G-15 TECHNICAL BULLETIN • EQUIPMENT SERIES

Scientific Services, Inc.
Commercial Trust Building
Fifteenth and Market Streets
Philadelphia 2, Pennsylvania
LOcust 3-3277

12-61

ACCESSORY CA-2

PUNCHED CARD COUPLER

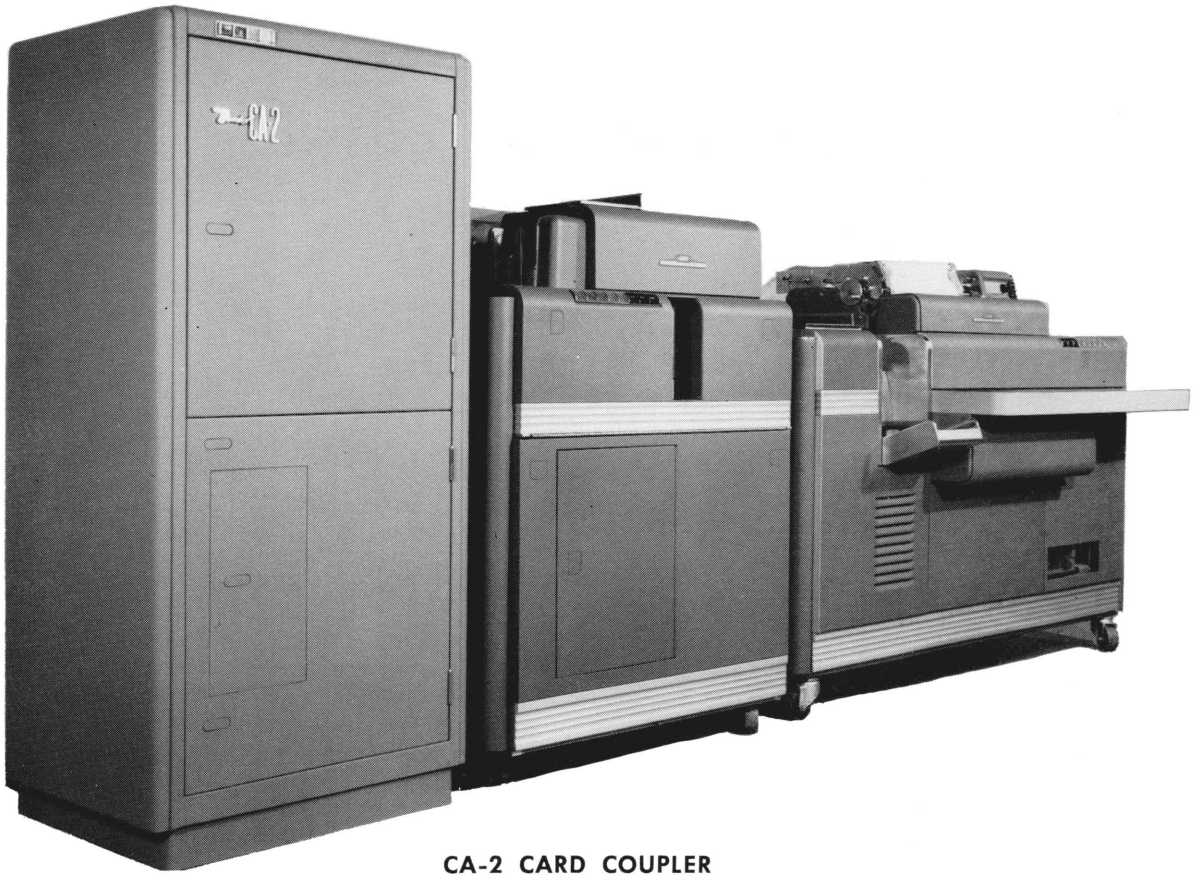
FOR THE BENDIX G-15

COMPUTER

CA-2 PUNCHED CARD COUPLER

FOR THE

BENDIX G-15 COMPUTER



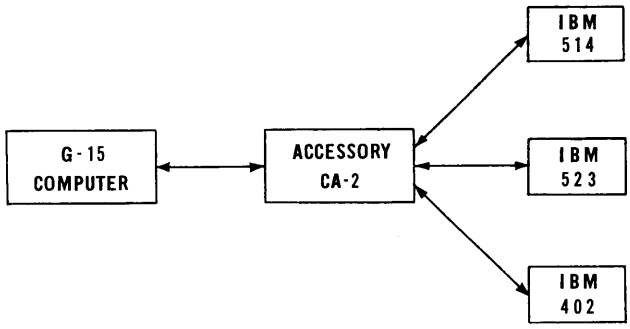
CA-2 CARD COUPLER
WITH TYPICAL PUNCHED CARD EQUIPMENT

SUMMARY OF CONTENTS

FACILITIES OF THE CA-2

Accessory CA-2 increases the versatility and speed of input-output operation for the Bendix G-15 Computer. The accessory enables the computer to operate in conjunction with conventional punched card and tabulating equipment.

Information may be read or punched at the rate of 100 cards per minute by card reader-punches such as the IBM-514, 519, or 523. Output information may be read at 100 cards per minute or tabulated at the rate of 100 lines per minute by the IBM-402 or IBM-403.



From one to three IBM units may be simultaneously connected to the CA-2. Cards may be read or punched in standard code; alphanumeric and numeric characters may be mixed. Special characters, indicated by multiple holes in card columns, may also be read or punched; they are handled in the same manner as alphanumeric characters.

Information can be tabulated, punched on cards, and read from cards automatically, under control of the computer program.

An input or output operation via the CA-2 may be simultaneous with internal computation, and with any input-output operation that does not make use of the CA-2. Input via the CA-2 and output via the CA-2 cannot be simultaneous.

Reading Cards

In a standard 80-column card, each column corresponds to one character. A character may be numeric, alphanumeric or special.

Any or all of the 80 columns on the card, in any order, may be read into the computer. The CA-2 is equipped with a plugboard, separate sections of which are controlled by separate CA-2 input-output commands.

During input, one group of 80 hubs carry output signals from the IBM equipment; another group of 80 carry input signals to the G-15. The user connects hubs in the first group, which correspond to the columns which are to be read, to hubs in the second group in the reading sequence desired.

Information from cards is read through the plugboard into the CA-2 and then into Line 17 in the memory of the computer. Line 16 in the memory contains control information which specifies the nature of each input character and the location in Line 17 in which it is to be written. Each input character in Line 17 is labelled in Line 16 as a numeric character, alphanumeric character, or the sign of a number.

After being read into Line 17, each numeric character occupies four bit positions; each alphanumeric character occupies six bit positions; the sign of a number occupies one bit position, which is the least significant bit position in a word. The input characters may be spaced in the line in any way desired.

Information read into one section of Line 17 can be processed by the computer at the same time that information is being read into a different section of the line.

Punching or Tabulating

The output process is analogous to the input procedure in reverse. Output information is converted to six-bit alphanumeric or four-bit numeric code and placed in Line 17. Each output character is labelled in Line 16 to indicate whether the output character in the corresponding word position in Line 17 is numeric, alphanumeric, or the sign of a number.

Information is sent from the CA-2 to the IBM equipment via a set of 80 plugboard hubs similar to the set used for input. The hubs permit selection of which output characters are to be punched or tabulated and in which columns to punch or tabulate them.

What the CA-2 Can Do

The CA-2 can, under program control, receive input from one IBM machine and provide output to another.

The CA-2 can, under program control, receive input from one IBM machine and provide output to two others. If desired, one output machine can punch cards and the other tabulate printed copy.

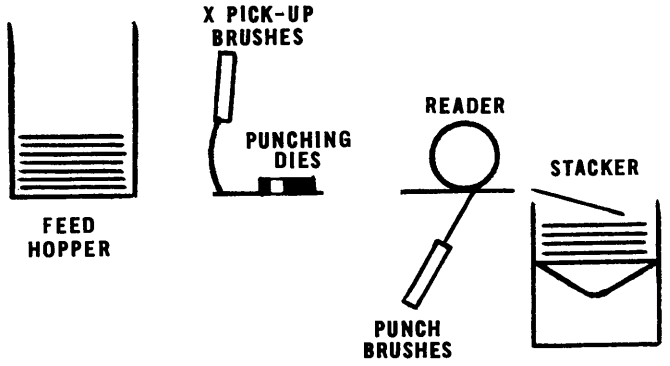
The CA-2 can, under program control, receive input from two IBM machines and send output to a third machine.

Any CA-2 input-output operation can be simultaneous with any other input-output operation that does not make use of the CA-2. No two CA-2 input-output operations can be simultaneous.

Any other G-15 accessory may be connected to the computer when the CA-2 is attached with the exception of Digital Differential Analyzer DA-1 and Card Accessory CA-1.

Card Equipment Which Can Be Used with the CA-2

IBM-523 Gang Summary Punch



Schematic Diagram of IBM 523

The IBM-523 can read or punch cards at the rate of 100 cards per minute. It has a single feed mechanism. Cards to be processed pass over an "X-detector" station, a "punch" station and a "read" station, in that order.

During an input operation, when the card passes under the "read" station, information may be read into the computer from any specified columns. The machine can be wired so that the X pick-up brushes detect X-punches in specified columns on the card and send this information to the computer. An X pick-up signal can either instruct the computer to change format in processing the card or can halt the reading operation.

During an output operation when the cards pass under the "punch" station, information may be punched in any desired columns.

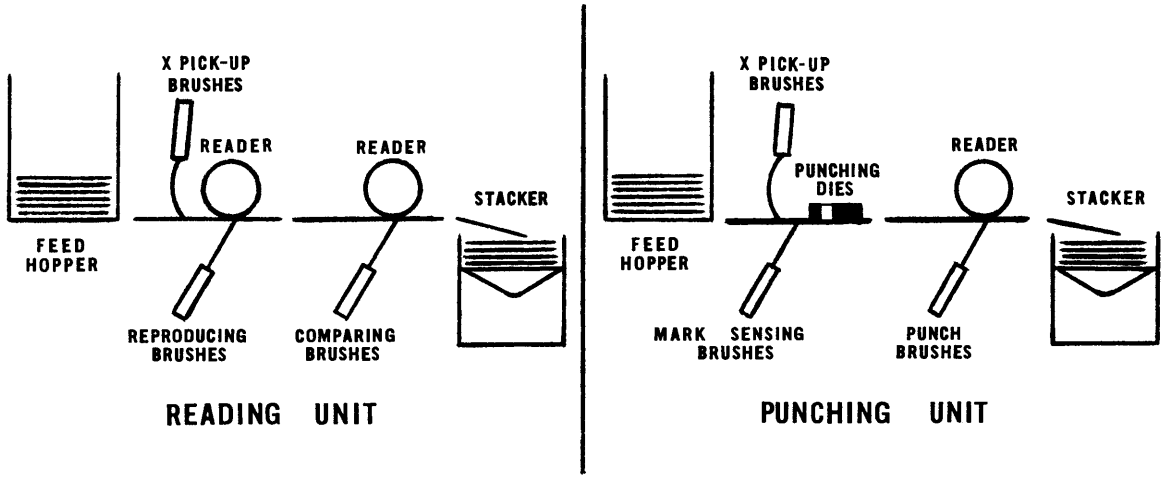
The names given the processing stations by IBM are shown in parentheses on the diagram.

In ordering an IBM-523 specify a machine with summary punch cable, an X pick-up delay and Selector 1, a self-contained power supply, and several permanent-type control panels. It is recommended that the machine be equipped also with idle-cycle control.

The IBM-514 can read or punch cards at the rate of 100 cards per minute. It has two sets of card feeds, one on the left and one on the right. The right hand feed is the same as the single feed on the IBM-523. The left hand feed has two "read" stations and no "punch" station.

The rollers which move cards on the left hand feed run only when the right hand feed is running.

In ordering an IBM-514 specify a machine with summary punch cable, an X pick-up delay and Selector 1, a self-contained power supply, and several permanent-type control panels. It is recommended that the machine be equipped with idle-cycle control.



Schematic Diagram of IBM 514

The right hand hopper is used for both reading and punching with the CA-2.

IBM-402 or 403 Tabulator

The IBM-402 or 403 tabulates information from the computer via the CA-2 at the rate of 100 lines per minute. A line may consist of as many as eighty characters. In normal operation a line consists of as many as 79 characters; the remaining character may be used for control of such functions as up-space suppression, single, double, or triple spacing, and carriage skips.

A commonly used model of the machine tabulates information in 88 columns. The 43 left hand bars on the machine contain alphanumeric characters. The 45 right hand bars contain numeric characters.

This machine may, under special conditions, be used for reading operations. A separate cable is used for reading.

In ordering an IBM-402 or 403 specify a machine with one or two digit selectors (preferably two) and several fixed panels. Specify the special character symbol to be placed in each type bar. Normally, a credit symbol, "CR", is provided for even-numbered type bars and an asterisk symbol, "*", is provided for odd-numbered type bars. Other symbols, such as a minus sign, are available upon request.

COMPUTER PROGRAMMING WITH THE CA-2

Data Codes

Codes on Punched Cards

The standard punched card codes are shown below. Punching in the top three rows is said to be "zone" punching, that which appears in rows 1 through 9, "digit" punching.

Most IBM equipment will accept these codes. However, certain printing equipment is not designed to handle all the characters; damage to the equipment may result from attempting to print characters not acceptable to the particular printing device.

The CA-2 can process all of the code assignments indicated below.

Codes within the Computer

The binary data transmitted to and from Line 17 of the computer is of three types: one-bit, four-bit and six-bit codes. ("Bit" stands for binary digit.) One-bit and four bit codes represent numeric information. Six-bit codes represent alphanumeric information or special characters. Labels placed in Line 16 of the computer specify whether the corresponding character read into Line 17 is a one-bit, four-bit, or six-bit code. (See Format Control, page 7.)

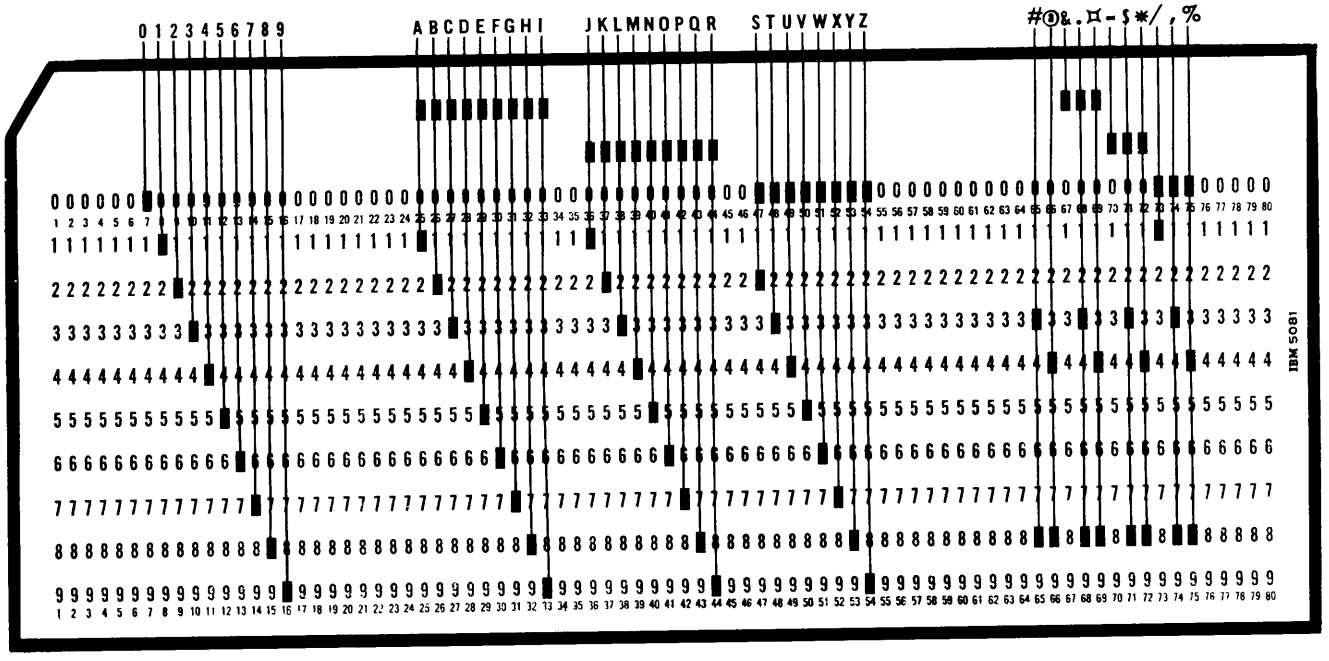
One-Bit Codes

One-bit codes are placed only in the least significant bit position of computer words in Line 17. A "1" in this position, indicated by an 11-row punch on the card, represents a minus sign in the G-15. A "0" in this position, indicated by a blank on the card, represents a plus sign in the G-15.

Four-Bit Codes

There are 16 four-bit characters which may be used within any position of a computer word

Optional Code Assignments



STANDARD PUNCHED CARD CODES

in Line 17, or overlapping two adjacent words, provided that the least significant of the four bits must not be placed in the least significant position, reserved for the one-bit sign code. These four-bit characters are often called hexadecimal characters. (See Table below)

SIGN AND NUMERIC CHARACTERS

Character	Code Within G-15	Punched Card Rows
-	1 in sign pos.	11
+	0 in sign pos.	Blank
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
u	1010	8-2
v	1011	8-3
w	1100	8-4
x	1101	8-5
y	1110	8-6
z	1111	8-7

ALPHANUMERIC AND SPECIAL CHARACTERS

Character	Code Within G-15	Punched Card Rows
Blank	00 0000	Blank
1	00 0001	1
2	00 0010	2
3	00 0011	3
4	00 0100	4
5	00 0101	5
6	00 0110	6
7	00 0111	7
8	00 1000	8
9	00 1001	9
	00 1010	8-2
#	00 1011	8-3
@	00 1100	8-4
	00 1101	8-5
	00 1110	8-6
	00 1111	8-7
& or /	01 0000	12
A	01 0001	12-1
B	01 0010	12-2
C	01 0011	12-3
D	01 0100	12-4
E	01 0101	12-5
F	01 0110	12-6
G	01 0111	12-7
H	01 1000	12-8
I	01 1001	12-9
	01 1010	12-8-2
.	01 1011	12-8-3
¤	01 1100	12-8-4
	01 1101	12-8-5
	01 1110	12-8-6
	01 1111	12-8-7
-	10 0000	11
J	10 0001	11-1
K	10 0010	11-2
L	10 0011	11-3
M	10 0100	11-4
N	10 0101	11-5
O	10 0110	11-6
P	10 0111	11-7
Q	10 1000	11-8
R	10 1001	11-9
	10 1010	11-8-2
$	10 1011	11-8-3
*	10 1100	11-8-4
	10 1101	11-8-5
	10 1110	11-8-6
	10 1111	11-8-7
0	11 0000	0
/	11 0001	0-1
S	11 0010	0-2
T	11 0011	0-3
U	11 0100	0-4
V	11 0101	0-5
W	11 0110	0-6
X	11 0111	0-7
Y	11 1000	0-8
Z	11 1001	0-9
	11 1010	0-8-2
,	11 1011	0-8-3
%	11 1100	0-8-4
	11 1101	0-8-5
	11 1110	0-8-6
	11 1111	0-8-7

The assignment of these special characters is optional:

#	$
@	*
.	,
¤	%

Six-Bit Codes

There are 64 six-bit characters which may be used within any position of a computer word in Line 17, or overlapping two adjacent words, provided that the least significant of the six bits must not be placed in the least significant position used for one-bit codes. These six-bit codes are called alphanumeric data codes. (See table on previous page.)

Format Control

Line 16 in the memory of the computer must contain control information which specifies: the nature of input-output information; where this information is to be placed in Line 17 during input; and in what order output information is to be punched or tabulated from Line 17.

The terms used in format control and an explanation of their functions are given below.

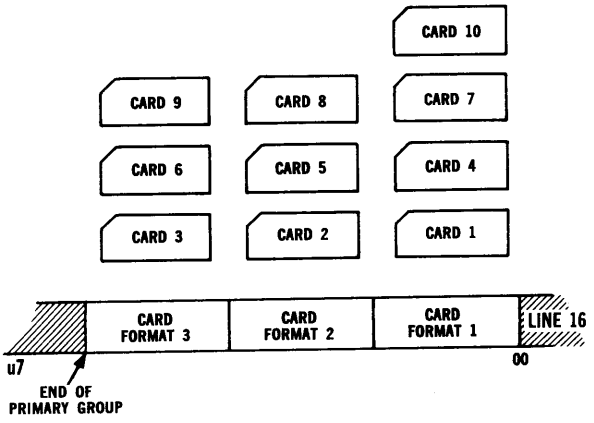
Card Format

The set of format codes that provide input or output control for information on one IBM card or for one line of print is called a "card format". Card formats comprise the control information entered into Line 16 of the computer.

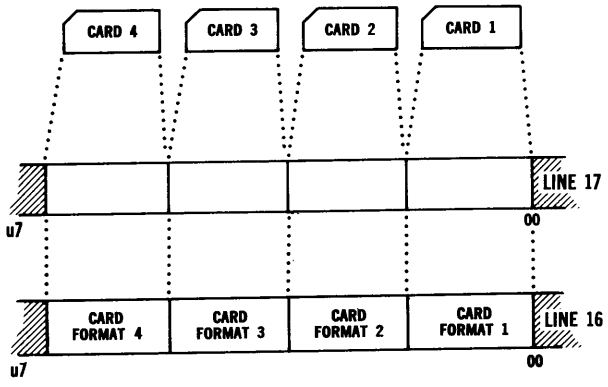
Format Group

A "format group" consists of one or more card formats. The number of card formats that each group may contain is optional. The first card processed is controlled by the first card format; following cards are controlled by the succeeding card formats. The use of card formats in a group is cyclic. After the last card format in the group, the CA-2 continues to process information on cards by repeating the cycle within the group, beginning with the first card format again.

Note that if a format group contains more than one card format, the cards must be properly positioned in the hopper before being read.



The cards in the illustration above are placed in the card hopper consecutively. The operation proceeds in a cyclic manner. After card 3 is processed, card format 1 is used again to control the processing of information on card 4. Card format 1 controls cards 1, 4, 7 and 10; card format 2 controls cards 2, 5 and 8; and card format 3 controls cards 3, 6 and 9.



Complete Format

A "complete format" in Line 16 is composed of one or two format groups. One is called the "primary" format group and, when a second format group is used, it is called the "alternate" format group.

The two format groups are placed in separate portions of Line 16. The primary format group is placed first, beginning at word 00 of Line 16 and includes possible vacant positions before the "format labels". The alternate format group begins at the next bit position after the end of the primary group and includes possible vacant positions before the "format labels".

One complete format is always needed in Line 16, beginning at word 00. Card equipment, such as the IBM-402 or 403, requires the use of two, identical, complete formats. In this case, the first complete format begins at word 00 of Line 16 and extends to word 51. Word 51 should not be used. The second, identical format begins at word 52 and extends to word 107 (u7). Output information in Line 17 must also be in duplicate for the IBM-402 or 403.

Format Selection

Cards that use two different sets of format codes can be read in during a single pass. The primary or alternate format group can be automatically selected, during reading operations, by CA-2 plugboard wiring. Alternate format may be selected upon detection of an 11-row punch (X-punch) in a previously specified card column. Primary format is used for cards that do not contain the X-punch. Primary or alternate format may also be selected for input or output operations under computer program control. (See the "Format Selector" commands described on page 13.) When the Format Selector is ON, alternate format is used; when OFF, primary format is used.

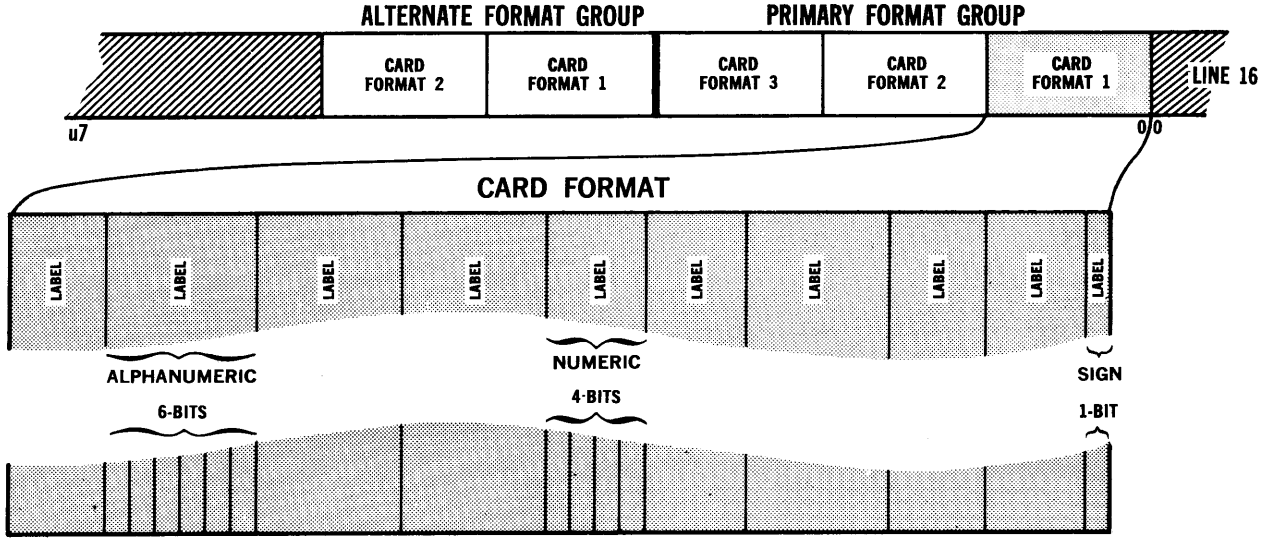
Prior to starting an input or output operation, the format group desired must be selected by the appropriate Format Selector command. During output, X-punched cards have no effect on format group selection. Once a format group is selected, processing continues in this format group until output operations stop.

For input operations, if alternate format is selected, it is operative only for one card. Reversion to primary format is automatically accomplished unless the next card contains an X-punch.

Format Label

A card format is composed of a number of bits, combinations of which are called "format labels". Each input or output character read into Line 17 has a format label in Line 16 to identify the character. Labels are placed in those bit positions in Line 16 which correspond to bit positions in Line 17 which are to contain information. The label specifies whether the corresponding character in Line 17 is alphanumeric, numeric, a special character, or the sign of a number.

There are three types of labels: one-bit, four-bit and six-bit.



Example

If a 4-bit label is used in bit positions 5-8 of word 43 in Line 16, the corresponding bit positions 5-8 of word 43 in Line 17 are assigned for use by a 4-bit data character.

One-bit labels are used only in the sign position (the least significant bit position of a computer word). A "1" in this position indicates that the corresponding bit position in Line 17 represents a sign character.

Four-bit labels specify numeric information. A four-bit label may be placed within any position of a word, or overlapping two adjacent words, in Line 16 except that the least significant bit of the label must not be placed in the bit position reserved for one-bit sign labels.

Six-bit labels specify alphanumeric or special character information. A six-bit label may be placed within any position of a word, or overlapping two adjacent words, in Line 16 except that the least significant bit of the label must not be placed in the bit position reserved for one-bit sign labels.

Labels for input or output characters may be placed in any word position of Line 16 except word 107.

The format labels need not be adjacent. The vacant positions between labels are filled with zeros.

Unassigned Locations

Bit positions in Line 17 that are not assigned specific storage functions by format labels in Line 16 may be used for general storage. This holds for unassigned bit positions within an individual card format as well as for bit positions outside the locations assigned by a group of card formats.

The contents of the portion of Line 16 used for format control are changed during card operations. The portion of Line 16 which is not used for format control, that is, the portion following the last card format in a complete format, may be used for general storage of information.

Format Control Bits

Format labels contain control bits called "markers". There are 4 markers represented by the letters A, B, C and D. A four-bit label is of the form A B 0 1 or C 0 0 1. A six-bit label is of the form A B C D 1 1. The most significant end of the label is the A-marker position. The marker bits indicate:

A-Marker:	The card format to be used first
B-Marker:	The last format label of each card format
C-Marker:	The end of a format group
D-Marker:	A halt at the end of processing a particular card format

D-Marker

A "1" placed in the D-Marker bit position of a 6-bit alphanumeric label halts a CA-2 input-output operation. To terminate card processing at the end of a particular card format, a "1" must be placed in some D-Marker bit position of a label within this card format. If no D-Marker bit within the card format contains a "1", the CA-2 will process the succeeding card formats of the group. After processing the last card format of the group, the CA-2 will continue to process cards by repeating the first card format in the group, in a cyclic manner. Card processing will continue until either a "1" appears in the D-Marker bit position, a Halt CA-2 instruction is executed by the computer, a Halt signal is received by the CA-2 Control Panel, or the STOP switch on the CA-2 is depressed.

C-Marker

The C-Marker bit identifies a format group. A "1" in the C-Marker bit position in a 4 or 6-bit label in a card format specifies that the most significant bit position of this card format is the end of that particular format group. The C-Marker bit must not be placed in a 4-bit label if it is the last label in a card format. One C-Marker bit is required for each format group; and only one C-Marker bit position may contain a "1" in each group.

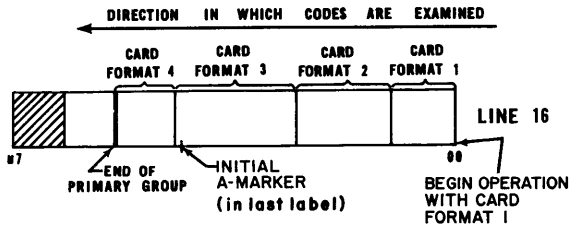
B-Marker

A "1" in the B-Marker bit position of a format label indicates that this format label is the last 4-bit or 6-bit label in the card format. All preceding B-Marker bit positions within the card format must contain "0".

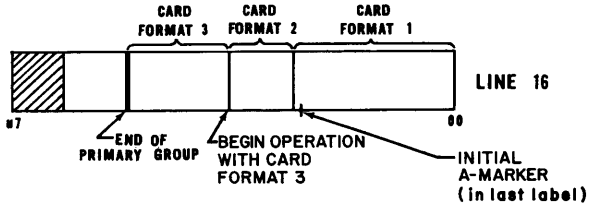
A-Marker

The A-Marker indicates which individual card format is to be used first. Initially, a "1" is placed in the A-Marker bit position two card formats to the right of the one at which CA-2 operation will begin (See Examples I & II below). During each card operation the A-Marker is advanced within the group one card format to the left. This operation proceeds in a cyclic manner, that is, after the last card format of a group, the sequence begins again with the first card format.

Example I



Example II



One A-Marker bit is required for each format group when both primary and alternate format are used. The placement of the A-Marker bits depends on which format group is to be selected by the first CA-2 input command. If primary format is used first, to begin card operation with the first card format one A-Marker bit must be inserted in the last label of the next to last card format of this group; and one A-Marker bit must be inserted in the last label of the last card format of the alternate group. If the first CA-2 input command uses alternate format, the positions of the A-Markers must be reversed. An A-Marker bit is inserted in the last label of the next to last card format of the alternate group and in the last label in the last card format of the primary group.

To Prepare a Format

Determine the bit positions in Line 17 which are to hold input or output information. Label bit positions proceeding from the lower to upper end of Line 16, that is, begin at word 00 bit 1 and end at word 106. Label the positions as alphanumeric, special character, numeric, sign, or space according to the rules below.

1. Do not cover more than twenty word positions with one card format.
2. Leave space between characters whereever desired.
3. Provide four consecutive bit positions for each numeric character and six consecutive bit positions for each alphanumeric or special character. Do not begin a character in the least significant bit position of a word.
4. Provide one bit position, which must be the least significant bit position in a word, for the sign of a number.
5. Characters may overlap from one word position into the next one.
6. Do not use word position 107 (u7).

Spaces that are left between labels in Line 16 are represented by zero bits. (A distinction must be made between this zero bit and the zero that is part of an alphanumeric or numeric code.)

A blank column on a card is represented by an alphanumeric label.

To complete the preparation of a format: An A-Marker bit must be inserted in the last label of one card format in each format group where required (see Examples I and II); a B-Marker bit must be placed in the last label of each card format; a C-Marker bit must be placed in one label in the last card format of each format group; and a D-Marker bit should be inserted in one alphanumeric label of the card format at which it is desired to halt card processing.

Example of Card Format Preparation

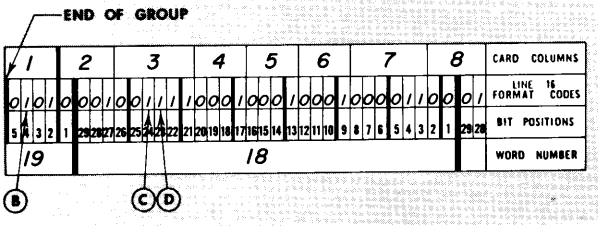
On an IBM card, column 3 of the card contains alphanumeric information. Column 7 is blank (not used). The remaining card columns contain numeric information. (All numbers are positive.) The layout for the format labels required for the first part of this IBM card is shown below.

This card format will be the last card format in the primary format group. Card operation will halt after the processing of the card controlled by this card format.

Preparation of a card format begins with column 80 and proceeds to card column 1. The column number is written above the format label to show the number of bits needed for each column.

Four-bit labels are placed in the bit positions corresponding to columns 1, 2, 4, 5, 6 and 8. A six-bit label is inserted in the bit positions corresponding to column 3. A six-bit label is also used for blank column 7. One C-Marker bit is inserted in bit position 24 of word 18 to indicate the end of the group. One D-Marker bit is inserted in bit position 23 of word 18 in order to halt card operation after this card is processed. One B-Marker bit is inserted in bit position 4 of word 19 to indicate the last label of the card format. If an A-Marker bit were used, it would be inserted into bit position 5 of word 19. Note that labels overlap words.

PORTION OF A CARD FORMAT



Note that the binary digits (bits), which make up the labels of the card format above, are divided into groups of four for convenient entrance into the computer in sexadecimal form. (See table on page 25 of the G-15 Operating Manual, July 1959.)

Card formats may be prepared on punched tape by means of a "Format Service Routine", if desired. The instructions for the use of this routine are available in a separate publication.

For detailed programming examples, see the CA-2 Reference Manual.

Special Considerations for Use of the IBM-402 and 403

Card machines, such as the IBM-402 or 403, require the use of the CA-2 Timing Control, which is selected by CA-2 Control Panel wiring. This feature effectively doubles the rate at which information is transmitted between the CA-2 and the attached card machine. The complete format must be duplicated in Line 16, the CA-2 plugboard must be wired for Timing Control, and a new number track must be used. This new number track may be used at all times in place of the old one, with or without the CA-2. The operations of previously written programs are not affected by the use of the new number track.

The two, identical, complete formats for the IBM-402 or 403 are placed in Line 16 as follows. One format begins at word 00 and extends to word 51. Word 51 should not be used. The format should be duplicated in the high order portion of the line. Word 107 (u7) should not be used. The output information in Line 17 must also be in duplicate.

The IBM-402 or 403 may have as many as 88 type bars. The type bars on the left of the machine are alphanumeric, and ordinarily only alphanumeric (6-bit) characters should be sent to them from the computer. The type bars on the right are numeric, and only numeric and sign characters should be sent them. There is a maximum of 43 alphanumeric type bars and 45 numeric type bars on the machine.

The standard IBM-402 or 403 does not have minus signs on the type bars. If it is desired to print a minus sign in any column, a "minus" type slug must be put in the special character position on that column. The output code 010000 will then print a minus sign if the bar is on the alphanumeric side of the machine.

A minus sign code (a bit in the least significant bit position of a word) can print a minus sign on the numeric side of the machine. For the printing of minus signs on the numeric type bars, the control panel on the IBM-402 or 403 must be wired in the manner indicated on page 28.

L_2 N 2 22 31

TEST CA-2 READY

If a CA-2 input-output operation is in progress, execute the command in location N. Otherwise, execute the command in location N + 1.

Comment: The use of this command can determine the completion of an input-output operation so that some desired action, for example, another input-output operation, may then be taken.

T N C 19 31

START CA-2

Begin a CA-2 input-output operation.

Comment: The "C" portion of this instruction may be given a value of 0, 2 or 3. The three possible forms of the command permit three different types of CA-2 input-output within a program. The specific operation performed by each form of the command is determined by the wiring of the CA-2 control panel plugboard.

For example, the plugboard may be wired so that the command "T N 0 19 31" causes an IBM-523 unit to read information into the computer from punched cards; the command "T N 2 19 31" causes cards to be punched on an IBM-514; and the command "T N 3 19 31" tabulates output information on an IBM-402.

The TEST CA-2 READY command is always used prior to this command. One drum revolution must elapse between the TEST CA-2 READY command and the START CA-2 command. If the same piece of card equipment is to be used in successive card read or punch operations, then three drum revolutions must elapse between the TEST CA-2 READY command and the second START CA-2 command.

T N 7 22 31

HALT CA-2

Terminate any input-output operation immediately after processing the current card, when executed within seven drum revolutions after beginning the processing of the current card format.

Terminate any input-output operation immediately after processing the next card format, when executed 17 drum revolutions after beginning the processing of the current card format but before starting the processing of the next card.

Comment: The execution of this command produces the same effect as depressing the white STOP button on the CA-2 or having a D-Marker in an alphanumeric label of a card format.

L_4 N 1 19 31

RESET AND HALT CA-2

Halt operations of the CA-2 and attached card machines, immediately, even if the current card has not been completely processed.

Comment: This command is normally executed only during program loading operations to insure that all preceding card operations have been voided. During program execution, the HALT CA-2 command should be used.

The execution of this command produces the same effect as depressing the yellow RESET button on the CA-2.

w T N 3 22 31

or

u T N 3 22 31

TEST PROCESSING POSITION

If the CA-2 is processing input-output information during execution of the command, execute the command in location N+1. Otherwise, execute the command in location N.

Comment: Before the command is executed, at least three drum revolutions must have elapsed after execution of the START CA-2 command "T N C 19 31".

This command should not be executed between row times 12 and 9 during printing operations with the IBM-402.

As a general rule, free of particular timing relations for attached card machines, this command should be executed within 17 drum revolutions after the START CA-2 command has been given.

If a group of cards is being read in a single input operation, this command enables the computer to determine when a specific card in the group has been processed so that the information from that card can be used immediately for computation.

T N 1 22 31

TEST FORMAT SELECTOR

If the Format Selector is ON and a CA-2 input-output operation is in progress, execute the command in location N + 1.

Comment: This command must be executed within 15 drum revolutions after the time a card has started being processed. This time is determined by the "Test Processing Position" command.

T N 5 22 31

TURN OFF FORMAT SELECTOR

If executed when the CA-2 is not processing input-output information, turn off Format Selector. Otherwise, ignore command. When the Format Selector is OFF, primary format is used.

T N 6 22 31

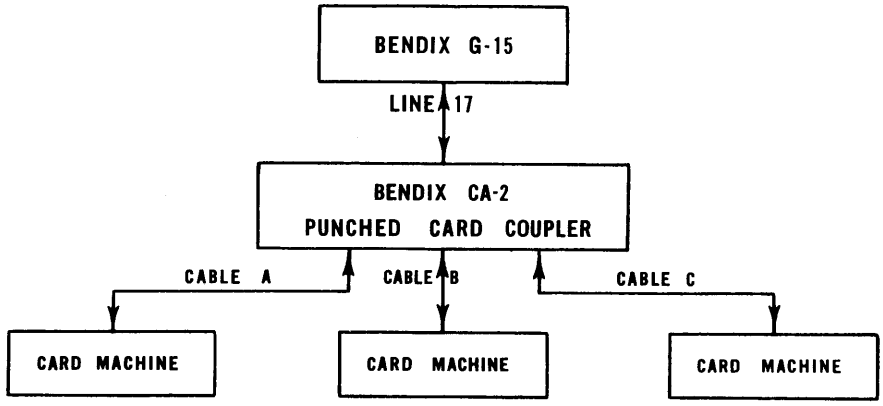
TURN ON FORMAT SELECTOR

If executed when the CA-2 is not processing input-output information, turn on Format Selector. Otherwise, ignore command. When the Format Selector is ON, alternate format is used.

CONTROL PANEL OF THE CA-2

Information Flow

Output data in Line 17 of the G-15 Computer is converted to electrical signals by the CA-2 and sent over one of the Cables A, B, or C to an attached card machine. Input data from a card machine is sent over one of the cables A, B, or C to the CA-2, which converts the signals read from cards and stores resulting codes in Line 17 of the G-15. Both input and output operations are, however, under the format control of labels placed in Line 16 of the G-15 (see Format Labels, page 8). The selection of the particular cable connection to be used is determined by the wiring on the CA-2 Control Panel. The CA-2 furnishes input or output information in a form acceptable to card machines that operate 12-edge first. The CA-2 can also provide output data in the row sequence 0-11-12-9-8-7 6-5-4-3-2-1. This sequence, which is required for operation with the IBM-402, is selected by wiring the 9-edge and OUT hubs on the control panel of the CA-2. (See steps 3 and 4, page 19.)



Wiring the Control Panel

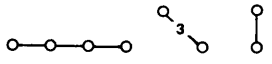
The CA-2 operates automatically by means of the control panel, which causes the machine to perform various functions according to the nature of the attached card machines.

Electrical signals originate within a card machine when contact is made between a brush and a metal roll or signals originate by electronic timing circuits within the CA-2. These signals are made available at hubs on the control panel, where, by means of external wires, the CA-2 may be directed to perform the required operations.

Internal wiring connects some of these hubs to the three cable connectors located at the lower rear of the CA-2 cabinet, where external cables may be attached to carry the signals to and from card machines.

On the Control Panel, an exit hub is one which emits a signal. An entry hub is one which can accept a signal. Some hubs always serve as exit hubs, others always as entry hubs, while some may serve as either exit or entry hubs. A connection is made from an exit to an entry hub by placing one end of a wire in the exit hub and the other end in the entry hub.

When two or more hubs are connected by lines, as shown below, these hubs are common, that is, several hubs serve the same purpose:



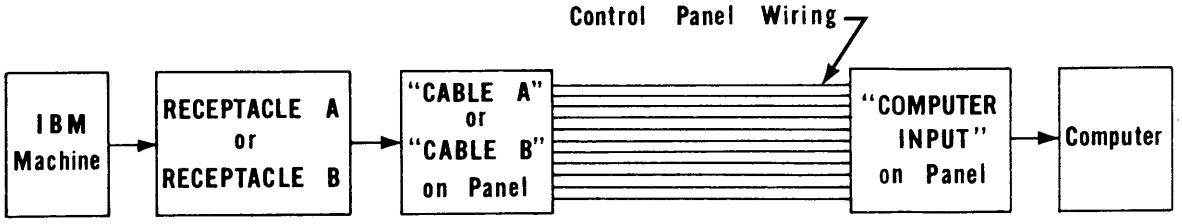
This arrangement reduces the need for "split wires" (wires with more than two ends), since these hubs are actually interconnected and, hence, serve the same purpose as split wires.

In addition to the normal hubs used for reading the 80 card columns, up to 12 extra hubs are available for use in special board wiring. For example, the X pick-up brushes in the

IBM-523 can be wired into these extra hubs and the corresponding hubs on the CA-2 Control Panel may be wired to control variable format or to automatically halt reading operations.

In addition to the normal hubs used for punching the 80 card columns, up to 12 extra hubs are available for use in special board wiring. For example, the X pick-up brushes in the IBM-523 can be wired into these extra hubs and the corresponding hubs on the CA-2 Control Panel may be wired to automatically halt punching operations.

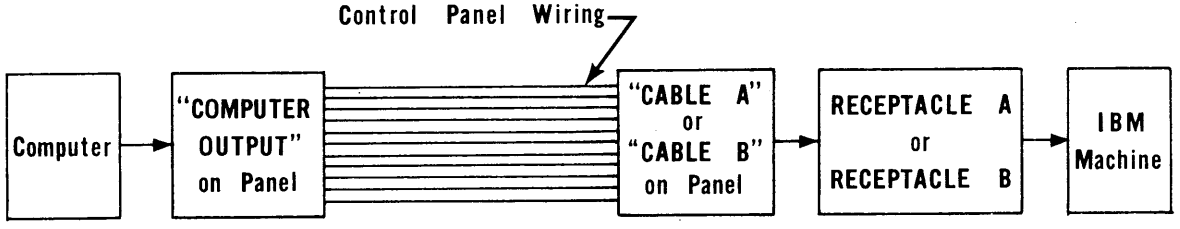
Input from One IBM Machine



Input from a single machine is sent to the computer via either the A or B receptacle. A control panel wire is put in a "CABLE A" or "CABLE B" hub for each column to be read from the cards. The other end of the wire is put in a "COMPUTER INPUT" hub; the order in which the wires are plugged into the COMPUTER INPUT hubs determines the order in which input information will be arranged in Line 17 of the computer.

If more than one card is read into Line 17, information from the first card is at the lower end of the line.

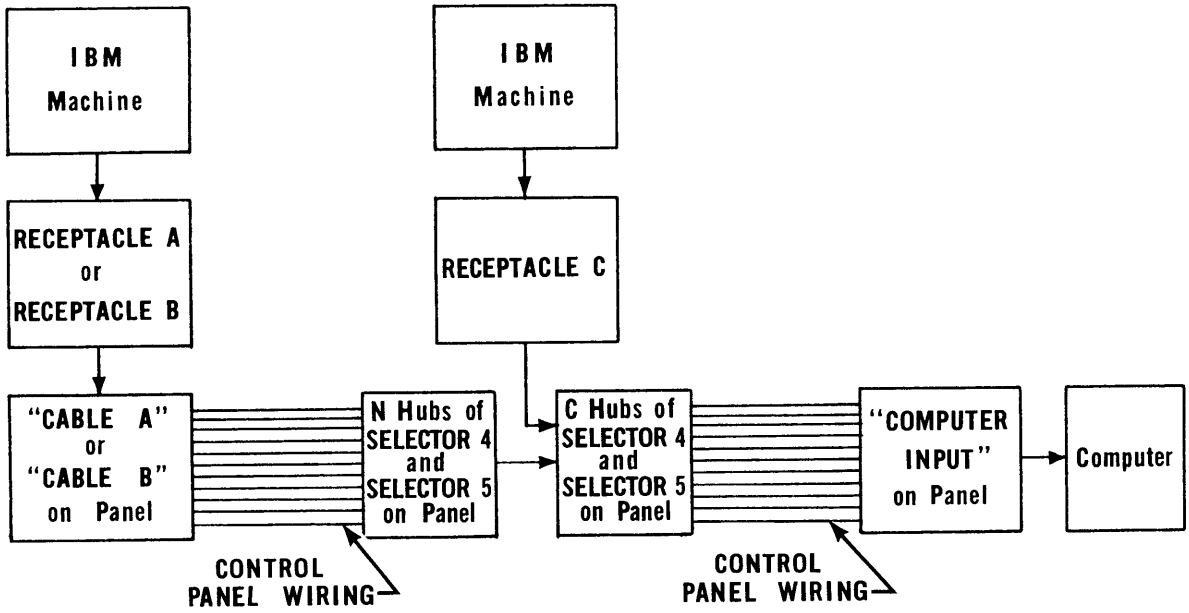
Output to One IBM Machine



Output to a single machine is sent via the A or B receptacle. A control panel wire is put in a "CABLE A" or "CABLE B" hub for each column to be punched or tabulated; the order in which the other end of the wires are plugged into COMPUTER OUTPUT hubs determines the order in which the columns are punched or tabulated.

If information from more than one card is held in Line 17, the first card will be punched with information from the lower end of the line.

Input from Two IBM Machines



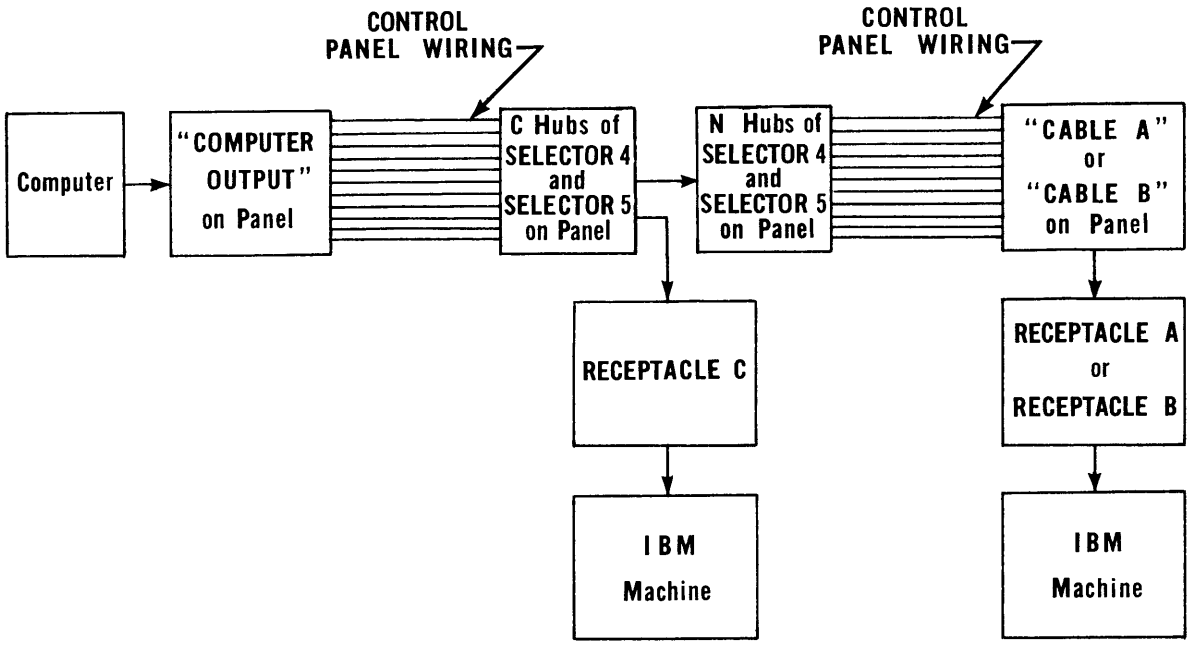
The computer can receive information from either of two machines under program control. If the number of columns read on a card differ for the two machines, attach the one from which the greater number of columns are read to the C receptacle.

Information flows to the C hubs of SELECTOR 4 and SELECTOR 5 from either the N hubs or from Receptacle C.

A wire is put in a C hub of SELECTOR 4 or SELECTOR 5 on the control panel for each column to be read from the machine at Receptacle C. The order in which the wires are plugged into the COMPUTER INPUT hubs is the order in which input information will be arranged in Line 17 of the computer.

A wire is put in a CABLE A or CABLE B hub on the control panel for each column to be read from the machine at Receptacle A or B. The other end of each wire is put into an N hub that corresponds to an already-wired C hub.

Output to Two IBM Machines



The computer can send information to either of two machines under program control. If the number of columns punched or tabulated differ on the two machines, attach the machine on which the greater number of columns are punched or tabulated to the C receptacle.

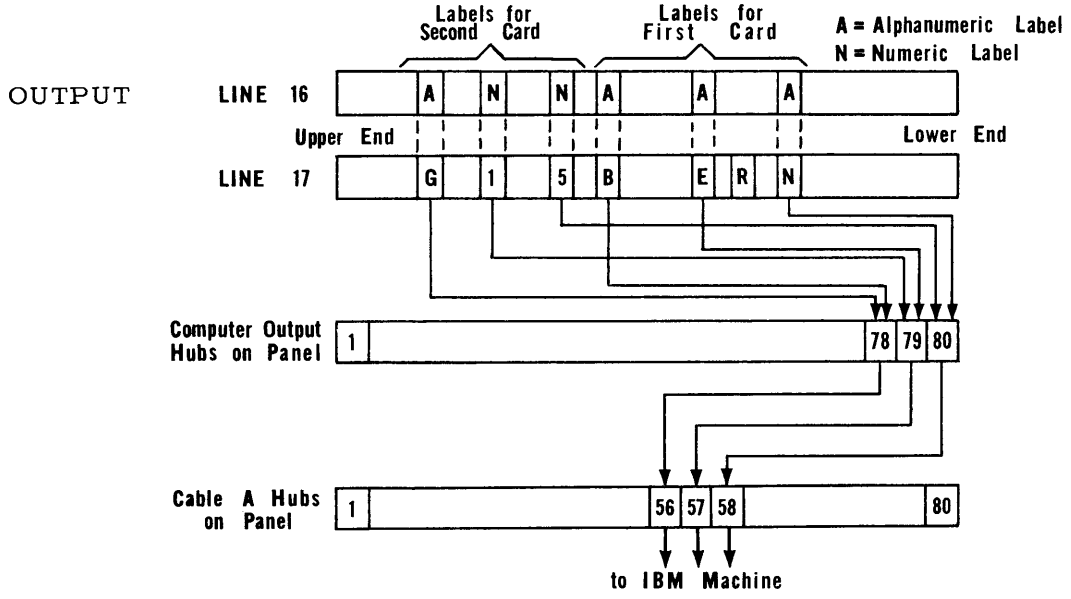
Output information flows via the C hubs of SELECTOR 4 and SELECTOR 5 to either the N hubs or to Receptacle C.

A wire is put from a COMPUTER OUTPUT hub to a C hub of SELECTOR 4 or SELECTOR 5 on the control panel for each column to be punched or tabulated on the machine at Receptacle C.

A wire is put in a CABLE A or CABLE B hub on the control panel for each column to be punched or tabulated on the machine at Receptacle A or B. The other end of each wire is put into an N hub that corresponds to an already-wired C hub.

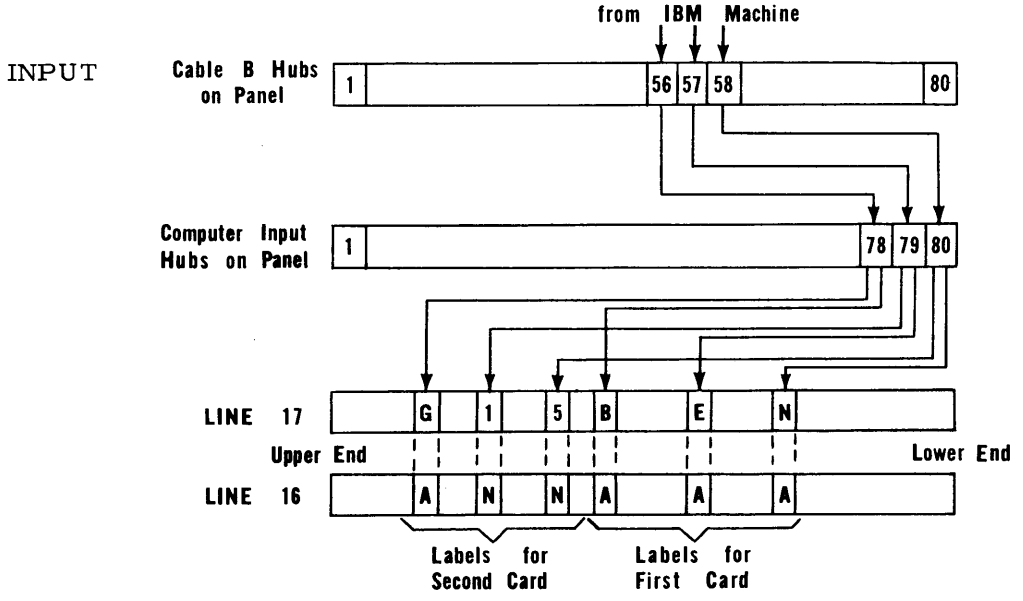
Detailed Illustration of Information Flow between Computer and Cards

"BEN" will be punched in Columns 56, 57, and 58 of the first card processed.
"G 15 " will be punched in Columns 56, 57, and 58 of the second card processed.



"R" is stored in Line 17 for later use; "R" will not be punched since it has no format label in Line 16.

If the first card read contains "BEN" in Columns 56, 57, and 58, and the second card read contains "G 15" in Columns 56, 57, and 58:



To Wire the Control Panel

1. Determine and write down the following information:

   The specific nature of each form of the command T N C 19 31.

   The receptacle on the back of the computer that is used for connection of each machine.

   The edge of the IBM card (the 12-edge or the 9-edge) that is being processed on the IBM equipment first.

   The columns that are to be read, punched, or tabulated; and the sequence in which reading, punching, or tabulating is to occur.

   If alternate format is being used.

2. Connect COMMAND to the corresponding CABLE PU determined in Step 1. There should be as many connections as there are versions of the T N C 19 31 command.

3. For each CA-2 output command, connect COMMAND to OUT.

4. If output is sent to the IBM 402 or 403 connect COMMAND to 9E and to TC.

The information and illustrations in the column below comprise an example for the items in the left hand column.

Example:

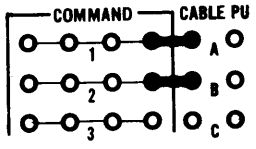
T N 0 19 31 = IBM 523 input
T N 2 19 31 = IBM 514 output

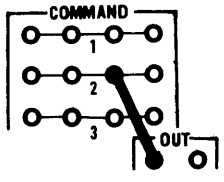
CABLE A Receptacle = IBM 523
CABLE B Receptacle = IBM 514

12-edge on IBM 523
12-edge on IBM 514

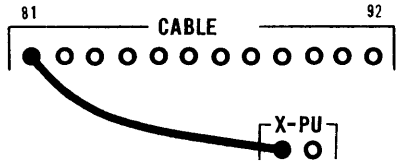
Columns 3 - 5 and 8 read in that order from IBM 523. Columns 61 and 62 punched in reverse order on IBM 514.

Cards for IBM 523 may have either primary or alternate format.





5. If alternate format is being used by any machine, connect X-PU to Hub 81 of CABLE A, CABLE B, or CABLE C, whichever one corresponds to that machine.

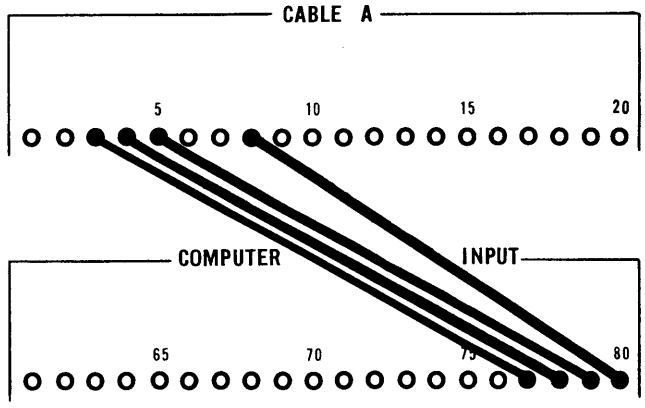


6. Follow the directions under one or more of the four headings below.

Input from One Machine

Make connections from COMPUTER INPUT to either CABLE A or CABLE B, whichever is proper.

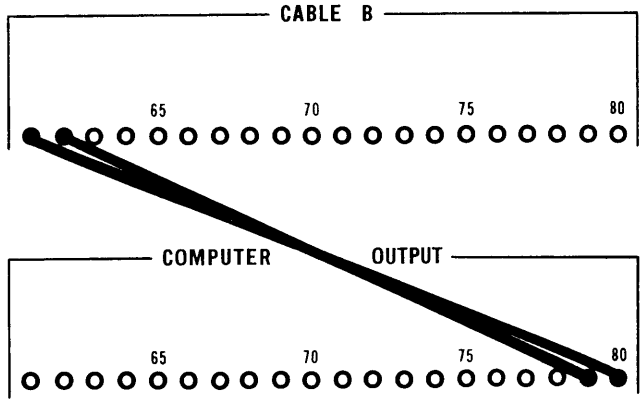
The CABLE A or CABLE B hubs determine which columns are being read. The COMPUTER INPUT hubs determine the order in which the information is stored in the memory.



Output to One Machine

Make connections from COMPUTER OUTPUT to CABLE A or CABLE B, whichever is correct.

The CABLE A or CABLE B hubs determine which columns are punched or tabulated. The connections from the COMPUTER OUTPUT hubs determine the order in which information is punched in the columns.



Input from Two Machines

An Example is on page 23.

If the number of columns being read from a card differ on the two machines, the machine from which the greater number of columns are read should be attached to the C receptacle on the CA-2.

1. Connect COMMAND, for the machine attached to the C receptacle, to hubs 4 and 5 of SELECTOR PU's.

2. Connect C hubs of SELECTOR 4 and/or SELECTOR 5 to COMPUTER INPUT.

   The connections at the C hubs specify the columns which are read on the machine at the C receptacle.

   The connections at COMPUTER INPUT specify the order in which information is read into Line 17.

3. Connect CABLE A or CABLE B to N hubs of SELECTOR 4 and/or SELECTOR 5.

   The connections at CABLE A or CABLE B specify which card columns are to be read on the machine at Receptacle A or B.

   Make connections to those N hubs which correspond to already-wired C hubs. The order of the connections to the N hubs determines the order in which information is read into Line 17. Arrange the connections so that the final order of information sent to the computer, after passing through the plugboard connections between the C hubs and COMPUTER INPUT hubs, is the order desired. See Flow Diagram on page 16.

Output to Two Machines

An Example is on page 24.

If the number of columns being punched or tabulated differ on the two machines, the machine on which the greater number of columns are punched or tabulated must be attached to the C receptacle on the CA-2.

1. Connect COMMAND, for the machine attached to the C receptacle, to hubs 4 and 5 of SELECTOR PU's.

2. Connect C hubs of SELECTOR 4 and/or SELECTOR 5 to COMPUTER OUTPUT.

   The connections at the C hubs specify the columns to be punched or tabulated on the machine at the C receptacle.

   The order of the connections at COMPUTER OUTPUT determine which information from Line 17 is sent to each column.

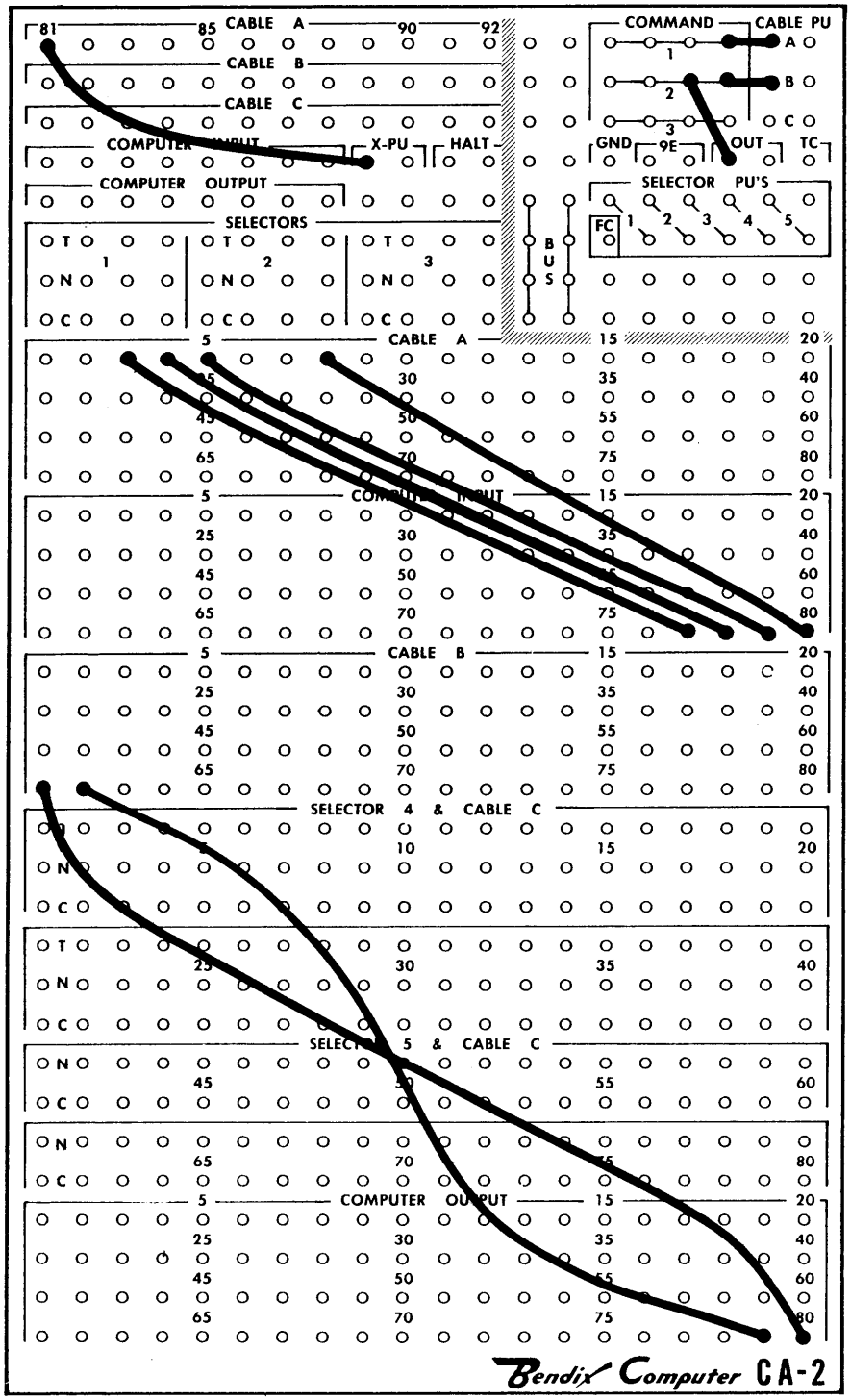
3. Connect N hubs of SELECTOR 4 and/or SELECTOR 5 to CABLE A or CABLE B.

   The connections at CABLE A or CABLE B specify the columns to be punched or tabulated on the machine at CABLE A or CABLE B.

   Make connections to N hubs which are directly above already-wired C hubs on the plugboard. The order of the N hub connections determines which information from Line 17 is sent to each column. To determine this order consider the rearrangement, if any, of the information from the computer in passing through the plugboard wires between COMPUTER OUTPUT and the C hubs. See Flow Diagram on page 17.

WIRING EXAMPLE FOR OUTPUT TO ONE MACHINE, INPUT FROM ONE MACHINE

The diagram is for the example on page 19.

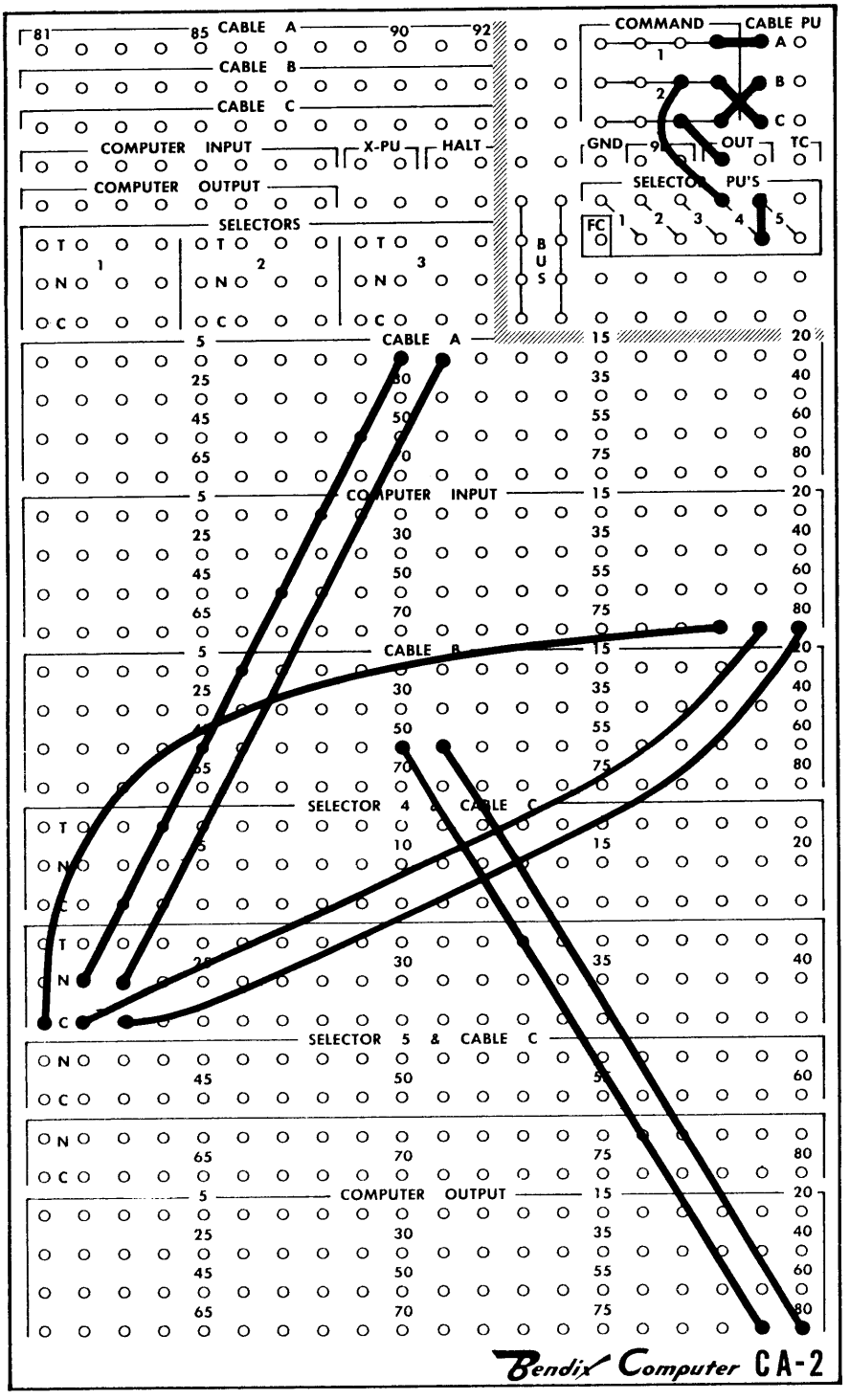


WIRING EXAMPLE FOR INPUT FROM TWO MACHINES, OUTPUT TO ONE MACHINE

The commands wired are:

T N 0 19 31 Input at Receptacle A from Columns 10 and 11
T N 2 19 31 Input at Receptacle C from Columns 21, 22, and 23
T N 3 19 31 Output at Receptacle B to Columns 50 and 51

All columns are read and punched in normal order.



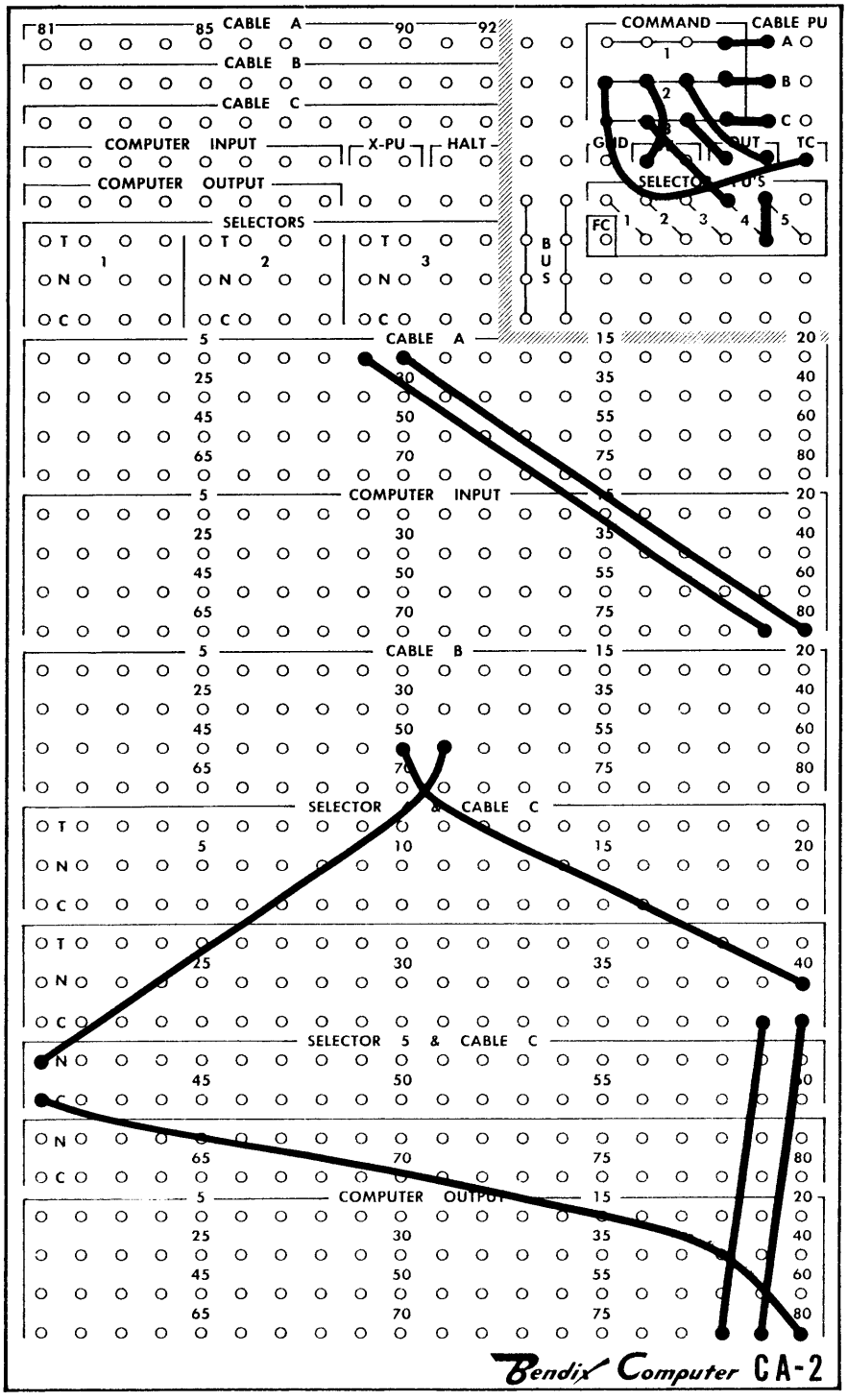
WIRING EXAMPLE FOR OUTPUT TO TWO MACHINES, INPUT FROM ONE MACHINE

The commands wired are:

T N 0 19 31 Input at Receptacle A from Columns 9 and 10
T N 2 19 31 Output at Receptacle B to Columns 50 and 51
T N 3 19 31 Output at Receptacle C to Columns 39, 40, and 41

All columns are processed in normal order.

Receptacle B is attached to an IBM-402 tabulator.



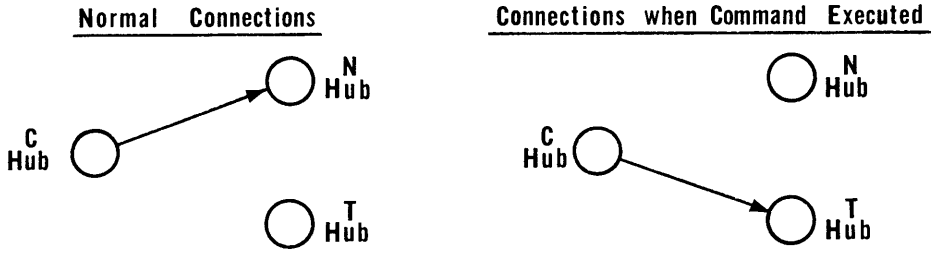
Additional Control Panel Facilities

Selectors

Selectors increase the flexibility of control panel wiring. Information signals connected to SELECTOR "common" hubs on the control panel can be switched from one path to another by any specified CA-2 input-output command.

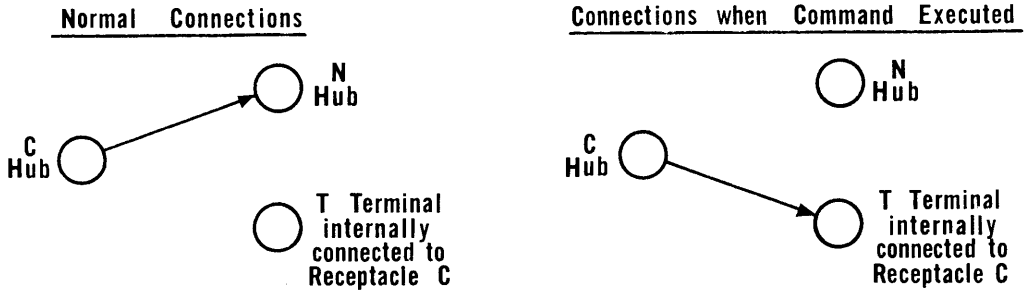
To use selectors a COMMAND hub is wired on the control panel to a SELECTOR PU's hub; SELECTOR PU's 1 through 5 correspond to SELECTORS 1 through 5.

Selectors 1, 2, and 3 (4 positions each)



Each C or "common" hub is internally connected to the correspondingly numbered N (normal) hub by a switch contact. Whenever a command wired to a SELECTOR PU's hub is executed, the corresponding SELECTOR connections are switched from N hubs to the T, or "transfer", hubs.

Selectors 4 and 5 (40 positions each)



SELECTORS 4 and 5 differ from SELECTORS 1, 2 and 3 in that the T terminals are internally wired to the C receptacle, and so are connected to whatever IBM machine is attached to the C receptacle. On SELECTOR 4 the T terminals are brought to hubs on the control panel in the same manner as SELECTORS 1, 2 and 3. On SELECTOR 5, however, the T terminals are not brought out to control panel hubs. Notice that SELECTORS 4 and 5 were used on the preceding pages to wire the control panel for input from two IBM machines and for output to two IBM machines.

Example

Wire a control panel so that:

The command "T N 0 19 31" punches columns 35 and 36 in normal order on the IBM machine at Receptacle A.

The command "T N 2 19 31" punches columns 25 and 26 in normal order on the IBM machine at Receptacle A.

The wiring is shown on page 27.

Hubs 81 to 92

Hubs 81 to 92, of CABLE A, CABLE B, and CABLE C, provide additional channels for communication between the computer and the machines attached to Receptacles A, B, and C.

They tie internally to column splits 11 - 12 (X - R) of the 523 or 514 control panel. Since these machines normally have only 8 column split positions, only the first 8, hubs 81 to 88, can be used.

Two rows of hubs numbered from 81 to 88 are labeled COMPUTER INPUT and COMPUTER OUTPUT. These hubs have connections only in an 88-column model CA-2.

Use of Special Control Panel Hubs

Timing Control 

This entry hub causes the CA-2 to examine Lines 16 and 17 twice each drum cycle, thereby effectively doubling the speed of drum rotation. It should be wired when used with IBM machines such as the IBM-402. This hub is normally wired from COMMAND. To be effective, a new number track (see Operating Note 2, page 28) must be used with the G-15.

First Card Control 

When 9-E (Nine Edge) has been impulsed from COMMAND, this exit hub emits a continuous signal for all CA-2 operations except the digit part of the first card cycle and rows 3, 2, 1, 0, 11, 12 of the last card cycle. It may be wired to SELECTOR PICKUP to control space suppression on the IBM-402.

X Pick-up 

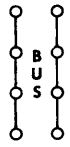
These entry hubs are wired to CABLE A, B, or C hubs and accept signals which originate at the X-brushes within IBM machines. When impulsed, they cause the format selector to be turned ON. Although these hubs will also accept other signals available on IBM equipment, such applications are not recommended due to certain timing relations which may exist between the CA-2 and IBM equipment.

These hubs should not be wired from COMMAND, since a heavy load would then be placed on internal circuits of the CA-2.

Halt 

These entry hubs are wired to CABLE A, B, or C hubs and accept signals which originate at X-brushes, counter exits, read brushes, or "10" pulses within IBM equipment. When impulsed at or before row 4-time they cause the CA-2 to stop operations immediately after processing the current card; when impulsed after row 4-time, they cause CA-2 operations to stop after the next card.

These hubs should not be wired from COMMAND, since a heavy load would then be placed on the internal circuits of the CA-2.



Bus

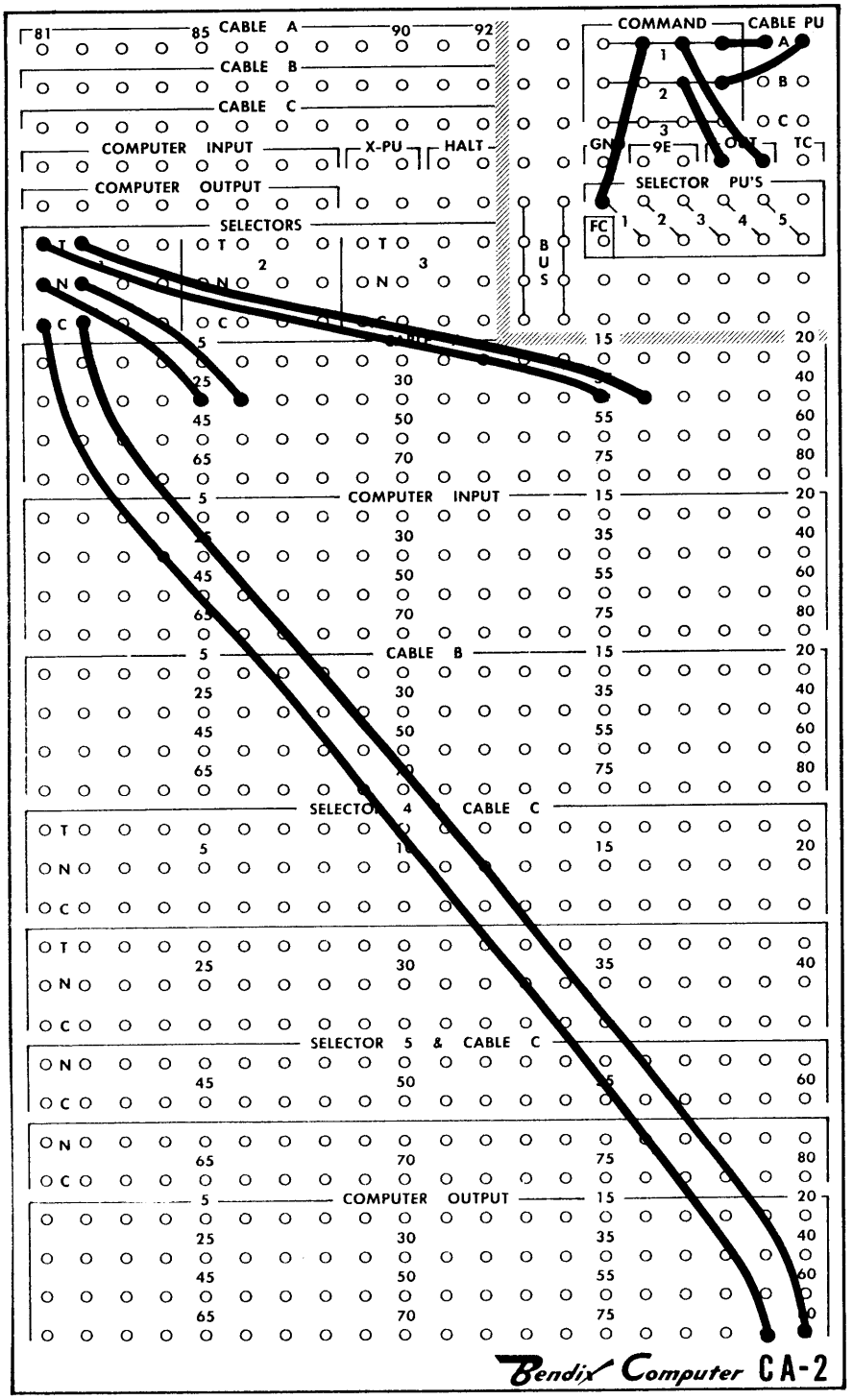
These hubs are connected together as shown in the figure above and may be used to extend the number of hubs available for a specific function without the need for "split wiring".

Ground 

This exit hub is used primarily by Customer Service Engineers, who wire from this hub to CABLE PU's or to SELECTOR PU's instead of from COMMAND, to assist them in performing certain checking operations. It may be used to keep a selector permanently transferred, if desired.

WIRING EXAMPLE SHOWING USE OF SELECTORS

The diagram is for the example on page 26.



OPERATING NOTES

1. Accessory CA-2 must be connected to the G-15 Computer before power is turned on.

2. Accessory CA-2 requires the use of a new number track, if used with Timing Control. The new number track may be used at all times, with or without the CA-2, in place of the old one. (The term "number track" is explained on page 1 in the G-15 Operating Manual, dated July 1959.)

3. For each minus sign sent to a numeric type-bar in the IBM-402, the wire from the cable attached to the CA-2 that would normally go to a numeric print entry hub must be connected instead to "X-PU" of a PILOT SELECTOR on the IBM-402 plugboard. Connect the C hub of the PILOT SELECTOR to a 10 hub. Connect the T hub of the PILOT SELECTOR to the numeric print entry hub.

   For each minus sign that is intended to be printed on an alphanumeric type-bar from the special symbol position (zone 12), the wire from the cable attached to the CA-2 that would normally go to the print or zone entry hub (or column splitting Co-selector) should go to the immediate pick-up of a PILOT SELECTOR. A 12-pulse from the digit selector should be plugged to the PILOT SELECTOR'S C hub, and the T hub should be wired to the zone entry of the desired alphanumeric print bar.

   To print zeros on an alphanumeric type-bar when 4-bit numeric format only is used, wire the signal from the CA-2 to the N hub of a CO-SELECTOR. Connect the C hub of this CO-SELECTOR to a NORMAL ALPHANUMERICAL PRINT ENTRY hub. Connect the zero DIGIT SELECTOR to the T hub of the CO-SELECTOR. Connect the Digit Impulse (DI) hub to the C hub of the same DIGIT SELECTOR.

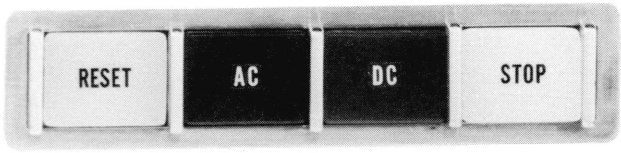
   To wire an IBM-523 or 514 to provide alternate format, X-PU on the CA-2 control panel must tie to the appropriate X pick-up point on the IBM machine. X-PU connects to hub 81 of CABLE A, B, or C on the CA-2 control panel. The other end of the wire from this hub ties via the cable to Column splits 11 - 12 of the 523 or 514 control panel; the latter point must be connected to the proper X pick-up brush or X pick-up delay. The X pick-up brushes must be properly adjusted in addition to being correctly wired.

Halting an Input-Output Operation

If format labels are inserted directly, in the manner described on pages 9 to 11, the insertion of a "1" in the D-marker bit position determines whether or not the input-output operation is halted.

There are three other methods of halting CA-2 input-output if the format is not required to do so. One method is by pressing the white button on the top of the CA-2 cabinet. A second is by the "halt" command described on page 12. A third method is by connection of an input signal from a card machine to the "Halt" hub on the CA-2 control panel.

In the latter method, if the card signal is from the X-brush or from row 12, 11, 0, 1, 2, 3, or 4, the CA-2 will halt after processing the card currently being read. If the signal to the "Halt" hub is from row 5, 6 7, 8, or 9 on the card, the CA-2 will halt after processing the card following the current one.



CA-2 INDICATORS AND PUSH BUTTONS

Indicators and Push Buttons

Two indicators and two push buttons that are distinguished by colored squares are located at the upper left front of the CA-2.

Reset Button

The yellow button may be used to clear immediately all internal storage circuits (flip-flops) in the CA-2 and to terminate any card operation which may be in progress. It is used only to reset the CA-2 manually prior to changing programs. This function may also be accomplished by execution of a CA-2 command.

AC Power Indicator

The red indicator is turned ON when G-15 controlled AC power has been supplied to the CA-2.

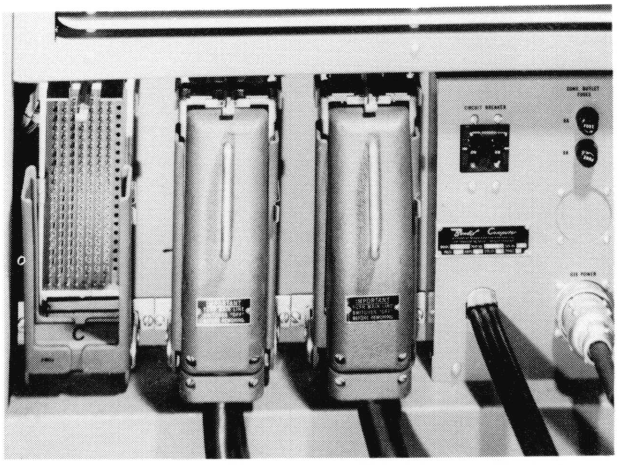
DC Power Indicator

The green indicator is turned ON when DC power is supplied to the CA-2 under control of the G-15 and indicates that the CA-2 is able to receive instruction from a stored program in the G-15 Computer.

Running Indicator and Stop Button

The white indicator light will be turned ON when any Start CA-2 command is obeyed if that command is plugged to activate a cable pick-up for one of the three cable receptacles provided. If a card machine is connected to the proper receptacle and is properly loaded, it will run during the time the light remains on.

If the button is pushed, it will signal the CA-2 to terminate operations at the end of the current card in process.

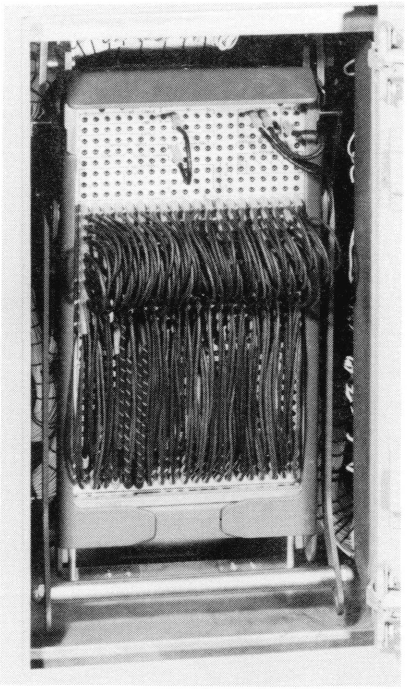


CABLE RECEPTACLES

Cable Connections

At the lower rear of the CA-2 are located three receptacles labeled A, B and C to which cables from card machines may be attached. Access to individual wires of the cables is provided by means of hubs on a removable control panel which is inserted in a receptacle located on the front of the CA-2.

If both G-15 and CA-2 do not operate, be sure circuit breaker is "ON".



CA-2 CONTROL PANEL

Offices

Boston 16
607 Boylston Street
CApitol 7-0450

Chicago 11
919 N. Michigan Avenue
MIchigan 2-6692

Cleveland 13
55 Public Square
CHerry 1-7789

Dallas 1
1511 Bryan Street
RIverside 7-8805

Denver 3
655 Broadway
Suite 910
ALpine 5-1403

Detroit 37
12950 West Eight Mile Road
JOrdan 6-8789

Kansas City 11, Mo.
3430 Broadway
VAlentine 1-8681

Los Angeles
291 S. La Cienega Blvd.
Beverly Hills, California
OLeander 5-9610

New York 17
205 East 42nd Street
Room 1205
ORegon 9-6990

San Francisco
1330 Broadway
Oakland 12, California
GLencourt 2-3664

Washington 6, D. C.
1000 Connecticut Avenue, N.W.
STerling 3-0311

CANADA
Computing Devices of Canada
P. O. Box 508
Ottawa 4, Ontario, Canada
TAlbot 8-2711

OTHER COUNTRIES
Bendix International Division
205 E. 42nd Street
New York 17, New York
MUrray Hill 3-1100

Bendix G-15

PUNCHED CARD AND TABULATOR COUPLER

. . . a new accessory for the Bendix G-15 Digital Computer for low cost, high performance punched card computing and data processing

Now, at a cost significantly below that of any similar equipment, Bendix provides a complete computing system with 100 card per minute punched card input and output, and 100 line per minute tabulation.

Heart of the system is the Bendix G-15 general purpose digital computer, which has proven its performance in over 300 successful installations.

The CA-2 coupler, a newly developed G-15 accessory, enables the computer to operate in conjunction with conventional punched card and tabulating equipment.

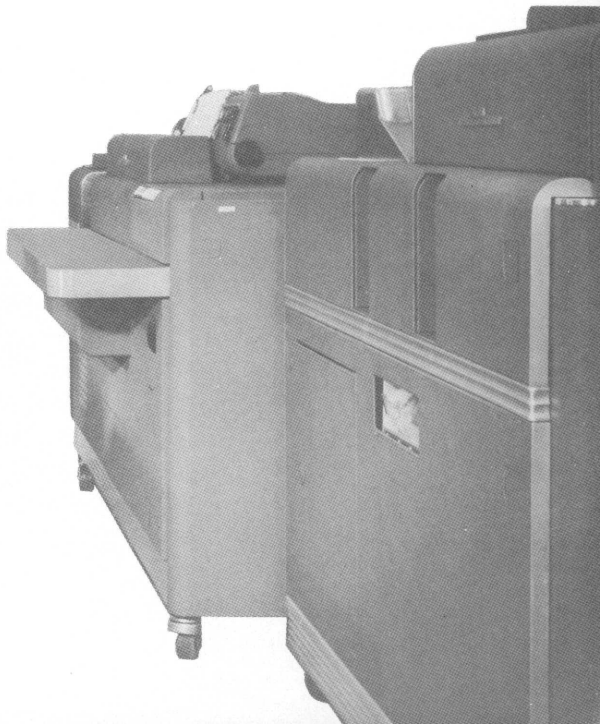
A full 80 columns of numeric, alphabetic, or special character information can be accommodated using only the CA-2 as a connecting link between the card equipment and the G-15. Any column of the card can contain any one of the three types of information.

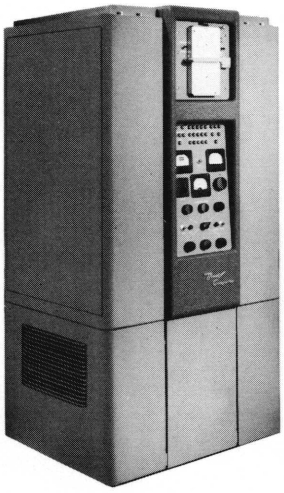
Three input-output units may be connected simultaneously . . . Data may be read or punched by standard card units, or printed by standard tabulators. All input and output is under complete control of the computer. Computation can proceed during the input or output cycle, thus assuring maximum over-all computing speed.

In addition to the CA-2, the computer's typewriter and paper tape equipment, and auxiliary magnetic tape storage units may be used for completely versatile input, output, and storage. Both power and space requirements of the complete punched card computer system are approximately half that of other systems of this type.

A system that includes the G-15 computer, the CA-2 coupler, two summary punches and a tabulator, leases for approximately half the price of a typical medium-priced system with similar capabilities.

Whether you are now using punched card or computing equipment, or if you are delaying such plans due to high costs, you will want to learn more about this inexpensive, efficient equipment. Detailed technical information on the G-15 and the CA-2 will be sent on request. Write to the Bendix Computer Division of Bendix Aviation Corporation, Los Angeles 45, California.





about the G-15

The G-15 is a general purpose digital computer. Low in cost and of medium speed, it is useful for an almost unlimited range of applications. Its physical size has been kept small by the use of serial logic and time-sharing techniques in internal design.

The basic price of the computer includes an electric typewriter for input, output and control, a high-speed photo-electric paper tape reader, and a paper tape punch. The CA-2 coupler, as well as other minimum cost card couplers and magnetic tape memory units may be obtained as accessories. Special accessories include an inexpensive device which enables the computer to perform as a digital differential analyzer, for direct solution of differential equations.

G-15s are available on either a lease or purchase basis. For detailed specifications and applications data, contact the Bendix Computer office nearest you. You will be surprised at the low-cost and simplicity of electronic computation with the G-15, already serving scores of progressive businesses, large and small, throughout the world.

Bendix

THE BENDIX CORPORATION
COMPUTER DIVISION, LOS ANGELES 45, CALIFORNIA

offices

BOSTON 16:
80 Boylston Street
CApitol 7-0450

CHICAGO 11:
919 N. Michigan Avenue
Michigan 2-6692

CLEVELAND 13:
55 Public Square Building
CHerry 1-7789

DALLAS 1:
1511 Bryan Street
Riverside 7-8805

DETROIT 37:
12950 West Eight Mile Road
JOrdan 6-8789

KANSAS CITY 11, MO.:
3430 Broadway
VAlentine 1-8681

LOS ANGELES:
291 S. La Cienega Blvd.
Beverly Hills, California
OLeander 5-9610

NEW YORK 17:
205 East 42nd Street
Room 1205
Oregon 9-6990

SAN FRANCISCO:
1330 Broadway
Oakland 12, California
GLencourt 2-3664

TUCSON:
P.O. Box 4333
University Station
MAin 3-0105

WASHINGTON 6, D.C.:
1000 Connecticut Avenue N.W.
STerling 3-0311

CANADA:
Computing Devices of Canada
P.O. Box 508
Ottawa 4, Ontario, Canada
TAlbot 8-2711

OTHER COUNTRIES:
Bendix International Division
205 E. 42nd Street
New York 17, New York
MUrray Hill 3-1100

BULLETIN AM-118-R0460

PRINTED IN U.S.A.

Bendix Computer Division
LOS ANGELES 45, CALIFORNIA

OFFICE

ADDRESSES

INSIDE COVER

T 16-4
AUG 1960