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Computer Systems Department

SELECTION CONTROL

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Keesler Technical Training Center
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Designed For ATC Course Use

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TABLE OF CONTENTS

I. INTRODUCTION

A. Purpose and Objective: This course is to instruct in the operation of the Selection and Control of I/O devices. This is a general outline of the course.

1. Review of the Program Element.
2. Selection Element and Controls.
3. Miscellaneous I/O units.
4. Card Machines
5. Tapes

These will be broken into various sections. For example: Card Machines is broken into:

1. Type 713 Card Reader.
2. Type 723 Card Recorder.
3. Type 718 Line Printer.

Discussed will be the use of the various units, programming of these units, the units operation, and computer timing. Block diagrams and logic will be used.

Information

II. REVIEW OF PROGRAM ELEMENT (UNIT #6)

A. Physical Layout of Unit #6

A	B	C	D	E	F	G	H	J	K
Index Regs 4 & 5	Index Regs 1 & 2	Address Reg	Address Reg Gates	Address Reg Gates	I/O Address CTR & I/O Word CTR	Program CTR	Drum Control Reg	Right I/O Buffer	Left I/O Buffer

B. Functions

1. Control sequence of programmed instructions.

   a. Program Counter

2. Select Indicated Memory Unit and Specific Memory Address.

   a. Program Counter (PT-Time)
   b. Address Register (OT - Time)
   c. I/O Address Counter (During Breaks)

3. Modify addresses through indexing.

   a. Address Register
   b. Address Register Adder
   c. Index Registers

4. Partial Control of I/O Operation

   a. I/O Word Counter
   b. I/O Address Counter
   c. Drum Control Register
   d. I/O Buffer

5. Serves as an information path for some I/O devices.

   a. I/O Buffer

      1) Drums
      2) Card Reader
      3) Manual Input Matrix
      4) Burst Time counters.

6. General.

   The program element, acting under the control of the instruction control element, carries out the instruction sequence scheduled by the programmer. The program element registers perform the following functions in the scheduling and sequencing of operations to be performed by the AN/FSQ-7 Combat Direction Central:

   a. Select the memory unit, and the memory address within that unit, as specified by the program instruction.

   b. Regulate the normal program instruction sequence and the branching of control so that the program is executed properly.

c. Modify the address portion of the instruction word by the process of indexing. This process modifies the content of the address register in the program element without affecting the instruction word contained in the memory element.

Program element operations are synchronized with the operations of both the instruction control element and the I/O element. Briefly, the I/O element generates the commands that execute the actual transfer of words into or out of the core memory element, the instruction control element generates the commands which execute the program instructions, and the program element exercises control of instructions during internal Central Computer System operations.

An internal Central Computer System operation is defined as one in which instructions and data contained in the memory element are used wholly within the Central Computer System. When memory is used in the transfer of a word to or from an external device, such a transfer is referred to as an I/O operation and is analyzed separately as a function of the I/O element.

C. Address Register Figure 4-1

1. Loaded from:

   a. Memory Buffers -- LS of L.M.B. and RS-R15 of R.M.B. at PT-7.
   b. Index Registers (1, 2, 4, and 5) -- Through Address Adder

      1) At PT-8 delayed when indexing
      2) At PT-3 of a conditional BPX Instruction (Reducing Specified Index Register)
      3) At PT-9 of an ADX Instruction.

Information | Presentation Notes

c. Right Accumulator (1X Reg #3) -- Through Address Adder

1) At PT-10 of an XAC Instruction
2) At PT-8 delayed when indexing
3) At PT-9 of an ADX Instruction

d. Left Accumulator Sign -- Through address adder at PT-10 of an XAC (10) Instruction.

e. Complement of Index Interval Register at PT-2 of BPX Instruction. (Preparing to reduce specified 1X Reg.)

2. Loads

a. I/O Address Counter at PT-3 of an LDC Instruction.

b. I/O Word Counter at PT-2 of a RDS or WRT Instruction. -- Complement transfer.

c. Program Counter at PT-0 of Branch Class Instruction when Branch Condition is met.

d. Index Registers (1, 2, 4, or 5)

1) At PT-6 of a conditional BPX Instruction if LS = 0 and branch FF on.
2) At PT-6 of an XAC Instruction if LS = 0.
3) At PT-6 of an XIN Instruction if LS = 0.

e. Right A Register -- At PT-5 of an ADX Instruction.

f. Memory Address Registers

1) At PT-0 if Branch FF is set.
2) At OT-0

3) 16 Bits to MAR 1 -- RS-R15
4) 12 Bits to MAR 2 -- R4-R15
5) 4 Bits to T.M. MAR -- R12-R15

g. Drum Control Register

1) At PT-2 of an SDR Instruction
2) At PT-2 of an SEL Instruction

3. General -- Address Register — Figure 4-1

The address register is a 17 bit register that holds the right half-word of the instruction word received from the memory element during a program cycle. The 17 bits are loaded initially with information from bits LS of the left memory buffer and from bits RS-R15 of the right memory buffer. The contents of the address register are then utilized in other registers of the computer, as specified by the operation part of the instruction.

If indexing is specified by the instruction, the contents of both the selected index register and the address register are added in the index adder before the right half-word in the address register is utilized in the other registers of the computer. The index adder is an integral part of the address register. The indexing operation modifies the operand address called for by the instruction. The sum of the index register and the initial contents of the address register is held in the address register for further operations. The original contents of the address register are lost by this addition but can be found in the memory register from which the original instruction was taken. The contents of the index register remain unchanged unless further operations are specified which change it. Not all instructions may be index in this manner.

D. Index Registers (1, 2, 4, and 5)

1. Loaded from Address Register at PT-6 of an XIN instruction if LS = 0.

2. Address Adder

a. Used in conjunction with index registers.

1) For indexing
2) During a conditional BPX instruction
3) During an ADX instruction

b. Review operation of adder using Figure 1. — Figure 1

Adder Reg.	0.101	0.101
Index Reg.	0.110	1.011
	1.011	0.000
		1
		0.001

c. Trace in Logic -- Normal Adder Logic — CC Logic Vol II

3. General - Index Registers

Four index registers, each 17 bits long, are provided in the program element. In addition to these registers, the right accumulator register of the arithmetic element may also be used as an index register. Selection of an individual index register is determined by the contents of bits L1, L2, and L3 of the operation part of the instruction word.

As noted, it is the function of the index registers to modify the address portion of the instruction word when this type of operation is specified by the operation part of the instruction word.

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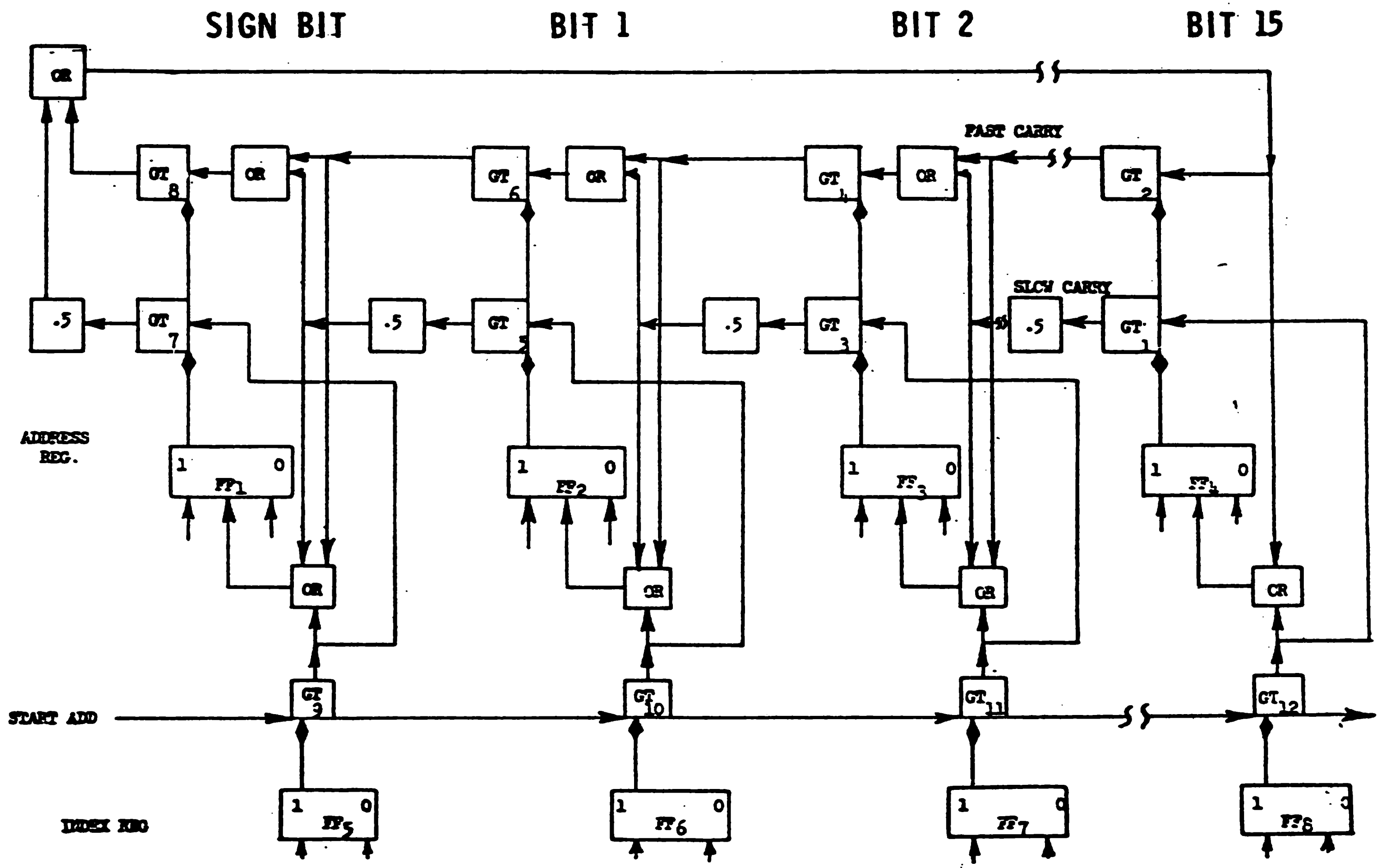

Figure 1 Four Bit Address Adder

Information | Presentation Notes

The four index registers are used in performing cyclic loop programs; the right accumulator register may be used as an index register to perform table lookup operations. The right accumulator register can also be used to reset any one of the four index registers for subsequent cyclic loop operation. The index registers are initially loaded by instructions of the reset class.

E. Program Counter

CC Logic Vol. II
0.4.1
Figure 4-1

1. 17 Bit Counter stepped by:

   a. Every PT-7
   b. OT-9 of a TOB instruction if the bit tested equals "1" (Step P. C. one extra time).
   c. OT-7 of a TTB instruction if the first bit tested equals "1" (Step PC two extra times).
   d. OT-9 of a TTB instruction if the second bit tested equals "1" (Step PC one extra time).
   e. OT-9 of the Compare instructions if no compare condition (Step PC one extra time).

2. Set to 3.77760 by:

   a. Select T. M. Pushbutton

   b. Start from T. M. Pushbutton

3. Set to 3.77770 by an Alarm Branch

4. Loaded from the Address Register at TP-0 of a Branch Class instruction if the Branch FF is set.

5. Transferred to R. A. Register at IP-11 of a branch instruction if the branch FF is set.

6. Transfers to MARs at PT-0 if the Branch FF is clear. -- Start Memory.

7. General -- Program Counter

The Program Counter is a 17 bit register that is used to specify the memory address of the next instruction in the program. As soon as an instruction is transferred to the operation and address registers from the memory buffer register, a 1 is added to the contents of the program counter so that this counter will always specify the memory address of the next program instruction.

The contents of the program counter may be changed by instructions of the branch class, which may be either conditional or unconditional. A conditional branch instruction senses for one of the following: the status of the sign bit of the selected index register, the status of certain registers in the arithmetic element, or the status of certain indicators and alarms, both internal and external to the computer. An unconditional branch instruction is always performed.

When the branch condition is met for a conditional branch instruction, or if an unconditional branch is to be performed, the program branches to the memory address specified by the address portion of the branch instruction word. This address is transferred from the address register to the memory address register which then selects the address in the memory element from which the next instruction is to be taken. Under these conditions, the program counter is cleared and the same address is transferred to the program counter so that succeeding instructions are selected from sequential memory locations starting with this new address.

F. I/O Address Counter — CC Logic Vol. II 0.4.1

1. Controls Memory Selection during I/O operations. — Figure 4-1

2. Loaded from Address Register at PT-3 of an LDC instruction.

3. Stepped by BI-2 or BO-2 pulses -- inhibited by PER(75).

4. General -- I/O Address Counter — Figure 4-1

The I/O address counter is used during I/O operations to designate the memory addresses from which or into which words are to be transferred during break cycles. The initial memory address which is involved in a word transfer is loaded into the I/O address counter from the address register by the Load I/O Address Counter (LDC) instruction. Information transfer between the memory element and the external storage equipment can occur in either direction. As each word is transferred, a 1 is added to the contents of the I/O address counter, thus ensuring that the next, sequential memory address is specified for the subsequent word transfer. The I/O address counter and I/O word counter are always used jointly during I/O operations.

G. I/O Word Counter — CC Logic Vol. II 0.7.3

1. Loaded by

a. Address of RDS or WRT

1) At PT-2
2) In complement form.

b. Set to complement of 3.77760 by "Master Reset" or "Clear Memory"

c. Set to complement of 27_8 by "Load from Card Reader" or "Load from AM drums".

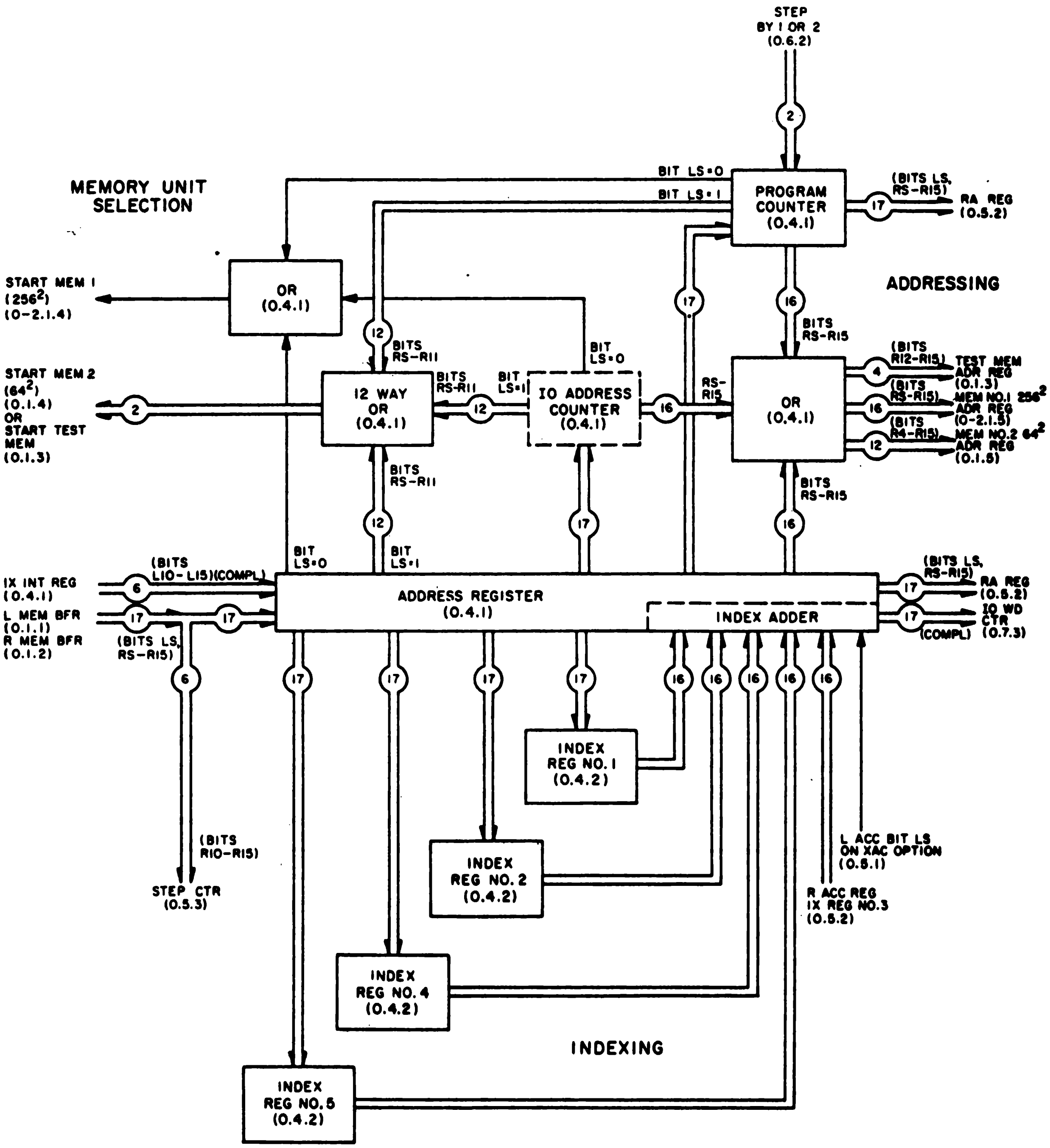

Figure 4—1. Program Element, Logic Block Diagram

Information	Presentation Notes
2. Stepped by	
a. Command 290 -- PT-3 of RDS or WRT	
b. BI-2 or BO-2 for all I/O Devices except Drums and Warning Lights.	
3. Controls the number of words to be transferred during an I/O operation.	
H. I/O Buffer	CC Logic Vol. II 0.7.1, 0.7.2
1. Used for temporary storage during I/O operations.	
2. Loaded from	
a. Drums	
1) Angular Position Counter (APC)	
2) Drum Words	
b. Card Reader	
c. M.I. Matrix	
d. Burst Time Counters	
3. Transfers to I/O Register	
4. Use in conjunction with Drum Control Register	
a. To compare APC during addressable drum operation.	
b. To compare identity bits during Status Identity drum operation.	
I. Drum Control Register	CC Logic Vol. II 0.7.2
1. Used to determine:	
a. Starting address during addressable drum operation.	
b. Which words to accept during Status Identity drum operation.	
2. Loaded from Address Register at PT-3 of SDR and at PT-3 of SEL.	

Summary Questions

1. The Program Counter is used to:

2. The I/O Buffer is used to:

3. The Address Register is <u>not</u> used to load which of the following:

   a. Drum Control Register
   b. I/O Register
   c. I/O Word Counter
   d. Memory Address Register

4. The Index Registers are used to:

5. Name the registers that can load the Address Register and give the times when it is loaded by each register.

6. PA #1 in 6CU (0.4.1) 9B is defective. The contents of which memory location will be in the accumulators at the end of this instruction?

   1000 1 CAD 1.01776
   $C(Ix_1) = 0.00011$

7. GT #7 in 4EH (0.4.1) 13C is defective. What instructions will be affected and how?

8. PA #5 in 4FE (0.4.1) 6A is defective. What instructions will be affected and how?

9. Address comparison for Drum operations is made between which register?

   a. I/O Buffer and I/O Register
   b. I/O Register and Drum Control Register
   c. I/O Buffer and Drum Write Register
   d. I/O Buffer and Drum Control Register
   e. Memory Buffer and I/O Register

III. INTRODUCTION TO SELECTION CONTROL

A. Physical Layout of Unit 5 Refer to Logic Index

A	B	C	D	E	F	G	Z
Ix.Int. Reg. and PER SEL BSN Matrix	Sense Gates and I/O Parity Check Circuits	SEL & PER Gates	Drum RDS/ WRT Con- trols	Break Con- trols and Break Pulse Gen.	Card Mach. Tape and Misc. Con- trols	Alarm Indica- tor FF	Power

B. Functions

1. I/O unit selection and control
2. BSN Instructions -- senses the status of a FF
3. PER Instructions -- Operate various units
4. Break control and pulse generation.

C. Breakdown

1. Selection Control -- performs a selection function.
2. I/O Element -- controls I/O transfers.

The following two sections will go into detail on these two elements.

IV. SELECTION ELEMENT

A. General

The selection element of the Central Computer performs a selection function during the execution of six specific instructions:

1. Test One Bit (TOB)
2. Test Two Bits (TTB)
3. Operate (PER)
4. Branch and Sense (BSN)
5. Select (SEL)
6. Select Drum (SDR)

Each of these instructions uses the selection element circuits to determine which specific circuit of an associated group is to be operated on by a command generated by the instruction control element.

As shown in figure 1-25, the selection element contains the index interval register, the PER-SELBSN matrix, the test, PER, and BSN circuits, and the select gates. During the execution of any of the above instructions, bits L10 through L15 of the instruction word(which contain the coded information to specify the desired circuit to be operated on) are transferred to the index interval register. The output of the index interval register is fed to the PERSELBSN matrix, which determines which of the 64 possible codes is specified. The selected line of the PERSELBSN matrix is supplied to the test, PER, BSN, and selected circuit groups, conditioning only one circuit in each group. The instruction control element specifies which circuit group is involved in the operation by generating the proper command pulse.

The test-bit circuits of the selection element are used during the execution of the Test One Bit (TOB) and the Test Two Bits (TTB) instructions

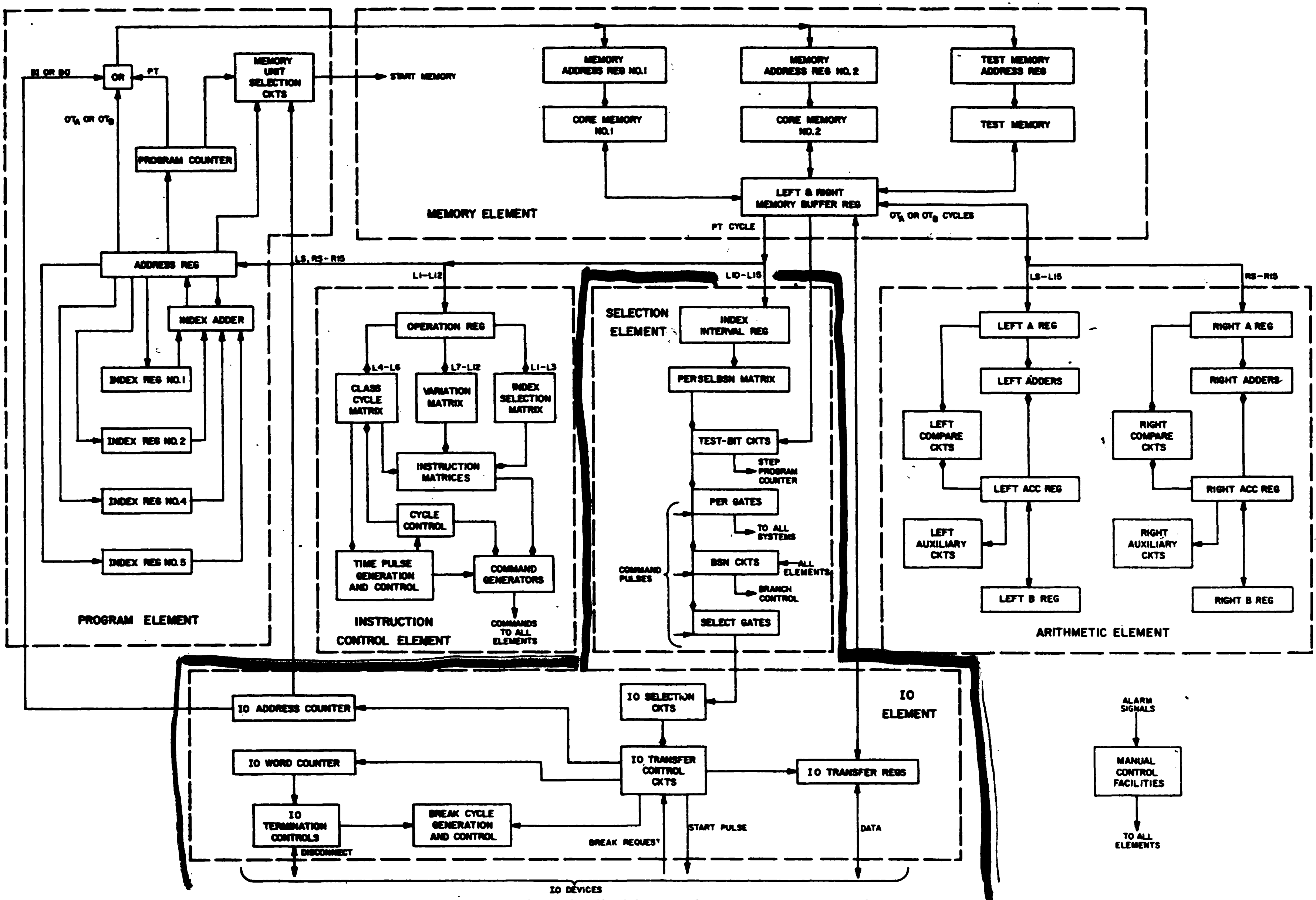

Figure 1—25. Major Circuit Groups of Central Computer System

to specify which bit (or bits) of the selected memory word is to be tested. If the specified bit (or bits) of the memory word is a 1, the program counter is stepped one or more times so that the next one or more sequential program instructions will be skipped.

During the execution of the PER instruction, the selected PER gate generates andoperate pulse to perform the specified operation.

The BSN circuits of the selection element contain the BSN selection gates and the associated flip-flops which are used to indicate the status of a large number of operating conditions in the AN-FSQ-7 equipment. During the execution of a BSN instruction, a specific condition is sensed to determine whether a branch of program control is to be performed.

The selection gates of the selection element are used during the execution of the Select (SEL) and Select Drum (SDR) instructions to set the specified I/O selection circuits and I/O transfer control circuits of the I/O element. The selected circuits in the I/O element specify the I/O devices to be used during the subsequent I/O operation and the mode of data transfer to be used.

It may be seen from figure 5-1 that the selection element consists of the index interval register, the PERSELBSN matrix, test circuits, PER circuits, BSN circuits, and SEL gates. During execution of BSN, PER, TOB, TTB, SDR, and SEL instructions, the index interval portion (L10-L15) of the instruction word is transferred from the left memory buffer register to the index interval register. The dc levels generated by the index interval register are used to condition the PER-SELBSN matrix. The PERSELBSN matrix decodes these levels and produces levels to condition the output line which reflects the contents of the index interval register. This selected output is used to

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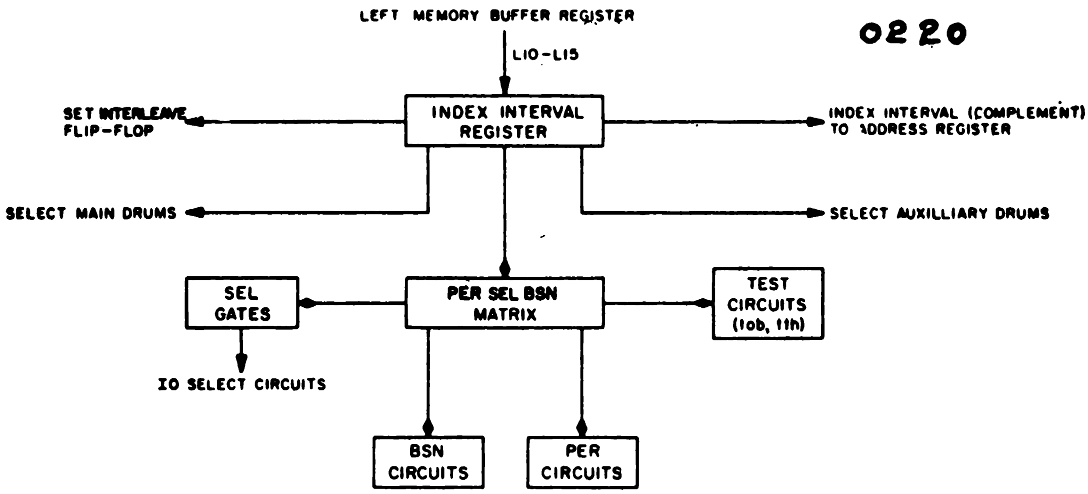

Figure 5—1. Selection Element, Simplified Block Diagram

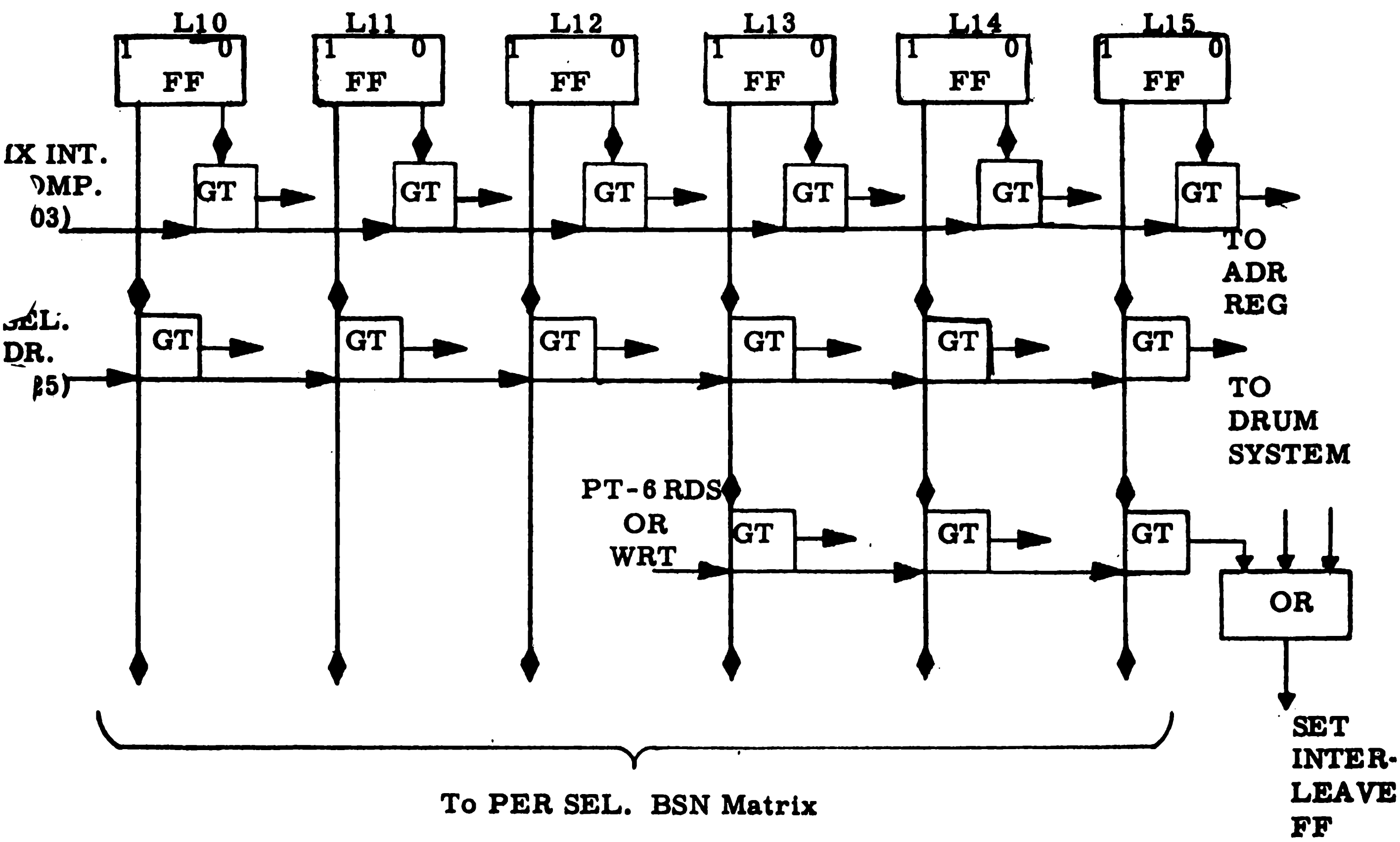

Figure 2, Index Interval Register

condition the circuit associated with the desired sense unit, device to be operated, word bit (s) to be tested, or I/O device to be selected.

B. Index Interval Register

Logic 0.6.1
Figure 2

The index interval register is composed of six flip-flops and their associated output gates. The index interval portion of the instruction word (L10-L15) is loaded into this register from the memory element by way of the left memory buffer register. The significance of the index interval bits depends upon the instruction word. The dc levels generated by the flip-flops are used to drive the PERSELBSN matrix and also to control the action of the associated gates.

The outputs of the index interval register gates perform the following functions:

1. Select a main drum field.
2. Select an auxiliary drum field.
3. Transfer the index interval (complement) to the address register during the execution of the BPX instruction.
4. Set interleave flip-flop.

General on Index Interval Register

1. Loaded from Bits L10-L15 of Left Memory Buffer at PT-7.

2. Used as control bits in:

    a. PER
    b. SEL
    c. BSN
    d. TOB, TTB -- Specified bits to be tested.
    e. SDR -- IX Int. transferred to drum selection register.
    f. Interleaving

        1) 01 by 8
        2) 02 by 16
        3) 04 by 64

g. Overflow -- Suppress overflow alarm
h. BPX -- Transfers to Adr. Reg. in complement form at PT-1

C. PER SEL BSN Matrix

The dc output levels of the index interval register flip-flops drive the PERSELBSN matrix. The matrix produces only one positive output level at a time. This single output is determined by the instruction code. To obtain a positive output level for a specific index interval, the corresponding levels from the index interval register are mixed in an AND circuit. Each possible combination of the index interval bits has an AND circuit assigned to it. Because some of the index interval codes are utilized by several instructions, each output line of the PERSELBSN matrix conditions several gates. The selection of which gate is to be used for a given instruction is made by the command pulses originating in the instruction control element. During execution of an instruction, only the conditioned gate which pertains to that instruction is sensed.

1. 63 "AND" circuits fed from Index Interval register.
2. Used to obtain one level to control an operation.
3. Same index interval amount may be used with different instructions; i.e., PER 01, SEL 01, BSN 01.
4. OT time necessary in these instructions due to rise time of matrix.
5. Example of PER instruction using PER 75. (Lock Adr. Ctr.)

   PER instruction timing
   Logic Index Appendix "A"

   a. Index int. reg. loaded at PT-7 with 75.
   b. Level out of 330 "AND" at 5ANF7 (0.6.1) 8A to 5CH1 (0.4.1) 1D to condition GT-7.
   c. GT-7 strobed at OT-9 to clear "Lock Adr. Ctr." FF, preventing stepping of I/O Adr. Ctr.

d. Note that even though the address portion of the PER instruction has no significance, memory will still be started and the location specified will be read out to the memory buffers.

6. Examples of PER instruction using PER 01 (Condition Light #1)

   a. Level out of 330 "AND" at 5ACA7 (0.6.1) 14D to 5BCB2 (0.7.4) 13B and condition GT-1 in 5CK.
   b. GT-1 strobed at OT-9 to set C.L. #1 FF.

7. Example of BSN instruction using BSN 01 (Condition Light #1)

   BSN Instruction Timing Logic Index Appendix "A"

   a. Level (01) out of matrix conditions one leg of 560 "AND" above "Cond. Light #1" FF in 5BC (0.7.4) 14B. FF being set conditions other leg.
   b. GT5 in 5BV (0.7.4) 4D conditioned which results in BSN Cond. met pulse at OT-9.
   c. Cond. met pulse sets "Branch" FF and clears "Cond. Light #1" FF.

8. Example of SEL instruction using SEL 01 (Card Reader)

   SEL Instruction Timing Logic Index Appendix "A"

   a. Level from matrix conditions GT1 in 5CF (0.7.4) 6A.
   b. PT-5 of SEL sets "Reader Not Ready", "Card Reader", and Card Machine Oper. FFs. -- "Reader Not Ready" FF sensed on BSN 11. (Used to determine which I/O Unit is selected.)

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AN/FSQ - 7

Summary Questions

1. The Index Interval Register is used to: Drive Perselbsn matrix

2. The Index Interval Register is loaded from: L MBfr

3. How many positive output levels does the PERSELBSN put out at one time? /

4. Logic 0.7.4 - 5CKA7(13A) is open. This will cause what to happen every time a PER instruction is executed?

5. Logic 0.7.4 - 5BCGT-6 has open filaments. How will this affect the condition light when sensed by BSN (03)?

6. What bits are used to specify the index interval? At what time are they loaded into the Index Interval Register? L 10-15 PT-7

V. INPUT/OUTPUT ELEMENT

A. General

The I/O element of the Central Computer (Fig. 1-25) contains the control circuits and transfer registers required to accomplish the transfer of information between the memory element and the various asynchronous, slow-speed I/O devices associated with the Central Computer. Since the transfer of I/O information is initiated by the stored program (except for initial program loading), the Central Computer must execute specific instructions to prepare the I/O element circuits before any information transfer can occur. These instructions must specify the following:

1. The I/O device or drum field to be involved in the subsequent I/O operation.
2. The drum starting address or identity code to be used if the subsequent I/O operation involves the Drum System.
3. The starting memory address from which or into which in formation is to be transferred.
4. The direction of information transfer; that is, whether information is to be transferred into or out of the memory element.
5. The number of words to be transferred during the subsequent I/O operation.

This basic information, which must be supplied to the I/O element each time a block transfer of I/O data is to take place, is supplied by a group of three instructions which constitute an I/O program. The basic I/O program is composed of the following instructions.

1. Select (SEL) or Select Drum (SDR)
2. Load I/O Address Counter (LDC)
3. Read (RDS) or Write (WRT)

Generally, the three required instructions are executed in the sequence noted above; the only restriction is that the Read (RDS) or Write (WRT) instruction must be executed last.

As noted above, one of two separate selection instructions is used to specify which I/O device is to be involved in the subsequent I/O operation. Two separate instructions are required because the selective capacity of a single instruction is not great enough to specify all the I/O devices associated with the Central Computer. If one of the individual I/O devices (other than a drum field) is to be selected, a Select instruction is used. During the execution of a Select instruction, the I/O selection and transfer control circuits of the I/O element are cleared, and the desired controls (flip-flops) are set as directed by the control signal generated by the conditioned select gate of the selection element. In this case, the selected controls indicate which I/O device is selected and the type of transfer control that will be exercised during the subsequent transfer of data. If the Central Computer is to be associated with one of the 39 fields of the main drum, or with one of the 36 fields of the auxiliary drum, a Select Drum instruction is used. The Select Drum instruction performs three distinct functions; it sets up the specified field selection circuits in the Drum System, sets up the I/O selection and transfer control circuits in the I/O element, and designates the drum starting address or identity code if this information is required by the selected drum field. During the initial execution of this instruction, the I/O selection and transfer control circuits of the I/O element and the main and auxiliary drum field selection registers of the Drum System are cleared in preparation for the new selection. During the latter part of the instruction cycle, the contents of the index interval register (which specifies the selected field in either drum) are transferred to the selected drum field selection register (specified by the contents of R1 of the instruction word).

At the same time, the conditioned select gate of the selection element will generate a control signal to set the associated I/O transfer control cycle, the contents of the address register (which specifies the drum address or identity code to be used) are transferred to the drum control register of the I/O transfer control circuits. Thus, the Select Drum instruction functions to set up the specified conditions in both the Drum System and the I/O element of the central computer.

The Load I/O Address Counter (LDC) instruction of the basic I/O program specifies the starting memory address to be used during the subsequent I/O operation. During the execution of this instruction, the contents of the address register (which specifies the memory starting address) are transferred to the I/O address counter of the I/O element. Subsequently, as each data word is transferred, the contents of the I/O address counter are increased by 1, with the result that consecutive memory locations are utilized during any I/O operation.

The final instruction executed during the processing of a particular I/O program depends upon the direction that the I/O data is to be transferred. If I/O data is to be transferred from the selected I/O device to the memory element, the Read (RDS) instruction is executed; if I/O data is to be transferred from the memory element to the selected I/O device, the Write (WRT) instruction is executed. The address portion of each of these instructions is used to specify the number of words to be transferred during the subsequent I/O operation. During the execution of either of these instructions, the following operations are performed.

1. The I/O interlock is set.
2. The complement of the address register content is transferred to the I/O word counter.
3. The specified read or write control circuit is set.
4. A Start Read or a Start Write command is generated.

The I/O interlock, which forms a part of the I/O termination controls of the I/O element, is always set at the beginning of an I/O operation and remains set for the duration of the operation. The I/O interlock functions to prevent subsequent I/O program instructions from disturbing the I/O operation in process. If such a condition occurs, all internal operations will be halted until the I/O operation in process is terminated.

The I/O word counter of the I/O element functions to keep a running record of the number of data words that remain to be transferred during the remainder of the I/O operation. As each data word is transferred, the contents of this counter are increased by1. When the contents of this counter are stepped from negative to positive zero, an end-carry pulse is generated which is used to terminate the I/O operation in process.

The read and write control circuits, which form a part of the break cycle generation and control circuits of the I/O element are used to specify which type of break cycle will be generated during the subsequent data word transfers. If the read flip-flops is set, the subsequent break cycles will be defined as BI cycles; if the write flip-flop is set, the subsequent break cycles will be defined as BO cycles.

The Start Read or Start Write command generated during the execution of the Read (RDS) or Write (WRT) instruction functions to start the I/O operation. These commands, which are generated in the instruction control element, are used to sense the I/O operation circuits of the I/O element, so that a start pulse may be applied to the selected I/O device. This start pulse functions either to set the selected I/O device in motion or to condition its control circuits. From this time until the I/O operation is terminated, the Central Computer is under the control of the selected I/O device.

During the I/O operation, the selected I/O device informs the computer, by means of the break request circuits, each time it is ready to transfer data between its associated I/O transfer registers and the memory element. The manner in which the I/O devices are connected to the I/O transfer registers (I/O buffer register and I/O register) is shown in detail in figure 1-25. As noted in the figure, the transfer of I/O data into or out of the memory element is accomplished between the memory buffer register and the I/O register. The I/O buffer register, which is used only during the transfer of input data, provides temporary storage. The transfer of data from the I/O buffer register to the I/O register is effected by the I/O transfer and control circuits.

After the I/O program instructions are executed, the Central Computer continues to execute the internal operations as directed by the stored program. At the end of each machine cycle, the break request circuits of the I/O element are sensed to determine whether I/O data is to be transferred into or out of the memory element. If the break request circuits are cleared, the computer continues with its internal operations. If the break circuits are set, the internal computer operations are stopped for one machine cycle, and the next memory cycle is designated as a BI or BO cycle. During the break cycle, the time pulses generated by the instruction control element are converted into BI or BO pulses to accomplish the required operations. These break pulses effect the data word transfer between the I/O register and the memory element and step the I/O word counter and I/O address counter in preparation for the next break cycle. After the break cycle is completed, the computer resumes its internal operations. This process of interleaving break cycles with internal machine cycles is repeated until the proper number of I/O data words have been transferred. When the I/O operation is completed, the I/O terminating circuits generate a disconnect signal, which either stops the selected I/O device or deconditions its control circuits.

B. Input/Output Break Control

1. Execution of any I/O class instruction or a HLT instruction, when the I/O interlock is set, will set the pause FF, preventing the execution of any more instructions until the pause FF is cleared. Pause FF is cleared after the I/O interlock FF is cleared.

2. Break and Pause Characteristics Logic 0.2.2, 0.2.3

The outputs of the break and pause flip-flops are arranged so that four operational set-and-clear combinations are possible. If, in the course of Central Computer internal operation, an arithmetic pause is specified by the instruction, the pause flip-flop is set as the instruction requires; if a break request occurs, the break flip-flop is set at the end of the cycle then in progress.

During a no-break no-pause condition, both the TP driver and IP driver outputs supply pulses to the time pulse distributor. During this time, the break or no-pause output level is applied to the AND circuit associated with the TPD 0 stage to allow the time pulse distributor to continue supplying time pulses and instruction pulses to the Central Computer System. During the resultant internal operation of the computer, the break-request flip-flop is sensed at TP 10 delayed of each memory cycle to determine whether the next memory cycle is to be associated with either a BI or BO cycle.

During a break-but-no-pause condition, the IP driver output is inhibited to terminate the internal operations of the computer. However, since the break-or-no-pause line remains at the +10V level, the time pulse distributor will continue to function to develop time pulses.

When a pause-but-no-break condition occurs, the generation of time pulses and instruction pulses stops because the break-or-no-pause output line is de-energized, causing the time pulse distributor to be deconditioned. Under this operating condition, the break request flip-flop is sensed at a 2-mc rate.

When a break-and-pause condition exists, the IP driver output line is inactive, but the break-or-no-pause level to the TPD 0 stage is energized to keep the time pulse distributor active and functioning. The break-request flip-flop is examined by the sense-break-request output at TP 10 delayed.

3. Pulses which will be generated when:

   a. No Pause and No Break

      1) TPs, IPs, possible 2 MC operate pulses.
      2) Check for break with TP-10 delayed.

   b. Pause and No Break

      1) Possible 2 MC operate pulses.
      2) Check for break with 2 MC IP driver pulses.

   c. Break and No Pause

      1) TPs, BI or BO, possible 2 MC operate pulses.
      2) Check for break with TP-10 delayed.

   d. Pause and Break

      1) TPs, BI or BO, possible 2 MC operate pulses.
      2) Check for break with TP-10 delayed.

Pause F.F. Status	Break F.F. Status	Timing Pulses (TP's)	Instr. Pulses (IP's)	Break Cycle	Instr. Being Executed
0	0	Yes	Yes	No	Yes
0	1	Yes	No	Yes	No
1	0	No	No	No	No
1	1	Yes	No	Yes	No

4. Break cycle generation

The initial conditioning of the I/O control circuitry for an I/O operation is accomplished through the execution of the SEL and LDC instructions. With the execution of the RDS or WRT instruction, further setting up is performed and the transfer operation is initiated with a start-read or a start-write pulse. However, every transfer of a word requires the initiation of a break cycle.

Three flip-flops (0. 2. 3, B-C 2-3) are involved in this portion of the operation: break-request-sync, break-request, and break. The break-request-sync flip-flop is set by any one of six pulses, provided that at the time the pulse is generated the word counter is not equal to 0 (note gate). The source of these pulses will be covered later in connection with the transfers to or from the various I/O units. The first 2-mc pulse generated after the setting of break request sync will set the break-request flip flop. The gate conditioned by the 1 side of break-request flip-flop is strobed by a TP 11 pulse or a 2-mc pulse (if pause no break condition). A gated TP then sets the break flip-flops. (A second break flip-flop exists in unit 4. It is set and cleared with the one on 0. 2. 3, but its output levels perform different functions.) The break request flip-flop is also set directly by a 2-mc pulse generated under an I/O register empty-I/O buffer full condition. This condition occurs only during a read operation of drums, BTC (Burst time counters), or MI matrix.

The level output from the break flip-flop is applied to two 2-way AND circuits (0. 2. 3 D4). The second input to each of the AND circuits is from the write and read flip-flops. The output from the AND circuit with the read level input is applied to gates which pass TPs to generate the BI pulse. The output from the AND with the write level input is applied to gates which pass TPs to generate BO pulses. The BI pulses or the BO pulses are distributed to control the transfer of the word for which the break cycle was initiated. Tables 6-2 and 6-3 give the function of the BI and BO pulses, respectively.

C. Input/Output Programming -- General

1. Instructions are:

    a. LDC
    b. SDR
    c. SEL
    d. RDS
    e. WRT

2. All instructions check I/O interlock before operating.
3. Used to set up for transfers between I/O equipment and Memory.
4. All instructions are indexable.

D. LDC Instructions

1. Used to load I/O Address Counter

TABLE 6–2. FUNCTIONS OF BI PULSES

PULSE	FUNCTIONS
BI 0	1. Clear break request FF 2. Transfer IO address counter to MAR 3. Start memory
BI 1	Not used
BI 2	1. Step IO address counter (0.4.1) 2. Clear IO register status flip-flop (0.7.7) 3. Step IO word counter (if drums not selected) 4. Transfer IO registers to memory buffers
BI 3	1. Start parity count (0.1.2) 2. Inhibit sample pulse (0.1.4) 3. Clear parity write flip-flop if IO word has parity bit (0.1.1)
BI 4	Transfer memory buffers to test registers (if test memory selected) (0.1.1)
BI 5	Not used
BI 6	Generate IO register break request pulse (if IO register selected) (0.7.5)
BI 7	1. Transfer IO buffer to IO register (if card machine operate flip-flop set; 0.7.6) 2. Sense parity check control flip-flop (0.1.1, B11) 3. Parity count (if no parity assigned)
BI 8	Not used
BI 9	Generate card mach 2nd break request (if 2nd break request flip-flop set; 0.7.6)
BI 10	Not used
BI 11	1. Generate clear IO interlock pulse (if word counter equals 0 and if IO buffer and IO register status is empty or BTC or MI matrix selected) 2. Generate word counter equal 0 pulse for tape adapter (if word counter equals 0 and tapes selected, 0.7.8) 3. Generate clear IO interlock pulse if IO register selected

TABLE 6–3. FUNCTIONS OF BO PULSES

PULSE	FUNCTIONS
BO 0	1. Clear break request FF 2. Transfer IO address counter to MAR 3. Start memory
BO 1	Not used
BO 2	1. Step IO address counter (0.4.1) 2. Step IO word counter (if MI matrix burst time counter, or drums not selected, 0.7.3)
BO 3	Not used
BO 4	Not used
BO 5	Transfer test memory to memory buffer (if test memory selected, 0.1.3)
BO 6	Generate IO register break request pulse (if IO register selected, 0.7.5)
BO 7	1. Transfer memory buffers to IO register 2. Start parity count and set parity check flip-flop 3. Set IO register status flip-flop
BO 8	1. Transfer IO register to tape write register (if tapes selected) 2. Transfer IO register to warning light register (if warning lights selected)
BO 9	Not used
BO 10	Not used
BO 11	1. Generate clear IO interlock pulse (if word counter equals 0 and drums selected) 2. Generate word counter equals 0 pulse for tape adapter (if word counter equals 0 and tapes selected) 3. Clear write flip-flop (if warning lights selected)

2. Address portion specifies memory location of first word to be transferred in or out of memory.
3. Time -- 6 microseconds
4. Study timing -- Logic Index App. A
5. Commands for logical instruction

    a. Pause option (PT-10)
    b. Address Reg to I/O Address Counter (PT-3)

6. Follow commands #148 and #72 on logic 0.4.1.

E. SEL Instruction

1. Address portion of instruction is meaningless.
2. Used to select a particular I/O Unit other than Drums.
3. Index Interval Bits specify the I/O Unit
4. Decoded in PERSELBSN Matrix
5. Time -- 12 microseconds (PT) (OT-A)
6. Study timing -- Logic Index App. A
7. Commands for logical instruction.

    a. Pause option (PT-10) #134
    b. Deselect Pulse (OT-5) #155

    NOTE: This is preliminary clearing of Sel. Control equipment.

    c. Select Pulse (PT-5) #156

    NOTE: This sets FF associated with a particular I/O Unit.

    d. OT time used to allow the I/O equipment to deselect before selecting.

8. Follow SEL pulse in logic. Logic 0.7.5

F. SDR Instruction

1. Used to select particular logic drum.
2. Address portion of instruction specifies address of drum.
3. R/1 bit specifies Aux "1" or Main "0"
4. Index Interval Bits specific logical drum field.
5. Index Interval decoded in drum control frame.
6. Time -- 12 microseconds (PT) and (OT)
7. Study timing chart -- Logic Index App. A
8. Commands for logical instruction.

    a. Pause option (PT-10) #134
    b. Deselect Pulse (OT-5) #155
    c. Address Reg. to Drum Control Reg. (PT-3) #151

    NOTE: Used for compare functions.

    d. Set drum Sel FF (PT-5) #325
    e. Transfer Index Interval Reg to Drum Selection Reg (PT-5) (0. 6. 1) #325

9. Follow PT-5 Pulse in Logic 0. 7. 7 (9A) (#325)

G. RDS Instruction

1. Used to initiate transfers into Memory from I/O Units.
2. Address portion indicates the number of words to transfer.
3. I/O Word Counter loaded from Adr. Reg. (Complement form)
4. Study timing -- Logic Index Appendix A
5. Commands for logical operation.

    a. Pause option (PT-10) #134
    b. Set I/O Interlock (PT-1) #294
    c. Clear I/O Word Counter (PT-1)
    d. Address Reg. Cpl to I/O Word Counter (PT-2) #152

e. Step I/O Word Counter (PT-3) #290

NOTE: This keeps us from reading one move than indicated by address portion.

NOTE: Provides means of detecting RDS- "0".

f. Set Read FF (PT-6) #180

1) Start Read Pulse to selected I/O device.
2) This actually conditions circuits so breaks may start.

g. Show commands in logic.

1) CL. I/O W.C. (149) Logic 0.7.3 6/A
2) Adr. Reg. Cpl to I/O W.C. (152) Logic 0.4.1 13C
3) Step I/O W.C. (290) Logic 0.7.3 2/B
4) Sets Read FF (180) Logic 0.7.3 6E

H. WRT Instruction

1. Used to initiate I/O transfer from Memory to I/O Unit.
2. Most other functions identical to RDS inst.
3. Differences from RDS Instruction.

   a. PT-6 set Write FF
   b. Send "Start Write Pulse" to selected I/O device.

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Summary Questions

1. The I/O Element contains:

   A. Control circuits only
   B. Transfer registers only
   C. The PERSELBSN Matrix
   D. Control circuits and transfer registers.

2. Complete the following table indicating the type of pulses obtainable for each of the following circumstances.

STATUS		TPs	IPs
No Pause	No Break	Yes	Yes
Pause	No Break	No	No
No Pause	Break	Yes	No
Pause	Break	Yes	No

3. In order to get break-in pulses, the RDS FF and the Break FF must be set. In order to get break-out pulses, the WRT FF and the Break FF must be set.

Answer the following True or False:

4. The De-Select Pulse occurs at PT-5. F

5. PT-1 of a RDS instruction will set the I/O Interlock. T

6. PT-6 of a WRT instruction will set the Break FF. F

7. The I/O Word Counter is loaded at PT-2 time from the Address Register. T

8. The Break FF is cleared by the Word Counter going to zero. T

VI. INPUT/OUTPUT REGISTER

A. Use

1. Used to clear memory.

   a. By programming
   b. Master reset or clear memory push-buttons

2. Used to store a pattern in memory by programming.

NOTE: Although the I/O register is generally used as the intermediate storage register between core memory and a selected I/O device, it may itself be selected as an I/O device using the SEL (04) instruction. The I/O register, so selected, serves as a source of words containing all 0's when it is desired to clear memory locations, or a word of any configuration when it is desired to write a test pattern into memory.

B. Programming Figure 8 Page 0680

1. General

   When any SEL instruction is executed, the I/O register is cleared (0.7.1, B-7, ctrl clr/deselect pulse). Normally, during the execution of a subsequent RDS or WRT instruction, the I/O register is cleared again, (0.7.1, C-7, command 144 and 147). Prior to the transfer of each word the I/O register is cleared. However, the SEL (04) instruction causes a gate (0.7.1, C-7, I/O reg not sel level) to be conditioned which prevents the clearing of the I/O register between transfers and when the RDS or WRT instruction is executed.

2. To clear memory locations.

   The basic I/O program is used to clear

Clear Memory

memory. To clear all memory locations including the test register, the number specified in the RDS instruction is 3.77760_8.

a.	LDC	0000	Starting Mem. location
b.	SEL (04)	----	SEL I/O Reg.
c.	RDS	N	
d.	Clears N memory locations in N break cycles.		

3. To store a pattern in memory

To write a particular pattern into core memory, the following program is used. The location specified in the LDC instruction contains the test word. Note that the I/O register is not selected a second time before issuing the RDS instruction. To do so would cause clearing of the I/O register and the loss of the test word.

a.	LDC	----(To pattern Word)
b.	SEL (04)	----
c.	WRT	0.00001
d.	LDC	----
e.	RDS	N
f.	Puts the pattern in the I/O Register and then stores it into N memory locations in N memory cycles.	
g.	If more than WRT one is programmed, a logical add of the words written will result in the I/O register.	

C. Timing — Logic 0.7.5

1. SEL (04)

a.	OT-5 deselect clears I/O Reg and clears all I/O controls.	Logic 0.7.1, 0.7.2, 0.7.5
b.	PT-5 select sets I/O Reg. FF.	Logic 0.7.5

2. RDS BI cycle

a. PT-1

1) Clear I/O Word Ctr. (0. 7. 3)
2) Set I/O interlock (0. 7. 3)(0. 3. 1)
3) Clear Read and Write FFs (0. 7. 3)
4) Set Word Counter Status FF (0. 7. 3) -- Indicates if Word CTR = 0 or ≠ 0.
5) Clear the parity check control FF (0. 1. 1) -- Allows parity assignment during breaks.

b. PT-2 -- Load I/O Word Counter (transfer Adr. Reg. Complement to Word Ctr.) (0. 4. 1) (0. 7. 3)

c. PT-3 (Command 290) (0. 7. 3)

1) Step I/O Word Counter (0. 7. 3)
2) Set Sense Word Counter FF (0. 7. 3)

a) Allows I/O Word Counter end carry, due to command 290 of a RDS or WRT zero instruction, to clear the I/O interlock.
b) I/O Word counter end carry also clears Word Counter Status FF.

d. PT-6

1) Set the Read FF if the Word Counter ≠ 0 (0. 7. 3) (Determined by Word Counter Status FF)
2) Clear the Sense Word Counter FF (0. 7. 3)
3) Set the Break Request Sync FF if the I/O Word Counter ≠ 0(0. 7. 5) (0. 2. 3)

e. Next 2 MC pulse sets the Break Request FF (0. 2. 3)

f. Next TP-10 Delayed sets the Break FF (0. 2. 2) (0. 2. 3)

3. Break In Cycle

   a. Refer to I/O Break Control in section VB — Table 6-2

   b. Applicable pulses.

      1) BI-0
      2) BI-2
      3) BI-3
      4) BI-4
      5) BI-6
      6) BI-7
      7) BI-11 Clear I/O interlock if I/O word counter = 0.

4. Successive breaks are taken until the I/O Word Counter = 0 -- If I/O Word Counter = 0, then a BI-11 pulse will clear the I/O interlock.

5. WRT -- Same as RDS except PT-6 sets WRT FF instead of RDS FF (0. 7. 3)

6. Break Out cycle

   a. Refer to I/O Break control in section VB. — Table 6-3, Page 0360

   b. Applicable pulses

      1) BO-0
      2) BO-2
      3) BO-5
      4) BO-6
      5) BO-7
      6) BO-11 -- Clear I/O interlock if I/O Word Counter = 0.

7. Successive breaks are taken until I/O word counter goes to zero. If I/O word counter = 0, then a BO-11 pulse will clear the I/O interlock.

Summary Questions

1. What is the purpose of being able to "Select" the I/O Register?

   clear mem. or store a pattern

2. At what rate are words transferred from or to the I/O Register when selected?

   10 μ sec

3. The I/O Register when selected is cleared by PT-2 of RDS or WRT instruction. (T or F)

4. The computer will not do any computations while the I/O register is selected and writing. (T or F)

5. Several patterns can be loaded into memory from the I/O register during the execution of one WRT instruction. (T or F)

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Uses OD Time

VII. MANUAL INPUT MATRIX

A. Description

Certain types of data are fed into the Central Computer through a buffer storage device called the manual input (MI) matrix and which is a part of the manual input element of the Input System. The matrix is made up of tape cores arranged in 128 rows of 33 (one core not used) cores each. Information is read from the matrix under computer command at a rate of one row (one computer word) every 20 usec. The MI matrix can be read entirely or in part during the execution of one transfer operation, but the reading is always sequential starting from the first row.

The status of the cores in rows 7-128 is determined by the setting of the keyboard switches on keyboard panels associated with various display consoles to which the cores are connected. In addition, certain cores in these rows are connected to simplex equipment (e.g. Input System channels and Display System consoles) so that the active or standby status of this equipment can be determined by the computer program. The reading of the cores in rows 7-128 does not affect the status of these cores (nondestructive readout).

The cores in the first six rows are connected to the ACTION pushbuttons on the several keyboard panels and to the light guns associated with certain situation display consoles. A core is set to the 1 state when the ACTION button to which it is connected is depressed (or if connected to a light gun, when the light gun is fired). When the cores in rows one through six are read, they are switched to the 0 state in the process (destructive readout). A core in the first six rows serves to indicate to the computer program whether the keyboard data for a particular console is to be recognized. The program determines which cores in rows 7 through 128 are associated with a particular core in rows 1 through 6.

1. $(128)_{10}$ word register $(200)_8$
2. Each word consists of 33 tape cores (1 not used)
3. Stores information from Display Consoles concerning requests or actions initiated by console operators. Also, the status (Active or Standby) of the Input Channels and display consoles are stored in cores within the matrix.

   a. First 2 words -- cores set by light guns (Destructive Readout)
   b. Next 4 words -- cores set by action pushbuttons on the keyboard panels. (Destructive Readout)
   c. Last $(122)_{10}$ words -- cores controlled by keyboard switches on keyboard panels and by Input Channel-Display Console Unit Status Switches. (Non-Destructive Readout).

4. Three methods used to set cores in MI matrix.

   a. Keyboard Button and Unit Status Switch (Non-Destructive Readout) Figure 3

      1) Keyboard Button

         a) The keyboard button will set certain cores in the MIM, which when read out will indicate to the program what operations have been requested by the operator.
         b) Operation -- With the button closed, the core contains a "one". Once the button is depressed, it will remain closed until a release button is depressed. Thus, readout of the core is non-destructive.

2) Unit Status Switch

a) Cores in the MIM are read out by the program to find out the status of simplex units.

b) Operation -- When in the "Standby" position, it will put a "one" in a core of the "Standby" computer's matrix and a "zero" in a core of the "Active" computer's matrix. When in the "Active" position, it will put a "one" in a core in the "Active" computer's matrix and a "zero" in the "Standby" computer's matrix.

b. Action Button (Destructive Readout) Figure 4

1) The active circuit is a logic circuit which applies a +10V pulse to an associated core upon depression of the action pushbutton. In Input System logic, the action pushbutton is used by the console operator to signal the Central Computer that there is a keyboard message in the core matrix ready to be read into the Central Computer. This is done after a message has been set up at a console keyboard.

2) Operation -- The action pushbutton is normally open, allowing C1 to charge to +10V through R1. When the pushbutton is depressed, mercury contact relay K1 is momentarily energized, providing a discharge path for the capacitor through R 2 and

the associated core in the core matrix. This action results in a pulse being applied to the core, setting the core to the 1 state. During the readout operation of the core matrix, the "A" bit contained in the core associated with a specific action pushbutton is destroyed and is not restored until the pushbutton is again depressed.

c. Light Gun (Destructive Readout) — Figure 5

1) At present the purpose and use of the light gun signals are classified. Refer to MI lesson plan.
2) Operation -- Firing the light gun generates a +10V level for 10 usec which puts a "one" in a core. The level goes from -30 volts to +10 volts for 10 usec and then returns to -30. The return to -30 allows destructive readout.

B. Programming

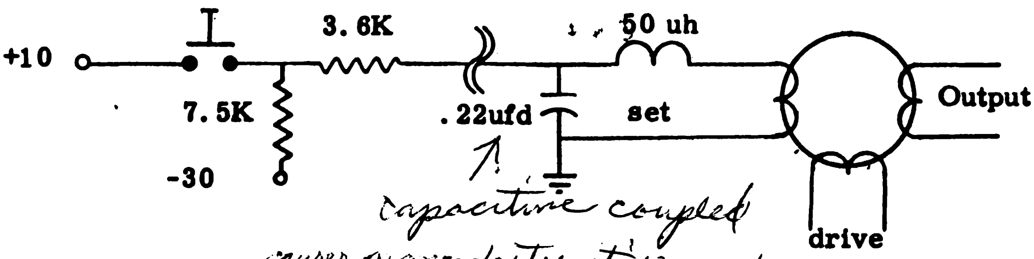
1.	LDC	xxx
2.	SEL(06)	---
3.	RDS	200

a. Matrix contains 128_{10} or 200_8 words.
b. RDS 200_8 reads entire matrix.
c. RDS more than 200_8 would read entire matrix and then put positive zeros into memory until the Word Counter goes to zero.

Example:

1)	LDC	200
2)	SEL (06)	
3)	RDS	400

0500



capacitive coupled
causes non-destructive read out

Figure 3, Keyboard Button Cores

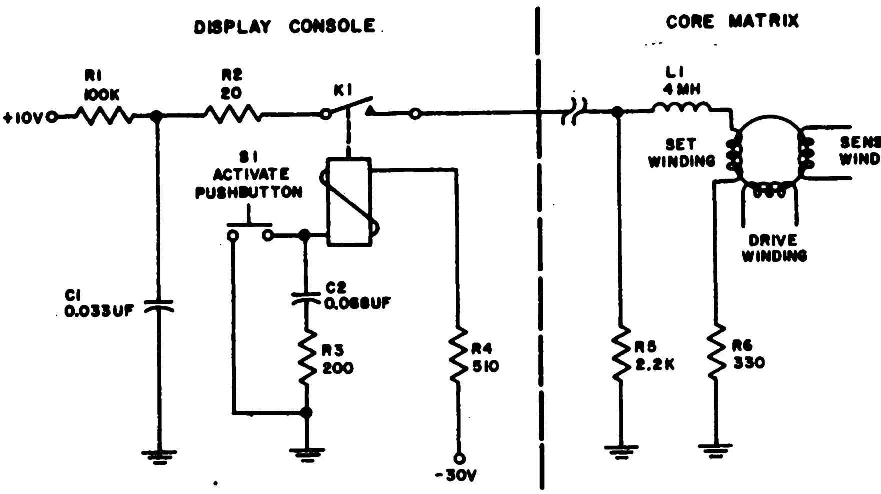


Figure 4, Action Button Cores

Destructive readout

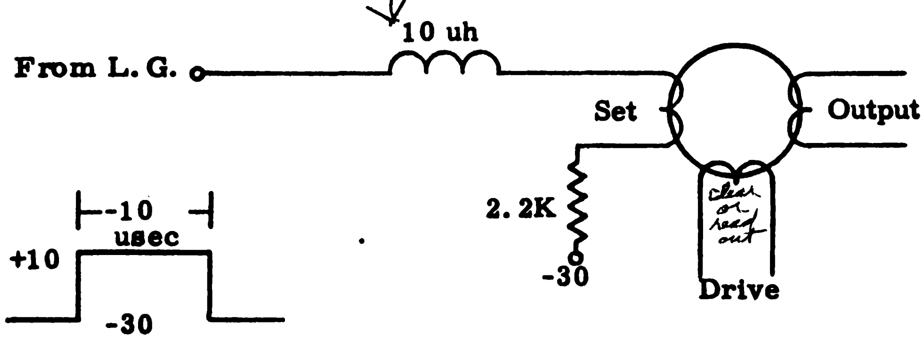


Figure 5, Light Gun Cores

4) Memory locations 200_8-377_8 would contain information from the MI Matrix and locations 400_8-577_8 would be cleared.

d. The first word in the matrix will always be the first word read.

e. Any time the first 6 words in the MI Matrix are read, they are no longer retained in the Matrix. (Destructive Readout)

C. Central Computer Timing

1. SEL

a. OT-5 -- Deselect

b. PT-5 -- Set MI Matrix FF (Selects MI Matrix) — Logic 0.7.7

2. RDS -- Same as for I/O Reg except for the following:

a. PT-2 -- Clear I/O Register — Logic 0.7.1, 0.7.2

b. PT-6 -- Start read pulse to MI Matrix read control (Logic 0.7.7)

3. Break In Cycle

a. Start read pulse starts in the MI Matrix read control circuitry.

b. Words are transferred at a 20 usec rate.

c. As each word is loaded into the I/O Buffer, a buffer loading pulse from the MIM controm circuitry will set the I/O Buffer Load Sync FF (0.7.7)

d. Next 2 MC Pulse sets the I/O Buffer Load FF (0.7.7)

e. Next 2 MC Pulse sets the I/O Buffer Status FF (0.7.7).

f. Next 2 MC Pulse — Logic 0.7.7

1) Xfer I/O Buffer to I/O Reg — Logic 0.7.1, 0.7.2
2) Set I/O Reg Status FF
3) Clear I/O Buffer Status FF
4) Sets Break Request FF — Logic 0.2.3

g. Refer: I/O Break Control Section VB for BI pulse functions. — 0360 Table 6-2 Page
h. Applicable pulses

1) BI-0
2) BI-2
3) BI-3
4) BI-4
5) BI-7
6) BI-11

i. Words are Xferred at a 20 usec rate until the I/O Word Counter goes to "zero".
j. Programming a RDS "Zero" will start the MIM read circuitry. As a result, 200_8 words from the Matrix will be logically added in the I/O Buffers, but no breaks will be taken. If another I/O operation (which uses the I/O Buffers) is programmed while the Matrix is transferring information, a logical add of the matrix information and information from the other I/O device will result.

D. Reading Operation of MIM — Figure 6-6, Logic 2.2.2

Reading of the MI matrix is initiated at PT 6 of the RDS instruction, which gates a start-read pulse to the core matrix control circuits.

This pulse is used to initiate the transfer of data from the MI matrix to the computer. When this operation is initiated, the control functions of reading and transfer are performed by the core-matrix control circuits, the core shift register, the thyratron core drivers, and the sense amplifier. (See Figure 6-6). The core-matrix control circuits initiate, control, and terminate the readout operation. The core shift register and thyratron core drivers cause a sequential (word-by-word) readout. The sense amplifiers amplify, filter, and shape the pulses which transfer the data word from the core matrix to the central computer system.

As shown in figure 6-6, the MI matrix derives its timing pulses from the MIXD drum-timing circuits which are located on the OD side of the Drum System. The timing pulses are designated OD-1, OD-2, OD-3 and OD-4, and they occur at intervals of 2.5 usec. Since OD-1 pulses, which are generated every 10 usec, are frequency divided readout of the core matrix occurs every 20 usec. When the readout process is initiated, a shift level is produced to transfer a word from the matrix, and a break-request pulse is generated and routed to the central computer system to inform it that a data word has been transferred from the core matrix. The computer keeps a cumulative count (in the I/O word counter) of the transfers and, when the specified number of transfers has been received, it transmits a disconnect MI matrix pulse to the core-matrix control circuits. As a result of receiving the disconnect pulse, the core-matrix-control circuits stop the generation of shift levels and terminate the readout of the core matrix. A detailed logic circuit analysis of the core-matrix-control circuits is presented in the following paragraphs.
As shown in figure 6-6, the read-manual-input-matrix pulse triggers SS-1. The resultant output pulse of the single-shot is designated the load-shift-register pulse. The load-shift-register pulse simultaneously writes a 1 in the first core (CS-1) of the core shift register and sets FF1. The resultant dc level which is generated at the 1 side of FF1 conditions GT1.

The next OD-1 pulse simultaneously examines FF 1 and FF 2, by pulsing GT 1 and GT 2, respectively. Since FF 1 is set and FF 2 is clear, the OD 1 pulse is gated by GT 1 and suppressed by GT 2. The gated OD 1 pulse sets FF 2, and the resultant dc level generated at the 1 side of FF 2 conditions GT 2. Because FF 2 is now in its 1 state, the next OD 1 pulse is gated through GT 2; as a result,. FF 3 and FF 4 are both set. The dc level generated by the 1 side of FF 3 is applied (through OR 6) to the 16 core shift drivers (shift/reset). At OD 2, a pulse passes through OR 4 to clear FF 3, thus establishing the length of the shift pulse at 2. 5 usec. The 2. 5 usec shift pulse is applied to the 16 core shift drivers which in turn apply a read-current pulse to the 128 core-shift circuits. Since core shift bit CS 1 contains a 1 (all others contain 0's) an output pulse is developed which sets core shift bit CS 2 and which applies a pulse to thyratron core driver TCD 1. The output of the thyratron core driver is used to drive all of the cores of the associated word to the 0 state. The cores that contained 1's develop output pulses on the associated sense lines which, when amplified and shapped into 0. 1 usec standard pulses by the sense amplifier blocking oscillator, are used to set the associated bit of the I/O buffer register.

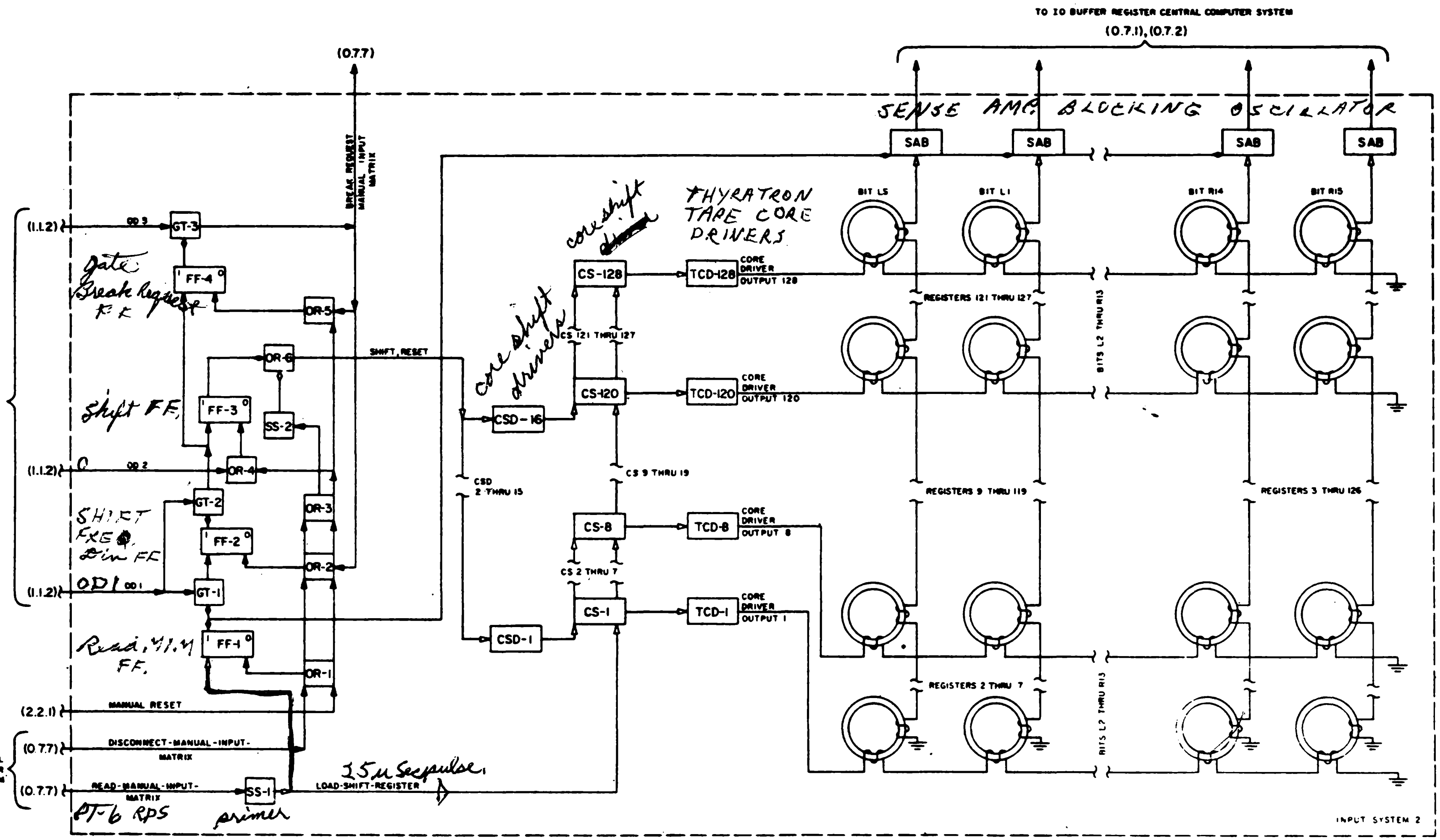
At OD 3, the status of FF 4 is examined by pulsing GT 3. Since FF 4 is set, GT 3 is conditioned and the OD 3 pulse is gated. The output pulse of GT 3 clears FF 4 and FF 2 and is routed to the Central Computer System as a break-request pulse. At the same time, the first data word is being transferred into the I/O buffer register.

Since the speed of the MI matrix is comparable to that of the Drum System, break-request circuits are also used for the MI matrix. As shown in figure 6, the break-request pulse is gated through GT 11 and, as a result, the I/O-buffer-load-sync flip-flop is set. Fig. 6

The break-in cycle is subsequently assigned, during which the I/O word counter and the I/O address counter are stepped by TI 1 and BI 3 respectively. The word in the I/O buffer register is transferred successively to the I/O register and to the memory buffer register, and the break-request flip-flop is cleared. Each new word is treated in the same way, the rate of their arrival being constant and dictated by the design of the MI matrix. As soon as the I/O word counter contents are equal to 0, the end-carry pulse resulting from the final stepping of this counter clears the I/O-word-counter-status flip-flop. The 0 side of this flip-flop and the 1 side of the MI-matrix flip-flop fully condition AND 2 whose output is gated by GT 13 to become a clear-I/O-interlock pulse and a disconnect-manual-input-matrix pulse at BI 11 (figure 6).

As shown in figure 6, the disconnect MI matrix pulse clears FF 1 and FF 2 after passing through OR 1 and OR 2, respectively. The pulse also triggers SS 2 after passing through OR 3. The resultant output level of SS 2 is applied through OR 6 to the core shift register as a reset level which clears the core shift register in anticipation of the subsequent readout operation.

The disconnect operation can also be accomplished manually through the duplex maintenance console. In this case, the manual-reset pulse, which originates at the duplex maintenance console, is applied to OR circuits 1, 2, 3, 4, and 5 simultaneously, thus clearing flip-flops 1, 2, 3, and 4. The clearing of these flip-flops permits the operator to immediately terminate the readout operation. The manual-reset pulse also triggers SS 2, which applies the reset level to the core shift register through OR 6. The reset level clears the core shift register in anticipation of the subsequent readout operation.



0560

Figure 6–6. Manual Input Matrix, Simplified Logic Diagram

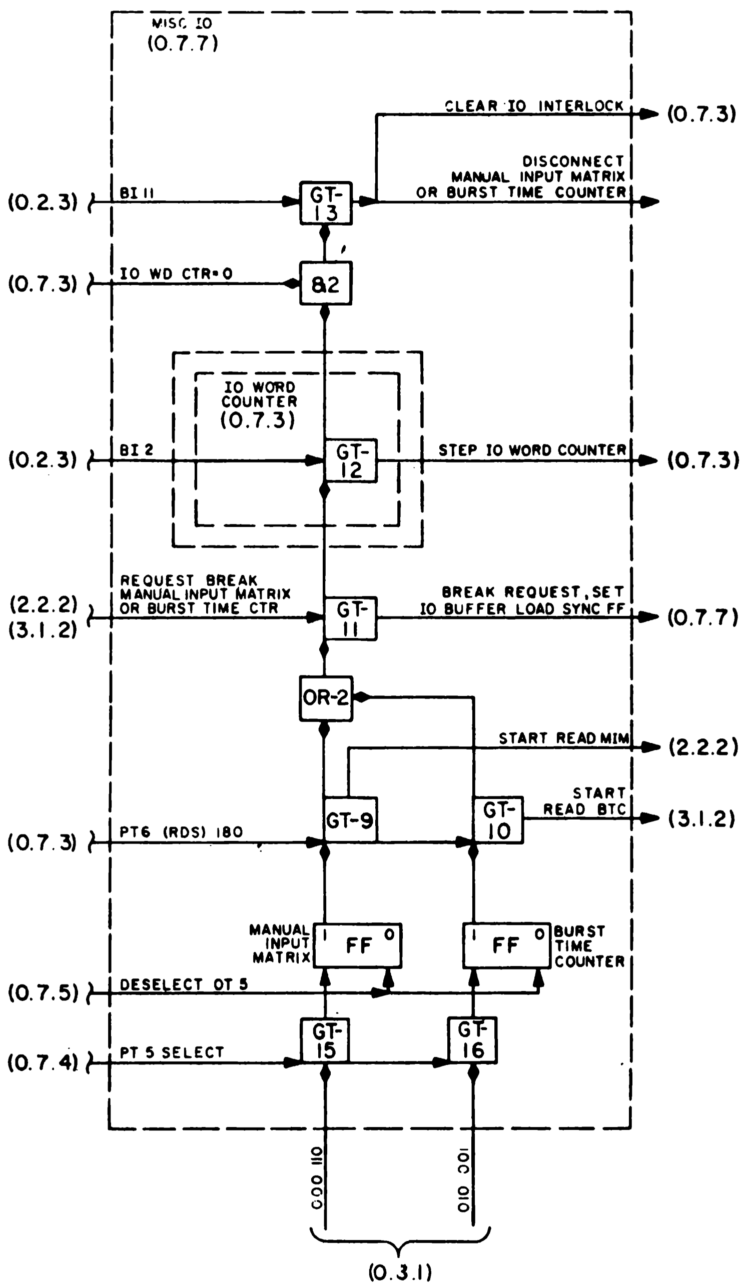

MISC IO
(0.7.7)
CLEAR IO INTERLOCK
(0.7.3)
DISCONNECT MANUAL INPUT MATRIX OR BURST TIME COUNTER
(0.2.3)
BI 11
GT-13
(0.7.3)
IO WD CTR=0
&2
IO WORD COUNTER
(0.7.3)
(0.2.3)
BI 2
GT-12
STEP IO WORD COUNTER
(0.7.3)
REQUEST BREAK MANUAL INPUT MATRIX OR BURST TIME CTR
(2.2.2)
(3.1.2)
GT-11
BREAK REQUEST, SET IO BUFFER LOAD SYNC FF
(0.7.7)
OR-2
START READ MIM
(2.2.2)
GT-9
GT-10
START READ BTC
(3.1.2)
(0.7.3)
PT6 (RDS) 180
MANUAL INPUT MATRIX
FF
BURST TIME COUNTER
(0.7.5)
DESELECT OT 5
GT-15
GT-16
(0.7.4)
PT 5 SELECT
000 110
010 001
(0.3.1)

Figure 6

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Summary Questions

1. The MI Matrix is read at a ___20___ micro-second rate. This is done so that the ___Tape cores___ will not overheat.

2. What will occur if a RDS instruction greater than 200_8 is given with the MI Matrix selected? ~~all 0's will be fed into the MIM~~
The MIM will ... on 200 4 post pos 0 in rest of locations

3. Whenever the MI Matrix is selected and a RDS 0.00200 is given, no words are read into memory. A RDS instruction of less than 200_8 functions properly. This could be caused by:

   A. Pluggable Unit 5EL-F7 open (0.7.3 - 2B)
   B. This is improper programming and the result is, therefore, normal.
   C. I/O word counter R8 a FF remains set. (0.7.3 - 3B)
   D. Address Register not transferring to I/O WD. Ctr.
   E. Pluggable Unit 6FU-G1 open (0.7.3 - 3B)

4. The MI Matrix is used to: furnish data ~~to~~

5. What information will be read into Core Memory if the MI Matrix is selected and a RDS 0.00006 is given?

VIII. BURST TIME COUNTERS

A. Description

The types of output data processed and transmitted by the Output System are ground-to-ground (G/G), teletype (TTY), and ground-to-air, time division (G/A-TD). The Output System reads output data from the OD side of the output buffer drum fields and examines each word to make up messages according to type of data and word sequence. The messages are made up by temporarily storing the individual words in particular locations of a ferrite core array, before reading out the completed messages to the transmission equipment. The left half-portion of the output words contains the information for making up the messages.

Besides separating data words by type and word sequence, it is necessary to identify data words as being associated with a particular message in a given type. To accomplish this, the Output System has four message counters (call burst counters), one for each type of output. Each output data word has a burst time count in the left half-portion of the word. The Output System checks for comparison of the burst count with the setting of the appropriate burst counter. Those words with burst counts less than the burst counter contents are rejected but left on the OB drum for future reading. Those that compare are stored for subsequent transmission. Those words with burst counts greater than the burst counter contents are rejected but left on the OB drum for future reading. A burst time counter is stepped by the Output System as each message is completed.

For the operating program to assign burst numbers to output data words, it must be able to obtain the contents of the various burst counters at any time. This facility is provided in the equipment so that the burst time counters can be read using the basic IO program.

0600

4. Ground to Ground Burst Time Counter

   a. 8 FF Counter
   b. Stepped every 70.8 millisec.
   c. G/G used for G/G messages from the computer. These messages are sent over phone lines to computers at other sites.

5. Teletype Burst Time Counters

   a. 5 FF Counter
   b. Stepped approximately every 1/2 sec (45/91 sec)
   c. TTY used for TTY messages from the computer. These messages are sent over phone lines to teletype machines at manual DCs, Missile Master Centers, Weather Stations, Texas Towers, Direction Centers, Combat Centers, etc.

6. Ground to Air Time Division Burst Time Counters

   a. 8 FF counter
   b. Stepped every 90 millisec.
   c. G/A-TD used for G/A messages from the computer that are transmitted to interceptors. Will also be used for transmission to future missiles. Uses time division type of transmission at the Data Link.

B. Programming

1. LDC xxx
2. SEL(21 ---
3. RDS 2, 3, 5, or 10

   a. RDS 1 reads +0
   b. RDS 2 reads G/G, and BTC
   c. RDS 3 reads G/G, and TTY BTC
   d. RDS 4 reads G/G, and TTY BTC and positive zero.
   e. RDS 5 reads G/G, and TTY BTC, positive zero, and G/A TD BTC
   f. RDS 6-10 reads BTCs and then positive zeros.
   g. RDS more than 10, disconnect generated in output system, but will not clear I/O Interlock.

C. Central Computer Timing -- Timing is identical to MI Matrix timing, except words are transferred at a 10 usec rate. — Logic 0.7.7, Figure 6-7

D. Reading Operation of BTC

Execution of the SEL (21) (Select Burst Time Counters) instruction results in setting the burst time counters select flip-flop (0.7.7, A-B). The output from the 1 side of this flip-flop gates the PT 6 pulse of the RDS instruction. The gated PT 6 pulse is sent to the output computer section of the Output System to set up the circuitry for reading out the contents of the burst time counters.

The burst time counters are read one at a time under control of the circuits in the output computer section. (See figure 6-7) The PT 6 (select and read) pulse sets FF 1. The following OD 3 pulse will be gated by the 1 side to set FF 2. The 1 side of FF 2 conditions GT 4 to pass successive OD 1 pulses which are used to set a 3-flip-flop counter. The output levels of the counter are decoded with five 3-way AND circuits to produce burst counter selection levels. As the counter is stepped by OD 1 pulses the proper selection level is applied to a number of 2-way AND circuits. The second input to these AND circuits is from the 1 side of the flip-flops in one of the burst time counters. The outputs of these AND circuits are applied to the readout gates. The readout gates are strobed by the OD 1 pulses for transfer to the I/O buffer register.

This circuit arrangement provides transfers at a 10 usec rate (the same as for addressable drum transfers). To read all four burst counters the RDS instruction must specify at least 5 words. Note that 0's will be transferred when the selection counter equals 011_2.

The read operation is terminated when the word counter goes to 0 or when the selection counter is stepped from 111_2 to 000_2 depending on the number of words specified in the RDS instruction.

Summary Questions

1. What are the Burst Time Counters used for? as a synchronizer between ~~channels~~ outputs and C.C.

2. What will be read into Central Computer for each of the following instructions with the BTC's selected?

A.	RDS	0.00001
B.	RDS	0.00002
C.	RDS	0.00003
D.	RDS	0.00010
E.	RDS	0.00011

3. The following program is given:

```
SEL21
LDC    100
RDS     01
HLT
```

At the completion of the program, the G/G BTC is found to be contained in location 101. This would be the result of:

A.	P.U. 5ES, pin H5 open	(0.7.3 - 7A)
B.	P.U. 5EL, pin F7 open	(0.7.3 - 2B)
C.	P.U. 5ER, pin A6 open	(0.7.3 - 7A)
D.	P.U. 5FT, pin F1 open	(0.7.7 - 13B)
E.	P.U. 5FV, pin B1 open	(0.7.7 - 13C)

Information is transferred from BTC's at a ___10___ usec rate.

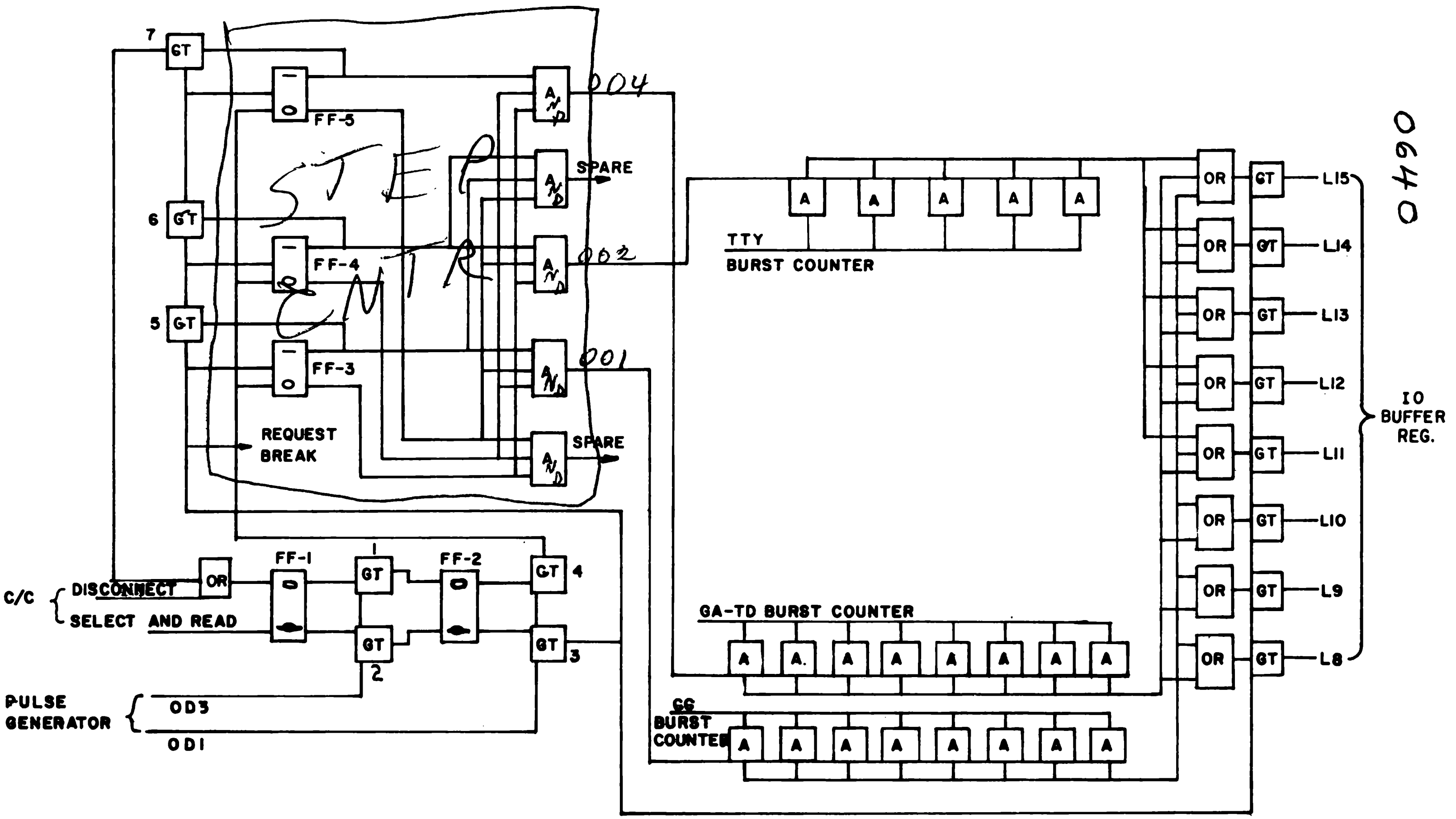

Fig. 6-7

Output System, Computer Section Simplified Logic Diagram

Information

IX. WARNING LIGHTS

A. Use

1. Provides program controlled indicators which notify personnel at display consoles of special computer actions.

   a. Audible alarm and light controlled by operator.
   b. Neon light controlled by computer.

2. Warning lights are used to alert operators at different consoles of certain Central Computer System operations. or error Provision is made for 256 lights, divided into eight registers groups of 32 lights each. Each group is considered a 32 bit register. To make use of the Warning Light System LDC, SEL, WRT is the basic I/O program which must be executed. The circuits in the I/O element required to implement the use of the Warning Light System are shown in figure 6-5.

   1 light per console

B. Operation of Warning Light — Figure 7

1. Explanation

   a. Conditions set up -- Unit 30 "A" relay is energized to allow signals from the "A" computer to go to the console.
   b. With the warning light FF set it will condition the WLD (Warning Light Driver) to pick K1 in the display console -- at the same time the FF will also light the steady neon on the display console.
   c. K1 picking will cause the thermal flasher to operate as long as K1 stays picked.
   d. The thermal flasher will cause K2 to pick and drop cycles until K1 is deenergized.

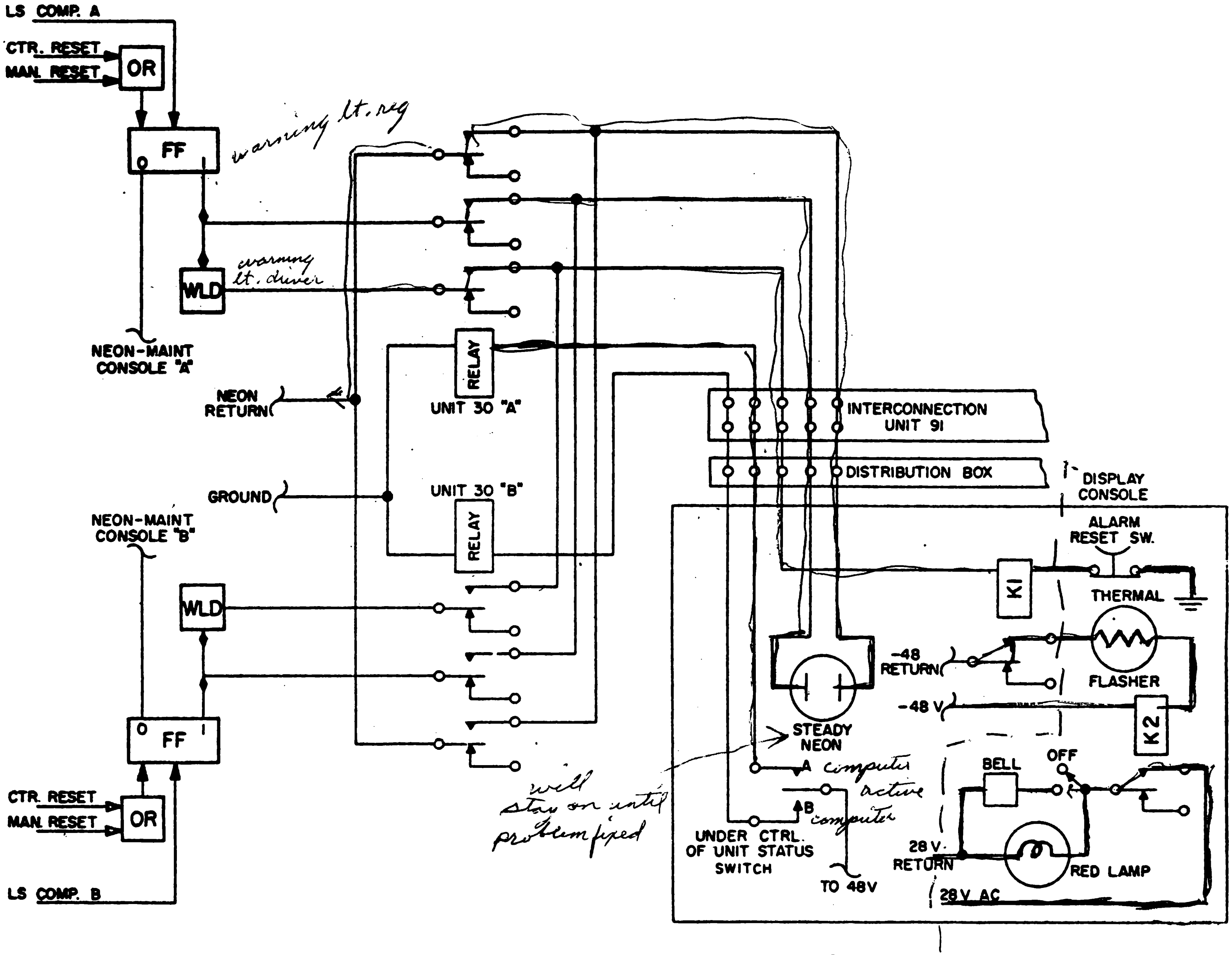

Figure 7, Display Warning Lights

0990

e. K2 picking and dropping will cause the red lamp to light up and go off at the same time as the bell is "Dinging".

0680

C. Programming — Figure 8 Page

1. LDC xxx
2. SEL (10) ---
3. WRT 10

WRT 10 will write in all 8 registers. On a WRT more than 10, W. L. registers will be written in more than once. Always start writing in the first register.

D. Central Computer Timing — Logic 0.7.9

1. Double complement method of loading W. L. registers (for economy).

The principle of operation depends upon the fact that complementing a flip-flop an even number of times does not alter its original status. To write new information into the warning light registers, the I/O registers are loaded with a new word every second memory cycle. For each word transferred, the first of the two cycles is a breakout cycle during which the word in the I/O registers is used to complement the eight warning light registers and the selected warning light register is cleared; the second cycle is a dummy cycle during which the word in the I/O register is again used to complement the eight warning light registers. Under this condition, the original content of the seven non-selected warning light registers will not be destroyed. Each of the eight warning light registers is modified in a similar manner so that, at the end of the I/O process, each register will duplicate the status of the core memory word assigned to it.

loaded by
complement clear
compliment load

SEL	RDS O	WRT O	RDS 3.77777	WRT 3.77777	BREAK FREQUENCY	NORMAL RDS or WRT
04 I/O REG	CLR I/O Intlk. No Breaks	CLR I/O Intlk. No Breaks	Normal Operation	Abnormal Programming Logical ADD to I/O REG.	6 usec.	WRT 1 RDS X
06 MIM	Abnormal Op., Start MIM, Logical ADD in I/O Bfr. at 20 u. Sec Rate. CLR I/O Intlk.	Does not Start MIM SET & CLR I/O Intlk.	Read 200 Words Normally, all O's after 200 words in Memory CLR I/O Intlk.	Cannot CLR. I/O Intlk., HANG ON NEXT I/O Operation	20 usec.	RDS 200
10 W.L.	CLR I/O Intlk. No Breaks	CLR I/O Intlk. No Breaks	Cannot CLR. I/O Intlk., HANG ON NEXT I/O Operation	Abnormal Programming W.L.'s will be written into more than once.	12 usec.	WRT 10
21 BTC	Abnormal Programming Logical ADD I/O Bfr., No Breaks, Set & Clr I/O Intlk.	Abnormal Programming Does Not Start BTC SET & CLR I/O INTLK.	Read more than 10 words, will cause HANG on next I/O Inst.	Cannot CLR. I/O Intlk., HANG on next I/O Operation	10 usec.	RDS 1-5

FIGURE 8, PROGRAMMING SUMMARY OF MISCELLANEOUS I/O DEVICES

a. Load I/O Reg. from W. L. image in C. M.
b. Complement each bit position in every W. L. Reg. where there is a "one" in the I/O Reg.
c. Clear only the W. L. Reg. which is to receive the new word.
d. Complement each register as in b.
e. Without double complement method, approximately 224 more GT's would be needed.

2. SEL

a. OT-5 deselect
b. PT-5 set W. L. FF, clear Aux. W. L. FF.

3. WRT -- PT-6 set W. L. Ctr. to 001 set Brk. Request Sync.

4. Breaks

Refer to BO Timing Page [redacted] 0360

a. TP-10 delayed sets Break FF
b. BO-8 sets Break Reg. Sync. Complements each W. L. Reg. where there is a "one" in the corresponding bit position in the I/O Reg.
c. BO-11 set aux. W. L. FF. Clear Write FF. This starts the "dummy" break cycle which is required to allow the W. L. FFs time to settle down. (Only TPs generated)
d. TP-4 step I/O Wd. Ctr. Clear W. L. Reg. #1. Step W. L. Ctr. to 010.
e. TP-8 check to see if Wd. Ctr. has gone to zero. If it has, clear I/O Interlock and Break FF.
f. TP-11 complement (Second time) W. L. Regs. according to contents of I/O Reg. Clear I/O Reg. Set Write FF to Start next break cycle.
g. This process continues until I/O Wd. Ctr. goes to zero. Requires 12 usec to change each W. L. Register.

E. Writing operation of W. L. Figure 6-5

The address of the first core memory word to be used is placed in the I/O address counter by the LDC instruction. During the SEL instruction, the warning-light flip-flop is set and the auxiliary-warning-light flip-flop is cleared. (See figure 6-5) After the WRT instruction, the I/O interlock and the I/O-word-counter-status flip-flops are set, and the I/O word counter contains the complement of the right half-word of the WRT instruction. The magnitude of the number in the I/O word counter cannot exceed 8 because there are only eight warning light registers, but it can have any intermediate value between 1 and 8.

The final pulse of the WRT instruction, PT 6, requests a break, sets the warning-light-counter No. 1 flip-flop, and clears the other two warning-light-counter flip-flops. The register matrix converts the reading of the warning light counter into a positive dc level on matrix output 001. AND circuit 9 is therefore energized conditioning GT 25.

As a result of the break request, the next memory cycle is assigned as a breakout cycle. The I/O word counter is stepped by TP-4 during the dummy break cycle and the I/O address counter is stepped at BO 2. After the stepping process is completed, the I/O word counter contains N-1 and the I/O address counter contains the address of the core memory word which is to affect the second warning light register. The word for the first warning light register has already been placed in the MBR's. This first word is transferred from the MBRs to the I/O registers at BO 7.

As shown in figure 6-5, the BO 8 pulse is gated by GT 28 associated with the warning-light flip-flop. Since this flip-flop was set at PT 5 of the SEL instruction, the BO 8 pulse is passed to cause the content of the I/O registers to complement the eight warning light registers. The warning light register flip-flops are slow-speed, flip-flops; therefore, about 2 usec must elapse before they can be operated upon again. Since there is not enough time between BO 8 and BO 11 to provide the 2 usec, a dummy cycle must be assigned. Accordingly, the BO 8 pulse requests a break. To prevent the generation of breakout pulses during the dummy cycle, the write flip-flop is cleared at BO 11. The BO 11 pulse also sets the auxiliary-warning-light flip-flop, conditioning the circuits which are to be inspected during the dummy cycle.

Since the auxiliary-warning-light flip-flop is set, the gate tubes associated with its 1 side are conditioned. At TP 4, the I/O word counter is stepped and the eight gate tubes associated with the register matrix are simultaneously sensed. At this stage in the process, GT 25 is conditioned; therefore, warning light register No. 1 is cleared. The status of the other warning light registers remains unchanged. The TP 4 pulse also steps the warning light register counter by complementing the warning-light-counter No. 1 and warning-light-counter No. 2 flip-flops. The resultant output from the register matrix is therefore 010, which conditions GT 26 and deconditions GT 25. However, the clearing pulse generated by GT 25 for warning light register No. 1 is developed before the gate tube is disabled.

The I/O register is not affected during the dummy cycle because of the absence of breakout pulses. At TP 11 (of the dummy cycle), the flip-flops of the warning light registers are again complemented in accordance with the contents of the I/O register. The TP 11 pulse also clears the auxiliary-warning-light flip-flop, resets the write flip-flop, and clears the I/O register.

With the break flip-flop and the write flip-flop set, the following memory cycle is another breakout cycle. During this cycle and its attendant dummy cycle, the contents of the second warning light register are changed to conform to the dictates of the word in the I/O register. After TP 11 of the

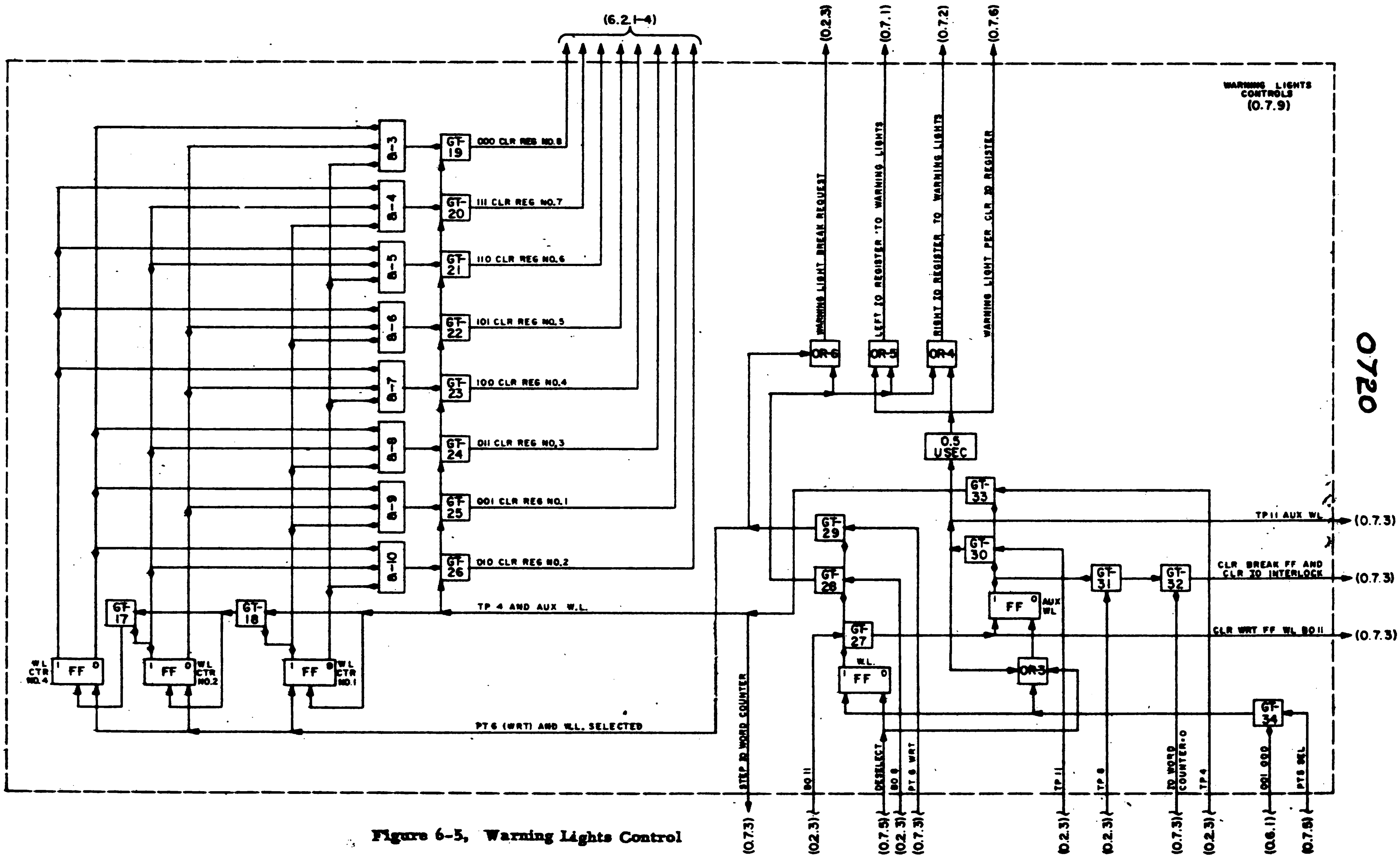

Figure 6-5, Warning Lights Control

dummy cycle, the first two warning light registers are correctly conditioned, GT 24 is conditioned by the register matrix, and the remaining registers still retain their initial contents. Each TP 11 pulse that is generated examines the status of the I/O word counter. As soon as the contents of this counter are equal to 0, a gate tube conditioned by the I/O-word-counter-status flip-flop gates the TP 11 pulse. As a result, the I/O interlock and the counter-control flip-flop are clared, terminating the I/O process.

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Summary Questions

1. How much time is required to change each Warning Light Register? 12 μ sec.

2. The following program is given and runs to completion. Nothing is written into the Warning Lights. (Assume all are cleared at start.)

000	SEL_{10}		
001	LDC	100	
002	WRT	010	
003	HLT	000	This malfunction could be caused by:

A.	5EK - C1 open	(0.7.3 - 7E)
B.	5GL - A7 open	(0.7.9 - 4C)
C.	5GE - E6 open	(0.7.9 - 2B)
D.	5GK - E5 open	(0.7.9 - 3C)
E.	5GK - H6 open	(0.7.9 - 3C)

3. The following program was executed with PA5, P.U. 5GL, removed. What is in Warning Light Register #5 when the program halts? All W.L. Regs clear at start.

000	SEL_{10}	
001	LDC	002
002	PER_{75}	001
003	WRT	005
004	HLT	000
005	1.77774	0.11111
006	0.35212	1.31126

A.	1.77774	0.11111
B.	0.35212	1.31126
C.	0.00000	1.31126
D.	0.00175	0.00001
E.	0.00000	0.00001
F.	0.00000	0.00000

X. TYPE 713 CARD READER

A. General

The IBM 713 Card Reader is a modified version of the standard IBM 711 Card Reader. It is used as a maintenance tool for the computer by providing a means of transferring data to the central computer from prepunched IBM cards. This is accomplished by mechanically feeding the cards (usually programs) into the card reader, sensing the punched holes with brushes, and transferring the data to the computer via the summary punch connector.

It must be kept clean. Cards also

The 713 Card Reader is a slower machine than the computer. After energization of the card feed by a Read (RDS) instruction, it takes approximately 20 ms for a card to travel from one row to another, whereas the computer can act on an instruction in microseconds. It is not feasible, therefore, to have the computer wait while the card travels from row to row, card by card, for the computer could complete many instructions during this time. Thus, between rows, the computer returns to its normal program. When the card reader has information ready for the computer, it indicates this fact by a request-break-in signal. The computer has continually inspected for this signal and, when finished with its particular problem, takes a break cycle. At this time, the information is put into Memory. Twelve break-in signals are generated, one for each row of the card. Between break-ins, the computer returns to its normal program.

The following will be a discussion on the physical functions of the Card Reader.

B. Basic Timing -- The timing of the card reader is discussed below; the discussion includes cycles, cycle points, and the machine index.

1. Cycle Definition -- The card reader can read 150 cards a minute, which indicates that it starts and completes a sequence of operation 150

times in one minute. This sequence is referred to as a cycle and is termed a machine cycle or a card feed cycle. It is called a card feed cycle because cards must be feeding when reading takes place. A machine cycle is any cycle that the machine operates. Thus, a machine cycle can, and often does occur without its being a card feed cycle; but for a card feed cycle to occur, a machine cycle must be coincident.

2. Cycle Point -- Since the card is fed 9-edge first, the first point during the cycle when the brush could read would be when a 9-hole is under the reading brush. The second point which could be read is an 8-hole. This procedure continues until the 12 reading position has been reached. The distance from one point, such as a 9, to the adjacent point, 8, is one cycle point.

The distance between centers of adjacent punched holes is 1/4 inch; this means that one cycle point must result in a 1/4 inch movement of the card. Because there is 1/4 inch of card above and below the first and last punched hole, the card is 3 1/4 inches from top to bottom. Thus, since a cycle point represents 1/4 inch card movement, a card is equivalent to 13 cycle points. If cards were fed edge to edge, it would result in a cycle which would contain 13 cycle points. However, because time is required to restore operating mechanisms to a normal position, a space is provided between cards. To provide this time and space, the feed rolls are geared to move the card 5 inches. This results in 1 3/4 inches between cards and 20 cycle points per cycle. For the 12 reading positions, the cycle points will be identified with the corresponding digit. Figure 3-4 illustrates the 20 cycle point machine cycle and its relationship to card movement.

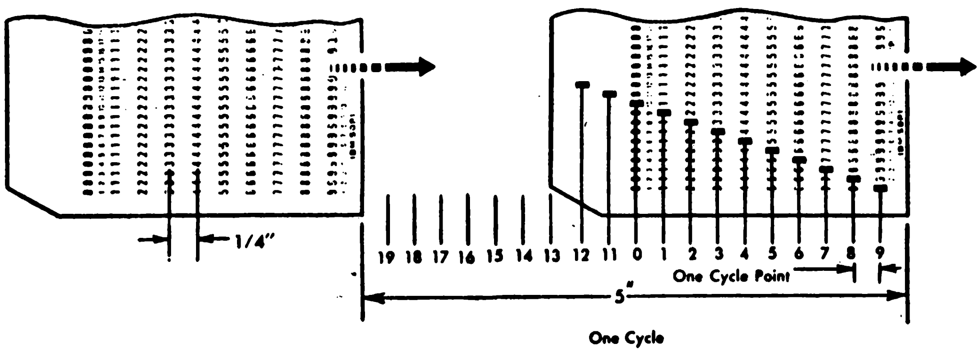

Figure 3–4. Cycle, Cycle Points, and Card Relationships

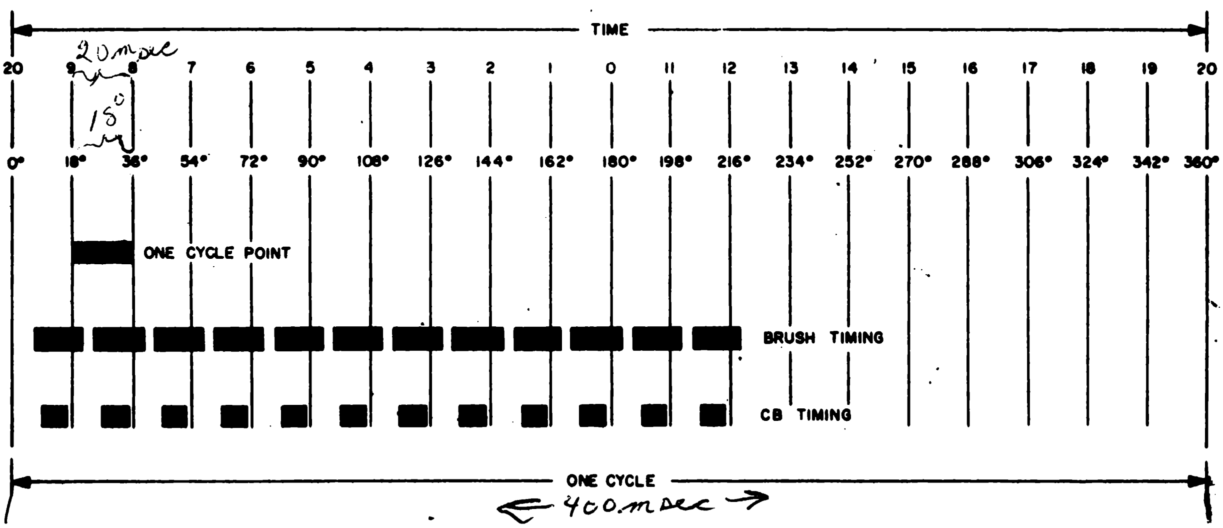

Figure 3–5. Machine Index and Timing

13 cycle points on card
7 between cards

3. Machine Index -- Many mechanisms on the card reader are timed to start or complete an operation at a specific time during a cycle. Thus, an index is attached to the card reader and is geared to make one revolution per machine cycle. The machine index is marked with graduations representing degrees so that mechanisms can be timed to it. An index with all 360 degrees indicated is used because this provides a finer definition of timing. The card reader, using 20 cycle points per machine cycle, has 18 degrees per cycle point.

   Figure 3-5 shows a timing chart which represents the machine index and timing relationships. The chart indicates one cycle divided into both cycle points and degrees. The timing relationships between the brushes and the circuit breakers are illustrated.

C. Card Feed Unit Figure 9

1. Speed is 150 cards per minute -- 3600 words per minute.
2. Card Hopper -- holds 800 cards. The side plates are adjustable to align the card columns with the read brushes.
3. Feed Knives -- pull a card from the hopper to the first set of feed rolls. The card feed employs mechanical feed knives to feed a card into the unit. The cards are placed in the hopper 9-edge first, face down, under the card weight. At a fixed time in each card cycle, the card is engaged by two feeding knives and fed through the throat. The feed knives are accurately timed and are designed to rock independently so that they may adapt themselves to the feeding of cards, which may not lie perfectly flat on the hopper bed.

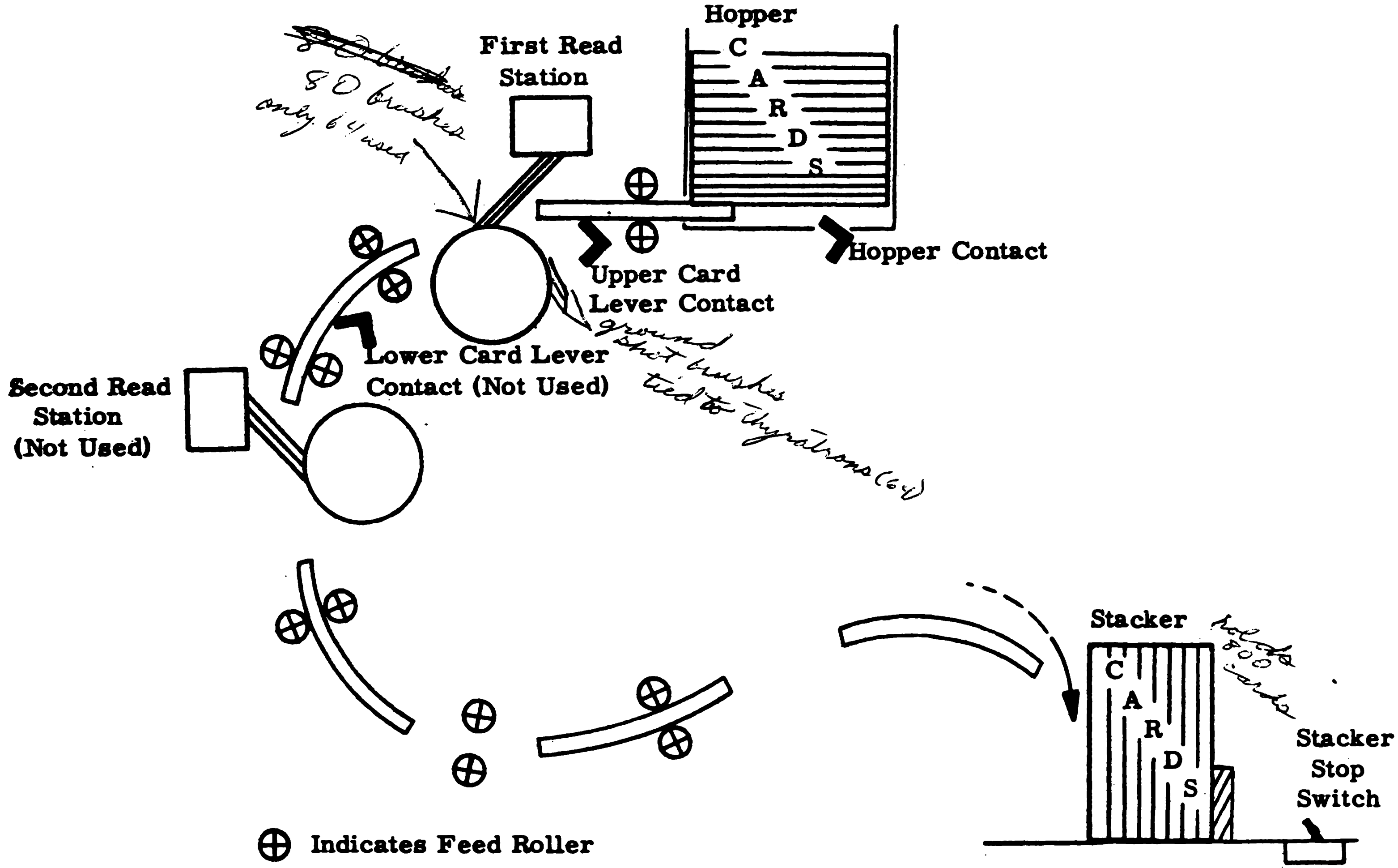

Figure 9, Card Feed Unit Of Card Reader

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4. Feed Throat -- while the feed knives will engage only one card, the friction between cards may cause more than one card to be fed if some means is not provided to prevent it. The feed throat (Fig. 3-8) is used to overcome this. The throat is placed at the point where the cards attempt to enter the card reader and is adjusted to permit the passage of only one card per feed cycle from the hopper. — Figure 3-8

5. Feed Rolls -- At a fixed time in each card cycle, the two feed knives come in contact with the edge of the card and move it through the throat to the first pair of feed rolls. The six pairs of feed rolls are so spaced that, before one pair loses control of a card, the next pair grips it. This positive control continues until the card has passed through the feed unit and is stacked.

6. Contact Rolls -- There are two contact rolls in the feed unit, one associated with each brush assembly. Since only the upper set of brushes is used for reading, its associated contact roll is the only one discussed. — Figure 3-9

   The electrical circuit from the read brushes to the summary punch connector is completed when the brushes make contact with the contact roll through the holes in the card (Fig. 3-9).

7. Read Brushes -- There are two sets of 80 brushes, but only the last 64 brushes of the upper set are used for reading. The second set, and its associated contact roll, is merely used as an aid in positioning the card as it is fed through the feed unit. The 64 brushes used control the inputs to core memory. This is done by completing a circuit, via the contact roll, through the punched holes, as the holes pass under the brushes (fib. 3-9). — Figure 3-9

8. Stacker -- The stacker drum rotates only when the card feed clutch is engaged. As the drum rotates, its four pairs of gripper fingers are cammed open and shut to grip the cards — Figure 3-10

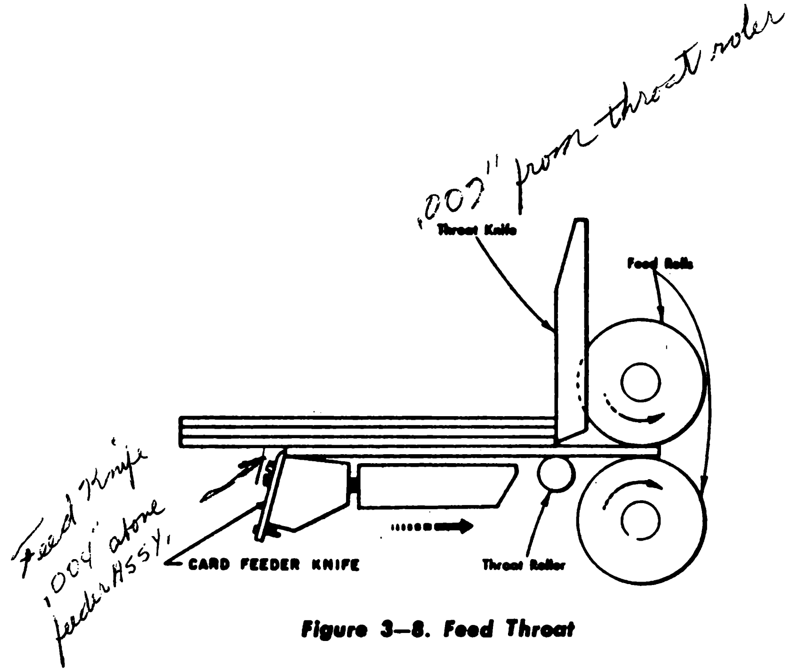

Figure 3—8. Feed Throat

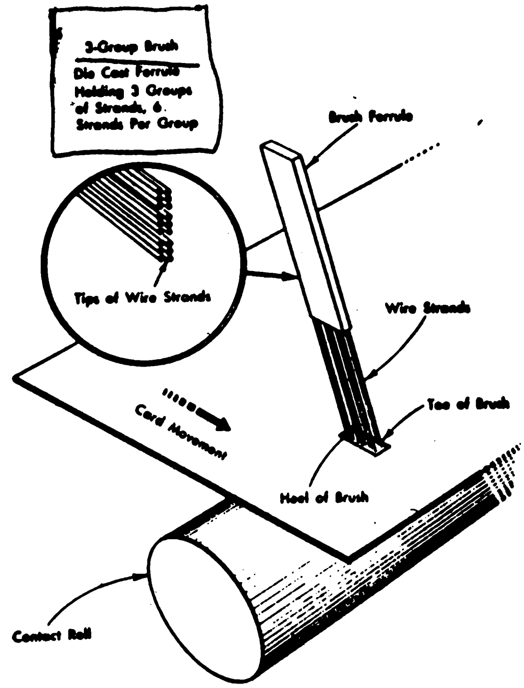

Figure 3—9. Brush, Card, and Contact Roll

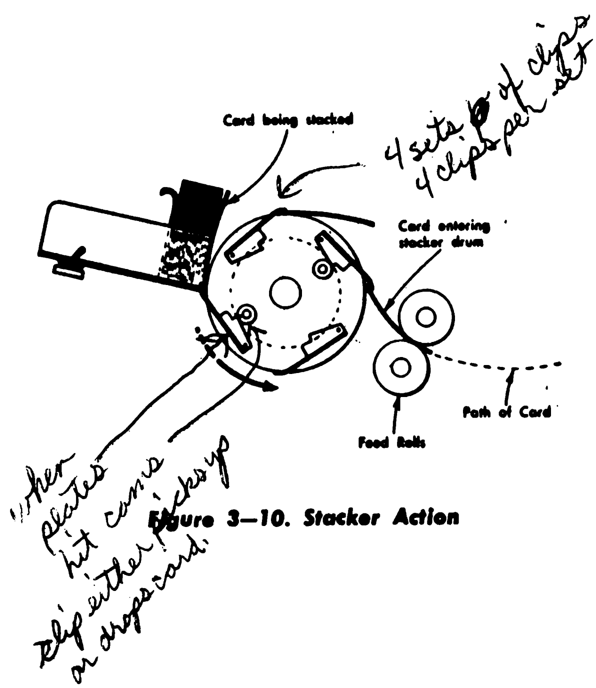

Figure 3—10. Stacker Action

as they emerge from the last pair of feed rolls, and to release the card when its correct stacking position is reached. The fingers grip the card in the center of the 9-row and stack the cards in an upright position in their proper sequence (Figure 3-10).

9. Feed Control -- The card feed mechanism does not rotate until the feed clutch is picked by a RDS instruction.

D. Card Feed Contacts — Figure 9

1. Hopper Contact -- closes when cards are placed in the hopper. When the contact is open, it prevents card reader operation with no cards in the hopper. When the card hopper becomes empty, the upper card lever remains open and stops the card reader. The computer loses control of the card reader, and the NOT READY light is turned on. To restart the card reader, place a deck of cards in the hopper, and perform the normal run-in procedure.
2. Upper Card Lever -- contact indicates that a card is in position to be read. It also detects card feed jams. When a card jam occurs, the upper card lever remains open, and the card reader stops. The computer loses control of the card reader, and the CARD FEED STOP and NOT READY lights are turned on. Clear the jam at the throat, repunch any cards that may have been damaged.
3. Lower Card Lever -- is not used.
4. Stacker Stop -- switch stops the card reader operation when the capacity of the stacker is reached. When the stacker becomes full, the stacker stop switch is activated, the computer loses control of the card reader, and the card reader stops with the NOT READY lamp lit. To restart the card reader, remove the cards from the stacker, and depress the START pushbutton as in the normal run-in procedure.

E. Operating Controls

Figure 10
If it is desirable to associate controls and lights with the wiring chart, refer to Par J of this section.

1. Main Line Switch -- Applies 115V, 60 cycles to the drive motor and the +46VDC supply (40V to 46V). 115 V comes from the Line Printer which does not have to be on to get this. Also +72VDC is supplied from the printer. The printer main line switch must be on before the card reader can be operated because of the +72V.
2. Start Pushbutton -- Puts the reader under computer control if there is a card at the read station. It will feed one card if there is no card at the read station, then put reader under computer control. "Ready I/O Units" or "Master Reset" PBs on the maintenance console do the same thing.
3. Stop Pushbutton -- Stops the card reader and removes it from computer control. If a card is being read at the time the button is depressed, the reader will not stop until finished reading the card.
4. Feed Pushbutton -- Will cause successive feed cycles as long as button is depressed. It is inoperative when the reader is under computer control.

F. Indicator Lights

Figure 10

1. Read -- Light indicates that the reader has received a RDS instruction (PT-6 of RDS). The computer is reading or trying to read when the light is on.
2. Fuse -- Light indicates that an indicator fuse has blown in the card reader relay circuit.
3. Not Ready -- light indicates that the reader is not under computer control for one or more of the following:

   a. Fuse blown
   b. Stacker full
   c. Hopper empty (last card past first read station)

d. Card feed jam
e. Stop PB depressed
f. Start PB not depressed

Additional "Not Ready" conditions for the computer are:

a. Main line switch off
b. ≠72V lost from printer

There is a "reader not ready" light also on Duplex Maintenance Console.

4. Card Feed Stop -- Light indicates a card feed failure from the hopper or a card jam.
5. Power On -- Light indicates that 46V and 72V power is present. Main line switch is on.

* P.B. START	* P.B. STOP	* P.B FEED will not op under computer control	LT. READ on only under comp. cntl. + read comm to machine read.	LT. Signal FUSE	LT. reader NOT READY not under comp. cntl.	LT. CARD FEED STOP jam	LT. the POWER ON

*Pushbutton

Figure 10, Operating Controls and Indicating Lights.

G. Demonstration -- At this time it may be desirable to look at and operate the card reader. Notice the following:

a. Fuses
b. Feed CBs
c. Feed clutch
d. Hopper
e. Path of card
f. Feed interlock contacts (hopper contact)
g. Contact roll and brushes (remove brush blocks)

Operation:

1. Observe operations by running cards through the machine with the use of the hand crank.
2. Become familiar with the use of the card gauge and the Go-No-Go gauge.

H. Programming

1. A typical program is:

0.00100	SEL (01)		Select card reader
0.00101	LDC	0.00000	First location
0.00102	BSN (11)	0.00102	Check I/O Unit Ready
0.00103	RDS	0.00030	Read 30 words, can specify any no. of words.
0.00104	HLT	0.00000	

2. "Load From Card Reader" PB executes a similar program. However, after the RDS instruction, a second SEL (01) is simulated to hang up the computer until the 30 words are read. Then a BPX to zero will be executed.
3. Binary Punched Card

   a. Col. 17-80 hold information in binary. (1-16 not used)

      1) Col 17-48 Left Words
      2) Col 49-80 Right Words

   b. Each card holds 24_{10} words (30_8)
   c. Cards read 1 row -- 2 words -- at a time.

4. Data Flow — Figure 11 & 12

   a. Left word from card goes to I/O Reg.
   b. Right word from card goes to I/O Bfr.

I. Control and Timing

1. SEL (01)

   OT-5 (Deselect)
   a. Clear Reader Not Ready FF — 0.7.4
   b. Clear Card Reader FF — 0.7.6 (8B)

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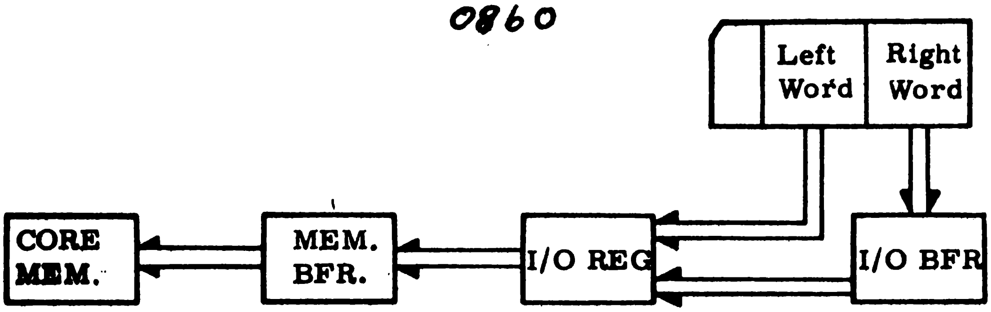
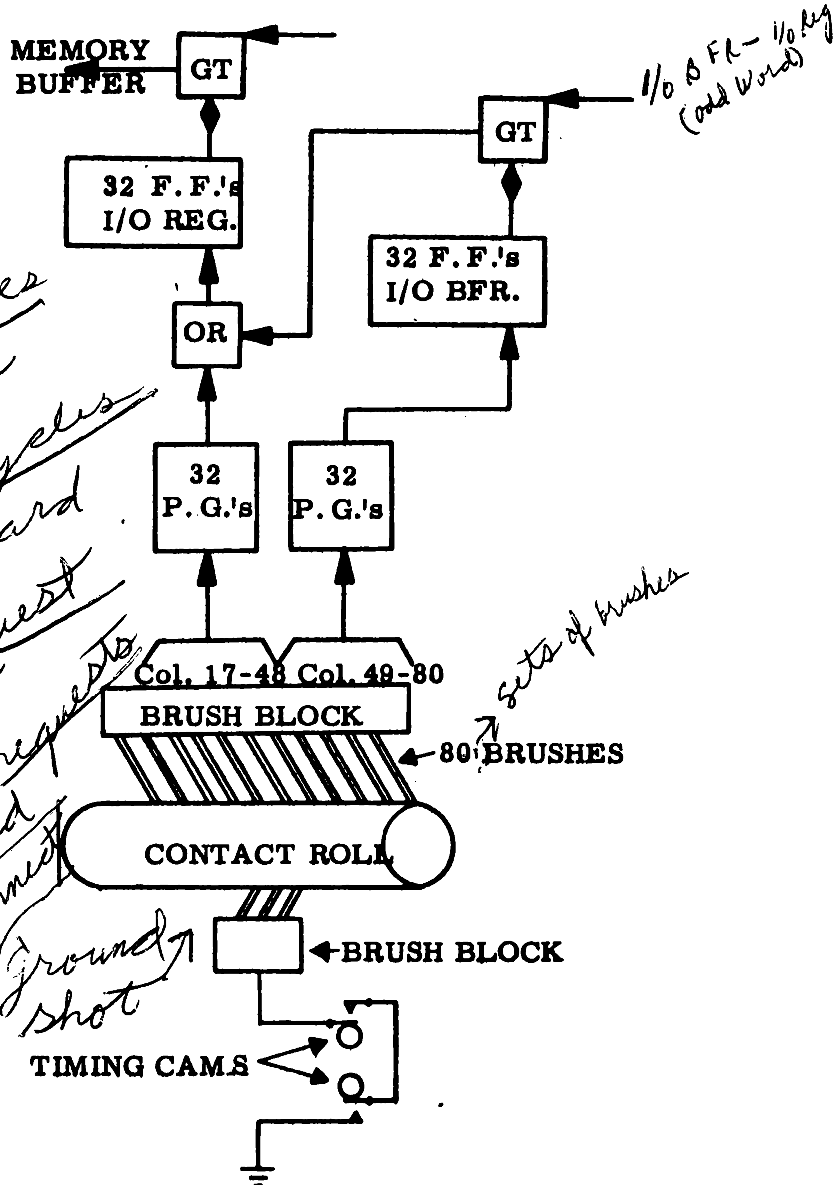


Figure 11, Card Reader Data Flow



2 break cycles per row
24 break cycles per card
1 break request per row
12 break requests per card
1 request disconnect per card.

Figure 12, Card Reader Data Flow

c.	Clear 2nd Break Reg. FF	0.7.6 (6C)
d.	Clear Card Mach. Op. FF	0.7.6 (7B)

PT-5 (Select)

a.	Set Card Reader FF	(8B)
b.	Set Reader Not Ready FF	0.7.4
c.	Sets Card Machine Op. FF	0.7.6 (7B)
d.	Clear RDS-WRT Zero FF	0.7.3 (4D)

1) This FF provides for clearing the I/O Interlock on a RDS zero instruction for all I/O Units except Card Machines and Tapes.

2) A card Reader RDS zero will feed one card and no words will be read.

2. LDC

a.	PT-10 -- Set Pause FF if I/O Interlock on. Occurs on any I/O instruction.	0.2.2 (8B)
b.	PT-3 -- Load I/O Address Ctr.	0.4.1

3. RDS

PT-1

a.	Clear I/O Buffer	0.7.1
b.	Set I/O Interlock	0.7.3 (3D)
c.	Clear I/O Wd. Ctr.	
d.	Set I/O Wd. Ctr. Status FF	(7D)
e.	Clear RDS and WRT FF	(7E)

PT-2

a. Load I/O Wd. Ctr.

b. Clear I/O Register

PT-3

a. Step I/O Wd. Ctr.

b. Command 290

c. End carry will clear Wd. Ctr. Status if a RDS zero instruction has been given.

PT-6

a.	Set RDS FF -- If I/O Wd. Ctr. = 0	0.7.3 (3D)
b.	Trigger $_B$SS to start reader	0.7.6 (9B)

1) Picks K-12 in Reader which energizes feed clutch cards start feeding.

2) In approx. 20 m.s., CF-18 will close to fire PG-4 generating a break request. Row 9 on card under read brushes. — 0.7.6 (6B)

   a) Set 2nd Brk. Req. FF — 0.7.6 (6C)

   b) Set Brk. Reg. Sync. FF — 0.2.3 (2B)

      (1) Next 2 MC sets Brk. Req.

      (2) TP-11 sets Brk. FF and clears Brk. Req. Sync.

3) Left word on card to I/O Reg., right word to I/O Buffer.

4. Breaks

BI-0

a.	Clear Brk. Req. FF	0.2.3 (3B)
b.	Clear Memory Buffers	0.1.1
c.	I/O Adr. Ctr. to MAR	0.4.1
d.	Start Memory	

BI-2

a.	I/O Reg. to Mem. Bfrs.	0.7.1
b.	Clear I/O Reg.	
c.	Step I/O Adder Counter	0.4.1
d.	Step I/O Word Counter	0.7.3

BI-3

a. Inhibit sample

BI-7

a. Inst. word in memory

b. I/O Bfr. to I/O Reg.

1) Card Mach. FF set
2) Second word now in I/O Reg. 0.7.6 (7C)

c. Clear I/O Buffer

BI-9
a. Set Brk. Req. Sync if: 0.7.6

1) Card Machine FF set
2) Second Break Req. FF set
3) Word Counter = 0

b. Clear second Break Request FF

TP-10 Delayed
a. Set Break FF for second break cycle.

Second break cycle same as first except BI-9, Brk. Req. Sync FF not set because second Brk. Req. FF is clear.

Next series of breaks comes approximately 20 m.s. later as Row 8 comes under the read brushes.

5. Disconnect 0.7.6 (11A)

Card reader generates a request disconnect at the end of each card.

a. Every 0.4 sec.
b. Clear I/O Buffer
c. Clear I/O Reg.

If Word Counter = 0

a. Clear I/O Interlock
b. Disconnect Card Reader

1) Picks K-13 which stops card feed, turns out "Read" light.
2) Reader is still "Ready" unless last card in deck was just read.

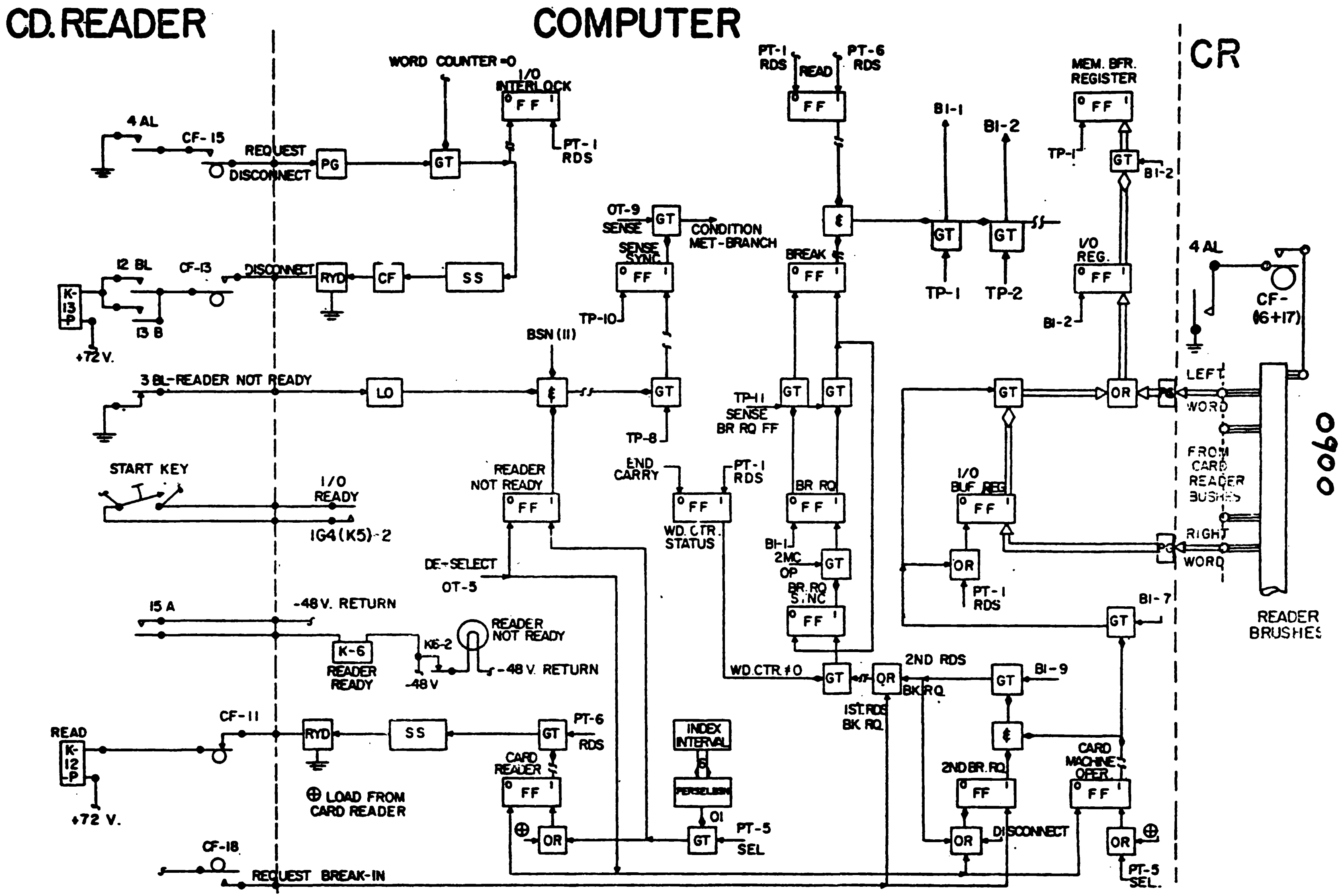


Figure 13, Computer Control Of Card Reader

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J. DETAILED ANALYSIS OF ELECTRICAL CIRCUITS

This section describes in detail the operation of the electrical circuits employed in the 713 Card Reader. First, a general discussion of the nomenclature and description of duo-type relays is presented. Following this, applicable relay sequences are presented, with relay sequence timing charts as aids to discussion. Emphasis is placed on the important manual controls (START and FEED) and on the computer *RDS* instruction and computer-disconnect signal. The remaining sequences are not discussed in detail, since only the cyclic operations may be checked with the dynamic timer. Finally, the power supply is analyzed, and the input voltages and the rectifier unit within the card reader are discussed. Wiring diagram 337401D (fig. 3–15) was used for this text.

1 RELAYS

All the relays used in the card reader are of the standard duo-type. The number of coils in the relays used in this machine vary (fig. 3–16). Relays also vary with respect to the number and types of contacts used. Normally closed relay contacts are referred to as NC; normally open contacts, as NO. Some contact points are transfer points, with a normally open and a normally closed side (fig. 3–16).

At times, an individual contact point on a relay may be referred to as the NO point, the NC point, or the operating point (OP) to better identify the point involved. For example, on the transfer point shown in figure 3–17, the lower point would be the NC point, the center point would be the OP, and the top point would be the NO point.

Some relays have only one coil (fig. 3–17); whenever a circuit is completed to this coil, the magnet is energized and the armature is attracted. (See sect. 2A of fig. 3–15, foldout, for an example.)

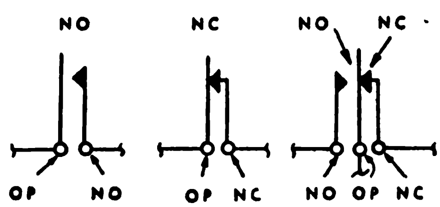

Figure 3–16. Contact Terminology

Some relays are made with two coils (fig. 3–17), and whenever a circuit is completed to either of these coils, the magnet is energized and the armature is attracted. One of these coils is the pickup coil, normally used for energizing the relay. The other, the hold coil, is normally used to keep the relay energized for a given period of time. The pickup coil will be referred to by the letter P; the hold coil, by the letter H. For example, relay 1 is a 2-coil relay (fig. 3–15). The pickup coil will be referred to as R1P; the hold coil, as R1H.

Some relays are wound with three coils (fig. 3–17) and, whenever any of these coils has a circuit completed to it, the magnet is energized and the armature is attracted. Two of the coils are picking coils; the third is the holding coil. Such relays are normally used when it is necessary to pick up or energize a relay from either of two separate circuits. The pickup coils are distinguished from one another in that one of the coils is known as the pickup upper (PU), and the other as the pickup lower (PL).

Relay contacts are designated as the A or the B contacts, depending upon their location on the relay assembly. The relay A contacts are on the left side of the relay, and the B contacts are on the right side of the relay, facing the armature end of the relay (fig. 3–17). In general, the B side of the relay coils is the common side and is connected to fuse.

Where two contact groups are mounted on the same side of the relay, they are designated AU and AL for A upper and A lower and BU and BL for B upper and B lower.

All relays that use two or three coils must have those coils correctly polarized when they are connected. The wires to the coils must be connected in such a way that the magnetic polarity of all coils will be in the same direction. This should be watched when installing special features or new circuits. If the pickup and hold coils do not have the same polarity, the magnetic fields of these coils will oppose each other and the relay may fail to hold.

2 SIGNAL FUSES

The card reader is equipped with four 5-amp signal fuses located on the fuse panel. A small brass plunger is built into the nontransparent fuse cartridge and is held under tension of a compression spring by the 5-amp fuse wire. When a fuse wire breaks, the compression

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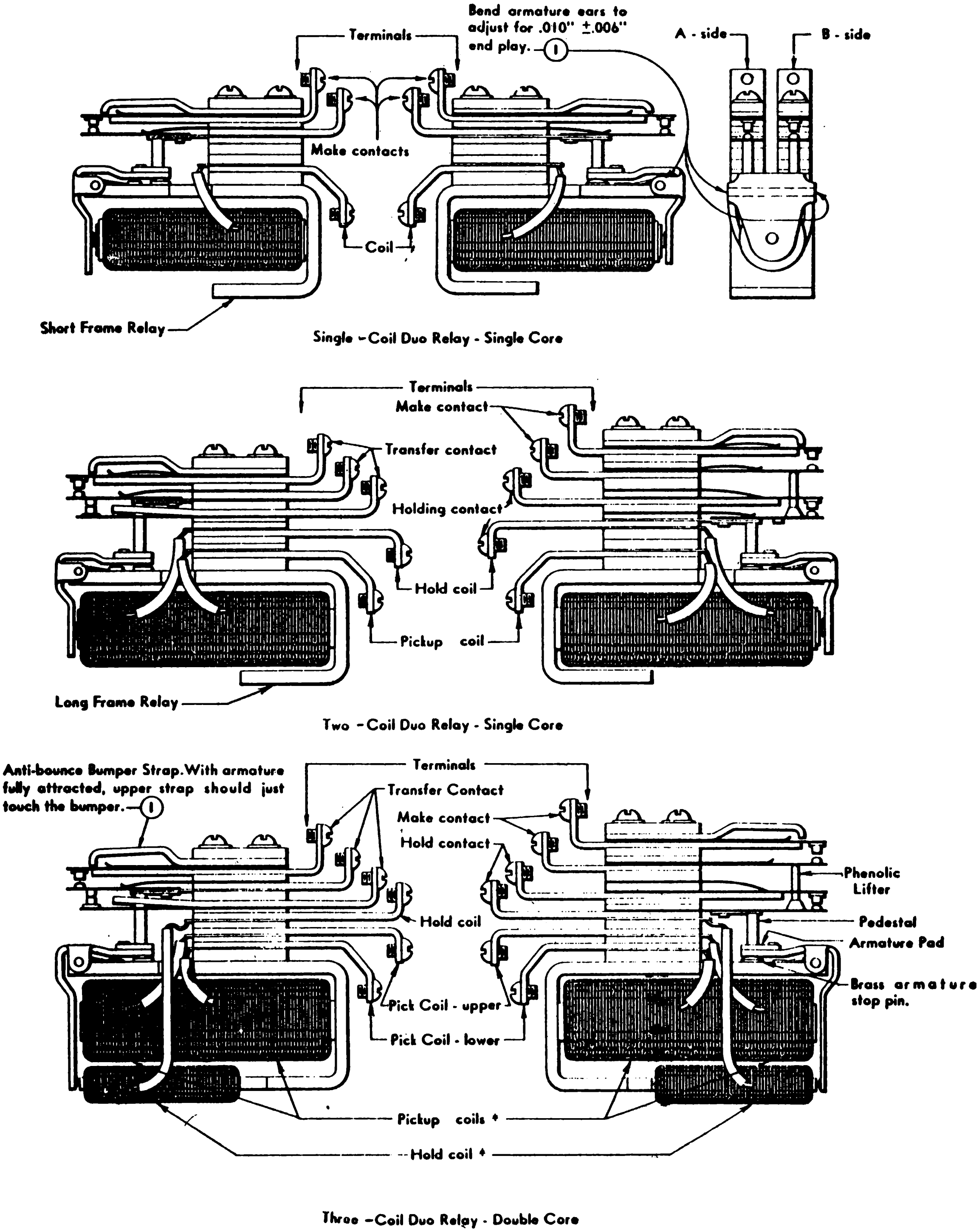

* See text on Three- Coil Relays

Figure 3—17. Duo Relay Assembly

spring forces the plunger into contact with a bus bar mounted under the row of fuses. Contact with any released plunger and the bus bar provides a path for the energization of the signal fuse relay (#14). The 4A (NC) point in section 1A of figure 3–15, opens the card reader running circuit, causing the card reader to stop. The circuit remains open until the blown fuse is replaced.

It is important that the signal fuse be inserted in its clips with the plunger end toward the bus. After the fuse is replaced, the cards are run out of the card reader, and the deck of cards is rerun through the card reader.

3 RELAY SEQUENCE FOR PLACING CARD READER UNDER COMPUTER CONTROL

It is assumed that, before an attempt is made to place the card reader in operation, there are cards in the hopper, the stacker is not full, power is available, and all fuses are good. With these assumptions, the main line switch is turned to ON, and the following sequences are initiated fig. 3–15.

Turning the main line switch to ON places 115V, 60 cycles, across the drive motor through the two 10-amp fuses and to the primary of the power supply transformer through two 5-amp fuses. The motor starts, and the rectifier, which is in the transformer secondary winding, produces 48Vdc for the relay circuits. The positive side of the rectfier is tied to a bus line common to the majority of the cam-activated contacts. The negative side is led to a bus common to the signal fuses and is tied to system ground.

The NOT READY lamp is lit by completing its circuit from a 72V input through the 300-ohm resistor (R8) and the 4AL (NC) point to ground. This results in an illuminated indication of the machine's present status.

Relay R7 (hopper relay in sect. 4A, fig. 3–15) is picked by the closing of the hopper contact, one of the starting assumptions being that there are cards in the hopper. However, its points are used merely to set up circuitry for following relay sequences.

Relay 11 (48V interlock in sect. 4B) is picked, since it is directly between the 48V line and ground. Relays 11A (NO) and 11B (NO) points in section 3B close and complete the circuit from the 72V supply (sect. 1B) to pick R10 (power-on relay in sect. 4B). Relay R11 uses dual contact points for this circuit to distribute the current drain resulting from the completion of the circuit. The 10B (NO) point closing in section 3B completes a circuit for the POWER ON light (sect. 4B). The relay 10A (NO) point in section 1A is in the start circuit and must be closed to complete the circuit when the START pushbutton is depressed.

Note

If there is no card at the read brushes, depressing the START pushbutton causes the card-feed mechanism to operate for one card cycle, moving the first card from the hopper to the read brushes. Control of the card reader is then transferred to the computer, and the NOT READY light is turned off. If there is a card waiting at the read brushes, depressing the START pushbutton merely transfers control of the card reader to the computer and turns off the NOT READY light. The START pushbutton is operative only if power is on, if the fuses are good, if there is no card-feed failure, if there are cards in the hopper, and if the stacker is not full. The START pushbutton is inoperative while the card reader is under computer control.

The START pushbutton (sect. 1B) or the READY IO UNITS pushbutton on the duplex maintenance console is depressed, and the following circuits are completed (fig. 3–18) (assume the START pushbutton is depressed at 260 degrees): R1P (auto start relay in sect. 2B) is energized through the path provided by 10A (NO), the STOP pushbutton, the stacker stop switch 6AL (NC), 14A (NC), the START pushbutton, 5AL (NC, 7BU (NO), 4AU (NC), 8BU (NC), the pick coil and to ground. The hold relay of R1 (sect. 2A) is energized when cam-actuated contact CF4 makes at 310 degrees and completes the circuit through R1AU, which is closed until 250 degrees, for a total of 300 degrees. Because the card feed unit is latched up, CF4 is in the closed state. This permits the R1 hold circuit to be completed when the START pushbutton is depressed.

The hold circuit for the original power path is completed by 1BL (NO), which parallels the START pushbutton (sect. 1B).

CF1, in conjunction with 1BU (NO), completes the circuit to the card-feed clutch magnet at 293 degrees when the contact closes (sect. 2B). Energizing the magnet attracts the clutch armature and latch, and at 330 degrees the clutch disc engages with the clutch pawl and mechanical feeding starts.

When the card reaches the upper card lever, the contact is caused to close and the following takes place: at 219 degrees, the upper card lever closes (sect. 3A) and provides a path to energize the R8P coil (upper card lever relay in sect. 4A), when CF7 closes at 222 degrees. The 8AU (NO) point enables the R8H and R9P coils to pick when CF6 makes at 252 degrees.

R9 has been added in parallel with R8H to give another point in the upper card lever circuit. Its action completes the circuit for the automatic start and places the card reader under computer control, waiting for an *RDS* instruction to feed cards under this control. However, at 250 degrees, CF4 opens and R1H (sect. 2A) drops. Since the pick coil was originally de-energized, all points of relay R1 are returned to a normal state. The 1BU (NO) opening (sect. 2B) de-energizes the feed clutch magnet when CF2 opens at 296 degrees. At 330 degrees, the card feed clutch pawl is mechanically disengaged from the 1-tooth ratchet of the clutch disc, and the feed unit stops with the binary initial loading card just before the read brushes.

4 RELAY SEQUENCE WITH CARD READER UNDER COMPUTER CONTROL

With the binary initial loading card just ahead of the read brushes, the LOAD FROM CARD READER pushbutton located on the duplex maintenance console is depressed fig. 3–19. Assume that it is depressed at 260 degrees. This selects the card reader through internal circuitry and reads the 24 words on the binary initial loading card into the first 24 memory registers.

At PT6 of the *RDS* instruction, the read thyratron energizes the R12 pick coil (sect. 3B, read relay) through CF11 (which is closed), through the 11A (NO) point, through the 11B (NO) point, to the 72V source in section 1B. The 12AU (NO) point in section 3A provides a path to energize the hold coil of R12 (sect. 4A) and also lights the READ light, which parallels the hold coil. The 12AL (NO) point provides a path to energize R1P (sect. 2B auto start relay) through CF10, which is closed at this time. R1H (sect. 2A) is picked via the 1AU (NO) point and CF4, CF4 also being made at this time.

The card feed clutch magnet (sect. 2B) is energized through the 1BU (NO) point and CF1 being closed; at 330 degrees (clutch-engaging time), the binary initial loading card is fed under the read brushes with the card reader under computer control.

Note

Since 4AU (NC) point is open (sect. 2B), the START pushbutton is ineffectual.

The 4AL and 12BU (NO) points (sect. 4B), in conjunction with CF17 and CF16, provide a path for the read brushes. The brushes are connected to the first 64 connections of the summary punch connector. CF18 generates the first request-break-in pulse (sect. 4B).

Note

The entering and leaving of the punched holes by the read brushes is followed and anticipated by the respective cam contacts. This prevents the read brushes from initiating or terminating an electrical circuit and from burning their tips because of arcing.

The combination of the request-break-in pulse (card-reader-index pulse) and the set condition of the word counter status flip-flop in the Central Computer permits the computer break-request circuit to initiate break-in pulses at TP 11. Consequently, the punched information is transferred from the IO register and the IO buffer register to core memory. Between break-in requests, the computer returns to its normal function. A total of 12 break-in requests are generated, corresponding to the number of rows on the card. For a thorough discussion of break-ins and word transfer, see the theory of operation manual on the Central Computer.

4.1 RDS Instruction

The *RDS* instruction sets the feeding mechanism in motion and reads the entire card into the IO register and the IO buffer register. The address portion of this instruction, which is placed in the IO word counter, specifies the number of words to be transferred during the read operation; e.g., *RDS (24)* words would be one complete card, *RDS (5)* words would be the first five words of the first card, etc. If this number is not a multiple of 24 (one or more complete cards), the words on the card after the number specified will not be read into core memory because the word counter contains the total number of words to be read. Each word that is read will step down this counter by 1 until the word counter goes to 0.

4.2 Word Transfer

As each index point is reached on the card being read, two words are simultaneously transferred from the card reader to the Central Computer, the even or left, word going to the IO register and the odd, or right, word going to the IO buffer register (fig. 3–20). At the same time, a break-request pulse is transmitted by the card reader to the Central Computer.

This break request initiates circuitry which results in a break-in level. During this break-in cycle, the word in the IO register is transferred to the memory buffer register, the IO register being cleared during this process, and the word in the IO buffer register is transferred to the IO register. An additional break-in cycle is required in order to place the second word in the memory buffer register and from there into core memory. This second break-in level is generated by Central Computer circuitry. At BT 11 of this second break-in cycle, the computer is again sensed for a break request. Since there are none, no more break-ins are generated, and the computer reverts to operate time and continues with its normal program. Approximately 20 ms later, another row of the card will be under the read brushes and the above process will be repeated. When the word counter equals 0, the break-in circuitry is deconditioned and no more break-ins are developed.

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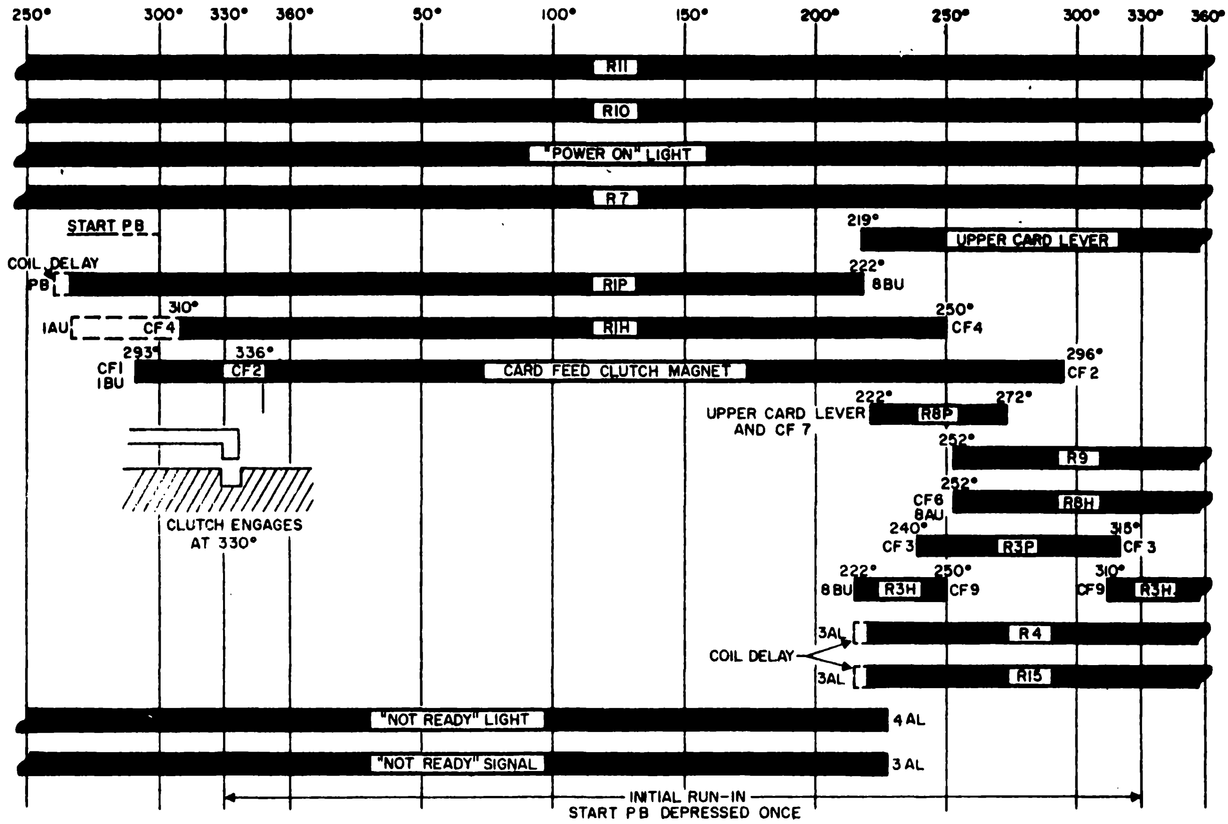


Figure 3—18. Relay Sequence for Initial Run-In

is as follows. If the START pushbutton is depressed and the first card fails to feed, the card lever contact fails to close, R8P fails to pick, and R8H and R9 are not energized. As a result, the R9A point in 1B opens and drops the auto start relay. This added point prevents continuous running of the card feed mechanism if the first card fails to feed.

Note

> The make and break times of CF6 and CF7 cams overlap each other so as to encompass 360 degrees. Thus, as soon as a card trips the card lever, the energization of R8 is assured for one complete cycle.

The original power path for the start circuit, which was completed to R1, is now directed to R3H (sect. 2B, calculator interlock relay) by the transfer of the dual-contact 8BU operating point. This 8BU operating point drops R1P (sect. 2B), but its hold coil (sect. 2A) remains energized until 250 degrees, when CF4 opens.

The 3BL (NC, sect. 4B) now opens and disconnects ground from the SP 51 A90 connection, permitting the computer to sense a ready state for the card reader. The 3AL (NO) point causes R4 and R15 (sect. 2A, calculator interlock relays) to be energized. Picking R4 opens the 4AU (NC) point, and the R3H relay is now dependent on CF9 (sect. 1B). The NOT READY light is now out because of the 4AL (NC) point opening (sect. 4B). The 3BU (NO) point (sect. 2B) closes and completes a circuit at 240 degrees by the action of CF3 to pick R3P.

Note

> Observe that the roles of the hold and pick coils have been reversed, as the hold coil may remain energized for long periods when the machine is not in use. The pick coil is used only as a running hold. Relay R3 is continuously energized by the overlap timing of CF3 and CF9. CF3 energizes the pick coil of R3 via 3BU (NO) from 240 to 315 degrees; CF9 energizes the hold coil via 3AU (NO) from 310 to 250 degrees.

The 4AU (NC) point (sect. 2B) has interrupted the original start circuit; therefore, when CF9 opens, R3H is de-energized (occurs at 250 degrees). This will not affect the status of R3 points, however, as the pick coil is still energized. The 4BU (NC) point (sect. 1B)

5 RELAY SEQUENCE ON RECEIPT OF COMPUTER-DISCONNECT SIGNAL

When the card reader has read the last word specified by the *RDS* instruction, the IO word counter equals 0. This IO-word-counter-equals-0 level will condition a gate in the computer which is pulsed by a request-disconnect signal at 270 degrees. This pulse, getting through the gate, will fire a single shot; this, in turn, will trigger a thyratron relay driver. When this relay driver is fired, the following takes place (fig. 3–152

The thyratron relay driver completes a path with 12BL (NO) and CF13 to pick R13 (disconnect relay in sect. 3B). At 261 degrees when CF13 closes, 13A (NC) opens and breaks the hold circuit for R12 (sect. 3A) and for the READ light circuit. Relay R13 remains energized through its own 13B (NO) point till 297 degrees, when CF13 opens. The 12AL (NO) point's opening causes R1P (auto start relay in sect. 2B) to drop. The hold circuit for the card feed clutch magnet provided by CF2 is broken at 296 degrees. At 330 degrees, the card reader will latch up.

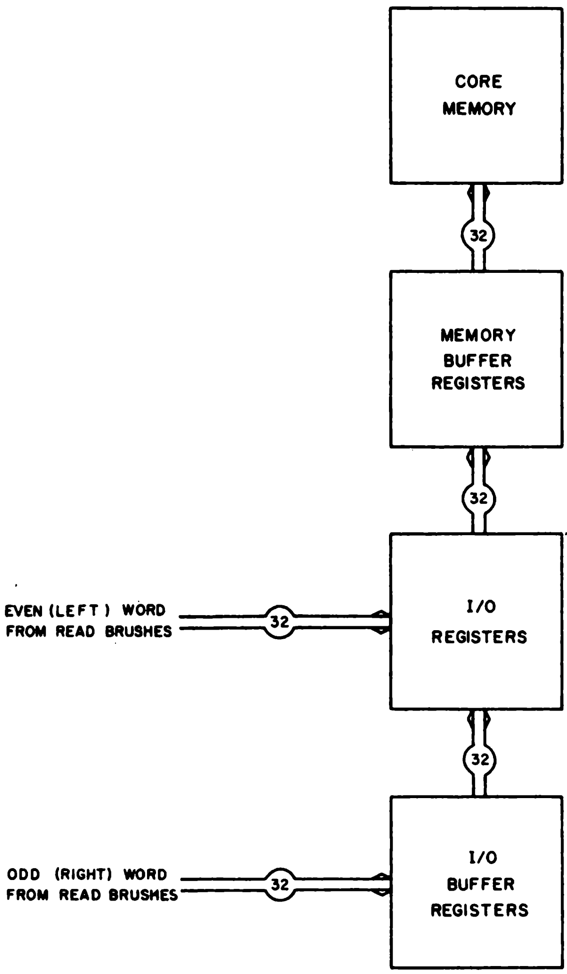


Figure 3–20. Information Transfer

6 RELAY SEQUENCE FOR MANUAL STOP

The manual STOP pushbutton may be depressed at any time to stop the reading of following cards. Depressing the STOP pushbutton will cause the computer to lose control of the card reader and turn the NOT READY light on. If a card is being read at the time the STOP pushbutton is depressed, the stop action is delayed until the end of the current card cycle. For this discussion, assume that the pushbutton was depressed at 100 degrees; thus, the card reader continues to read the card under the brushes.

The pick coil of R6 (stop relay in sect. 2A) is energized through the path provided by 10A (NO), the STOP pushbutton, R6P, and to ground. The hold circuit for R6 is completed through its own 6AU (NO) point, and the 1AL (NO) and 10A (NO) points which are now closed. The 6AL (NC) point (sect. 1A) opens, interrupting the circuit to the hold coil of R3, and, with the pick coil circuit already broken at 315 degrees of the previous cycle by CF3, R3 is de-energized.

The hold circuit of R1 is maintained until 250 degrees by CF4, thus sustaining the card feed clutch magnet via the 1BU (NO) point in section 2B. After 250 degrees, the card feed clutch magnet relies on CF2 until 296 degrees and is then de-energized (sect. 2B). Thus, the cycle is completed, and information is read into core memory. Meanwhile, 6AL (NC in sect. 1A) opens the power line to R1P and prevents the energizing of R1P at 245 degrees. Relay R6 is de-energized by the 1AL (NO) point in section 2A, permitting 6AL (NC) to close again, but the hold coil of R3 cannot be picked because of the 1BL (NO) point's being open.

With the dropping of R4, 4AL (NC) assumes its normal position, and the NOT READY light circuit is completed. Because R15 parallels R4, it is also de-energized and 15A (NO) interrupts the ready relay circuit (sect. 4B), turning on the CARD READER NOT READY light on the duplex maintenance console.

CF14 (sect. 1A) shunts the stop key and stop relay contact 6AL (NC). CF14 is closed from 332 degrees to 222 degrees and prevents dropping the calculator interlock relays if the stop key is depressed after the CF clutch unlatches (330 degrees) and before CF5 makes (0 degrees). If the stop key were depressed between those timings, without CF14 in the circuit, a card would be fed without reading.

Note

The precise adjustment of the timing of CF14 will prevent the trouble stated above and will allow the stop key to render the card reader not-ready when the feed is latched as well as when it is operating.

7 AUTOMATIC STOP

Three automatic switches are incorporated in the card reader. The card reader will stop and become not-ready when any one of these switches are activated. The following paragraphs discuss the operation and relay sequence of each switch. No relay sequence timing charts are included, these not being cyclic operations that can be checked with the dynamic timer. Reference is made to the wiring diagram. Following the automatic switches is a brief discussion of the operation of the four signal fuses in the card reader.

7.1 Card Feed Jam

The upper card lever serves to energize the computer interlock relay. This lever is located just ahead of the read brushes. When a card feed jam occurs, the upper card lever opens and signals the card reader. Certain assumptions must be made before starting the analysis of this sequence: the cards are in the hopper, the card reader is functioning normally, and the stacker is not full. At this point, a card feed jam occurs at the throat.

Note

When a card feed jam occurs, the NOT READY lamp lights, the CARD FEED STOP light is turned on, the READ light remains lit, and the card reader stops with three cards positioned past the read brushes.

The last card through the throat is read. At 219 degrees of the last card cycle, the first abnormal action takes place; the upper card lever fails to make, since no card is coming through the throat. Thus, R8P in section 4A is not energized at 222 degrees. The R8H coil drops at 225 degrees through the action of CF6, and the 8BU and 8BL (NO) points open in section 2B. The 8AL (NC) point, closing (sect. 2A), picks R5P (feed interlock relay), since the hopper relay is still energized and the 3AL (NO) point is closed. The 5AU (NO) point's closing provides a path to pick R5H. This also lights the CARD FEED STOP light as the light parallels R5.

Relay R3P cannot pick at 240 degrees, as is normal, since the 8BL (NO) point is now in its normal condition. Relay R3H drops at 250 degrees, and the 3BL (NC) point in section 4B completes the not-ready-signal circuit. Relay R3H, dropping at 250 degrees, leaves R4 and R15 dependent on CF5, and they drop when the cam opens at 290 degrees. The 4AL (NC) point in section 4B closes and turns on the NOT READY light. The 4BU (NC) point in section 1B closes and opens the circuit to R1P at 290 degrees. This action opens the 1BU (NO) point in section 2B and turns control of the card feed clutch magnet over to CF2, which opens at 296 degrees. Thus, the card feed clutch will latch up at 330 degrees, and the card reader will stop.

7.2 Cards Removed from Hopper

The hopper contact prevents card-reader operation if there are no cards in the hopper. This contact is located in the hopper and opens when the cards are removed from the hopper. Certain assumptions must be made before starting the analysis of this sequence: the cards are in the hopper, the card reader is functioning normally, and the stacker is not full. The cards are removed from the hopper.

Note

When the hopper contact opens, the NOT READY light is turned on, the READ light remains lit, and the card reader stops, with three cards positioned past the read brushes.

The hopper contact opens at 219 degrees of the previous card cycle (last card to be fed through the throat). The last card to enter the feed unit is read in the normal fashion. The upper card lever opens at 75 degrees as the last card passes it but fails to make again at 219 degrees since no card came through the throat. Thus, R8P in section 4A is not energized at 222 degrees. The R8H coil drops at 225 degrees through the action of CF6, and the 8BU and 8BL (NO) points open in section 2B. Relay R3P cannot pick at 240 degrees, as is normal, since the 8BL (NO) point is now in its normal condition. Relay R3H drops at 250 degrees, and the 3BL (NC) point in section 4B completes the not-ready-signal circuit. Relay R3H, dropping at 250 degrees, leaves R4 and R15 dependent on CF5, and they drop when the cam opens at 290 degrees.

The 4AL (NC) point in section 4B closes and turns on the NOT READY light. The 4BU (NC) point in section 1B closes and opens the circuit to R1P at 290 degrees. This action opens the 1BU (NO) point in section 2B and turns control of the card feed clutch magnet over to CF2, which opens at 296 degrees. Thus, the card feed clutch will latch up at 330 degrees, and the reader will stop.

5.7.3 Stacker Stop Switch Activated

The stacker stop switch prevents card reader operation when the capacity of the stacker is reached. This switch is located at the rear of the stacker.

Since the stacker stop switch is rarely activated (the capacity of the stacker is 800 cards), and the relay sequence is similar to the sequence initiated by the STOP pushbutton's being depressed, this discussion is brief.

The assumptions made before starting the analysis are: the cards are in the hopper, the card reader is operating normally, and the stacker is one card short of its capacity. When this last card is stacked, the following occurs.

Note

When the stacker stop switch is activated, the NOT READY light is turned on, the READ light remains lit, and the card reader stops, with three cards positioned past the read brushes.

The stacker gripper fingers open at approximately 345 degrees to stack the card. Since the card feed clutch is engaged at 330 degrees, the card reader action continues another cycle and reads one more card. At 345 degrees, the R3H circuit is broken by the action of the stacker stop switch (sect. 1A), and, with the pick coil circuit broken at 315 degrees of the previous cycle by CF3, R3 is de-energized, sending the not-ready signal to the computer.

The stacker stop switch opens the circuit to R1P and prevents the R1P coil from being energized at 245 degrees. But the hold circuit of R1 is maintained until 250 degrees by CF4, thus sustaining the card feed clutch magnet via the 1BU (NO) point in section 2B. After 250 degrees, the card feed clutch magnet relies on CF2 until 296 degrees and is then de-energized. Thus, the cycle is completed, and information is read into core memory.

Relays R4 and R15 (sect. 2A) drop at 290 degrees by the action of CF5. The 4AL (NC) point turns the NOT READY light on.

8 RESTART

Visual indications of a card feed jam are: the CARD FEED STOP light is lit, the NOT READY LIGHT is lit, and the card reader is halted with a jam at the throat.

To restart the card reader when a card feed jam has occurred, proceed as follows:

1. Turn main line switch off, and remove remaining cards from hopper. This turns CARD FEED-STOP light off.
2. Remove jammed cards from throat.
3. Locate and correct cause of card feed jam.
4. Employing normal runout procedure, stack three cards that are positioned past read brushes.
5. Repunch any cards damaged by jam, and replace them in their correct positions in deck.
6. Depress MASTER RESET pushbutton on duplex maintenance console to clear core memory of data that was read prior to jam.
7. Replace deck of cards in hopper.
8. Depress START pushbutton to feed in first card; this turns off NOT READY light.
9. Depress LOAD FROM CARD READER pushbutton located on duplex maintenance console; card reader will read deck into core memory, functioning normally.

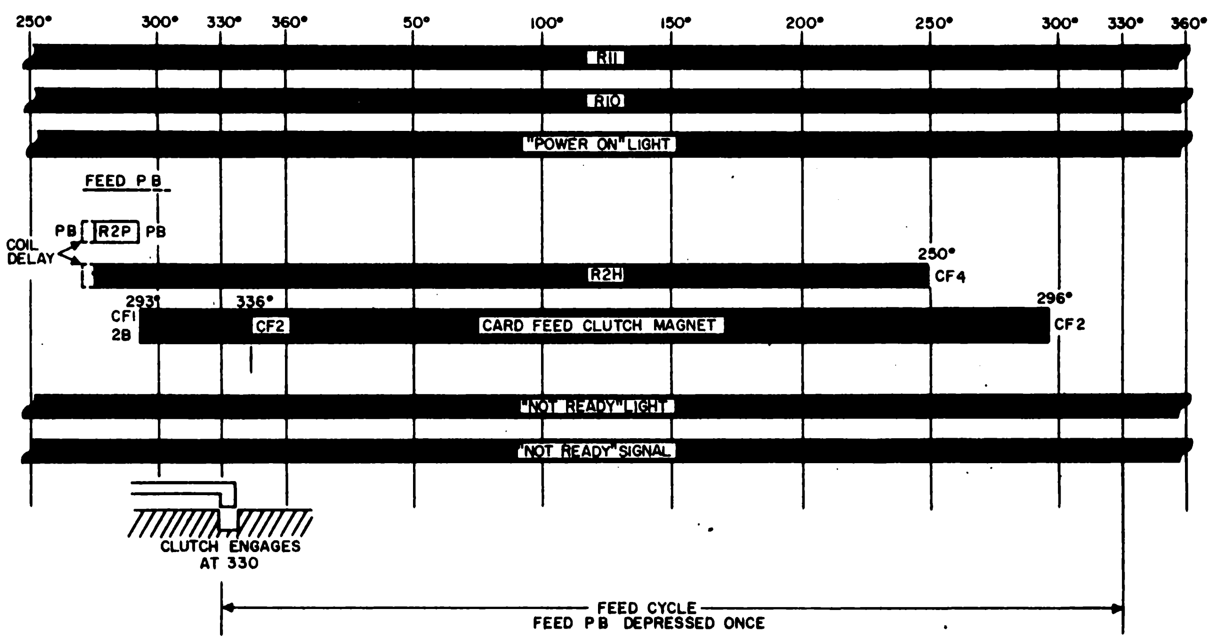


Figure 3–21. Feed Sequence

0990

9 RUNOUT OPERATION

The FEED pushbutton is operative only when the card reader is not under computer control and causes the card feed to operate for one or more cycles until the pushbutton is released. The pushbutton is ineffective once the card reader is in the ready condition, since 4BU (NC) in section 1B will be open, interrupting the circuit to R2 (feed relay). If all conditions are normal, and the card reader is in the not-ready condition, depressing the FEED pushbutton causes the following to occur (fig. 3–21). Assume that the FEED pushbutton was depressed at 270 degrees, The R2 pick coil is energized (sect. 2B). Picking R2 causes 2B (NO) in section 2B to close, and this, in turn, energizes the card feed clutch magnet through CF1. The card feed clutch will remain engaged for one or more card feed cycles, depending on how long the FEED pushbutton is kept depressed.

Summary Questions

1. What card columns contain each of the following? To what register is each directly transferred?

   A. Right words 49-80 I/O Bfr.
   B. Left words 17-48 I/O Reg

2. List the four steps necessary to make the Card Reader "Ready".

3. The "Request Disconnect" from the Card Reader will clear the I/O Interlock only if the Wd Cntr. has stepped to zero.

4. A RDS 100_8 words is given. How many cards will pass under the read brushes before the card feed halts? 3

5. Write a program to read one card and load this information into Core Memory starting with location 0.00000.

6. Given: A card with 20_8 words in the first 20_8 locations on the card.

Program A		Program B	
SEL_{01}	0000	SEL_{01}	0000
LDC	1000	LDC	1000
RDS	0020	RDS	0030
HLT	0000	HLT	0000

Select the correct answer in regard to the above programs from the following:

A. Program A will require more time than Program B.
B. Program A will not clear the I/O Interlock.
C. Program B will not clear the I/O Interlock.
D. Program A and B will require the same amount of Machine Time.
E. Program B will require more time than Program A.

7. Given the following program

SEL_{01}	0000
LDC	1000
RDS	0030
HLT	0000

The Computer hangs up in an I/O pause and passes all cards through the card reader. A cause for this could be:

Summary Questions

A.	5FH-H7 open	(0.7.6 - 6C)
B.	GT_4 in 4EW, open filaments	(0.7.3 - 5D)
C.	5EP-A3 open	(0.7.3 - 7D)
D.	GT-7 in 5EP, open filaments	(0.7.3 - 3D)
E.	cFF_4 in 5 FH cannot be set	(0.7.6 - 8B)

8. The Word Counter Status FF remains set. (0.7.3 - 7D) The following program when executed would result in:

000	SEL_{01}	
001	LDC	1000
002	RDS	1000
003	LDC	2000
004	HLT	

A. Hang up on step 002 with the I/O Interlock on.
B. Hang up on step 003 with I/O Interlock on, Prog. Ctr. = 4
C. Hang up with program counter = 3
D. Halt with Program Counter = 5
E. Hang up on step 004 with I/O Interlock on.

9. The I/O Buffer transfers to the I/O Register at what time during a RDS operation?

A. TP-6
B. BI-2
C. BI-7
D. IP-9
E. BO-2

10. What card reader trouble could cause the following failures? (Assume loading program had LDC 1000)

In Memory			Should be in Memory		
1000	CAD	11005	1000	CAD	11005
1001	ADD	11006	1001	ADD	11007
1002	FST	00101	1002	FST	00101
1003	ADD	11002	1003	ADD	11003
1004	FSD	11011	1004	FST	11011
1005	BPX	20006	1005	BPX	20007
	etc.			etc.	

Summary Questions

A. Read Brush 48, open
B. Read Brush 75, open
C. Read Brush 80, open
D. Read Brush 17, open
E. Read Brush 49, open

11. If GT_9 in 5FF, logic 0.7.6-11B, passes all pulses and the following program is given, which of the statements below would be most correct?

SEL_{01}	000
LDC	100
RDS	030
HLT	000

A. I/O Interlock would never be cleared.
B. I/O Interlock would be cleared after 30th word.
C. I/O Interlock would be cleared after 1st word.
D. Two words would be put into memory.
E. I/O Interlock would be cleared after 60th word.

12. The following program is executed while 5FH-H7 is open (0.7.6-6B). Which of the statements below is correct?

SEL_{01}	0000
LDC	1000
RDS	0030
HLT	0000

A. Locations 1001, 1003, 1005, etc., will contain zeros.
B. Computer will hang up in an I/O pause.
C. The Card Reader would have to send two cards through before it could get a disconnect.
D. The RDS 30 would function normally.
E. No words would be read into Memory.

13. In executing the following program, only the first word is loaded into Memory correctly. All other words read in are a logical add of two words. Which of the following could cause this:

SEL_{01}	000
LDC	050
RDS	010
HLT	000

Summary Questions

A. 5DW-A1 open (0.7.7 - 11B)
B. GT_3 in 5ER open filaments (0.2.3 - 2B)
C. 5FH-H7 open (0.7.6 - 6C)
D. 5ET-H3 open (0.2.3 - 2A)
E. 5ET-B2 open (0.2.3 - 2A)

14. The first card of a deck is fed into the Card Reader with the "Start" key, making it "Ready". To cause more cards to be fed, it is necessary to depress the:

A. "Start" key again
B. "Feed" key
C. "Load from Card Reader" PB
D. "Ready I/O Units" PB
E. "Master Reset" PB

15. What is the information path for all the ODD words read from the Card Reader to Central Computer?

A. I/O Buffer to Memory Buffer to Core Memory.
B. I/O Buffer to I/O Register to Core Memory.
C. I/O Buffer to I/O Register to Memory Buffer to Core Memory.
D. I/O Register to Memory Buffer to Core Memory.
E. I/O Register to I/O Buffer to Memory Buffer to Core Memory.

16. Answer the following true or false:

A. One machine cycle of the Card Reader may allow 30_8 words to be read. T
B. Two words from the Card Reader are trnasferred to the I/O Buffer and I/O Register at the same time. T
C. Twelve index pulses from the Reader generate 30_8 break cycles to read one card into Memory. T
D. Feeding un-punched cards into the Card Reader transfers no information to Memory. F
E. The Card Reader "Request Disconnect" pulse clears the I/O Buffer Register. T

17. Computer is operating normally. The following program is run. What are the results?

Summary Questions

000	SEL_{01}		007	BPX	004
001	LDC	1000	010	PER_{27}	
002	BSN_{11}	002	011	LDC	2000
003	RDS	030	012	1XIN	1.77777
004	CSW		013	$1BPX_{01}$	013
005	ADD	015	014	HLT	
006	BFZ	010	015	0.00000	0.00025

A. Information read will be put in location 2000-2027.
B. No cards will be read because I/O Interlock is cleared before reader can start.
C. First two words in locations 1000 and 1001 rest in locations 2000-2025.
D. Only the first two words read in, rest of the information is lost.
E. Information read will be in locations 1000-1027.

Information | Presentation Notes

XI. TYPE 723 CARD RECORDER

A. Introduction to Card Recorder

1. The Card Recorder is an automatic card punch designed to punch standard IBM cards with up to 24 binary words, of 32 bits each, at the rate of 100 cards per minute. It serves to produce a punched card record of data generated in Central Computer. Punching is under control of the computer at all times. Used to punch out:

   a. Program decks
   b. Data
   c. Marginal Check Control Cards

B. Mechanical Operation

1. Block diagram -- General — Figure 3-1

This section and its associated logic block diagram, figure 3-1, give an overall picture of the 723 Card Recorder and the control of it by the Central Computer. Each block in the diagram is discussed briefly in the subsequent text in relation to its function and its relationship to the other blocks.

The feed magazine stores the cards before punching. It contains the feed knives, roller throat, and magazine card lever. The magazine will feed one card at a time to the first set of feed rolls. The feed rolls are used to move the card intermittently through the machine from station to station. There are three sets of feed rolls, all of which are drived by the drive unit.

The punch station receives the information from the Central Computer and punches it in the cards as they pass through the recorder. Power to drive the punches through the card is supplied from the drive unit through the eccentric shaft.

The read station reproduces information from columns 1 to 16 of the card at the read station into the card following it. This is accomplished by 16 brushes, which can be connected directly to the first 16 punch magnets. The information that is reproduced is usually of an identifying or control nature and is common to all cards to be contained in one desk.

The stacker stores the cards temporarily after they have been fed through the machine and punched. Power is supplied by the third set of feed rolls through a gear train.

On the outer edge of master roll gear

The drive unit is used to change the continuous motion of the drive motor into intermittent motion to drive the feed rolls. The intermittent motion is provided by the Geneva mechanism and is supplied to the feed roll drive gears. The drive unit also supplies mechanical power to the feed magazine, the stacker station, and the circuit breakers.

The circuit breakers are used to initiate signals to be sent to the computer at certain index times to help transfer information to the punch. They are also used to control relay sequence by providing paths which cause relays to be picked up or dropped out at certain index times. The mechanical power for the circuit breakers comes through a gear train from the drive unit. The relays are used to control all manual and automatic machine operations.

The punch clutch is used to couple the drive motor to the drive unit. This clutch can be engaged manually or automatically by the computer. When engaged, the punch clutch causes the cards to be fed.

The manual controls, START, FEED, and STOP, are used to prepare the recorder for computer control.

The signal lights, NOT READY, WRITE, POWER ON, FUSE; andCARD FEED STOP, are used to indicate the status of the machine.

The drive motor furnishes the mechanical power to the drive unit. The motor can be used manually, or automatically by the computer.

Before the card recorder can be used by the computer, the recorder must be in a ready state, which requires the existence of the following conditions:

a. There must be a card at the punching station and a quantity of cards in the hopper.
b. The stacker must not be full.
c. Power must be on.
d. All fuses must be good.

To put the recorder in the ready state, place a stack of cards in the feed magazine, turn on the ac power, and depress the START pushbutton. This causes a card to be fed from the magazine to the first feed rolls. The first feed roll moves the card to the punch station, and the card recorder stops. The NOT READY light is extinguished, and the not-ready signal to the computer is removed. The card recorder is now in the ready condition.

The computer can now start the card recorder by sending a write signal to it. When the write signal is received by the recorder, relay circuitry starts the drive motor and engages the punch clutch. The card starts to move intermittently, one row at a time, past the punches.

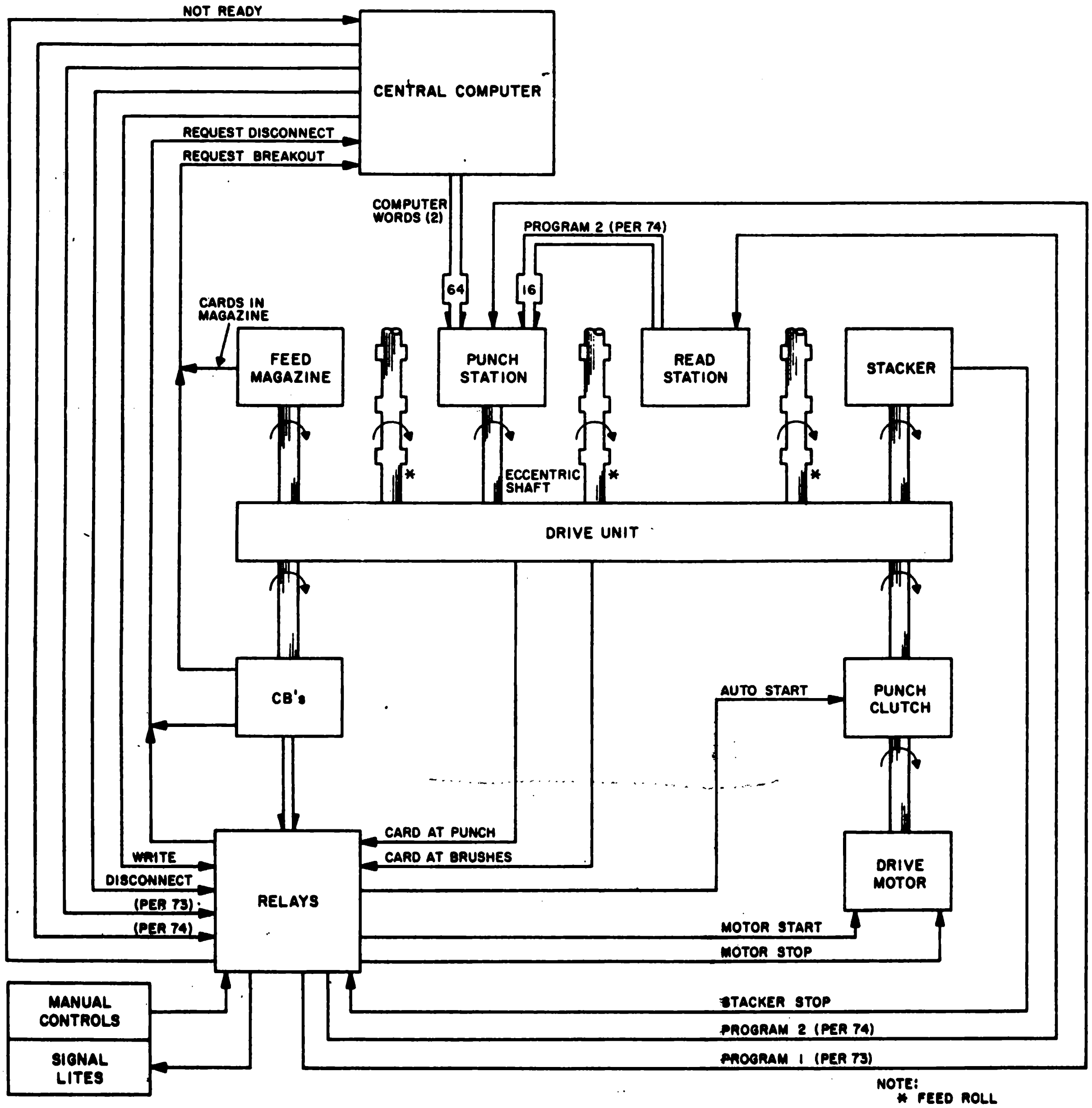


Figure 3–1. 723 Card Recorder, Block Diagram

As each row moves to the punches and stops, the circuit breakers send a breakout request to the computer, which sends two words from memory to condition the appropriate punch magnets. The punch bail then drives the proper punches through the card. The card now moves with its next row under the punches, and another breakout request is sent. This results in two more words being transferred and punched. This process continues until all 12 rows of the card have been punched. As the last row of the card leaves the punch station, the circuit breakers send a disconnect request to the computer. If all information has been transferred, the computer will send a disconnect signal to the punch. The disconnect signal will turn off the drive motor and allow the punch clutch to latch up, causing card feeding and punching to stop. If all information has not been transferred, the punch will continue to feed and punch cards until a disconnect signal is received.

The card recorder may be used for gang punching by the computer, if desired. The punch is capable of reproducing in each successive card all information contained in columns 1 through 16 of the first card of a deck. To accomplish this, the computer must use two Operate instructions: PER 73 and PER 74.

The information to be punched into the first 16 card columns is identification information used to identify all cards belonging to one deck. Since the first 16 punch magnets (65-80) are not permanently wired to the computer, a PER 73 instruction must be included in the computer program. This instruction will select certain relays in the card recorder. The relays will transfer the information normally found in card columns 17 through 32 to card columns 1 through 16. The first card that is fed through the machine will now contain the punched identification information in columns 1 through 16 of one card to columns 1 through 16 of the next card, a PER 74 instruction must be given. This instruction will connect the read brushes over columns 1 through 16 to the punches over card columns 1 through 16.

As the 9 row of the first card reaches the brushes, the 9 row of the second card is at the punch station. The first and second cards proceed in step through the read and punch station, and all information in columns 1 through 16 of the first card is punched into columns 1 through 16 of the second card. As the second card proceeds through the punch station, the data words from the computer will be punched in it. This process continues to transfer the information in columns 1 through 16 of the card at the punch station, until all data words have been transferred from the computer and a disconnect signal has been received to stop the recorder.

2. Hopper -- holds up to 800 cards which are placed face down 9 edge forward. Figure 14
3. Feed Knives -- Pull card from hopper, through throat, to feed rolls.
4. Feed Rolls -- the three sets of rollers move the cards with an intermittent motion (cards must be stationary while being punched) from hopper to punch station, punch station to read station, read station to stacker.
5. Geneva Mechanism -- Provides the intermittent motion for feed rolls.
6. Stacker -- Holds up to 800 cards and has a stacker stop switch to prevent cards from being jammed into the stacker.
7. Principles of punching

   a. Eccentric shaft continuously rotating.
   b. Magnets energized through thyratron registers from central computer.
   c. Magnet trips interposer allowing punch bail to drive punch through card.
   d. 80 magnets and interposers.

8. Reading

   a. 80 read brushes that make contact with contact roll through holes in card.
   b. Similar to sensing in Card Reader.
   c. Only 16 read brushes used.

      1) Col. 1-16
      2) Used for gang-punching

C. Automatic Switches

If it is desirable to associate controls, lights, and switches with wiring diagram, refer to Part I of this section.

1. Magazine Card Lever

   a. Closes when cards are in hopper.
   b. Prevents recorder operation when open.

2. Die Card Leverl

   a. Closed with card in punch station.
   b. Prevents recorder operation when open.

3. Die Contact Strap -- Open with die not latched in position.
4. Brush Card Lever

   a. Open with card not in read station.
   b. Detects jams.

5. Stacker Stop Switch -- Stops recorder when stacker is full.

D. Operating Controls

Figure 15

1. Main Line Switch -- Applies to 110VAC to the motor. The printer supplies +46V and +72VDC. 110VAC comes from a buss in the printer but the printer main line switch need not be on for the punch to receive this voltage.

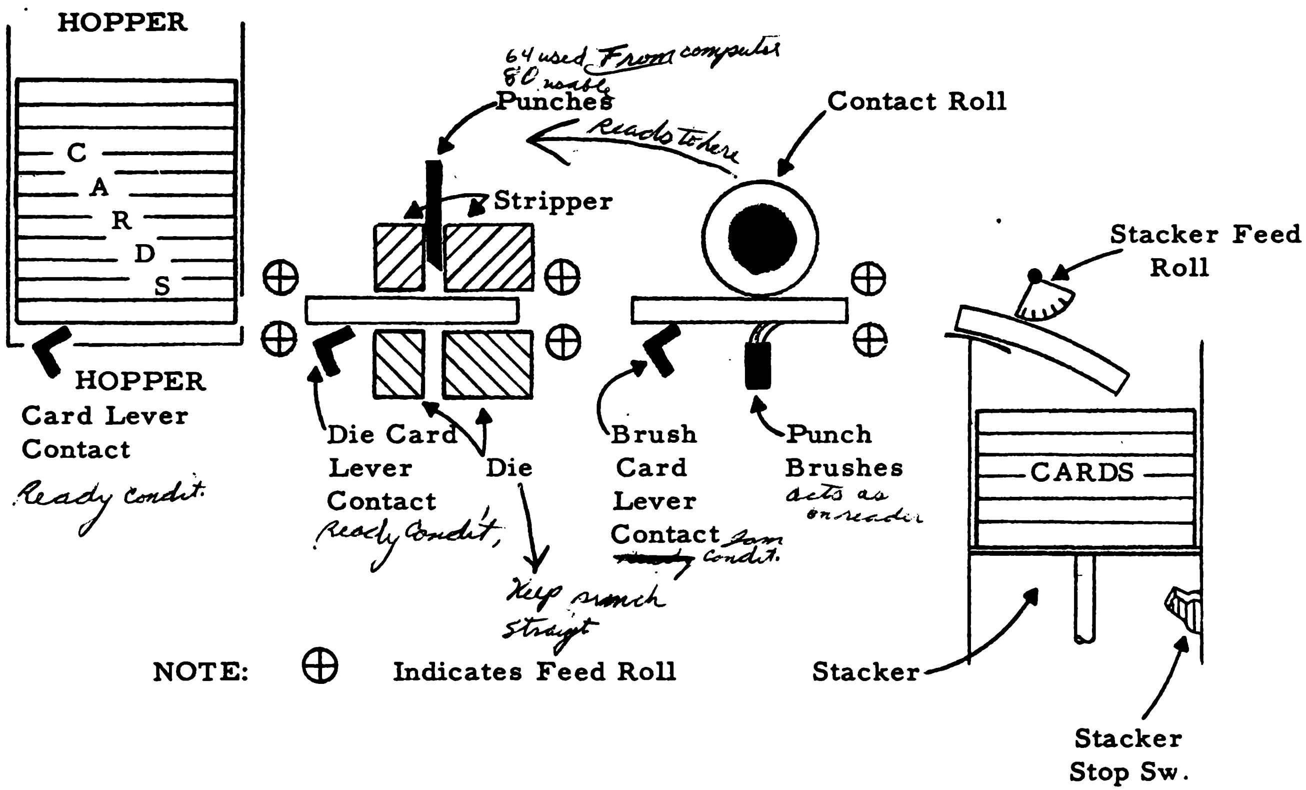


FIGURE 14 - CARD FEED PATH OF CARD RECORDER

1120

2. Start Pushbutton -- Puts recorder under computer control if there is a card at the punch station. Will feed one card if there is none at the punch station, then put the recorder under computer control. Inoperative when under computer control. "Ready I/O Units" or "Master Reset" PBs on the Duplex Maintenance console do the same.
3. Stop Pushbutton -- Removes the recorder from computer control. If a card is being punched, the recorder will not stop until the end of the card.
4. Feed Pushbutton -- Causes successive feed cycles as long as the button is depressed. Inoperative when under computer control.

* START	* STOP	* FEED	NOT READY	WRITE (Ready on Card Reader)	CARD FEED STOP	POWER ON	FUSE

* Pushbutton

Figure 15, Operating Controls and Indicator Lights.

E. Indicator Lights — Figure 15

1. Write -- Is lit while the computer is writing or trying to write. Turned on by PT-16 of WRT with punch selected.
2. Fuse -- Indicates a blown signal fuse.
3. Not Ready -- Indicates the punch is not under computer control for one or more of the following reasons (Punch Not Ready light also on DMC).

   a. Power off (Printer must be on to light the Not Ready light).
   b. Signal fuse blown.
   c. Start PB not depressed.
   d. Stop PB has been depressed.
   e. Magazine (hopper) empty.

f. Stacker Full.
g. Card Feed jam.
h. No card at the punch station.
i. Die not in place.
j. Knockoff bar not in place.

NOTE: Some of these conditions light other indicators also in order to allow the operator to distinguish between conditions.

4. Card Feed Stop -- Indicates a feed failure or a card feed jam at the throat.
5. Power On -- Indicates all power is available.

F. Demonstration -- It may be desirable to look at and operate the Card Recorder. Notice the following:

1. Hopper
2. Magnet Unit
3. Card Feed
4. Gang punch brushes (brush assembly removal)
5. Punch die assembly (removal)
6. Stacker
7. Fuses

Operation -- Familiarize yourself with the operation of the recorder.

1. Observe operations by running cards through using the hand crank.
2. Check registration using the card gauge.

G. Programming

Refer to Instruction Analysis lesson plan Section XXI

1. A typical program to punch data in cards is:

0.00100	SEL(02)		Select card recorder
0.00101	LDC	0.00000	First location
0.00102	BSN (11)	0.00102	Check I/O Unit ready
0.00103	WRT	0.00030	Write 30 words, can
0.00104	HLT	0.00000	specify any no. of words.

2. Data Flow

a. Data flows from Memory to Memory Buffer to I/O Register.
b. The I/O Register will condition two sets of write thyratrons. Which set of thyratrons fires is dependent upon which side of the card the computer word is to be punched in.
c. When the thyratron fires (one for each bit position) it will pick a punch magnet which will stay picked until both computer words are transferred and the holes are punched in one row.

3. PER(73)

a. This instruction is used to punch data in columns 1 - 16.
b. Always should follow the WRT instruction, if programmed as below, the PER (74) could possibly be operated on within the punch before the PER (73) due to pick speed of the relays involved.

use prog. on next page

```
SEL(02)
LDC
PER(73)
WRT
PER(74)
WRT
```

By having the WRT instruction before the PER, any preceding WRT instruction would have to be completed before the PER instruction would be reached thereby insuring proper operation.
c. Information normally punched in cols. 17-32 will be punched in cols. 1-16.
d. Normally used in punching identification information in the first card of a deck.
e. Examine how the card image is arranged to give the proper punching format. Figure 17

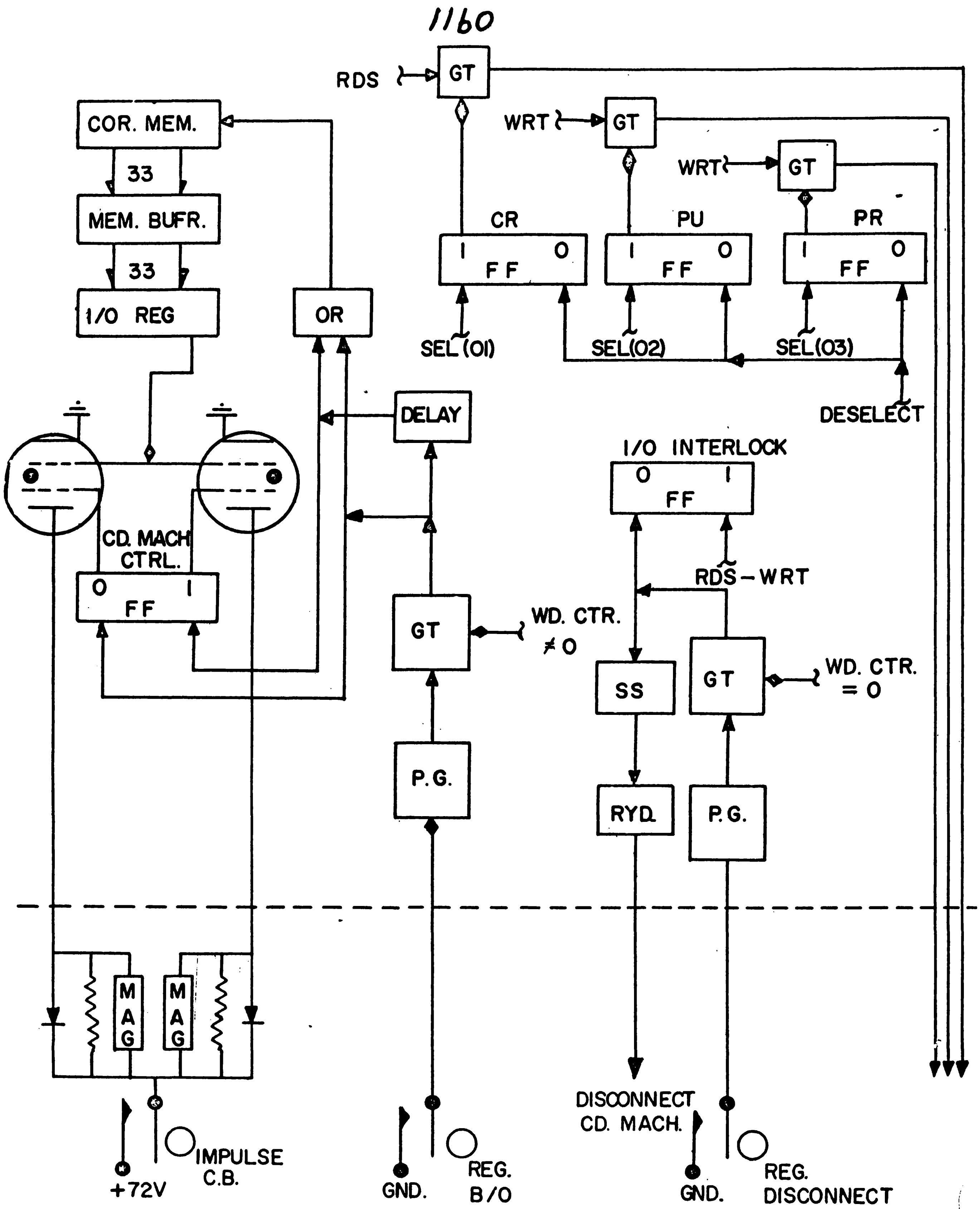


Figure 16, Information Flow From Computer To Printer or Punch.

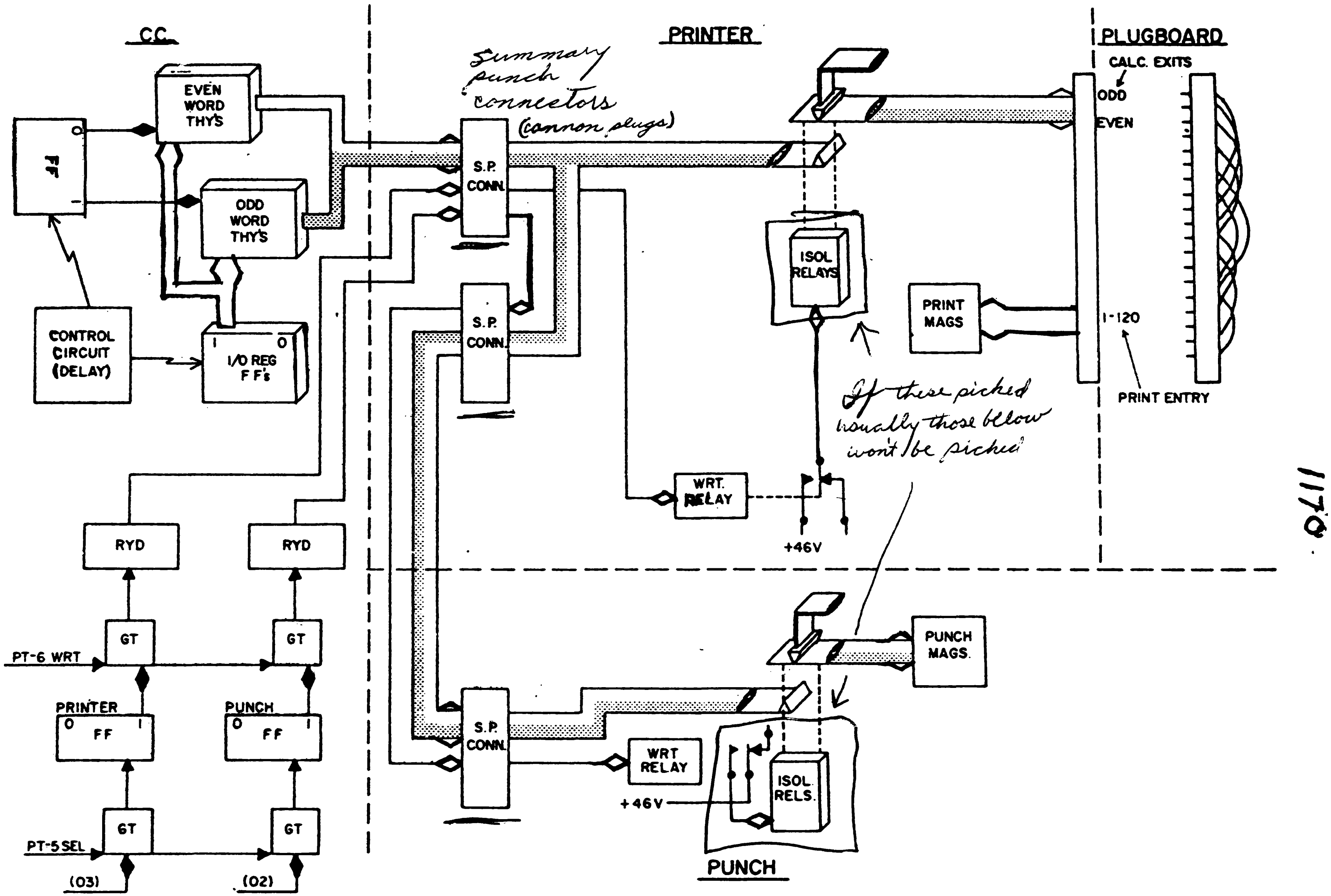
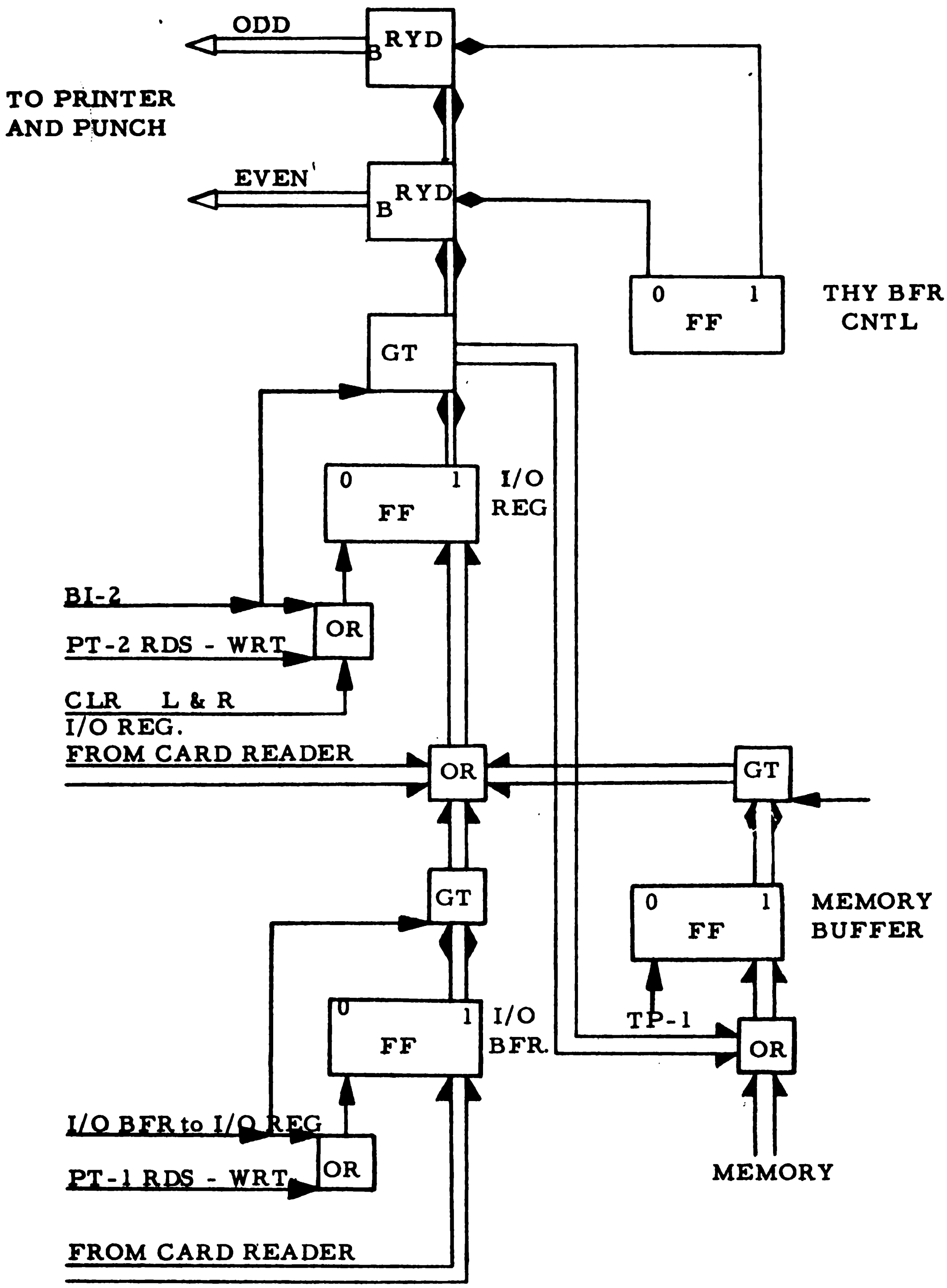


Figure 16A, Information Flow From Computer To Printer or Punch

1180


ODD
B RYD
TO PRINTER
AND PUNCH
EVEN
B RYD
0 1 FF
THY BFR CNTL
GT
0 1 FF
I/O REG
BI-2
PT-2 RDS - WRT
OR
CLR L & R I/O REG.
FROM CARD READER
OR
GT
GT
0 1 FF
MEMORY BUFFER
0 1 FF
I/O BFR.
TP-1
OR
I/O BFR to I/O REG
PT-1 RDS - WRT
OR
MEMORY
FROM CARD READER

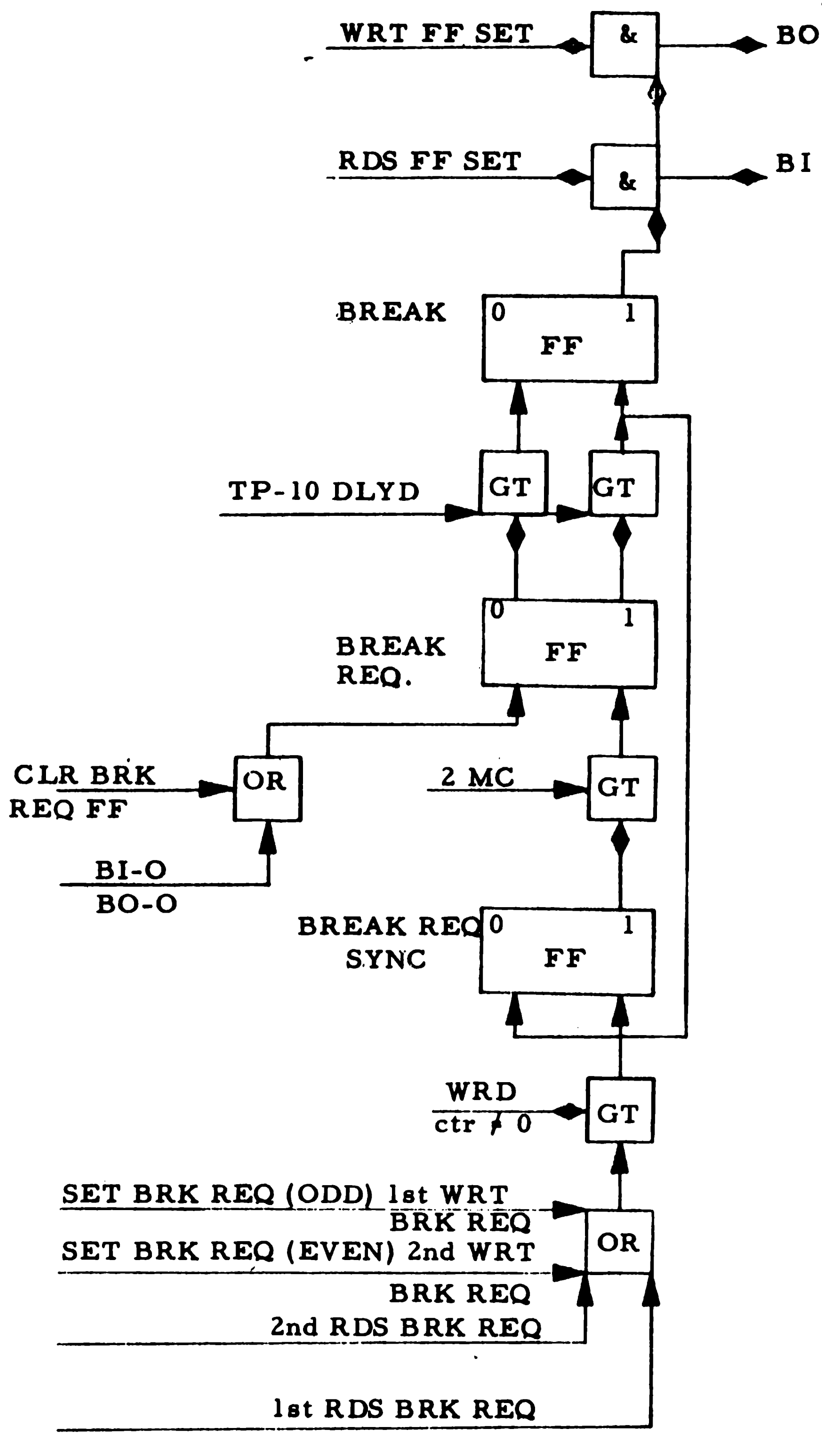


FIGURE 18A BREAK CONTROL CIRCUIT OF 0.2.3

1200

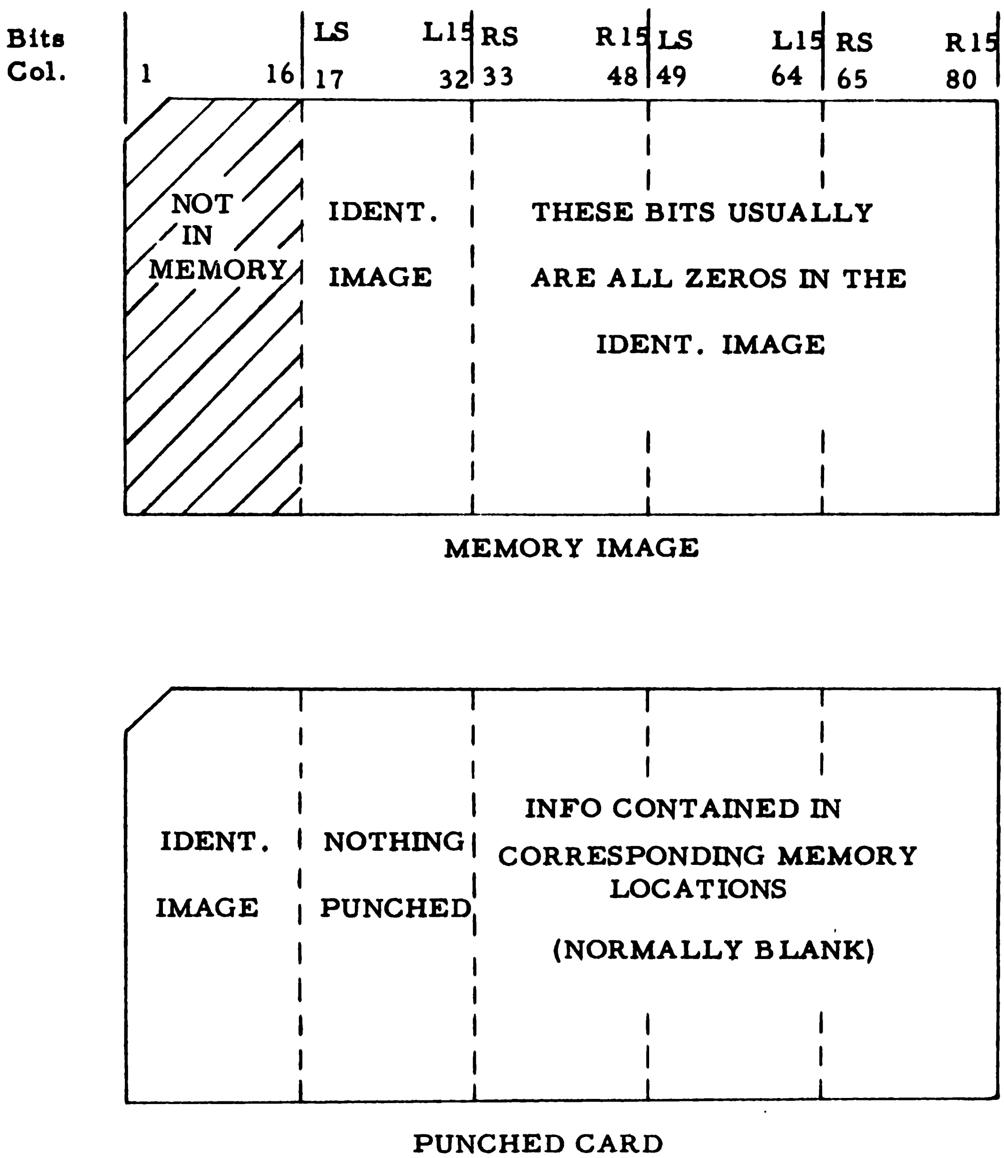


FIGURE 17

4. PER (74)

   a. Used to gang punch in columns 1-16 whatever is in columns 1-16 of the previous card which is at the read station.
   b. Always should follow the WRT instruction (as explained above).
   c. Both PER (973) and PER (74) will remain in effect until the end of the associated WRT instruction and need not be programmed for each card to be punched.

5. Typical program using PER (73) and PER (74)

   SEL (02)
   LDC
   BSN (11)
   WRT
   PER (73)
   WRT
   PER (74)

6. A WRT 0 feeds one card but will punch no information. Can be used to keep successive punched decks separate by programming a WRT O between the decks.

H. Central Computer timing and control

1260 1280
Pages [redacted] and [redacted] Figure 6-4 and 18; suggest to use these figures first, then go into logic.

1. SEL (02)

   a. PT-10 set the pause FF if the I/O Interlock is on.
   b. OT-5, deselect any previous selection.
   c. PT-5, select.

      1) Set Punch Not Ready test FF (0.7.4)

      Note: Called punch not ready FF in logic

      2) Set Punch FF (0.7.6)
      3) Set Card Mach. Oper. FF (0.7.6)
      4) Clear RDS/WRT zero tapes and C.M. FF (0.7.3)

2. LDC -- loads the I/O address counter.
3. WRT

   a. PT-1

1)	Set the I/O Interlock	0.3.1, 0.7.3
2)	Clear RDS and WRT FF	0.7.3
3)	Set the W.D. CTR Status FF	0.7.3
4)	Clear the I/O Word Counter	0.7.3
5)	Clear the I/O Buffer	0.7.2

   b. PT-2

1)	Adr. Reg. to I/O Word Ctr. (complement form)	0.4.1, 0.7.3
2)	Clear I/O Register	0.7.1, 0.7.2

   c. PT-3 -- Prestep the I/O Word Counter (command 290) — 0.7.3

   d. PT-6

      1) Set WRT FF (if the I/O Word Counter ≠0) — 0.7.3
      2) Pulse out at 5 ELG2 (Start WRT pulse) goes to (0.7.6) 5 FDF3 and 5 FDB3 conditioned by the punch FF has output which fires the BSS in 5 FE. — 0.7.6

         a) GT-3 in 5FD conditioned by the Punch FF has output which fires the BSS in 5FE.
         b) Start Punch to logic 0.9.1.
         c) Approx. 43 M.S. later, a break request will be initiated by the recorder as row 9 on the card is coming under the punch.

4. Break cycle introduction — Figures 6-14, 18, 19; suggest to use these figures first, then go into logic.

   a. Each break request from the punch will cause two break cycles to be taken since two computer words are punched simultaneously.

b. Break cycles controlled by the Card Machine RDS/WRT Control Circuit.

c. 4 Basic Delays

1) Condition screen grids of first set of thyratrons for initial delay. Must be conditioned approximately 10 usec before control grid to insure proper firing.
2) Condition grid of thyratron for more than 5 usec to insure proper firing (2nd delay).
3) Condition screen grids of second set of thyratrons. (Same as 1.) (Third delay.)
4) Condition control grids. (Same as 2.) (Fourth delay.)

5. Break Request (Index Pulse, Card Mach.) Begining Armenian Delay

a.	Generated by the recorder	0.7.6
b.	Clear the WRT FF	0.7.3
c.	Set the Break Req. Sync. FF (If the I/O word ctr. ≠0)	0.2.3
d.	Set the card word XFER FF	0.7.6
e.	Set Cond. Delay FF	0.7.6
f.	Clear THY BFR Control FF	0.7.6

1) Conditions the screen grids of BRDY's for punching cols. 17-48 (first level).
2) BRYD's will fire when the I/O REG FFs are set (second level).
3) RYD's must have the conditioning level applied to the screen grids for at least 10 usec before the conditioning level is applied to the control grids.
4) Level on the control grid must be up for at least 5 usec in order to insure firing of the thyratrons.

6. Next 2 MC pulse sets the Break Req. FF 0.2.3
7. TP-7 (#1) sets the Interword Delay FF 0.7.6
8. TP-11

   a. Clear Break Req. Sync. FF 0.2.3
   b. Set the Break FF (Note that no break pulses occur as yet because the WRT FF has been cleared).

9. TP-7 (#2)

   a. Clear Interword Delay FF
   b. Clear Cond. Delay FF
   c. Clear Card Word XFER FF
   d. Set WRT FF (begin generating B.O. pulses, BO-8 through BO-7)

10. BO-11 (TP-10 delayed)

    a. Strobe GT's over the Brk. Req. FF
    b. Break FF Already set but is still pulsed on the set side.

11. BO-0

    a. Clear Break Req. FF
    b. Start Memory

12. BO-2

    a. Step I/O Adr. Ctr.
    b. Step I/O Wd. Ctr.

13. TP-7 (#3) and BO-7

    a. Transfer Memory Buffers to I/O Reg. (BO-7)

NOTE: I/O Reg. will remain filled until TP-7 (#5) to allow time for thyratrons to fire.

    b. Set firing delay FF.
    c. Set Card Word Transfer FF
    d. Clear Write FF (stop BO pulses)
    e. Set Brk. Req. Sync. FF

14. Next 2 MC pulse - set the Brk. Req. FF so that the Brk. FF will remain set at the next TP-10 delayed.
15. TP-10 delayed, clear the Brk. Req. Sync FF
16. TP-7 (#4), set INTERWORD DEL. FF
17. TP-7 (#5)

    a. Set Delay FF
    b. Clear Firing Delay FF
    c. Clear Interword Delay FF
    d. Clear I/O Register

        1) Thyratrons for Col. 17-48 are now fired, have picked punch magnets, and will stay fired until + 72V is removed from plate by cams in the recorder.
        2) No punching as yet.

18. TP-7 (#6), set Interword Del. FF

19. TP-7 (#7)

    a. SET ~~Clear~~ Cond. Del. FF
    b. Clear Interword Del. FF
    c. Set THY, BFR, CTRL. FF (third level)

        1) Conditions BRYD's for punching cols 49-80.
        2) Second word to the I/O Reg. will fire the thyratrons.

20. TP-7 (#8), set Interword Del. FF.
21. TP-7 (#9)

    a. Clear Cond. Del FF
    b. Clear Interword Del. FF
    c. Clear Card Word Xfer FF
    d. Set WRT FF (start generating BO pulses BO-8 through BO-7)

22. BO-0

    a. Start memory (to bring the second word out)

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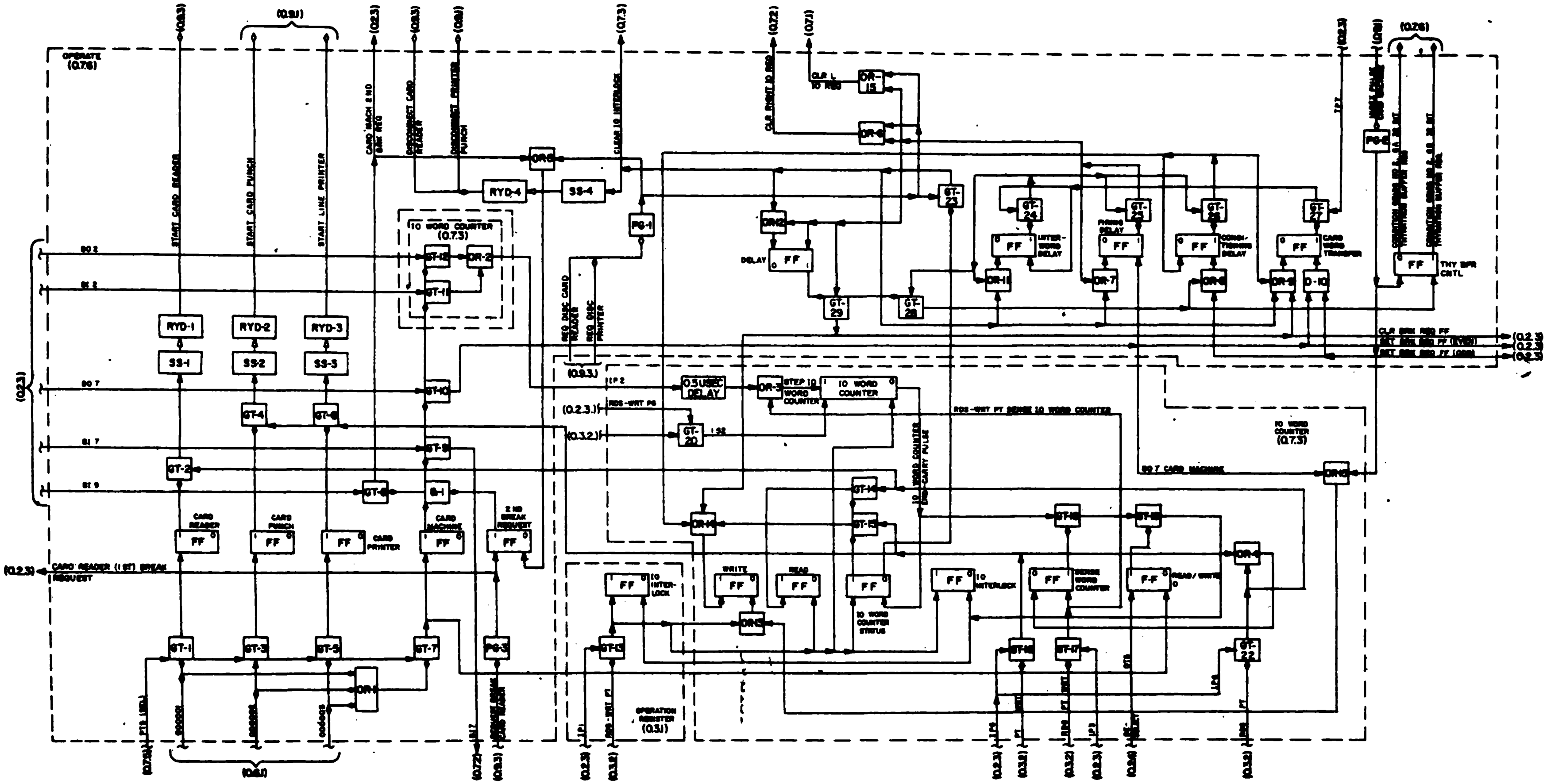

Figure 6-4. Card Machines Read and Write Operations, Simplified Logic Diagrams

b. Clear Brk. Req. FF (if the word ctr. had gone to zero prior to this, the brk. FF would have been cleared by the TP-10 delayed pulse and only BO-8, 9, 10 and 11 would be generated. The second word would not be brought out of memory. This would occur on a WRT 1 instruction.

23. BO-2

a. Step I/O Address Counter
b. Step I/O Word Counter

24. TP-7 (#10) (Also BO-7)

a. Transfer second word from Mem. Bfr. to the I/O Reg.
b. Begin conditioning thyratrons for cols. 49-80 (fourth level).

25. Next 2 MC pulse, set the Brk. Req. FF (if the Brk. Req. Sync. FF was set).
26. TP-10 delayed, Brk. FF remains set (if the Brk. Req. FF was set.)
27. TP-7 (#11), set Interword Del. FF
28. TP-7 (#12)

a. Clear Delay FF
b. Clear Firing Delay FF
c. Set Conditioning Delay FF
d. Clear Interword Delay FF
e. Clear Card Word Transfer FF
f. Clear Break Req. FF
g. Clear I/O Register

NOTE: Thyratrons for Col. 17-80 are now fired and the first two words will be punched into Row 9 of the card at the punch station approx. 20 MS later.

h. Set Write FF.

NOTE: If the Break FF is still set, BO-8 through 11 will be generated, but will do nothing.

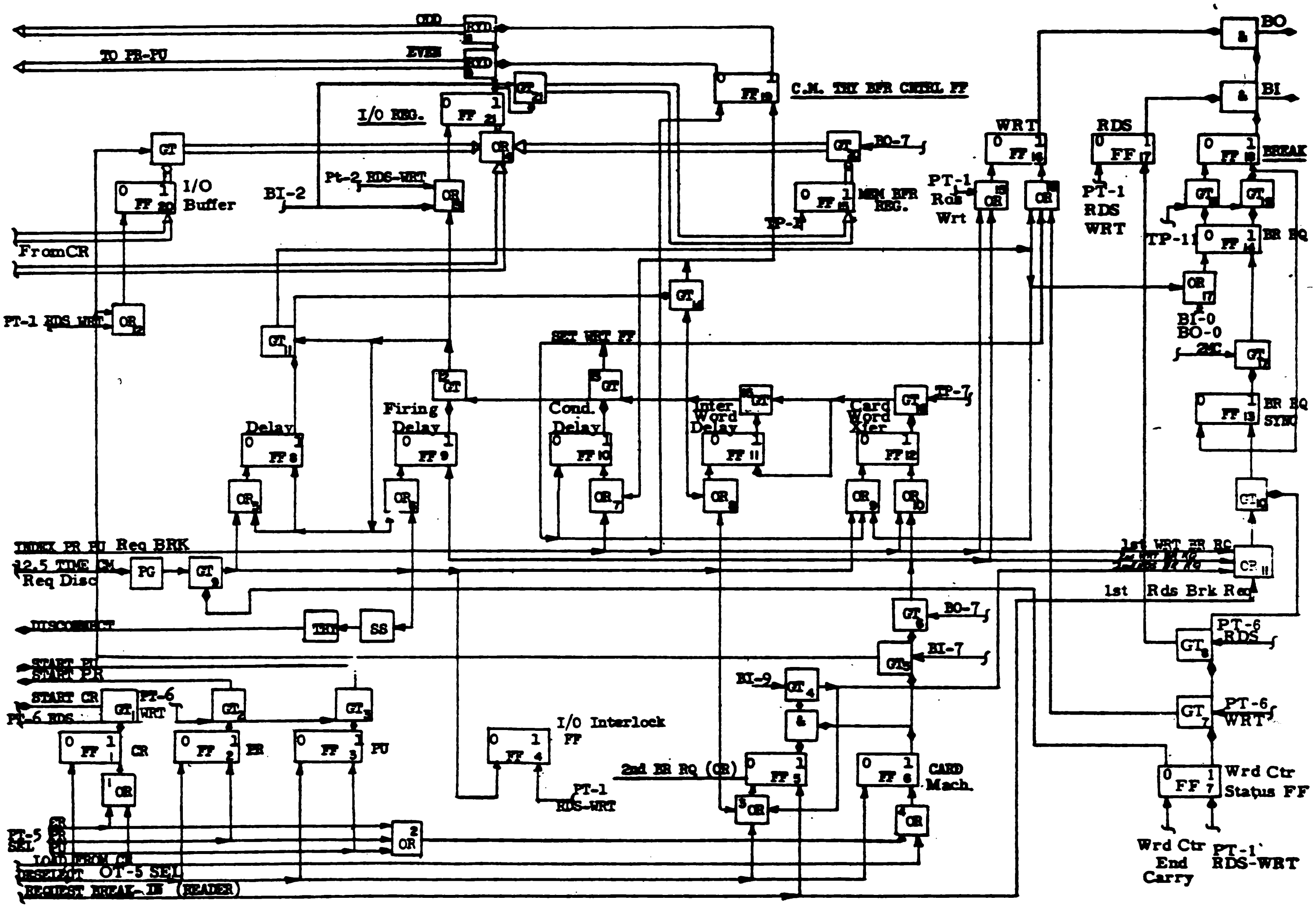

Figure 18, Card Machines Read Write Operations

29. TP-10 delayed.

    a. Clear Brk. FF (stop generation BO pulses)
    b. WRT FF remains set until the next index pulse from the recorder.

30. Time elapsed from the break request to the above TP-10 delayed is approximately 72 usec. The time will vary due to the fact that the punch is in no way synchronized with CC, therefore, the break request could occur such that the first TP-7 used might occur after the BRK FF had been set. The computer can resume internal operations for about 42.8 msec before the next break request.

31. The above process continues until the Word Ctr = 0. When the Word Ctr goes to zero, no more break cycles will be generated; therefore, no more punch magnets energized. Note that the I/O Interlock is NOT cleared by the Word Ctr. end carry. At the end of the card in which the word ctr. goes to zero, the request disconnect will be honored.

32. Disconnect

a.	Set DISC. I/O Interlock Sync. FF	0.7.3
b.	Clear all delay FFs except cond. delay which had previously been cleared.	0.7.6
c.	Clear the I/O Buffer	0.7.1, 0.7.2
d.	Clear the I/O Register	0.7.1, 0.7.2
e.	Disconnect pulse to punch to drop the WRT relays.	0.7.6

33. PER (73) and PER (74) 0.7.6 (1B)

    a. Index interval decoded by PERSEL-BSN matrix OT-9. -- Trigger bSS to fire aRYD.
    b. Pick Prog. 1 or Prog. 2 relays in recorder.

        1) Prog. 1 relays connects output of thyratrons.

1300

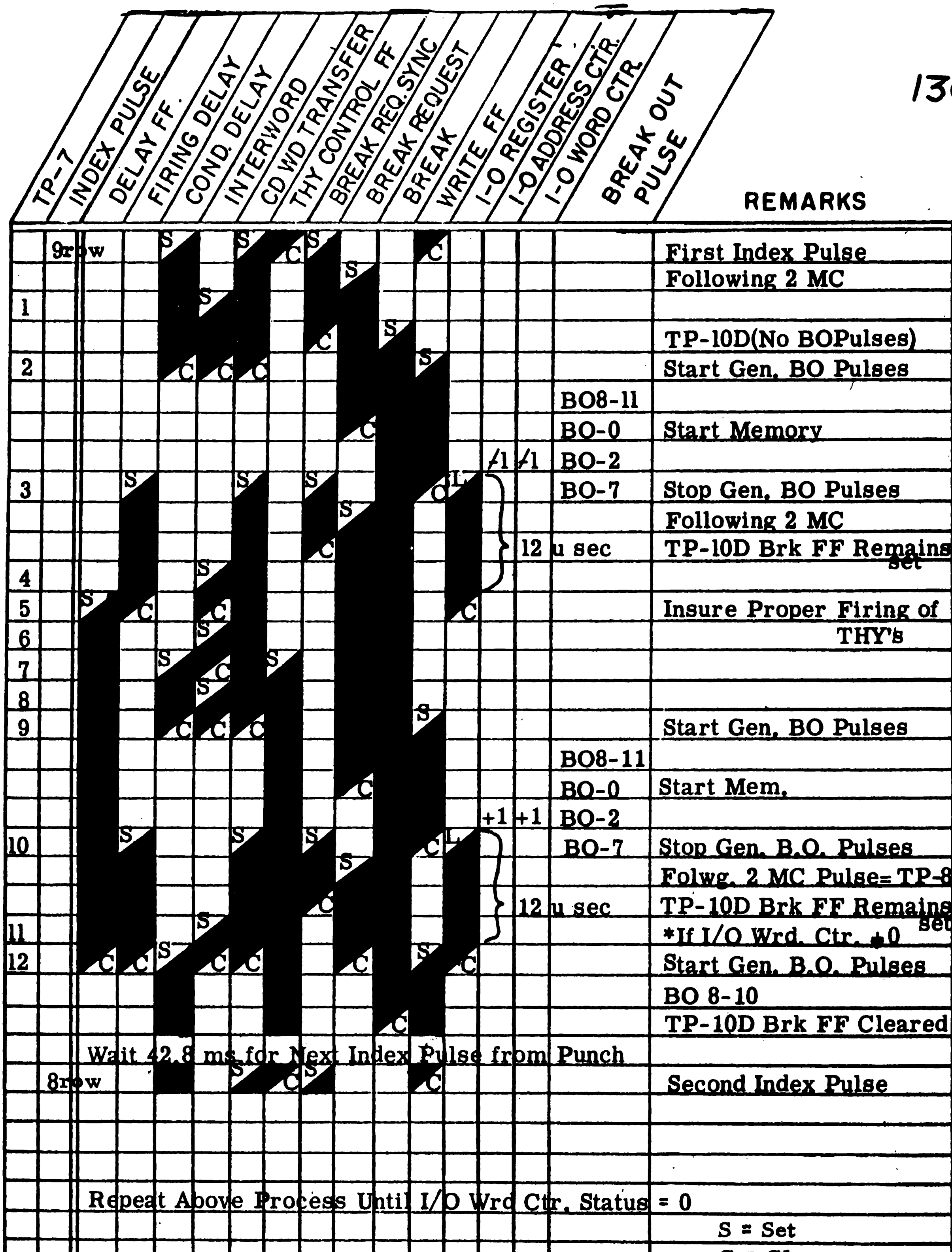

Figure 19, Card Machine Write Control

2) Prog. 2 relays connect read brushes for col. 1-16 to punch magnets for col. 1-16.
3) Both Prog. 1 and Prog. 2 relays held through write relay contacts 86-1.

I. Familiarization of Recorder Wiring Diagram.

1. Orientation

a. Power input (1B)
b. Card Levers (1A)
c. Contact Roll (7A)
d. Punch Magnets (8A)
e. Relay Contact Charts (9A)
f. Timing Charts (11A, 12A)
g. Point out that the punch magnet designations are reversed from the columns which they will punch. That is, magnet 80 punches col. 1, 79 punches 2, etc.
h. Mention that timings shown are with reference to teeth on the index gear in the punch and that its designations are reversed with respect to actual card index points. This is due to the fact that cards are fed into the machine 12 edge first in commercial applications.

2. Turn on Main line switch (printer main line switch must also be on)

a. Pick HD-3(1B) - HD-3 points (1A) allow 40V to relay circuits.
b. Turn on Not Ready light (3B)
c. Pick HD-2 (1A) allow 72V to the recorder circuits.
d. Pick R2(4B) 72V interlock.

1) 2-2 points (4B) light the "Power On" light.
2) 2-3 points (2A) allow 40V to start and feed keys.

3. Place deck of blank cards in the magazine -- Pick R84(1B)
4. Depress Start Key (2A)

    a. Pick R3P (2B) Ready Interlock

        1) R3-1 holds R3H(2B)
        2) R3-2 picks R10P
        3) R3-3 picks R6P

    b. Auto start relay

        1) R6-1 holds R6(3B)
        2) R6-3 picks R9 and HD-1 Motor Start (3B)
        3) R6-4 picks punch clutch magnet (2B) start a cycle.

    c. Die card lever contact makes at 8. 0

        1) Pick R83-83-2 picks R1
        2) R1-2 (3B) picks R11H, R14P and R26.
        3) R11-3 extinguishes the "Not Ready" light.

    d. R6H drops at 9. 4.
    e. Punch clutch latches up at D.
    f. The machine is now "Ready".

5. Show how depression of stop key makes the recorder "Not Ready".

    a. Drop R1 and R11 H
    b. Turn on Not Ready Light

6. Program a WRT Instruction (assume ready) -- Pick R8P (8B)

    a. Turn on Write light (6B)
    b. Pick R86 (6B)

        1) Energize Isolation relays (5A)
        2) 86-3 and 86-4 (8AB) insert are suppression networks across isolation relay points.

c. Pick R7P (6B)
d. Provide path to Disconnect relay R82 (8B)
e. Pick R6P (2A)

   1) Energize clutch magnets.
   2) Energize Motor Start and Motor Control relays (3A).
   3) Motor is now running and the card is being moved under the punch station.

7. Request Break

   a. Point out CAM 16 (7B)
   b. Refer to cam timing chart to show when breaks are requested.
   c. Correlate punching action with break request timing as shown in the charts.

8. Information Flow

   a. Input from thyratrons (7A)
   b. Through isolation relay points.
   c. Pick various punch magnets.

9. PER (73) (Operation Prog. 1) and PER (74) (Operation Program 2) operation.

   a. PER (73)

      1) Pick R15 (8B)
      2) 15-1 and 15-2 points (5B) pick R17, R18 and R20 through N/C points of a program 2 relay.
      3) R17, R18, and R20 points (7A) cause the information which would have gone to magnets 49-64 to be routed to magnets 65-80. Punching will then occur in cols. 1-16.
      4) 20-5 N/O points provide a hold path for the Prog. 1 relays.

b. PER (74)

1) Pick R16 (8B)
2) 16-1 and 16-2 points (5B) pick R21, R23, and R24 through N/C points of a Prog. 1 relay.
3) R21, R23, and R24 points (7A) transfer the info from the read station to the punch magnets for cols. 1-16.
4) 24-5 N/O points provide a hold path for the Prog. 2 relays.

c. The program 1 and 2 relays interlock each other so that only one operation may take place on a given WRT instruction.

d. The program relays are held for the entire duration of the WRT instruction through 86-1 N/O points in 5A, thus, it is not necessary to program the PER instruction for each card punched.

10. Request disconnect

a. Point out cam 15 (7AB)
b. Show timing on cam timing chart and point out that the request comes near the end of each card.

11. Disconnect

a. Pick R82(8B)
b. Drop R8 and R86 (6B)
c. Drop isolation relays.
d. Drop program relays.
e. Prevent energizing R6P (2B)

1) Drop clutch magnets.
2) Prevent energizing Motor Start and Motor Control relays (3B)
3) Motor coasts to a stop between 7 and 9 time dependent upon CR CAM (3A)

12. Checks made of the recorder.

   a. Ready condition
   b. Time required for break cycles.
   c. Correct punching is checked by punching the deck and then reading it into CC to check it.
   d. PER instructions are visually checked.

Note: This is a sampling only and not intended to be all inclusive.

AN/FSQ - 7

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Summary Questions

1. The card recorder can punch 100 cards per minute.

2. How many punch magnets in the Card Recorder? 80

3. What is the purpose for using the Geneva Mechanism? provides intermittant motion for feed rolls

4. How are the punch magnets energized? current fed through contact roll and brushes

5. What voltages does the Line Printer supply to the Card Recorder?
+46V & +72VDC

6. Of what use is the PER (73) instruction? Punch data into columns 1-16

7. Of what use is the PER (74) instruction? to gang punch in col. 1-16 what was in col. 1-16 of previous card

8. What will occur if the Punch is selected and a WRT 0.00000 is given?

9. The following program is given:

SEL02	
LDC	0.01050
WRT	0.00060
HLT	

When the program is completed, it is found that only 40_8 words were punched. The computer did not hang up. This could be caused by which of the following?

A. 4EW-C7 open		(0.7.3 - 5C)
B. GT9 in 4FD has open filaments		(0.7.3 - 8C)
C. 5FF-J1 open		(0.7.6 - 11B)
D. FF4 in 5FD has open filaments		(0.7.6 - 9A)
E. FF8, 9 in 6FT remains set		(0.7.3 - 4A)

10. The following program is run; two cards feed past the punch.

SEL02	0.00000
LDC	0.02000
WRT	0.00030
HLT	

The trouble could be: (0.7.3)

A. 5EL-H6 open	(2B)
B. 6FE-E5 open	(5B)
C. 5EL-F7 open	(2B)

Summary Questions

D. 6FE-H3 open (5B)
E. GT6 in 5ER passes no pulses (7D)

11. I/O Register Right Sign FF won't clear. c(1000) to c(1027) = All zeros. The following program is run.

```
SEL02
LDC     1000
WRT       30
HLT
```

A. Punches in Columns 33 and 65, first and seventh rows only.
B. Punches in Columns 33 and 65, first row only.
C. No punches in any columns.
D. Punches in Columns 33 and 65, all rows.
E. Punches in Columns 65, row 1.

12. The Card Punch places both words on the even side of the card, thus requiring twice the normal number of cards. This could be the effect of: (0. 7. 6)

A.	3LF-F5 opening	(5B)
B.	5FF GT4, open filament	(7C)
C.	3KD-C1 opening	(7D)
D.	3KD-E6 opening	(7D)
E.	5CT-G3 opening	(2D)

13. The gate tube for the punch "Request Disconnect" pulse passes all pulses. With the following program given, which of the below would occur?

```
000  SEL02
001  LDC      1000
002  WRT      110
003  HLT
```

A. Punch 3 cards and halt.
B. Punch 2 cards and halt.
C. Hang up on step 003 and pass all cards through punch.
D. Punch 1 word and halt.
E. Punch 1 card and halt.

Summary Questions

14. The following program is executed:

SEL02	0000
LDC	0000
WRT	0060

At the completion of the WRT instruction, it is found that only 20_8 words were written, but the computer did not hang up. Which of the following malfunctions listed below could cause these symptoms?

A.	4EW-C7 is open.	(0.7.3 - 5C)
B.	GT9 in 4FD, open filaments	(0.7.3 - 8C)
C.	5FF-J1 is open	(0.7.6 - 11B)
D.	FF4 in 5FD has open filaments	(0.7.6 - 9A)
E.	FF8, 9 in 6FT remains set	(0.7.3 - 4A)

15. The following program is executed and upon completion nothing has been punched in the card. Locations 1000 through 1027 contain ones in R10-R15.

000	SEL01	0.00000
001	LDC	0.01000
002	RDS	0.00030
003	BSN 14	0.00003
004	SEL02	0.00000
005	LDC	0.01000
006	WRT	0.00030
007	HLT	0.00000

A.	No output from GT6 in 5EC.	(0.2.3 - 2D)
B.	No output from CF9 in 5EM.	(0.7.3 - 2D)
C.	aFF in 6FT remains set.	(0.7.3 - 4A)
D.	GT4 in 5ER passes all pulses.	(0.7.3 - 7D)
E.	GT1 in 5EE, open filaments.	(0.2.3 - 4D)

16. List the Flip-Flops by name that make up the armenian delay.

COMPUTER ENTRY PUNCH

XII. INTRODUCTION AND GENERAL INFORMATION

A. Purpose

Units
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1. The primary function of the 020 Computer Entry Punch is to serve as one of the means of entering data into the Central Computer System of AN/FSQ-7 Combat Direction Central or AN/FSQ-8 Combat Control Central. The design of the CEP enables it to operate as a printing card punch, as a printing card punch and reader, or as a pre-punched card reader. The use of the IBM card system in the operation of this manual input (MI) equipment provides a permanent record of data entered into the computer.

2. The following types of data are entered through the CEP:

   a. Flight Plans
   b. Weather
   c. Interceptor and Weapon Status
   d. Boundaries
   e. DEW
   f. Texas Towers and Picket Vessels
   g. AEW
   h. Teletype

B. Basic Requirements of CEP

1. Adapted from commercial model 026.

2. Must be able to read cards and store information until called for by MDIE.

3. Must be able to recognize a change of computer status, and give indication to operator that status has changed. Sequence of cards must be rerun to assure all information in a sequence going to the same computer when a status change has taken place.

C. Description

1. The 020 Computer Entry Punch is manufactured by IBM. The machine is 42 1/2 inches long, 34 inches wide, and 39 inches high. The front of the machine is the vertical surface on which the reading board is mounted. (Fig. 2-1).

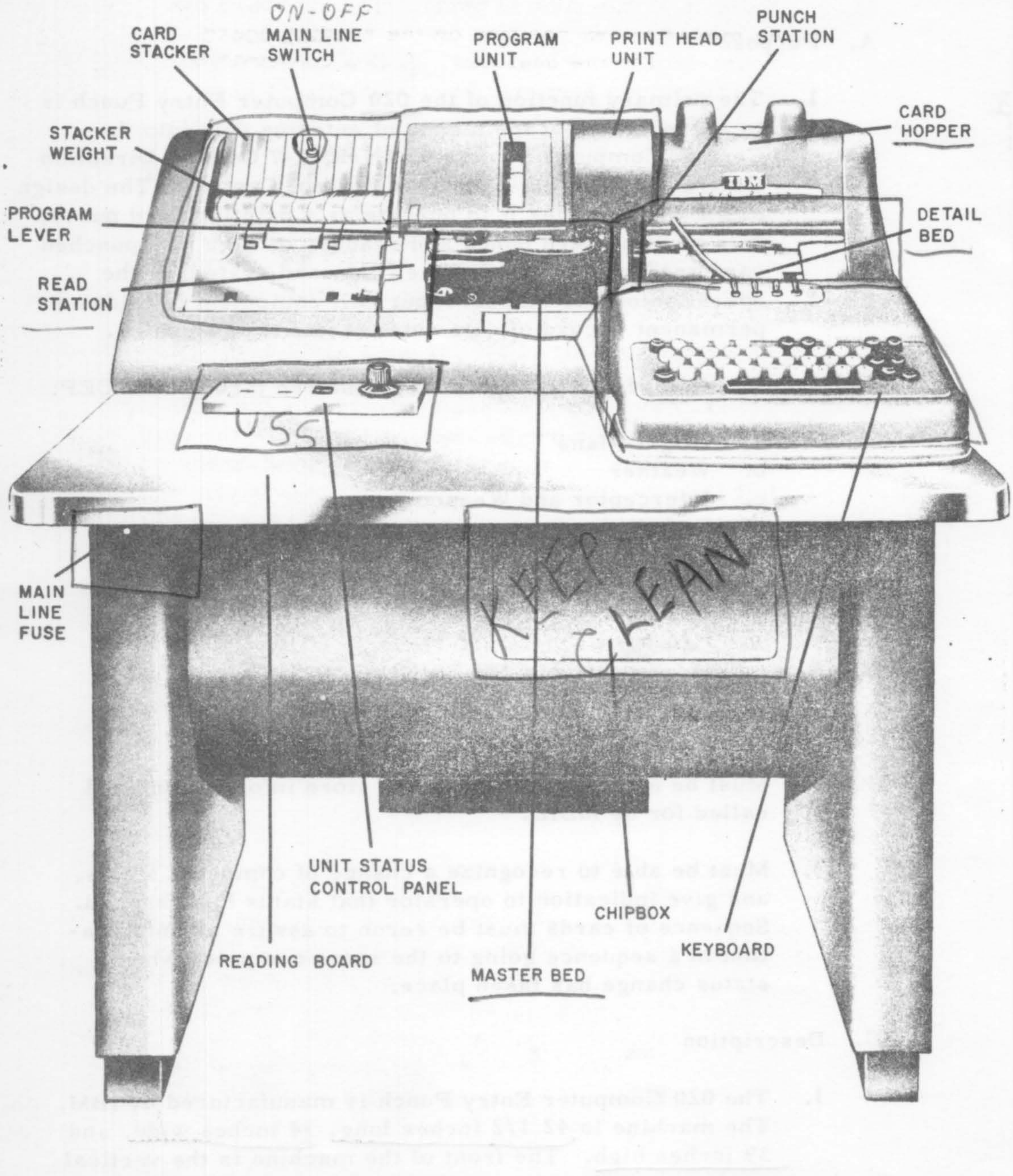


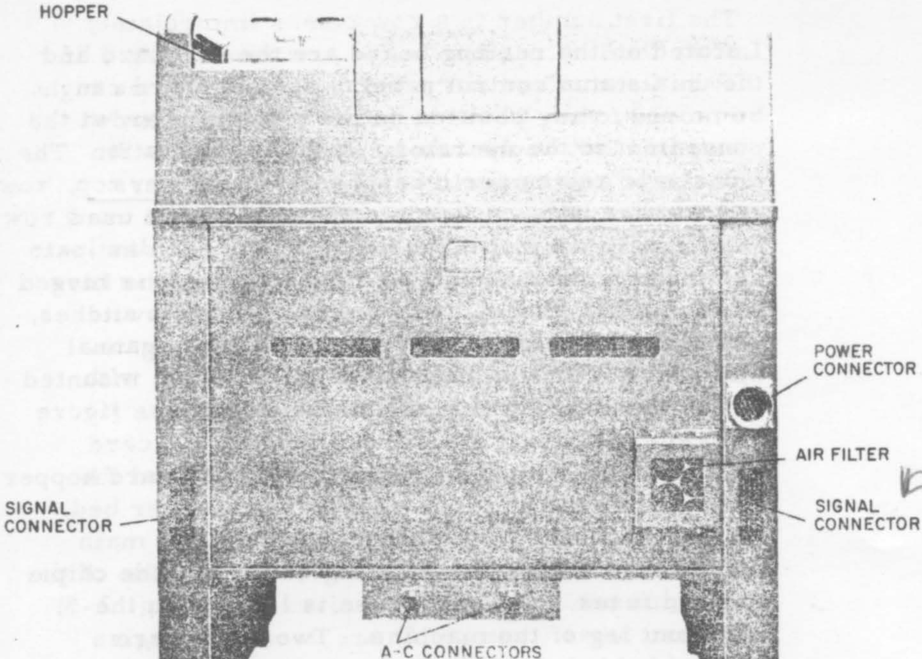
Figure 2–1. 020 Computer Entry Punch, Detailed Front View

Located on the reading board are the keyboard and the unit-status control panel. The keyboard can be moved to any position on the reading board convenient to the operator. It is a combination alphabetic and numeric keyboard with 44 keys and a space bar. A number of the keys are used to manually control machine functions such as duplicating, feeding and skipping. Above the keys on the keyboard are the functional control switches, which are used for various automatic and manual operations. The unit-status control panel, mounted on the left, has two lights and two switches.

Located at the top of the machine are the card hopper, the detail bed, the punch station, the master bed, the read station, the card stacker, and the main line switch. Below the reading board are the chip box and fuses. The main fuse is located on the left front leg of the machine. Two others are located behind the chip box and are accessible when the box is removed.
Mounted on the rear legs of the CEP are the power and signal connectors (fig. 2-2). The two signal connectors are 40 position connectors with spring-loaded contacts. Power is brought into the machine through the power connector, located on the right leg (facing the rear) above the signal connector. This 30 position, quick-disconnect connector and the a-c connectors supply all voltages necessary for operation of the machine.

By removing the top cover and tilting the base unit to the vertical position, the card feed cams and card feed circuit breakers can be seen, located behind the hopper (fig. 2-3). The print head unit is located above the punch station. To the right of the print head unit is the program unit. In the rear, below the program unit, are the punch cams (P cams) and punch circuit breakers. Located behind the stacker is the drive motor, which supplies the necessary mechanical power to operate the machine.

Removing the rear cover exposes the relay gate (fig. 2-3), which contains 18 duo-type relays, 39 wire-contact relays, and one high-speed relay. The relays are numbered from left to right in each row when viewing the relay gate from the rear.



Small Summary Punch

Figure 2-2

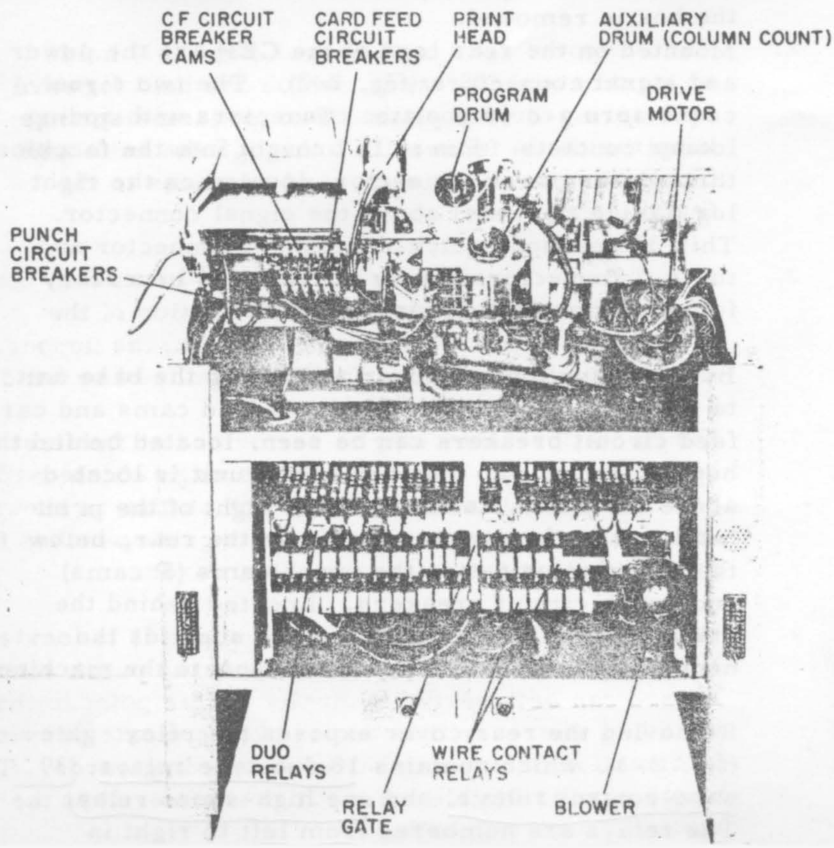


Figure 2-3

The first number in a row comes immediately after the last number in the row above; e.g., if 20 is the number of the relay at the extreme right in a row, then 21 is the number of the relay at the extreme left in the row immediately below it. The duo-type relays are located in the first, or top, row; the wire contact relays, in the second and third rows. A blower is mounted on the relay gate to dissipate the heat from the relays. The relay gate is hinged to facilitate access to the terminal boards and electrical components located behind the gate. Figure 2-4 shows the rear of the machine with the relay gate lowered. Pointed out in this figure are the rectifiers, the power relays, the card count mechanism, the filter capacitor, and the terminal posts.

The tube chassis is located on the right side of the machine behind a louvered cover panel (fig. 2-5). Fifteen tubes (type 25L6) are used to energize relays and magnets. "They drive Relays + Punch Magnets"

2. Card Hopper: The card hopper (fig. 2-1) holds approximately 500 cards, which are held forward by a spring-driven plate. Two magazine springs keep the cards from falling through the knife and block-type throat as each card advances to the feeding position.

1 card MUST BE AT PUNCH STATION TO "PUNCH"

3. Detail Bed: The detail bed (fig. 2-1) located to the right of the punch station, is that portion of the card bed into which cards are fed from the hopper. Cards may also be placed in the detail bed by hand.

4. Punch Station: Punching is performed at the first of two stations in the card bed, through which cards pass from right to left. The punch station is shown in figure 2-1. It contains 12 rectangular punches for punching information onto the IBM cards.

5. Master Bed: The master bed (figure 2-1) is located between the read (sense) station and the punch station. A card can be inserted manually at this point in the card bed whenever it is desired to duplicate prepunched information on any number of succeeding cards. The whole card is visible before it is registered at the read station.

6. Read (Sense) Station: The read station (fig. 2-1), where the holes in the card are sensed for reading is located approximately the distance of one card length to the left of the punch station. There are 12 sensing positions at the read station, each position containing dual sensing pins.

7. Card Stacker: The card stacker (fig. 2-1) holds approximately 500 cards and is located at the upper left side of the machine on a level with the hopper. After a card passes the read station, it is fed into the stacker automatically or by key depression. Cards are stacked at an angle with the 12 edge down, card face to the rear, and are held in position by a card weight. When removed from the stacker, the cards are in their original sequence.

8. Main Line Switch: Figure 2-1 shows the location of the main line switch. Operation of the machine may be started approximately one-half minute after the main line switch has been turned on. This delay allows sufficient time for the electron tubes to heat. When the stacker becomes filled to capacity, the switch is automatically turned off.

9. Card Feed Cams and Circuit Breakers: Located below the hopper are six card feed cams and the associated circuit breakers (fig. 2-3). The card feed circuit breakers are numbered 1 through 6, from right to left, when viewing the machine from the rear.

10. Print Head Unit: The print head unit (Fig. 2-3) houses the printing and ribbon feed mechanisms. The ribbon feed mechanism contains two ribbon spools and the ribbon reversing mechanism. The printing mechanism contains the code plate from which the individual characters are printed. Printing takes place at the discretion of the operator. The coded character punched in a column is printed across the top of the card above that column in which it was punched.

11. Program Unit: The program unit is located in the center of the base assembly above the master bed (fig. 2-1) and contains the program drum. A program card with coded information is fastened around

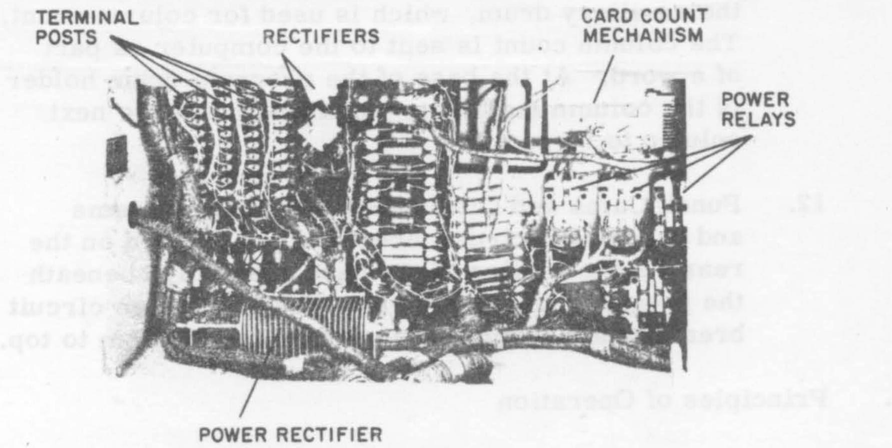


Figure 2—4. Terminal Recess

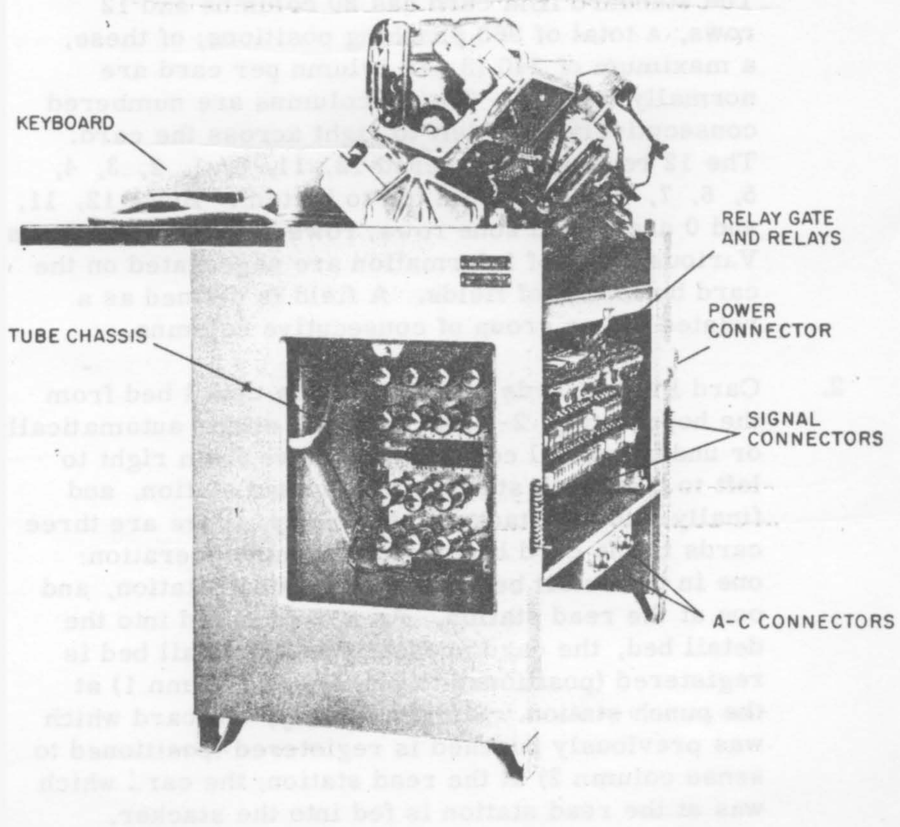


Figure 2—5. Computer Entry Punch, Right Side

the program drum. Behind the program drum is the auxiliary drum, which is used for column count. The column count is sent to the computer as part of a word. At the base of the program drum holder is the column indicator, which indicates the next column to be punched.

12. Punch Cams and Circuit Breaker: The P cams and associated circuit breakers are located on the rear center portion of the base assembly, beneath the program unit (fig. 2-3). The punch cam circuit breakers are numbered in order from bottom to top.

D. Principles of Operation

1. The 020 Computer Entry Punch is used as a card punch, manual input unit for the AN/FSQ-7, 8 Systems.

   The standard IBM card has 80 columns and 12 rows, a total of 960 punching positions; of these, a maximum of 240 (3 per column per card are normally utilized. The 80 columns are numbered consecutively from left to right across the card. The 12 rows are numbered 12, 11, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 from top to bottom. Rows 12, 11, and 0 are called zone rows; rows 1-9, numeric rows. Various types of information are segregated on the card by means of fields. A field is defined as a related set or group of consecutive columns.

2. Card Path: Cards are fed into the detail bed from the hopper (fig. 2-1 and fig. 2-7) either automatically or under manual control, and move from right to left to the punch station, to the read station, and finally into the stacker. Normally, there are three cards in the card bed during machine operation: one in the detail bed, one at the punch station, and one at the read station. As a card is fed into the detail bed, the card presently in the detail bed is registered (positioned to punch into column 1) at the punch station. Simultaneously, the card which was previously punched is registered (positioned to sense column 2) at the read station; the card which was at the read station is fed into the stacker.

Two mechanisms control the movement of the cards through the machine: the card feed and the escapement mechanisms. The card feed mechanism operates to feed a card to the detail bed, to register the card in the detail bed at the punch station, to register a card in the master bed at the read station, and to eject a card into the stacker. All four operations are performed simultaneously during a card feed cycle.

The escapement mechanism controls the card movement through the punch and read stations and drives the program drum and the column count drum in synchronism with the card movement. The program mechanism controls the machine when automatic operation is selected. All these operations occur during an escape cycle.

3. Punching: When a card reaches the punch station, the information is punched into the card, column by column. The punching code used is the standard IBM Hollerith code. The Hollerith code uses one hole for each numeric character, two holes for each alphabetic character (one zone and one numeric), and either two or three holes for each special character. Ordinarily, one to three holes are punched in any column, depending on the character selected.

   Punching may be initiated either manually by use of the keyboard or automatically by duplication. Duplication is automatic reproduction on the detail card of the information being read from the master card. Skipping (bypassing columns or fields not pertinent to the current operation) may also be performed. However, duplication and skipping can be controlled either manually or automatically. Automatic operations are controlled by programming; manual operations, from the keyboard.

4. Printing: The printing feature of the CEP is optional since printing may be suppressed, when desired, by program control or by use of the keyboard switch. When the information being punched is to be printed, a system of wire printing is used to print the selected character above the column being punched. A code plate with projections outlining all characters used in the system is positioned during the punching process and pressed against a group of 35 sturdy,

flexible wires. The wires contacted by the projections are forced against the typing ribbon to cause printing. The code plate is approximately 3/4 inch wide by 1 1/4 inches high and has 668 projections.

5. Reading: Information is read when the card reaches the read (sense) station. Twelve sets of dual sensing pins are used, one for each row in the IBM card. When the dual sensing pins sense holes in the cards, they close circuits to pick interposer relays. These relays, in turn, close circuits to transfer information to the computer, to duplicate or to do both, as determined by the machine operation selected.

   Duplication is the operation in which data which is being read may be automatically reproduced on the following card as it is read. Skipping (bypassing columns or fields not pertinent to the current operation) may also be performed. The reading rate will vary according to the number of columns to be read. The maximum reading rate is 13 cards per minute, based on the reading of all 80 columns in a card. When the card has been read and column 80 passes the sensing pins, the card moves to the eject station (fig. 2-7). During the subsequent feed cycle, the card is moved into the stacker fingers and placed in the stacked position.

6. Information Transfer: The information which is sensed at the read station is sent (when programmed) to the MI unit (unit 23) with the card count and column count information. The MI unit adds identifying information and transfers the assembled word to the Drum System for eventual transfer to the Central Computer System. (fig. 2-10).

   a. Word Makeup: Information from the CEP is transmitted to the MI unit as 24 bit words.

      LS - L11 = Data
      L12 - L15 = CEP identify (made up in MDIE)
      RS - R1 & Not used
      R2 - R6 = Card Count, a "one" bit in only 1 of
                these five positions
      R7 - R13 = Column Count in octal
      R14 - R15 = Type of data (CEP = 00)(made up in MDIE)

4 cards in machine (a, b, c, d,

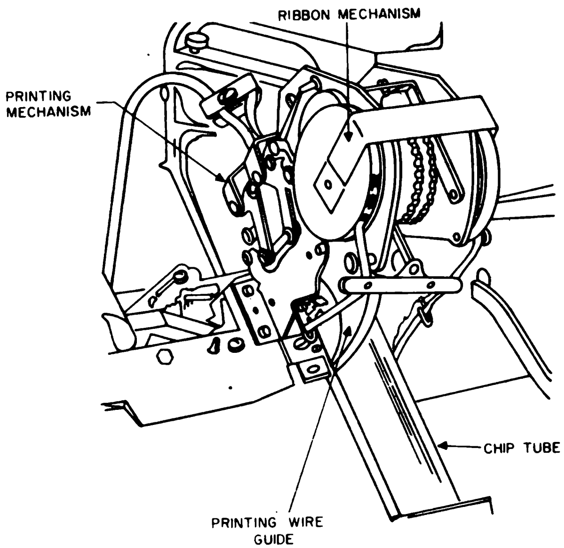


Figure 2–6. Print Head Unit

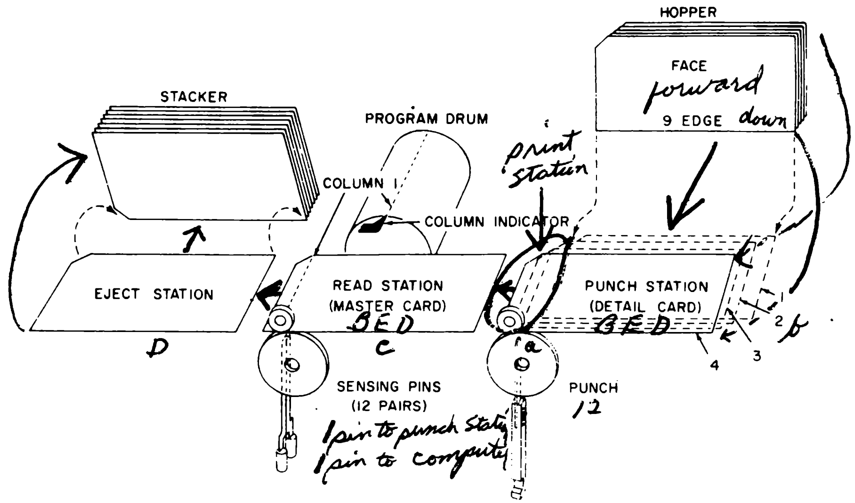


Figure 2–7. Card Path

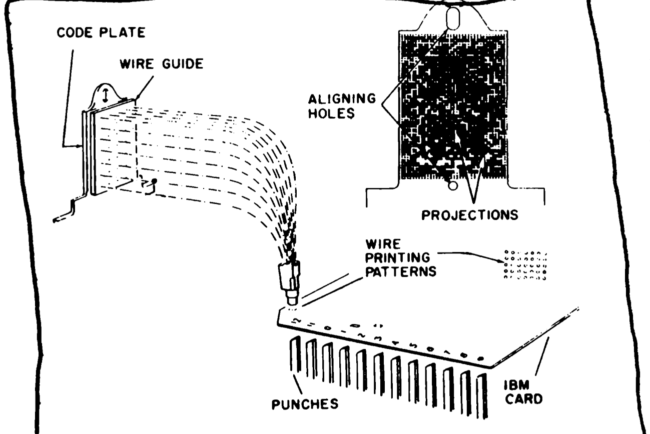


Figure 2–9. Printing Method

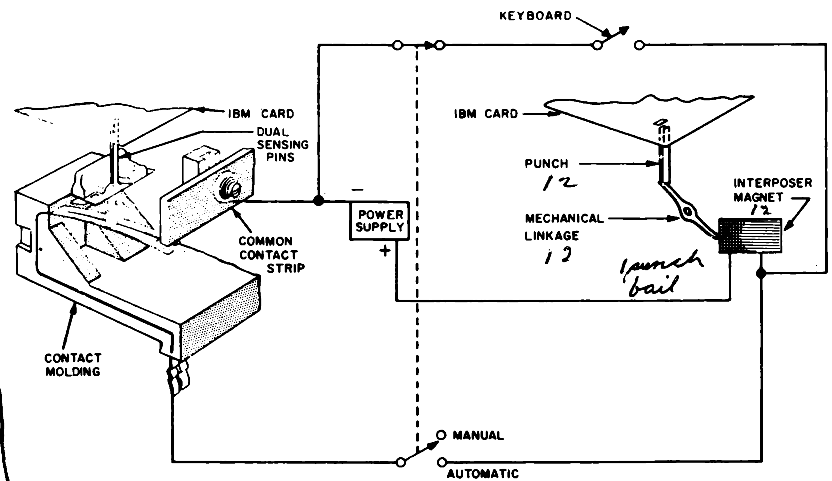


Figure 2–8. Punching Control

PUNCHES ONLY
HOLLERITH

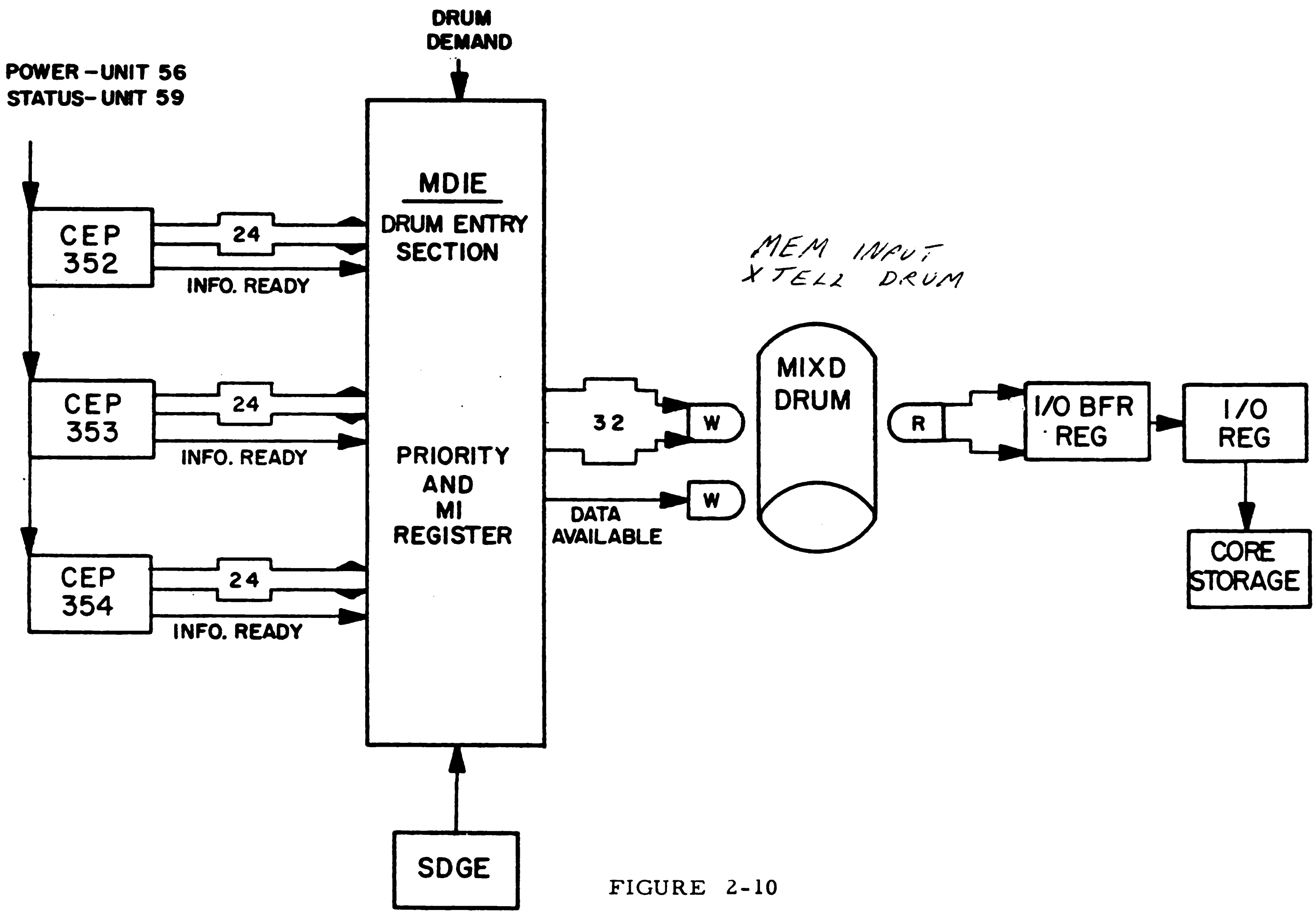

DRUM DEMAND
POWER-UNIT 56
STATUS-UNIT 59
CEP 352
CEP 353
CEP 354
24
24
24
INFO. READY
INFO. READY
INFO. READY
MDIE
DRUM ENTRY SECTION
PRIORITY AND MI REGISTER
SDGE
32
DATA AVAILABLE
W
W
MEM INPUT XTELL DRUM
MIXD DRUM
R
I/O BFR REG
I/O REG
CORE STORAGE

FIGURE 2-10

There are 12 bits of information (corresponding to the 12 rows in each card column) and 12 bits of identification for each card column (card count and column count).

The identification bits are required so that the computer can reconstruct a message when data from more than one card from a machine is stored on the MI drum field at one time. Five of the 12 identification bits are used to assign a card count to each card read into the computer. The card counter mechanism generates the card counting pulses by raising one of its five outputs to +10V while the remaining four are at -30V. Except for a card in which an error has been detected, the impulse counter advances one position between cards. The remaining seven bits of identification are a binary indication of the sensed column. This binary indication is generated by the column count drum mechanism. Each column of the card associated with this mechanism is punched to indicate the binary number of that column. The associated sensing mechanism transmits this indication as the column count drum is moved in synchronism with the program drum.

b. Information Path: Data is transferred as dc levels from the CEP to the MI unit. As the column is read, an information-ready pulse is sent to the MI unit. Interposer relays are energized for each column in which a punched hole is sensed. A drum-demand pulse (originating in the MIXD drum) strobes the MI unit on a priority basis. If the information-ready pulse has been received and the drum-demand pulse selects the CEP, data bits are written on the drum.

The interposer relays are then released, and the next card column is read. If information cannot be accepted by the drum, a P-cam causes the interposer relays to be held energized and the CEP is interlocked to prevent the card from advancing to the next card column position. This dependence on the drum-demand pulse allows the CEP to operate on a serial demand system, with interruption of card reading when higher-priority information is ready for transfer to the MI drum field.

c. Programming: Card machine operations can be controlled automatically by sensing punched holes in a program card mounted on the program drum. The program card can contain either a standard program code, an alternate program code or both. The standard program utilizes 6 of the 12 rows of the program card. The alternate program feature, which uses the remaining 6 rows of the program card, makes it possible to punch codes for two separate card designs in the same program card. The alternate program is selected from the keyboard. By proper programming, any or all of the 80 columns of an IBM card can be read into the computer.

E. Electrical and Functional Details

1. Voltage Characteristics: Table 2-1 lists the nominal voltage requirements of the CEP.

Table 2-1. Voltage Requirements

Application	Voltage
Input	115 ac, 50-60 cycles
Output	10 dc
Filament	22-25 dc
Plate	130 dc
Bias	-49 dc

2. Motor Data:

a. The drive motor is a 1/12 hp motor that operates on 115V ac, single-phase, 60 cycle power at 1,725 rpm, with a current drain of 2.1 amperes (amp). Running the motor will cause a 40° C (72°F) rise in the motor temperature.

b. The fan motor used has a rating of 20 cubic feet per minute (cfm) and operates on 115V ac power at 3,250 rpm.

3. Tube, Relay, and Fuse Complement: The CEP uses 15 type 25L6 power amplifier tubes and three fuses, two 2-amp fuses and one 4-amp slow-blow fuse.

4. Functional Characteristics: Table 2-2 lists the functional characteristics of the machine.

Table 2-2. Functional Characteristics

Function	Description
Printing	A 3/4 inch by 1-1/4 inch code plate is used to actuate a 35 wire matrix (7 x 5).
Punching	Twelve punches, one for each of 12 rows.
Reading	Twelve sets of dual sensing pins operate at 13 cards per minute (based on reading 80 columns per card).
Skipping	Maximum of 80 columns per second.
Duplicating	Eighteen columns per second in automatic control; 9 columns per second in manual control.

F. IBM Card Description

1. Because of their flexibility and because of the availability of the associated punching, verifying, and duplicating equipment, IBM cards are used as a primary input medium for the SAGE Computer. Information can be verified prior to computer entry, and errors can be detected and easily corrected. The simultaneous preparation of data on several CEPs expedites the input operation, and the use of cards provides a permanent record of the data entered into the computer.

2. There are 80 columns in which punching may take place. These columns are numbered, from left to right, 1 through 80. In each column are 12 punching positions (rows), which are numbered 12, 11, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 from top to bottom. Rows 12, 11 and 0 are called zones, rows 1-9 numerics.

TABLE 3—1. HOLLERITH CODE

NUMERIC PUNCH	NO ZONE	12 ZONE	11 ZONE	0 ZONE
None	(Blank)	&	—	0
1	1	A	J	/
2	2	B	K	S
3	3	C	L	T
4	4	.D	M	U
5	5	E	N	V
6	6	F	O	W
7	7	G	P	X
8	8	H	Q	Y
9	9	I	R	Z
8-3	#		$	,
8-4	@	¤	*	%

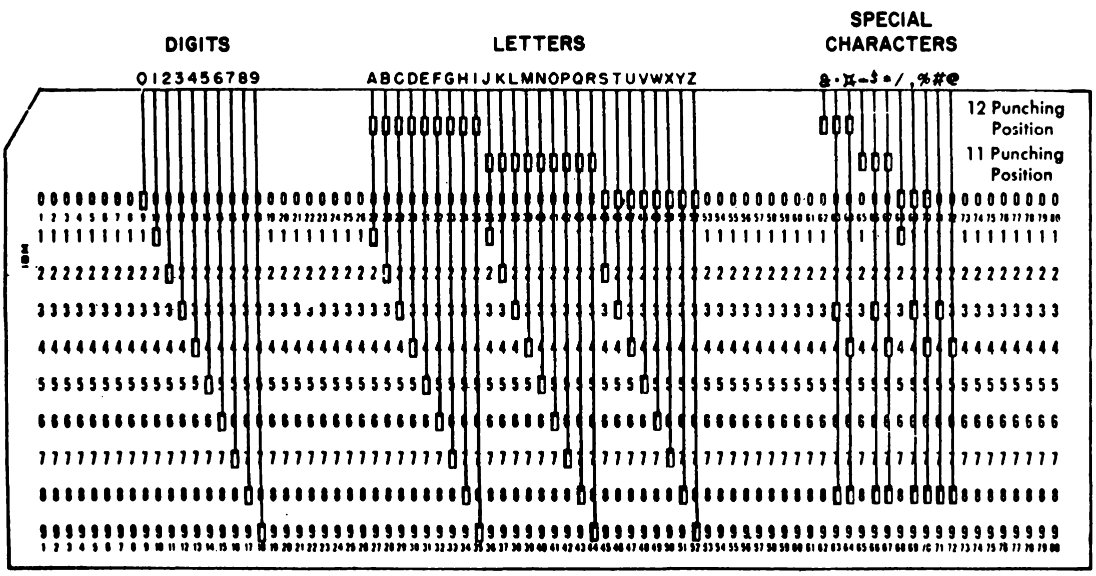


Figure 3—1. Punching Positions in IBM Card

3. As illustrated in figure 3-1, numbers are recorded by a single hole in the corresponding numeric or zone position of the desired column. A letter is recorded as a combination of one zone and one numeric punch in the desired column, and special characters are recorded as one, two, or three holes, in the desired column. Punching of the correct number of holes in a column for a letter or special character is automatic on depression of the corresponding key at the keyboard. The complete code (Hollerith code) for the AN/FSQ-7, 8 is shown in table 3-1. Each numeric punch may be used alone or with any zone punch. Each combination signifies a different character. For example, a 5 punch (indicated in the Numeric Punch column) used with a punch in the 11 row signifies the letter N (indicated in the 11 Zone column). A 5 punch used alone signifies the numeral 5 (indicated in the No Zone column). A 5 punch and a 12 zone punch indicate an E; a 5 punch and 0 zone punch indicate a V. The special characters are signified by an 8 and a 3 punch, an 8 and a 4 punch, or an 8-3 zone or 8-4 zone punch combination. Notice that the letters A-I use consecutive numeric punches in combination with a 12 zone punch. Letters J-R use consecutive numeric punches in combination with an 11 zone punch. Letters S-Z use consecutive numeric punches (starting with a 2 punch) in combination with a 0 zone punch. Eleven characters other than the standard 26 alphabetic and 10 numeric characters may be punched.

G. Summary Questions

Questions:

1. What three operations are possible with the 020 CEP?

2. How many cards will the hopper hold?

3. How is printing accomplished in the 020 CEP?

4. How many bits are transferred from the CEP to MDIE and what do the bits represent?

5. What does an information-ready pulse sent to the MDIE from the CEP mean?

6. What does the drum demand pulse do?

7. What code is used on IBM cards in the CEP?

II. BLOCK DIAGRAM ANALYSIS

A. General

1. The 020 Computer Entry Punch is used as a manual input device for the AN/FSQ-7, 8 equipment. It can punch information on IBM cards and simultaneously print the same information across the top of the card. The source of duplicated information is a previously punched card being passed through the read station.

2. Card information sensed at the read station can be sent to the MI unit (unit 23) or duplicated in the following card, or both operations can be performed concurrently, depending upon the desired operation.

3. The operations of the machine are controlled manually from the keyboard and automatically by programming. Some operations may be manually initiated at the keyboard with control taken over by the program unit.

B. Card Travel

1. The cards used in the 020 will be from one of four sources (fig. 3-2), depending upon the type of data to be handled by the machine:

   a. Cards punched by the 026 Card Punch.
   b. Cards processed by the 056 Verifier
   c. Prepunched cards from the permanent files.
   d. Blank cards for the transcription of original data.

2. Cards placed in the card hopper are moved through the machine as indicated in figure 3-2. A card feed cycle moves a card from the hopper to the detail bed. The next card feed cycle moves the card from the detail bed to registration at the punch station. As the desired punching operations are being performed, the card moves from the punch station to the master bed. The card is moved column by column through this station and the read station by escapement cycles in conjunction with the punching operation. Subsequent card feed cycles move the card from the master bed to registration at the read station and from the read station to the stacker. As each card progresses to a new

station, its former position is filled by a card simultaneously fed from the preceding station. This assures a continuous flow of cards until the supply of cards in the hopper is depleted or until the feed cycle is interrupted by some other function.

3. Cards may also be inserted individually into the machine at the detail bed or at the master bed. An instance in which this arrangement might be advantageous would be the duplication of a single prepunched card. The card to be duplicated is inserted in the master bed, and the blank card is inserted in the detail bed. Single cards should not be fed into the machine from the hopper. Since it is not practical to read blank cards, the block diagram shows no provision for inserting blank cards directly into the master bed.

C. Mechanical Operation

1. All the mechanical moving parts of the machine receive power from the 1/12 hp drive motor (fig. 3-2). The reduction drive unit is belt-driven directly from the motor. A second belt drives the punch drive unit under control of a punch clutch. The reduction drive unit drives the card feed and the escapement mechanisms to move the card through the machine. The punch drive unit drives the punching, printing, and reading mechanisms simultaneously.

2. The card feed mechanism operates to enter a card into the detail bed from the hopper, to register the card in the detail bed at the punch station, to register a card in the master bed at the read station, and to stack a card in the stacker. These operations are performed simultaneously under control of the card feed clutch. Energizing the card feed clutch initiates a card feed cycle. The card feed index is latched up at 0 degree. There is 2.78 milliseconds (ms) per degree, or 1 second per card feed cycle.

3. The escapement mechanism, which controls card movement through the punch and read stations, receives the driving power from the reduction drive unit through a friction clutch. The program

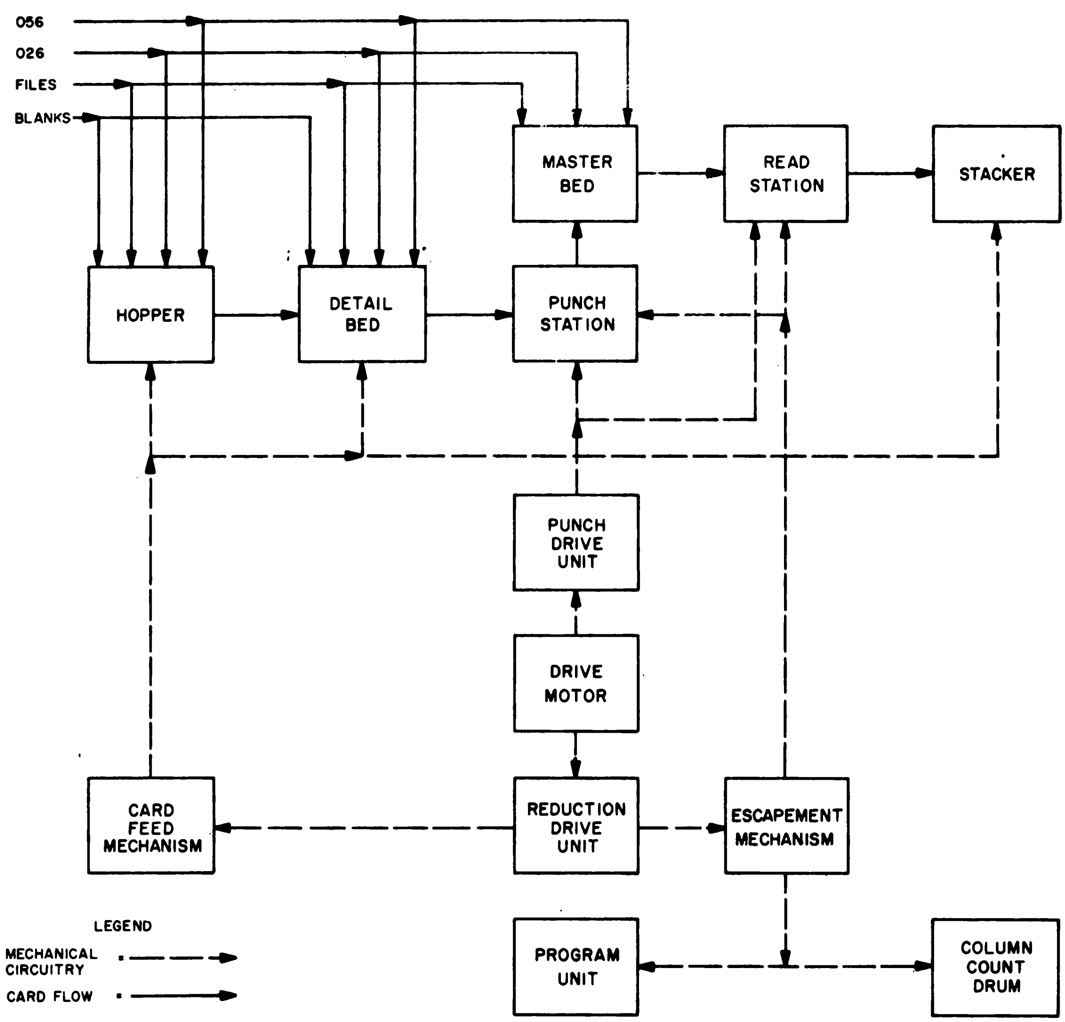


Figure 3—2. System Block Diagram, Mechanical

unit and column count drum are also driven by the escapement mechanism in synchronism with the card movement through the punch and read stations. An escapement cycle is initiated by energizing the escapement magnet. It takes 6 ms to move the armature out of a tooth of the escape wheel. When the wheel is moving, it moves at a rate of 12 ms per tooth. One tooth represents one card column.

4. A punch cycle includes the punching operation, the printing operation, and the sensing operation. All three operations are controlled simultaneously by the punch clutch. The punching and printing operations enter information on the card while the sensing operation detects the punched card information for duplication or computer entry. Each of these operations is performed on a column-by-column basis. A punch cycle is initiated by energizing the punch clutch. The punch clutch is latched at 345 degrees and one cycle moves the index through 360 degrees at a rate of 0.154 ms per degree, or 55.44 ms per punch cycle.

   The timings of the escapement cycle, the card feed cycle, and the punch cycle are completely asynchronous.

D. Electrical Operation

1. Electrical power for the 020 Computer Entry Punch is supplied by the simplex input CB unit (unit 56). The unit status switch is capable of selecting either the standby or the active power supply and of connecting the data outputs of the relay switching network to the corresponding MI unit. It is also capable of connecting the machine to the standby power supply and leaving the signal outputs disconnected entirely.

2. Power from the selected power supply is connected to the terminal panel through the relay switching network for distribution to the various subassemblies. Power from the terminal panel is used to operate magnets in the keyboard, the interposer magnets, and the relay switching network. It

also supplies the drive unit with 115VAC to operate the 1/12 hp drive motor. This motor supplies the power for all the mechanical action of the machine.

3. The card count mechanism controls a counting process to identify the cards as the card data is entered into the MI unit. The card count forms a portion of the identification section of each word as the word is placed on the drum. Each word is identified by a column count and a card count. Because of the relatively slow operation of the card machine, it is not necessary to have a card count greater than 5.

4. The operation of the relays which control the machine function is dependent upon the action of either the program sensing unit or the function controls on the keyboard.

5. A means is provided for sensing a change of computer status. A change will stop machine operation and light the DUPLEX SWITCH light at the unit status control panel. Operation cannot be resumed until the cards in the punch and/or read station are removed and the RESET button at the unit status control panel is depressed. A connection between the unit status control panel and the maintenance console (unit 47) enables monitoring of machine status at the console.

6. The drum-demand pulse initiates the data transfer from the CEP through the MI unit (unit 23) to the MIXD drum. The initiation takes place when a CEP cam (P7) passes an information-ready pulse (through relay switching), and a subsequent drum-demand pulse causes unit 23 to select the CEP as the MI unit which is to transfer data. The drum-demand circuitry is also used as an interlock on machine operation when data is to be transferred. The absence of a drum demand due to acceptance of higher priority data at unit 23 will prevent the card from being moved to the next column. This eliminates the possibility of reading a second card column before the preceding column data has been transferred to the MIXD Drum.

7. The information-ready circuitry is connected to the appropriate MI unit through the relay switching network.

E. Data Flow

1. Data may be entered into the CEP either through the keyboard or by inserting prepunched cards from other machines. Data entered through the keyboard is passed to the interposer magnets by key depression. When a punch cycle is taken, the interposer magnets transfer the data to the card by punching the card. The card carries the data to the read station, where it is read and sent to the interposer relays. The interposer relays energize the interposer magnets if duplication is desired. The data to be transferred is passed from the interposer relays through the relay switching to the MI unit.

2. A column count and a card count are also transferred through relay switching to the MI unit. These two quantities, with the original data, are assembled with other identifying information to make up the final input word as it is transferred from the MI unit to the MI drum field. The final input word is assembled in the following form.

P	LS L11	L12 L15
NOT USED	CARD INFORMATION	CEP IDEN

RS R1	R2 R6	R7 R13	R14 R15
NOT USED	CARD COUNT	COLUMN COUNT	INPUT UNIT ID

F. Summary Questions

Questions:

1. The cards used in the 020 are from what four sources?

2. How many degrees on the card feed index are there in a card feed cycle?

3. At what degree does the card feed clutch latch at?

4. How many columns can be punched in one punch cycle?

5. How is a punch cycle initiated?

II. OPERATING INSTRUCTIONS

A. General

1. The 020 Computer Entry Punch (fig. 2-1) can be used as a printing card punch and reader or as a pre-punched card reader. The various machine operations are:

   a. Skipping: Omitting columns where information is not to be punched or sensed.
   b. Duplicating: Reproducing data into the detail card from the master card.
   c. Field Defining: Sensing the extent of field. A field is defined as a columnar division of a card used to segregate various types of information. It may be any number of columns.
   d. Alpha-numeric Punching: Punching alphabetic or numeric characters in an IBM card according to the Hollerith code.
   e. Data Transfer: Transferring information from the 020 to the computer via unit 23.
   f. Zone Suppression: Preventing transfer of 0, 11, 12 data to the computer.
   g. Print: Printing the character above each column as it is punched.
   h. Print Suppression: Preventing printing on card without affecting punching.
   i. Feeding: Moving cards from the hopper to the detail bed.
   j. Multipunching: Punching more than three characters in one column.

2. The function relays governing machine operations are controlled either manually by the keyboard switches and keys or automatically by the program-sensing mechanism. The program controls the mode of operation.

3. Certain operations may be controlled either manually or automatically. Multiple-punching, registering (REG key), releasing a card in error, and switching to the alternate program are possible only under manual control. Defining a field, transferring data to the computer, and zone suppression are possible only in automatic control. Automatic feeding is possible but is controlled by a switch rather than by programming.

4. A circuit is provided which automatically stops the machine and lights the DUPLEX SWITCH light if the computer status is changed. The cards must be removed from the read and/or punch station and the RESET button must be depressed to restore the machine to normal operating condition. The interrupted sequence of cards must be restarted to ensure that all the information contained in the cards is transferred to the correct computer.

B. Operating Controls

1. Manual Controls

a. The computer entry punch employs four groups of manual controls: the keyboard controls, the unit status controls, the function control switches, and the three miscellaneous switches.

b. Keyboard

1) A combination alphabetic and numerical keyboard is used. (See fig. 5-2) Punching keys are gray with blue lettering. The keyboard is interlocked to prevent two character or functional keys from being depressed at the same time. The alphabetic keys are arranged so that the standard typewriter touch system can be used. A group of dual purpose keys at the right side of the keyboard serves for numeric as well as alphabetic punching. This permits punching numeric characters with the right hand and frees the left hand for document handling.

2) The touch system for the 10 numerical keys is as follows: index finger for digits 1, 4, and 7; middle finger for digits 2, 5, and 8; ring finger for digits 0, 3, 6, and 9. The punching of a digit or a letter with any of the combination keys depends upon the shift condition of the keyboard. For example, the depression of the 4-J key punches a 4 when the keyboard is in numeric shift but a J when in alphabetic shift. This shifting is similar to upper or lower case

TABLE 5–1. KEYBOARD CONTROLS

KEY	MANUAL CONTROL	PROGRAM CONTROL
FEED	On the first depression, one card is fed to the detail bed from the hopper. On the second depression, this card is registered at the punch station, and the second card is fed to the detail bed under the first card. During subsequent operations, registration at the read station and stacking of cards in the stacker also take place.	Same as manual control.
REG (Register)	When depressed, the same functions are performed as those performed when the FEED key is depressed except that cards are not fed from the hopper.	Same as manual control.
ENTRY	Releases cards at the rate of 12 ms per column.	A card is released at the rate of 18 columns per second except when a skip field is programmed without the entry. Under this condition, the card will be released at the rate of 80 columns per second.

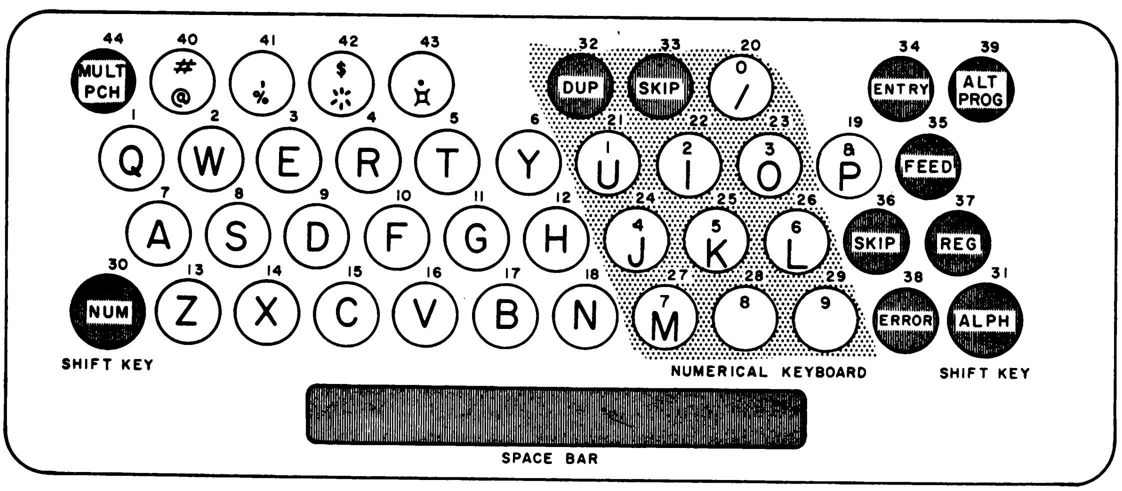


Figure 5–2. Combination Keyboard

TABLE 5–1. KEYBOARD CONTROLS (cont'd)

KEY	MANUAL CONTROL	PROGRAM CONTROL
SKIP (Key 33)	Punches in the 11 row.	Serves as an 11 key during numeric punching and as a dash-skip key during alphabetic punching. In numeric operation, one depression is required for each field to be skipped. An 11 is punched in the column in which the key was depressed, and the remainder of the field is skipped at a rate of 12 ms per column.
Space Bar	The card is advanced one column each time the bar is depressed.	Same as manual control.
NUM	Shifts the combination keyboard into numerical status as long as it is held down. Used to permit the punching of numbers in an alphabetic field.	Shifts keyboard to numerical position when depressed in programmed ALPHA field.
ALPHA	When duplication is being performed, this key permits automatic spacing over blank columns.	Normally used to permit punching of letters in a numerical field. Shifts the combination keyboard into alphabetic status as long as it is held down. Prevents skipping caused by X punching.
DUP	Causes duplication on a column-by-column basis as long as it is held depressed.	A single depression causes duplication of the field in which it is depressed.
SKIP (Key 36)	Performs same function as space bar.	Operated on a nonrepeat basis for each field, requiring a separate depression for each field to be skipped.
ALT PROG (Alternate prog)	Not used.	Shifts program control to the lower rows of the program card. Program contacts 4 through 9 become operative for the remainder of the card in which ALT PROG key is depressed.
MULT PCH (Multiple punch)	Shifts keyboard to numeric status; prevents escapement to new column until key is released. While depressed, any number of numeric keys may be depressed one at a time.	Inoperative.
ERROR	Not normally used.	Releases the detail card, which is in error, at the rate of 50 ms per column and prevents any data from this card from entering the computer.

shifting on a standard typewriter and may be controlled automatically by the program unit or manually by key depression. The section containing the combination keys is readily distinguished by the shaded blue area of the key plate.

3) The top row contains four special-character keys at the left. These keys punch eight characters as shown on the key tops. The shift status of the keyboard will determine which of the two characters will be punched and printed by each of the four special-character keys.

4) The keyboard also contains the shift key for alphabetic and numeric, the MULT PCH, the manual DUP, the ALT PROG, the FEED, the SKIP, the ERROR, and the ENTRY keys. The uses of the keyboard controls are listed in table 5-1.

5) Keys 1-18 can be depressed to punch the appropriate letters only when the keyboard is in alphabetic shift. If one of these keys is depressed while the keyboard is in numeric shift, the keyboard becomes locked up. Operation can be resumed by releasing the card or by depressing the alphabetic shift key to allow the letter to be punched and printed. Figure 5-2 shows the numbered keyboard.

6) Combination keys 19-29 punch the characters indicated below:

Key	Numeric Shift	Alpha Shift
19	&	P
20	0	/
21	1	U
22	2	I
23	3	O
24	4	J
25	5	K
26	6	L
27	7	M
28	8	8
29	9	9

7) Special-character keys can be depressed when the keyboard is in either numeric or alphabetic shift to punch and print the characters listed below:

40	#	@
41	,	%
42	$	*
43	.	¤

8) The punching code for the different characters is known as the Hollerith code (table 3-1).

c. Unit Status Panel Controls: There are two switches on the unit status control panel: the unit status switch for establishing the CEP power and signal status, and the RESET pushbutton, for initiating the restoration of contact between the computer and the punch. (Fig. 5-4 and Table 5-2)

d. Functional Control Switches: Four 2 position switches are located just above the key section of the keyboard. The two positions for each switch are ON and OFF. The switches are identified and their functions described in table 5-3. (See Fig. 5-3)

e. Miscellaneous Control Switches: A number of controls on the computer entry punch are listed independently because of their isolated locations. The functions of these controls are described in table 5-4.

1) Program control located on bottom PROGRAM DRUM
2) Main line located in stacker
3) Keyboard Restore located on side of master bed.

C. Indicator Lights: Two lights are located on the unit status control panel (fig. 5-4) to the left of the RESET pushbutton. The POWER ON light indicates that power is applied to the punch. The DUPLEX SWITCH light indicates a change of computer status.

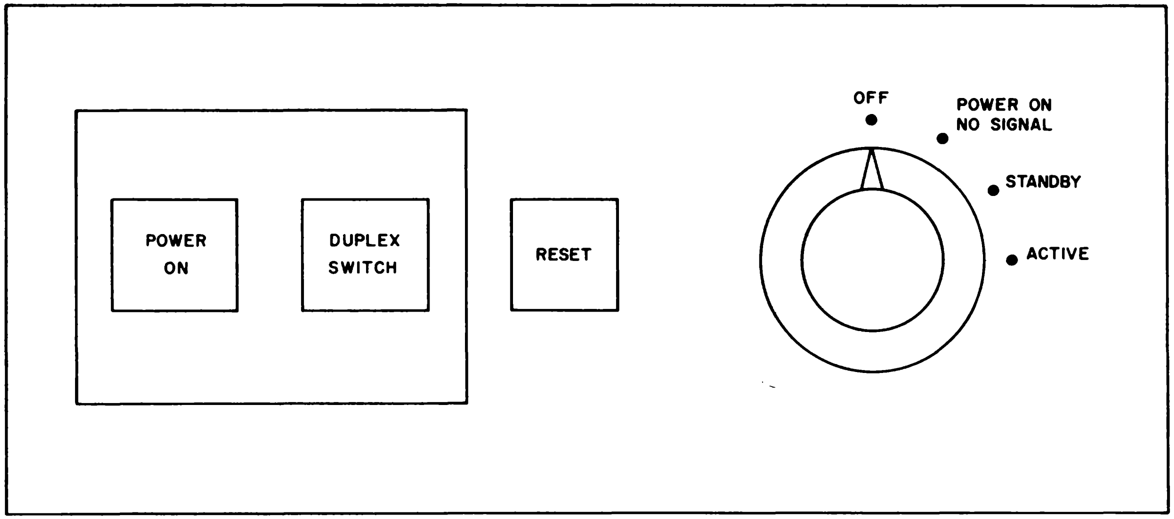


Figure 5–4. Unit Status Panel

TABLE 5–2. UNIT STATUS PANEL CONTROLS

CONTROL	TYPE OF SWITCH	FUNCTION
Unit Status	4-position rotary	OFF: Power and signals are disconnected from the punch. POWER ON: Power is available to the punch, but no signal connections are made. STANDBY: Power is available to the punch, and signals are connected to the standby computer. ACTIVE: Power is available to the punch, and signals are connected to the active computer.
RESET	Pushbutton	Restores normal machine operation after the computer has undergone a status change and the interlock has prevented any futher reading to the computer.

TABLE 5—3. FUNCTIONAL CONTROL SWITCHES

CONTROL	TYPE	FUNCTION
AUTO FEED	Toggle switch	ON: Initiates automatic feed cycle immediately after column 80 of the detail card has been passed.
		OFF: Suppresses automatic feeding.
AUTO SKIP AUTO DUP	Toggle switch	ON: Allows programming for automatic skipping and automatic duplicating.
		OFF: Prevents automatic duplicating and automatic skipping by program control but does not affect manually controlled skipping and duplication.
PRINT	Toggle switch	ON: Permits printing above the punched column.
		OFF: Suppresses printing.
AUTO ENTRY	Toggle switch	ON: Automatically releases cards at the rate of 18 columns per second to allow a deck of prepunched cards to be read and the designated data to be entered into the computer. No punching possible.
		OFF: Prevents automatic entry.

TABLE 5—4. MISCELLANEOUS CONTROL SWITCHES

CONTROL	TYPE	FUNCTION
PROGRAM CONTROL	Lever switch	ON: Engages program sensing mechanism, making program control effective and shifting the keyboard to numeric status. Serves as a mechanical interlock by preventing program drum removal.
		OFF: Disengages program sensing mechanism. Shifts keyboard to alphabetic status.
MAIN LINE	Toggle switch	ON: Supplies power under control of unit status control switch.
		OFF: Disconnects power. Operates automatically when stacker is full.
KEYBOARD RESTORE	Pushbutton	Restores locked keyboard to operating condition.

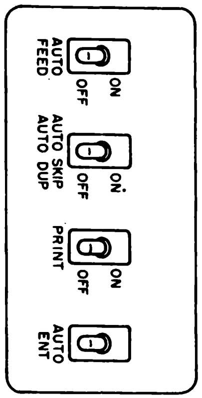


Figure 5—3. Functional Control Switches

D. Operating Sequence

1. Visual Check: The following steps should be observed for proper operation:

   a. Be sure that POWER ON light is lighted.
   b. Make sure that signal and power connectors are properly connected.
   c. See that detail and master beds are free from any pieces of cards that may interfere with proper operation.
   d. Be sure that DUPLEX SWITCH light is out. To extinguish it, depress RESET button.

2. Loading Cards into Hopper: Cards are placed in the hopper face forward, 9's down, and are fed front card first.

3. Starting the Machine: To start the machine, proceed as follows:

   a. Turn main line switch on.
   b. Turn unit status switch to POWER ON. This lights the POWER CONTACTORS CLOSED light (simplex maintenance console) associated with the standby power supply.
   c. Depress RESET button.
   d. Turn unit status switch to STANDBY position, assuming that A computer is active and B computer standby.
   e. If AUTO FEED switch is off, depress FEED key twice to register first card. If switch is on, depress FEED key only once.

4. Punching, Single and Multiple

   a. Single punching is performed by standard operation of the keyboard. In multiple punching, two or more numeric characters may be punched in one column by holding the MULT PCH key down while the keys are depressed one at a time.

   b. The keyboard is automatically shifted to numerical status when the MULT PCH key is depressed. Multiple-punched columns other than standard alphabetic characters or special characters should not be duplicated.

c. Multiple punching is generally used for preparing a program card when more than two punches are required in a column.

5. Column Spacing

   a. Depressing the space bar will move the card one column without punching.

   b. Without program control, the DUP key may be used to space over columns if the corresponding columns are blank in the preceding card or if there is no card immediately ahead. This operation is faster than using the space bar.

6. Skipping: This operation is controlled manually by depression of the SKIP key. Skipping is used when no information is to be punched in a column or field.

7. Manual Card Insertion

   a. When single cards are to be fed manually, they should be placed directly in the detail bed for punching or in the master bed for reading. Depress the REG key once to position the cards properly for punching or reading. Single cards should not be fed from the card hopper.

   b. Detail Bed: To insert cards in the detail bed, proceed as follows:

      1) Place a card in detail bed right of punching station, positioning right-hand edge of card against card pusher.
      2) Depress REG key to register card at punch station.
      3) Punch desired information, starting in column 1. Depress numerical shift key when necessary.
      4) After punching, release card.

5) Insert next card in detail bed to right of punch station, and depress REG key. This registers first card at read station and new card at punch station. First card is released to left of read station when ENTRY key is depressed after punching of second card; it is moved into stacker when third card is registered.

c. Master Bed: When certain fields are to be duplicated from a prepunched master card, it is necessary to insert the master card manually in the master bed before duplicating the first card of the group. The master card is inserted in the master bed in the following manner:

1) Turn AUTO FEED switch off before completing punching of last card of preceding group.
2) After last card is released from punch station, manually move it to left until its left end touches feed rolls at read station.
3) Depress ENTRY key to advance card past read station.
4) Place master card in master bed, positioning it so that left edge is just between feed rolls and not in registered position.
5) Depress FEED key to register master card and detail card, which is at detail bed, and to feed a new card from hopper. Turn AUTO FEED switch on. Normal punching of first card of new group may then proceed, with automatic feeding of detail cards following.

8. Clearing Card Bed:

a. When the card bed is to be completely cleared at the end of a punching operation without feeding more cards from the hopper, the

AUTO FEED switch should be turned off during punching of the next to the last card. The last card is then registered for punching by depressing the REG key. After the last card is punched and moved to the master bed it is moved to the stacker by depressing the REG key again.

b. If the AUTO FEED switch is turned off after the last card to be punched is completed, the ENTRY and REG keys must be depressed alternately three times. In this case, two blank cards will be stacked behind the last punched card in the stacker.

9. Duplicating: Depressing the DUP key will cause the information sensed at the read station to be reproduced in the corresponding column in the detail card at the punch station. Duplication occurs only as long as the key is held down in manual control. In program control, depressing the DUP key in a manual field will cause duplication of the entire field. Manual duplication is used in the repunching of damaged cards and in the correction of errors.

10. Error Correction -- Blank Detail Cards: Errors in punching are often noticed and corrected by the operator at the time they are made. Normally, this involves rekeying a large portion of the card. The 020 reduces re-keying to a minimum, requires no concern about the precise column in which the error occurred, minimizes the possibility of making another error while correcting the first, and practically eliminates card handling. To correct this error, proceed as follows:

a. Depress ERROR key immediately upon detection of error. This advances the card without punching for the fields coded for manual punching, but causes duplication of the fields programmed for automatic duplication beyond the point of release. This retains the common information for duplication into the following cards. The three cards in the card bed advance to their proper stations, and a new card feeds from the hopper.

b. Duplicate correctly punched fields by a single depression of DUP key for each field.

c. Re-key field in which error occurred, and manually punch remaining fields programmed for manual punching,

d. Remove card containing error from stacker and continue normal operations.

11. Error Correction -- Partially Prepunched Cards:

a. Partially prepunched cards in the hopper may contain prepunched names or codes, or they may be serially numbered and punched. When an error is made in the punching of cards of this type and the correction is to be made immediately, automatic feeding from the hopper must be interrupted and a blank card must be inserted manually in the card bed. Since each card fed from the hopper contains some prepunched data, it is not possible to duplicate into the following card. Make the correction as follows:

1) Turn off AUTO FEED switch. This will prevent the feeding of a card from the hopper and the registering of the card from the right of the card bed when the error card is released.
2) Depress ERROR key. The error card will be advanced past the punch station without punching, except for the fields which are programmed for automatic duplication. The duplication of these fields retains the data for duplication into the correction card.
3) Turn off AUTO SKIP and AUTO DUP switch to prevent automatic skipping during correction of error card. When correcting an error in pre-punched fields programmed for automatic skipping, manually duplicate these fields into the blank card.
4) Remove card following error card from detail bed, and insert a blank card in its place.

5) Depress REG key to register error card at read station and blank card at punch station. This will also stack card from left of read station.
6) Duplicate correctly punched fields by depressing DUP key at beginning of each field.
7) Re-key field containing error.
8) Duplicate remaining fields.
9) Turn AUTO SKIP AUTO DUP switch on, and replace card removed in step 4.
10) Depress FEED key to register correction card at read station and replaced card at punch station, to feed next card from hopper, and to stack error card.
11) Remove error card from stacker, turn AUTO FEED switch on, and continue normal operation.

12. Card Removal

a. A card may be removed from the master bed without affecting the succeeding cards by manually moving the card into the read station and depressing the ENTRY key. This moves the card to the left of the master bed, where it can be lifted out manually.

b. When a card has been released from the read station but not stacked, it is positioned to the left of the master bed. For easy removal, move the card to the extreme left by pressing down on the eject arm that extends from the left of the read station. If, for any reason, a card must be removed manually from the punching or read station, the pressure roll release lever should be held down while the card is pulled out. If a card at the punch station does not move easily, it may be freed by depressing all the numerical keys. Then, with the pressure roll release lever held down, the card can be pulled out without tearing.

13. Keyboard locking and unlocking: The keyboard is locked under the following conditions:

a. The main line switch is turned off and then on while a card is registered at the punch station. The keyboard may be unlocked by depressing the RESTORE button.

b. An alphabetic key is depressed in a field programmed for numerical punching. The keyboard can be unlocked by releasing the card or by depressing the alphabetic shift key. In the first method, the card is released without punching. In the second method, the letter is punched.

c. A blank column is duplicated in a field programmed for numerical punching. This serves as a blank column detection device to ensure that a digit is punched in every column of a numerical field which is being duplicated. The keyboard can be unlocked by depressing the RESTORE button or the alphabetic shift key.

d. A card is not registered at the punch station. This feature makes it impossible to do any punching or spacing unless a card is in position to be punched. The REG or FEED key can be depressed to move a card into punching position.

e. The REG or FEED key is depressed when a card is registered at the punch station. The keyboard can be unlocked by depressing the ENTRY key.

14. Stopping Procedure:

a. When an operation is to be stopped and the main line switch turned off before a quantity of work is completed, the card at the punch station should first be completely punched and released. Before the card is released, however, the AUTO FEED switch should be turned off. This will permit restarting the job without additional card handling.

b. When one deck of cards is to be followed by another deck, using the same master information and program control, a blank card should follow the last card of the group through the punch station. The blank card can be released past the punch station at the time that the last card is released past the read station. This will cause the blank card to be automatically punched with the master information for duplication into the first card of the next deck and thus eliminate the necessity of rekeying the master information. The AUTO FEED switch should be off when the cards are released.

15. Program Control:

a. The program unit provides automatic control of machine operations. The program card is a basic part of the unit and is moved through its cycle in synchronism with the cards in the card bed. The holes punched in the program card determine the operations to be performed on the cards in the machine.

b. Program Codes: The following codes are used in preparing a program card:

Normal Code	Function	Alternate Code
12	Field definition	4
11	Start auto-skip	5
0	Start auto-dup	6
1	Alphabetic shift	7
2	Computer entry	2
8	Zone suppression	8
3	Print suppression	9
Blank	Start normal field	Blank

Both the normal and alternate codes may be punched in a single program card. This permits changing operations without changing program cards.

To use the alternate program feature for a complete card, the ALT PROG key may be depressed either before or after the card is registered, depending upon the normal program coding in column 1. If column 1 of the normal program is coded for manual punching, the key may be depressed after the card is registered. If column 1 of the normal program is coded for automatic skipping or duplicating, however, this key must be depressed before the card is registered. In this case, the AUTO FEED switch must be turned off before the preceding card is completely punched. Then depressing the ALT prog key, after the preceding card is released, causes transfer to the alternate program and also initiates a card feed cycle.

When the first part of a card is punched under normal program control and the remainder is punched under alternate program control, this key is depressed whenever the alternate program is to be effective.

When the ALT PROG key is depressed, programming from the alternate program is effective for the remainder of that card. When the following card is fed, the normal program again becomes effective. It is not possible to return to the normal program in the same card cycle once the ALT PROG key has been depressed.

Program cards punched with both normal and alternate program codes should not be duplicated.

The following explanation of the various functions are presented as an aid for preparation of program cards:

1) Field definition: The determination of the length of a field. Each column except the first column of a field must have a hole punched in the 12 row (or 4 row for the alternate code). The first column will contain the punch designating the desired operation.

2) Automatic Skipping: When a hole is punched in the 11 row (or a 5 for the alternate code) of a program card, skipping will start at that point and continue as long as consecutive 12 holes are encountered. If several successive fields are to be skipped, they should be programmed as one single continuous field.

3) Automatic Duplication: When a hole is punched in the 0 row (6 for alternate program), auto dup will start at that column and continue as long as consecutive 12 holes are encountered. A field programmed for automatic duplication will cause the data of that field of the master card to be reproduced in the corresponding field of the detail card. If several consecutive fields are to be duplicated, they should be programmed as one single continuous field. Any field programmed for auto-duplication should also be programmed for alphabetic shift. This will eliminate the possibilities of undesired skipping and of a machine halt when a blank column is encountered.

4) Alphabetic Shift: The keyboard is normally in numeric shift when the machine is under program control. If all or most of a field is to be punched alphabetically, it should be programmed for an alphabetic shift (1 punch in program card for each desired alphabetic column; 7 punch for alternate program). In a duplication field, an alphabetic shift will permit duplication of blank columns and prevent skipping when a column to be duplicated only contains a punch in the 11 row.

5) Computer Entry: Data to be transferred to the computer must be programmed for such a transfer. A 2 hole must be present in every column that is to be transferred.

6) Zone Suppression: Where a punch in a zone row of a card is not to be entered into the computer, programming for zone suppression of that column will prevent such a transfer. Zone rows sometimes contain control or identification

punches which are not part of the computer data. It should be evident that zone suppression will only be necessary in columns programmed for computer entry.

7) Print suppression: Printing may be controlled by the PRINT switch, but it is not precise enough to allow column-by-column control. Printing may be suppressed by programming for individual column control.

8) Manual field: The absence of a punch in the first column of a field signifies that manual operation is desired for that field. Keyboard punching is usually performed in such a field, but manual skipping or duplicating is also possible.

c. Program Card Installation:

1) The program card is mounted on the program drum for insertion into the machine. The program drum has a clamping strip to hold the card and a handle on the top to tighten or release the strip. To fasten a card around the drum, proceed as follows:

   a) Hold drum in horizontal position with handle to right. Turn handle away (counter-clockwise direction) as far as it will go. This loosens smooth edge of clamping strip.
   b) Insert column 80 edge of card under smooth edge of clamping strip. Two alignment check holes in clamping strip make it possible to see that card is flush with metal edge under strip. The card should be positioned so that 9 edge is against rim of drum.
   c) Turn handle to center position. This tightens smooth edge of clamping strip and loosens tooth edge.

d) Wrap card tightly around drum, and insert column 1 edge under tooth edge of clamping strip.

e) Turn handle in a clockwise direction as far as it will go. This fastens tooth edge of clamping strip. Drum is now ready to be inserted into machine.

2) To remove a card from the drum, reverse the procedure.

3) To place the drum on the spindle, raise the program sensing wheels, using the program control lever. Rotate the drum on the spindle so that the aligning pin falls into the aligning hole in the column indicator dial. The clamping handle may have to be rotated slightly to properly position the aligning pin. Turn the program control lever to lower the reading star wheels onto the program card, and depress the ENTRY key to engage the reading mechanism fully. Before removing the drum, operate the program control lever to raise the star wheels.

d. Numerical and Alphabetical Punching

1) Although the keyboard is normally in numerical shift when the program is turned on, alphabetic information can be punched by changing to alphabetic shift. This is done automatically by punching 1's in the program card as shown in figure 5-7.

2) If a field is to be punched with both alphabetic and numeric characters, it should be programmed for whichever will occur most frequently. Since keyboard control takes precedence over program control in determining shift status, the appropriate keyboard shift key can be used when a shift is necessary.

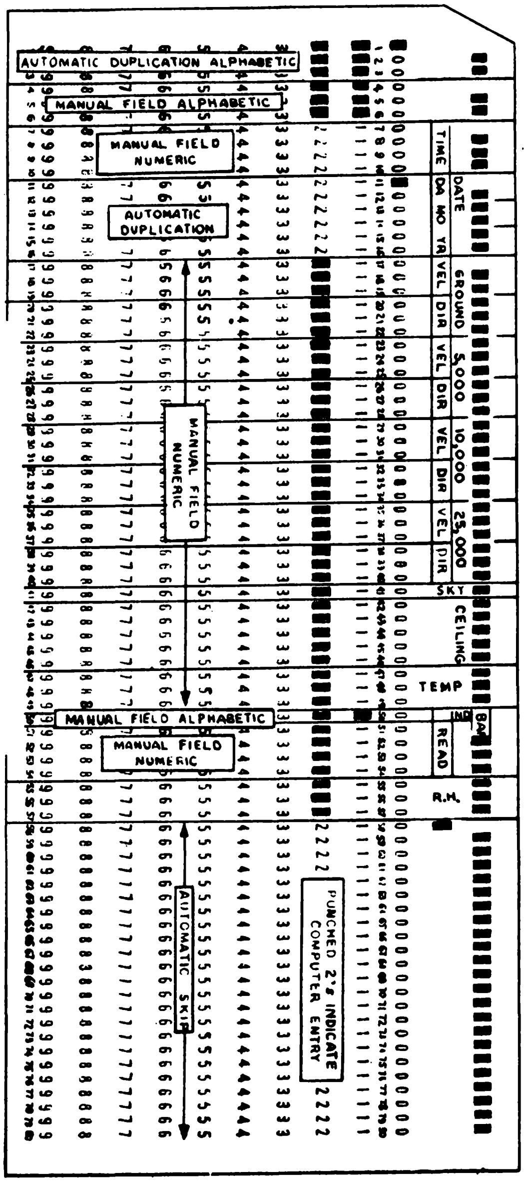


Figure 5–7. Example Program Card

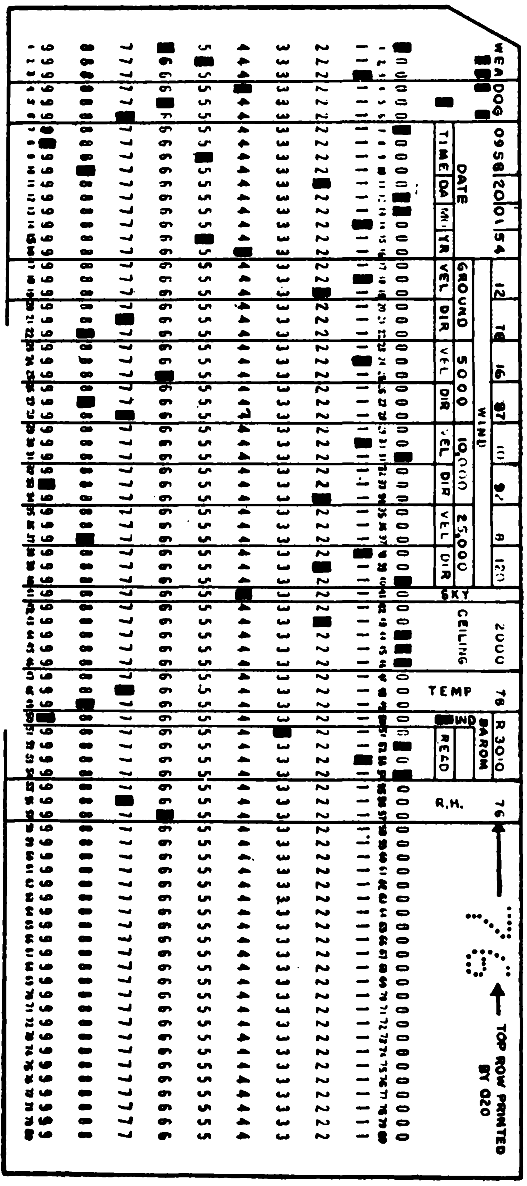


Figure 5–8. Example Detail Card

e. Duplicating: Sensing a zero hole in the first column of any program card field automatically starts duplication when the AUTO SKIP AUTO DUP switch is on. The operation is continued by the 12's punched in the remaining columns of that field. This is illustrated in the sample program card shown in figure 5-7. Figure 5-8 shows a sample card which could be punched using the program card shown in figure 5-7.

f. Error Correction

1) When an error has been made while punching, the operator can depress the ERROR key to prevent the card containing the error from being read into the computer. This card is released to the read station. Computer entry and duplication of the preceding card remain under control of the program drum.
2) Duplicate the information preceding the error from the error card into a correction card. Correct the error, and continue the operation interrupted by the error.

g. Manual Punching of First Card of New Group:

1) Master information must be punched into the first card of each new group manually. Therefore, automatic duplication must be suspended for that card by turning off the AUTO SKIP AUTO DUP switch.
2) Several procedures for punching the first card of a group are discussed in the subsequent text. The procedures vary according to card design.
3) Whenever possible, the first field of a card should be programmed for manual operation. (See Fig. 5-9. A). This gives the operator an opportunity to turn the AUTO SKIP AUTO DUP switch off before punching the first card of a new group:

a) When first card of a new group is registered at column 1, turn AUTO SKIP AUTO DUP switch off.
b) Keypunch complete card.
c) When second card of group is registered at column 1, turn AUTO SKIP AUTO DUP switch on. (This switch may be turned on after the master information has been punched.)

4) Automatic duplication should not immediately follow an automatic skip. (See the card illustration in fig. 5-9, B). Design a manually operated field between the two operations if possible.
   a) Keypunch first field.
   b) Automatically skip second field (AUTO SKIP AUTO DUP switch on)
   c) Turn AUTO SKIP AUTO DUP switch off. Keypunch third field.
   d) Keypunch fourth field. Turn AUTO SKIP AUTO DUP switch on.

5) Sometimes other factors in the use of the cards make it necessary for automatic duplication to follow an automatic skip. (See the card illustration in fig. 5-9C). In such a case, the possible procedures should be studied and the best one followed. Two procedures are outlined below.

   a) Long Skip Field
      (1) Keypunch first field.
      (2) Automatically skip second field. During skip, turn off AUTO SKIP AUTO DUP switch to prevent automatic duplication in following field. This can be done if the skip is fairly long.
      (3) Keypunch third field, and turn AUTO SKIP AUTO DUP switch on.

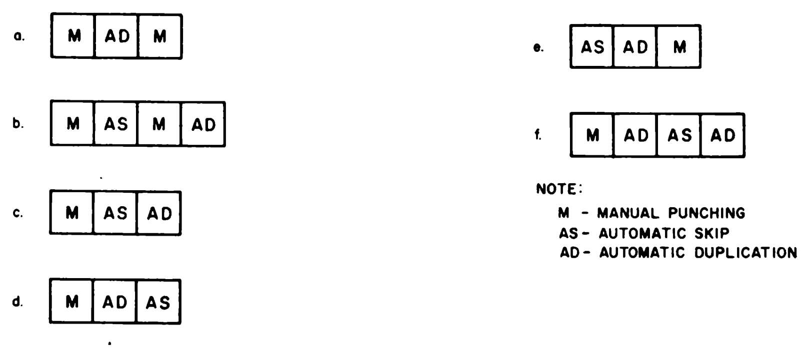


Figure 5—9. Card Field Layout

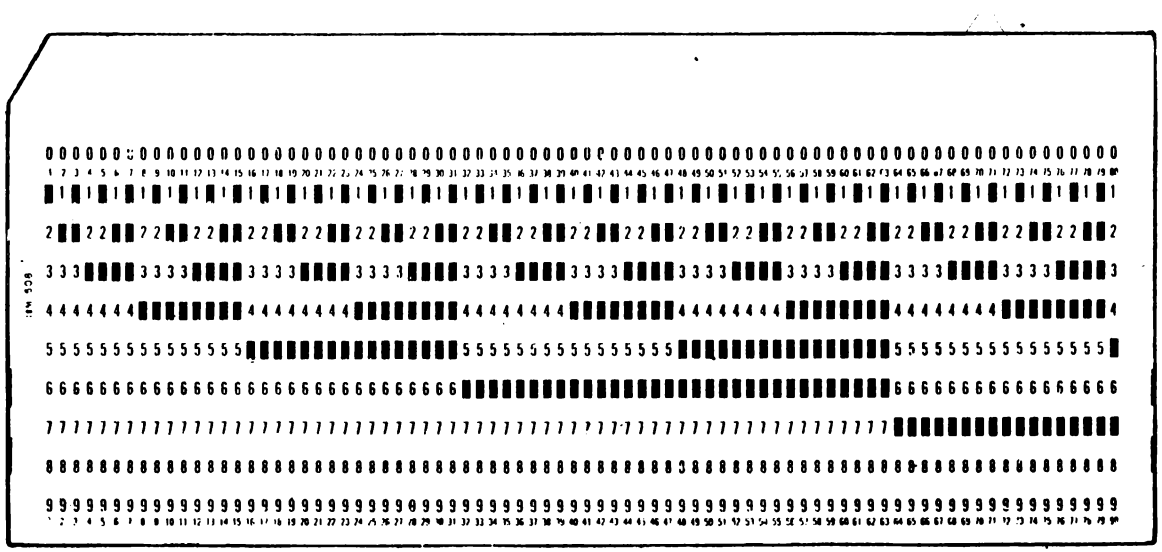


Figure 5—10. Column Count Card

b) Short Skip Field

(1) Turn AUTO SKIP AUTO DUP switch off when card is registered at column 1.
(2) Keypunch field.
(3) Skip second field by use of SKIP key.
(4) Keypunch third field, and turn AUTO SKIP AUTO DUP switch on.

6) When automatic duplication is immediately followed by an automatic skip, the first card is punched as shown in figure 5-9, D.

a) Turn AUTO SKIP AUTO DUP switch off when card is registered at column 1.
b) Keypunch first field.
c) Keypunch second field. Either during or at end of this field, turn AUTO SKIP AUTO DUP switch on so that following field can be automatically skipped.
d) Automatically skip third field.

7) If an automatic skip must come first in a card and is immediately followed by automatic duplication, follow the long skip field procedure outlined below. (See card illustration fig. 5-9, E).

a) Long Skip Field

(1) Automatically skip first field. During skip, turn off AUTO SKIP AUTO DUP to prevent automatic duplication in second field. This can be done if skip is fairly long.
(2) Keypunch second field, and turn AUTO SKIP AUTO DUP switch on.
(3) Keypunch third field.

b) Short Skip Field

(1) Turn AUTO SKIP AUTO DUP switch to OFF before last card of preceding group is punched in column 80.
(2) Depress SKIP key to skip first field.
(3) Keypunch second field, and turn AUTO SKIP AUTO DUP switch to ON.
(4) Keypunch third field.

8) When an automatic skip field comes between two fields programmed for automatic duplication (fig. 5-9), the first card is punched as outlined below:

a) Turn AUTO SKIP AUTO DUP switch off when card is registered at Column 1.
b) Keypunch first and second fields.
c) Skip third field by using SKIP key
d) Keypunch fourth field, and turn AUTO SKIP AUTO DUP switch on.

16. Column Indicator: The column indicator located at the base of the program drum holder, indicates the next column to be punched. Spacing to a particular column is facilitated by reference to the indicator.

17. Column Count Drum: The column count drum, which is identical with the program drum, moves in synchronism with the card being read at the read station. By placing the column count card (shown in fig. 5-10) on this drum, a binary indication of the column being read is entered into the computer as part of the word being transferred.

E. Ribbon Replacement: The ribbon on the 020 (fig. 5-11) may have to be replaced because of wear or deterioration. Ribbon replacement is accomplished as follows:

1. Turn off main line switch.
2. Remove ribbon spool retaining-clamp.
3. Cut or break old ribbon.

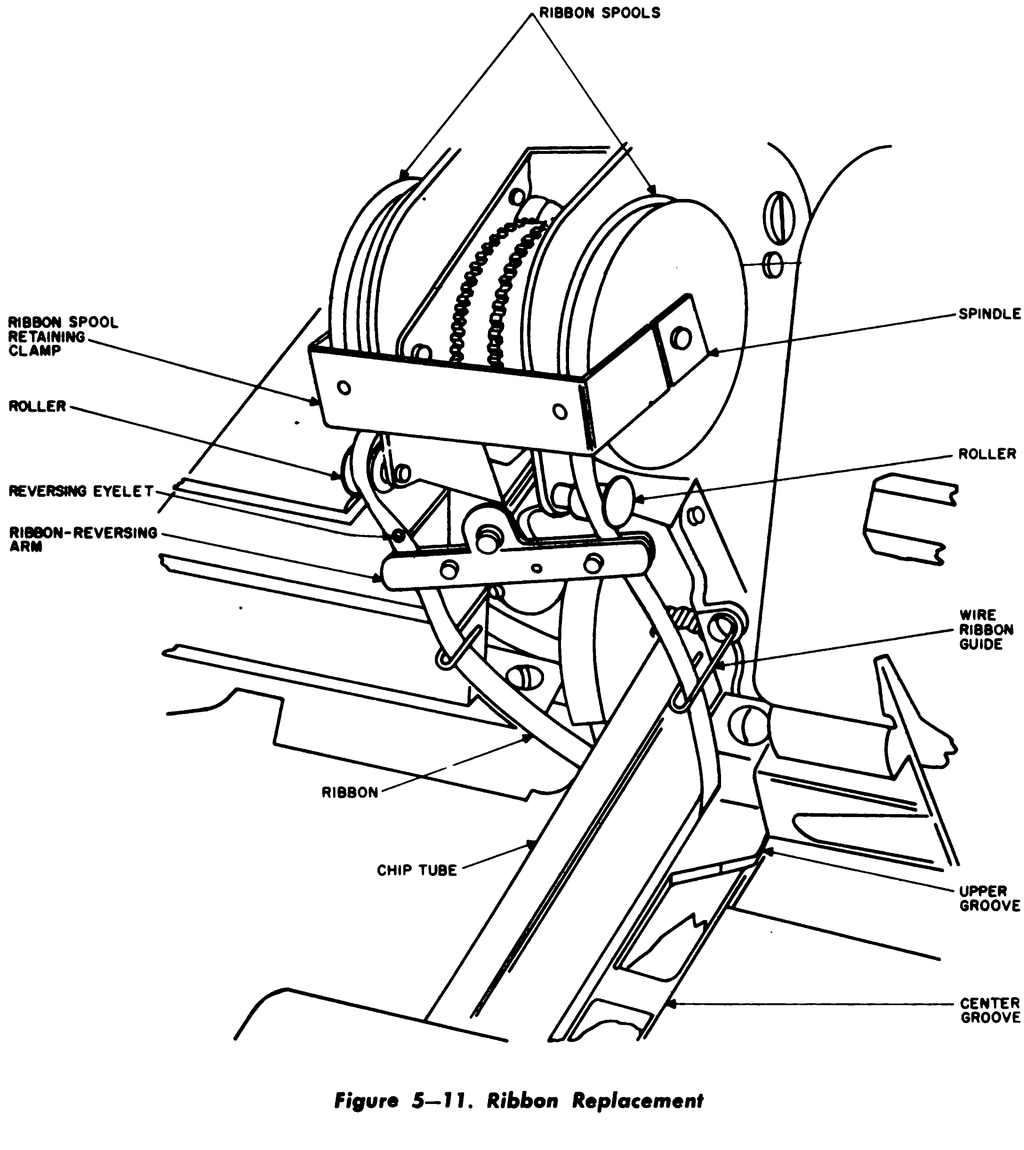


Figure 5–11. Ribbon Replacement

4. Remove both spools from their spindles and pull out the two pieces of ribbon. Empty one of the spools.
5. Place spool of new ribbon on right-hand spindle, positioning it so that ribbon feeds from top of spools toward front of machine. Lift up right end of ribbon-reversing arm, and unroll about 1 1/2 feed of ribbon; then push right end of ribbon-reversing arm down to hold spool steady.
6. Feed metal leading-end of ribbon between punch die and card bed, sliding it through groove in center of detail bed (between punching positions 3 and 4). The groove permits the extra thickness of the metal end and reversing eyelet to pass between the punch die and card bed. Be sure to keep the ribbon straight, with the top side up at all times.
7. Hook metal leading-end of ribbon in slot center of empty spool, and wind ribbon onto spool until reversing eyelet is on spool.
8. Place spool on left spindle, positioning it so that ribbon feeds onto spool over top. Be sure that ribbon is not twisted and that top side of ribbon is still up.
9. Hook ribbon around right and left wire ribbon guides, and slide it through right and left ends of reversing arm and over rollers in front of ribbon spools.
10. Slide ribbon up under punch die so that it is in the upper groove provided for it in card-printing position (above punching position 12), and take up the slack.
11. Replace ribbon-spool retaining clamp.

F. Chip Box: The operator is to keep the chip box clean at all times. The chip box is located under the reading board. It is free to be removed like a drawer.

G. Summary Questions:

1. Match the following:

1.	12__________	a.	Computer Entry
2.	11__________	b.	Print Suppression (Alt. Program)
3.	0__________	c.	Alpha Shift (Alt. Program)
4.	1__________	d.	Start Auto Skip
5.	2__________	e.	Start Auto Dup. (Alt Program)
6.	3__________	f.	Field Definition
7.	4__________	g.	Start Normal Field
8.	5__________	h.	Print Suppression
9.	6__________	i.	Field Definition (Alt. Program)
10.	7__________	j.	Start Auto Dup.
11.	8__________	k.	Alpha Shift
12.	9__________	l.	Zone Suppression (both programs)
13.	Blank__________	m.	Start Auto Skip (Alt. Program)

2. If keyboard is in numeric shift and key "40" is depressed on the keyboard Fig. 5-2, what will result?

3. For the card on the program drum to have control over skipping and duplicating, what functional switch(s) must be ON?

4. What are some things that will cause keyboard to lock up?

5. Name the functional control switches.

6. What is the function of the "Duplex Switch" light?

7. True or False

   a. The "Mul Punch" key automatically shifts the keyboard to numeric shift.

   b. Manual duplication and skipping cannot take place unless the Auto Skip Auto Dup switch is on.

   c. The keyboard is normally in numeric condition when in manual control. (Star wheels raised.)

   d. Pushing an alpha key when in numeric shift will lock the keyboard.

e. Pushing the "Entry" key when in manual control will release cards at 80 col/sec.

f. The unit status switch is a 5 position switch.

g. The "Reset" pushbutton is used to unlock the keyboard.

h. Turning the "print" switch on will suppress printing.

8. What will be the machine operation if a "0" punch in the program card is followed by ten "12" punches?

9. What will be the machine operation if an "11" punch is followed by seven "12" punches?

10. Besides allowing us to punch alpha characters, what two other functions do the "1" punches in the program card perform?

11. What are the three ways to put the machine into alpha shift?

XIV. COMPUTER ENTRY PUNCH

The information is intended as an aid in circuit study and as a reference in diagnosing machine malfunction. A basic knowledge of the function of mechanical components and of the purpose of specific circuits is assumed.

The action of the mechanical and electro-mechanical devices employed in the CEP is closely interrelated with that of the electrical circuitry. Consequently, information is included (when applicable) defining the mechanical action which occurs as the result of a completed electrical circuit. In general, the step-by-step sequential operations which are listed for each circuit are presented in the same order in which the circuits are completed and in which mechanical operations take place. When simultaneous or parallel operations occur, the operations are listed in logical sequence and the order of presentation does not indicate circuit priority. The CEP wiring diagram 337022-D (App A) shows the wiring arrangement, the referenced electrical components, and the electrical and mechanical timing charts.

UNIT STATUS SWITCH

The objective is to apply the necessary power to the CEP and to connect the signal output to the proper computer, under control of the unit status switch.

Switch Position 1 (OFF)

No power is applied, and no signal transfer occurs.

Switch Position 2 (POWER ON)

Assume that the C power supply is active, the D power supply is standby, and the CEP main line switch is on:

1. —48V is applied to pins 9 and 17 of power plug from active and standby power supplies.
2. Pick R1 and R20 using —48V applied through 2B, top deck of unit status switch.
3. R1 contacts apply 110Vac from D power supply to the drive motor, blower motor, CEP power transformer, and POWER ON light.
4. R20AL (1B) lights D POWER CONTACTORS CLOSED light on simplex operating console.
5. R20L (10B) applies +10Vdc to signal circuits.

Switch Position 3 (STANDBY)

Assume that the D power supply and B computer are standby, that the CEP main line switch is on, and that —48Vdc is applied to pins 6, 7, 12, 14, 9, and 17 of the power plug:

1. Apply power from standby power supply as in D.1.2.
2. Pick R3 (2B) through R3B and center deck of unit status switch.
3. R3B (2B) lights B SIGNAL CONTACTORS CLOSED light on simplex operating console.
4. R3A (2B) picks B signal relays. CEP signals connected to unit 23B.
5. R3A (2B) also applies —48V from pin 7 of power plug to R16BL (9B).
6. R16 (2B) picks through R17BL.
7. Hold R16 through R16AL, R19AL.
8. Pick R17 through R15AL, R16BL.
9. Pick R18 through R16AU.
10. R18AU lights DUPLEX SWITCH light.
11. R18BL (6B) prevents computer entry.
12. R18AL (8B) prevents card feeding.
13. R18BU (8B) prevents pick of R2.

Note

At this point, manual intervention is required to release the interlocks and enable normal machine functions to proceed.

14. Depress RESET switch to pick R19 (10A).
15. R19AL (9B) opening drops R16.
16. R16AU (9B) opening drops R18.
17. R17 held through R15AL, R17BL.

The CEP can now be operated. If the status of the computers is switched (B computer made active), the following sequence takes place:

1. Drop R3 and pick R4 (2B) caused by —48V changes at power plug when computers were switched. Unit status switch still in standby and A signal relays now picked.
2. —48V applied through R3A to R16BL (9B) is removed, dropping R17.
3. —48V applied to R14BL (9B) through R4A (2B).
4. Pick R14 through R15BL.
5. Hold R14 through R14AL, R19BL.

6. Pick R15 through R17AL, R14BL.
7. Hold R15 through R17AL, R15BL.
8. Pick R18 through R14AU, to disable CEP.

To release interlocks and allow normal operation to resume:

1. Depress RESET to pick R19.
2. R19BL opens to drop R14.

If there were cards in the CEP at the time of switchover, R2 (8B) would be picked. R2BL (9B) would then hold R14 until the cards have been removed.

1. Depress ENTRY key to remove cards and drop R2, and then depress RESET button.
2. R14AU (9B) opening drops R18, and CEP is restored to operation. If information was being entered into the computer when the switchover occurred, the complete sequence of cards should now be rerun.

Switch Position 4 (ACTIVE)

The sequence is the same as for position 3 (STANDBY) except that power is received from the active power supply and signals are sent to the active computer. When the signal relays are picked, either R9 or R10 is also picked. R9AL or R10AL (10B) supplies +10Vdc to enable operation of MI interlocks and to set the unit status core in the MDI matrix.

CARD FEED

The objective is to feed cards into an operating position using the FEED key. Assume that power is on, cards are in the hopper, and no cards are in the detail or master bed:

1. Depress FEED key (7B).
2. Pick card feed clutch through R18AL.
3. Pick card count (8B) through R6BL.
4. Card feed mechanism is now rotating.
5. Pick keyboard restore magnets through CF4 (5A) at 6°. This opens up FEED key contact to drop CF clutch and card mount magnet.
6. CF1 (5B) disables DUP key until cards are registered and pressure rolls have dropped (67° of feed cycle).
7. Card enters feed rolls at 58°.
8. Card lever switch (7B) makes at 210°. Note that this contact makes after CF3 (7B) opened (140°) so that R4 will not be picked on this feed cycle.
9. Card feed latches at 0° since feed clutch has been dropped.
10. Depress FEED key.
11. Pick CF clutch.
12. Pick card count.
13. Restore keyboard through CF4 at 6°.
14. Register first card at 67° and feed second card.
15. Pick R4P (8B) at 60° through CF3 and the card lever switch.
16. Pick R2P and R3P through R4AU (8B).
17. R2, 3, and 4 held through program cam contact 2 until column 87½ of program drum.
18. R3BU opens to remove the ground from the FEED and REG keys, disabling these keys.
19. R5 will be picked through CF3 and the read card lever on the next cycle. A card in the master bed will close the read card lever.
20. R8 picks on each feed cycle at 80° (8B). R8AL drops R1 if in auto-entry (8A). R8BL prevents picking of R34 (6B); R8BU initiates punch cycle (5A). This punch cycle will enter column 1 information into the computer if there are "2" holes in the program card.

REGISTER KEY

Register operation is the same as feed, except that the card feed latch prevents the feed knives from operating. No card is fed:

1. Depress REG key.
2. Pick card feed latch magnet.
3. Pick CF clutch and card count magnet through CF latch magnet contacts.
4. Hold CF latch, CF clutch, and card count magnet through CF2 and CF latch magnet contacts until 255°.

AUTO-FEED

Auto-feeding consists of maintaining an automatic and uninterrupted flow of cards to the card bed at the proper time, through the use of the AUTO FEED switch and a program cam contact. Assume that the program card and the master card are registered at column 80 and that the detail card is registered at column 79:

1. Depress key on keyboard to punch last column in detail card causing escapement.
2. Program cam contact 1 closes to cause a skip to column 1.
3. Program cam contact 2 closes at column 87½-88½.
4. Relays 2, 3, 4, 5, and 7 drop.
5. Pick CF clutch through AUTO FEED switch and R18AL.
6. Pick card count.
7. Repick and hold R2, 3, 4, and 5 through CF cycle.

ALPHANUMERIC SHIFT

The objective is to shift the keyboard from numeric status to alphabetic status, to provide for duplication over blank columns, and to suppress skipping if a column containing an 11 punch is duplicated.

With the program star wheels down, the keyboard is in numeric shift unless programmed for alphabetic (1 punch in program card or depression of the ALPHA key on the keyboard). With program star wheels raised (manual control), the keyboard is in alphabetic shift unless the NUM key is depressed.

When R30 (6B) is picked, the machine is placed in alphabetic shift status:

1. Pick R30 in manual control through program handle switch 2, numeric key contact, and MP key contact. Depressing NUM key will open this path to drop R30.
2. Pick R30 in program control through star wheel contact 1 or 7, numeric key contact, and MP key contact. Keyboard can be put into numeric shift by depressing the NUM key (except when duplicating). When duplicating, R29-2 (5B) will be closed, bypassing the NUM and MP key contacts.

Note

There is no hold for R30 through 12 holes in the program card. There must be a 1 hole for every column which is to be in alphabetic status.

3. R30 contacts operate as follows:
   a. R30-1 (5A) provides a path for duplicating over blank columns.
   b. R30-2 (3B) transfers ground from numeric latch contacts to alpha bail contacts on keyboard.
   c. R30-3 (3B) grounds zone punch bail contacts on keyboard.
   d. R30-4 (4A) prevents picking of X-skip relay by dash-SKIP key when in alphabetic status.
   e. R30-5 (4A) determines whether bail contact 15 will pick interposer magnet 3 or 4 for special characters.

KEY PUNCH OPERATION

The objective is to space one column and to punch a hole in a card by depressing a key on the combination keyboard. Assume that the machine is in numeric status and a numeric code is to be punched:

1. Depress key 1 on keyboard.
2. Pick interposer magnet 1 through latch contact 1 (4A).
3. Close interposer bail contacts (5A). These contacts will open when punch bail pulls punch operating interposer down.
4. Pick escape magnet through bail contacts R25-4, R24-3, MI interlock, R22-3 (6A).
5. Close escape armature contact, and escape to first column.
6. Pick R22 through escape armature contact and R25-5:
   a. R22-1 (7A) holds R22 until 65° of punch cycle.
   b. R22-2 (5B) is used only for manual duplication.
   c. R22-3 (6A) drops escape magnet (escape only one column).
   d. R22-4 (5B) picks punch clutch. (B+ for punch clutch through P1).
7. Refer to punch mechanism timing:
   a. Interposer armatures restored by 36°.
   b. Punches through card at 126°.
   c. Printing occurs at 130°.
   d. Punch clutch relatches at 345°. (Punch clutch de-energized at 0° when P1 opens.)

MULTIPUNCH

The objective is to punch more than one numeric character in a single column by depressing several keys while the MULT PCH key is held down:

1. Depress MP key, and hold until all desired keys have been depressed. The first number key will initiate a standard escape cycle.
2. Pick R24 through R35-3, R22-6, R28-6, and MP key (6A).
3. Hold R24 through R35-3, R24-1, R28-6, and MP key.
4. Inhibit further escapement by opening R24-3NC (5A).
5. Further punch cycles will be initiated through the interposer bail contacts, R25-4, and R24-3NO (5A).
6. R24-2 prevents auto-skip operation (5A).
7. R24-4 prevents auto-duplication operation (5B).
8. MP key stem upper contact (5B) places keyboard in numeric shift (R30 dropped).
9. MP operation is suppressed when the CEP is used for computer entry by R35 being picked (R35-NC opens) (5A).

SKIPPING OPERATION

The objective is to cause skipping, punching, spacing, or combinations of these operations under manual or program control.

D.8.1 Single-Column Skip Operation

The CEP is in manual control when the star wheels are raised or when the star wheels are down and there are no field definition punches in the program card. Each depression of the SKIP key causes a 1-column skip:

1. Depress SKIP key, and pick R21 (4A).
2. Pick space interposer magnet through SKIP key and R21-2.
3. Close interposer bail contacts (5A).
4. Pick escape magnet through bail contacts, R25-4, R24-3, MI interlock, and R22-3.

5. Pick keyboard restore through bail contacts, R28-3, and R25-3. This opens skip contact on keyboard.
6. R21 held through P2, and R21-1, until 65°.
7. Pick R22 through R25-5 and escape armature contact (5A).
8. Pick punch clutch through R22-4 (5B).
9. Pick R25 at 10° through P3, R21-4, R24-2 (5A).
10. Drop R25 when P3 opens at 60°.
11. Drop R21 when P2 opens at 65°.
12. Punch clutch relatches at 345°.

SKIP Key with Field Definition

The star wheels are down, and field definition punches are in the program card. Skipping will continue until the end of the field. Operation is the same as in D.8.1 until step 10.

1. Hold R25 through 12 star wheel contact and R25-1.
2. Drop R21 when P2 opens at 65° (8A).
3. Pick escape magnet at 180° of P1 (B+ returns) and through 12 star wheel contact, R25-1, R25-4, R24-3, MI interlock, and R22-3.
4. Prevent picking of R22 by opening R25-5 NC (5A).
5. R25 and escape magnet stay picked until end of 12 punches in program card. No further punch cycles are taken. Card escapes at 80 columns per second.

Dash-SKIP

Depressing the dash-SKIP key while in either numeric or alphabetic status causes an 11 hole to be punched in the card:

1. Depress dash-SKIP key. In numeric status, the X-skip relay (R21) is picked. Skip operation is the same as in D.8.1 and D.8.2 except that an 11 hole is punched in the first column.
2. Depress dash-SKIP key. An 11 hole is punched in the card.
3. R30-4 NC points are open, and R21 is not picked. Skipping does not occur while in alphabetic shift status.

Programmed SKIP

Assume that the star wheels are down and an 11 hole is sensed by the program mechanism:

1. Pick R25 through 11 star wheel, R39-2, AUTO SKIP-AUTO DUP switch, and R24-2. (6A).
2. Pick escape magnet through R25-4, R24-3, MI interlock, and R22-3.
3. Hold R25 and escape magnet through 12 star wheel contact, R38-1, and R25-1. Skip at 80 columns per second to end of field. If no 12 punches are present, skip only one column.

MANUAL DUPLICATION

The objective is to duplicate information from a master card into a detail card by depressing the DUP key. Two types of operations are involved:

1. Duplication is continued only as long as the DUP key is depressed.
2. Duplication is manually initiated by depressing the DUP key and continued automatically by programmed field definition.

Manual Duplication with Manual Control

Manual duplication requires two punch cycles for each column punched: first a dummy punch or sensing cycle, then a normal punch cycle. Manual duplication with star wheels raised, or with star wheels down and no field defined, occurs as follows:

1. Depress DUP key (5B). This contact stays closed as long as finger is held on key, even if keyboard is restored (key-stem contact).
2. Pick R28 and R29 through DUP key, CF1, R22-2, R27-5, R21-3, and R25-2 (6B).
3. Pick R34 through DUP key, CF1, R22-2, R27-6, R8BL, R43-1, and R29-5 (6B).
4. Hold R34 through R22-4, and R34-1 until R22 picks. After R22 picks, hold R34 through P4 and R34-1.
5. Computer entry inhibited by R34-4 (10B).
6. R28-3 picks keyboard restore (5A).
7. Pick punch clutch through R27-4, R28-4 (5A). Note that escape magnet is not picked.
8. Drop punch clutch when P1 opens at 0°.
9. Pick R27H through P3 (at 10°), R28-5 (7A).
10. Hold R27P through R27-1 (6B).
11. Pick R41, 42, and 43 through P5 and R27-2 at 86° (3B).
12. Interposer magnets energized through pin sense contacts when P6 makes at 120°.
13. Interposers drop but do not latch under punch bail. Punch bail is in its downward travel. Interposer bail contacts make.
14. Ground grid of tube 3 through interposer bail contacts, R25-4, R24-3, MI interlock, and R22-3.
15. Escape magnet picks at 180° when P1 makes.
16. Card starts to move at 219°.
17. Escape armature contact closes to pick R22 through R25-5. R34 now held through P4.
18. R22-3 drops escape magnet.
19. R22-4 picks punch clutch.
20. Punch shaft would normally latch at 345° but, since the punch clutch is picked, it now starts a second cycle. Interposers dropped during the first cycle will latch under the punch bail.

21. P4 opens at 355° to drop R34.
22. R34-2 opens, dropping R27, 28, and 29.
23. P2 opens at 65° to drop R22.
24. Interposer bail contacts are now open so escape magnet does not pick when R22-3 closes. No escapement on this punch cycle.
25. If duplicating only one column, the DUP key contact will be open at this time so R27, 28, 29, or 34 will not repick. If DUP key is held, R28 and 29 will repick. R34 does not repick because R43 will pick before R29. R43-1 opens before R29-5 closes (5B). R27 will not pick until P3 closes at 10° of the next punch cycle. R27-2 (3B) open will prevent the picking of any interposers on this punch cycle.
26. Punches driven through card by 126°.
27. The punch clutch relatches at 345° since the punch clutch magnet was dropped when P1 opened at 0°. If the DUP key had been held down, the punch clutch would have been repicked at 180° and the dummy punch cycle for the second column would start.
28. Picking of R34 is necessary only for manual duplication with star wheels down, no field defined, and 2 punches in program card. Under the above conditions, R34 will be picked during dummy punch cycles to inhibit sending information to the computer twice per column.

Manual Duplication with Field Definition

Manual duplication with the star wheels lowered and a field defined on the program card is similar to auto-duplication. The only difference is that in manual duplication R34 is picked on the dummy punch cycle to inhibit sending information from the first column of duplication to the computer twice.

AUTO-DUPLICATION

The objective is to duplicate information from a master card into a detail card with control initiated and continued by the program sensing mechanism in conjunction with the AUTO DUP-AUTO SKIP switch.

The initiation of an automatic duplication process depends on the method of card movement into the duplication field. If the program control caused a skipping operation immediately preceding the duplication field, the first column of the field to be duplicated would not be sensed and a dummy punch cycle (sensing only) is taken to energize the necessary relays. If a normal punch cycle is taken immediately before entering the duplication field, the necessary relays will be energized by that sensing cycle and a dummy punch cycle is not required. In the following sequence, assume that a dummy punch cycle is necessary:

1. Pick R28 and 29 through 0 program contact, R39-3, AUTO SKIP AUTO DUP switch R24-4 (5B).
2. Pick keyboard restore magnet through R28-3, R25-3 (5A).
3. Pick punch clutch magnet through R27-4, R28-4 (5A).
4. Pick R27H (8A) through P3 (10°), R28-5.
5. Hold R27 through R27-1 (6B).
6. Drop punch clutch when P1 opens at 0°.
7. Pick R41, 42, and 43 (3B) when P5 makes at 86°. R27-2 is closed. Interposer relays pick.
8. Pick interposer magnets through P6 at 120°. Punch operating interposers drop but do not latch under punch bail. Interposer bail contacts close.
9. Pick escape magnet (when P1 closes at 180°) through interposer bail contacts, R25-4, R24-3, MI interlock, and R22-3 (5A). If a blank column had been sensed, the interposer bail contacts would not have been closed. If the CEP is in numeric shift, there will be no escapement; if in alphabetic shift, the escape magnet would be picked at this time through R30-1, R27-3, R25-4, R24-3, MI interlock, and R22-3 (5A).
10. Close escape armature contact at 215°.
11. Pick R22P through escape armature contact and R25-5.
12. R22-3 opens to drop escape magnet.
13. R22-4 picks punch clutch.
14. Hold R22 through P2, R22-1 until 65° of the next punch cycle.
15. Punch shaft does not latch up at 345° since the punch clutch magnet is picked.
16. Drop punch clutch magnet at 0° when P1 opens.
17. The second punch cycle punches holes in a column of the detail card and sets up interposers for punching in the next column.
18. 12 holes in the program card will hold R27P, R28, and R29 through R38-1, R28-2, R27-5, R21-3, and R25-2 (5A).
19. Auto-duplication will continue using subsequent punch cycles as sensing cycles.

ENTRY

The objective is to release cards through the punch and read stations under varying operating conditions and speeds.

Entry operations should not be confused with computer entry. The only requirement for entering information in the computer is that there be a 2 punch in the program card. The ENTRY key and the AUTO ENTRY switch on the keyboard are used to release cards through the read and punch stations at either 18 or 80 columns per second.

Entry Operation without Field Definition

Assume that there are no 12 holes in the program card and that the start wheels are down. Depress ENTRY key, or throw AUTO ENTRY switch on. Cards will be released at 18 columns per second:

1. Pick R1 through ENTRY key or AUTO ENTRY switch (8A).
2. Hold R1 through 1AL and program cam contact 2 until column 87½.
3. Pick keyboard restore magnet through R1BL (5A).
4. Pick escape magnet through R1BU, R3BL, program handle switch 1, R25-3, R25-4, R24-3, MI interlock, and R22-3.
5. Pick R22 through R25-5 and escape armature contact.
6. Drop escape magnet when R22-3 opens (6A).
7. Pick punch clutch magnet through R22-4 (5B).
8. Start punch cycle.
9. Drop punch clutch magnet when P1 opens at 0°.
10. Drop R22H when P2 opens at 65°.
11. R22-3 closes and initiates another escape-punch cycle. Card is released at 18 columns per second until end of card.
12. If AUTO FEED switch is on, a card will be fed and the release operation will continue until either the ENTRY key is released or the AUTO ENTRY switch is turned off.

Entry Operation with Field Definition

Assume that the star wheels are down and 12 holes are present in the program card. The AUTO ENTRY switch is on or the ENTRY key is depressed. The card is released at 80 columns per second:

1. Pick R1 (8A).
2. Pick keyboard restore magnet through R1BL (5A).
3. Pick skip relay R25 through 12 star wheel contact, R38-1, R28-2, and R1AU (6A).
4. Pick escape magnet through R25-4, R24-3, MI interlock, and R22-3.
5. R22 will not pick when escape armature contact closes because R25-5 (5A) is open. Escape magnet stays picked, and card is released at 80 columns per second until the end of the 12 punches in the program card.

Entry Operation with Star Wheels Raised

Assume that the AUTO ENTRY switch is on or the ENTRY key is depressed; the star wheels are raised. Under these conditions, the card is released at 80 columns per second:

1. Pick R1.
2. Pick skip relay R25 (6A) through R1BU, R3BL, program handle switch 1 (NO).
3. Pick escape magnet through R25-4, R24-3, MI interlock, and R22-3.
4. The escape interlock (R22) does not pick since R25-5 (5A) is open. Cards escape at 80 columns per second.

COMPUTER ENTRY

The objective is to enter information into the computer under CEP program control:

Standard Computer Entry Operation

To enter information into the computer, it is necessary to have the star wheels down and to have 2 punches in the program card:

1. Pick R35 and HS13 through star wheel contact 2, R5BL, and R18BL (6B).
2. R35-4 closes (10B).
3. As punch and sense cycles are taken, the interposer relays will be picked. P7 (10B) closing at 135° grounds a PG in the MI section to give an information-available pulse.

~~D.12.2~~ Computer Entry Preceded by Skipping

The maximum rate of entering information into the computer is 18 columns per second. If the CEP is in an operation where the skip relay (R25) is picked (i.e., skip, or entry operation with star wheels down and 12 punches in program card), the card will be released at 80 columns per second. This is slowed down to 18 columns per second when 2 holes are sensed as follows:

1. R25 being picked will hold the escape magnet energized.
2. Pick R35 and HS-13 (6B) through 2 holes in program card.
3. Pick R22P through R35-3, R25-6, and R13-1. This path will be closed because HS-13 is a fast pick relay. R13-1 will close approximately 8 ms before R35-3 opens.
4. R22 picking drops the escape magnet (R22-3 opens) and initiates a punch cycle (R22-4 closes).
5. The escape interlock (R22) will be picked on future cycles (as long as 2 punches are present in the program card to hold R35 and HS-13) through R35-2 when the escape armature contact closes.

D.~~13~~ ERROR

The ERROR key is used if the operator makes an error while punching a manual field and the information being punched was to be entered into the computer from the read station. Depressing the ERROR key will release the card as in entry operation, inhibit the sending of the information on the error card to the computer, and inhibit the stepping of the card count:

1. Depress ERROR key.
2. Pick R1 through ERROR key and diode (7B). Card will be released. Computer entry and duplication of the preceding card remain under control of the program drum.
3. Pick R6 through ERROR key. Hold R6 through CF2 and R6AU (8B).
4. Pick CF clutch at column 87½, through program cam contact 2 and AUTO FEED switch.
5. R6BL (8B) prevents picking of card count.
6. Error card registered at read station.
7. Pick R7P at 60° through CF-3 and R6AL (8B).
8. Hold R7 through R7AU and program cam contact 2. This will hold R7 until column 87½ of the error card.
9. Prevent entry of information to the computer (R7BL open) (10B).

PRINT SUPPRESSION

Printing is set up as a punch or punches are mechanically driven through the card. Normally, the actual printing occurs a short time later in the punch cycle. When the print suppression magnet is energized, the action of the print drive rod is inhibited and printing is thereby suppressed. The print suppression magnet can be energized through three circuits.

1. PRINT switch off (5B).
2. 3 or 9 punches in program card through tube 9 (5B).
3. 12's in program card will pick the print suppression magnet through R25-1, R21-5, and R31-1. This prevents printing 0's to the left of a significant digit in a field. The first significant digit in a field will pick R31 when the interposer is picked (4A). R31-1 (5B), opening, drops the print suppression magnet.

XII TYPE 718 LINE PRINTER

A. General -- The 718 printer is used to make permanent visual records of data from the Central Computer, primarily for test and maintenance. By selecting proper programs, the operator can use the recorded data to:

1. Check programs

   a. Program listings
   b. Memory printouts

2. Check a problem at various points during its computation.
3. Print out the results of marginal check programs.

   a. Success and error indications
   b. Which line checked.

4. Prepare tables
5. Print out new programs for inspection -- memory printout.
6. Printed record for troubleshooting analysis.

The printer is also used as a source of power; it supplies power to the 723 Card Recorder and the 713 Card Reader. All ac power for the reader and recorder comes by way of the printer.

Using the 718 printer, the computer can make permanent and readable records. The printer consists basically of a mechanical printing device and drive unit and the necessary electrical circuitry to control the various functions of the printing mechanism. **Figure 3-1**

The mechanical driving force for the printing mechanism, obtained from the drive motor and controlled by the magnetic drive clutch, is distributed to the various parts of the printing mechanism by the main drive unit. The main drive system of the printer is a train of shafts and gears that deliver the power to the various sections and units of the printer.

The magnetic clutch is the link between the drive motor and the main drive. The drive motor runs continuously as long as power is supplied to the printer. The main drive is driven by the motor only when the clutch is energized. The clutch is energized as a result of the computer's executing a Write instruction when the printer is under computer control, or as a result of the PRINT push-button's being depressed when the printer is in the test mode. As a result of energizing the clutch, the printing mechanism prints whatever data is sent to the printer.

The overall operation of the printing mechanism (fig. 3-1) covers the operation of the analyzer unit, print magnets, and the print mechanism represented by three blocks on the diagram. Since the operation of one is dependent upon the operation of the others, the three must be considered together.

The printing action of this machine is performed in cycles (print cycles). One print cycle results from the execution of one Write 30 instruction by the computer. One print cycle causes one revolution of the dynamic timer index, which is divided into 360 degrees. All timings for this machine are in degrees corresponding to the timer index.

The early part of the print cycle is used to position the typewheels for the characters to be printed, and the later part is used for the actual printing; i. e., the typewheels are driven to the platen by the print cams.

Data to be printed is in the form of pulses which cause the print magnets to be energized at some time during the print cycle. The time at which a print magnet is pulsed determines which character on the typewheel is printed. For example, a print magnet receiving a 4 pulse and an 11 pulse causes the letter M to be printed.

The analyzer unit is a mechanical time delay and decoder between the print magnets and the print mechanism. A time delay is necessary to permit the extra pulse to be received when special characters are being printed which require three pulses (8 and 3 pulses or 8 and 4 pulses in combination with a zone pulse). Consequently, time must be allowed before the typewheels are set up.

The printer has two modes of operation: normal and test. The operator determines the mode of the printer by use of the TEST switch. When the TEST switch is placed in the NORMAL position, the printer can be placed under computer control by depressing the START pushbutton. When the printer is under computer control, it waits for the computer to select it and to execute a Write instruction. Upon the execution of a Write instruction, the computer sends the printer a write pulse that causes the drive clutch to be energized and, therefore, the printer to begin a print cycle. The isolation relays are energized at this time, connecting the printer to the data lines from the Central Computer. At 12 different times during the first part of the print cycle, the printer sends the computer breakout requests. At these times, the computer sends print impulses to the printer from the card image in core memory. The impulses are available at the 64 control panel calculator exit hubs. The manner in which the control panel is wired determines which of the 120 printing positions are printed. The print impulses energize the print magnets at specific times that determine what characters on the typewheels are to be printed. As long as the computer executes Write instructions, the printer continues to print out the data contained in the card image. The number of Write instructions of course, depends upon the program. When the I/O word counter goes to zero, which means that the computer is finished writing, a gate is conditioned so that the disconnect pulse, which is produced every print cycle by the printer, is allowed to pass and to cause the printer to be disconnected from the computer. The printer remains under computer control, but must be selected again by the computer before it can be instructed to write.

In the test mode, the printer is isolated from the computer through the use of relay circuitry; only the PRINT pushbutton is operative. The printer is caused to operate by the PRINT pushbutton's being depressed and held down as long as printing is desired. The only source of print impulses under test conditions is the character emitter. The outputs of the character emitter are wired to the control panel. Using the control panel, the operator can connect any of the character emitter outputs to any or all of the 120 printing positions. Any position not wired to print will be inactive because of the action of the print control contacts.

B. Operating principles

1. The speed of the printer is 150 lines per minute. There are 24 cycle points per print cycle with 16.7 msec per cycle point. 400 msec per cycle
2. The capacity of the printer is 120 characters per line (120 type wheels).

   a. 48 characters on each type wheel

      1) 26 alphabetic
      2) 10 numeric
      3) 12 special characters -- one of the asterisks cannot be printed.

   b. The computer can set up only 64 characters per print cycle.

3. The Control Panel controls operation of printer. Print positions, spacing, selection can be controlled by wiring in the control panel. This allows for greater flexibility.
4. Hollerith Code -- Review

   a. Card image in memory.
   b. Establish a card image to print out one line of information.

Ref: Programming Card and Section XX of Instruction Analysis lesson plan.

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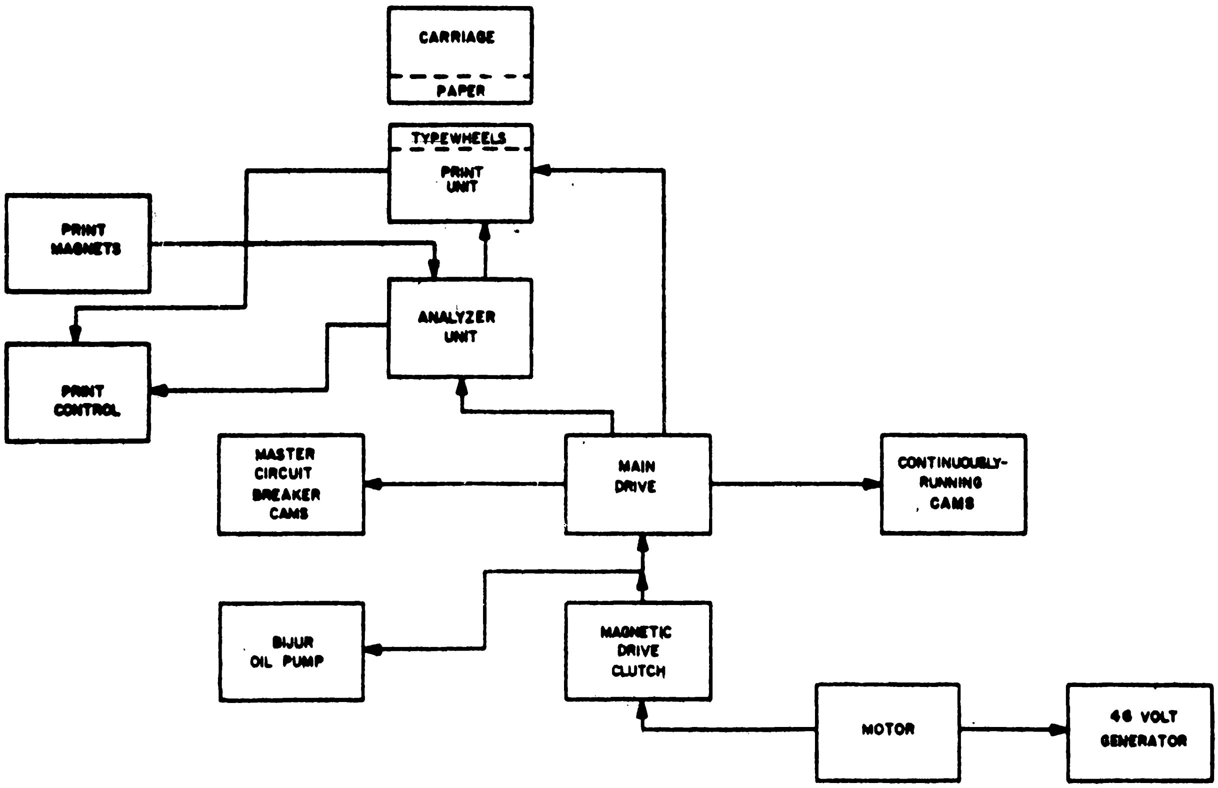

Figure 3–1. 718 Printer Mechanical Drive, Block Diagram

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5. General -- The printer, in order to print one line (64 characters when computer controlled) of information, will take 3 print cycles. They are called: set up, print, and idle. For two lines, it would be set up, print, print, idle. The printer will take one print cycle for each line to be printed.

C. Indicator Lights — Figure 22

1. Power On -- Indicates that 46V and 72VDC power supplies are supplying power to printer and other card machines, Main Line switch "ON".
2. Form -- Indicates that form in carriage has nearly come to an end, and cause "Not Ready" light to light if "Form Stop" switch is on.
3. Not Ready -- Indicates the printer is not under computer control for one or more of the following reasons:

    a. No paper (form stop)
    b. Power off
    c. Fuse blown
    d. Control panel not in place or "PR ON" hubs not wired.
    e. Stop key depressed
    f. Carriage stop key depressed
    g. Test switch on
    h. Start button not depressed

4. Fuse -- Indicates that signal fuse in printer circuits has burned out.
5. Write -- Indicates that printer has been instructed to write.

ready condit		ready condit		ready condit		Ready condit	Ready condit
* START	* STOP	* PRINT	when WRT instr receives from Comp to printer WRITE	out of paper or a jam FORM	NOT READY	FUSE	POWER ON

* Pushbutton

Figure 22, Operating Controls and Indicator Lights

make sure printer panel ~~is~~ in

D. Operating Controls

Pushbuttons

1. Start -- Puts printer under computer control if all ready conditions are met. Ready I/O Units or "Master Reset" PBs on the maintenance console do the same thing.
2. Stop -- Releases printer from computer control and causes "Not Ready" lamp to go on.
3. Print -- Causes continuous print cycles when not under computer control; when printer is under computer control and "Stop Before Print" switch is on, the print PB will allow <u>one</u> print cycle.

Switches

1. Main Line -- Switch connects 208 VAC, 3 phase to the printer. Dropped to 115 VAC
2. Test -- Switch places printer in test status for manual control. Effectively releases printer from computer control.
3. Stop Before Print -- Switch causes computer to hold up printing until operator hits "Print PB".
4. Form Stop -- Switch causes the printer to stop before carriage runs out of paper.
5. Alteration -- Switches pick relays through the control panel to change printing format. There are 4 switches. to expand plugboard possibilities
6. Drive Clutch -- Switch permits machine to take full print cycle or partial machine cycle under control of "Auxiliary Start" jack. Used in "test".
7. Auxiliary Start -- Jack serves to plug an extension starter switch, used for convenience during maintenance.

ALTER 1	ALTER 2	ALTER 3	ALTER 4	STOP BEFORE PRINTING	TEST	FORM STOP

Figure 23 Switches

E. Carriage Controls

1. Platen Clutch ---Controls the platen drive MUST BE ON by engaging or disengaging the platen clutch.
2. Restore -- Causes the carriage to be restored to start, or home, position (hole in channel 1 of control tape).
3. Stop -- Will stop the carriage instantly, halts printer at end of print cycle, and removes printer from computer control.
4. Space -- Advances carriage one space each time PB is depressed.
5. Platen Knob -- is used to position paper when platen clutch is disengaged.
6. Vernier Knob -- Used to move form paper up or down to obtain exact printing registration with platen clutch engaged.
7. Form thickness -- Adjust varies distance between typewheels and platen.
8. Pressure Release -- releases the paper.
9. Platen Shift -- Shifts the platen laterally.
10. Shift Lock -- locks the platen shift.

F. Carriage Control Tape

Figure 6-3

1. General -- The control tape has 12 channels in which control punches may be placed (fig. 6-3). A maximum of 22 inches (132 lines) can be used for the control of a form, although for convenience the tape blanks are slightly longer. Horizontal lines on the tape are spaced six to an inch for the entire length of the tape. Round holes in the center of the tape are prepunched for the pinfeed drive in the tape-sensing mechanism. The tape advances through the sensing mechanism. The tape advances through the sensing mechanism, in synchronism with the movement of the printed form through the carriage.

   Thirteen brushes, one for each channel, plus a common brush, are positioned over the tape to sense the holes that may have been punched

   13th doesn't touch control carriage
   It is a ground shot

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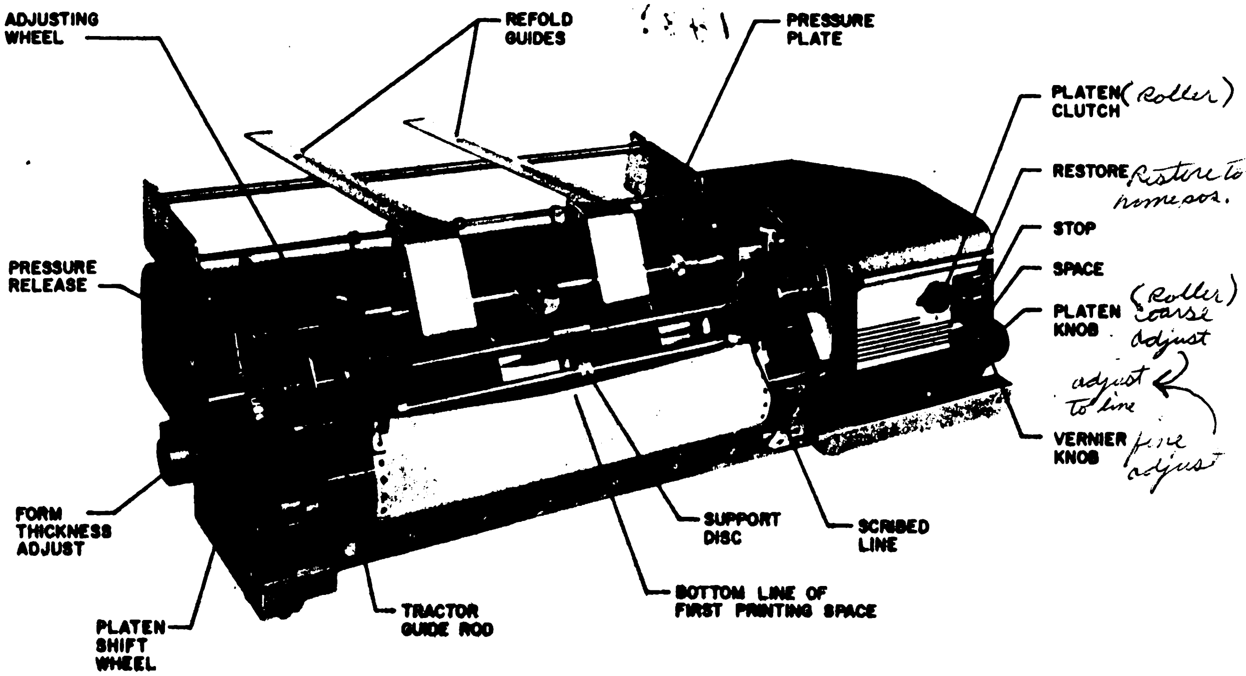

Figure 6—2. Carriage Controls

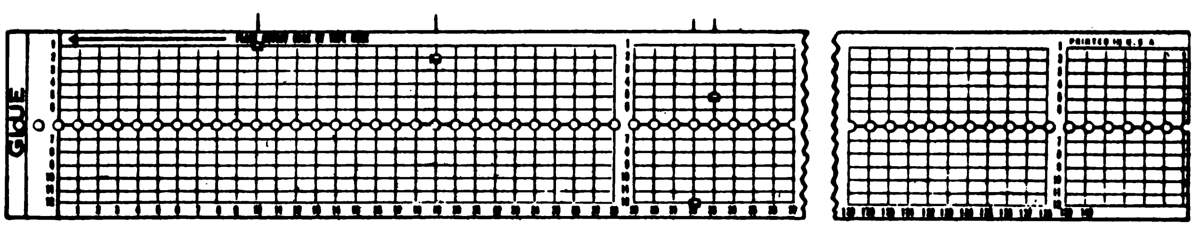

Figure 6—3. Carriage Control Tape

in the various channels. As viewed from the front of the machine, the channels and brushes are numbered 1 through 12 from left to right, excluding the common. Brush 1 rests on channel 1, brush 2 on channel 2, and so on. A hole in a channel of the tape allows the associated brush to make contact with the metal contact roll and to set up the necessary circuits that are normally used to stop skipping or to initiate an overflow.

2. Tape Channels -- Tape channels are punched to control the following functions:

   a. First printing line stop. Channel 1 is normally punched for the first printing line of a form. This is called the starting or home position.
   b. Normal skip stops. Channels 2 through 10 are used to stop a form at one of nine positions including the first body line. They may be used in any order or sequence desired. Skipping is initiated by wiring the carriage skip hubs on the control panel in the desired manner.
   c. Overflow control. The 12th channel of the tape must be punched in a position corresponding to the last printing line of a form. The overflow hubs on the control panel emit a pulse when this punch is read and are generally wired to carriage-skip-one hubs to initiate the overflow.
   d. Selective space. All line spacing may be controlled by the SEL hubs on the control panel and a hole in channel 11 of the tape. Control panel wiring will initiate spacing; sensing a hole in channel 11 will stop the operation.

G. Printer Control Panel Figure 24, Page 1570

1. General -- The control panel is a patch panel by which the operator can control the various

functions of the printer. Carriage functions such as skipping, spacing, and overflowing are controlled by the control panel in conjunction with the carriage control tape.

Figure 24 shows the control panel with the layout of the outlets or hubs. To facilitate the finding of the various hub locations, numbers 1 through 44 appear across the top of the plug board, and letters A through HH appear from top to bottom through the center of the plug board. A coordinate system employing the above numbers and letters identifies the hub groups.

2. Carriage Skips Hubs 1-10 (Location 1-10, F)

   a. 10 hubs
   b. When impulses, carriage starts to skip.
   c. Carriage will stop when hole is sensed in that channel on control tape.
   d. Normally wired to operate exits.

NOTE: Skips 1 is normally wired, for carriage overflow, to overflow hubs.

   e. When one of the carriage skips hubs 1-10 receives an impulse, the carriage starts skipping, stopping only when the next hole in that channel is read by the control tape read brushes. These hubs are usually wired from the operate exits hubs, and carriage skips 1 is normally wired for carriage overflow to the overflow hubs. To be effective, an impulse to the carriage skips hubs must occur between 230 and 315 degrees of a print cycle.

3. Short Skip Hubs 1-4 (Location 23-24, A-D)

   a. Hubs 1-4 provide for skipping with no interruption of printing.
   b. Used only for a skip of less than two inches.

7. The short skip hubs 1-4 provide for skipping with no interruption of printing. A short skip hub can be used whenever a skip is less than 2 inches or when an overflow occurs that is less than 1 inch. All spacing and sheet overflow is done at low speed, while all skipping operations are done at high speed. An [illegible] exits impulse used to cause a skip of less than 2 inches should be wired from a short skip hub to a carriage skips hub. An impulse to a short skip hub releases the interlock, which normally causes the printer to lose at least one machine cycle for each skipping operation.

8. [illegible] 1 Hubs (Location 19, DE) -- Wiring the 1 hubs together results in one space of [illegible] before printing takes place.

9. [illegible] 2 Hubs (Location 20, DE) -- Wiring the 2 hubs together results in two spaces of [illegible] before printing takes place.

10. [illegible] 1 and 2 (Space Select) Hubs (Location 18, [illegible]

a. [illegible] selective spacing of less than 7 [illegible] controlled by channel 11 of control [illegible].

b. When the two selective space hubs are wired together, they allow spacing of less than seven lines to be selectively controlled by punches in channel 11 of the control tape. The action is such that, [illegible] each line of printing spacing is [illegible] started, a punch in channel 11 [illegible] the spacing. For spacing of less than three lines, it is necessary only to connect the selective space hubs and to punch the desired positions in the tape. For spacing of more than three but less than seven lines, it is necessary to impulse the space-suppress and extra space hubs from print cycles. [illegible] suppress and extra space hubs [illegible] impulsed on a selective space [illegible] lines so that the spacing will [illegible] printing, thus allowing the [illegible] time for spacing.

7. Extra Space Hubs (Location 16-17, D)

a. Used in conjunction with space 1 or 2 holes.
b. Causes spaces after printing.
c. Extra space hubs are used in [illegible] with space 1 or space 2 hubs. [illegible] 1 is wired and an extra space hub is impulsed, an extra space results. [illegible] space 2 wired, an extra double [illegible] results. Triple spacing can be [illegible] by wiring the common space hub [illegible] of a coselector, space 1 to the [illegible] and space 2 to the N hub, picking the [illegible] by a split column control 6 hub, and impulsing the space-suppress and extra space hubs from print cycles. Wiring an extra space hub causes spacing after printing.

8. SUP (Space-Suppress) Hubs (Location 16-17, E)

a. Suppress all normal spacing during cycle it is impulsed.
b. Normally wired if extra space hubs to suppress spacing before printing.
c. If one of the space-suppress hubs is impulsed, all normal spacing is [illegible] during the cycle in which the [illegible] impulsed. If space-supp[illegible] space hubs are impulsed, [illegible] spaces after printing. An [illegible] to these space-suppress hubs [illegible] 320 and 140 degrees will [illegible] before printing.

9. NP (Nonprint) Hub (Location 21-22, G)

   a. If impulsed at start of cycle (before 110 degrees), it suppresses printing and spacing before printing.
   b. Normally wired to operate exit.

10. Print Cycles Hubs (Location 11-20, C)

   a. Emit a continuous pulse for most of every print cycle (355° to 285°)
   b. May be used in spacing
   c. May be used to pick selector relays.

11. OVFL (Overflow) Hub (Location 21-22, E; 22, F) -- The overflow hub emits a pulse whenever a punch in channel 12 of the control tape passes the control-tape reading brushes. The OVFL hub is usually wired to a CARRIAGE SKIPS 1 hub, providing a skip from the last line printed on the page to the first line of the next page.

12. Sense Entry Hubs 1 and 2 (Location 11-15, D) -- The sense entry hubs supply an indication to the computer that the printer has finished or started a certain operation, depending upon which impulse is wired to the sense entry hubs. These hubs can be wired to be impulsed by machine impulses depending on the requirements of the computer program. A BSN 31 or BSN 32 instruction, when executed by the computer, senses these hubs and, if the hubs are being impulsed at this time, the computer branches to the address specified by the BSN instruction.

13. Split Column Control Hubs (Location 11-21, F) -- Split column control hubs emit impulses between normal digit impulses. A coselector pickup wired from hub 8 of this group causes the selector to be transferred between the corresponding print times. The selector should be transferred after 8 time and before 7 time.

14. PR On (Print-On) Hubs (Location 22, A, B)

    a. These print-on hubs must be connected if the printer is to be used as an I/O device with the computer.
    b. Used to pick an interlock relay -- this relay must be picked or printer cannot be made ready.

15. Pilot Selector Pickups Hubs 1-10 (Location 1-10, D) -- The pilot selector pickups hubs will accept impulses to transfer the corresponding pilot selector, location 1-10 (G to L). A pilot selector is a relay equipped with two transfer points which are directly connected to the hubs in the panel, thus acting as an automatic switch. When a pilot selector is in the normal, de-energized state, a circuit can be completed through the C and the N hubs. In the energized state, a circuit can be completed through the C and the T hubs. Each selector has a coupling exit (16) which emits an impulse when the selector is energized. A common application for a pilot selector is to impulse the pilot selector pickups hubs from the operate exits hubs to transfer information through the selector points.

    This impulsing causes the selector to be transferred from 315 degrees of the print cycle impulsed to 286 degrees of the following print cycle. A pilot selector picked up from the digit would not transfer until the second print cycle.

16. Pilot SEL (Selector) Coupling Exits Hubs 1-10 (Location 1-10, C) -- Each of the coupling exit hubs 1-10 emits an impulse during 330 to 195 degrees of each cycle that the pilot selector is energized. Coupling exit hubs are normally wired to coselector pickup hubs for the purpose of expanding the pilot selector beyond two positions.

17. Pilot Selector Hubs

    a. Picked at pick up hub.
    b. Once picked, the contacts are not transferred until end of that print cycle. Once transferred, remain so until end of next cycle.
    c. Coupling exit - a pulse is made available here when contacts transfer.

NOTE: This pulse normally used to pick coselectors or other pilot selectors.

    d. 10 relays used.
    e. 2 sets of points per relay available at plugboard.
    f. Common use is to pick from operate exits.

18. Coselector Pickup Hubs (Location 1-21, A-B; 1-13, M-N) -- Coselector pickup hubs accept any impulse and cause the coselector relay to be energized immediately. The relay will be held and transferred to the remainder of a print cycle, provided that it is impulsed sometime after 350 degrees. A coselector pickup hub wired to split column control 6 would be transferred by 5 print time. Therefore, printing impulses 9 to 6 could be printed through the C and T hubs. Operate exit hubs should not be used to pick coselectors for transferring printing impulses.

19. Coselector Hubs

    a. Picked at pick up hub.
    b. Once picked, will be held for most of the rest of the print cycle.
    c. 32 relays used.
    d. 5 sets of points per relay available at plug board.
    e. Generally used to transfer inputs to print entry hubs.
    f. Normally picked by alteration hubs.

20. Operate Exits Hubs 1-10 (Location 1-10, E) -- There are 10 operate exits which emit impulses on Operate (PER) 51-62$_{(8)}$ instructions. The operate exits are conditioned so that pulses can be emitted from these hubs at the end (240 and 350 degrees) of a print cycle. The operate exits impulse is available only for 340 degrees of a cycle during which a carriage skip operation is started. Extra-space, space-suppress, and non-print operations may be controlled directly from operate exits hubs.

21. CALC (Calculate) Exit Hubs: Odd Words and Even Words (Location 25-40, A-D)

    a. Transfers words from computer to printer.
    b. May be wired directly to print entry hubs or through selector relays so some form of alteration may be used.
    c. Calculate exit hubs are exits for words sent from core memory to the printer. There are 64 hubs; they may be wired directly to any print entry hubs, or they may be routed through coselectors to print entry so that some form of alternate format can be used.

22. Print Entry Hubs (Location 25-44, K-V) -- The entry hubs are for impulses to the individual printing positions. There are 120 printing positions and 120 hubs. Any hub that is wired from a calculator exit or from the character emitter will print. Therefore, any combination of print positions can be wired to print, such as every other one; hubs from the middle section; right or left end, or whatever the operator desires.

23. Filter Hubs: In, Out (Location 21-22, O-HH) -- The filter hubs are used to provide a one-way circuit to prevent back circuits under certain wiring conditions. The pulses may enter the

filters from either the entry (in) or exit (out) hubs, depending upon the polarity of the source in question. The character emitters and calculate exit pulses all must enter the entry (in) hub in order to complete the circuit through the filter, while all other inputs should enter the exit (out) side in order to complete the circuit through the filters. The filter circuits consist of selenium rectifiers with the anode terminal connected to the in hub and the cathode terminal connected to the out hub.

24. Exit Group Hubs:.(Period), $ (Dollar Sign), and , (Comma) (Location 21-22, H-J)

    a. The exit group hubs emit proper impulses to print periods, dollar signs, and commas.
    b. Not normally used.

25. Alter (Alteration) Hubs 1-4 (Location 21-22 C-D)

    a. 4 Used
    b. When the associated Alteration Switch is on, an impulse is made available at the beginning of each print cycle.
    c. Generally used to pick co-selectors and pilot selectors.
    d. The alteration hubs emit an impulse in every machine cycle, provided the corresponding ALTERATION Switch is in the ON position. The purpose of these hubs, which are normally wired to co-selector pickup hubs, is to change the control panel setup without actually changing the wiring. The coselectors, in turn, are used to change the functions performed. The type of reports may then be changed by operating the ALTERATION toggle switches.

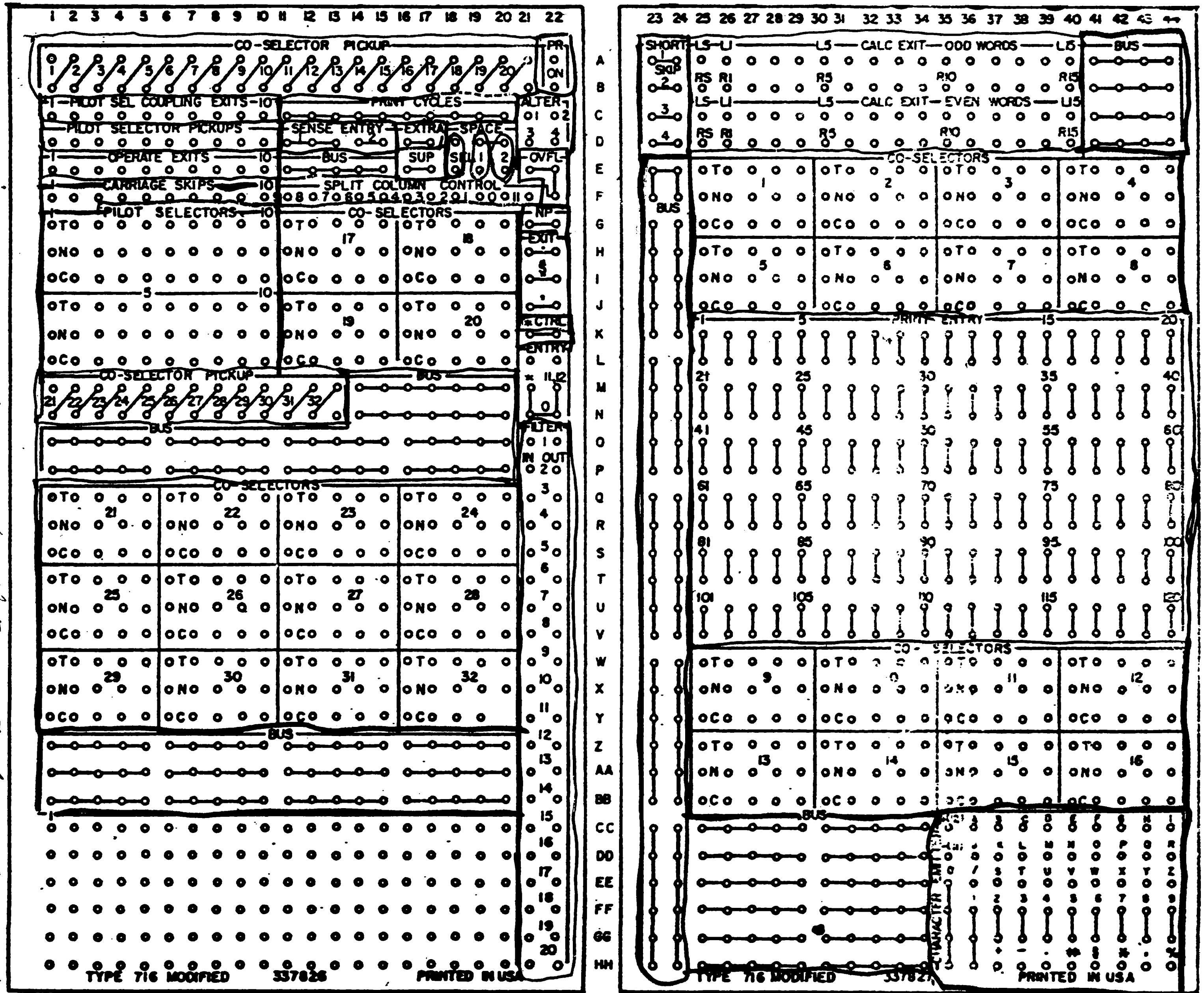

Figure 24, Printer Control Panel

I WHOLE PANEL

Black lines between hubs are wires that connect these points in the printer itself

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26. *CTRL (Asterisk Control) and Entry Group Hubs (Location 21-22, K-N) -- The asterisk control, and the *, 11-12, and 0 entries should not be used.

27. Bus Hubs -- The bus hubs are 50 separate common hub groups, at various locations on the control panel. The hubs are tied together as the lines on the control panel indicate. Any hub on the board can be expanded through the use of these hubs. This facility is especially useful when making up boards that involve a considerable amount of wiring.

28. Character Emitter Hubs

    a. Emit pulses at correct time for printing constant information.
    b. Used in non-computer testing of printer.

H. Control Panel Wiring -- There are two kinds of hubs on the control panel, exits and entries. An exit is one which usually emits an impulse but may at times accept an impulse. Some exits are under the control of the computer; others emit pulses as a result of some function previously performed, or are automatic for every print cycle. An entry hub is one which can accept or emit an impulse when properly wired. A connection in most cases will be made from an exit to an entry by placing one end of a wire in the exit hub and the other end in the entry hub. Which exits and entries are used will depend entirely upon the operation the machine is called upon to perform.

Figure 6-9, Page 1610

Whenever two or more hubs are connected by lines scribed on the surface of the control panel (figure 6-9) these hubs are common; that is, two or more exits or entries serve the same purpose. Such an arrangement eliminates the need for split wires (wires with more than two ends) because these hubs are actually connected and serve the same purpose as split wires.

In figure 6-9, isolated examples of connections used in control panel wiring are shown. If the function of the control panel hubs is considered, the purpose of hub interconnection becomes more apparent. Wires 1 through 11 for each of the connections in figure 6-9 are identified and their purpose explained below.

a. Wire 1. The information contained in the even words from memory bits R1 through R8 is applied to print entry hubs 2 through 9, via the normally closed contacts of coselectors 1 and 2.

b. Wire 2. A PER 51 instruction causes an impulse from operate exits 1 to energize pilot selectors 1. Pilot selectors coupling exits 1 then energizes coselectors 1 and 2. With coselectors 1 and 2 energized, the letters A, B, C, D, and E from the character emitter print in print positions 5 to 9 through the transferred points of the coselectors, and words from R1 to R8 of the calculator exit hubs are not printed.

c. Wire 3. This wiring permits only numerical information to be printed in print position 1.

d. Wire 4. This wiring causes the carriage to skip to the punch in channel 2 of the carriage tape when a PER 52 is read from the program. The printing is normally interrupted to allow time for the skip.

e. Wire 5. When skipping is wired, this wire is added to prevent interruption of printing during the skip. This wiring can be used only when the skip is 2 inches or less.

f. Wire 6. This wiring causes the paper to overflow to the next form when the punch in channel 12 of the carriage tape is reached. The overflow is stopped by the first punch in channel 1 of the carriage tape. It is normally used to allow margins at the beginning and at the end of the forms. Depressing the RESTORE button on the carriage also stops the paper at the first punch in channel 1 of the carriage tape.

g. Wire 7. This wiring causes no printing or spacing to be done in the print cycle in which a PER 54 instruction was given.

h. Wire 8. This wiring causes coselector 18 to be energized when ALTERATION switch 1 is on. This connects the space hub to the 2 hub through the transferred points of the coselector, causing the printer to double space. When ALTERATION switch 1 is off, the space hub is connected to the 1 hub, causing the printer to single-space.

i. Wire 9. With ALTERATION switch 2 in the ON position, coselectors 18 and 19 are energized, causing a double space through coselector 18 and an extra double space through coselector 19. The wiring to energize the coselector must be connected through filters to prevent back circuits so that ALTERATION switch 2 will energize both coselectors 18 and 19 while ALTERATION switch 1 will energize only coselector 18.

j. Wire 10. A PER 57 instruction causes all normal spacing to be suppressed; however, if extra space is impulsed, the carriage spaces after printing, even though space suppress is impulsed.

k. Wire 11. This wiring is followed to inform the stored program of a form overflow. The BSN 31 instruction is given some time within the portion of the print cycle in which the overflow hub is emitting a signal. If during the execution of this sense instruction the sense entry hub is being impulsed, the stored program branches control. For example, if page numbers were printed at the top of the page, the program would branch to print the page number after an overflow.

1610

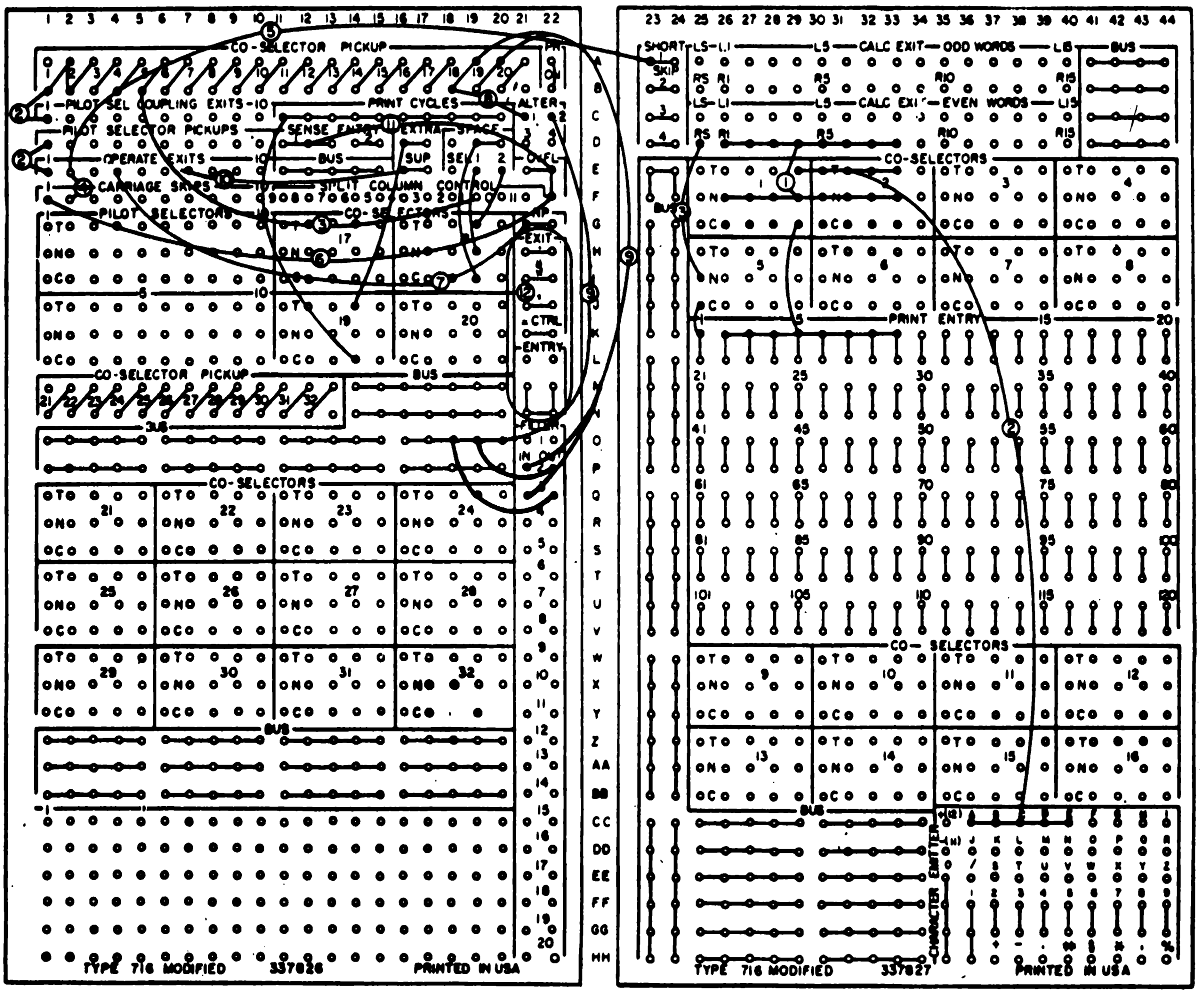


Figure 6–9. Control Panel, Typical Wiring Connections

I. Demonstration -- It may be desirable at this time to look at and operate the 718 Line Printer. Notice the following:

1. Switches
2. Power Supplies
3. Fuses
4. Carriage operation
5. Control panel

Operation: Become familiar with the physical operation of the printer. Wiring problems:

1. Simple board wiring -- Wire boards to print Team #, Class #, Dept. # in type wheels 1-35.

2. Using pilot and coselectors

   a. Wire board as above, except be able to delete any portion by using the alteration switches.
   b. Wire to print the names of three members of the group on consecutive print cycles, and keep repeating the sequence.

J. Programming

Refer to Instruction Analysis lesson plan Section XXI.

1. A typical program is:

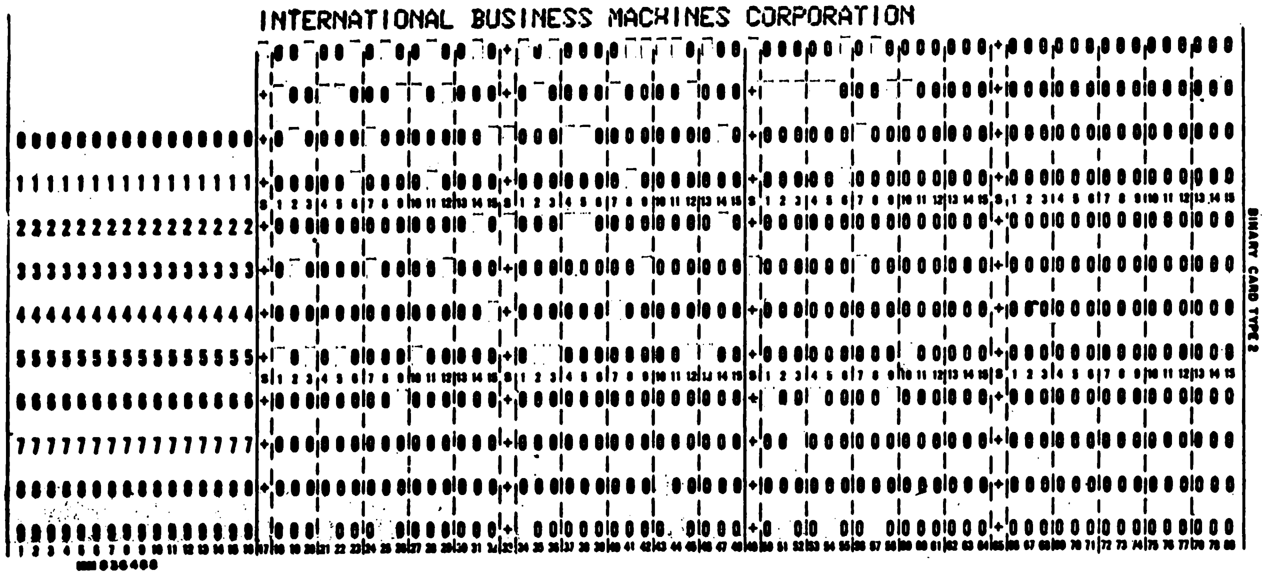
0.00100	SEL(03)		Select Printer
0.00101	LDC	0.01000	First location
0.00102	BSN (11)	0.00102	Check I/O Unit Ready
0.00103	WRT	0.00030	Write 30 words, can specify
0.00104	HLT	0.00000	any number of words.

WRITE IN MULTIPLES OF 30

2. Hollerith Code -- The Hollerith code is used for printing information with the line printer. In order to use this, a card image must be set up in Memory to supply the printer with the necessary data. If the words International Business Machines Corporation were to be printed by the Line Printer with the preceding program, the card image received would be as shown in figure 25. The memory locations would contain that shown on the same figure.

Ref: Programming Card

1630



CORE MEMORY CONTENTS

0.01000	-	1.04200	0.40020
0.01001	-	0.22200	0.00000
0.01002	-	0.00000	0.00040
0.01003	-	0.00000	0.00000
0.01004	-	0.00000	0.00000
0.01005	-	0.10000	0.00000
0.01006	-	0.00100	0.00000
0.01007	-	0.44100	0.00000
0.01010	-	0.52040	0.30014
0.01011	-	0.00040	0.00000
0.01012	-	0.00001	0.00400
0.01013	-	0.00000	0.00000
0.01014	-	0.20410	0.00100
0.01015	-	1.00400	0.00000
0.01016	-	0.00002	1.06002
0.01017	-	0.00000	0.00000
0.01020	-	0.01020	0.00200
0.01021	-	0.01000	0.00000
0.01022	-	0.20401	1.06002
0.01023	-	0.00400	0.00000
0.01024	-	0.46150	0.20410
0.01025	-	0.76140	0.00000
0.01026	-	1.11222	0.50364
0.01027	-	1.01200	0.00000

Figure 25, CARD IMAGE FOR PRINTING

3. Data Flow — Figure 16 and 16A of Section XI.

   a. Same as Card Recorder except isolation relays in printer are picked instead of in the punch.
   b. The data sent to the printer during the 30_8 break cycles is temporarily stored and interpreted in the analyzer unit.

K. Timing and Control — Figure 6-4, 18, 19 o. Section XI.

1. Timing and control for the printer is essentially the same as the punch. The differences are:

   a. Printer index pulses every 16.7 msec.
   b. Printer request disconnect every 0.4 sec.

2. Review Figure 6-4, 18, and 19 completely.

AN/FSQ - 7
1650

Summary Questions

1. List the two main uses of the 718 Line Printer. to make permanent records of ~~the~~ data in mem / show test results
2. There are 2 718 Line Printers at each sector.
3. They are Units 52 A+B.
4. The 718 Line Printer is capable of printing 150 lines/minute.
5. The 718 Line Printer is capable of printing a maximum of 120 characters/line.
6. When programmed by the computer, the 718 Line Printer can print only 64 characters/line.
7. There are 24 cycle points/print cycle.
8. Each cycle point is equivalent to 16.7 msec of time.
9. There are 120 type wheels.
10. Each type wheel contains 48 characters.
11. What is the main advantage in using a Control Panel to control Printer operation? panel, by wiring, can control spacing, print positioning, and character selection.
12. The selection code for selecting the Line Printer is what? 03
13. When programming for the Line Printer, the address portion of the WRT instruction should be in multiples of what? ~~[illegible] whole data~~ 30 to wrt. whole data
14. A card image in Core Memory will contain how many locations? 24
15. The Wheel Code contains how many special characters? 12
16. The following program is run. What would result if aFF in 5AX (0. 6. 1-10A) could not be set?

000	SEL 03	0.00000	006	BSN 14	0.00012
001	LDC	0.01000	007	SEL 02	0.00000
002	WRT	0.00030	010	LDC	0.02000
003	CAD	0.03000	011	RDS	0.00030
004	ADD	0.03001	012	CAD	0.03002
005	FST	0.03010	013	HLT	0.00000

Summary Questions

A. Computer would hang up on Step 002.
B. Computer would hang up on Step 007.
C. Program would halt with Prog. Ctr. = 14.
D. Program would not halt, but would go into a pause at Step 013.
E. Program would hang up on Step 001.

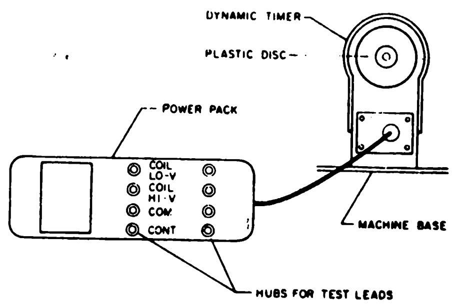
17. The following program is given:

```
SEL 03
LDC      000
WRT      030
HLT      000
```

Instead of printing out the desired information, it was punched on the Card Punch. This could be caused by:

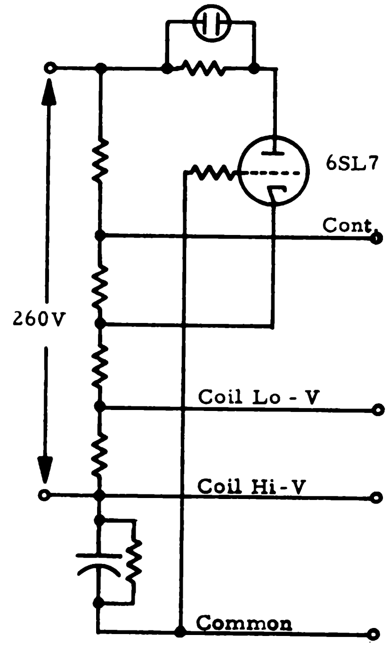
A. Punch in "Not Ready" condition.
B. P. U. 5AX, pin E5 open (0. 6. 1 - 11E)
C. P. U. 5AC, pin B8 open (0. 6. 1 - 13D)
D. P. U. 5AY, pin C1 open (0. 6. 1 - 10A)
E. P. U. 5AY, pin A5 open (0. 6. 1 - 10A)

A. Dynamic Timer



Dynamic Timer with Power Pack

Figure 15



Dynamic Timer Power Pack

Figure 16

1. Purpose (Figure 15)

a. A dynamic timer (located on the right side of the card reader) is provided to facilitate checking pulse timing and duration. The dynamic timer consists of a plastic disc (graduated in degrees) and a timer disc (mounted in back of the plastic disc). Two neon bulbs are mounted on the timer disc. The two bulbs serve as pointers as the timer disc rotates. Each bulb is supplied with a separate control circuit, making it possible dynamically to compare two separate conditions. Power for the neon bulbs in provided by the dynamic power pack.

b. Hubs on the power pack are marked COM (common), COIL LO-V, COIL HI-V, and CONT (contact). Test probes are plugged to CONT and COM, or to COIL and COM, depending upon the type of operation to be checked. The power pack is plugged into the dynamic timer base. Figure 15 illustrates the hookup of the power pack with the dynamic timer.

2. Basic Theory of Operation (Figure 16)

a. Tube is normally cutoff by the -38 volts bias.

b. Objective is to overcome this bias to light the neon.

3. Use of Common and Contact Terminals

a. Neon is lit by shorting these terminals together.

b. All voltages should be removed from the relay points when using the timer to indicate when they are closed.

c. Polarity is not considered when used in this manner.

4. Use of Coil and Common Connectors

a. Can be used to indicate the presence of voltage by having the voltage overcome the normal negative grid bias.

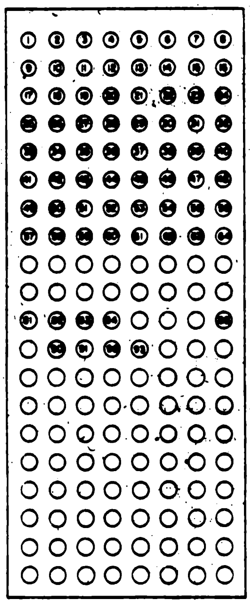
b. Can indicate the energizing of a relay.

c. The low voltage coil terminal can be used to indicate a voltage as low as five volts.

d. Polarity of connections must be considered using these terminals.

CONNECTOR CABLE PANEL
FACING FRONT OF PANEL

SP9IA



DESCRIPTION	LOC
CARD BRUSHES	4A
HOPPER CONTACT	3A
UPPER CARD LEVER	3A

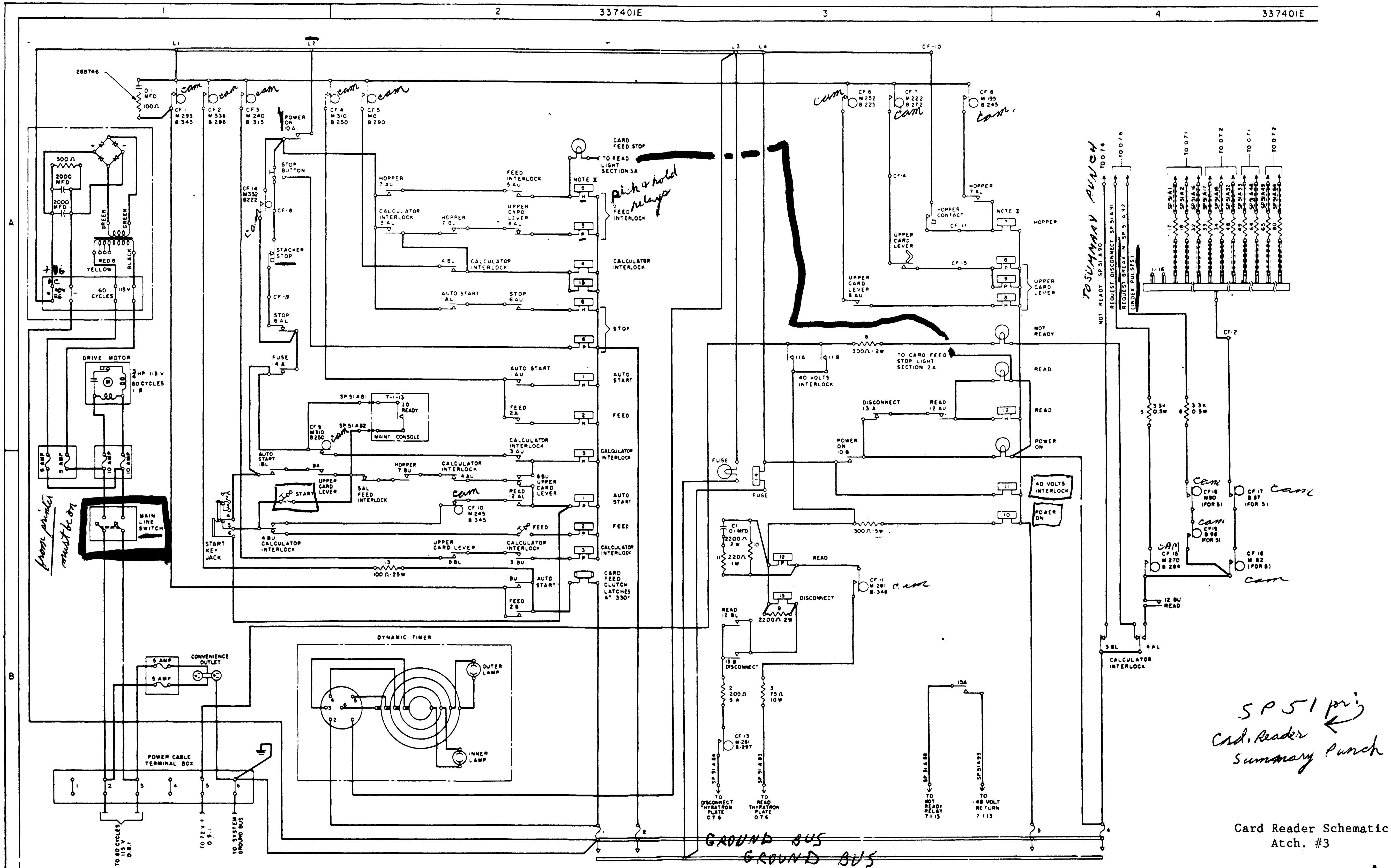
CARD FEED CAMS

CAM NO	LOC	MAKE TIME	TOL. IN DEG	BREAK TIME	TOL IN DEG	DURA-TION	CONTACT AIR-GAP	NAME	PART NUMBER
1	1A	293	±1	343	±3	50	012 - 018	CARD FEED CLUTCH MAGNET PICK	116107
2	1A	336	±3	296	±1	320	.027 - .033	CARD FEED CLUTCH MAGNET HOLD	182320
3	1A	240	±2	315	±3	75	.012 - .018	CALCULATOR INTERLOCK HOLD	123281
4	2A	310	±3	250	±1	300	027 - .033	AUTO START AND FEED HOLD	120382
5	2A	0	±3	290	±1	290	027 - .033	CALCULATOR INTERLOCK HOLD	182290
6	3A	252	±3	225	±1	333	.027 - .033	CARD LEVER HOLD	116108
7	3A	222	±1	272	±3	50	012 - 018	CARD LEVER PICK	116107
8	3A	195	±3	245	±1	50	027 - 033	HOPPER CONTACT RELAY HOLD	116107
9	1A	310	±3	250	±2	300	027 - 033	CALCULATOR INTERLOCK PICK	120382
10	2B	246	±2	345	±3	100	012 - 018	AUTO START PICK	184378
11	3B	261	±1	346	±3	85	.012 - 018	READ THYRATRON PLATE	182085
12									
13	3B	261	±2	297	±3	36	012 - 018	DISCONNECT THYRATRON CATHODE	116106
14	1A	332	±0	222	±1	250	027 - .033	READ INTERLOCK	182280
15	4B	270	±1	284	±3	14	012 - .018	REQUEST DISCONNECT	120381
16	4B	88(FOR 51)	+1/2 - 0			SEE CHART	012 - 018	READING BRUSH MAKE	238235
17	4B			87(FOR 51)	+1/2 -0	SEE CHART	027 - .033	READING BRUSH BREAK	238235
18	4B	90(FOR 51)	±0			SEE CHART	C12 - 018	REQUEST BREAK IN	122258
19	4B			98(FOR 51)	±0	SEE CHART	027 - 033	REQUEST BREAK IN	122258

DUO RELAYS IN CARD READER

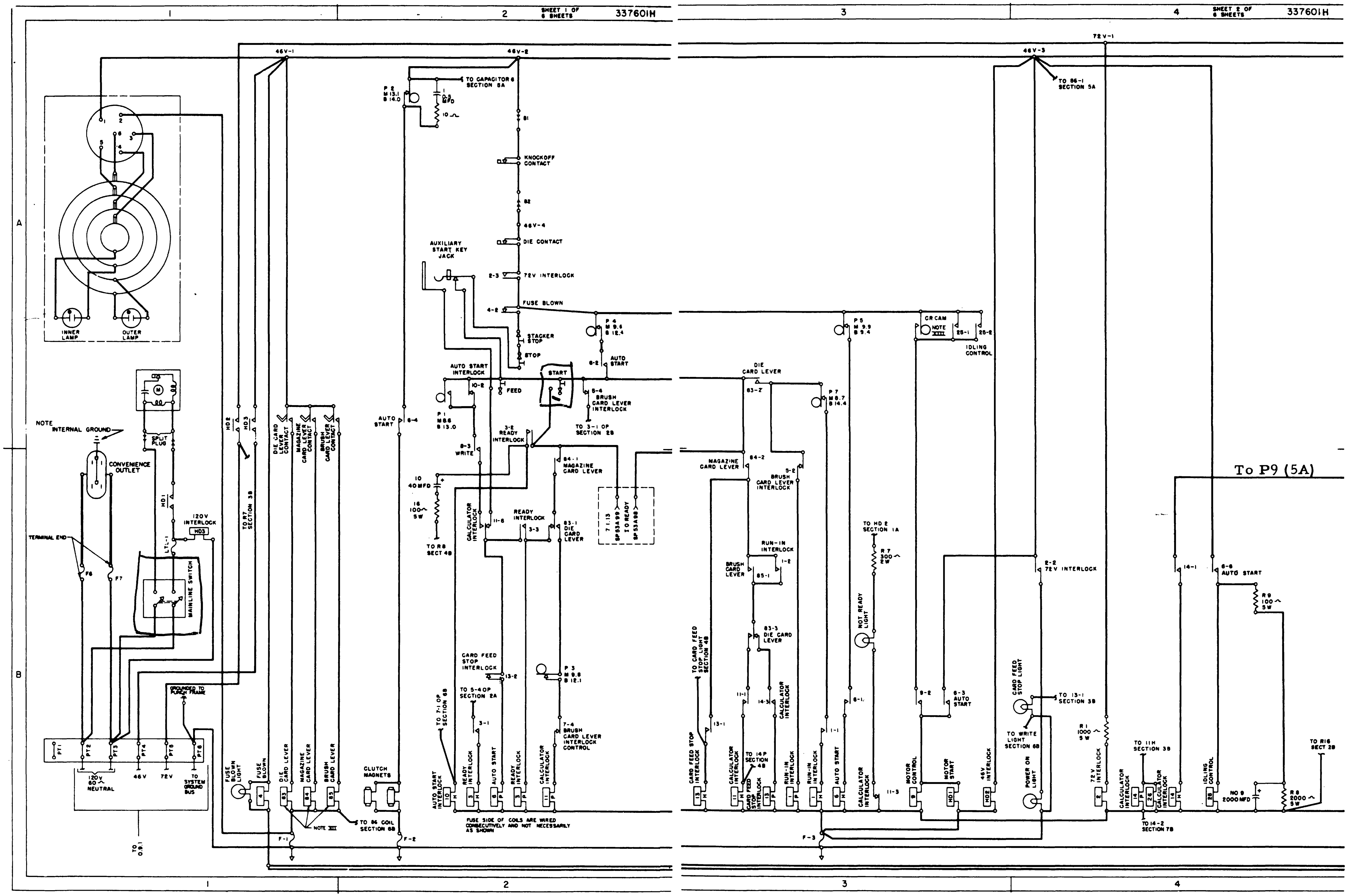
RELAY NO	COILS		CONTACT POINTS								NAME	PART NUMBER	TYPE
	P	H	A	AU	AC	AL	B	BU	BC	BL			
1	2B	2A		2A		2A		2B		1B	AUTO START	127700	D
2	2B	2A	2A				2B				FEED	121058	D
3	2B	2B		2B		2A		2B		4B	CALCULATOR INTERLOCK	127700	D
4	2A			2B		4B		1B		2A	CALCULATOR INTERLOCK	124843	S
5	2A	2A		2A		2B					FEED INTERLOCK	157747	S
6	2A	2A		2A		1A					STOP	157747	D
7	4A			2A		3A		2B		2A	HOPPER	124843	S
8	4A	4A		3A		2A		2B		2B	UPPER CARD LEVER	127700	D
9	4A		1B								UPPER CARD LEVER	111354	S
10	4B		1A				3A				POWER ON	111381	S
11	4B		3A				3A				40 VOLTS INTERLOCK	111381	S
2	3B	4A		3A		2B		4B		3B	READ	182693	D
13	3B		3A				3B				DISCONNECT	111381	S
14	3B		1A								FUSE	111381	S
15	2A		3B								CALCULATOR INTERLOCK	111381	S

Card Reader Cams
Atch. #2



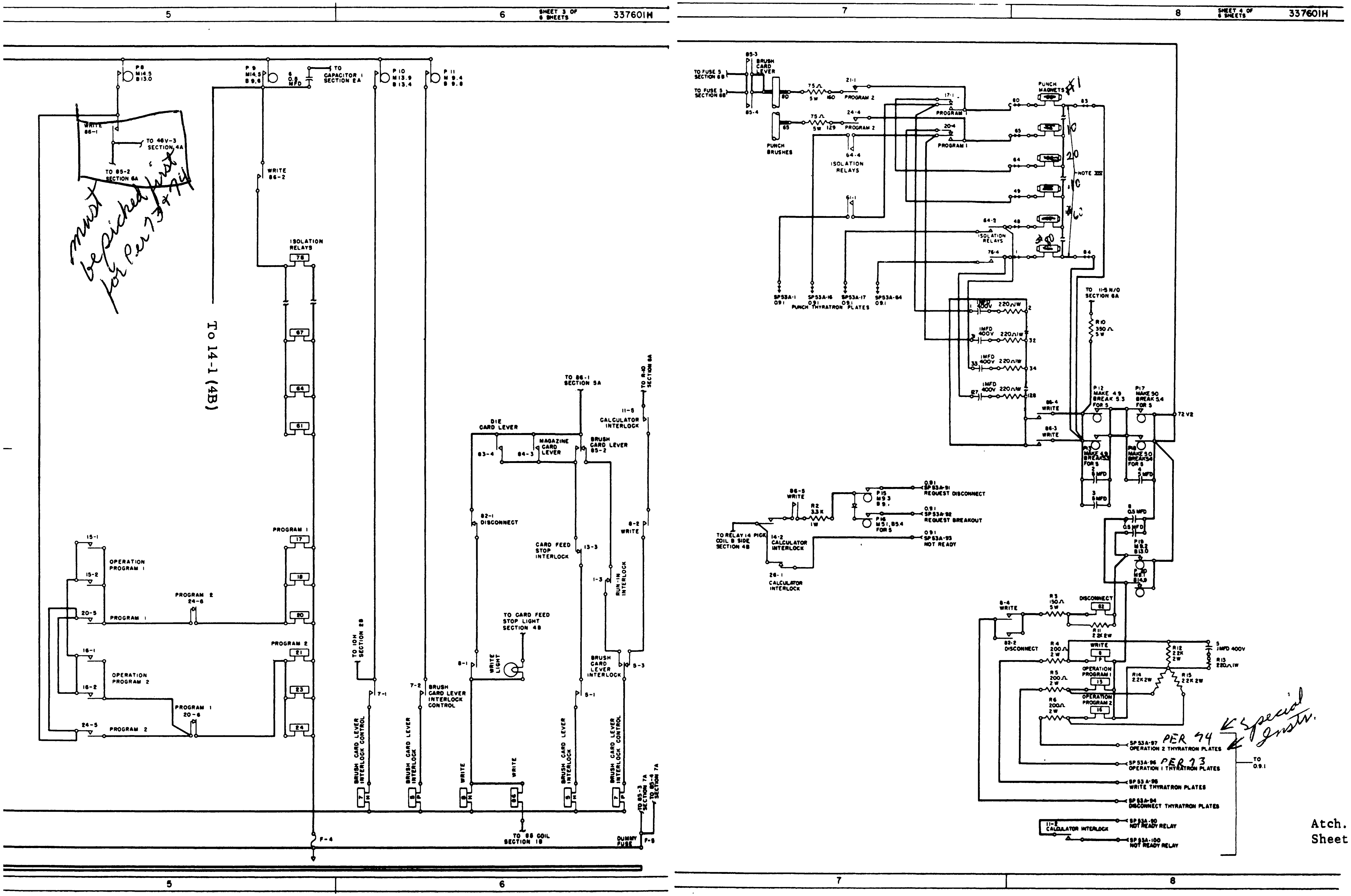
Card Reader Schematic
Atch. #3

A



Atch. #4
Sheet 1

B



Atch. #4
Sheet 2

C

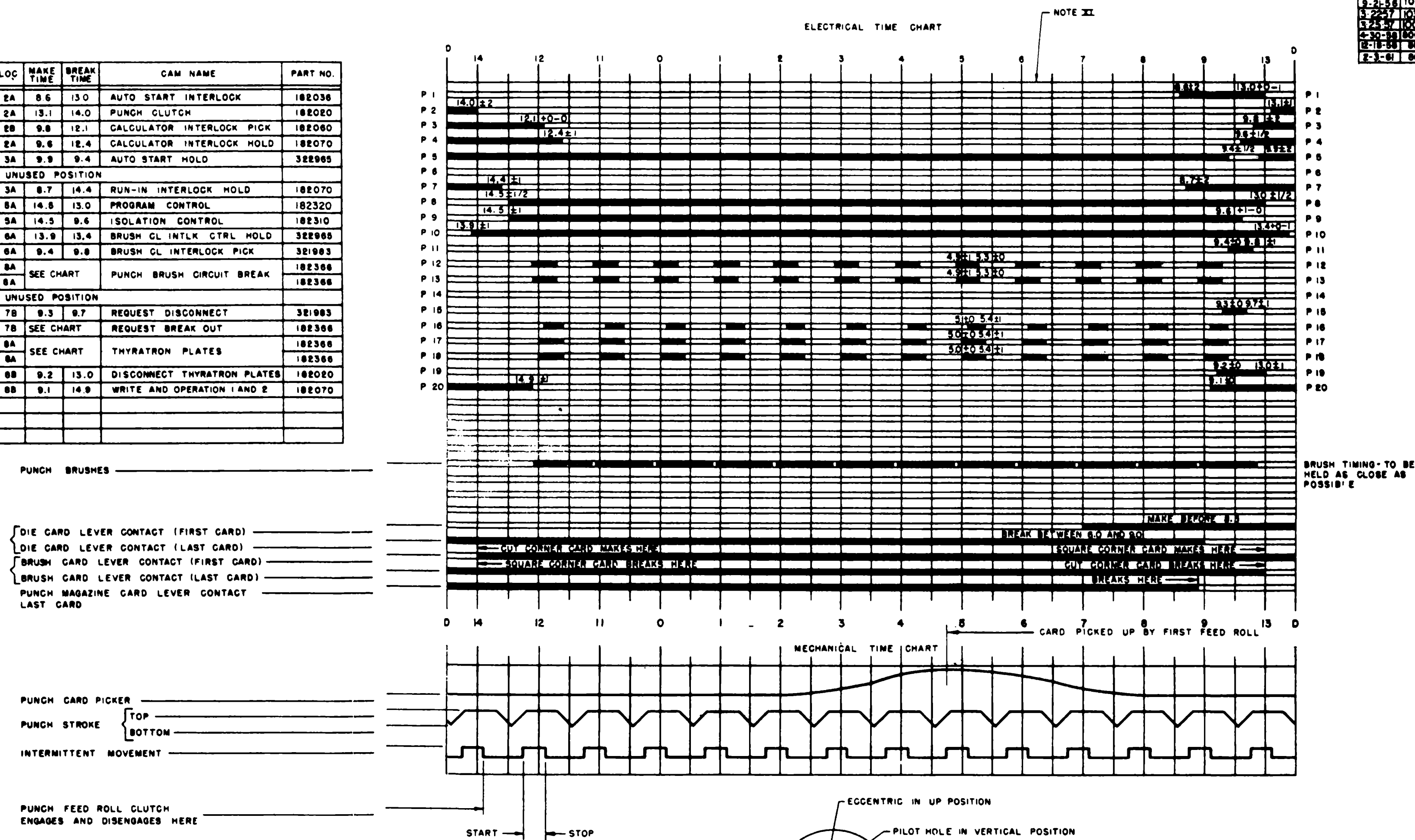
STANDARDS CODE
NONE

DATE	
5-14-56	100597A
8-1-56	100597B
9-21-56	100597C
3-22-57	103766
3-25-57	100597D
4-30-58	800123F
12-18-58	800251
2-3-61	801806

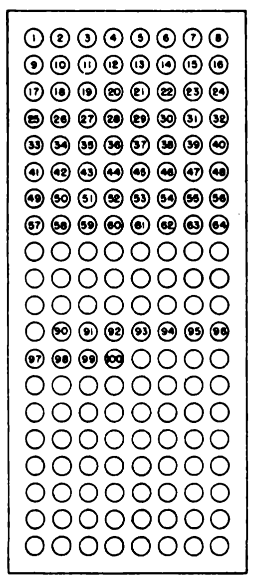
RELAY NO.	COILS P	COILS H	CONTACT POINTS 1	2	3	4	5	6	7	8	9	10	11	12	IBM PART NO	NAME	SIZE
1	3B	3B	3B	3B	6B										196208	RUN-IN INTERLOCK	4
2	4B			4B	2A										196206	72V INTERLOCK	4
3	2B	2B	2B	2A	2B										196208	READY INTERLOCK	4
4	1B			2A											196206	FUSE BLOWN	4
5	6B	6B	6B	3B	6B	2A									196208	BRUSH CL INTERLOCK	4
6	2B	3B	3B	2A	3B	2A		4B							196198	AUTO START	6
7	6B	6B	6B	6B		2B									196208	BRUSH CL INTLK CTRL	4
8	8B	6B	6B	6B	2B	8B									196208	WRITE	4
9	3B			3B											196206	MOTOR CONTROL	4
10		2B		2A											196208	AUTO START INTERLOCK	4
11	2B	3B	3B	8B	3B		6A	2B							196198	CALCULATOR INTERLOCK	6
13	3B	3B	3B	2B	6B										196207	CARD FEED STOP INTLK	4
14	4B	4B	4B	7B	3B										196208	CALCULATOR INTERLOCK	4
15	8B		5B	5B											196206	OPERATION PROGRAM 1	4
16	8B		5B	5B											196206	OPERATION PROGRAM 2	4
17	5B		7A	NS	NS	NS	NS	NS							196196	PROGRAM 1	6
18	5B		NS	NS	NS	NS	NS	NS							196196	PROGRAM 1	6
20	5B		NS	NS	NS	7A	5B	5B							196196	PROGRAM 1	6
21	5B		7A	NS	NS	NS	NS	NS							196196	PROGRAM 2	6
23	5B		NS	NS	NS	NS	NS	NS							196196	PROGRAM 2	6
24	5B		NS	NS	NS	7A	5B	5B							196196	PROGRAM 2	6
25	4B		3A	3A											196206	IDLING CONTROL	4
26	4B		7B												196206	CALCULATOR INTERLOCK	4
61	5A		7A	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	196186	ISOLATION RELAY	12
64	5A		NS	NS	NS	7A	7A	NS	NS	NS	NS	NS	NS	NS	196186	ISOLATION RELAY	12
67	5A		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	196186	ISOLATION RELAY	12
70	NS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	196186	ISOLATION RELAY	12
73	NS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	196186	ISOLATION RELAY	12
76	5A		NS	NS	NS	7A									196206	ISOLATION RELAY	4
82	6B		6B	8B											196206	DISCONNECT	4
* 83	1B		2B	3A	3B	6B									104763	DIE CARD LEVER	4
* 84	1B		2B	3B	6B										104763	MAGAZINE CARD LEVER	4
* 85	1B		3B	6B	7A	7A									104763	BRUSH CARD LEVER	4
86	6B		5A	5A	8A	8A	7B								196198	WRITE	6

* NOTE XII

CAM NO.	CONTACT AIR GAP	LOC	MAKE TIME	BREAK TIME	CAM NAME	PART NO.
P-1	.012-.018	2A	8.6	13.0	AUTO START INTERLOCK	182036
P-2	.012-.018	2A	13.1	14.0	PUNCH CLUTCH	182020
P-3	.012-.018	2B	9.8	12.1	CALCULATOR INTERLOCK PICK	182060
P-4	.012-.018	2A	9.6	12.4	CALCULATOR INTERLOCK HOLD	182070
P-5	.012-.018	3A	9.9	9.4	AUTO START HOLD	322965
P-6		UNUSED POSITION				
P-7	.012-.018	3A	8.7	14.4	RUN-IN INTERLOCK HOLD	182070
P-8	.012-.018	8A	14.8	13.0	PROGRAM CONTROL	182320
P-9	.012-.018	5A	14.5	9.6	ISOLATION CONTROL	182310
P-10	.012-.018	6A	13.9	13.4	BRUSH CL INTLK CTRL HOLD	322965
P-11	.012-.018	6A	9.4	9.8	BRUSH CL INTERLOCK PICK	321983
P-12	.012-.018	8A	SEE CHART		PUNCH BRUSH CIRCUIT BREAK	182366
P-13	.012-.018	8A				182366
P-14		UNUSED POSITION				
P-15	.012-.018	7B	9.3	9.7	REQUEST DISCONNECT	321983
P-16	.012-.018	7B	SEE CHART		REQUEST BREAK OUT	182366
P-17	.012-.018	8A	SEE CHART		THYRATRON PLATES	182366
P-18	.012-.018	8A				182366
P-19	.012-.018	8B	9.2	13.0	DISCONNECT THYRATRON PLATES	182020
P-20	.012-.018	8B	9.1	14.9	WRITE AND OPERATION 1 AND 2	182070

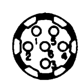


SUMMARY PUNCH 53 A CABLE CONNECTOR PANEL FACING FRONT OF PANEL

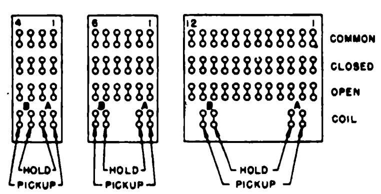


HEAVY DUTY RELAY CHART

RELAY NO.	COILS P	COILS H	CONTACT POINTS 1	2	3	4	5	6
HD 1	3B		1B					
HD 2	3B		1A					
HD 3	1B		1A					



DYNAMIC TIMER SOCKET FEMALE VIEW

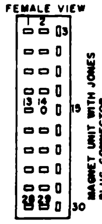


RELAY MOULDINGS (CABLE SIDE VIEW)

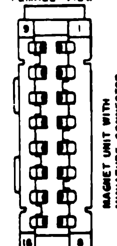
PUNCH MAGNET RELAY CHART

MAG NO	REL POS	MAG NO	REL POS	MAG NO	REL POS	MAG NO	REL POS	MAG NO	REL POS	MAG NO	REL POS	MAG NO	REL POS	MAG NO	REL POS
1	76-4	11	73-6	21	70-8	31	67-10	41	64-12	51	64-2	61	61-4	71	61-10
2	76-3	12	73-5	22	70-7	32	67-9	42	64-11	52	64-1	62	61-3	72	61-9
3	76-2	13	73-4	23	70-6	33	67-8	43	64-10	53	61-12	63	61-2	73	61-8
4	76-1	14	73-3	24	70-5	34	67-7	44	64-9	54	61-11	64	61-1	74	61-7
5	73-12	15	73-2	25	70-4	35	67-6	45	64-8	55	61-10	65	64-4	75	61-6
6	73-11	16	73-1	26	70-3	36	67-5	46	64-7	56	61-9	66	64-3	76	61-5
7	73-10	17	70-12	27	70-2	37	67-4	47	64-6	57	61-8	67	64-2	77	61-4
8	73-9	18	70-11	28	70-1	38	67-3	48	64-5	58	61-7	68	64-1	78	61-3
9	73-8	19	70-10	29	67-12	39	67-2	49	64-4	59	61-6	69	61-12	79	61-2
10	73-7	20	70-9	30	67-11	40	67-1	50	64-3	60	61-5	70	61-11	80	61-1

JONES PLUG SOCKET FEMALE VIEW



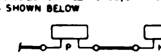
MAGNET TERMINAL BLOCK FEMALE VIEW



NOTES

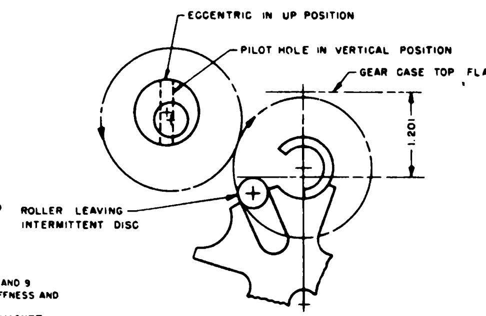
XI ONE SPACE EQUALS FIVE TEETH ON INDEX GEAR

XII THE COILS OF RELAYS 83, 84 AND 85 ARE CONNECTED AS SHOWN BELOW

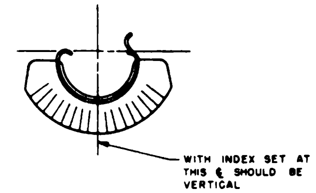


XIII - TIME THE CR CAM TO STOP THE MACHINE BETWEEN 7 AND 9 CAM SHOULD BE TIMED AFTER MACHINE LOSES STIFFNESS AND OIL IS WARM

XIV PUNCH MAGNET COMMONS ARE CONNECTED TO MAGNET TERMINAL STRIP COMMON AND NOT NECESSARILY AS SHOWN



SETTING ECCENTRIC SHAFT TO INTERMITTENT DISC



SETTING OF STACKER FEED ROLL SHAFT

CAPACITOR CHART

NO	VAL	LOC	NO	VAL	LOC
1	0.5	2A	6	0.5	5A
2	5.0	8B	7	0.5	8B
3	5.0	8B	8	0.5	8B
4	5.0	8B	9	2000	4B
5	0.1	8B	10	40	2B

DIODE CHART

NO	LOC	TYPE	PART NO
1	7B	1N540	524906

RESISTOR CHART

NO	VAL (Ω)	LOC	PART NO	NO	VAL (Ω)	LOC	PART NO
1	1000Ω 5W	4B	253527	11	2.2K 2W	8B	317086
2	3.3K 1W	7B	317055	12	2.2K 2W	8B	317086
3	150Ω 5W	8B	337626	13	220Ω 1W	8B	321196
4	200Ω 2W	8B	335138	14	2.2K 2W	8B	317086
5	200Ω 2W	8B	335138	15	2.2K 2W	8B	317086
6	200Ω 2W	8B	335138	16	100Ω 5W	2B	454187
7	300Ω 2W	3B	334931				
8	2K 5W	4B	228469				
9	100Ω 5W	4B	454187				
10	360Ω 5W	8A	317358				

FUSE CHART

NO	VAL	LOC	PART NO
F 1	5AMP	1B	104909
F 2	5AMP	2B	104909
F 3	5AMP	3B	104909
F 4	5AMP	5B	104909
F 5	DF	6B	9022
F 6	5AMP	1B	123786
F 7	5AMP	1B	123786
LTL-1	8AMP	1B	107668 *
LTL-1	5AMP	1B	107666 **

* FOR 1/3 HP MOTOR
** FOR 1/4 HP MOTOR

INTERNATIONAL BUSINESS MACHINES CORP.

NAME CARD RECORDER

DESIGN	E.W.	7-19-54	MODEL	0723	
DETAIL	E.W.	7-19-54	SCALE	NONE	
CHECK	J.P.	7-19-54	DRAW	JAE	3-19-54
APPROVED	[illegible]	[illegible]	CHECK	[illegible]	[illegible]

Atch. #4
Sheet 3

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NOTES

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