CARD COUPLER FOR

THE BENDIX G-15 COMPUTER

CA-2 PUNCHED CARD COUPLER
FOR THE G-15 COMPUTER

REFERENCE MANUAL

This manual supplements the CA-2 Punched Card Coupler
Technical Bulletin. Control panel wiring, preparation of
card formats, and program steps for reading, punching and
printing operations are described and illustrated.

CONTENTS

BENDIX CA-2 PUNCHED CARD ACCESSORY WITH G-15 COMPUTER
AND TYPICAL CARD EQUIPMENT.

Board Wiring

Examples of control panel wiring are given on the following pages for reading, punching and printing operations. Diagrams are included which show how special cable attachments are connected to various card machines. The examples are not exhaustive; they have been chosen to indicate some of the useful wiring configurations available.

READING WITH THE IBM 523

The IBM 523 Summary Punch may be used to read cards at the rate of 100 cards per minute. This card machine has a single feed mechanism. Cards are fed into the Summary Punch <u>face</u> <u>down</u>, <u>12-edge</u> <u>first</u>. The sequence in which cards pass the

operating stations within the IBM 523 is shown in the schematic diagram, Figure 1. Cards first pass six Punch X-brushes, which can be set to read any six non-adjacent columns of the card. The purpose of the X-brushes is to read 11-row punches which are used to distinguish two different formats. The cards next pass 80 punch dies. There is a separate punch magnet and die for each column of the card. All 12-row positions are punched first, all 11-row positions are punched next, continuing through the last, or 9-row position. Eighty punch brushes represent the last station where a card is read by the punch brushes as the following card passes the punch dies. Card feeding is synchronized in such a manner that when each row position of the first card is being read by the punch brushes, the corresponding row position of the card immediately following is at the punch dies. After leaving the last station (punch brushes), cards are placed in the card stacker.

The Summary Punch cable, which is part of the IBM 523 and is located at the lower left side of this machine, may be connected to the Bendix CA-2 at the cable connectors A, B, or C which are located at the rear of the CA-2. Over this cable, electrical signals are transmitted to and from the CA-2 to control operations of the IBM 523. For this example, we will use Cable A, and will assume that the Summary Punch cable has been attached to this connector on the CA-2. We will also assume that the Start CA-2 instruction with a "C" of 0 is to be used by the programmer for reading operations.

Figure 1. Schematic Diagram
of Summary Punch

1
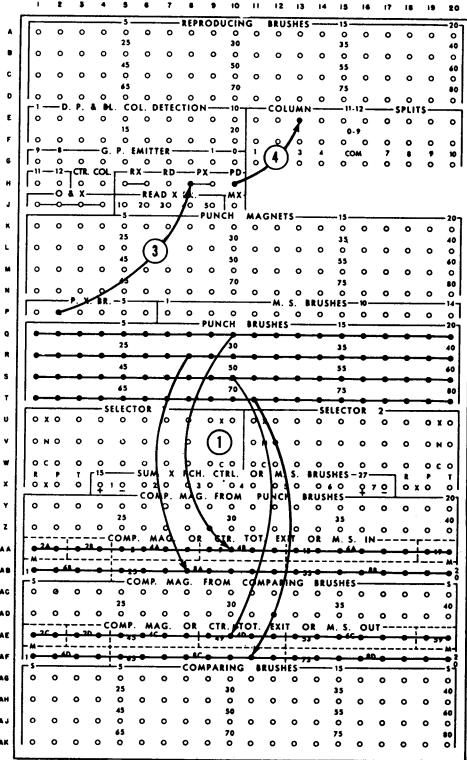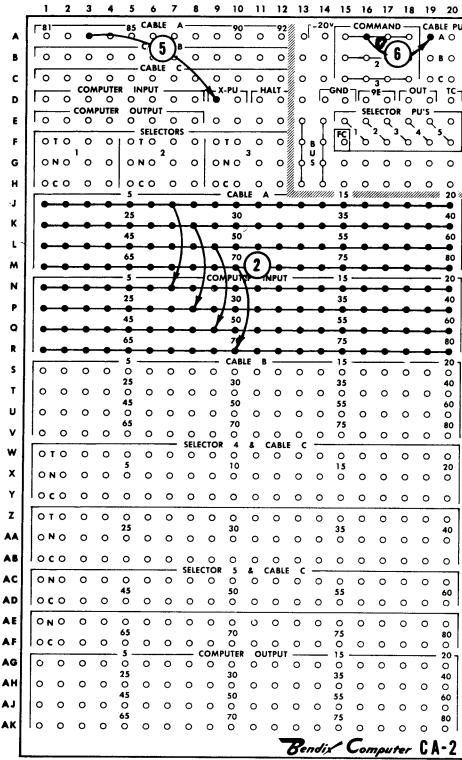
Figure 2. Reading with IBM 523

The Bendix CA-2 and IBM 523 Control Panels may be wired as described below for reading operations. See Figure 2.

523 (1) The PUNCH BRUSHES 1-80 (Q-T, 1-20) are wired to the COUNTER TOTAL EXITS (AA-AB, 1-20 and AE-AF, 1-20). The counter total exit hubs are internally connected to wires inside the Summary Punch cable which is attached to the Cable A connector of the CA-2.

CA-2 (2) The CABLE A hubs 1-80 (J-M, 1- 20) are wired to COMPUTER INPUT (N-R, 1-20) thereby completing the connection from the Punch Brushes of the IBM 523 to the COMPUTER INPUT hubs.

523 (3) One of the PX (PUNCH X) BRUSHES (P, 1-6) is wired to PUNCH X ENTRY (H. 8-9) to delay the signal until the following card cycle at which time the card containing the 11-row punch will be read by the Reading

Brushes. Although not of concern in this example, a signal to this hub also causes suspension of punching when the card reaches the punch dies.

523 (4) The PD (Punch Delay) hub (H, 10) is wired to one of the ten hubs marked 11-12 Column Splits (E, 11-20). These hubs are internally connected to wires inside the Summary Punch cable which correspond to positions 81-90 of the CA-2 cables.

CA-2 (5) One of the hubs 81-90 of Cable A (A, 1-10) which corresponds to the position used in step 4 is wired to X-PU (D, 9-10) to permit an 11-row punch to be read by the X Punch Brushes and be delayed one card cycle; the Format Selector, which is used to automatically select the format group, is turned on.

CA-2 (6) One of the COMMAND 1 hubs (A, 15-18) is wired to CABLE A PU (A, 19-20)

2

to initiate card feeding in the IBM 523 when the Start CA-2 instruction (with a "C" of 0) is executed by the G-15.

The CARD "X" PUNCHED Switch, located inside the door near the control panel of the IBM 523, should be placed in the MASTER (UP) pcsition.

PUNCHING WITH THE IBM 523

The IBM 523 Summary Punch, which has a single feed mechanism, may be used to punch cards at the rate of 100 cards per minute. Cards are fed into the Summary Punch face down, 12-edge first. The sequence in which cards pass the operating stations within the IBM 523 is shown in Figure 1 and has been described above under "READING WITH THE IBM 523".
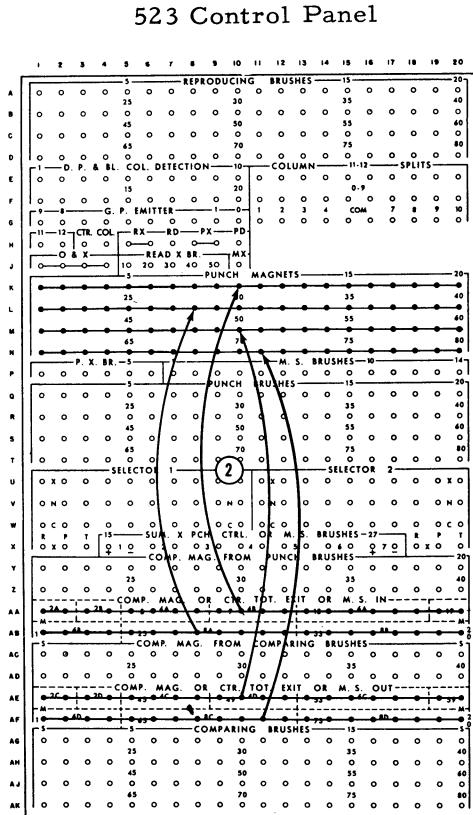
The Bendix CA-2 and IBM 523 control pan-

els should be wired as described below for punching operations. We assume for this example that the Summary Punch cable is connected to Cable B and that the Start CA-2 instruction with a "C" of 2 is to be used by the programmer for punching operations. See Figure 3.

CA-2 (1) COMPUTER OUTPUT hubs 1-80 (AG-AK, 1-20) are wired to CABLE B hubs 1-80 (S-V, 1-20) to supply output signals to the IBM 523.

523 (2) The COUNTER TOTAL EXIT hubs 1-80 (AA-AB, 1-20 and AE-AF, 1-20) are wired to the PUNCH MAGNETS (K-N, 1-20) thereby completing the connection from COMPUTER OUTPUT to the PUNCH MAGNETS.

CA-2 (3) One of the COMMAND 2 hubs (B, 15-18) is wired to CABLE B PU (B, 19-20) to initiate card feeding operations.

523 Control Panel
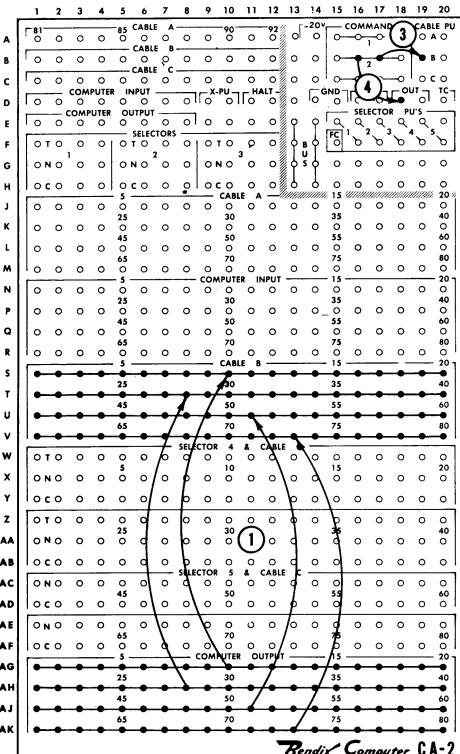
CA-2 Control Panel

Figure 3. Punching with IBM 523

CA-2 (4)   Another one of the COMMAND
2 hubs (B, 15-18) is wired to OUT (D,
18-19) to indicate that an output operation
from the CA-2 is desired.

The CARD "X" PUNCHED switch, located
inside the door near the control panel of
the IBM 523, should be placed in the
MASTER (UP) position.

READING AND PUNCHING
WITH THE IBM 523

One IBM 523 Summary Punch may be used
for both reading and punching operations.
To accomplish both reading and punching
operations (totalling more than 92 columns
and without changing control panels) with a
single IBM 523 Summary Punch, a special
Cable assembly is used (Bendix Part No.
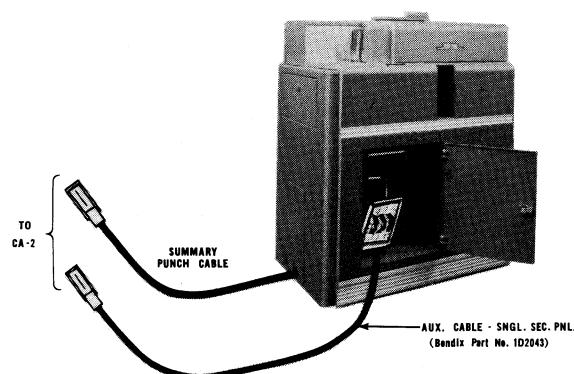
**Figure 4.   Auxiliary Cable
Single Section Panel**

1D2043 - Auxiliary Cable - Single Section
Panel).   See Figure 4.

The cable which terminates at the IBM 523
Control Panel and the Summary Punch cable
from the IBM 523 are attached to two of the
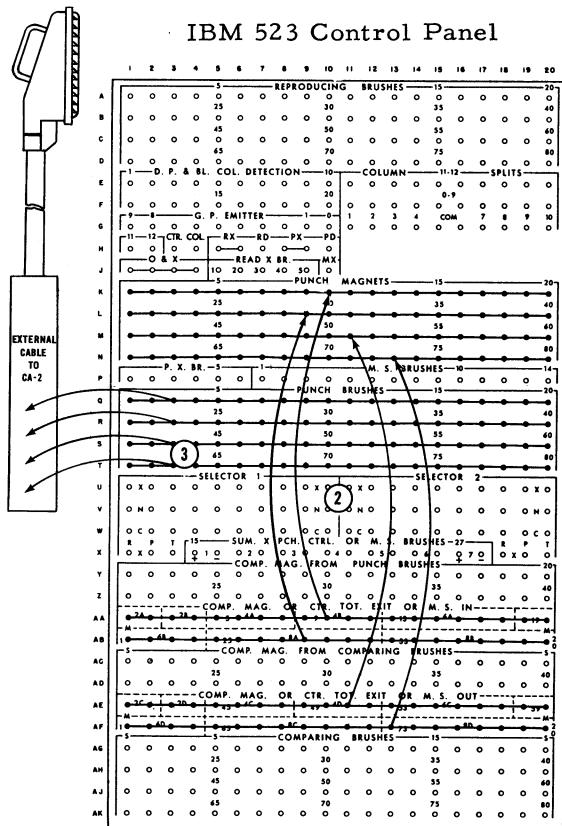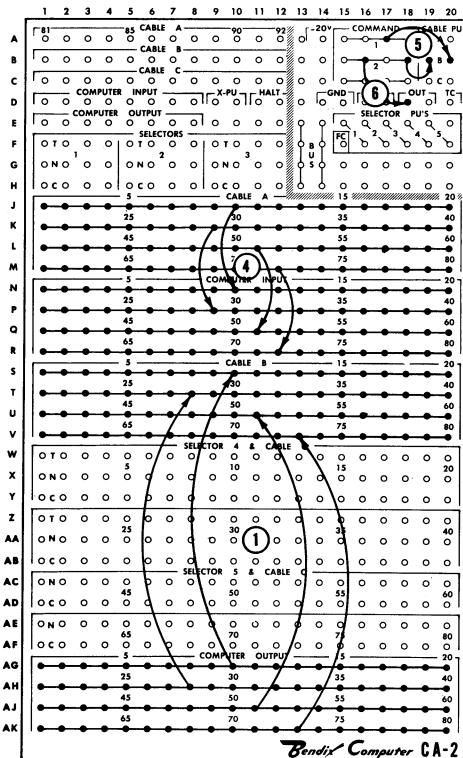
Figure 5.   Reading and Punching with the IBM 523

CABLE A, B, or C connectors located at the lower rear of the CA-2.

We assume for this example that the external cable is connected to the CABLE A connector, that the Summary Punch cable is connected to the CABLE B connector, and that the Start CA-2 instructions with "C's" of 0 and 2 are to be used for reading and punching operations, respectively.

The Bendix CA-2 and IBM 523 Control Panels should be wired as described below. See Figure 5.

CA-2 (1)   COMPUTER OUTPUT hubs 1-80 (AG-AK, 1-20) are wired to Cable B entries (S-V, 1-20).

523 (2) The COUNTER TOTAL EXIT hubs (AA-AB, 1-20 and AE-AF, 1-20) are wired to PUNCH MAGNETS to cause the electrical signals provided at COMPUTER OUTPUT to activate the punch magnets.

523 (3)   The PUNCH BRUSHES (Q-T, 1-20) are wired to positions 1-80 of the auxiliary cable (which has been attached to the CABLE A connector).

CA-2 (4)   The CABLE A hubs 1-80 (J-M, 1-20) are wired to corresponding COMPUTER INPUT hubs (N-R, 1-20).

CA-2 (5)   COMMAND 1 (A, 15-18) is wired to CABLE PU B (B, 19-20) to initiate card feeding operations. CABLE B is used because the Summary Punch cable containing the interlock controls is plugged into the B receptacle.

CA-2 (6)   COMMAND 2 (B, 15-18) is wired to CABLE PU B (B, 19-20) to initiate card feeding operations and to OUT (D, 18-19) to initiate an output operation.

READING AND PUNCHING WITH IBM 513-514

The IBM 513 and 514 Automatic Reproducing Punches feed cards at the rate of 100 cards per minute. These card machines have dual feed mechanisms, known as the read and punch sections. See Figure 6. However, for reading and/or punching with the Bendix CA-2, only the punch section is used. Cards are fed into the Automatic Reproducing Punch face down, 12-edge first. The sequence in which cards pass the operating stations of the punch section within the IBM 513-514 is similar to that for the IBM 523 which has been described above under "READING WITH THE IBM 523".

Control Panel wiring for reading (only), for punching (only), or for reading and punching operations using the 513-514 is identical with that given above for the IBM 523. See Figures 2, 3, 4 and 5.
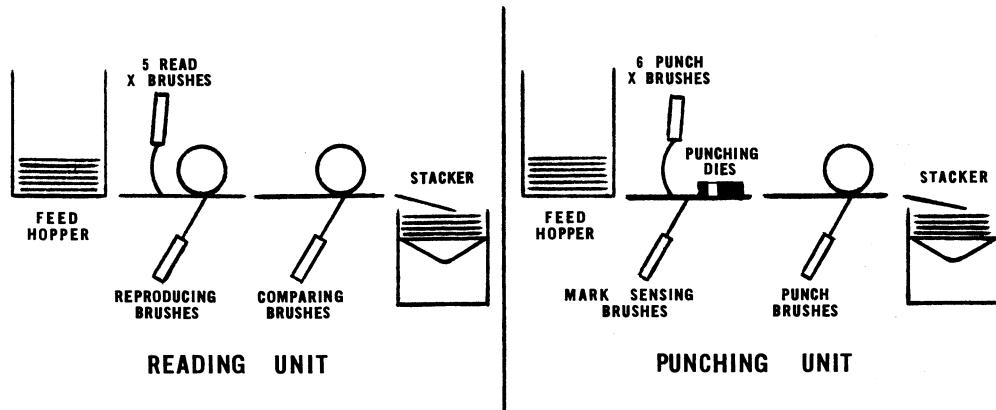

Figure 6.   Schematic Diagram of IBM 514

The switches located inside the door near the control panel of the IBM 513-514 should be placed in the following positions:

REPRODUCE switch to the OFF (UP) position, SELECTIVE REPRODUCED AND GANG PUNCH COMP. switch to the OFF (UP) position, and the CARD X PUNCHED switch to the MASTER (UP) position.

READING WITH THE IBM 519

The IBM 519 Document-Originating Machine may be used to read cards at the rate of 100 cards per minute. Within this card machine are two feed mechanisms, known as the read and punch sections. See Figure 7. However, for reading or punching with the Bendix CA-2, only the punch section is used. Cards are fed into the Document-Originating machine face down, 12-edge first. The sequence in which cards pass the operating stations of the punch section within the IBM 519 is similar to that for the IBM 523.

For this example, we will use Cable A, and will assume that the Summary Punch cable has been attached to this connector on the CA-2. We will assume that the Start CA-2 instruction with a "C" of 0 is to be used by the programmer.

The Bendix CA-2 and IBM 519 Control Panels should be wired for reading opera-

tions as described below. See Figure 8.

519 (1) The REPRODUCING switch (A-B, 1-2) is wired OFF.

519 (2) The MARK SENSING switch (C-D, 1-2) is wired OFF.

519 (3) The GANG PUNCHING AND INTER-PRETING BRUSHES (J, 5-44 and U, 5-44) are wired to COUNTER TOTAL EXIT hubs (R-S, 5-44) which are internally connected to wires within the Summary Punch cable.

CA-2 (4) The 1-80 hubs of CABLE A (J-M, 1-20) are wired to COMPUTER INPUT (N-R, 1-20) thereby completing the wiring from the Gang Punch and Interpreting Brushes within the IBM 519.

519 (5) One of the PUNCH X PICKUP brushes (H-S, 2) is wired to Punch Delay Entry (L, 3) and the Punch Delay Exit (L, 4) is wired to one of the COLUMN SPLITS 11 and 12 hubs (E, 32-43) which are internally connected to the 81-88 wires in the Summary Punch Cable.

CA-2 (6) One of the 81-88 hubs of CABLE A (A, 1-8) which corresponds to the hub used in step 5 is wired to X-PU (D, 9-10).

CA-2 (7) One of the COMMAND 1 hubs (A, 15-18) is wired to CABLE A PU (A, 19-20).

519 (8) Special interlock is wired.
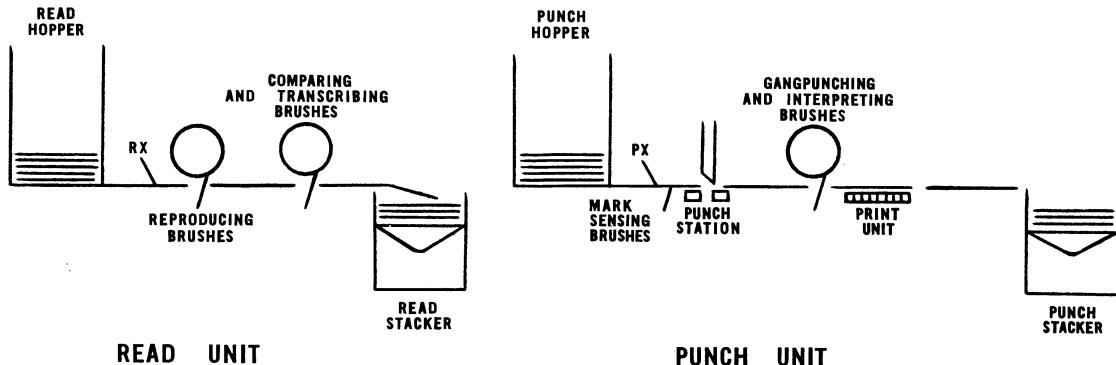
Figure 7. Schematic Diagram of IBM 519

519 Control Panel
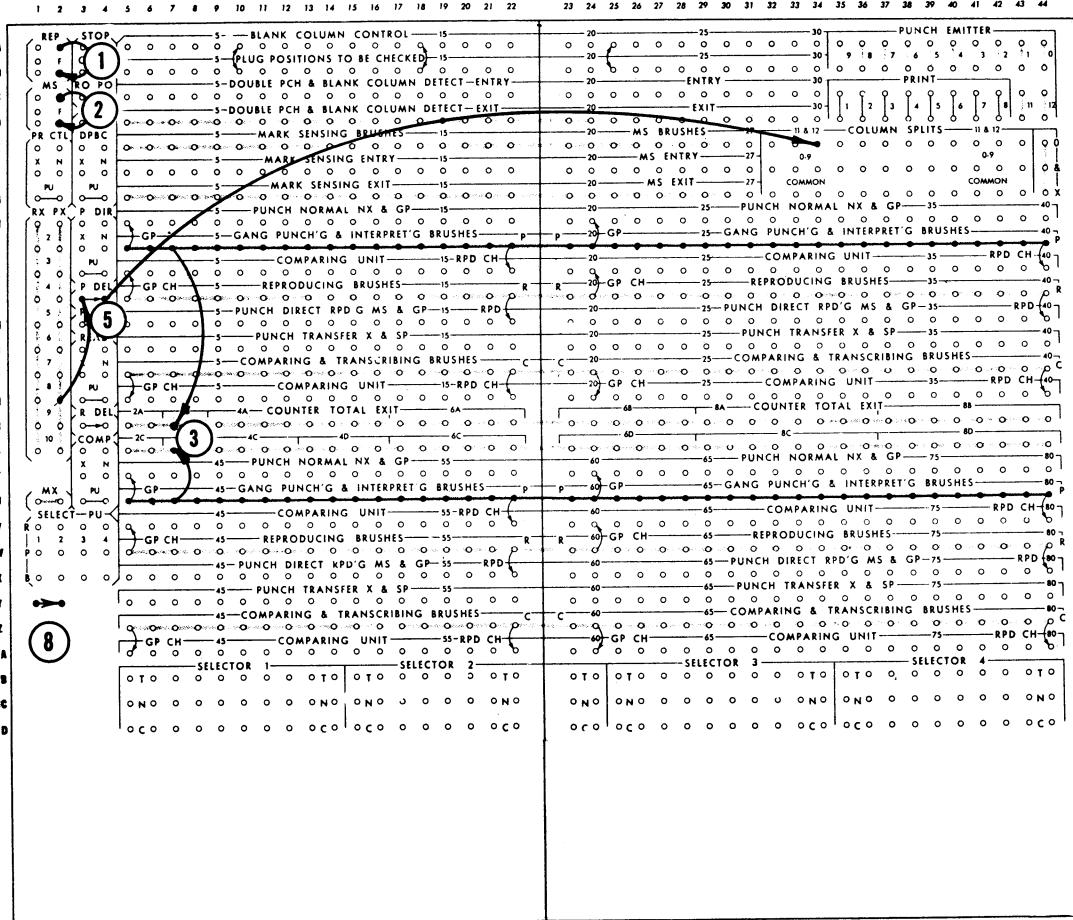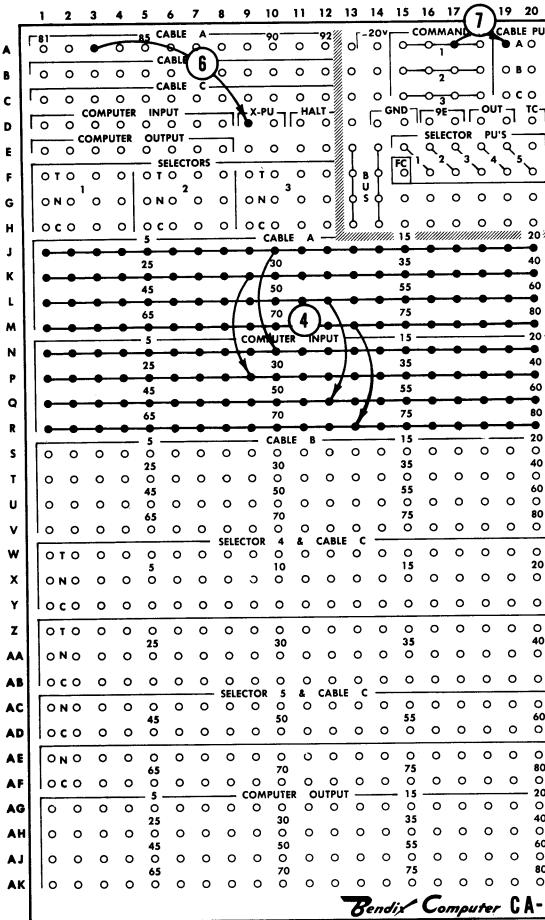
CA-2 Control Panel

Figure 8. Reading with the IBM 519
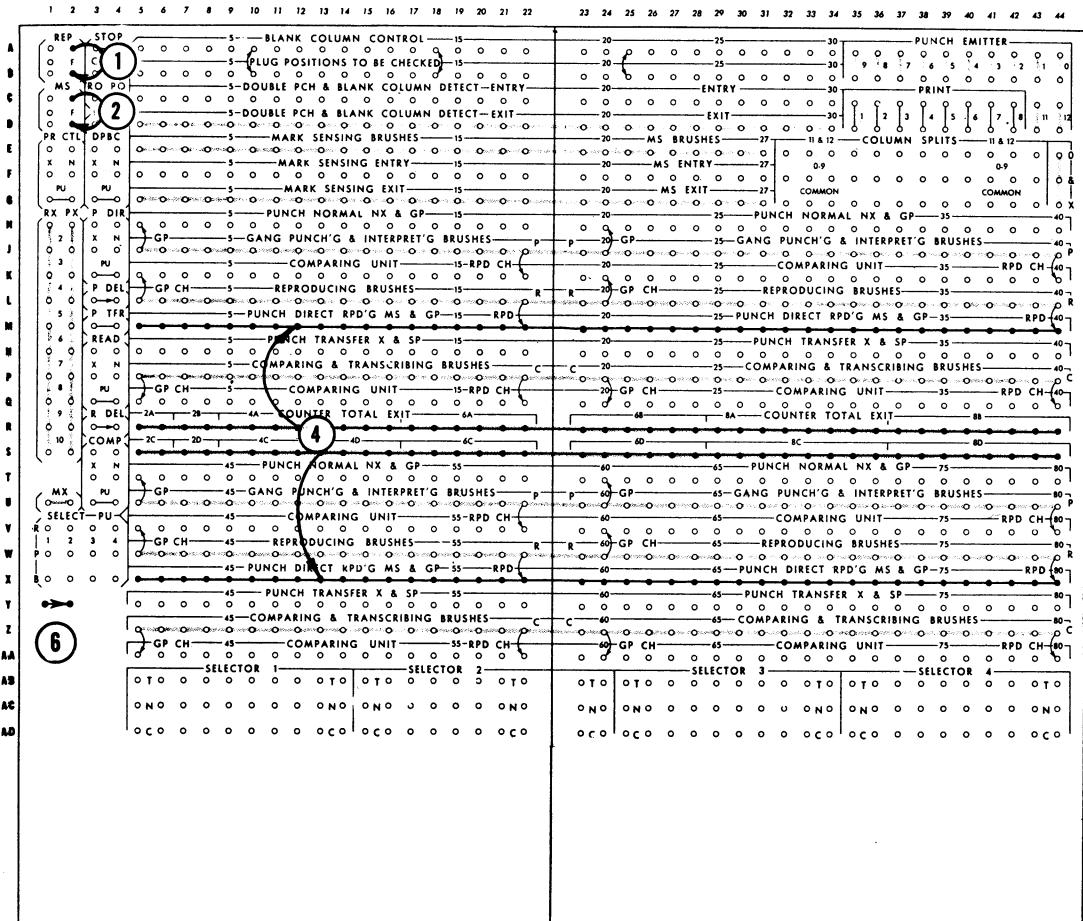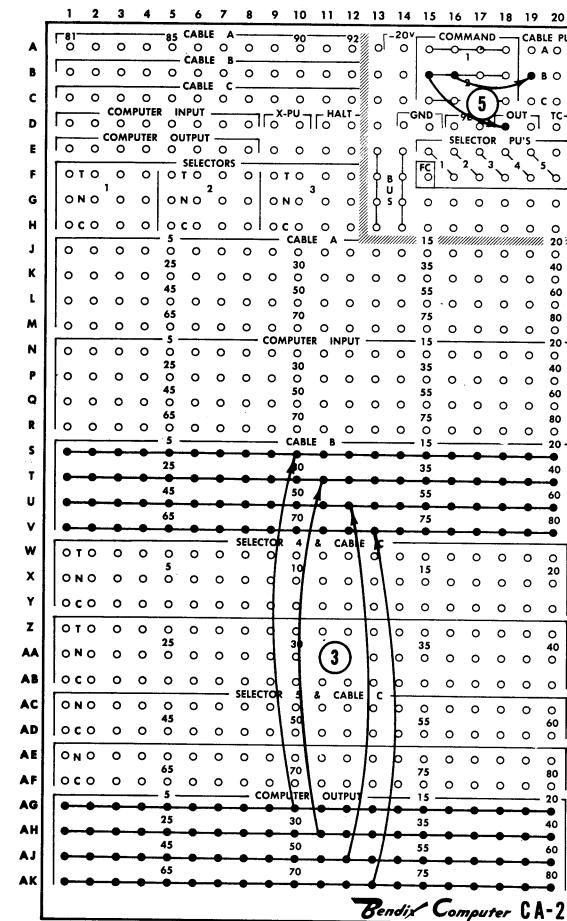
Figure 9. Punching with the IBM 519

PUNCHING WITH THE IBM 519

For this example, we will use Cable B, and will assume that the Summary Punch cable has been attached to this connector on the CA-2. We will assume that the Start CA-2 instruction with a "C" of 2 is to be used by the programmer.

The Bendix CA-2 and IBM 519 Control Panels should be wired as described below for punching operations. See Figure 9.

519 (1) The REPRODUCING switch (A-B, 1-2) is wired OFF.

519 (2) The MARK SENSING switch (C-D, 1-2) is wired OFF.

CA-2 (3) The 1-80 hubs of COMPUTER OUTPUT (AG-AK, 1-20) are wired to the 1-80 hubs of CABLE B (S-V, 1-20).

519 (4) The COUNTER TOTAL EXIT hubs (R-S, 5-44) which are internally connected to wires within the Summary Punch cable are wired to PUNCH DIRECT, REPRODUCING, MARK SENSING, AND GANG PUNCH (M, 5-44 and X, 5-44).

CA-2 (5) COMMAND 2 (B, 15-18) is wired to CABLE B PU (B, 19-20) and to OUT (D, 18-19).

519 (6) Special interlock is wired.

READING AND PUNCHING WITH THE IBM 519

To accomplish both reading and punching with a single IBM 519 Document Originating Machine, a special cable assembly is used (Bendix Part No. 1D2079 - AUX. CABLE DBL. SEC. PNL.). See Figure 10. The cable which terminates at the IBM 519 Control Panel and the Summary Punch cable from the IBM 519 are attached to two of the CABLE A, B, or C connectors located at the lower rear of the CA-2.

We assume for this example that the external cable is connected to the CABLE A con-
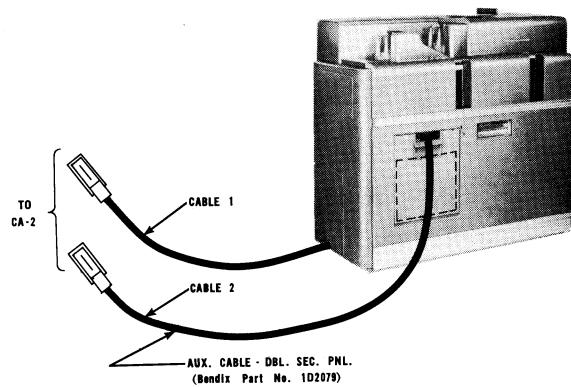
Figure 10.
Auxiliary Cable - Double Section Panel

nector, that the Summary Punch cable is attached to the CABLE B connector, and that the Start CA-2 instructions with "C's" of 0 and 2 are to be used for reading and punching operations, respectively.

The Bendix CA-2 and IBM 519 Control Panels should be wired as described below. See Figure 11.

519 (1) The REPRODUCING switch (A-B, 1-2) is wired OFF.

519 (2) The MARK SENSING switch (C-D, 1-2) is wired OFF.

519 (3) The GANG PUNCHING AND INTER-PRETING BRUSHES (J, 5-44 and U, 5-44) are connected to wires 1-80 of the external cable connector which is attached to the CABLE A connector at the lower rear of the Bendix CA-2.

CA-2 (4) The 1-80 hubs of CABLE A (J-M, 1-20) are wired to COMPUTER INPUT (N-R, 1-20) thereby completing the wiring from the Gang Punching and Interpreting Brushes within the IBM 519.

519 (5) One of the Punch X Pickup Brushes is wired to PUNCH DELAY ENTRY (L, 3) and the PUNCH DELAY EXIT (L, 4) is wired to one of the COLUMN SPLITS 11 and 12 hubs (E, 32-43), which are internally connected to the 81-88 wires in the Summary Punch Cable.

519 Control Panel
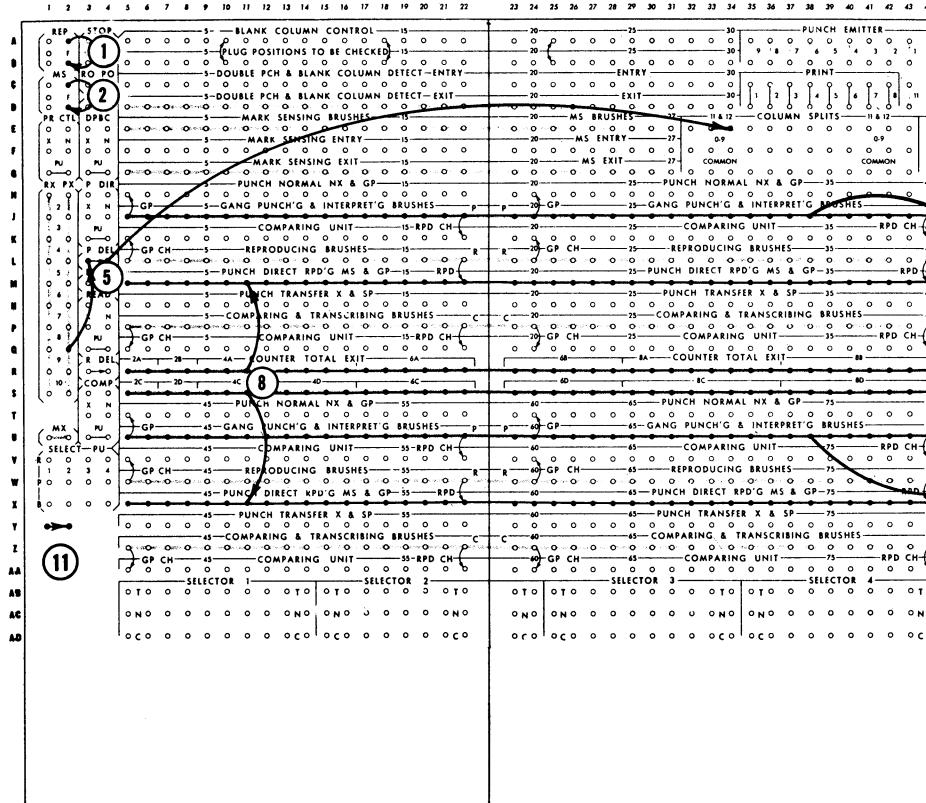
CA-2 Control Panel
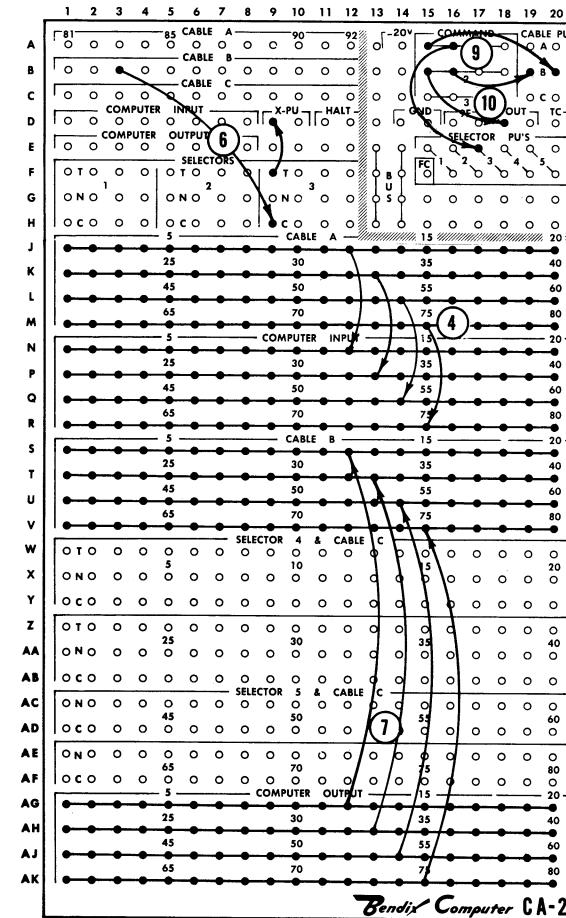
Figure 11.   Reading and Punching with the IBM 519

CA-2 (6) One of the 81-88 hubs of CABLE B (B, 1-8), which corresponds to the hub used in step 5, is wired to one of the C (Common) hubs of Selector 3 (H, 9-12) and the T (Transferred) hub is wired to X-PU (D, 9-10).

CA-2 (7) The 1-80 hubs of COMPUTER OUTPUT (AG-AK, 1-20) are wired to the 1-80 hubs of CABLE B (S-V, 1-20).

519 (8) The COUNTER TOTAL EXIT hubs (R-S, 5-44), which are internally connected to wires within the special external cable assembly, are wired to PUNCH DIRECT RE-PRODUCING, MARK SENSING, AND GANG PUNCH (M, 5-44 and X, 5-44).

CA-2 (9) COMMAND 1 (A, 15-18) is wired to CABLE B PU (B, 19-20) and to Selector 3 PU (E, 17).

CA-2 (10) COMMAND 2 (B, 15-18) is wired to CABLE B PU (B, 19-20) and to OUT (D, 18-19).

519 (11) Special interlock is wired.

PRINTING WITH THE IBM 402

The IBM 402 Accounting Machine may be used with the Bendix CA-2 to print infor-mation at the rate of 100 lines per minute. To accomplish this, a special cable assem-

Figure 12. Cable - 402 Attachment

bly is used (Bendix Part No. 1E2042, Cable - 402 Attachment). See Figure 12. Cable 1, which terminates at the IBM 402 Control Panel, is attached to one of the CABLE A, B, or C Connectors located at the lower rear of the CA-2.

Cable 2 attaches to the Summary Punch receptacle at the lower front of the IBM 402.

We assume for this example that Cable 1 is attached to the CABLE C connector, and that the Start CA-2 instruction with a "C" of 3 is to be used for printing opera-tions.

The IBM 402 Control Panels should be wired as described below. See Figure 13.

(1) The BI (Bendix Impulse) hub (which has been placed at AD, 45 for this example) is wired to the lead marked < DI > .

(2) The three switches (which have been placed at AC-AD, 46-48 for this example) are jack-plugged to form the card interlocks within the IBM 402, making it unnecessary to feed cards when operated with the Bendix CA-2.

(3) The SUMMARY PUNCH switch (AC, 49-50) is jack-plugged.

(4) ALL CYCLES (AK, 41-50) is wired to SUMMARY PUNCH CONTROL PU (Z, 49).

(5) A "10" impulse (AA, 41-44) is wired to the lead marked < BC> .

(6) The DI (Digit Impulse) hub (L, 44) is wired to the C (Common) hub of a Digit Selector (A-B, 57).

(7) The 0 hub (A-B, 54) from the same digit selector as used in step 6 above is wired to the lead marked < FC > .

(8) SPLIT COLUMN CONTROL 1 (X, 41) is wired to Co-Selector 1-PU (A, 58) .

(9) CO-SELECTOR 1-PU's 2-8 (A-B, 59-65) are jack-plugged to continue the wiring of step 8 above.

Figure 13.   IBM 402 Control Panels

(10) The leads marked "1" thru "40" from the external cable 1 are wired to the Common (C) hubs of CO-SELECTORS 1-8 (AA, 1-40).

(11) The Transferred (T) hubs of CO-SELECTORS 1-8 (Y, 1-40) are wired to NORMAL ZONE ENTRY hubs 4-43 (M, 4-43) and the Normal (N) hubs of CO-SELECTORS 1-8 (Z, 1-40) are wired to NORMAL ALPHA-MERICAL PRINT ENTRY hubs 4-43 (S, 4-43).

(12) The wires marked 41-79 from the external cable 1 are wired to the NUMERI-CAL PRINT ENTRY hubs 1-39 (T, 1-39).

(13) The wire marked 80 from the external cable 1 is wired to the Common (C) hub of a DIGIT SELECTOR (A-D, 45-57).

(14) Digit 12 (C-D, 56) is wired to the X-PU of a Pilot Selector (E-N, 51-66) and the T (Transferred) side is wired to NON-P (AB, 43-44).

(15) Digits 0, 1, 2, and 3 (C-D, 51-54) are wired to the D PU hubs of Pilot Selectors (E-N, 51-66).

(16) ALL CYCLES (AK, 41-50) is wired to the Common hubs of Pilot Selectors used in steps 14-15 above and the T (Transferred) sides of the selectors are wired to SPACE CONTROL (AC, 41-44) 1, 2, 3 and S. (S is via a bus connection).

(17) Digits 4-8 (C-D, 46-50) are wired, respectively, to CARRIAGE "SKIP TO" D 4-8 (R-V, 45).

(18) ALL CYCLES (AK, 41-50) is wired to S P (Summary Punch) CONTROL ENTRY 1.

(19)· S P CONTROL ENTRY 2 is wired to SPACE CONTROL SUPPRESSION (AC, 41) by means of the same bus used in step 16 above.

(20) S P CONTROL ENTRY 3 is wired to LIST (AB, 41-42).

The CA-2 panel (see Fig. 14) used for this

CA-2 Control Panel
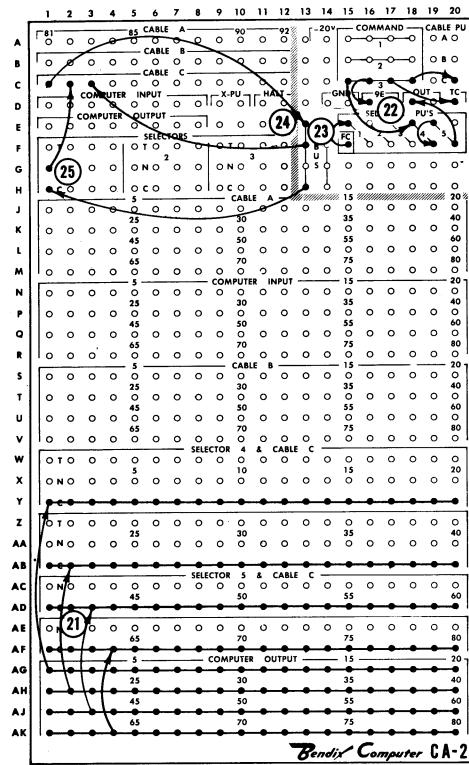
Figure 14. Printing with the IBM 402

example should be wired as described below.

(21) COMPUTER OUTPUT (AG-AK, 1-20) is wired to CABLE C entries (Y, AB, AD, AF, 1-20).

(22) COMMAND 3 (C, 15-18)is wired to CABLE C PU (C, 19-20), to TC (TIMING CONTROL) (D, 20) to 9E (9-EDGE) to SELECTOR 4 and 5 PU (E-F, 18-20) and to OUT (D, 18-19).

(23) The FC (First Card) hub (F, 15) is wired to SELECTOR 1 PU (E-F, 15-16).

(24) CABLE C 81 (C, 1) is wired to a BUS hub (E-H, 13-14) and from this BUS to CABLE C 83 (C, 3).

(25) The same BUS used in step 24 above is wired to the C (COMMON) hub of SELECTOR 1; the N (Normal) hub is wired to CABLE C 83 (C, 2).
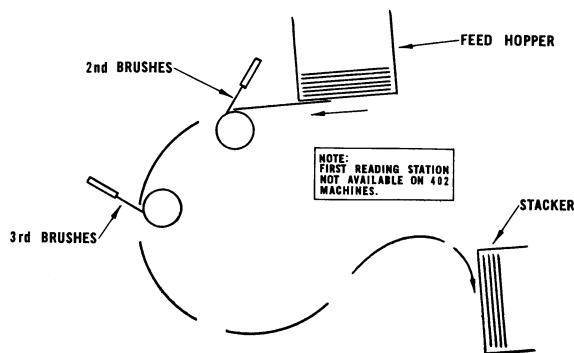
Figure 15. Schematic Diagram of IBM 402

READING WITH THE IBM 402

The IBM 402 Accounting Machine may be used with the Bendix CA-2 to read information at the rate of 100 cards per minute. To accomplish this, a special cable assembly is used (Bendix Part No. 1E2042, Cable - 402 Attachment). See Figure 12. Cable 1, which terminates at the IBM 402 Control Panel, is attached to one of the CABLE A, B, or C Connectors located at the lower rear of the CA-2. Cable 2 attaches to the Summary Punch receptacle at the lower front of the IBM 402. The sequence in which cards pass the operating stations within the IBM 402 is shown in the schematic diagram, Figure 15.

We assume for this example that cable 1 is attached to the CABLE A Connector, and that the Start CA-2 instruction with a "C" of 0 is to be used for reading operations.

The IBM 402 Control Panel should be wired as described below. See Figure 16.

(1) The BI (Bendix Impulse) hub (which has been placed at AD, 45 for this example) is wired to the lead marked $<$DI$>$.

(2) Note that the three switches at AC–AD 46–48 are not jack–plugged in this example as they were in "Printing with the IBM 402".

(3) The SUMMARY PUNCH switch (AC,

49-50) is jack-plugged.

(4) ALL CYCLES (AK, 41-50) is wired to SUMMARY PUNCH CONTROL PU (Z, 49)

(5) A "10" impulse (AA, 41-44) is wired to the lead marked $<$BC$>$.

(6) The 1-80 hubs of SECOND OR THIRD READING (AF-AG, 1-40) are wired to the external cable leads marked 1-80 in the reverse sequence; thus, third reading hub 80 is connected to lead 1, hub 79 to lead 2, etc. Note: Cards will be fed 12-edge, face down.

(7) ALL CYCLES (AK, 41-50) is wired to S P (Summary Punch) CONTROL ENTRY 1.

(8) S P CONTROL ENTRY 2 is wired to SPACE CONTROL SUPPRESSION (AC, 41).

(9) S P CONTROL ENTRY 3 is wired to NON-PRINT (AB, 43-44).

The CA-2 control panel used for this example is shown in Fig. 17 and should be wired as described below.

(10) CABLE A (J-M, 1-20) is wired to COMPUTER INPUT (N-R, 1-20).

(11) COMMAND 1 (A, 15-18) is wired to CABLE A PU (A, 19-20), to TC (Timing Control) (D, 20), and to SELECTOR 2 PU (E-F, 16-17). Note: 9E is not wired.

(12) CABLE A 81 (A, 1) is wired to a BUS hub (E-H, 13-14). The remaining BUS hubs are wired to CABLE A 82-83 (A, 2-3).

HAMMERSPLITS AND HAMMERLOCKS

There are 88 hammersplit, 88 short hammerlock and 88 long hammerlock levers located in front of the Print Unit of the IBM 402. See Figure 18. When a hammersplit lever is raised, zeros and special character positions to the right of it, up to the next significant digit, are suppressed. A special

14
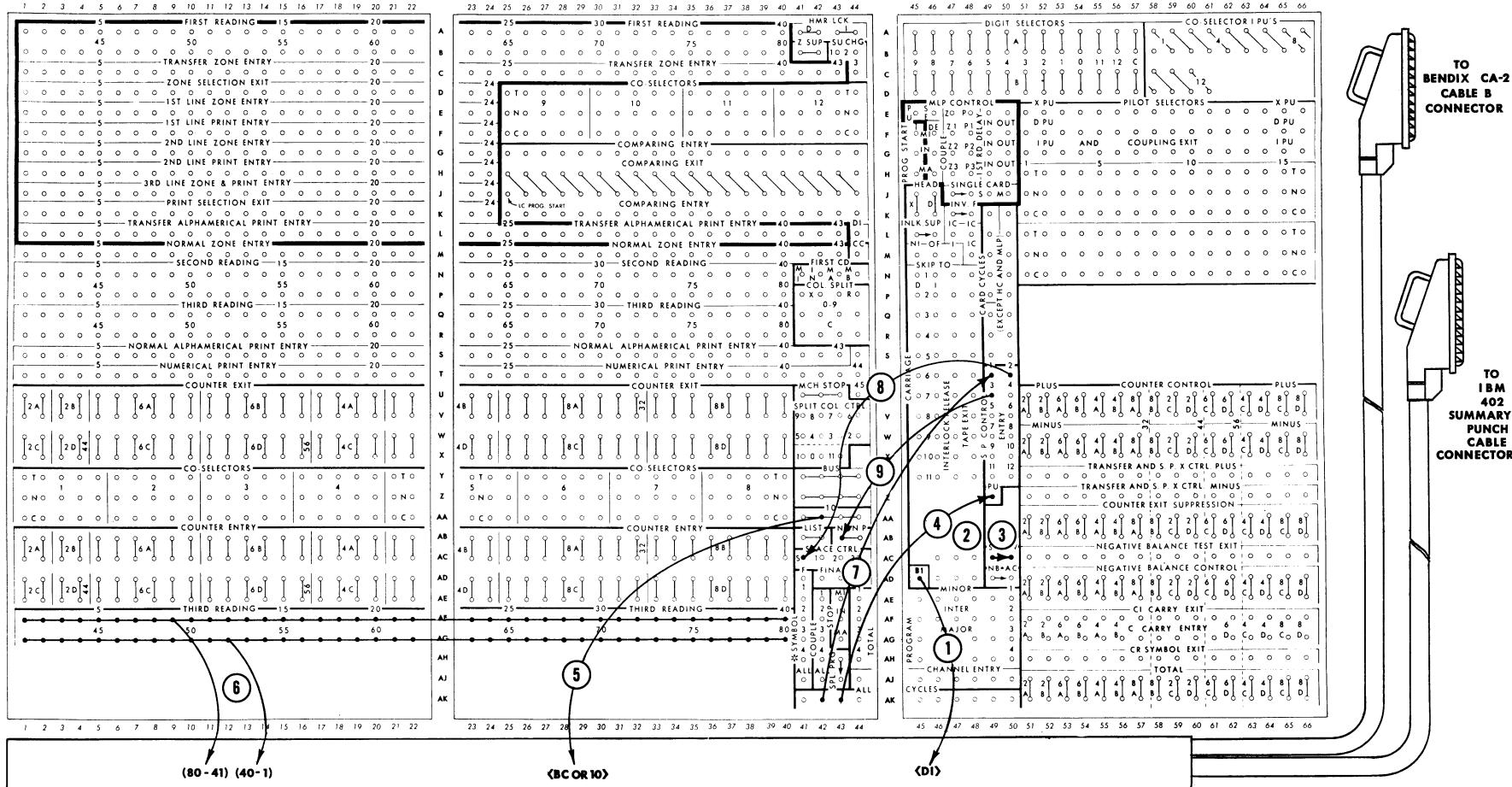
Figure 16.   Reading with the IBM 402

CA-2 Control Panel
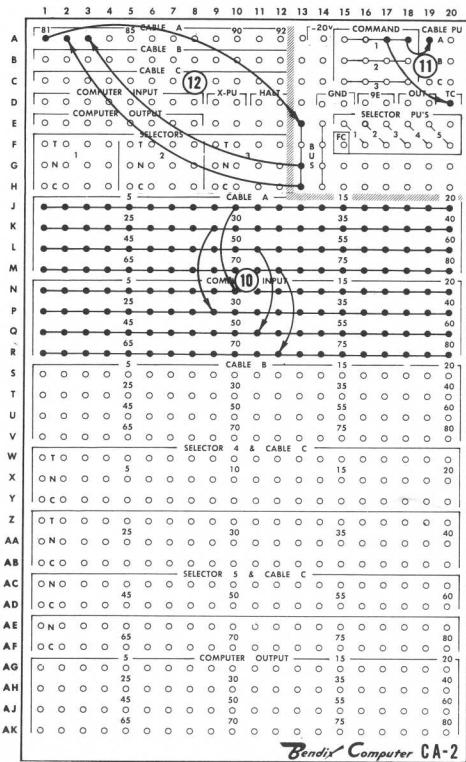
Figure 17. Reading with the IBM 402

character can be printed on the alphanumeric type-bars by a single 12-row punch. Printing of this character is under the control of the hammersplit levers, as is the zero position. It is possible to print a zero from any alphanumeric type-bar without a significant digit to the left by using a combination of 0 and 1 rows. It should be noted that the CA-2 provides both a 0 and 1-row signal for the 6-bit zero character (110000) when the 9-E and OUT hubs are impulsed (as is required for printing with the 402). Hence, the six-bit zero character will always cause a "0" to print from the alphanumeric type-bars, regardless of whether or not the hammersplit levers have been raised.

Hammerlock levers are used to suppress printing of selected fields. When both levers are down, the hammer will hit the type-bar on every printing cycle. When the short hammerlock is raised, the hammer will never hit the type-bar and, therefore, no printing will occur in that printing position. When the long hammerlock is raised, the hammer is under the control of the hammerlock hubs on the IBM 402 Control Panel which, when impulsed, prevent the hammer from striking the type-bar.
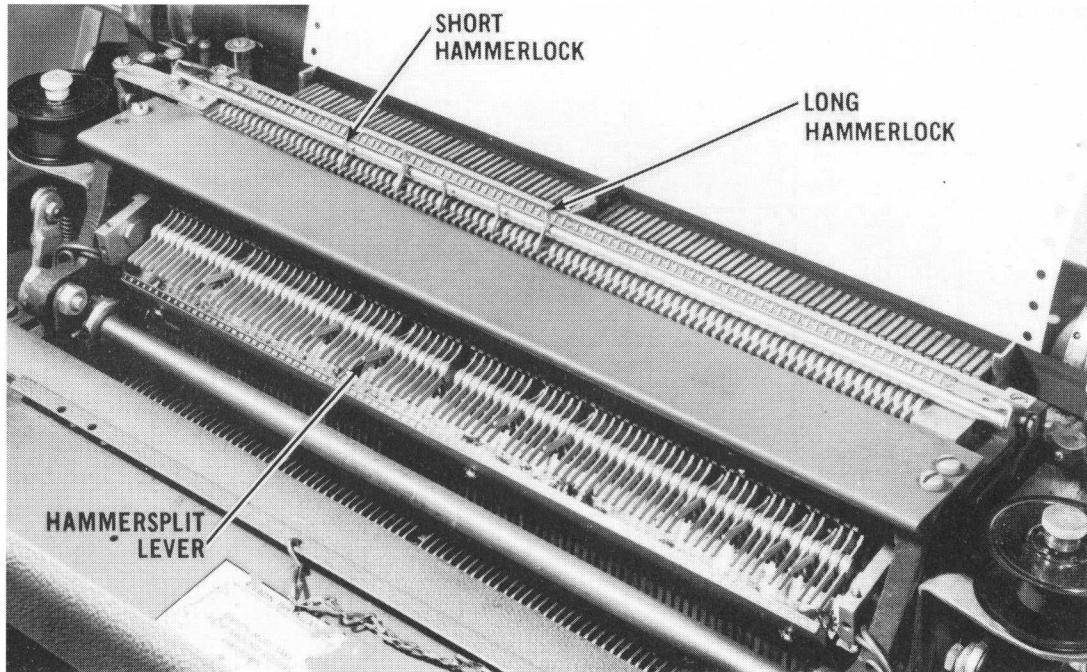
Figure 18. Hammersplits and Hammerlocks

READING AND PRINTING
WITH THE IBM 402

The IBM 402 Accounting Machine may be used with the Bendix CA-2 to read cards at 100 cards per minute and to print lines of information at the rate of 100 cards (or lines) per minute. To accomplish this, a special cable assembly is used (Bendix Part No. 1E2169. CABLE-402 DUAL CONN.) See Figure 19. Cables 1 and 2, which terminate at the IBM 402 Control Panel, are attached to two of the CABLE A, B, or C connectors located at the lower rear of the CA-2. Cable 3 attaches to the Summary Punch receptacle at the lower front of the IBM 402. Note that Cable 1 contains the interlock connections required to start each card cycle within the IBM 402. Thus, the CABLE PU hub, on the CA-2 Control Panel associated with the cable connector (A, B, or C) used with Cable 1, must be wired from a COMMAND hub for both reading and printing operations.

Note that the card feed always operates during printing. Therefore, combined operations of reading and printing during the same run must have blank or dummy cards mixed with data cards for each line of print. In general, this procedure is not recommended. The main reason for the IE2169 dual cable is to eliminate manual changing of the heavy cable board on the 402 between printing runs and reading runs.

We assume for this example that Cable 1 is attached to the CABLE A receptacle, Cable 2 is attached to the CABLE C receptacle, and that the Start CA-2 instructions with "C's" of 0 and 3 are to be used for reading and printing operations, respectively.

The IBM 402 Control Panel used for this example should be wired as described below. See Figure 20.

(1) The BI (Bendix Impulse) hub (which has been placed at AD, 45 for this example) is wired to the lead marked ⟨DI⟩.

(2) The three switches (which have been placed at AC-AD, 46-48 for this example)
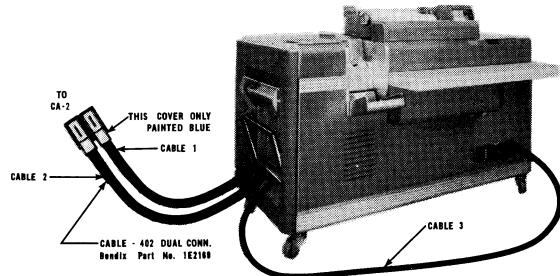
Figure 19. Cable-402 Dual Connector

are jack-plugged to form the card interlocks within the IBM 402, which is convenient when operated with the Bendix CA-2.

(3) The SUMMARY PUNCH switch (AC, 49-50) is jack-plugged.

(4) ALL CYCLES (AK, 41-50) is wired to SUMMARY PUNCH CONTROL PU (Z, 49).

(5) A "10" impulse (AA, 41-44) is wired to the lead marked ⟨BC⟩ .

(6) The DI (Digit Impulse) hub (L, 44) is wired to the C (Common) hub of a Digit Selector (A-B, 57).

(7) The 0 hub (A-B, 54) from the same digit selector as used in step 6 above is wired to the lead marked ⟨FC⟩ .

(8) SPLIT COLUMN CONTROL 1 (X, 41) is wired to CO-SELECTOR I-PU 1 (A-B, 58-66).

(9) CO-SELECTOR I-PU's 2-8 (A-B, 58-66) are jack-plugged to CO-SELECTOR I-PU 1.

(10) The leads marked "1" thru "40" from the external cable 1 are wired to the COMMON (C) hubs of CO-SELECTORS 1-8 (AA, 1-40).

(11) The Transferred (T) hubs of CO-SELECTORS 1-8 (Y, 1-40) are wired to NORMAL ZONE ENTRY hubs 4-43 (M, 4-43) and the Normal (N) hubs of CO-SELECTORS

1-8 (Z, 1-40) are wired to NORMAL ALPHA-MERICAL PRINT ENTRY hubs 4-43 (S, 4-43).

(12) The wires marked 41-79 from the external cable 1 are wired to the NUMERICAL PRINT ENTRY hubs 1-39 (T, 1-39).

(13) The wire marked 80 from the external cable 1 is wired to the Common (C) hub of a Digit Selector (A-D, 45-57).

(14) Digit 12 (A-B, 56) is wired to the X-PU of the Pilot Selector (E-N, 51-66) and the T (Transferred) side is wired to NON-P (AB, 43-44).

(15) Digits 0, 1, 2, and 3 (A-B, 51-54) are wired to the D PU hubs of pilot selectors (F, 55-58).

(16a) ALL CYCLES (AK, 41-50) is wired to the Common hubs of the selectors used in step 15.

(16b) The transfer hubs are wired to SPACE CONTROL (AC, 41-44) 1, 2, 3 and S. (S is via a bus connection).

(17) Digits 4-8 (A-B, 46-50) are wired, respectively, to CARRIAGE "SKIP TO" D4, D5, D6, D7, D8. (R-V, 45).

(18) ALL CYCLES (AK, 41-50) is wired to S P (Summary Punch) CONTROL ENTRY 1.

(19) S P CONTROL ENTRY 2 is wired to SPACE CONTROL SUPPRESSION (AC, 41) by means of the same BUS used in step 16 above.

(20) S P CONTROL ENTRY 3 is wired to LIST (AB, 41-42) and S P CONTROL ENTRY 4 is wired to NON-PRINT (AB, 43-44).

(21) The 1-80 hubs of THIRD READING (AF-AG, 1-40) are wired to the external cable 2 leads marked 1-80 in reverse sequence; thus, third reading hub 80 is connected to lead 1, hub 79 to lead 2, etc.

The Bendix CA-2 Control Panel used for
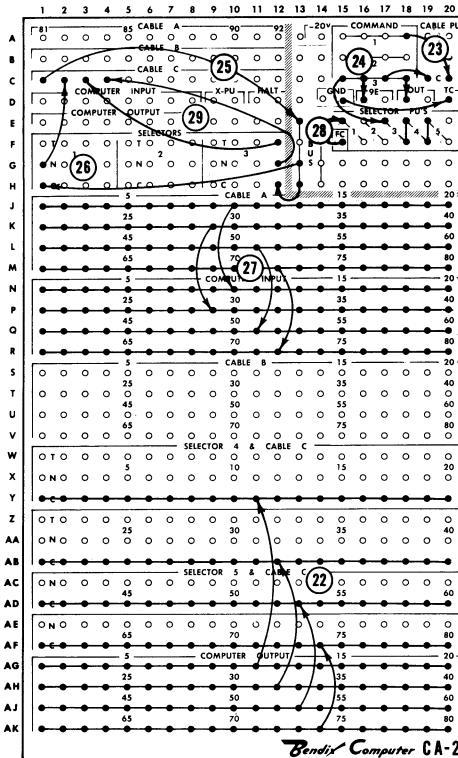
Figure 21. Reading and Printing with the IBM 402

this example should be wired as described below. See Figure 21.

(22) COMPUTER OUTPUT (AG-AK, 1-20) is wired to CABLE C entries (Y, AB, AD, AF, 1-20).

(23) COMMAND 1 (A, 15-18) is wired to CABLE C PU (C, 19-20).

(24) COMMAND 3 (C, 15-18) is wired to CABLE C PU (C, 19-20), to OUT (D, 18-19), to 9E (9-EDGE) (D, 16-17), and to SELECTORS 3-5 (E-F, 17-20). GND (D, 15) is wired to TC (D, 20).

(25) CABLE C 81 (C, 1) is wired to a BUS hub (E-H, 13-14).

(26) The same BUS used in step 25 above is wired to the C (COMMON) hub of SELECTOR 1; the N (NORMAL hub is wired to CABLE C 82 (C, 2).

(27) CABLE A (J-M, 1-20) is wired to COMPUTER INPUT (N-R, 1-20).

(28) The FC (First Card) hub (F, 15) is wired to SELECTOR 1 PU (E-F, 15-16).

(29) The same BUS used in step 25 above is wired to COMMON of Selector 3 (H, 9-12). The Transferred side of this selector is wired to CABLE C 83 (C, 3) and the Normal side of this selector is wired to CABLE C 84 (C, 4).

PRINTING SPECIAL CHARACTERS

The six-bit character for a 12-row punch (010000) may be used to print the "special character" symbol from any alphanumeric type-bar on the IBM 402 by wiring the lead from the CA-2 to an Alphanumeric Print Entry hub.

The one-bit character, the minus sign, (1 in sign position) may be used to print the special character symbol on an alphanumeric type-bar by wiring the lead from the CA-2 to the I-PU of a Pilot Selector. Next, a 12-pulse from the Digit Selector is wired to the C (Common) hub of the Pilot Selector and the T (Transferred) side is wired to the Alphanumeric Print Entry hub.

The six-bit character for a 12-row punch (010000), the six-bit character for an 11-row punch (100000), or the one-bit character (1 in sign position) may be used to print the special character from a numeric type-bar by wiring the lead from the CA-2 to X-PU of a Pilot Selector; then a "10"-pulse is wired to the C (Common) hub of the Pilot Selector and the T (Transferred) side is wired to the Numeric Print Entry hub.

Note that the printing of the special character is under the control of the hammersplit levers in the same way as is the zero position.

The special character symbol is usually a credit symbol (CR) for even-numbered type-bars and an asterisk (*) for odd-numbered type-bars. Not infrequently, however, individual machines are found with other symbols (for example, all type-bars with minus signs). Modifications of this kind are performed by representatives of the IBM Corporation.

Programming

The examples in this section include card format preparation and some of the program steps used in reading, punching and printing operations. Before reading these examples, see the discussion of "Format Control" in the Bendix CA-2 Punched Card Coupler Technical Bulletin.

BINARY FORM	HEXADECIMAL FORM
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	u
1011	v
1100	w
1101	x
1110	y
1111	z

Figure 22. Binary-Hexadecimal Conversion

Note that in Figure 24 the 29 bits of each computer word are divided into groups of four for convenient entrance into Line 16. This form of notation is called hexadecimal, that is, a single character is used to represent each 4 bits in the manner shown in Figure 22. In Figure 24 a "1" in the least significant bit position of a word signifies a minus sign, and a "0" in this position, a plus sign. Thus, if the binary form of a computer word is:

1001 0001 0100 0111 0110 0011 1000 1

then, the hexadecimal form is seen to be:

9   1   4   7   6   3   8   -

FORMAT PREPARATION

The card layout for a PAYABLES DISTRIBUTION card is shown in Figure 23.

Figure 23. Payables Distribution Card

The VENDOR ABBREVIATION field is alphabetic; the CARD CODE in column 80 is a special character; all other fields on the card are numeric; and card columns 73-79 are blank (not used). Preparation of this card format starts with word 00 and column 80 and proceeds to computer word 19 and to card column 1. See Figure 24.

Figure 24. Payables Distribution Format

First, for each column on the card, a one-, four-, or six-bit format label is written in the small squares marked LINE 16 - FORMAT CODES and the card column number is written directly above the label to show the number of bits needed for each column. All unused bit positions are filled with zeros. Note that six-bit labels are used for card columns 73-79 since these columns are to be left blank. (A four-bit label would cause a 0 to be punched).

Next, a B-marker bit is placed in bit position 16 of word 19 to indicate the last column of the card (column 1). Then, a C-marker bit is placed in bit position 23 of word 16 to indicate that this card format is the last card (in this example, the only card) within the format group. Since single card operations are desired, a D-marker bit to indicate a halt is placed in bit position 22 of word 15. Finally, an A-marker bit is placed in bit position 17 of word 19, thereby completing the preparation of the card format.

Using hexadecimal notation, the results obtained in Figure 24 are summarized in Figure 25.

SINGLE-CARD OPERATIONS

Reading

Assume that an IBM 523 Summary Punch, with its control panel wired for reading, is attached to CABLE A of the CA-2 and that the CA-2 control panel has been wired to use COMMAND 1 for reading operations, as shown in Figure 2. The card format shown in Figures 22-24 is assumed to have been stored in word locations 00-19 of Line 16 prior to the execution of the program steps shown in Figure 26.

LOC	P	T	N	C	S	D	
10		10	10	2	22	31	Test CA-2 Ready
11		12	13	5	22	31	Here when CA-2 Ready. Turn OFF Format Selector.
13	u	14	14	0	29	17	Clear Line 17.
14		15	16	0	19	31	Read 1 Card.
16		17	16	2	22	31	Test CA-2 Ready.
17	—	—	—	—	—	—	Continue

Figure 26. Program Steps for Reading

The instruction in location 10 tests the CA-2 to insure that it has completed any

WORD	CONTENTS	MARKERS	CARD COLUMNS	FIELD NAME
19	000x111	A, B	1-4	Entry Date
18	0001111		5-8	Invoice Date
17	00030w3		9-11	
16	02w30w3	C	12-15	Vendor Abbreviation
15	01w30w3	D	16-19	
14	0011111		20-24	Vendor No.
13	0011111		25-29	Our Invoice No.
12	0000011		30-31	Entry
11	0111111		32-34	Account No.
10	0000111		38-40	Dept. Charged
09	0011111		41-45	Material or Part No.
08	0111111		46-51	Order Number
07	0000111		52-54	Dept. Using
06	0001111		55-58	Due Date
05	0011111		59-63	Quantity
04	0000011		64-65	Unit
03	1111111		66-72	Item Amount
02	0000186		73-75*	(Blank)
01	30w30w3		75*-79	
00	0000003		80	Card Code

Figure 25. Format Summary

current card operations before proceeding to the instruction in location 11. Next, the Format Selector is turned OFF to insure that the primary group will be used first. Line 17 is then cleared and card reading is initiated. (This is not an essential instruction, since the CA-2 will automatically clear all bit positions assigned by labels prior to reading information from the card. Line 17 is cleared in this example to insure that the bit positions not assigned by labels will be initially set to zero). Only one card is read due to the presence of a D-marker bit in the card format. See Figure 24. The instruction in location 16 prevents the computer from continuing its operation until after all data from the card have been stored in Line 17.

Punching

Assume that an IBM 523 Summary Punch, with its control panel wired for punching is attached to CABLE B of the CA-2 and that the CA-2 Control Panel has been wired to use COMMAND 2 for punching operations as shown in Figure 3. The card format shown in Figures 23-24 is assumed to have been stored in word locations 00-19 of Line 16 and data to have been stored in the corresponding word locations of Line 17 prior to the execution of the program steps shown in Figure 27.

LOC	P	T	N	C	S	D	
10		10	10	2	22	31	Test CA-2 Ready.
11		12	13	5	22	31	Here when CA-2 Ready. Turn OFF Format Selector.
13		14	15	2	19	31	Punch 1 Card.
15		16	15	2	22	31	Test CA-2 Ready.
16	—	—	—	—	—	—	Continue.

Figure 27. Program Steps for Punching

The instruction in location 10 tests the CA-2 to insure that it has completed any current card operations before proceeding to the instruction in location 11. Next, the Format Selector is turned OFF to insure that the primary group will be used first. Only one card is punched when instruction 13 is executed due to the presence of a D-marker bit in the card format. See Figure 24. The

instruction in location 15 prevents the computer from continuing its operation until after all data have been punched on the card from Line 17.

Printing

For this example, we will assume that an IBM 402 accounting machine is attached to CABLE C of the CA-2, that the CA-2 Control Panel has been wired to use COMMAND 3 for printing operations, and the IBM 402 Control Panel has been wired as shown in Figures 13 and 14. The card format must be stored in both word locations 00-19 and 52-71 prior to the execution of the program steps shown in Figure 28 which have been prepared for execution from Line 04. We will print only that data in Line 17 which correspond to card columns 1-79 and will store a special code in words 00 and 52 to cause single upspacing after printing. The wiring for card column 80 shown in Figure 13 makes available additional characters for Carriage Control operations. See Figure 29. The instructions in locations 10 and 11 insure that all preceding card operations have been completed and that the Format Selector is turned OFF so that the primary group will be used. Instructions 13, 15, and 16 store the single spacing code for Carriage Control in the bit positions used for "column 80". The last two instructions cause the IBM 402 to print a single line (due to the presence of a D-marker in Line 16) and insure that the printing operation has been completed before the computer continues its operation.

LOC	P	T	N	C	S	D	
10		10	10	2	22	31	Test CA-2 Ready.
11		12	13	5	22	31	Here when CA-2 Ready. Turn OFF Format Selector.
13		14	15	0	04	28	Copy Single Space Code into AR
14	0000001						(Single space code)
15		00	16	0	28	17	Store Carriage Control Code in words 00
16		52	17	0	28	17	and 52 of Line 17.
17		18	19	3	19	31	Print 1 line.
18		19	18	2	22	31	Test CA-2 Ready.
19	—	—	—	—	—	—	Continue

Figure 28. Program Steps for Printing

BINARY CODE	CARRIAGE CONTROL OPERATION
111001	Suppress upspace
000001	1 Upspace (after printing)
000010	2 Upspaces (" ")
000011	3 " (" ")
000100	Carriage Skip to 4 (" ")
000101	" " " 5 (" ")
000110	" " " 6 (" ")
000111	" " " 7 (" ")
001000	" " " 8 (" ")
010000	Suppress Printing
010001	" " and 1 Upspace
010010	" " and 2 Upspaces
010011	" " and 3 Upspaces
010100	" " and Carr. skip to 4
010101	" " and Carr. skip to 5
010110	" " and Carr. skip to 6
010111	" " and Carr. skip to 7
011000	" " and Carr. skip to 8

Figure 29. Carriage Control Codes

CONTINUOUS OPERATION

For this example we will assume that two different card formats have been stored in words 00-15 and 16-30 of Line 16, respectively, that each card format contains a 1 in A, B, and C-Marker bit positions, but that there is no 1 in any D-Marker bit position. By such coding, we have identified two format groups (Primary and Alternate) which contain only one card per group, and have indicated (by the absence of a D-Marker) that continuous card feeding is desired.

The cards to be processed have an identifying 11-row punch in column 80 MASTER (alternate group) cards only. DETAIL (primary group) cards are distinguished from MASTER cards by the absence of the 11-row punch in column 80.

Certain computations are to be performed by the computer for each MASTER card; different computations are to be performed by the computer for each DETAIL card.

Since the Format Selector must be turned ON or OFF prior to reading the first card, it is important that we specify whether the first card to be read will be a MASTER or a DETAIL card. For this example we will assume that the first card read will always be a MASTER card. Thus, the Format Selector will be turned ON prior to reading and the data from the first card (a MASTER card), which has an 11-row punch in card column 80, will be placed in the Alternate group (words 16-30) of Line 16.

It is not necessary to specify the number of DETAIL cards which will follow each MASTER card, since the computer program will test the Format Selector for each card.

For this example, we use an IBM 523 for reading with the Control Panels of the IBM 523 and Bendix CA-2 wired as shown in Figure 2. The flow chart given in Figure 30 shows the sequence in which the program steps of Figure 31 are executed.

First, the CA-2 is tested to insure that all previous card operations have been finished. Then, the Format Selector is turned ON (since the first card is to be a MASTER card). The Start CA-2 instruction follows next after which the instruction in location 15 is executed repeatedly until processing starts in the Alternate group. (Note that we are assured that the first card will be processed in this group). The instruction in location 18 is executed next and is repeated until processing is ended for the Alternate group. The computations to be performed for each MASTER card follow immediately (beginning at location 17) and are represented
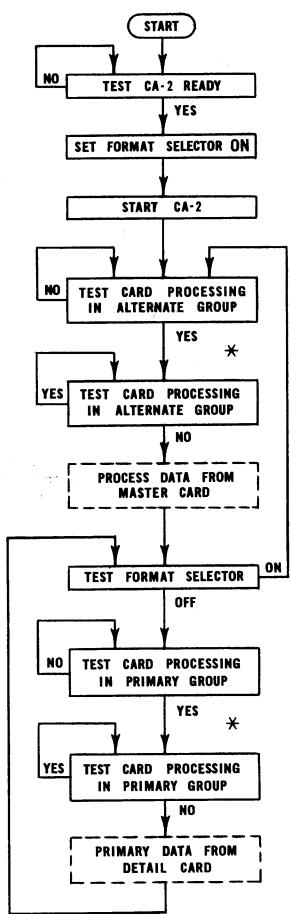
Figure 30. Flow Chart

in Figure 30 by the first sequence of dotted lines. The time required to perform these computations must not be less than 2 nor more than 12 drum cycles.

After performing these computations, the instruction in location 90 is executed next. This instruction tests the Format Selector to determine whether the next card to be read will be a MASTER or DETAIL card and chooses a corresponding route (shown by the arrows in Figure 30).

The remaining instructions process detail cards in a manner similar to that described above for MASTER cards.

It should be noted that, since no 1 appears in any D-Marker bit position of either card format in Line 16, this reading process will operate continuously. In order to terminate the process, a Halt CA-2 instruction (T N 7 22 31) may be executed by the computer. This instruction should be executed within 2 drum cycles after processing begins for a particular card and would normally be incorporated into the set of program steps by making slight modifications at the points indicated by asterisks (*) in Figure 30.

LOC	P	T	N	C	S	D	
10		10	10	2	22	31	Test CA-2 Ready
11		13	13	6	22	31	Here when CA-2 Ready. Set Format Selector ON.
13		15	15	0	19	31	Start CA-2
15	w	30	15	3	22	31	Test Card Processing in Alt. Group.
16		17	18	0	00	00	In process - go to location 18.
18	w	30	17	3	22	31	Test Card Processing in Alt. Group.
17	—	—	—	—	—	—	—	Here when processing completed. Process data from master card and go to location 90.
	—	—	—	—	—	—	—	
	—	—	—	—	—	—	—	
	—	—	—	—	—	—	—	
	—	—	— 90	—	—	—	—	
90		92	14	1	22	31	Test Format Selector. If ON, return to loc 15.
14		15	19	0	00	00	If OFF, go to location 19.
19	w	14	19	3	22	31	Test Card Processing in Primary Group.
20		21	22	0	00	00	In process - go to location 22.
22	w	14	21	3	22	31	Test Card Processing in Primary Group.
21	—	—	—	—	—	—	—	Here when processing completed. Process data from detail card and return to loc. 90.
	—	—	—	—	—	—	—	
	—	—	—	—	—	—	—	
	—	—	— 90	—	—	—	—	

Figure 31. Program Steps for
Continuous Reading

A-MARKER MOVEMENT AND DATA TRANSMISSION

Current Operation	Previous Operation Used Group	Format Selector		A-Marker Advances Within Group	Data Transmitted To Group
		Set by Program Instruction	Set by X-punch in Next Card		
Input-Output	Primary-Alternate	OFF		Primary	Primary
Input-Output	Primary-Alternate	ON		Alternate	Alternate
Input-Output	Primary		OFF	Primary	Primary
Input-Output	Alternate		ON	Alternate	Alternate
Input	Primary		ON	Primary	Alternate
Input	Alternate		OFF	Alternate	Primary
Output	Primary		ON	Primary	Primary
Output	Alternate		OFF	Alternate	Alternate

Since there may be both a primary and alternate format group in a complete format, each group containing its own A-marker, it is necessary to know which of the two A-markers will be moved and within which group data transmission will occur. (The "Test Processing Position" command may be used without knowing the actual location of the A-marker. SEE TEST PROCESSING POSITION, page 12, Accessory CA-2 Punched Card Coupler Technical Bulletin.)

To determine which A-marker is moved and to which group data is transmitted, use the table above.

Example: The current operation is to be an input operation, the previous operation used the primary group, and the Format Selector was turned ON by the next card. According to the table, the A-marker in the primary group will be advanced, but the data read in will be transmitted to the alternate group.

If at least two card formats are used in each format group, input data will always be transmitted under control of the next adjacent card format in each group. Therefore, no card formats will be skipped within a group regardless of the random sequence of primary or alternate group cards being read.

When the CA-2 is halted, the halt operation takes effect before the A-marker is moved. If operation is resumed in the case of information being read alternately into both format groups, care should be taken to avoid skipping a card format or entering information into wrong locations. The A-marker for each format group should be re-inserted in the appropriate position in Line 16. (See "A-Marker" in the Accessory CA-2 Punched Card Coupler Technical Bulletin.)

For output operations, X-punched cards have no effect on format group selection. Once a format group is selected by the appropriate Format Selector command, processing continues in this group until output operations stop. Thus, A-marker movement and data transmission are confined to the group selected.

HINTS FOR DEBUGGING

This section contains a discussion of symptoms and their probable causes which may arise during the debugging phase of program checkout. Suggestions are made for the removal of these difficulties.

Symptom 1

A program which has been successfully run on an earlier date "hangs up" on the Start CA-2 instruction (T N C 19 31), with the white STOP switch remaining ON and the attached card machine failing to operate.

Cause 1

The power switch on the card machine may not be turned ON; the card hopper may be empty; control panels in the CA-2 and attached card machine may not be properly wired - in particular, check to see that COMMAND is wired to CABLE PU.

Symptom 2

A program which has been successfully run on an earlier date causes the attached card machine to feed cards, but no information is read or punched.

Cause 2

The proper control panels are not being used or the CARD "X" PUNCHED switch on the card machine is probably not in the correct position. This switch should be placed in the MASTER (UP) position.

Symptom 3

The program being debugged causes the attached card machine to feed cards but no information is read or punched; the white STOP switch on the CA-2 remains ON; and the computer "hangs up" on a "Test Processing Position" command (T N 3 22 31), indicating the first card fed has not been processed.

Cause 3

Check to see that the A-marker is present and in its correct position in Line 16.

Symptom 4

The program being debugged causes the attached card machine to operate, but either no information is read or punched, or the information appears to be "shifted" on the card or stored in improper locations in Line 17.

Cause 4

Check to see that the B-marker is present and in its correct position in Line 16.

Symptom 5

The program being debugged calls for single card operations but, instead, causes multiple, or continuous, operations; or calls for continuous operations but causes single card operations. The <u>white</u> STOP switch on the CA-2 flashes OFF and ON during card operations.

Cause 5

This symptom is, almost without exception, due to improper use of the D-marker. If operating with card machines which have internal operating cycles more rapid than 1500 rows per minute (such as the IBM 402), check to see that exact agreement exists for both card formats (the original stored in word locations 00 to 51 and the duplicate stored in word locations 52 to u7) and that both formats contain D-markers.

Symptom 6

The program being debugged causes several cards to be read or punched correctly, after which peculiar data transmissions occur, or the CA-2 "hangs up" on a Start CA-2 instruction (T N C 19 31) with the <u>white</u> STOP switch on the CA-2 turned ON.

Cause 6

Before checking subtle violations of timing restrictions in the main program which do not allow adequate processing of data between card operations, check to see that C-markers are present in Line 16 and are properly located.

Symptom 7

All but a few card columns are punched or read correctly with either no information being transmitted for these few columns or the character transmitted being altered by the addition or deletion of one or more bits. (It is important to note whether this symptom can be reproduced at will or is intermittent in its nature.)

Cause 7

If no information is transmitted, check the control panels of the CA-2 and attached card machines for broken external wiring connecting the hubs associated with the columns of the card which exhibit this symptom. (A rapid method of performing this check is to interchange the wiring for the column exhibiting the difficulty with a column free from this symptom.) If the symptom can be reproduced, the label in Line 16 which corresponds to the column producing this difficulty should be examined for faulty coding. (See Cause 6, also.)

If the symptom is intermittent and careful checking determines that the program is not, in some way, altering the transmitted information, request the assistance of Customer Service Engineers.

Appendix

MACHINE SPECIFICATIONS

IBM 523 SUMMARY PUNCH

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

From Bendix: If the IBM 523 is to be used for reading or punching only, no auxiliary cable attachment is required. However, if a single IBM 523 is to be used for both reading and punching operations (totalling more than 92 columns), to avoid changing cable connections, order Single Aux. Cable - Bendix Part No. 1D2043. Order from IBM one 523 Control Panel to which the cable may be attached.

Upon Delivery: Request a Field Service Representative from Bendix to make the wiring connections within the IBM 523 as described on Bendix Drawing No. 3D627, "BASIC CONTROL CIRCUITS - IBM 523 - CA-2".

IBM 513-514 AUTOMATIC REPRODUCING PUNCHES

From IBM: Order an IBM 514 (or 513) with a summary punch cable, an X Pickup delay and Selector 1, a self-contained power supply and several permanent-type control panels. It is recommended that the machine also be equipped with idle-cycle control.

From Bendix: If the IBM 514 (or 513) is to be used for reading or punching only, no auxiliary cable attachment is required. However, if a single IBM 514 (or 513) is to be used for both reading and punching operations (totalling more than 92 columns), to avoid changing cable connections, order Single Aux. Cable - Bendix Part No. 1D2043. Order from IBM one 523 Control Panel to which the cable may be attached.

Upon Delivery: Request a Field Service Representative from Bendix to make the wiring connections described on Bendix Drawing No. 3C626, "BASIC CONTROL CIRCUITS - IBM 514 - CA-2".

IBM 402 ACCOUNTING MACHINE

From IBM: Order an IBM 402 with at least one digit selector (two are recommended) 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.

From Bendix: If the IBM 402 is to be used for reading or printing operations (but not both) order "CABLE - 402 ATTACHMENT - Bendix Part No. 1E2042". If the IBM 402 is to be used for both reading and printing operations, order "CABLE - 402 DUAL CONN. - Bendix Part No. 1E2169". Order from IBM one 402 Control Panel to which the cable may be attached.

Upon Delivery: Request a Field Service Representative from Bendix to make the wiring connections described on Bendix Drawing No. 3C628, "BASIC CONTROL CIRCUITS - IBM 402 - CA-2".

OPERATING SPEED OF CARD EQUIPMENT
## THAT CONNECT TO THE CA-2

Equipment	Cards Per Minute	Points Per Card Cycle	Rows or Lines Per Minute
513	100	14	1400
514	100	14	1400
519	100	14	1400
523	100	14	1400
528	**100**	**14**	**1400**
402	100	20	2000
403	100	20	2000
416	150	20	3000

Internal operating cycles of IBM card-handling equipment vary. The row or line speed per minute of this equipment is determined by multiplying the card cycles per minute times the points per card cycle. See table above.

CHARACTERS PRINTED ON ALPHANUMERIC
TYPE-BARS (1-43) ON THE 402-403 TABULATOR

		ZONE SELECTION			
		N(NoZone)	12	11	0
N	9	9	I	R	Z
U	8	8	H	Q	Y
M	7	7	G	P	X
E	6	6	F	O	W
R	5	5	E	N	V
I	4	4	D	M	U
C	3	3	C	L	T
S	2	2	B	K	S
E	1	1	A	J	Numeric 0
L	0	Numeric 0	Blank	Spec. Char.	Zone 0
E C T I O N	Stop	Blank	Special Character	Zone 0	

The wiring for an additional method of halting is shown
above. Operation will halt after the reading of a card in
which an 11 or 12-row is punched over a column that con-
tains a digit punch. The digit punched in this column is
read normally.

PRINTING ZEROS ON ALPHANUMERIC TYPEBAR

SIGNAL
FROM CA-2

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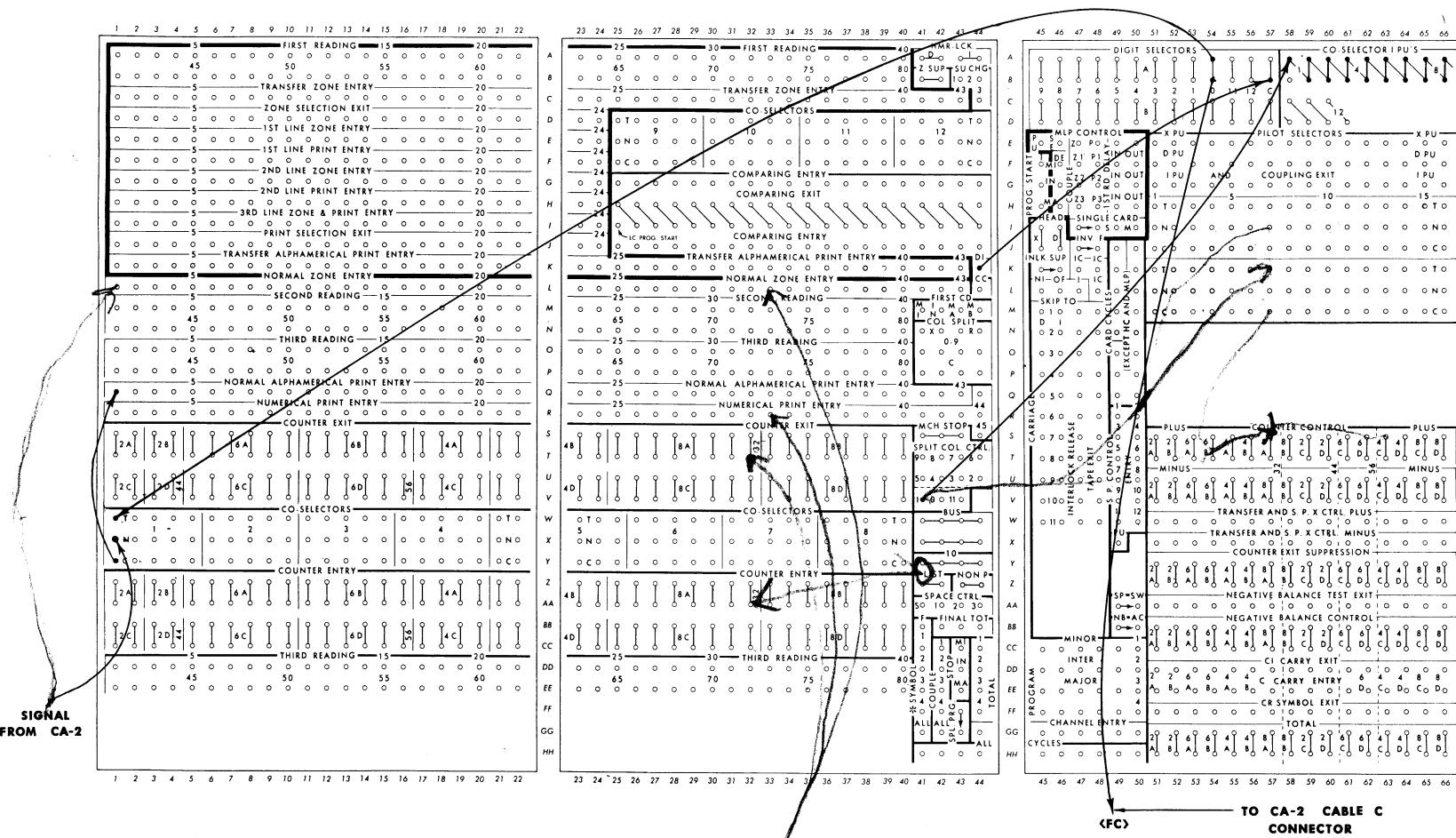
To print zeros on an alphanumeric typebar when 4-bit numeric format only is used,
wire the signal from the CA-2 to the N hub of a CO-SELECTOR. Connect the C hub
of this CO-SELECTOR to a NORMAL ALPHANUMERICAL PRINT ENTRY hub.
Connect the zero DIGIT SELECTOR to the T hub of the CO-SELECTOR. Connect
the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

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