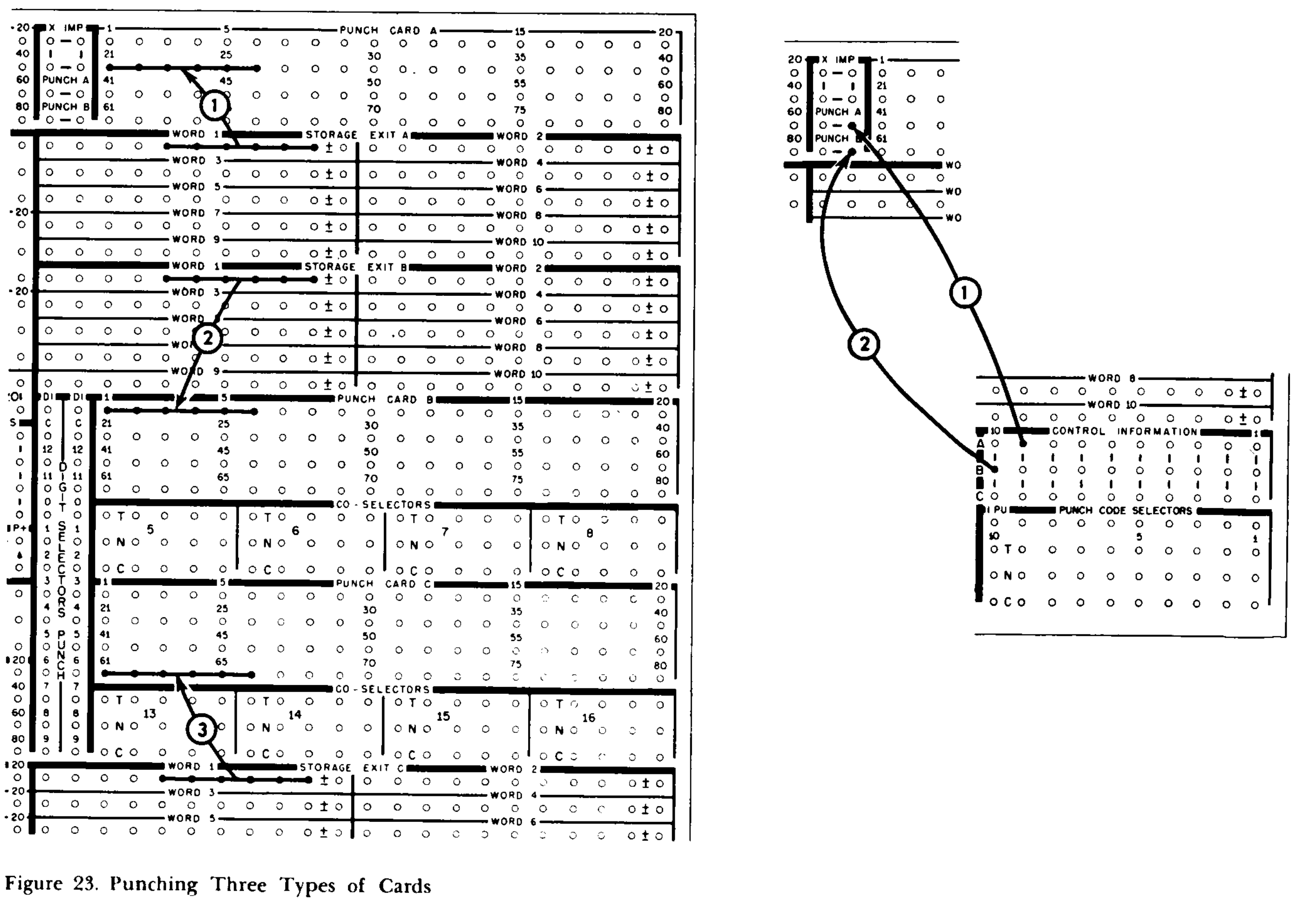


Figure 23. Punching Three Types of Cards

Output Signs

Punching of signs in output cards is controlled by the PSU and P+ switches. With these switches it is possible to duplicate, in the output cards, all the possible sign conditions that are present in the input cards. That is, signs may be punched over the units position of the field, or in any other column of the card. Also, positive signs may or may not be punched.

PSU (Punch Sign over Units; 11). When this switch is wired, signs are automatically punched over the units position of the storage-exit word. The sign position of each storage-exit word is inactive. When this switch is not wired, the sign impulses are directed to the sign exit position of each storage-exit word. This switch can be selected and is independent of the P+ switch.

P+ (Punch Plus Sign; 11). This switch is wired when it is desired to punch positive sign indications in the card. When this switch is *not* wired, only negative sign impulses are available at the control panel. The positive sign is a 12-impulse and the negative sign is an 11-impulse. The P+ switch can be selected.

Wiring Example (Figure 24)

1. The PSU switch wired indicates that the sign is punched over the units position of the word. The P+ switch not wired indicates that only negative signs is punched, and that positive factors are indicated by the absence of any sign punching.
2. Storage-exit C, word 1 is wired to punch card C for punching in card columns 61-68. The units position of the storage-exit word will emit both the digit and sign impulses.
3. The PSU switch not wired indicates that the sign is punched in other than a units position. The P+ switch not wired indicates that only negative sign indications are punched.
4. Position 3 and the sign exit of word 1 are split-wired to punch card C-66. Position 3 emits digit impulses and the sign exit position emits the negative sign impulse.
5. The PSU switch wired indicates that the sign is punched over the units position of the word. The P+ switch wired indicates that a 12 is punched for a positive sign in addition to the 11-punch for a negative sign.
6. Storage-exit C, word 1 is wired to punch card C positions 61-68 for punching in the corresponding columns of the card. The units position of word 1 emits both the digit and sign impulses.
7. The PSU switch not wired indicates that the sign is punched in a position other than the units position. The P+ switch wired indicates that a 12 is punched for a positive sign in addition to an 11-punch for a negative sign.
8. Position 3 and the sign exit position of word 1 are split-wired to punch card C-66 for punching in the corresponding card column. The third position will emit the digit impulses. The sign impulses are emitted from the sign-exit position.

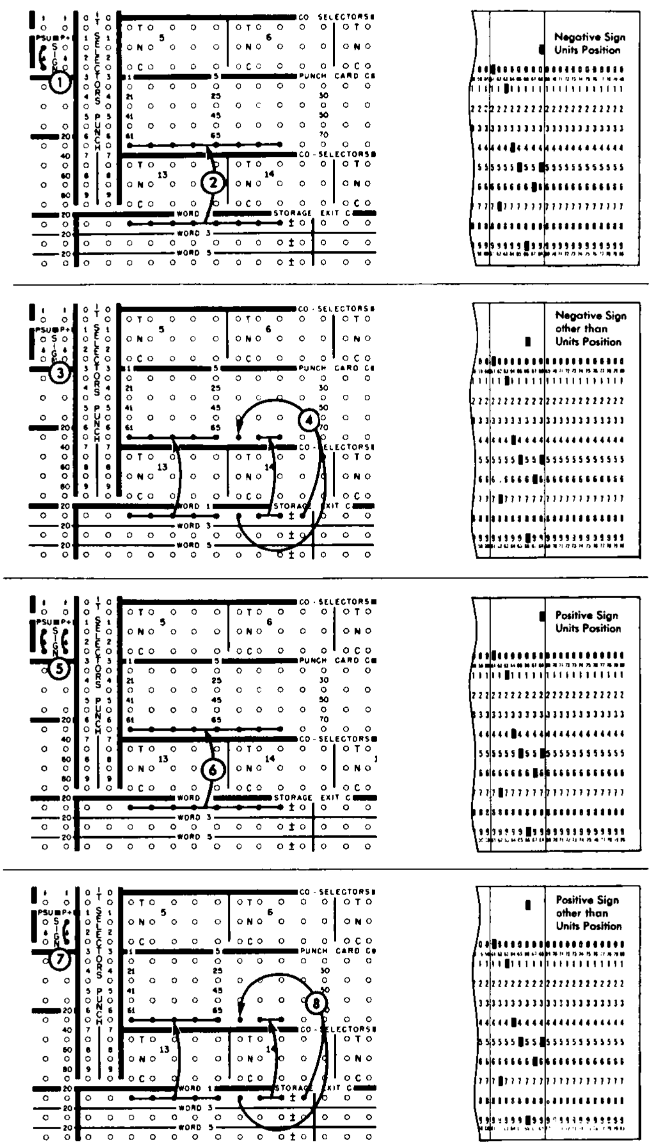


Figure 24. Sign Punching

Double-Punch Blank-Column Detection (DPBC)

The 533 is equipped with 20 positions of DPBC detection as a standard feature. Additional positions are available in groups of 10 with a maximum of 6 additional groups.

With this device it is possible to check output cards for both double-punched and blank columns. Also, card columns can be checked for either condition selectively. To activate this device, the punched-output cards are read by the punch brushes (Figure 12) and wired on the control panel for the appropriate check.

Punch Brushes (10). These hubs are exits for digit impulses (12-9), read from the output card one cycle after the card is punched. The hubs are numbered to correspond to the card column being read.

BC OFF (Blank Column Off; 6). This switch is wired when no card columns are to be checked for a blank condition. This switch can be selected, and should be wired when no DPBC check is being made.

DP and BC Det Entry (Double-punch and blank-column detection entry; 10). These hubs are entries for the information being read by the punch brushes. They are used to detect double-punched columns only (BC OFF wired), or to detect both double-punched and blank columns in the output card.

BC Det Entry or GP Exit (Blank-column detection entry or gangpunch exit; 10). These hubs can be used as either entries or exits.

As entries, they are used to detect blank columns in the output cards, without using double-punch detection (BC OFF not wired).

As exits, they are wired to punch card A, B, or C for gangpunching. When used as gangpunch exits, only the first digit read from any columns wired to a DP and BC DET ENTRY is available at the associated GP EXIT.

BC Det Control (Blank-column detection control; 10). These hubs provide a means for selective control of blank column detection. All positions of DPBC are internally connected for blank-column detection. By control-panel wiring, it is possible to bypass one or more positions that are not to be checked for blanks.

Bypassing is accomplished by wiring *around* those positions that are not to be checked. The position preceding the first position to be bypassed is wired to the last position to be bypassed. If position 1 is to be bypassed, the left-hand hub of the BC OFF switch is considered the preceding position (BC DET CONTROL-0).

DPBC (15). These hubs emit an impulse one punch-feed cycle following the detection of the double-punched or blank column by the DPBC device. This impulse can be wired to the STOP hubs to stop the punch feed with the error card in the stacker.

Wiring Example (Figure 25)

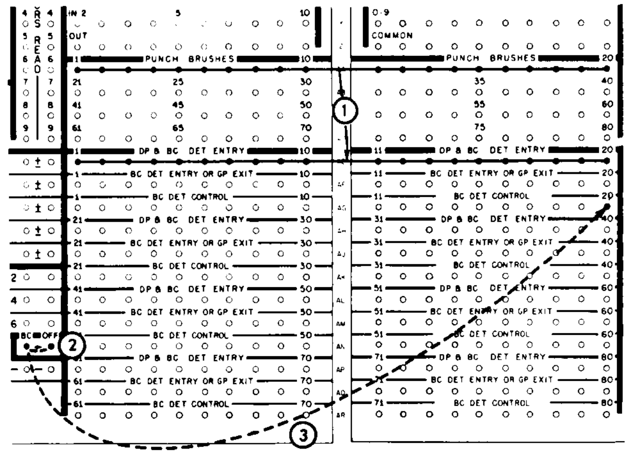


Figure 25. DP Only or DP & BC Detection

1. Punch brushes 1-20 are wired to DP and BC DET ENTRY 1-20. This wiring makes the impulses read from card columns 1-20 available for checking for double punches only or double punches and blank columns.
2. If it is desired to check only for double-punched columns, the BC OFF switch is wired. An alternate wiring is:
3. The BC hub is wired to BC DET CONTROL-20. This wiring is equivalent to wiring the BC OFF switch. The OFF side of the BC OFF switch is equivalent to the last position of BC DET CONTROL installed on the machine. The BC side of the BC OFF switch could be considered position 0 of BC DET Control.

Wiring Example (Figure 26)

1. Positions 1-10 are checked for double punches and blank columns; the same columns are also gang-punched.
2. Positions 11-20 are checked for blank columns only.

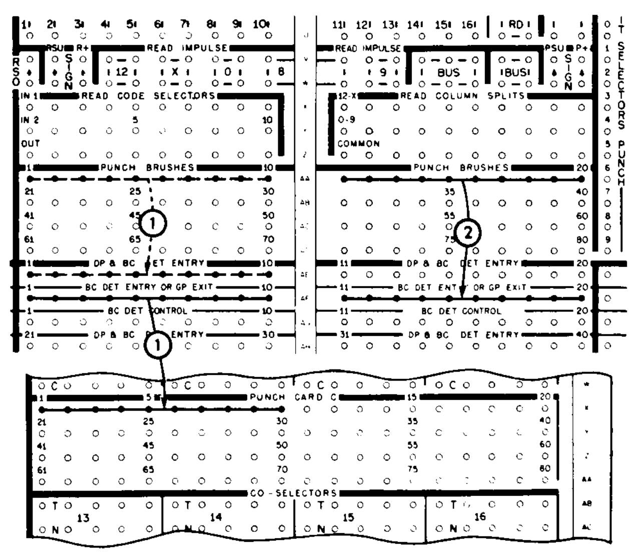


Figure 26. Gang Punching & Blank-Column Detection Only

Wiring Example (Figure 27). This example shows 2 separate control panels. In the first example, positions 1-20 are to be checked for double punches. Also, all positions except 10-13 are to be checked for blank columns.

In the second example, positions 1-10 are to be checked for double punches. Also, only position 4-10 are to be checked for blank columns.

1. Punch brushes 1-20 are wired to DP and BC DET ENTRY 1-20 for the detection of both double punches and blank columns (BC OFF not wired).
2. BC DET CONTROL 9 (preceding column) is wired to BC DET CONTROL 13 (last position) to bypass checking for blank columns in positions 10-13.

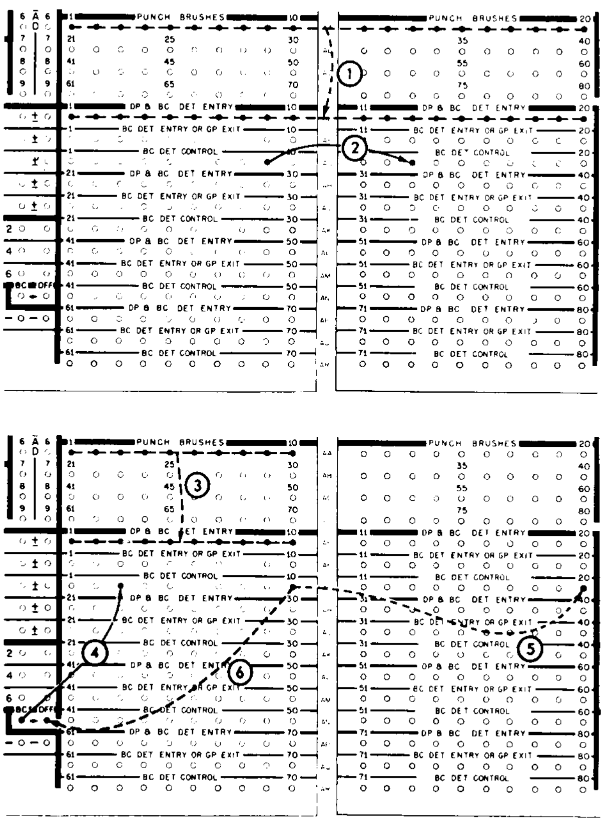


Figure 27. Blank Column Detection Control Selection

3. Punch brushes 1-10 are wired to DP and BC DET ENTRY 1-10 for the detection of both double-punched and blank columns (BC OFF switch not wired).
4. The BC side of BC OFF is wired to BC DET CONTROL-3. This bypasses checking for blank columns in positions 1-3.
5. BC DET CONTROL-10 is wired to BC DET CONTROL 20. This wire bypasses the blank-column check on all unwired positions. Whenever the punch unit is in operation, all unwired DPBC positions must be bypassed or BC OFF must be wired.
6. This is an alternate wiring to 5. This wiring is possible, because the OFF side of BC OFF is equivalent to the last installed position of BC DET CONTROL.

Wiring Example (Figure 28)

1. Punch brushes 1-20 are wired to DP and BC DET ENTRY 1-20 for the detection of double-punched and blank columns.
2. If a double-punched or blank column is detected, the DPBC hub emits an impulse that is wired to STOP. The error card is in the stacker when the machine stops.

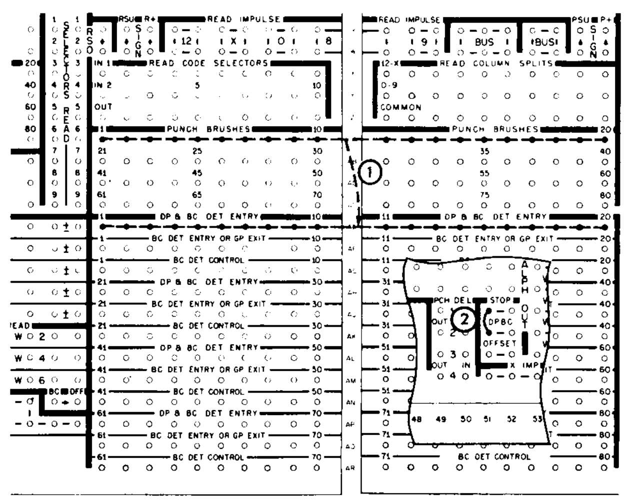


Figure 28. DPBC Machine Stop

EMITTING PUNCH IMPULSES

Control-panel hubs are provided for emitting impulses for use while output cards are being punched.

X IMP (15). These hubs emit an 11 (X) impulse during each punch-feed cycle.

Digit Selectors—Punch (11). One punch-digit-selector is standard on the 533. One additional punch-digit-selector or one half-time-emitter may be added. A punch-digit-selector can be used to separate or combine multiple digits. It may also be used as a punch-digit-emitter by connecting the C hub to the DI hub. DI emits all punch digit impulses (12-9) every punch-feed cycle.

Punch Hold (11). These hubs emit an impulse which, when wired to a co-selector or pilot-selector hold, causes the selector to remain transferred for the duration of the punch-feed cycle during which the pickup hub was impulsed.

Wiring Example (Figure 29). In this example there are 2 types of output cards. The information for one of the output cards is identified by the presence of an 8 in position 1 of control-information. The other is identified by the absence of the 8 in the first position of control-information. The card controlled by an 8 in position 1 of control-information is to be identified by having an 11 punched in column 80 and a 1 punched in column 55. The card controlled by the absence of an 8 in control-information is to be identified only by a 2 in column 55.

1. The 8 in position 1 of control-information impulses co-selector 16 to pick up before punching.
2. Co-selector 16 is held for the duration of the punch cycle.
3. All punch-digit impulses (12-9) are made available to the punch-digit-selector.
4. Punch-digit 1 is taken to the transferred side of co-selector 16. Punch-digit 2 is taken to the normal side of co-selector 16. The common of co-selector 16 is wired to punch card C-55. When co-selector 16 is transferred, a 1 is punched in column 55 of the output card. When co-selector 16 is normal, a 2 is punched in column 55 of the output card.

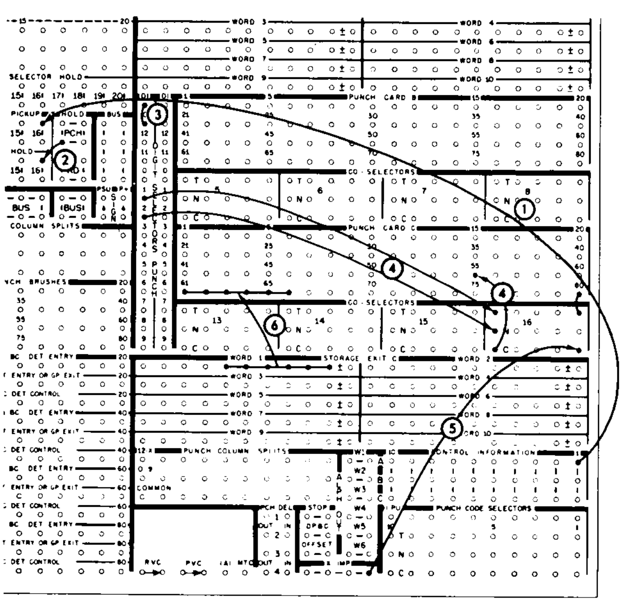


Figure 29. Card Identification & Digit Emitting

5. The X-impulse is wired to the common of co-selector 16. The transferred side of the co-selector is wired to column 80. When co-selector 16 is transferred, an X is punched in column 80.
6. The information from storage-exit, word 1 is punched in columns 61-66 of the output card.

Punch Delay (15). There are four sets of punch delay hubs on the control panel. Each set of hubs consists of an IN hub and OUT hub. The IN hub accepts any impulse timed to the punch feed. The OUT hub emits an impulse just prior to punching time on the punch cycle following the one during which the IN hub is impulsed. It is possible to delay up to four cycles by wiring the OUT of one to the IN of the next.

Wiring Example (Figure 30). This example is based on Figure 29. The card identified by an 8 in position 1 of control-information is to have column 80 checked for both double-punched and blank column. The card identified by the absence of an 8 does not check column 80 for either condition. Columns 55, 61-66 are to have double-punch and blank-column detection on both types of cards. Only the additional wiring for this checking is shown:

1. The control information impulse from position 1 is entered into the IN of punch delay 1. This is at the beginning of the cycle during which the X80 card is punched.
2. The output from punch delay 1 is used to pick up co-selector 13. This is at the beginning of the cycle following the one during which the X80 card was punched.
3. Co-selector 13 remains transferred as the X80 card passes the punch brushes.
4. The information from column 80 of the card is taken through co-selector 13 transferred to the DPBC DETECTION ENTRY. This makes possible checking this column for double punches and blanks. If the selector had been normal, no path would have existed between punch brush 80 and DPBC Detection Entry. Therefore, this column would not be checked for double punching.
5. The purpose of this wiring is to shift the last position for which blank-column detection is done. For the card identified by the control-information impulse, blank-column checking must include that position to which the information from column 80 is taken. For the other card, this position must be bypassed.

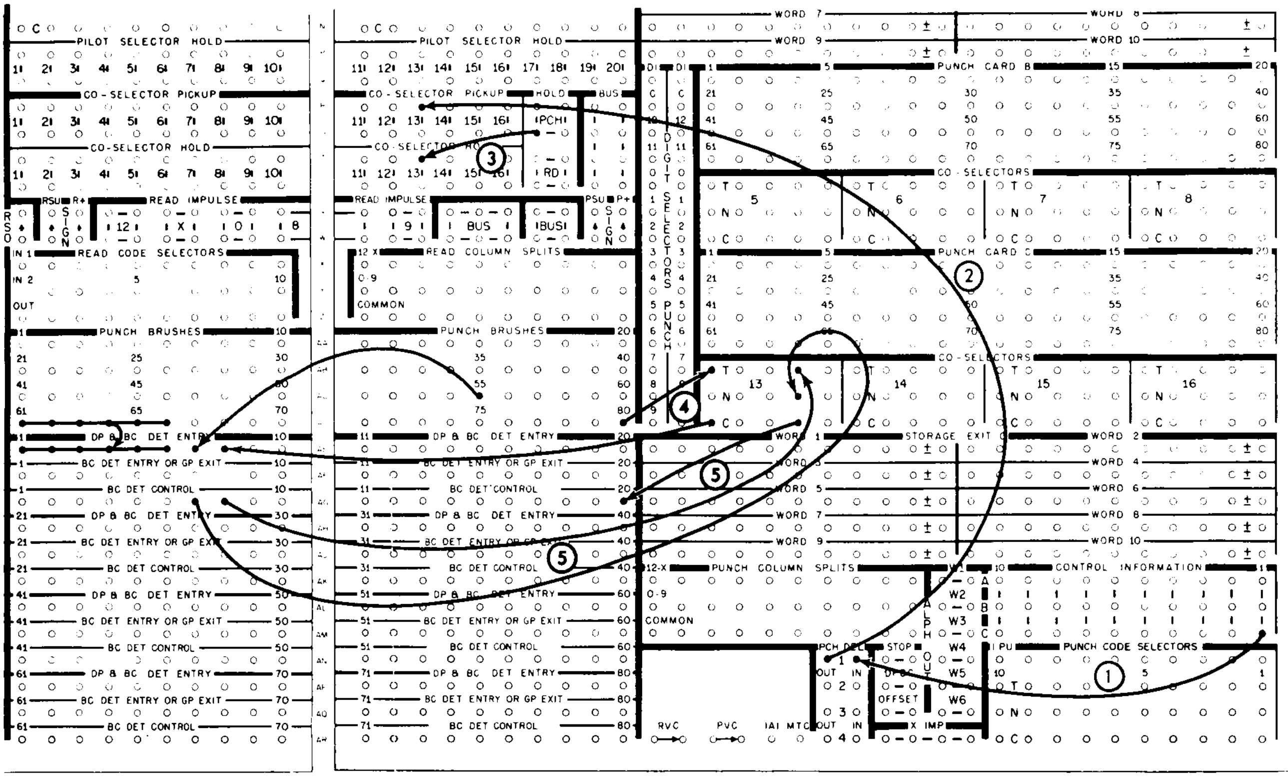


Figure 30. Selection using Punch Delay

Punch Column Splits (15). These hubs are used to separate 12-11 punch impulses from 0-9 punch impulses.

Wiring Example (Figure 31). In this example, column 20 of the output card contains digit punching (0-9), and positive and negative sign punching (12-11). The column splits are used to separate the digit and sign punching for purposes of double-punch and blank-column detection.

1. All impulses from column 20 are wired to the common of the column split.
2. The sign punching is taken from the 12-X side of the column split to position 20 of DPBC Detection Entry. The sign can now be checked for both double-sign punching and no-sign punching.
3. The digit punching is taken from the 0-9 side of the column split to position 19 of the DPBC Detection Entry. The digit punching can be checked for both double punching and no punching.

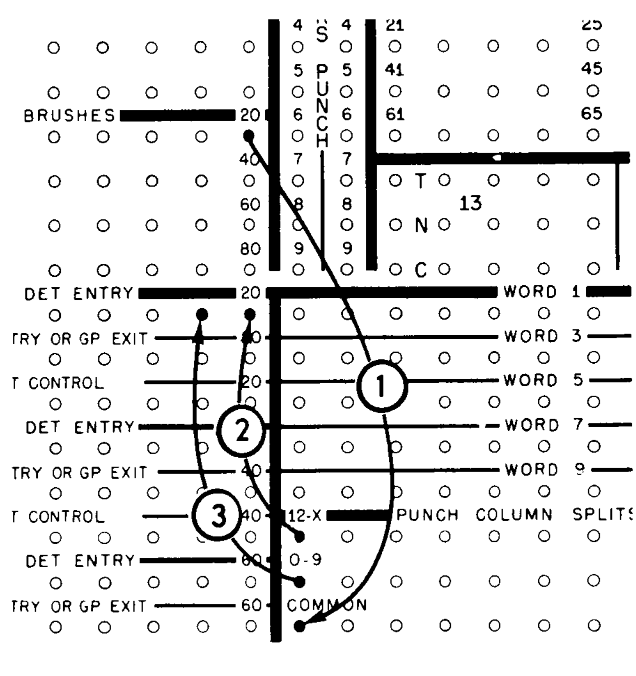


Figure 31. Column Splitting

IBM 537 Card Read Punch

This machine, with a maximum rate of 155 cards per minute, provides both input and output for the 650 System. It has been designed to permit punching calculated results into the card that contains the original source data. However, it may be used exclusively for either input or output if desired. As in the 533, information read from the card must pass through the input synchronizer to general storage. Also, any information to be punched must pass from general storage to the output-synchronizer area before it can be punched into the card. In contrast to the 533, the functions of the 537 (input and/or output) are performed in one feed.

Feed Configuration

Figure 32 shows the schematic layout of the 537 feed. Cards are placed into the hopper, face down, 12-edge first. All or any part of the card can be read at the FIRST, SECOND or PUNCH-READING station; and all or any part of the card can be punched at the PUNCH station.

The first reading station is normally used to differentiate between cards on the basis of control punching, and to pick up selectors for subsequent operation. Group control is performed by internal programming. On operations involving alphabetic information, information from first reading is wired to the alphabetic-first-read entry hubs. Information can be entered into an input synchronizer from first reading.

The second-reading station is normally used to enter information from the cards into an input synchronizer. The first and second reading stations of the 537 perform the same function as the first and second reading stations of the 533 read feed.

The calculate station represents the position of the card while data read from that card is being processed.

The punch station is used to punch the results of calculation into the card. Gangpunching and punching emitted information also takes place at this station.

The punch reading station is normally used to check the output results by using double-punch blank-column detection. It can also be used for reading the information used in gangpunching. The punch station and the punch reading station perform functions similar to the same stations in the 533 punch feed. Information may be entered into an input synchronizer from punch reading.

Because the single feed serves for both input and/or output operations, the programmer should consider the following:

1. All cards move on a card-feed cycle. Operation codes 70, 71, 73, 74, 76, 77 will result in a card-feed cycle. Operation codes 72, 75, 78 do not cause a card-feed cycle (see Input-Output Operation Codes).
2. Execution of RD (70, 73, 76) code causes 537 to execute a card-feed cycle. During this cycle the storage-entry hubs are active and the storage-exit hubs are inactive. Therefore, a card passing the punching station on this cycle is not punched, except for emitted information.
3. Execution of a WR (71, 74, 77) operation also causes the 537 to take a card feed cycle. During this cycle the storage-exit hubs emit information from the output synchronizer for punching. The storage-entry hubs may or may not be active on this cycle, depending upon the operation code that precedes the execution of the WR code. If the WR instruction is preceded by RC (72, 75, 78) instruction, the storage-entry hubs are active on the feed cycle. If the WR instruction is not preceded by an RC instruction, the storage-entry hubs are *not* active and no information is read into the input synchronizer. (For further information, refer to RC operation codes.)
4. When information is to be both read and punched simultaneously, an RC command must precede the WR command.

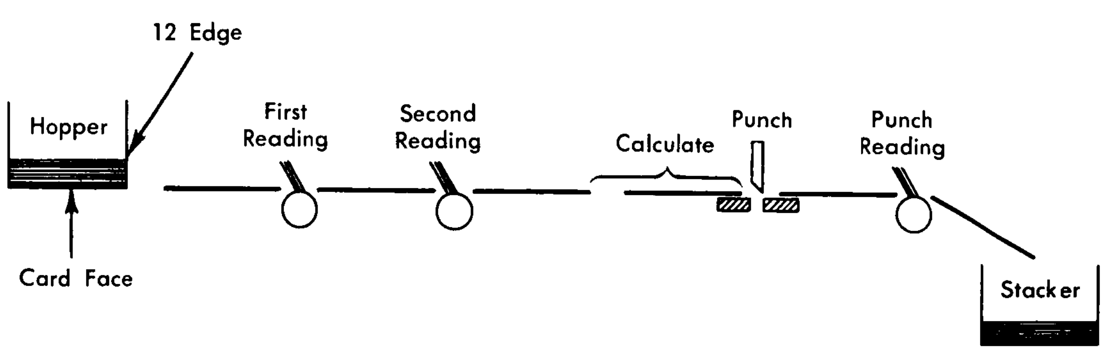


Figure 32. 537 Feed Schematic

Operating Keys and Signal Lights (Figure 33)

Main-Line Switch

This switch controls the application of power to the 537. It is located on the right end of the unit.

Ready Light

When this light is on, it indicates that the machine is ready for operation. It goes out when cards are in process position in the feed, and stays out until either the STOP key is pressed, the hopper runs out of cards, or a feed failure occurs.

Fuse Light

This light turns on whenever a fuse blows in the 537.

Start Key

The major function of this key is to initially place cards in position where further feeding is under control of the stored program.

If four or more cards are placed in the hopper, a single, momentary depression of the start key results in either three or four cards being fed (depending upon the punch-only switch on the control panel). If this switch is *not* wired, three cards are fed. If it *is* wired, four cards are fed. After the run-in, the start key has no further effect while cards remain in the hopper. When the last card leaves the hopper, the machine stops. The start key can be used to run the remaining cards out of the feed without processing.

Stop Key

This key is pressed to stop card feeding.

End-of-File Key

After the last card has left the hopper, pressing this key allows processing the cards remaining in the feed.

Reset Key

Pressing this key turns out the DPBC light. It must be pressed before the machine can be restarted after DPBC stop.

End-of-File Light

This light turns on when the end-of-file key is depressed.

DPBC Detect Light

This light turns on whenever a double-punched or blank-column is detected by control-panel wiring. It is turned off by the reset key.

Card-Feed-Stop Light

This light turns on whenever a card fails to feed from the hopper.

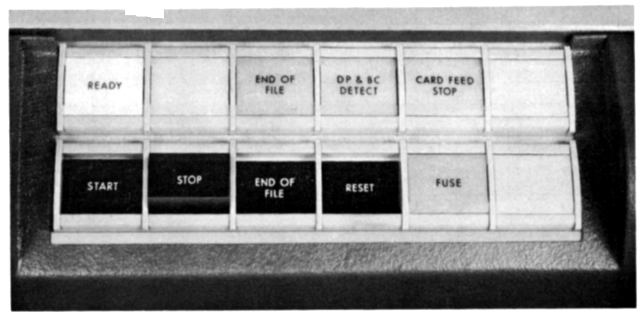


Figure 33. Operating Keys & Signal Lights

Output Only

When used only for output, 537 operation is similar to the operation of the 533 Punch Feed. To convert the 537 to this mode of operation, the punch-only switch on the control panel must be wired. With this switch wired:

1. On the run-in, a single depression of the start key results in four cards being fed. This places the first card in position before the punch station (Figure 34).
2. Only a WR instruction (71, 74, 77) can be executed by the 537. If a RD (70, 73, 76) or RC (72, 75, 77) instruction is issued for this machine, program execution is stopped on the D half cycle of the RD or RC command.

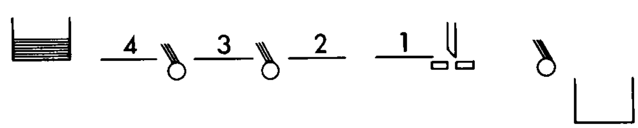


Figure 34. Run-In, Punch Only Switch Wired

Input Only

When used only for input, 537 operation is similar to the operation of the 533 Read Feed. For this type of operation the punch-only switch on the control panel is not wired. When the switch is not wired:

1. On the run-in, a single depression of the start key results in three cards being fed (Figure 35). The information from the first card automatically enters the input synchronizer.
2. All input-output operation codes (RD, RC, WR) can be executed. However, when using the 537 as input only, the RD (70, 73, 76), codes should be used.

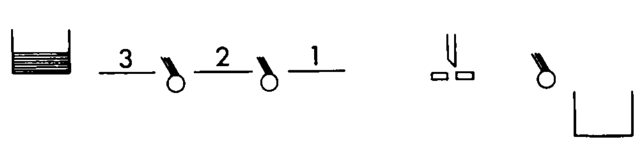


Figure 35. Run-In, Punch Only Switch not Wired

End-of-File

When the last card leaves the hopper, the machine stops with three unprocessed cards in the feed. To process these cards, the end-of-file key is pressed. This turns on the end-of-file light and allows the program to resume control of card movement. After the last card is processed, the end-of-file light goes out, and the remaining cards can be run out of the feed with the start key.

Combined Input-Output

The basic design of the 537 makes possible punching output results into the input card. For this type of operation, the programmer must keep in mind those items discussed under Feed Configuration.

EXAMPLE:

This example is included to assist in understanding the mechanical and programming aspects of a combined operation. Assume the 537 to be connected to synchronizer 1. This block diagram and program will be used as the basis of the example (Figure 36).

1. Cards are placed in the hopper, face down, 12-edge first.
2. The start key on the 537 is pressed. This results in 3 cards being fed (Figure 37). The input information from card A is automatically entered into the input synchronizer through 537 control-panel wiring.

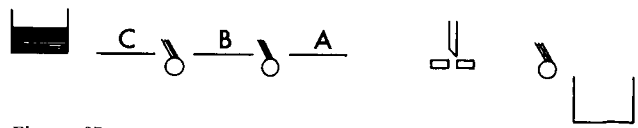
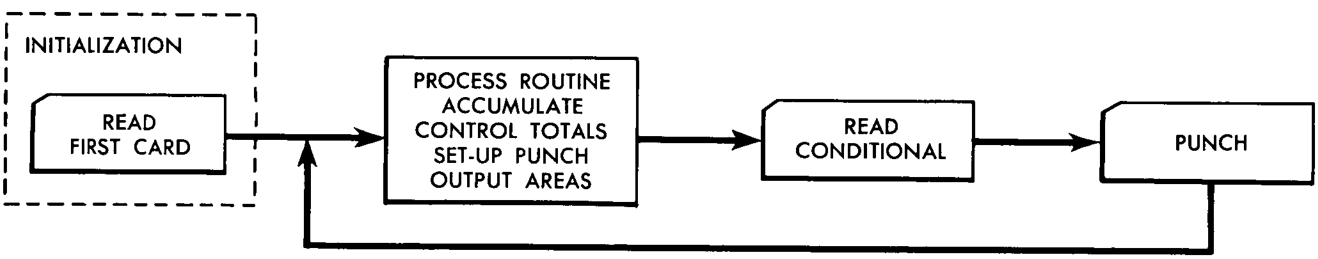


Figure 37.

3. Program execution is started at the control console. (At the end of the 3 card run-in, the only instruction that can be executed by the 537 is RD (70) code. An attempt to use the RC (72) or WR (71) code stops the 650.
4. The first instruction executed (70-0001-0051) transfers the contents of the input synchronizer (card A) to general storage and initiates the me-



Location of Instruction	Instruction OP	Instruction Data	Instruction Instruction	Operation Abbrev.	
8000	70	0001	0051	RD1	Initial Read
0051	XX	XXXX	XXXX		
					Instructions for Process Routine, Control Totals, Set-up of Punch Output Area, etc.
	XX	XXXX	0011		
0011	72	0001	0101	RC1	Read Conditional
0101	71	0027	0051	WR1	Punch Card — Return to Process Routine

Figure 36. Combined Input-Output Generalized Block Diagram and Program

chanical cycle that moves card B past the second reading station to refill the input synchronizer (Figure 38).

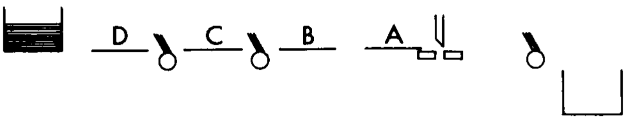


Figure 38.

5. During the time that the input synchronizer is receiving information from card B, program execution continues using the data from card A.
6. Just prior to the execution of the RC1 instruction (72-0001-0101) the following conditions exist:
   a. The data from card A has been completely processed and stored in the output area of general storage.
   b. The information from card B has been completely entered into the input synchronizer.
7. When the RC1 instruction is executed, the contents of the input synchronizer (card B) are transferred to general storage (no mechanical feed cycle takes place). If a RD1 (70) code is used instead of the RC1 (72) code, a mechanical feed cycle would take place, during which card A would pass the punch station without being punched.
8. The execution of the WR1 instruction (71-0027-0051), following the RC1 instruction, causes the contents of the output area of general storage (results of card A) to be transferred to the output synchronizer for punching. Also, it initiates a mechanical feed cycle during which card A is punched from the output synchronizer, and card C is read into the input synchronizer. Because the data from card B is transferred to general storage by the RC1 command, no conflict results. NOTE: The I-address of the WR1 command returns the program to the first instruction of the process routine and not to the RD1 command. This way, the RD1 command is used only once, immediately after the run-in. At the end of the mechanical feed cycle initiated by the WR1 command, the cards are in the feed this way (Figure 39):

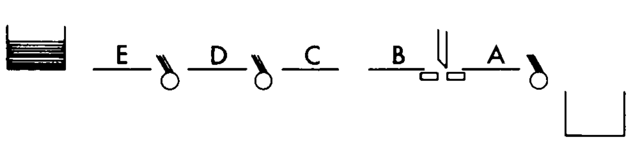


Figure 39.

9. During the time that the mechanical feed cycle is in progress (card A being punched), card B is processed and the program advances to the RC1 instruction. The program then repeats itself for cards B, C and D. As the cards pass the punch reading station, they can be checked with the double-punch blank-column device.
10. Feeding and processing continue until the last card leaves the hopper. At this point, program execution stops. To process and punch the last four cards the end-of-file key must be pressed.
11. When the end-of-file key is pressed, the program resumes control of card movement and processing continues as before. This is the position of the cards just before the transfer of card L from the input synchronizer to general storage, and the punching of card K (Figure 40).

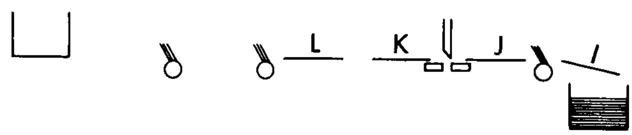


Figure 40.

12. When the RC1 (72) command is executed, the information from card L is transferred from the input synchronizer to general storage. When the WR1 (71) command is executed, the information from the output area of general storage (for card K) is transferred to the output synchronizer for punching. Also, a mechanical feed cycle is initiated, during which card K is punched.

Note: during this cycle no card passes the second reading station. Therefore, the input synchronizer contains blanks. Also, during this cycle the data from card L is processed. This drawing shows the position of cards at the completion of the cycle during which card K is punched (Figure 41).

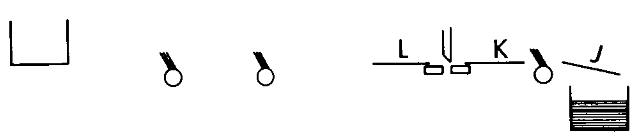


Figure 41.

13. When the next RC1 instruction is executed, an RVC stop will *not* occur as the blanks are transferred to general storage because the RVC is automatically suspended during this cycle. This allows the program **to** continue and punch the **last card (L).**

Processing Fewer Than Four Cards

To process fewer than four cards in the 537, use the following procedure. However, it should be remembered that normal run-in and end-of-file procedures still apply.

1. Press computer reset key (program reset could also be used).
2. Place card(s) into hopper.
3. Press both the 537 start and end-of-file keys together. Hold them down until the end-of-file light comes on.
4. Press PROGRAM START key.

Restart Procedures

Card-Feed-Stop Restart

A card-feed-stop is caused by the failure to feed a card from the hopper (except run-out) on a card-feed cycle. This is signaled by the card-feed-stop light.

A card-feed-stop can also occur if a card fails to advance within the feed during a card-feed cycle. If this happens, clear the feed and begin again.

Output Only

1. Remove cards from hopper.
2. Run cards out of feed using start key.
3. Repair damaged card—usually the bottom card of the group removed from hopper.
4. Remove top three cards from stacker and place in front of group from hopper.
5. Replace cards in hopper and press start key.

Input Only. The program is halted on the D half cycle of the RD command following the cycle during which the misfeed occurred. At this time, the last two cards to enter the feed have not been processed and must be re-entered into the system. To restart:

1. Remove cards from hopper.
2. Run cards out of feed using start key. The last two cards are not processed.
3. After repairing damaged card, place last two cards from stacker in front of group removed from hopper.
4. Replace the cards in hopper and press start key.

Combined Input-Output. When a card-feed-stop occurs on a combined operation, program execution is halted on the WR1 command (Figure 36) following the cycle during which the misfeed occurred. The cards are then in the following position (Figure 42):

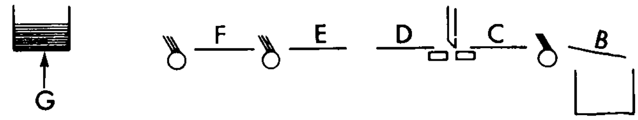


Figure 42.

At the time program execution stops:

1. The information from card D has been completely processed and is in the general storage output area. It would have been punched by this WR1 instruction if the feed failure had not occurred during the cycle than punched card C.
2. The information from card E has been transferred from the input synchronizer to general storage. This took place on the RC1 instruction that preceded the WR1 command during which program execution halted.

Because these two conditions exist, the restart procedure must provide for punching card D without reprocessing that data from card D. To restart:

1. Remove cards from hopper and repair nicked card.
2. Run cards B, C, D, E, F, out of feed using start key. Card D is not punched.
3. Remove last three cards (D, E, F) from stacker and place them in front of cards removed from hopper. Replace cards in hopper.
4. Press program reset key to clear out WR1 instruction.
5. Press 537 start key to run-in first three cards (D, E, F). This enters information from card D into the input synchronizer. Because the results for card D are still in the output area of general storage, there is no need to reprocess card D.
6. Enter this instruction (70-0001-0100) into the storage entry switches.
7. Press program start key. The first instruction executed is the one entered into the storage entry switches in step 6. This moves card D into punching position, and enters the information from card E into the input synchronizer. Note that the I-address of the instruction in the storage entry switches takes the program to the RC1 instruction (Figure 36). This bypasses reprocessing card D while moving it into punching position.
8. Executing the RC1 instruction moves the information from card E from the input synchronizer into general storage. This places it in position to be processed.
9. Executing the WR1 instruction, following the RC1, punches card D and enters card F into the input synchronizer. The program then returns to the first instruction of the process routine and the restart is complete.

Read Validity Check Restart (RVC)

An RVC stop occurs when the machine detects the transfer of invalid information from an input synchronizer to general storage.

Input Only. Program execution is halted during the D half cycle of the RD command on which the RVC occurs. The Control Console shows:

1. Data address light on.
2. Storage selection light on.
3. RD code (70, 73, 76) in operation lights.
4. Valid address in address lights.

To restart:

1. Remove cards from hopper.
2. Run cards out of 537 with start key.
3. Correct error card. This will be the fourth card from the top of the group in the stacker.
4. Place corrected card and the three other unprocessed cards from the top of the stacker group, in front of cards removed from the hopper.
5. Replace the cards in the hopper.
6. Press error reset key on control console.
7. Press 537 start key.

Combined Input-Output. An RVC error during a combined operation will stop program execution on the RC1 instruction. At the time the program stops, the cards will be in this position (Figure 43).

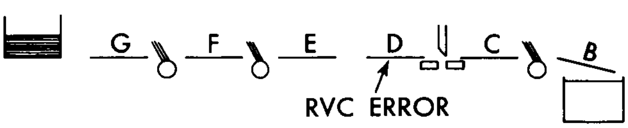


Figure 43.

As a result of the RVC error:

1. The processing of card D is completed and the results stored in the output area of general storage for punching.
2. A validity error has been detected in the information from card E as it was transferred from the input synchronizer to general storage.

The restart procedure must provide for punching card D without reprocessing its data.

To restart:

1. Remove cards from hopper.
2. Run cards (B, C, D, E, F, G) out of feed, using start key.
3. Remove top four cards (D, E, F, G) from stacker.
4. Correct card E.
5. Place the four cards from the stacker in front of those removed from hopper.
6. Replace cards in hopper.
7. The remaining steps in this restart procedure are identical to those covered under Restart after Feed Stop, beginning with step 4.

Control Panel (Figure 44)

The control panel used with the 537 is identical to that used with the 533. Because of the similarity of wiring principles, only the differences and exceptions are covered in this section. For further detail, refer to the section on 533 control panel.

In the 533, certain impulses are timed to the reading function, and others are timed to the punching function (impulses from one function cannot be used with the other function). However, because the 537 is a single feed machine, all impulses are *in time* to both functions.

The number following the hub name indicates in what area of the control panel the hub is located.

Punch Only (1). This switch is used exclusively with the 537. Connecting these two hubs together conditions the 537 to operate as an output unit only.

Pilot and Co-Selectors. The operation of pilot and co-selectors in the 537 is identical to that described in the 533 section. However, because holding a selector is internally controlled, no external hold wiring is necessary.

Pilot Selector Hold (2). These hubs are inactive.

Co-Selector Hold (2). These hubs are inactive.

Read Hold, Punch Hold (2). These hubs are inactive.

Read Column Split (4); Punch Column Split (6). These can be used interchangeably.

Digits Selectors—Read and Punch (3). These units can be used interchangeably.

Read Impulses (5). These impulses can be used to control punching functions as well as reading functions.

Punch Delay (6). The operation of the punch delay feature differs considerably from that of the 533.

Each unit consists of an IN hub and an OUT hub. The IN hubs accept any timed impulse. The OUT hubs for units 1 and 2 emit an impulse (just prior to 12 time) two cycles after the corresponding IN hub is impulsed. The OUT hubs for units 3 and 4 emit an impulse (just prior to 12 time) three cycles after the corresponding IN hub is impulsed. It is possible to delay as much as 10 cycles by wiring the OUT hub of one unit to the IN hub of the next.

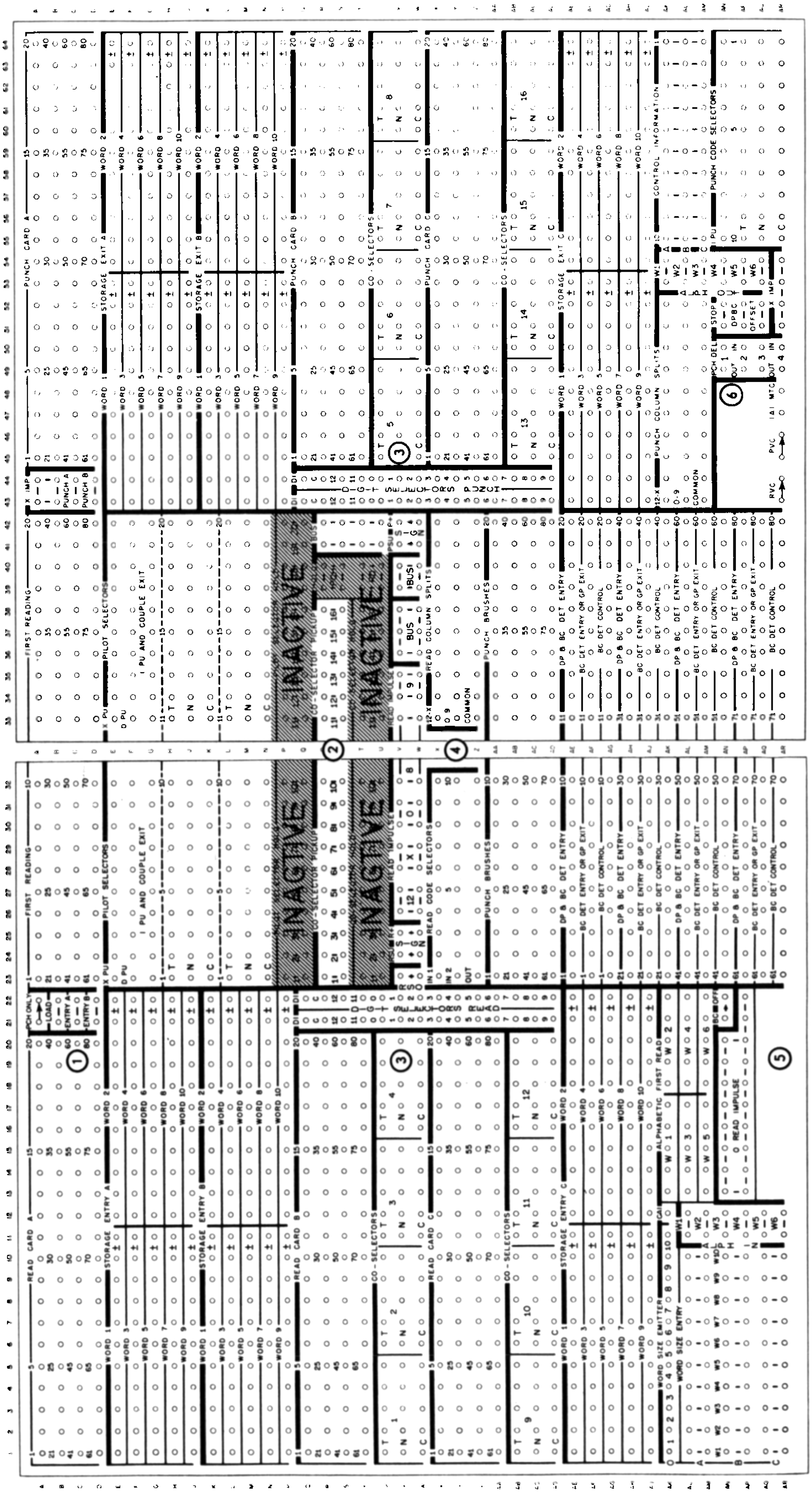


Figure 44. 537 Control-Panel Features

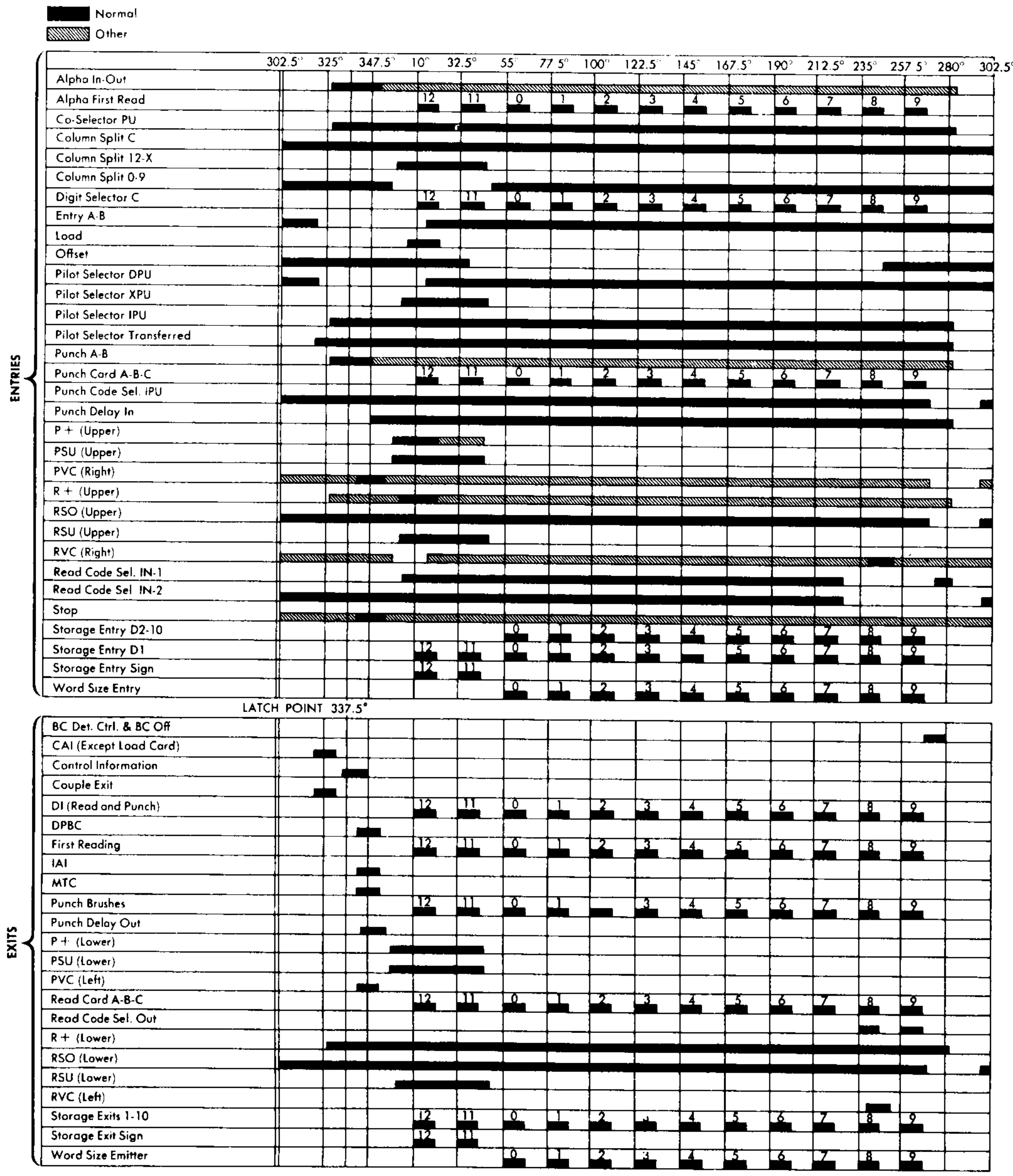


Figure 45. 537 Timing Chart (Wiring Diagram 438402)

Timing Chart (Figure 45)

When wiring control panels, this chart should be consulted to insure that the normal rules of timing are not violated. Here are some conditions peculiar to the 537:

1. When constant alphabetic information is desired in the output format, the CAI impulse should be wired to the ALPHA-OUT hubs.
2. If selective control of alphabetic information is desired in the output format, impulses from the pilot selector couple exits or from the control information exits should be used.
3. Control-information cannot be used to pick up a selector for alphabetic control on the same cycle.
4. The PSU hub (lower) should *not* be used on the 537 to control ALPHA-OUT. Use of these hubs may result in the intermittent dropping of 12-zone punches.

NOTE: The CAI impulse is interrupted during the reading of a load card. Therefore, in applications using interspersed load cards, care should be taken that a card being punched during the reading of a load card does not rely on the CAI impulse for alphabetic information.

The digit-emitting hubs on the 537 control panel emit impulses on all cycles, including load-card cycles. Therefore, caution must be used when running load-cards through the 537. If digit impulses are wired to active punch entries, the load card will be punched as it passes the punch station .

IBM 407 Accounting Machine

Printed output and card input for the 650 system is provided by a standard 407 (Model A1 or A2) equipped with a special device that provides for the transfer of information to and from the 407 and the 650. In addition, the 407 can have a Summary Punch attached to it.

Line printing and card reading are under control of the 650 program. The maximum output rate is 150 lines per minute. The maximum input rate is 150 cards per minute. Each input and output cycle requires 400 ms to complete (see Bulletin 6; 328-7990). All features of a standard 407, such as counters, selectors, storage units, carriage skipping, multiple-line reading, can be used during a 407-650 operation.

The 407 can also be used as a conventional accounting machine, independent of the 650, without removing the interconnecting cables.

Mechanical Considerations

When attached to the 650, the 407 is functionally 2 separate units: an input device and an output device. However, the two units are inter-related mechanically. This means if a print operation (Op codes 71, 74, 77) is called for while a read operation (Op codes 70, 73, 76) is in progress, the execution of the print command is delayed until the completion of the mechanical card-feed cycle. Likewise, if a read operation is called for while a print cycle is in progress, the execution of the read command is delayed until the completion of the mechanical print cycle.

From a programming standpoint, this means the following program results in 75 cards per minute input and 75 lines per minute output:

0001-RD1-70-0051-0002
0002-WR1-71-0027-0001

By using the read conditional (72) in place of the read (70), the rates can be raised to 150 cards per minute input and 150 lines per minute output.

0001-RC1-72-0051-0002
0002-WR1-71-0027-0001

This is because this combination of codes causes the card-feed cycle and print cycle to occur simultaneously.

Operating Keys, Switches, and Signal Lights

Only those keys, switches, and signal lights used in 407-650 operations will be discussed here. For additional information see 407 Manual, Form 224-5765.

Start Key (Figure 46)

The major function of this key is to initially put the 407 in a *ready* status. The results of pressing this key depend on whether the 407 is being used for input only, output only, or as a combined input-output device. The detailed explanation of the function of this key is covered in later sections.

Stop Key (Figure 46)

Pressing this key removes the 407 from ready status.

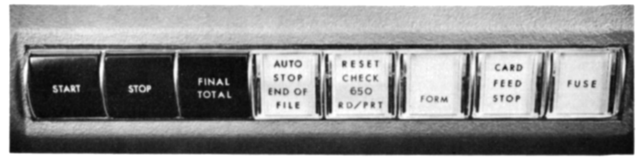


Figure 46. 407 Operating Keys & Lights

End-of-File Switch (Figure 47)

This switch is located on the right-end of the machine. It has a dual function:

1. When the 407 is used in a print-only operation, this switch must be ON.
2. When the 407 is being used for input only or combined input-output, the function of this switch is similar to the end-of-file key on the 533.

The detailed explanation of the function of this switch is covered in later sections.

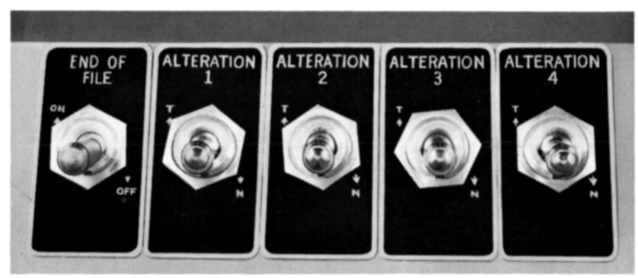


Figure 47. 407 End-of-File Switch

End-of-File Light (Figure 46)

This light comes on during an end-of-file operation or a print-only operation.

Independent Operation Switch (Figure 48)

This switch is located behind the fuse panel cover on the left end of the machine. When this switch is ON, the 407 can be used independently of the 650 without disconnecting the cables. When this switch is OFF, it works in conjunction with the calculate switch on the control panel to set up the machine for combined 407-650 operations.

Calculate Switch

This switch, located on the control panel, is used in conjunction with the independent operation switch to set up the 407-650 for combined operations. This switch is effective only when the independent operation switch is OFF.

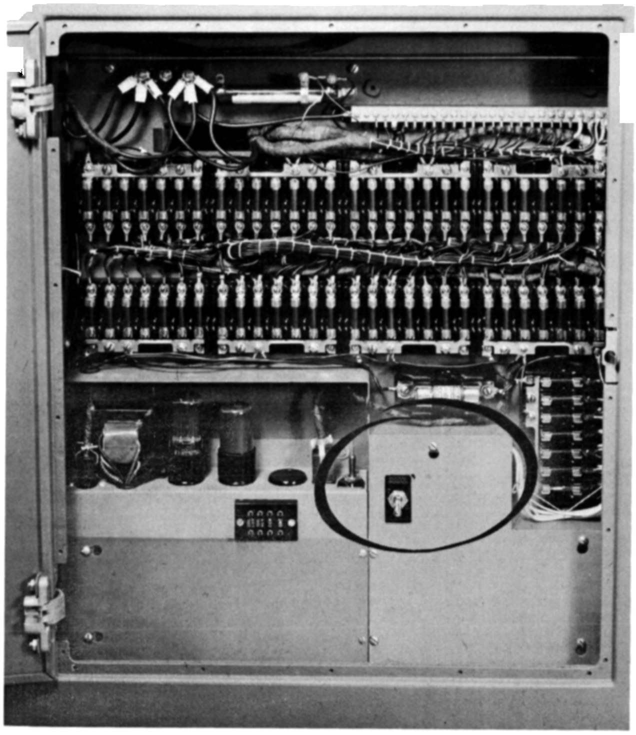


Figure 48. 407 Independent Operation Switch

407 Cycles

When set up for 407-650 operation, the 407 is running continuously. That is, it is taking *machine cycles* during the entire time it is in a ready condition and connected to the 650 system. This is true even though the 407 may not be performing any input and/or output function. During 407-650 operations, there are several types of cycles that can occur simultaneously with machine cycles:

1. Print cycles
2. Card feed cycles
3. Card feed/print cycles
4. Load-card read cycles
5. Program cycles
6. Inactive machine cycles

Print Cycles

These cycles are specifically designated as those initiated by a 650 WR code (71, 74, 77). It does not include any printing cycle that is not initiated by the 650 program. As a result of the WR code, the 650 will:

1. Transfer the output data from general storage to the output-synchronizer area.
2. Start a 407 print cycle.
3. Restart 650 program execution.
4. Interlock the 407 to prevent any print, read, or read conditional operation from being executed until this print operation is completed.
5. Validity check (PVC) the output information as it is being transferred from the output synchronizer to the storage exits on the control panel. PVC can be made inoperative by control-panel wiring.

Card Feed Cycles

These cycles are specifically designated as those initiated by a 650 RD code (70, 73, 76). This does not include a card-feed cycle initiated by a combination of RC/WR operation codes. The execution of an RD code will:

1. Transfer information from the input synchronizer to general storage. As this transfer takes place, check the information for validity (RVC). If the information is invalid, stop program execution. If the information is valid, allow program execution to continue. RVC can be made inoperative by conrtol-panel wiring.
2. Start a 407 card-feed cycle.
3. Restart 650 program execution and interlock the 407 so that another read, read conditional, or write operation cannot be executed until this cycle is complete.
4. Read the information from the card into the input synchronizer.

Although card-feed cycles are used primarily to read data into the system, the impulses from the second reading station can be used for detail printing, accumulating in counters, entering data into storage units, etc.

If a 650 card-feed cycle is also an MLR cycle, storage entry will be active only on the first MLR cycle (MLR LINE 1). Succeeding MLR cycles are independent of 650 program execution, which continues while the second and succeeding MLR cycles occur. However, the 407 is interlocked to prevent the execution of any input/output operation code until MLR printing is completed.

Card Feed/Print Cycles

These cycles are specifically designated as those initiated by the use of the RC code (72, 75, 78) in conjunction with the WR code (71, 74, 77). The execution of an RC code will:

1. Transfer the information from the input synchronizer to general storage. As the transfer is made, validity-check (RVC) the information. If the information is valid, program execution will continue. If the information is invalid, program execution will be stopped on the D half cycle of the RC instruction.

2. Condition the 407 feed to operate simultaneously with the print unit when a WR instruction is executed. NOTE: If another RC or RD instruction is encountered prior to a WR instruction, 650 program execution stops.
3. Restart 650 program execution. The next 650 instruction need not be a WR instruction.

When the WR instruction is executed, it results in a simultaneous print cycle and card-feed cycle. During this combined cycle all additional 407-650 control-panel hubs can be active. If the card feed portion of this cycle is also the beginning of an MLR operation, storage entry and storage exit are active only on MLR LINE 1. The remainder of the MLR operation is similar to that described under card-feed cycles and is interlocked the same way.

Load-Card Read Cycles

A 12-impulse wired to LOAD on the control panel will cause the next card-feed cycle to be a load-card cycle. Normally, LOAD is wired from the first reading station to cause a load cycle for that particular card as it is being read at the second reading station. Load cycles are similar to the other card-feed cycles discussed, except for:

1. Storage-entry, words 1-8 are inactive.
2. Second reading is internally connected to words 1-8 of the input synchronizer.
3. The RVC feature is inoperative. The word-size-emitter for words 1-8 is inopertive.
4. Unless a plus or minus sign is punched over the units positions of each word, the word is entered without a sign.
5. CAI is inoperative (special feature).
6. Word-size-emitter 0 is internally connected to word-size-entry for words 9-10 to provide automatic entry of zeros.

The second reading hubs on the 407 control panel are active on a load card read cycle and thus can be used to detail-print or accumulate data from the load card. Carriage spacing takes place on load-card cycles unless space suppress is wired. Although words 9 and 10 are automatically filled with zeros, the storage entry hubs for these words are active on load-card cycles. Therefore, any information wired into these hubs is entered on top of the zeros—resulting in invalid information.

Program Cycles

These cycles are initiated by impulsing program start during a card-feed, print, or card-feed/print cycle. Program cycles occur immediately after the 650 controlled cycle, and function in the normal 407 manner. During program cycles, the 407 is interlocked so that RD, RC or WR command cannot be executed until the program cycles are completed.

Inactive Machine Cycles

During any 407-650 operation the 407 is running continuously. Any machine cycle that is not a RD or WR cycle is considered inactive. During inactive machine cycles many of the 407 control-panel hubs are operative. These include such hubs as pilot selector MC HOLD. On these cycles the normal print entry hubs are active, and any characters received by them will be printed if care is not exercised when wiring the control panel.

Control Panel

The unshaded areas of Figure 49 are those hubs that are added for 407-650 operations. This section describes their function and any standard 407 hubs that are modified when used in a 407-650 operation.

The letters A, C, L, and P, in the hub title, indicate the type of cycle during which the hub is active.

A = All Cycles
C = Card Feed Cycles
L = Load Cycles
P = Print Cycles

In addition, the number following the letter indicates the section of Figure 49 where the hub is located. EXAMPLE: CAL (Calculate Switch – A – 6); this indicates that this switch is active on every cycle and is located in section 6 of Figure 49.

When a modified 407 is used for independent operation, all standard control-panel hubs, except program start, operate as described in the 407 Manual, Form 224-5765. Program start accepts impulses on any cycle except program cycles.

The timing chart for the hubs described in this section is shown by Figure 50.

CAL (Calculate Switch—A—6). This switch must be wired for 407-650 operations. In addition, the Independent Operation switch must be OFF. When the Independent Operation switch is ON, the CAL switch has no function.

Pilot Selector Hold (FC—C—1) (MC—A—1). In a standard 407, pilot selector hold is through internal machine wiring. On 407-650 operations, pilot selector hold is through control-panel wiring. This wiring can hold the selector until the end of the card-feed cycle (FC) on which it transfers or until the end of the machine cycle (MC) on which it transfers.

For hold purposes, the pilot selectors are divided into groups of five. Thus, the hub labeled 1 controls the hold of pilot selectors 1-5. The hub labeled 2 controls the hold of pilot selectors 6-10, etc. This means

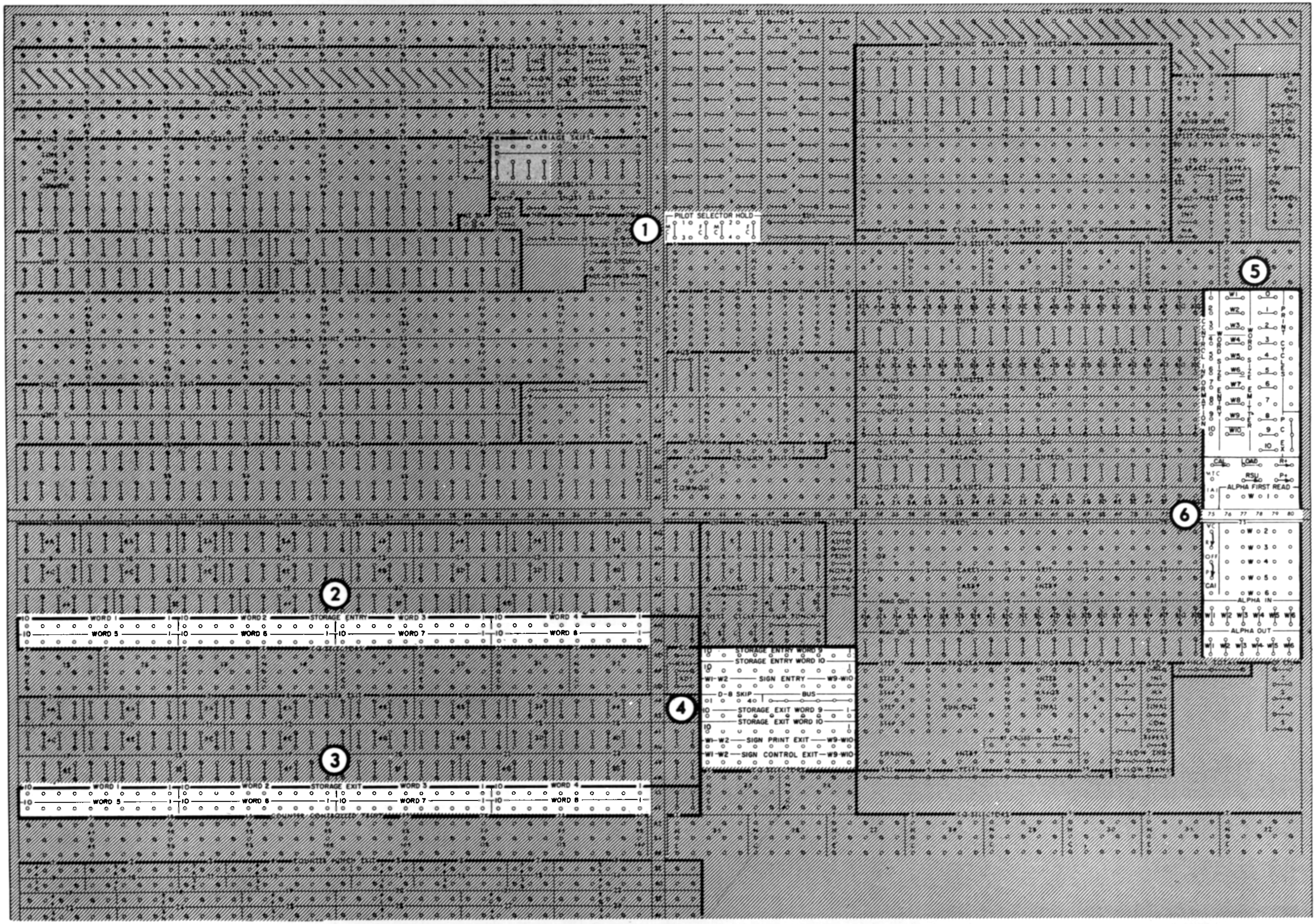


Figure 49. 407-650 Control-Panel Diagram (Form X24-6382)

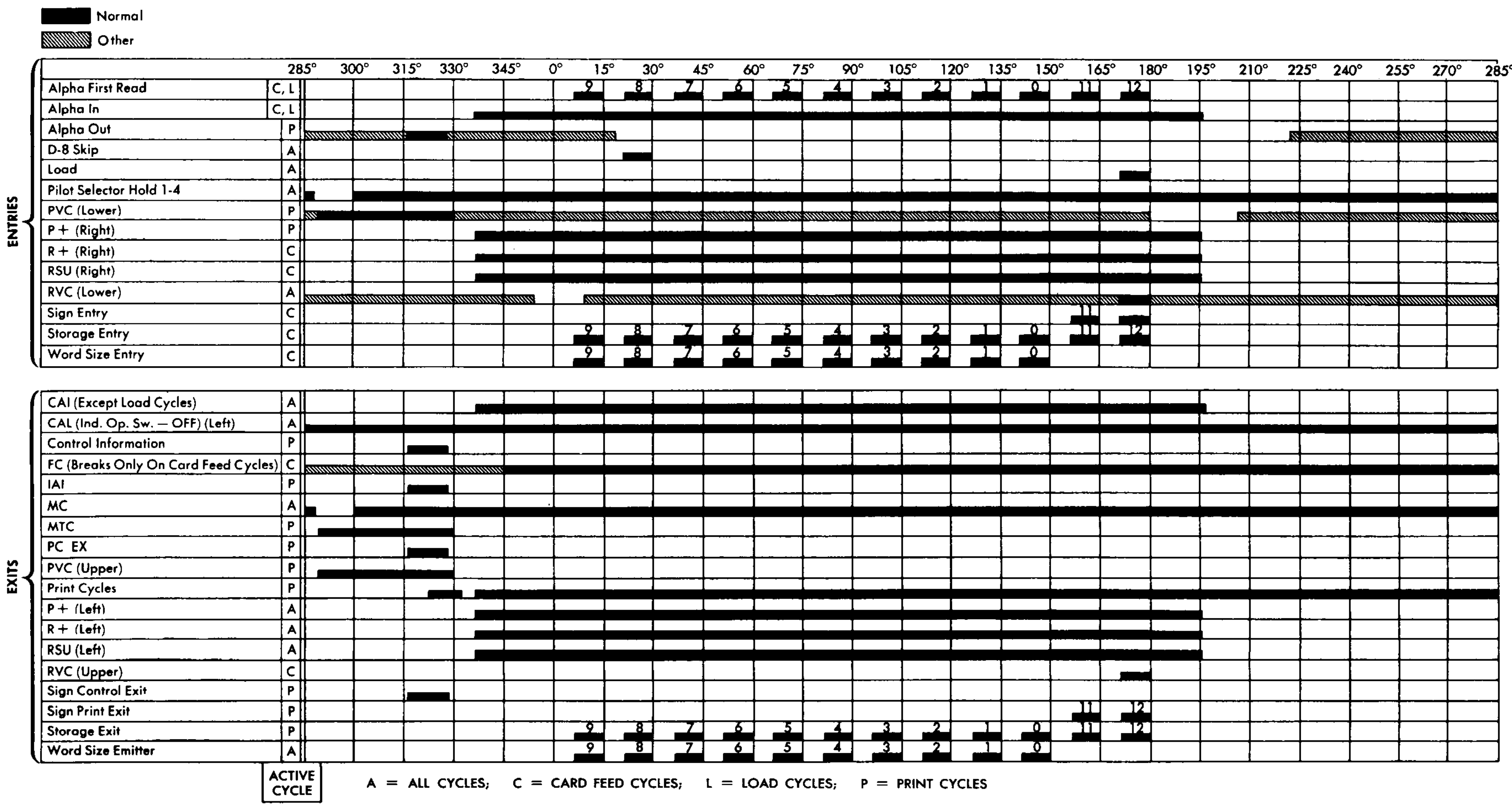


Figure 50. 407-650 Timing Chart (Wiring Diagram 224507F)

that if selector 1 is holding to FC, selectors 2, 3, 4, 5 cannot be used for functions requiring an MC hold, etc. If no hold wiring is used, an impulse into the XPU or DPU of the selector will not transfer the selector. Also, if no hold wiring is used, an impulse to the IPU or the selector will tranfser the selector only for the duration of the pickup impulse.

Storage Entry—C—2, 4. This group of hubs provides entry to an input-synchronizer. The particular input area is determined by cable connections at the 655 Power Unit. These hubs normally receive impulses from the second reading station during card-feed cycles (except load cycles) but will accept any digit impulse during card-feed cycles. During load-card cycles, words 1-8 are inactive while words 9-10 can accept impulses (see *Load Card Read Cycles).*

The units position (labeled 1) of each storage entry word can accept all read impulses (9-12) under control of the RSU and R + switches. Positions 2-10 of each word will accept only 9-0 impulses.

Word-Size-Emitter—A—5. See 533 section.

Word-Size-Entry—C—5. See 533 section.

RSU (Read Sign over Units—C—6). This pair of horizontally adjacent hubs is a switch. When wired, the sign indication punched in the card must be over the units position of the storage-entry word. The units position of every storage-entry word is conditioned to accept both the digit punching (0-9) and the sign punching (11-12). The sign position of the storage entries need not be wired.

When this switch is not wired, the sign entry must be wired. This wiring can be from any column of the card. Sign-entry will accept only 11- or 12-punches.

The RSU switch can be selected with pilot and co-selectors. This switch is independent of the R + (READ PLUS SIGN) switch.

R + (Read Plus Sign—C—6). This pair of horizontally adjacent hubs is a switch. When wired, a plus sign must be indicated by a 12-punch in the card for all words, including those wired to word-size 0. When not wired, the machine automatically supplies a plus sign on any words that do not have the minus sign indicated by an 11-punch. The R + switch can be selected with pilot or co-selectors.

Sign Entry—C—4. These 10 hubs are the sign-entry hubs for the 10 words of storage entry. They are active when RSU is not wired. Each hub is associated with its respective storage-entry word. If these hubs receive an 11-impulse the associated word receives a minus sign. When R + is wired, these hubs must receive a 12-im pulse to give the associated word a positive sign. In summary:

1. If neither RSU nor R + is wired,
   a. The units position of each storage-entry word will not accept sign (11-12) impulses.
   b. Only negative signs must be indicated.
   c. Sign-entry accepts the negative sign impulse (11).
2. If both RSU and R + are wired,
   a. Sign-entry is inactive.
   b. Both positive and negative signs must be indicated.
   c. The units position of each storage-entry word accepts both sign impulses (11-12).
3. If only RSU is wired,
   a. Sign-entry is inactive.
   b. Only negative signs must be indicated.
   c. The units position of each storage-entry word accepts the negative sign impulse (11).
4. If only R + is wired,
   a. The units position of each storage-entry word does not accept sign (11-12) impulses.
   b. Both positive and negative signs must be indicated.
   c. Sign-entry accepts both sign impulses.
5. Alphabetic words (special device) automatically receive a positive sign.

RVC (Read Validity Check—A—6). This pair of vertically adjacent hubs is a switch. When wired, the input validity check feature is made inactive. This switch can be selected with pilot and co-selectors. The read validity check is also made inactive by impulsing LOAD.

Wiring Examples (Figures 51 and 52). Because the 407 has only one set of storage entry hubs as compared to the three sets (A, B, C) on the 533 and 537, selectors must be used when more than one card format is used to enter information. Figure 51 is a method of entering three card formats using pilot and co-selectors. Figure 52 is a method using progressive selectors.

Wiring for Figure 51:

1. Pilot selectors 1-5 are conditioned to hold until the end of a card-feed cycle (FC).
2. The X in column 28 (type 1 card), when read at the first reading station, impulses pilot selector 1. The selector transfers on the next card-feed cycle as the type 1 card is being read at second reading.
3. Co-selectors 1-2 are transferred during the same cycle as pilot selector 1.
4. The information from card columns 21-26 enters the transferred side of co-selectors 1-2, which

routes it from the common side of the selectors to STORAGE-ENTRY, WORD 1.

5. Word-size-emitter 6 enters the transferred side of pilot selector 1, which routes it to word-size-entry, word 1. This enters zeros to the left of the information from card columns 21-26.

6. The X in column 30 (type 2 card), when read at the first reading station, impulses pilot selector 2. This selector transfers on the next card-feed cycle as the type 2 card is read at second reading.

7. Co-selectors 3-4 are transferred during the same cycle as pilot selector 2 (type 2 card at second reading).

8. The information from card columns 9-15 enters the transferred side of co-selectors 3-4, which routes it to the normal side of co-selectors 1-2 and then to storage entry, word 1.

9. Word-size-emitter 7 enters the transferred side of pilot selector 2, which routes it through the normal side of pilot selector 1 to word-size-entry, word 1. This enters zeros to the left of the information from card columns 9-15.

10. When a type 3 card passes first reading, no selectors are impulsed. Therefore, the selectors are normal when this card passes second reading. The information from card columns 43-50 will be entered into storage entry, word 1.

11. Word-size-emitter 8 enters the normal side of pilot selector 2, passes through the normal side of pilot selector 1 to word-size-entry, word 1. This enters zeros to the left of the information from card columns 43-50.

12. Word-size-emitter 0 is wired to word-size-entry, words 2-10. This fills the unused entry words with zeros.

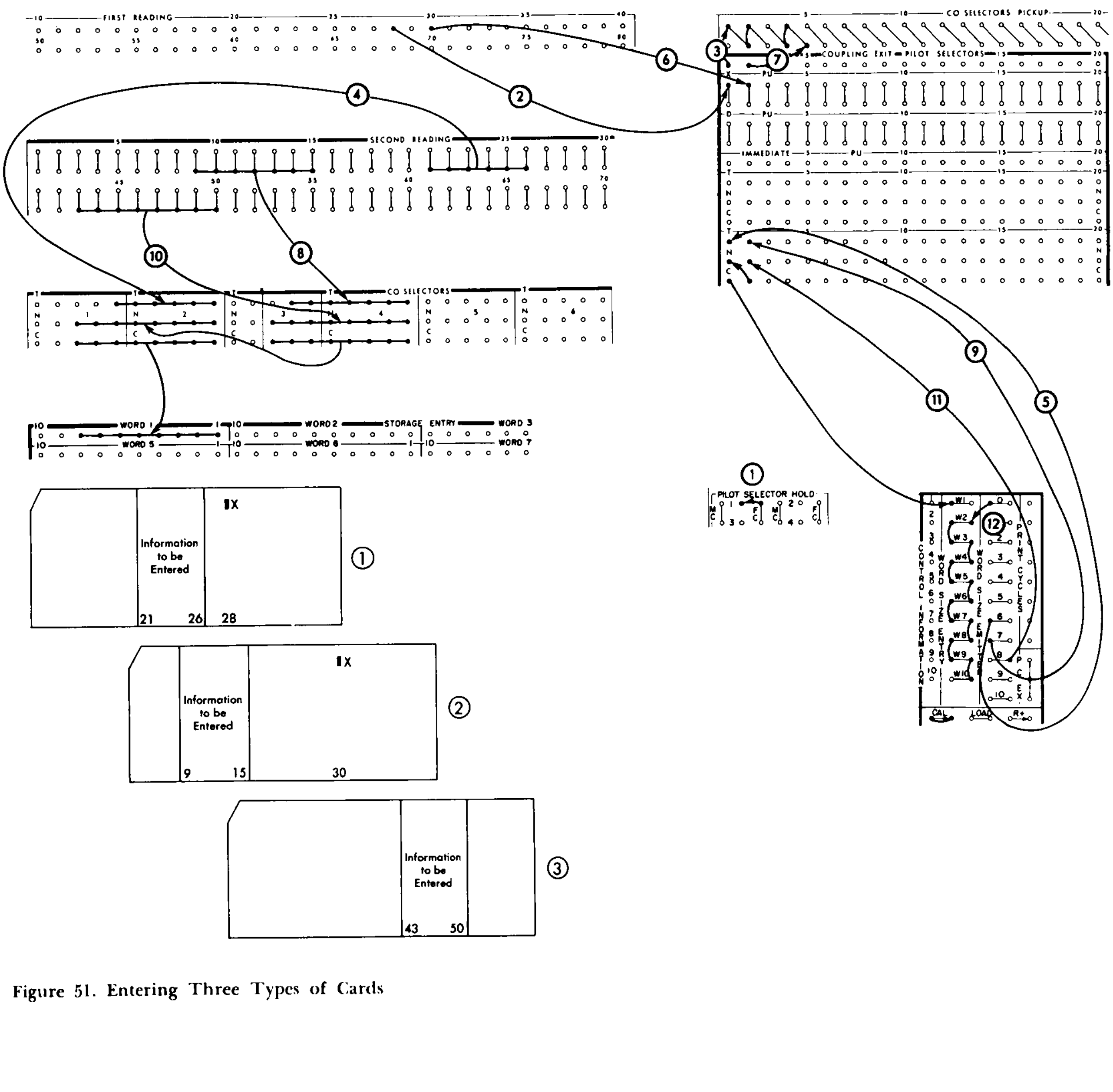


Figure 51. Entering Three Types of Cards

Wiring for Figure 52:

1. Pilot selector hold is the same as in the previous example.
2. The selection of the word-size-emitter impulses is the same as in the previous example.
3. The function of X28 and X30 is the same as the previous example.
4. A type 1 card (X28) causes pilot selector 1 to be transferred. The card cycles impulse is routed through the transferred side of pilot selector 1 to pick up line 1 of the progressive selector.
5. The information from card columns 21-26 is routed through line 1 of the progressive selector to storage-entry, word 1.
6. A type 2 card (X30) will cause pilot selector 2 to be transferred. The card cycles impulse is routed through the normal side of pilot selector 1 and the transferred side of pilot selector 2 to pick up line 2 of the progressive selector.
7. The information from card columns 9-15 is routed through line 2 of the progressive selector to storage-entry, word 1.
8. A type 3 card has no effect on pilot selectors 1-2. The card-cycles impulse is routed through the normal side of both pilot selectors to pick up line 3 of the progressive selector.
9. The information from card columns 43-50 is routed through line 3 of the progressive selector to storage-entry, word 1.

Storage Exit—P—3,4. These hubs are the exits from an output-synchronizer. The specific output area is determined by cable connections at the 655 Power Unit. Each word has 10 exit hubs, one for each position of the word. They emit information under control of the WR Op codes (71, 74, 77).

Sign Print Exit—P—4. These hubs are the sign-exits for their respective words (1-10). Whenever the sign of a storage-exit word is negative, its associated sign-print-exit emits an 11-impulse which can be used to print a minus sign. If P + is wired, a 12-impulse is emitted for positive signs in addition to the 11-impulse for negative signs. Sign impulses are not emitted from the units position of any storage-exit word on the 407.

Sign Control Exit—P—4. Each of these 10 hubs is associated with a specific storage-exit word. If the sign of a word is minus, the associated sign-control-exit emits an impulse prior to printing time. This impulse can be wired to the IPU of a pilot or co-selector to control the selection of card-cycles, all-cycles, and print-cycles. It may also be used for format control of the information from the storage-exits. The sign-control-exit impulse cannot be used to impulse progressive selector couple, non-print or transfer print.

P + (Print Plus—P—6). When this switch is wired, a 12-impulse is emitted from any sign-print-exit whose associated storage-exit word is positive. This impulse can be used to print the positive identification.

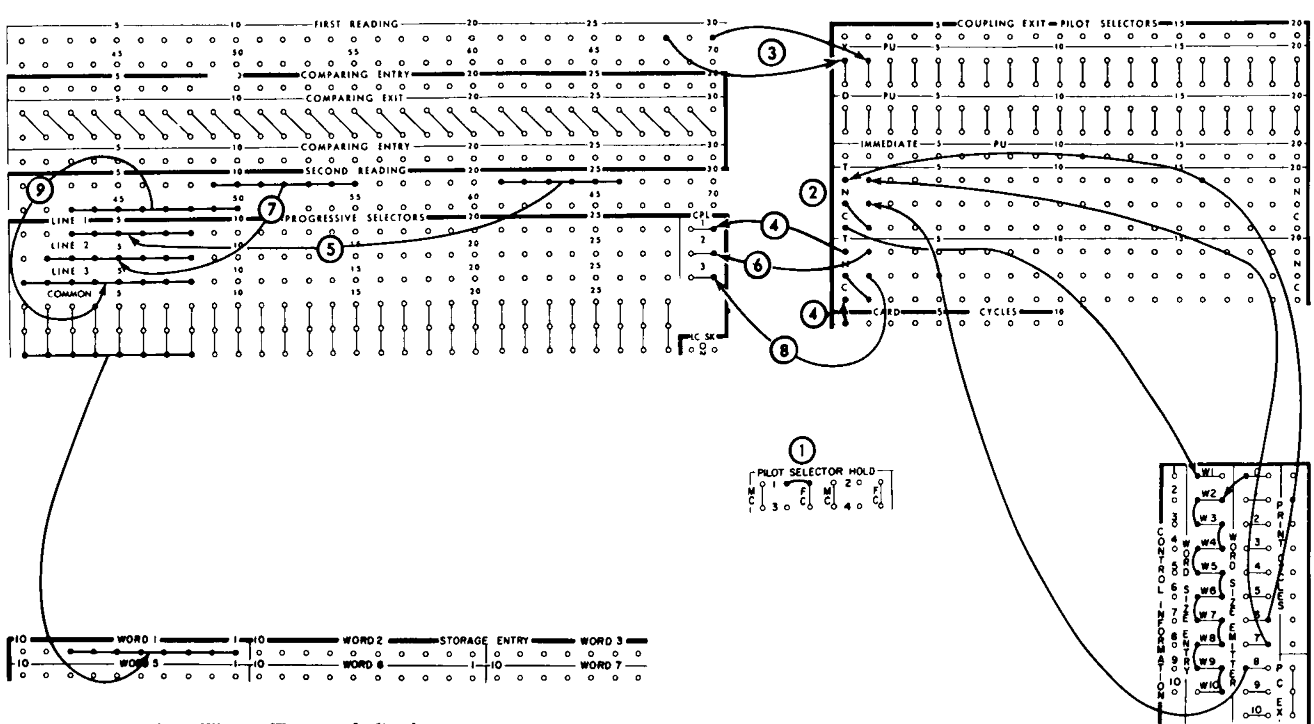


Figure 52. Entering Three Types of Cards

Wiring Example (Figure 53). This example illustrates format control using sign-control-exit.

Positive amounts from output word 2 are printed in positions 31-36 without sign identification. Negative amounts from output word 2 are printed in positions 21-26 with sign identification in position 27.

1. If output word 2 is negative, sign-control-exit 2 emits an impulse prior to printing time, to pick up co-selectors 4 and 5. These selectors remain transferred throughout this print cycle.
2. The information from output word 2 is routed through the transferred side of the selectors to print positions 21 through 26.
3. The negative sign impulse (11) goes to print position 27 to identify negative amounts.
4. When output word 2 is positive, the information is routed through the normal side of the selectors to print positions 31 through 36. Co-selectors 4 and 5 are normal because no impulse is emitted from sign-conrtol-exit on positive information.

Control Information—P—5. These hubs emit an impulse, prior to printing time, if there is a digit 8 in the corresponding position of storage-exit, word 10. If there is any digit other than 8 in a particular position, no impulse is emitted.

Print Cycles—P—5. These hubs emit on any print cycle initiated by a WR code (71, 74, 77). The impulse can be used for transfer print, counter entry and exit controls, progressive selectors, etc.

PC EX (Print Cycle Exit—P—5). These three common hubs emit an impulse, prior to printing time, on any print cycle initiated by a WR code (71, 74, 77). This impulse can be used to control pilot and co-selectors.

PVC (Print Validity Check—P—6). During a print operation, the information coming from the output synchronizer to storage-exit is checked for validity. If an invalid character is detected, 650 program execution stops on the next WR instruction for that synchronizer. The PVC switch, when wired, makes this check inoperative. This switch can be selected.

D-8 Skip—A—4. These are entries to control forms skipping. They accept only a digit 8 impulse (control-information cannot be used). Four hubs are provided to initiate skipping to carriage tape channels 1-4, respectively. Skipping takes place after the line has been printed.

Carriage Skip X and D—P—1. The standard 407 X- and D-skip hubs for channels 1-4 have been modified to permit skipping on print cycles. Carriage skip X and D for channels 5-10 operate like a standard 407 and should be used to control skipping only during card-feed cycles.

A possibility exists, when two 407's are used together for printed output, that skipping operations will slow down output rates. A complete discussion of this is covered in 650 Bulletin 18, Form 328-0417.

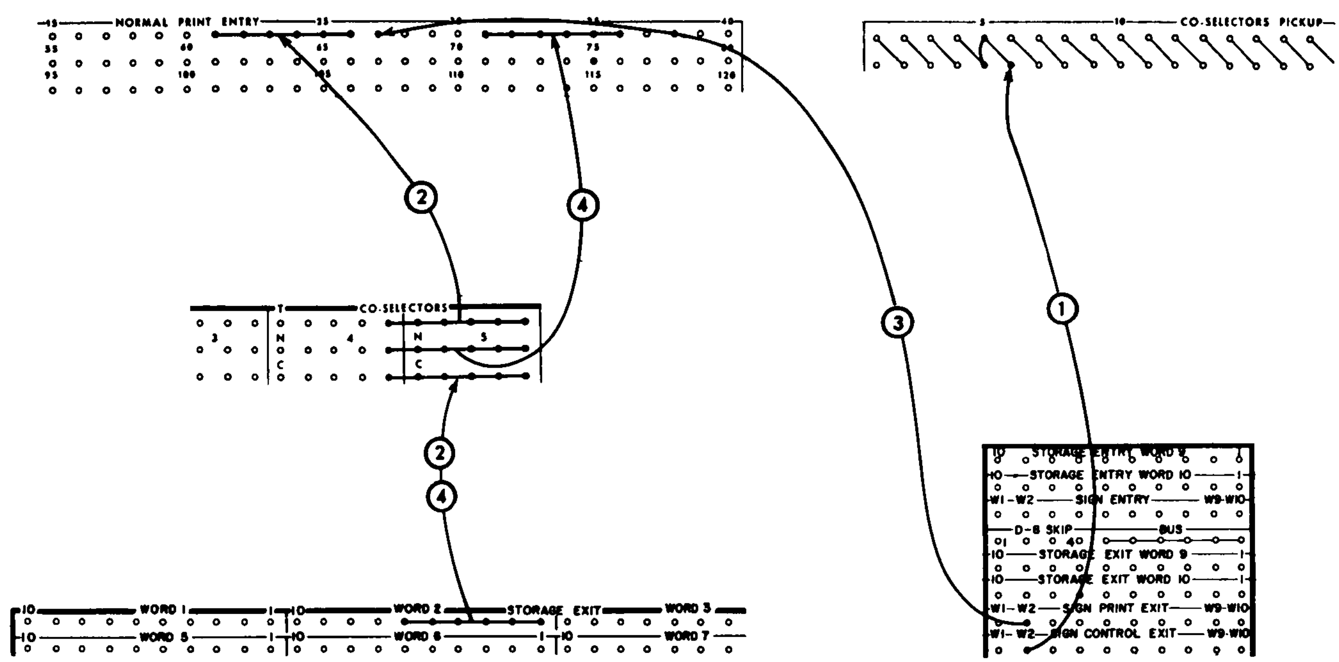


Figure 53. Format Control using Sign Control Exit

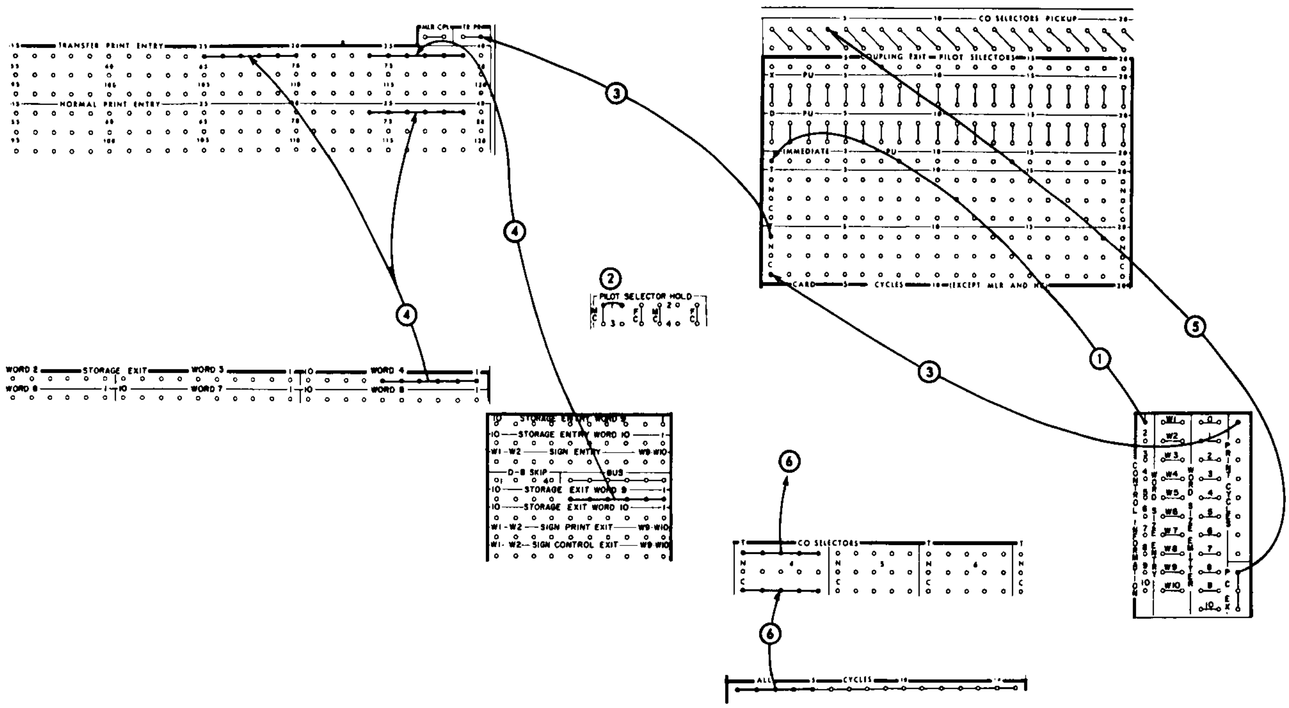


Figure 54. Format Control using Control Information

Wiring Example (Figure 54). This example shows format control using control-information and transfer print (pilot and co-selectors or progressive selectors could also have been used). Also shown is a method of expanding the number of print cycles impulses using PC EX.

If there is an 8 in the units position of output word 10, printing is to be done through transfer print entry. If no 8 is present, printing is to be through normal print entry.

1. An 8 in the units position of output word 10 results in an impulse from position 1 of control-information. This impulse comes before printing time and is used to pick up pilot selector 1.
2. Pilot selector 1 remains transferred for the duration of this print cycle.
3. A print cycles impulse is routed through the transferred pilot selector to activate transfer print. This makes TRANSFER PRINT entry active and normal print entry inactive.
4. The information from storage-exit, word 9 is printed in positions 34-39. The information from storage-exit, word 4 is printed in positions 25-30. Note that while storage-exit, word 4 is also wired to normal print entry 34-39, it is accepted only when transfer print is not impulsed.
5. The PC EX impulse is available on every 650-initiated print cycle. It is used to pick up co-selector 4. Co-selector 4 is transferred prior to the beginning of the all-cycles impulse.
6. The all-cycles impulse is routed through the transferred selector, which makes this impulse available only on 650-initiated print cycles. They can then be used in place of print-cycles impulses.

Load—A—6. These hubs accept any 12-impulse. The internal connection between the second reading station and the synchronizer storage area is set up one card-feed cycle after LOAD is impulsed. Therefore, LOAD is normally wired from first reading. The internal wiring automatically reads card columns 1-80 into synchronizer storage words 1-8. Card column 1 goes to the high-order position of word 1; column 2 to position 9 of storage-entry, word 1; column 3 to position 8 of storage-entry, word 1; etc. Storage-entry, words 9 and 10 automatically receive zeros and plus signs.

Impulsing LOAD activates the branching function of the RD or RC code on the cycle that the load card information is transferred from the input-synchronizer to general storage. The location of the instruction following the RD or RC is specified by the D-address of the instruction.

During the cycle when the load-card information is transferred from the input-synchronizer to general storage, RVC is made inactive.

Using The 407 for Output

To set up the 407 for an output-only operation:

1. Independent Operation switch OFF
2. Calculate switch wired
3. End-of-file switch ON
4. Press 407 start key.

This puts the 407 in a ready condition (continuously running). The End-of-File light is on throughout the operation.

Three types of 407 cycles are now possible:

1. Print Cycles—initiated by 650 instructions (71, 74, 77).
2. Program Cycles—initiated by impulsing program start on a print (71, 74, 77) cycle. A convenient method of impulsing program start is with control information.
3. Inactive Machine Cycles—because the 407 is in a ready condition, any cycle that is neither a print nor a program cycle is considered inactive. During these inactive cycles, many control-panel hubs are active:
   a. DI
   b. MC
   c. FC
   d. PROGRAM START
   e. ALPHABET (storage unit control)

   Therefore, when wiring the panel, use caution to prevent unwanted functions from occurring.

At the completion of an output-only operation, the 407 remains in a ready condition. To return the machine to normal:

1. Turn End-of-File switch OFF
2. Hold 407 Start key down until End-of-File light goes out.

Pilot Selectors

Pilot Selectors are normally picked up by wiring an early impulse (CONTROL-INFORMATION, SIGN CONTROL EXIT, etc.) to the IPU. This causes the selector to transfer at the beginning of the same print cycle. To hold the selector for this cycle only, MC should be used. If wired to FC, the selector remains transferred throughout the remainder of the operation.

In some applications it may be desirable to impulse a pilot selector during one print cycle and have it transferred during the next print cycle. Because there can be any number of inactive machine cycles between the two print cycles, special wiring to bridge the inactive cycles is necessary.

Wiring Example (Figure 55). This example illustrates a method of pilot-selector control that bridges any inactive machine cycles that occur between print cycles.

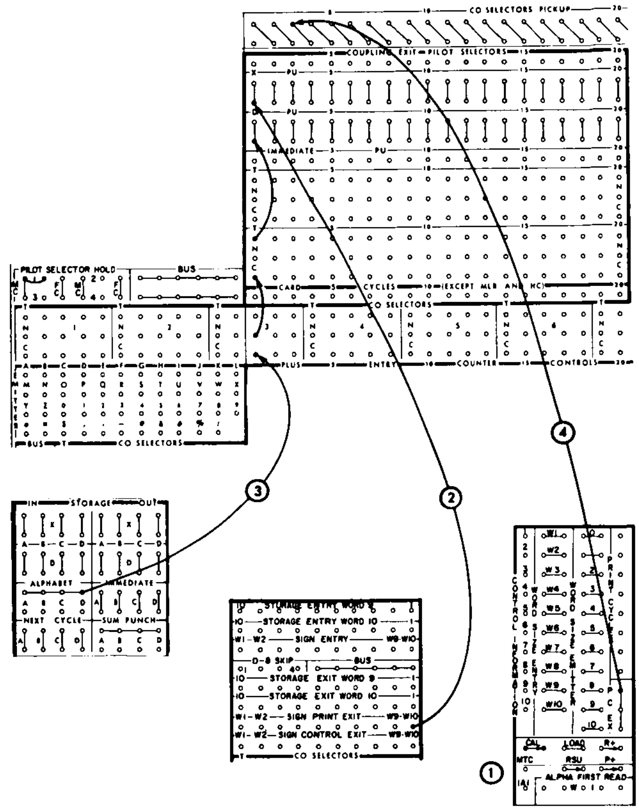


Figure 55. Pilot Selector Hold Control

If output word 10 is negative, pilot selector 1 is to be transferred on the next print cycle.

1. Because the P+ switch is not wired, sign-print-exit, word 10 will emit only when output word 10 is negative (11-impulse).
2. The negative-sign impulse for output word 10 is used to control pilot selector 1. Pilot selector 1 will not transfer on this print cycle (normal selector operation) but rather on the next machine cycle, which may be either another print cycle or an inactive machine cycle.
3. If the next cycle is an inactive machine cycle, the ALPHABET impulse is routed through the normal co-selector and the transferred pilot selector to the DPU of the pilot selector. This assures that the pilot selector will be transferred for another cycle. This continues for all ensuing inactive machine cycles.
4. On the next print cycle the PC EX impulse picks up co-selector 3 to prevent the repicking of pilot selector 1 with its DPU. However, if output word 10 is again negative, the XPU of pilot selector 1 will be impulsed.

Carriage Control

Skipping can be before or after 650 controlled line printing.

Wiring Example (Figure 56). This example illustrates 650 control of carriage skipping both before and after the output line is printed.

Two inches is the maximum skip that can take place before the line is printed and must be controlled as a short skip.

1. The carriage skips to tape channel 3 before printing the output line. Note that the short skip is also impulsed (maximum skip is 2 inches).
2. An 8 in position 9 of output word 10 causes the carriage to skip to tape channel 2 after the output line is printed. The broken line is an alternate wiring to accomplish the same function.
3. If output word 8 is negative, the carriage skips to tape channel 4 before the line is printed and to tape channel 1 after the line is printed.

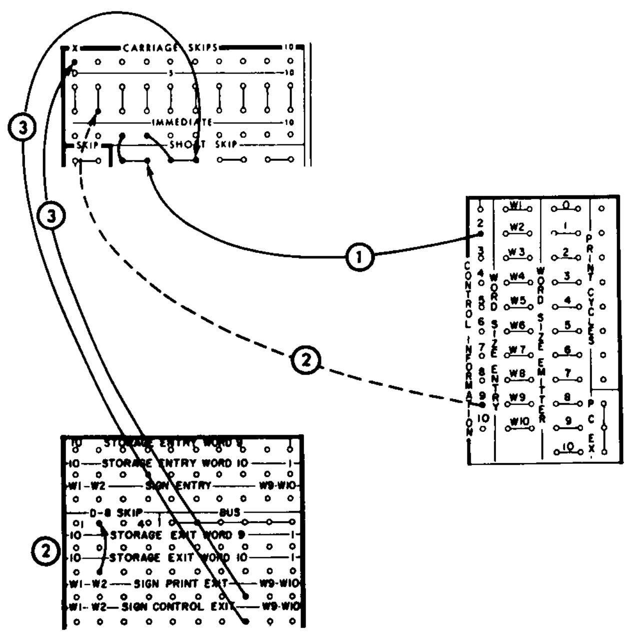


Figure 56. Carriage Control

Storage Units

It is possible to read information into a 407 storage unit during one print cycle, store it for any number of intervening cycles, and then read out and print this stored information under control of the 650.

Because of mechanical timing, information cannot be read into a storage unit during the same cycle that the controlling impulse occurs. Storage unit read-in occurs during the cycle following the controlling impulse. One possible method of controlling read-in is with programming:

0001	71-0027-0002	Dummy print cycle used to impulse storage unit read-in.
0002	71-0027-xxxx	Regular print cycle – read into storage unit.

When this method is used, the over-all output rate is reduced because of the dummy cycles. The same objective can be accomplished with control-panel wiring. This wiring can bridge any number of inactive machine cycles that occur between successive print cycles. The only program logic necessary is that it must be known during one print cycle that storage unit read-in will take place during the next print cycle, so that a controlling impulse can be supplied.

Storage unit read-out can occur during the same print cycle that the controlling impulse occurs.

Wiring Example (Figure 57). This figure illustrates a method of controlling storage unit read-in with control-panel wiring.

1. Control information 1 indicates that information is to be read into storage unit A on the next print cycle. Co-selector 2 is transferred only on the print cycle preceding the storage unit read-in.
2. Pilot selector 2 is transferred on every print cycle.
3. The alphabet impulse is routed through the transferred co-selector and transferred pilot selector to impulse storage unit A to read in on the next cycle (print or inactive machine). At the same time pilot selector 1 DPU is impulsed, which transfers pilot selector 1 on the next cycle (print or inactive machine).
4. If the next cycle is a print cycle, the information from storage-exit, word 4 is entered into storage unit A. Note that pilot selectors 1, 2 are both transferred and co-selector 2 is normal. Therefore, no paths exist for impulsing the X or DPU of pilot selector 1 or the next cycle of storage unit A.
5. If the next cycle is an inactive machine cycle, pilot selector 1 is transferred while pilot and co-selector 2 are normal. A path then exists for the alphabet impulse to re-impulse storage unit A read-in, and simultaneously, re-impulse pilot selector 1 through the DPU. Re-impulsing the DPU insures that pilot selector 1 will remain transferred throughout all intervening inactive machine cycles. The next print cycle results in the same conditions as existed in step 4.
6. Control information 10 impulses storage unit A to read out on the same cycle. The information from the storage unit is printed in positions 1-10.

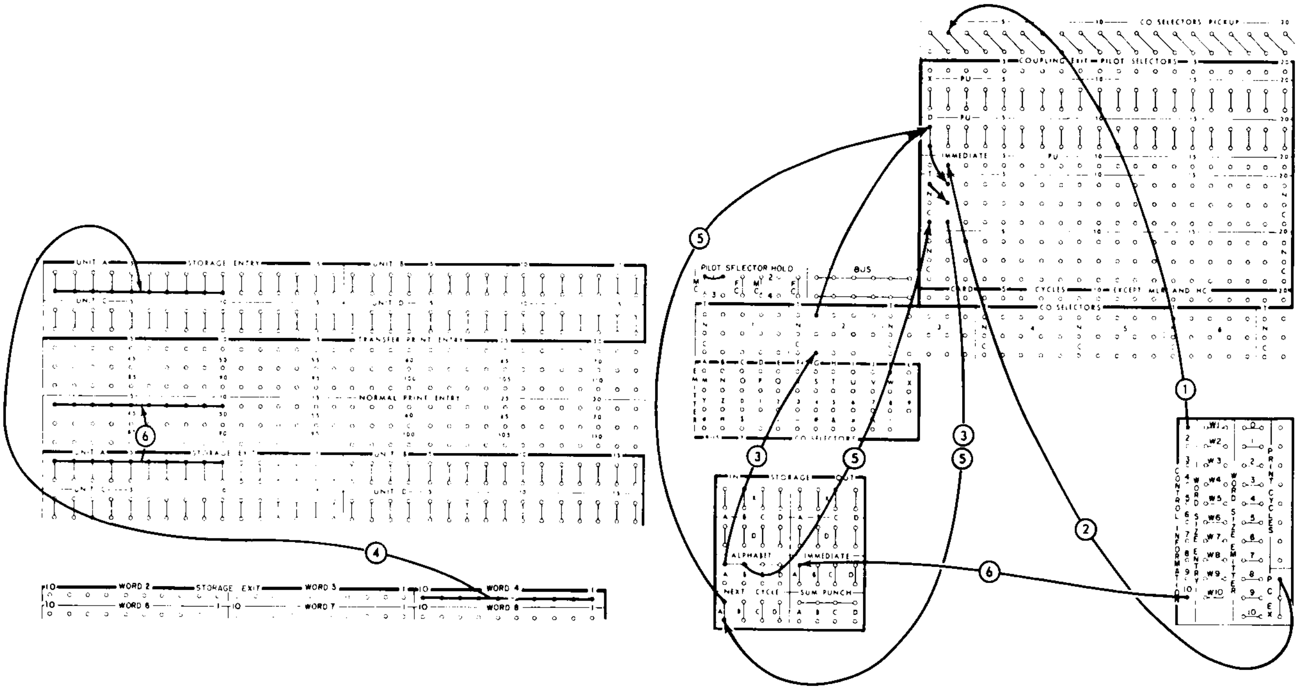


Figure 57. Controlling 407 Storage Units

Printing Special Characters Using Transfer Print
To print commas, decimals, and dollar signs through the *Transfer Print Entry,* the two methods shown in Figure 58 can be used:

METHOD 1

1. PC Ex impulses pilot selector 1.
2. COUPLE EXIT keeps TRANSFER PRINT active for the entire cycle.
3. The comma is printed in position 115 through TRANSFER PRINT ENTRY.

METHOD 2

4. CONTROL INFORMATION 1 is wired to co-selector 4 Pickup hub.
5. P+ is wired to a transfer hub of co-selector 4 and out of the common hub to the pickup of TRANSFER PRINT.
6. The comma is printed in position 115 through TRANSFER PRINT ENTRY.

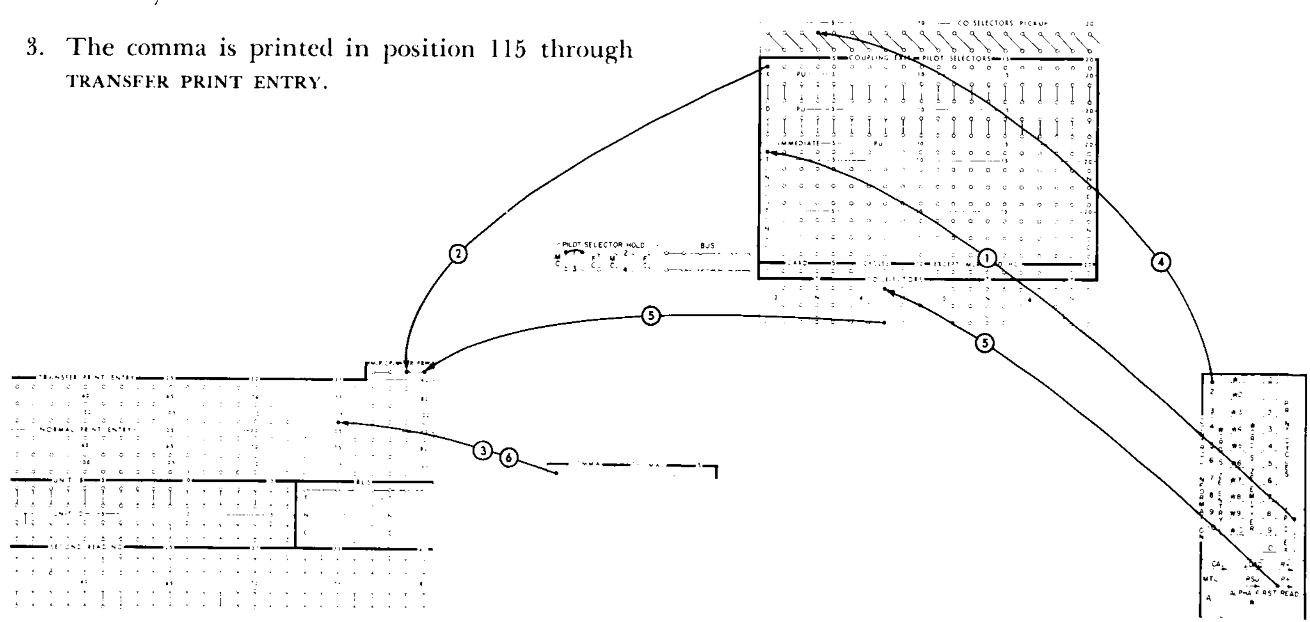


Figure 58. Two Methods of Special Character Printing Using Transfer Print

Emitted Page Headings

Page headings can be printed using the Character Emitter and Transfer Print Entry controlled by Overflow Program. First page headings are controlled by the Last Card Total switch.

The dotted wiring in Figure 59 is used when a Skip-to-2 is desired after the page heading. The solid wiring causes an extra space.

1. This switch wired makes FIRST CARD MINOR (3) active on the first page.
2. CARD-CYCLES activates transfer print through the first-card-minor selector.
3. FIRST CARD MINOR initiates an extra space or a Skip-to-2.
4. OVERFLOW initiates an overflow program.
5. OVERFLOW also initiates a delayed Skip-to-1 before printing the page heading.
6. OVERFLOW PROGRAM activates Transfer Print and Overflow End.
7. OVERFLOW COUPLE initiates an extra space or a Skip-to-2 (all pages except first).

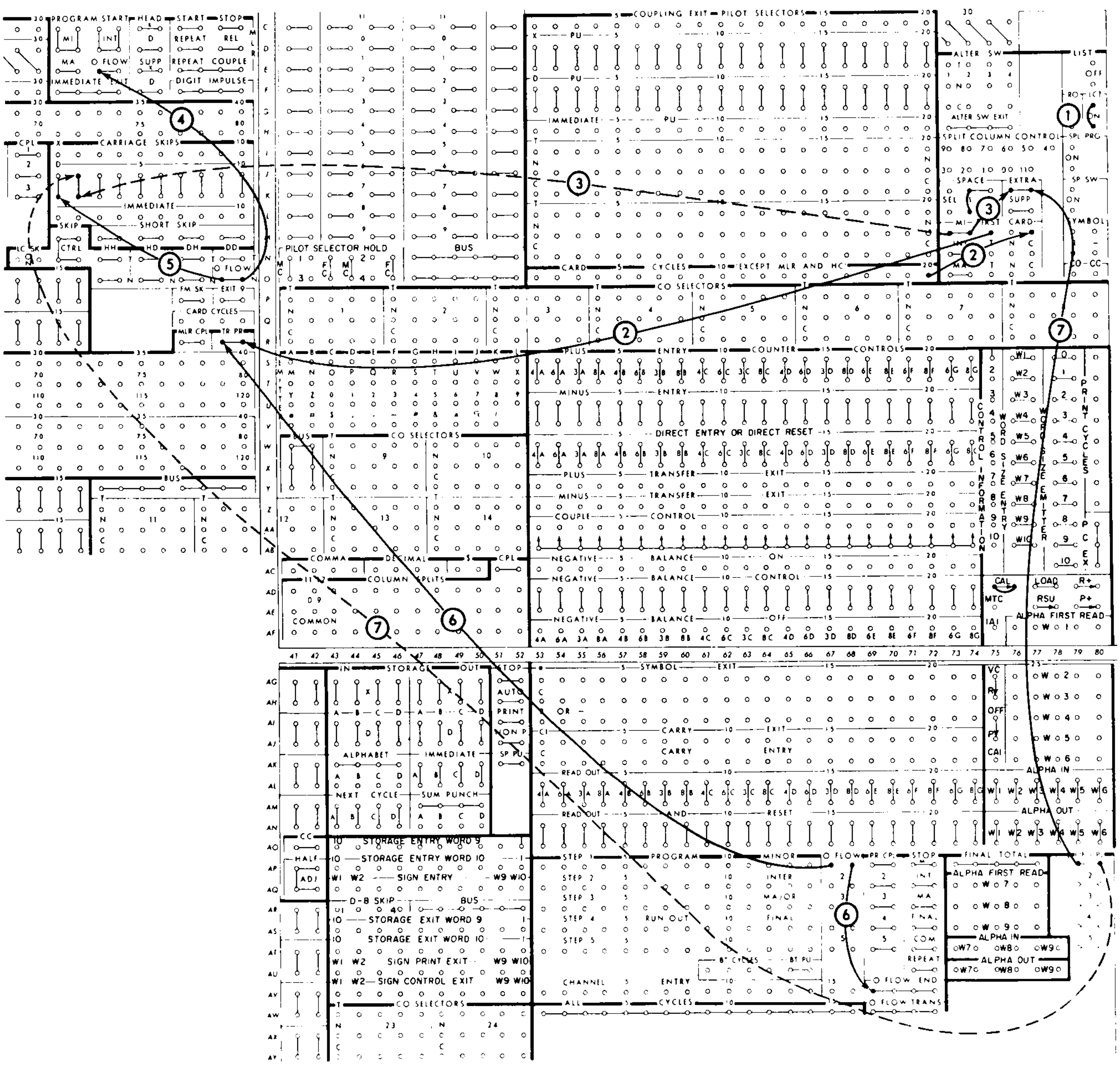


Figure 59. Emitted Page Headings

Using The 407 for Input

To set up the 407 for an input-only operation:

1. Independent operation switch OFF
2. Calculate switch wired
3. End-of-file switch OFF
4. Press 407 start key to initiate run-in.

At the completion of the run-in, the 407 is in a ready condition. The cards are in position as shown by Figure 60 with the information from card A in the input synchronizer. When the first RD command is executed the 650 will:

1. Transfer the information (card A) from the input synchronizer to general storage.

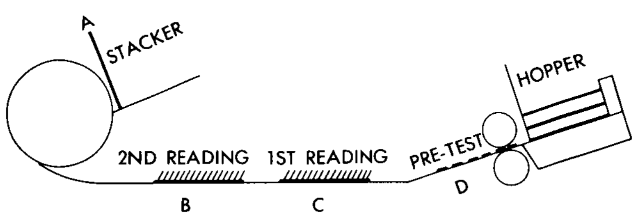


Figure 60. 407 Run-In

2. Initiate a mechanical card-feed cycle. During the first half of this cycle, card B is read into the input synchronizer and card D is advanced from the hopper to the pre-test station.
3. On the second half of the feed cycle card B is moved into the stacker, card C is moved to the second reading station and card D is moved to the first reading station (Figure 61).

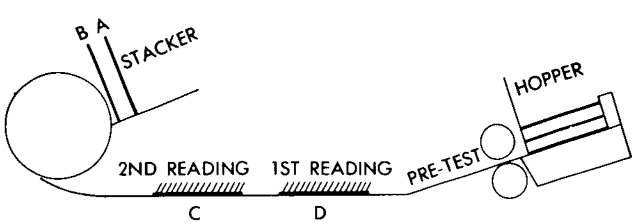


Figure 61. 407 Read Cycle

Entering Information from First Reading

If information is to be entered into the 650 from the first card, using first reading, a blank card must precede the first data card.

End-of-File

After the last card has been fed from the hopper, 650 program execution is halted on the next RD command.

At this point three cards remain unprocessed. To process these cards:

1. Turn end-of-file switch ON.
2. Press 407 start key. If this key is pressed before the end-of-file switch is turned ON, the remaining cards are run out of the machine without being processed.

After the last card has been processed, the 407 remains in a ready condition with the end-of-file light on. To return the machine to normal:

1. Turn end-of-file switch OFF.
2. Hold 407 start key down until end-of-file light goes out.

Using The 407 for Combined Input-Output

To set up the 407 for a combined operation:

1. Independent operation switch OFF.
2. Calculate switch wired.
3. End-of-file switch OFF.
4. Cards in hopper.
5. Press 407 start key to initiate run-in.

At the completion of the run-in, the same conditions exist that existed for input-only. Figure 62 is the analysis of a sample program and a block diagram of a combined input-output operation using the 407.

NOTE: There is a two-cycle delay between reading a card, and printing the results of processing that card.

End-of-File

When the last card leaves the 407 hopper, 650 program execution stops on the next WR command (for that unit) without executing the command. This command would have printed the results of the third-from-last card. To process the remaining cards:

1. Turn end-of-file switch ON.
2. Press 407 start key.

If the start key is pressed prior to turning the end-of-file switch on, the remaining cards are run into the stacker without being processed.

The WR command that prints the results ot the next-to-last card also causes a mechanical card-feed cycle. During this cycle there is no card at the second reading station and blanks are entered into the input synchronizer. When the program returns to the RC command, the blanks are transferred to general storage, and program execution stops if RVC is not made inactive for this cycle.

Location of Instruction	Instruction			Operation Abbrev
	OP	Data	Instruction	
	INITIALIZE			
0001	70	0051	0002	RD 1
0002	XX	PROCESS ROUTINE		
		STORE FOR PRINTING		
	20	0027	0101	STL
		READ AND PRINT		
0101	72	0061	0102	RC 1
0102	71	0027	0002	WR 1
		END OF FILE ROUTINE		
0061	71	0027	0000	WR 1
0000	01	XXXX		HLT

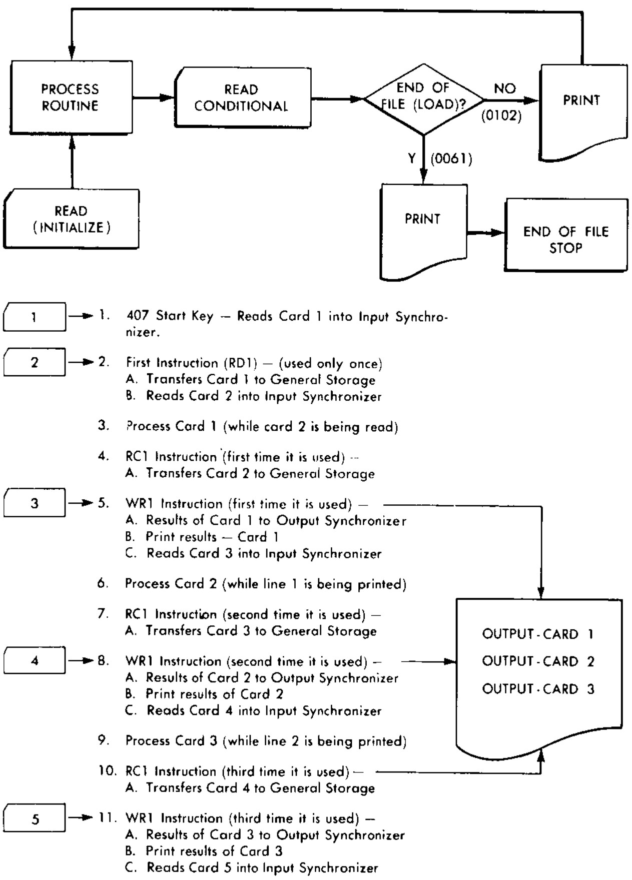


Figure 62. Combined 407 Input-Output and End-of-File

Wiring Example (Figure 63). This example (based on Figure 62) illustrates a method of inactivating RVC and setting up and end-of-file stop:

1. It is assumed that column 80 of every card has some digit (0-9) punch. This keeps pilot selector 1 transferred whenever there is a card at first reading.

2. Once impulsed, pilot selector 1 remains transferred throughout the remainder of the card-feed cycle.

3. When no card is present at first reading (last card at second reading) pilot selector 1 is normal

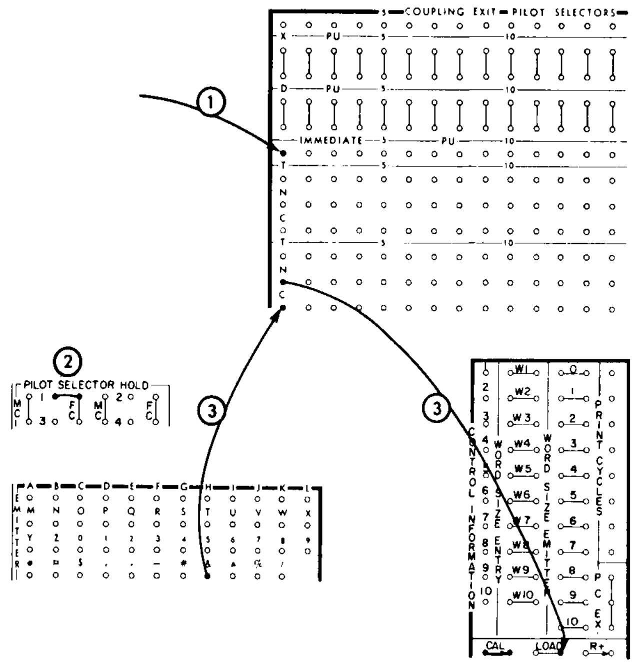


Figure 63. Transfer to End-of-File

and the 12-impulse from the character emitter is routed to LOAD. Because LOAD is impulsed, RVC is inactive on the cycle when the blanks are transferred from the input synchronizer to general storage by the RC command. Also because LOAD is impulsed, the D-address of the RC instruction is the location of the next instruction. This is the beginning of the end-of-file routine.

Wiring Example (Figure 64). This example illustrates the transfer to End-of-File when the last card is an MLR card.

1. It is assumed that column 40 of every card has some digit (0-9) punch. This keeps pilot selector 1 transferred whenever there is a card at first reading.

2. The MLR COUPLE impulse keeps pilot selector 2 transferred on all MLR cycles.

3. When the last card is at Second Reading, the 12-impulse is routed to LOAD which inactivates RVC and activates the branching function of the RC command.

4. Once impulsed, the pilot selectors remain transferred throughout the remainder of the card-feed cycle.

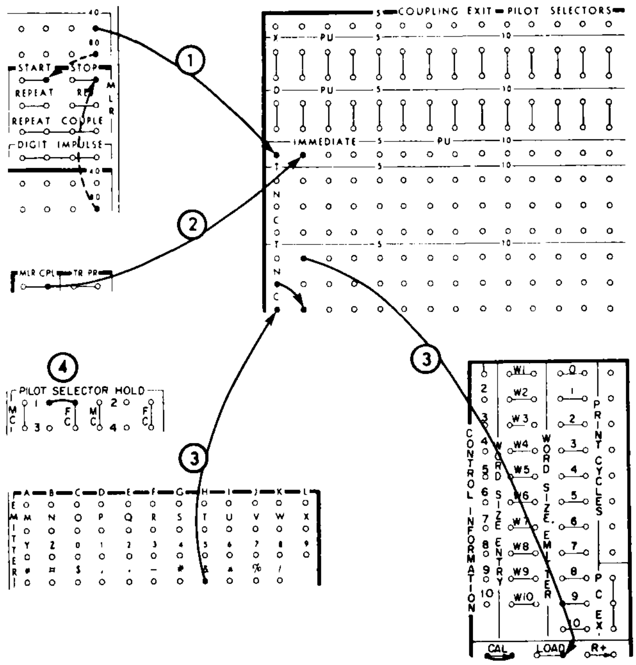


Figure 64. Transfer to End-of-File (MLR)

Printing Indicative Information

Some of the information read from the data card(s) is not used in processing, but identifies the results of processing. This indicative information can be entered into the system along with the data to be processed, transferred from the input area to the output area, and printed along with the results.

If the amount of data to be processed is such that no extra storage space is available within the 650, the storage devices (counters, storage units) of the 407 can be used for indicative information.

Figure 62 shows that during the cycle that any one card is being read, the results of the card read 2 cycles previously are being printed. If the indicative information is to be printed on the same line with the results, it must be stored. The general sequence of steps is:

FIRST CYCLE — Read data into 650; read indicative information into 407 storage.

SECOND CYCLE — Process data from first read cycle; hold indicative information in 407 storage.

THIRD CYCLE — Print results of processing; read-out indicative information from 407 storage to print on same line.

Storing in Counters. If the indicative information is all numerical, it can be stored in counters. Three separate counter groups and controlling pilot selectors are required to achieve the necessary delay between reading and printing. Figure 65 shows the function of each group on various cycles. The detailed control-panel wiring to accomplish these functions is shown in Figure 67.

CARD FEED CYCLE	1 RUN-IN	2	3	4	5	6	7	8
READ CARD 2nd READING	1	2	3	4	5	6	7	8
PROCESS CARD	–	1	2	3	4	5	6	7
PRINT CARD	–	–	1	2	3	4	5	6
COUNTER GROUP A	READ-IN FROM CARD 1	STORE CARD 1	READ-OUT CARD 1	READ-IN FROM CARD 4	STORE CARD 4	READ-OUT CARD 4	READ-IN FROM CARD 7	STORE CARD 7
COUNTER GROUP B	–	READ-IN FROM CARD 2	STORE CARD 2	READ-OUT CARD 2	READ-IN FROM CARD 5	STORE CARD 5	READ-OUT CARD 5	READ-IN FROM CARD 8
COUNTER GROUP C	–	–	READ-IN FROM CARD 3	STORE CARD 3	READ-OUT CARD 3	READ-IN FROM CARD 6	STORE CARD 6	READ-OUT CARD 6

Figure 65. Storing Indicative Information in Counters

Storing in Storage Units. If the indicative information is all or partially alphabetic, 407 storage units can be used. Each 407 storage unit can store a maximum of eight alphabetic characters or sixteen numerical characters. Three separate storage-unit groups and controlling pilot selectors are required to achieve the necessary delay between reading and printing. Figure 66 shows the function of each group on various cycles. The detailed control-panel wiring to accomplish these functions is shown in Figure 68.

CARD FEED CYCLE	RUN-IN 1st CARD AT 1st READ	1 RUN-IN	2	3	4	5	6	7
READ CARD 2nd READING	–	1	2	3	4	5	6	7
PROCESS CARD	–	–	1	2	3	4	5	6
PRINT CARD	–	–	–	1	2	3	4	5
STORAGE UNIT A	IMPULSE TO READ-IN	READ-IN FROM CARD 1	STORE CARD 1	READ-OUT CARD 1 IMPULSE TO READ-IN	READ-IN FROM CARD 4	STORE CARD 4	READ-OUT CARD 4 IMPULSE TO READ-IN	READ-IN FROM CARD 7
STORAGE UNIT B	–	IMPULSE TO READ-IN	READ-IN FROM CARD 2	STORE CARD 2	READ-OUT CARD 2 IMPULSE TO READ-IN	READ-IN FROM CARD 5	STORE CARD 5	READ-OUT CARD 5 IMPULSE TO READ-IN
STORAGE UNIT C	–	–	IMPULSE TO READ-IN	READ-IN FROM CARD 3	STORE CARD 3	READ-OUT CARD 3 IMPULSE TO READ-IN	READ-IN FROM CARD 6	STORE CARD 6

Figure 66. Storing Indicative Information in Storage Units

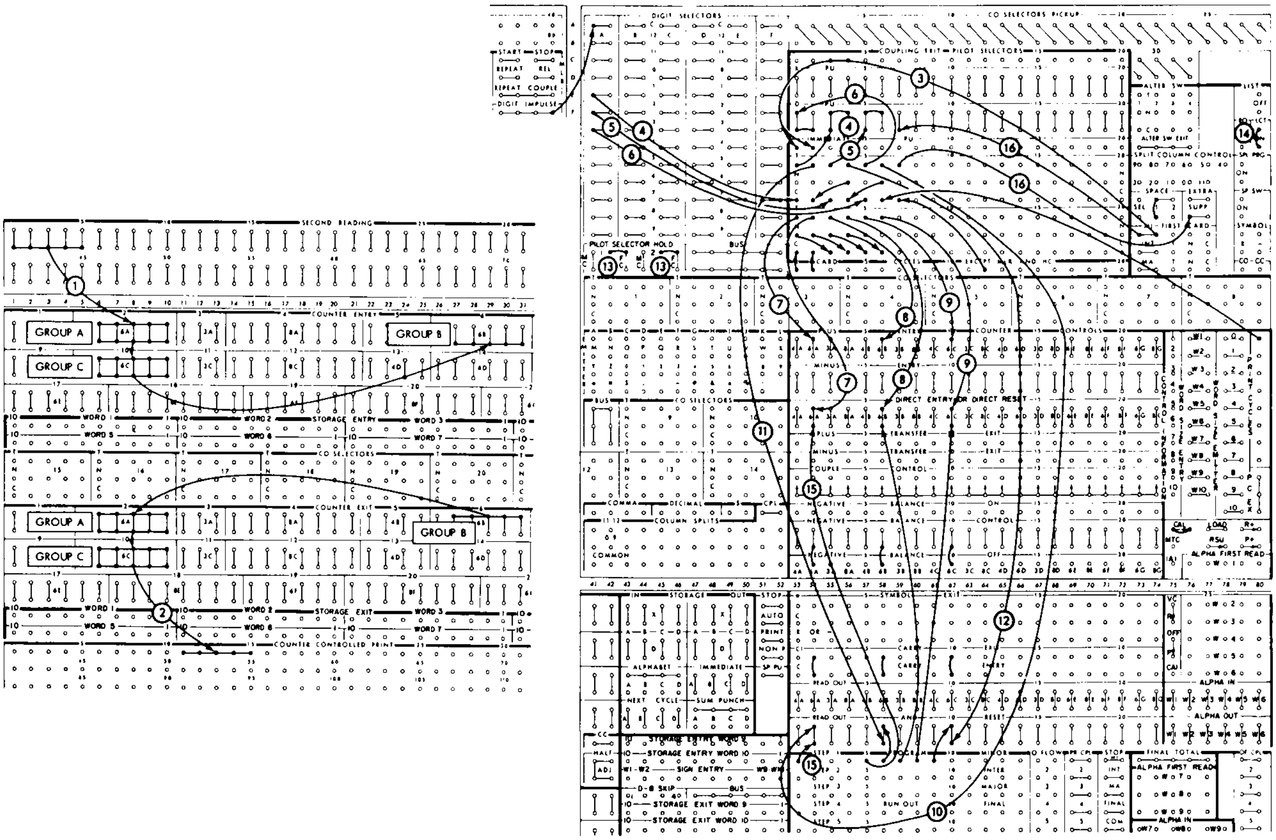


Figure 67. Storing Indicative Information in Counters

Wiring Example (Figure 67).

1. Indicative information is wired to three counters from second reading.
2. Counter exits are wired to counter-controlled print.
3. The first card minor impulse causes pilot selectors 1 and 2 to transfer when the first card is at second reading.
4. An emitted digit impulse passes through the transferred side of pilot selector 1 to the DPU of pilot selectors 3 and 4 and causes them to transfer one cycle later.
5. An emitted digit impulse passes through the transferred side of pilot selector 3 to the DPU of pilot selectors 5 and 6 and causes them to transfer one cycle later.
6. An emitted digit impulse passes through the transferred side of pilot selector 5 to the DPU of pilot selectors 1 and 2 and causes them to transfer one cycle later.
7. Counter group A adds (direct entry) when pilot selectors 1 and 2 are transferred (1st, 4th, 7th . . . cycles).
8. Counter group B adds (direct entry) when pilot selectors 3 and 4 are transferred (2nd, 5th, 8th . . . cycles).
9. Counter group C adds (direct entry) when pilot selectors 5 and 6 are transferred (3rd, 6th, 9th . . . cycles).
10. Counter group A reads out and resets on the 3rd, 6th, 9th . . . cycles.
11. Counter group B reads out and resets on the 1st, 4th, 7th . . . cycles.
12. Counter group C reads out and resets on the 2nd, 5th, 8th . . . cycles.
13. Pilot selectors 1 through 10 are wired to FC hold.
14. Last card total switch is wired ON to give program cycles on the run-in.
15. Counter groups A, B, and C are wired for direct reset on a minor total to suppress counter printing on the run-in and run-out.
16. A first card minor impulse is wired to the DPU of pilot selector 7. A card cycle passes through the transferred points of this selector to space-suppress to prevent spacing before the first WR instruction is executed.

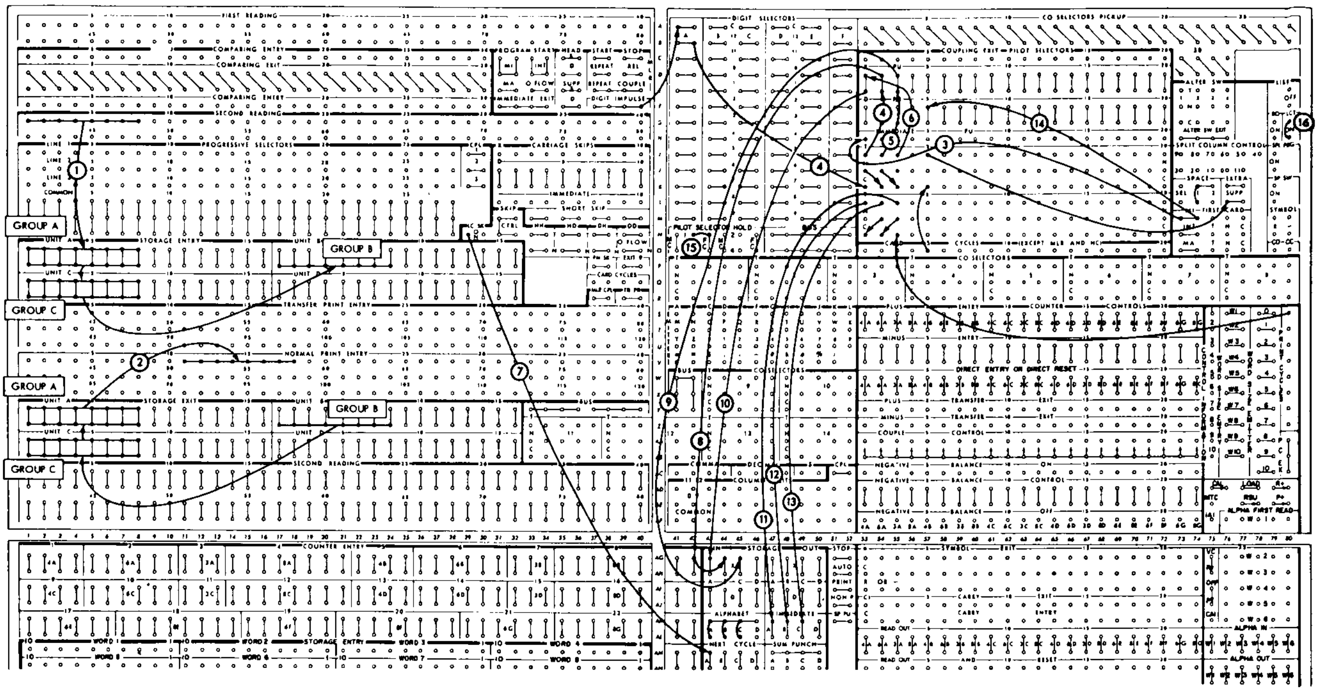


Figure 68. Storing Indicative Information in Storage Units

Wiring Example (Figure 68).

1. Indicative information is entered into storage units from second read. (This wiring is for eight positions of alphabetic. If sixteen positions of numerical are to be handled, the storage units would not be controlled for alphabetic read-in.)
2. Storage exits are wired to normal print entry.
3. A first card minor impulse to the IPU of pilot selector 1 transfers the selector when the first card is read at second read.
4. An emitted 12-impulse passes through the transferred points of pilot selector 1 to the XPU of pilot selector 2. This transfers the selector one cycle later.
5. An emitted 12-impulse passes through the transferred points of pilot selector 2 to the XPU of pilot selector 3. This transfers the selector one cycle later.
6. An emitted 12-impulse passes through the transferred points of pilot selector 3 to the XPU of pilot selector 1. This transfers the selector one cycle later.
7. A LAST CARD SKIP impulse (emits when the first card is at the pre-test station and when the first card is at first read) impulses group A to read during the next cycles. Group A reads in when the first card is at second reading. (Thereafter, A is controlled to read in by wire 10.)
8. The 12-impulse that picks pilot selector 2 is also used to impulse group B to read in (x). Group B will read in at the same time that pilot selector 2 is transferred.
9. The 12-impulse that picks pilot selector 3 is used to impulse group C to read in (x). Group C will read in at the same time that pilot selector 3 is transferred.
10. The 12-impulse that picks pilot selector 1 is also used to impulse group A to read in (x). Group A will read in at the same time that pilot selector 1 is transferred.
11. Group A reads out when pilot selector 3 is transferred (two cycles after it reads in).
12. Group B reads out when pilot selector 1 is transferred (two cycles after it reads in).
13. Group C reads out when pilot selector 2 is transferred (two cycles after it reads in).
14. A first card minor impulse is wired to the DPU of pilot selector 5. A card cycles impulse passes through the transferred points of this selector to suppress spacing before the first WR Instruction is executed.
15. Pilot selectors 1 through 5 are wired for a FC hold.
16. Last card total switch is wired ON to activate FIRST CARD MINOR.

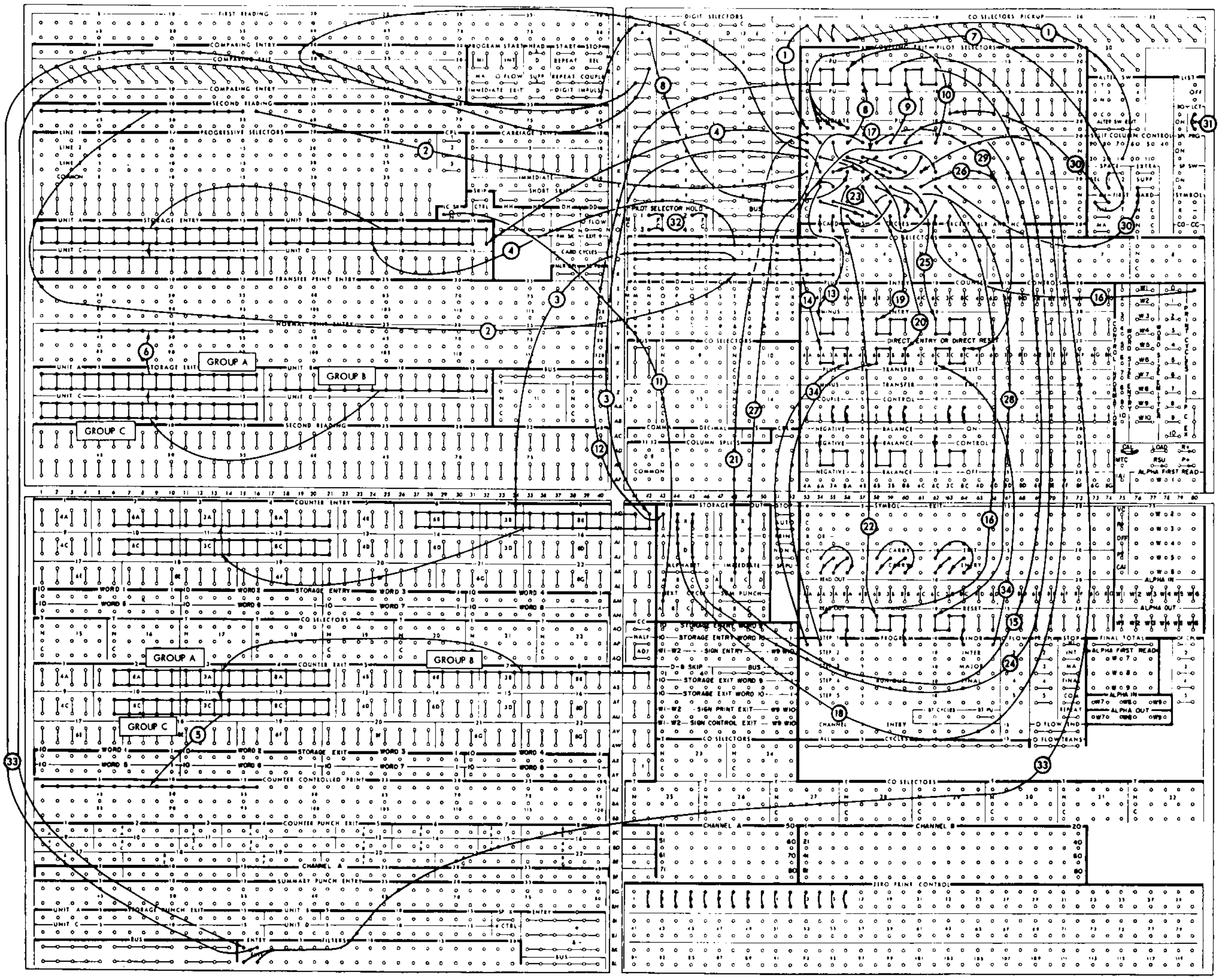


Figure 69. Storing Sixteen Alphabetic Characters

Storing Sixteen Characters of Indicative Alphabetic Information. Neither of the two previous methods can store over eight characters of alphabetic information. Figure 69 is a method that stores up to sixteen alphabetic characters using Storage Units for the zone and Counters for numerical.

Wiring Example (Figure 69).

1. A HALF-AFTER-1 impulse is used to transfer co-selectors 1 through 3, and pilot selector 1.
2. The alphabetic field is wired from second read to the C of co-selectors 1 through 3, and pilot selector 1.
3. Digit impulses 1-9 are wired from the N of the co-selectors to counter entry.
4. Zone impulses 0-12 are wired from the T of the selectors to storage entry.
5. Counter exits are wired to counter-controlled print entry.
6. Storage exits are wired to normal print entry.
7. A first card minor impulse is used to transfer pilot selectors 2 through 4.
8. A 12-impulse passes through the transferred points of pilot selector 4 to the XPU of pilot selectors 5 through 7. These pilot selectors transfer one cycle after pilot selectors 2 through 4 transfer.
9. A 12-impulse passes through the transferred points of pilot selector 7 to the XPU of pilot selectors 8 through 10. These pilot selectors transfer one cycle after pilot selectors 5 through 7 transfer.
10. A 12-impulse passes through the transferred points of pilot selector 10 to the XPU of pilot selectors 2 through 4. These pilot selectors transfer one cycle after pilot selectors 8 through 10 transfer.
11. A LAST CARD SKIP (emits as the first card is at the pre-test station and as the first card is at first read) impulses group A storage unit to read in

on the next cycle. Group A storage unit reads in from the first card at second read. Thereafter, group A storage unit is controlled to read in by wire 12.

12. The 12-impulse that picks pilot selectors 2 through 4 also impulses Group A storage unit to read in (x). Group A storage unit reads in at the same time selectors 2 through 4 transfer (4th, 7th . . . cycles).
13. Group A counters direct-subtract when pilot selector 2 is transferred (1st, 4th, 7th . . . cycles).
14. DIRECT ENTRY of group A counters is impulsed when the counter group subtracts.
15. A half-after-1 impulse passes through the transferred points of pilot selector 8 to impulse group A storage unit to read-out two cycles after it reads in. The half-after-1 is used so that storage exit impulses will not interfere with the reading-out of the counters.
16. A print cycles impulse passes through the transferred points of pilot selector 10 to read out and reset group A counters two cycles after they read in.
17. DIRECT RESET of group A counters is impulsed at half-after-1 and zero time of the counter readout and reset cycle so that zero impulses from the counter will not read out and interefere with corresponding storage exits.
18. The 12-impulse that picks pilot selectors 5 through 7 also impulses group B storage unit to read in (x). Group B storage unit reads in at the same time selectors 5 through 7 transfer (2nd, 5th, 8th . . . cycles).
19. Group B counters direct-subtract when pilot selector 5 is transferred (2nd, 5th, 8th . . . cycles).
20. DIRECT ENTRY of group B counters is impulsed when the counter group subtracts.
21. A half-after-1 impulse passes through the transferred points of pilot selector 2 to impulse group B storage unit to read-out two cycles after it reads in.
22. A print cycles impulse passes through the transferred points of pilot selector 4 to read out and reset group B counters two cycles after they read in.
23. DIRECT RESET of group B counters is impulsed at half-after-1 and zero time of the cycle that the counters read out and reset.
24. The 12-impulse that picks pilot selectors 8 through 10 also impulses group C storage unit to read in (x). Group C storage unit reads in at the same time selectors 8 through 10 transfer (3rd, 6th, 9th . . . cycles).
25. Group C counters direct-subtract when pilot selector 8 is transferred (3rd, 6th, 9th . . . cycles).
26. DIRECT RESET of group C counters is impulsed when the counter group subtracts.
27. A half-after-1 impulse passes through the transferred points of pilot selector 5 to impulse group C storage unit to read out two cycles after it reads in.
28. A print cycle impulse passes through the transferred points of pilot selector 7 to read out and reset group C counters two cycles after they read in.
29. DIRECT RESET of group C counters is impulsed at half-after-1 and zero time of the cycle that the counters read out and reset.
30. A first card minor impulse is wired to the DPU of pilot selector 11. A card cycles impulse passes through the transferred points of the selector to suppress spacing until a WR instruction is received from the 650.
31. The last card total switch is wired ON to give program cycles on the run-in and run-out.
32. Pilot selectors 1 through 15 are wired to FC hold.
33. This wiring is used to create an impulse whose duration is from half-after-1 through zero time. See items 17, 23, and 29.
34. Counter groups A, B, and C are wired for direct reset on minor total to prevent printing on the run-out.

Restart Procedures

Card-Feed-Stop Restart

A card-feed-stop is caused by failure to feed a card from the hopper (except run-out) on a card-feed cycle. It is signalled by the card-feed-stop light (Figure 46).

Input-Only. Program execution is halted on the D half cycle of the RD command following the cycle during which the feed failure occurred. The last two cards to enter the feed have not been processed and must be re-entered into the system. To restart:

1. Remove cards from hopper.
2. Run out cards using 407 start key.
3. After repairing damaged card, place last two cards from stacker in front of group removed from hopper.
4. Replace cards in hopper and press the 407 start key.

Input-Output. Program execution is halted on the D half cycle of the RC command following the cycle during which the feed failure occurred. Figure 70 shows the position of the cards. At the time program execution stops:

1. The processing of card B is complete and the results stored for printing.
2. The information from card C is in the input synchronizer.

To restart, use same procedure as for Input-Only.

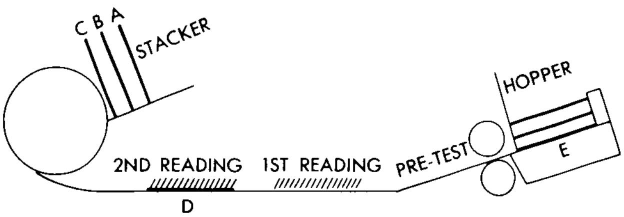


Figure 70. Position of Cards on Card-Feed Stop

RVC Restart

An RVC stop occurs when the 650 detects invalid information being transferred from an input synchronizer to general storage.

Input-Only. Program execution is halted on the D half cycle of the RD command during which the RVC occurs. A card-feed cycle is taken by the 407, but no reading takes place. The control console will show:

1. Data address light on.
2. Storage selection light on.
3. RD code (70, 73, 76) in operation lights.
4. Valid address in address lights.

To restart:

1. Remove cards from hopper.
2. Run out cards using 407 start key.
3. Correct error card. This is the fourth card from the back of the stacker.
4. Place corrected card and the three other unprocessed cards from the stacker in front of the cards removed from the hopper.
5. Replace cards in hopper.
6. Press error-reset key on control console.
7. Press 407 start key.
8. Press program-start key.

Input-Output. Program execution is halted on the D half cycle of the RC command during which the RVC occurs. Figure 71 shows the position of the cards. At the time program execution stops:

1. The processing of card B is completed and the results stored for printing.
2. A validity error has been detected on the information from card C as it was transferred from the input synchronizer to general storage.

To restart:

1. Remove cards from hopper.

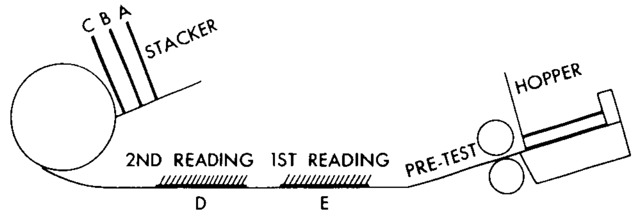


Figure 71. Position of Cards on RVC

2. Run out cards using 407 start key.
3. Correct error card. This is the third card from the back of stacker.
4. Place corrected card and the two other unprocessed cards from the stacker in front of the cards removed from hopper.
5. Replace cards in hopper.
6. Press error-reset key on control console.
7. Press 407 start key.
8. Press program-start key.

PVC Restart

A PVC stop occurs when the 650 detects invalid information being transferred from the output synchronizer to the storage-exits on the control panel.

Output-Only. Program execution is halted on the D half cycle of the WR command following the cycle during which the PVC occurs. The control console shows:

1. Data address light on.
2. Storage selection light on.
3. WR code (71, 74, 77) in opertion lights.
4. Valid address in address lights.

To restart:

1. De-clutch the carriage, and advance platen until last printed line is accessible.
2. Mark this line to indicate error has occurred.
3. Return platen to original position and engage carriage clutch.
4. Press error-reset key on control console.
5. Press program-start key on control console.

The error line should be examined and manually reconstructed at a later time. If the error is caused by dropped bits, no printing takes place in the position wired from the corresponding storage exit. If the error is caused by extra bits, the character printed depends upon the combination of bits in the synchronizer.

Input-Output. Same procedure as Output-Only.

Processing Fewer Than Four Cards

One Card

1. Place card in hopper.
2. Momentarily press 407 start key. This causes one feed cycle.

3. Turn end-of-file switch ON.
4. Press 407 start key. This results in entering information from this card into the input synchronizer. Processing is now under control of the 650 program.

Two Cards

1. Place cards in hopper.
2. Momentarily press 407 start key. This causes two feed cycles.
3. Turn end-of-file swicth ON.
4. Press 407 start key. This results in entering information from the first card into the input synchronizer. Processing is now under control of the 650 program.

Three Cards

1. Place cards in hopper.
2. Momentarily press 407 start key. All three cards are fed and information from the first card is entered into the input synchronizer.
3. Turn end-of-file switch ON.
4. Press 407 start key. Processing is now under control of the 650 program.

In any of these procedures, if the start key is held down before turning the end-of-file switch ON, the card(s) ıun through the feed without being processed.

End-of-File Routines for Multiple Input

End-of-file and end-of-job routines become more complex as the number of input units is increased. This discussion is based on a system in which three 533's (referred to in the accompanying flow chart, Figure 72, as 533-A, 533-B, and 533-C) are used to read three files.

When the last card of any file has been read, processing in the 650 can continue only if some provision is made for bypassing or modifying the RD instruction associated with the 533 which is out of cards. A load card placed at the end of the file can be used to transfer to the end-of-file routine. Columns 1-10 of the load card are normally punched 00 0000 XXXX, where XXXX is the location of the first instruction in an end-of-file subroutine. Transfer to the subroutine is effected by reading the load card, and instructions can be included in the subroutine to modify the RD instruction if return to the main routine is desired.

With three 533's reading three files, a typical end-of-file routine will provide for setting a switch when a given 533 is at an end-of-file condition. This switch prevents reading from that unit again. It is also necessary to include a test to determine whether all three units have reached end-of-file. A convenient technique for accomplishing this is to initialize three digit positions of a storage word with "9's" and to replace one of them with an "8" when a given 533 reaches end-of-file. This test word is used in conjunction with BD instructions to effect transfer to an end-of-job routine when all three 533's are at end-of-file. This is illustrated by the following program steps:

Location	*Op*	*Data*	*Inst.*
———	LDD	ssss	aaaa
aaaa	BD1	bbbb	nnnn
bbbb	BD2	cccc	nnnn
cccc	BD3	xxxx	nnnn

ssss = location of the test word
nnnn = location of the first instruction in the main routine
xxxx = location of the first instruction in the end-of-job routine

Control-panel wiring can be utilized instead of load-cards to provide an end-of-file signal. For example, a pilot selector can be picked up from first reading on every card; after the last card passes first reading, the selector returns to normal.

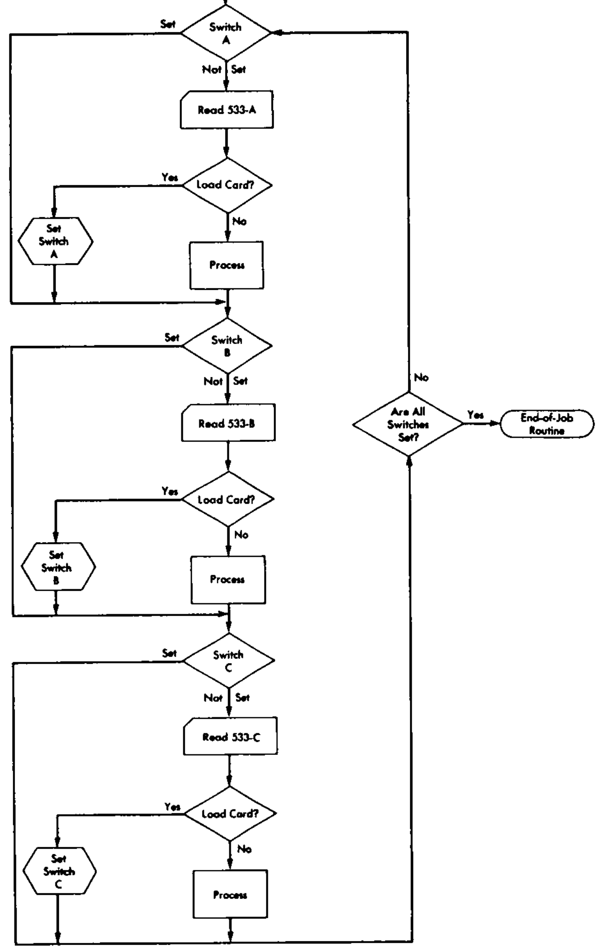


Figure 72.

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