UNIVAC® FILE-COMPUTER DATA AUTOMATION SYSTEM

90 COLUMN CARD UNIT

ANOTHER SERVICE OF

MANAGEMENT SERVICES AND OPERATIONS RESEARCH

Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION

P R E L I M I N A R Y   M A N U A L

90 COLUMN

CARD UNIT

UFC

December, 1957

Another Service of . . . Management Services & Operations Research
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CONTENTS

CONTENTS (cont'd).

INTRODUCTION

The File-Computer

The Univac File-Computer, a medium sized member of the Remington Rand family of electronic computers, is distinguished by its building-block versatility. A central computer, at the present time, may be combined with 1 to 10 large capacity, random access storage drums, and from 1 to 10 input-output units.

Input-Output Devices

Each of the input-output devices is designed for a specific purpose; any one or all of them may be added to the computer to accomplish desired applications. Perhaps the most important feature of the input-output units is their ability to share operating time with the storage drums and the central computer so that all may operate simultaneously under control of a single program. An instruction to an input-output unit or instructions to several input-output units may be initiated without causing delay in the computer's execution of logical or arithmetic operations. A program from any source is therefore available in the operating memory of the computer at any required time, and all data processed by the program is either stored in the central computer or sent to an output device.

The 90 Column Card Unit

One of the input-output devices available for incorporation in a Univac File-Computer System is the 90 Column Card Unit with Post-Read Checking, which consists of an adaptor and a card processor. This manual describes the operation of the 90 Column Card Unit and contains programming features, instructions, and techniques, together with other pertinent information.

Purpose of the 90 Column Card Unit

The Univac File-Computer 90 Column Card Unit reads data punched in a 90 column tabulating card in the standard card code, translates the data into the Univac code, and transmits the data to the computer. The 90 Column Card Unit also performs the reverse operation. The computer Univac code is transmitted to the 90 Column Card Unit wherein the Univac code is translated into 90 Column Card code and punched into tabulating cards. The 90 Column Card Unit, upon completion of the above sensing and punching operations, also checks these two operations for accuracy. This is called post-read checking.

The UFC 90 Column Card Unit with Post-Read Checking has been designed for use in the Univac File-Computer Model 0 and Model 1 systems. It may be used as a tabulating card input unit, as a tabulating card output unit, or as a combined input-output unit which punches in the same tabulating card from which it reads. The "post-read" feature consists of resensing the tabulating card at the completion of its sensing and punching operations and checking it against the card data stored in the 90 Column Card Unit for sensing or punching errors.

Method of Operation

The unit operates in a cyclical manner, each card cycle initiated by a signal from the computer. A signal originates as a result of the computer program indicating that a new card should be read or punched. Each card moves through three card stations (see Figure 1) at the rate of one station per card cycle. Except during the run-in operation (loading the card unit) and the run-out operation (unloading the card unit), there is a card at every station, and a card cycle advances each card to the next station. Figure 9 and Table 2 illustrate from a programming viewpoint the more important sequence of operations taking place during the processing of one card.

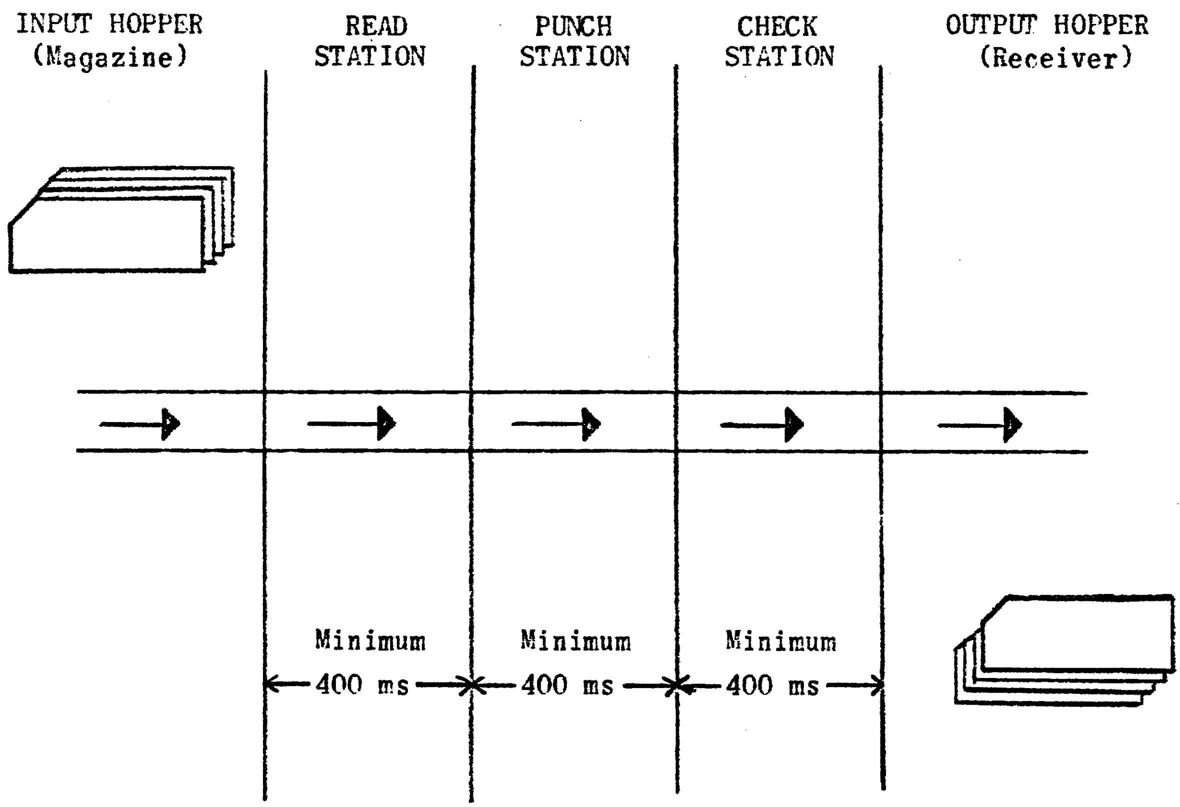

Fig. 1

Card Flow Through 90 Column Card System

Input-Output Medium

The 90 Column Card Unit accepts standard Remington Rand 90 column punch cards, prepared by the Remington Rand Key Punch Unit. The 37 characters usually found on the Remington Rand Keypunch Unit are 0 through 9, A through Z, and one special character. Other combinations of punches can be achieved on the Key Punch Unit; the 90 Column Card Unit translates 63 combinations of punches, shown in Figure 2, into Univac 7 level code.

Programming Features

There are ten main programming features available for the operation of the 90 Column Card Unit.

1. Any one of the 90 card columns can be assigned to any of the 120 character positions in input storage. Any card column can be placed in as many different input storages as desired. (See Examples 1 and 2 in "Wiring Examples," ff.)

2. Any character position in output storage can be assigned for punching to any card column that is desired. Any output storage position can be punched in as many different card columns as desired, within the maximum hole limitations for any one card. (See Example 6 in "Wiring Examples," ff.)

3. The sequence of computer operations to be performed on the data in an input card can be selected according to program-altering control punches on the card. For example, in an inventory problem, based on program-altering control punches in the cards, the computer would be able to differentiate between a receipt card and a withdrawal card and send each through the proper sequence of operations. (See Example 9 in "Wiring Examples," ff.)

4. Input storage assignments can be selected on the basis of format control information that has been punched on input cards. For example, in an inventory problem, a withdrawal card might have a customer's identification number in card columns 30 to 35 while a receipt card might have a vendor's identification number in the same card columns, 30 to 35. Based on an identifying punch in the card, the customer's identification number could be assigned to input storages 19 through 24 (or any other six designated positions), and the vendor's number assigned to input storages 31 through 36 (or any other six positions). One method of accomplishing the above is illustrated in Example 10 in "Wiring Examples," but note that selector wiring and the corresponding storage assignments are not shown in this example.

5. Output storage assignments to card columns can be selected according to format control information that has been punched on the input cards. For example, in an inventory problem involving a withdrawal transaction, the total dollar amount of items withdrawn can be computed, put in output storages, such as 32 through 36, and punched in card columns 21 through 25. If the transaction involves the receipt of new items for stock, the dollar amount of the receipt can be computed, assigned to the same output storages (32 through 36) and punched in

XS-3 / ZONE		0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
00	CHAR.	ɨ	Δ	_	0	1	2	3	4	5	6	7	8	9	▾	&	(
	CARD CODE	0-1-7-9	—	0-3-5-7	0	1	1-9	3	3-9	5	5-9	7	7-9	9	0-1-3-7-9	0-1-3-5-7	1-5-7-9
01	CHAR.	⊤	,	.	;	A	B	C	D	E	F	G	H	I	#	¢	@
	CARD CODE	0-1-3	1-3-5-7-9	1-3-5-9	0-3-5-9	1-5-9	1-5	0-7	0-3-5	0-3	1-7-9	5-7	3-7	3-5	0-1-5-7	0-1-7	0-1-3-7
10	CHAR.	†	"	|	)	J	K	L	M	N	O	P	Q	R	$	*	?
	CARD CODE	0-1-3-9	0-3-5-7-9	0-1-3-5	1-3-5-7	1-3-5	3-5-9	0-9	0-5	0-5-9	1-3	1-3-7	3-5-7	1-7	0-1-3-5-9	0-1	0-1-5-9
11	CHAR.	Σ	β	:	+	/	S	T	U	V	W	X	Y	Z	%	=	
	CARD CODE	0-1-5-7-9	0-3-7-9	0-5-7-9	1-3-7-9	3-5-7-9	1-5-7	3-7-9	0-5-7	0-3-9	0-3-7	0-7-9	1-3-9	5-7-9	0-1-5	0-1-9	0-1-3-5-7-9

REMINGTON RAND CARD CODES

FIGURE 2

different columns, such as 31 through 35. One method of accomplishing the above is illustrated in Example 10, "Wiring Examples," but note that selector wiring and the corresponding storage are not shown.

6. Output storage assignments to card columns can also be selected according to conditions arising in the computer program. For example, in an inventory problem, let us assume that the quantity on hand is to be punched in card columns 31 through 35 if the quantity is above the minimum reorder point, and in card columns 21 through 25 if the quantity is below the minimum reorder point. In both cases the information to be punched can be in the same computer output storages, such as output storages 32 through 36.

7. Output card columns can be punched on the 90 Column Card Unit by a unique method called "Synthetic Punching." Synthetic punching is accomplished by patchcord wiring. The means for such punching is provided on the plugboard of the 90 Column Card Unit, whereby a pulse is generated without corresponding data pre-stored in the central computer. For example, if it is desirable, in an inventory problem, to identify all withdrawal cards which create a backorder by punching a zero in a certain column, such as 44, this zero can be punched from a synthetic zero rather than from a zero stored in output storage. For another illustration of synthetic punching usage see Example 8 in "Wiring Examples."

8. The zero card row can be used for over-capacity input. Eighteen additional numeric characters (108 characters per card) or 12 additional alphanumeric (102 characters per card) can be sensed under certain conditions. In representing numeric information on Remington Rand 90 column cards, it is not necessary to use the zero row. The positions in the zero sensing row can be wired together in groups of five and can be used to represent additional numeric information. (See Example 5, "Wiring Examples.")

9. The checking of input sensing is normally accomplished after computation on the input data that is sensed. However, in a UFC Model 1 System when the 90 Column Card Unit with Post Read Checking is used solely for input, checking the sensing of the input card can be accomplished prior to the computation of data in the computer. This checking of input information for accuracy before its use in the central computer, is accomplished through "Cycle Delays." See Example 7, "Computer Routines." For a definition of "Cycle Delay," see "Communication with the Computer" ff.

10. The programmer has the choice of checking any number of columns in the card from 1 to 90 (see "Wiring Example 11"), or at his discretion, he may dispense with the checking altogether.

INSTRUCTION REPERTOIRE

The 90 Column Card Unit is able to execute any of the following four control commands: Program Complete, Skip, No Check, and Sort. Program Complete is an action initiating command. The other three are conditioning commands which are executed along with the next related Program Complete command.

1. Program Complete. A Program Complete pulse is generated within the computer at the end of the computer program. It is then transmitted to the I/O unit over computer-to-I/O control line A. The Program Complete pulse initiates a card cycle. During each card cycle (except run-in and run-out), one input card is fed into the card processor and one output card is produced. At the end of each card cycle, the card processor stops automatically unless another Program Complete pulse is transmitted from the computer.

2. Skip. A Skip pulse prevents the punch operation. In order to be effective, this pulse must be initiated by the computer program at least 15 ms before the Program Complete command is given.

3. No Check. A No Check pulse inhibits the checking operation.

4. Sort. A Sort pulse initiates the isolation of a selected card. Each output card is ordinarily deposited in what is called the "Normal" receiver. If a sort pulse is received, however, the output card is directed to another receiver, called the "Sort" receiver. This feature makes it possible to separate the cardsinto two categories.

COMMUNICATION WITH THE COMPUTER

Communication for exchanging control information between the computer and the 90 Column Card Unit is accomplished through a Demand Station. In the UFC Model 0 System, two sets of control lines are used: input-output to computer (I/O-to-C) control lines and computer to input-output (C-to-I/O) control lines. In the UFC Model 1 System, three sets of control lines are used: the same two as above and High Speed Input-Output to Computer ((HS) I/O-to-C)control lines. A complete discussion of the Demand Station concept is included in the UFC Model 1 Programmer' Manual.

Computer-to-Input-Output Control Lines (C-to-I/O)

Computer to Input-Output (C-to-I/O) control lines are used to send control signals from the computer to the input-output unit. For these signals to be received, the 90 Column Card Unit must be On Demand.

Ready and Not Ready Status

As previously explained, the 90 Column Card Unit operates in a cyclical manner with each card cycle initiated by a Program Complete signal received over C-to-I/O control line A. This signal can only be received when the 90 Column Card Unit is in a Ready status. The signal immediately causes the unit to assume the Not Ready status. The unit remains in the Not Ready status until it reaches the phase in the card cycle where the input transfer is complete. At this point the unit assumes the Ready status and remains in that status until the next signal is received over C-to-I/O line A. Input transfer is the transfer of the information in the cards through the translator onto the I/O track of the central computer.

Demand In

The demand circuits have delays built into them so that a Demand In signal does not immediately reach the Input-Output Unit. In an internal program, a demand instruction, specifying that a signal be sent over C-to-I/O control line A, is executed so that the Demand In signal reaches the Input-Output Unit and determines its status before any other signals are allowed to reach the unit. In an external program, however, if a step pulse is bussed to C-to-I/O line A and to Demand In, the signal over C-to-I/O line A will cause the 90 Column Card Unit to go Not Ready before the Demand In pulse reaches the unit. The nature of the program itself will determine whether the C-to-I/O line A (Program Complete) pulse will be bussed to Demand In or Demand Out. Examples of bussing to Demand In are shown in "Computer Routines" 1, 2, and 4. Bussing to Demand Out is shown in Example 6.

Demand Out

A Demand Out pulse requires three conditions: 1) a Demand In pulse, 2) the 90 Column Card Unit in the Ready status, and 3) no special conditions present in the High Speed Control lines.

Special Out

A Special Out, like a Demand Out, requires three conditions: 1) a Demand In pulse, 2) the 90 Column Card Unit in the Ready status, and 3) a special condition present in the (HS) I/O-to-C control lines. The (HS) I/O-to-C control lines are available only in the UFC Model 1. Part of the demand station circuitry consists of four (HS) I/O-to-C control lines designated as W, X, Y, and Z, over which control signals can be sent from the 90 Column Card Unit to the computer.

By means of patchcord wiring on the 90 Column Card Unit plugboard, a control hole may be sensed and the resulting signal eventually used to activate an (HS) I/O-to-C control line. The (HS) I/O-to-C control hub must be activated either by an interrupted B+, a combine out, a cycle delay out, or a control signal amplifier out. (See Example 10 in "Wiring Examples".) If an (HS) I/O-to-C control line has been activated, the regular Demand Out is inhibited, and a special out signal is sent to the computer notifying it to test high speed incoming control lines in order to determine which high speed line was activated.

Input-Output To Computer Control Lines (I/O-to-C)

Input-Output to Computer (I/O-to-C) control lines are used to send program-altering signals from the Input-Output Unit to the computer plugboard. These signals are continued until the end of the card cycle in which they were initiated. The I/O-to-C control line signal on the computer plugboard lasts until either the 90 Column Card Unit goes off demand or until the end of the card cycle in which the signal was initiated, depending upon which condition occurs first. At the end of the card cycle, the 90 Column Card Unit automatically discontinues the I/O-to-C control line signals, and the activated selectors are dropped out.

Cycle Delays

I/O-to-C control signals and (HS) I/O-to-C control signals can be delayed by Cycle Delays (see Section on Connection Panel), for use in later card cycles. For example, in using the 90 Column Card Unit for sensing input only, when it is desired to check the sensed input before computation in the computer begins, cycle delays would be required to delay program-altering signals. This operation would require a delay of two card cycles when I/O-to-C control lines are used.

STARTING AND STOPPING

The programmer has to make no special provisions in his computer program to handle the starting and stopping of the 90 Column Card Unit. Run-In and Run-Out circuits automatically handle any problems involved.

Starting

The Start signal, manually initiated from the Control Panel on the 90 Column Card Unit, causes the unit to cycle until the input transfer of the first card is complete. Up to this time the unit has been in a Not Ready status. When the input transfer is complete, the unit assumes the Ready status. The first card is then available for the computer program.

Stopping

The 90 Column Card Unit will continue to go Ready after every input transfer until there is no card left in the sensing station. The Program Complete command, signifying the end of computation on the last card, causes the unit to assume the Not Ready status. The output transfer takes place and the last card, which is at the punching station, is punched. However, when the 90 Column Card Unit detects no card in the sensing station, the transfer of data to the card unit buffer and to input transfer is inhibited and the unit does not go Ready. Hence, the computer will stop the next time the unit is demanded since no Demand Out will be provided. The 90 Column Card Unit automatically takes care of passing the last card through the checking operation and into the output hopper.

TIMING AND CHECKING

Timing

The 90 Column Card Unit reads one card at a time at a maximum speed of 150 cards per minute. This timing means that at top speed one card falls into the output hopper every 400 ms. The cycling of the unit is such that information can be read from a card, computed, and the results punched into the same card (see Fig. 5). Of the total time required for the entire read-punch processing of one card, approximately 235 ms are available for operations within the computer. If the computer operations require more than 235 ms, the cycle time will be the computational time plus 175 ms. In a straight read operation on the Model 1, there are 400 ms available for operation within the central computer.

Checking

Provision is made in the 90 Column Read-Punch Unit for checking the sensing and punching of information recorded in the cards. The comparison checking takes place after the card has been punched, and therefore sensing and punching are checked at the same time. Table II shows the way in which comparison checking fits into the operational cycle. This check can be omitted if the programmer so desires; he need only omit the wiring from the checking system. Selective checking may be employed by utilizing the No Check hub if any part of a program does not require checking. Input-Output parity checking is automatic.

EXAMPLES OF COMPUTER ROUTINES

The following routines are examples demonstrating the method by which the computer exchanges control information with the 90 Column Card Unit. Each example illustrates a given type of operation and is explained by a logical flow chart. In all the following examples, it is assumed that the run-in required to put the card unit in operating condition places the data from the first card on the I/O track and sets up a Ready condition in the card unit. These illustrations are not intended to include all possible methods, but merely to illustrate possible alternatives. In UFC Model 1 operations, since each demand station has two input-output tracks which are alternately connected to either the computer or the input-output unit, the computer and input-output unit can operate simultaneously. Hence, it is desirable to design the computer program so that the central computer is not delayed while the input-output unit performs its functions. In the case of the 90 Column Card Unit, this is possible if the unit is used strictly for input or strictly for output, but it is not possible if the requirement is to read from and punch into the same card with one card unit.

The first two examples illustrate routines for the UFC Model 0; the following four examples illustrate routines for the UFC Model 1.

Example 1. UFC Model 0-Single Unit-Read and Punch In Same Card. (See Figure 3)

Oper. No.	Operation	Explanation
1	Wire Start to Demand In	To establish connection with the proper input-output track and to make sure the data from the first card is on the track. A Demand Out will not be received until the data is on the track (i.e. until the 90 Column Card Unit goes Ready as a result of the manual run-in.)
2	Demand Out to In of Computation Step	When the Demand Out signal is received, the appropriate computing routine is determined and computation begins.
3	Out of last computing step to (a) computer to I/O Control Line A, (b) to Demand In (Oper. 1)	As nothing has happened since the previous Demand Out to put the 90 Column Card Unit in a Not Ready status, it is still Ready and can receive the Program Complete (cycle-initiating) signal over C-to-I/O Control Line A. With the 90 Column Card Unit, Line A is internally wired to effect the Program Complete instruction. Each Program Complete punches the computed results on the card processed by the computer and reads in the next card. Although the Out of Step pulse was bussed to C-to-I/O Line A and to Demand In, the Demand In circuits contain delays so that the Program Complete pulse reaches the 90 Column Card Unit first. The unit then assumes a Not Ready status. When the Demand In pulse arrives to probe for Ready, it finds the unit Not ready, and no Demand Out results until the input transfer phase of the card cycle has been completed and the card unit again goes Ready.

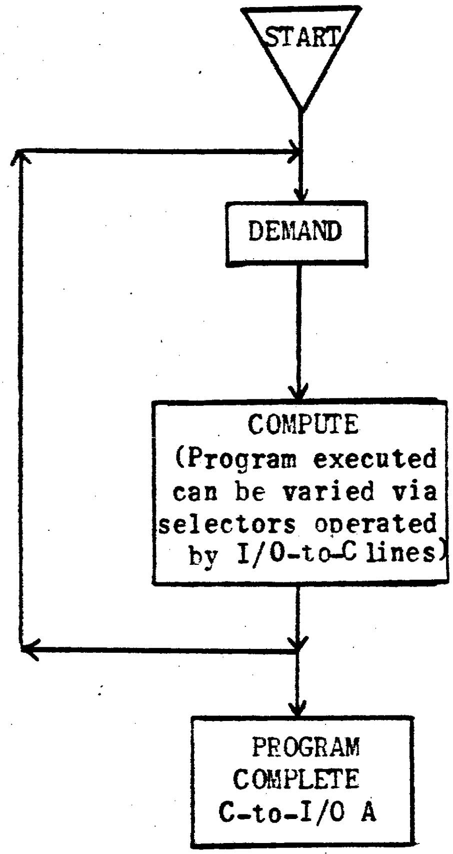

Fig. 3

UFC Model 0 - Single Unit-
Read and Punch in Same Card

Example 2. UFC Model 0 - Multiple Card Unit - Read and Punch in Same Card
(See Figure 4)

When computation is complete on a card from card unit 1, we start the card cycle to punch out the results of the computation and read in the data from the next card. However, instead of waiting for this new data from card unit 1 to become available for computation, computer delay may be avoided by starting the computation immediately on data from card unit 2 or reading in data from card unit 2.

Oper. No.	Operation	Explanation
1	Wire Start to Demand In card unit 1	To establish connections with the proper input-output track and to make sure the data from the first card is on the track.
2	Demand Out to In of Computation Step	When the Demand Out is received the appropriate computing routine is determined and computation begins.
3	Out of last computing step to (a) C-to-I/O control line A and (b) to Demand In card unit 2.	Since the 90 Column Card Unit remains On Demand until another station is demanded, card unit 1 is still on demand as this operation begins; and as nothing has occurred since the previous Demand Out to put card unit 1 in a Not Ready status, it is still Ready. Thus the pulse sent over C-to-I/O control line A goes to card unit 1 and initiates another card cycle in that unit. Although the Out of last computing step was also bussed (see Point A on flow chart) to Demand In card unit 2, the demand circuits contain delays so that card unit 1 is not taken off demand (i.e., Control Line A still goes to unit 1) until after the Program Complete signal initiates the next card cycle. If card unit 1 is demanded again it will be Not Ready until the input transfer phase of the card cycle is complete. However, the computer program is continued without delay by demanding card unit 2.

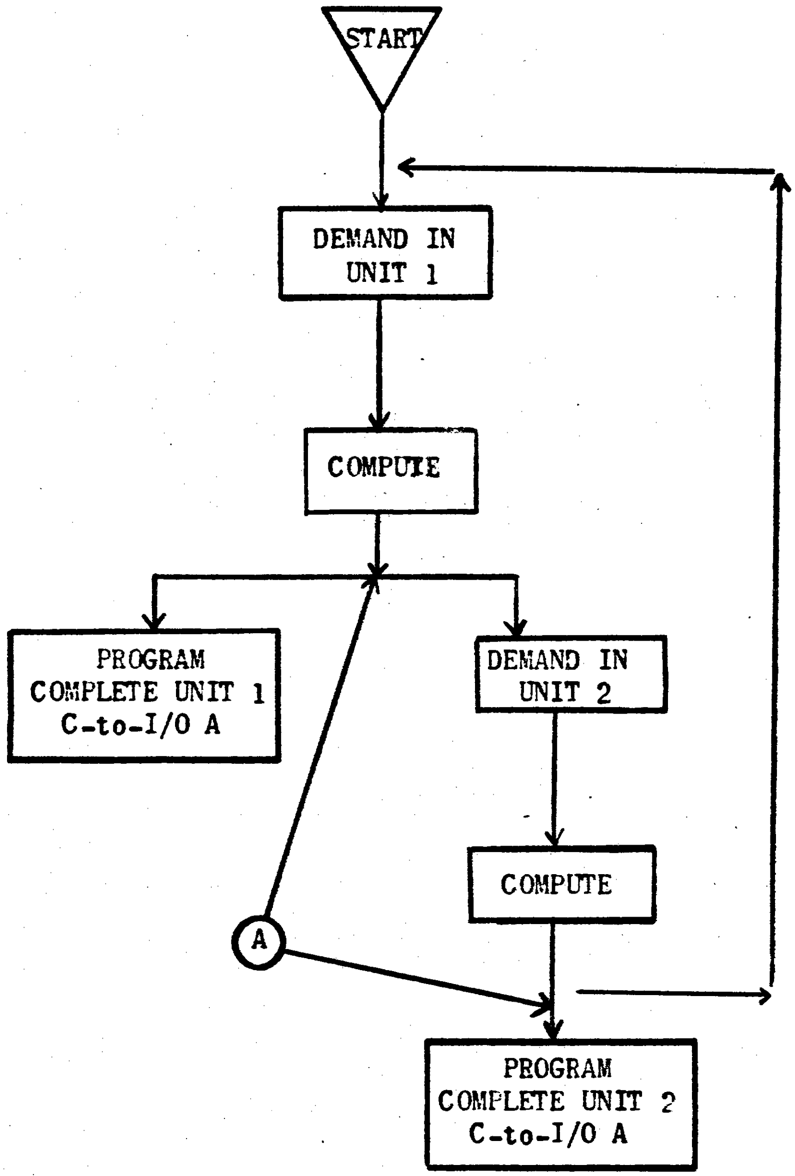

Fig. 4

UFC Model 0 - Multiple Card Unit - Read and Punch in Same Card

Example 2. Cont'd

Oper. No.	Operation	Explanation
4	Demand Out card unit 2 to In of computation steps	A Demand Out is received if card unit 2 is Ready or when it goes Ready. Card unit 2 is probably Ready and the Demand Out will be immediate because card unit 2 has had the time to complete its card cycle through the input transfer phase, while card unit 1 computation was taking place.
5	Out of last computing step to (a) C-to-I/O control line A and (b) to Demand In card unit 1	The same comments apply here as to Operation No. 3 except that card unit 1 and card unit 2 are interchanged.
6	Demand Out card unit 1 to In of computation steps	The same comments apply here as to Operation No. 4 except that unit 1 and unit 2 are interchanged

Example 3. UFC Model 1 - Read and Punch in Same Card - Internal Program (See Figure 5)

Oper. No.	Operation	Explanation
1	Demand Card Unit, Track Switch	To make data from first card available to computer. In an internal demand instruction, the Demand In is executed first, and no other part of the instruction will be executed until the input-output unit demanded provides a Ready signal. Once it is determined that the unit is in the Ready status, High Speed Control Line memory is examined to determine whether or not an (HS) I/O-to-C control line has been activated. If a High Speed Control Line has been activated, a Special Out occurs (see Fig. 5, Point A). If no (HS) I/O-to-C control line has been activated, a Demand Out signal results. The track switch will not take place until the 90 Column Card Unit completes the input transfer and goes Ready.
2	Compute	
3	Demand Card Unit, Track Switch, Program Complete	The card unit is demanded in order to make output data for first card available to it. A Special Out occurring at this time is handled in the manner illustrated in coding instruction

Example 3. Cont'd

Oper. No.	Operation	Explanation
		word 134, and in Fig. 5, Point B. At this time, the input-output tracks are switched, making the output data available to the 90 Column Card Unit. A Program Complete signal initiates a cycle to read in another card. The card unit should always be ready at this time.
4	Go to Operation No. 1	To delay computer program until data from next card can be made available to computer. The double track switch and resulting delay insure the punching of computer output data into the proper card.

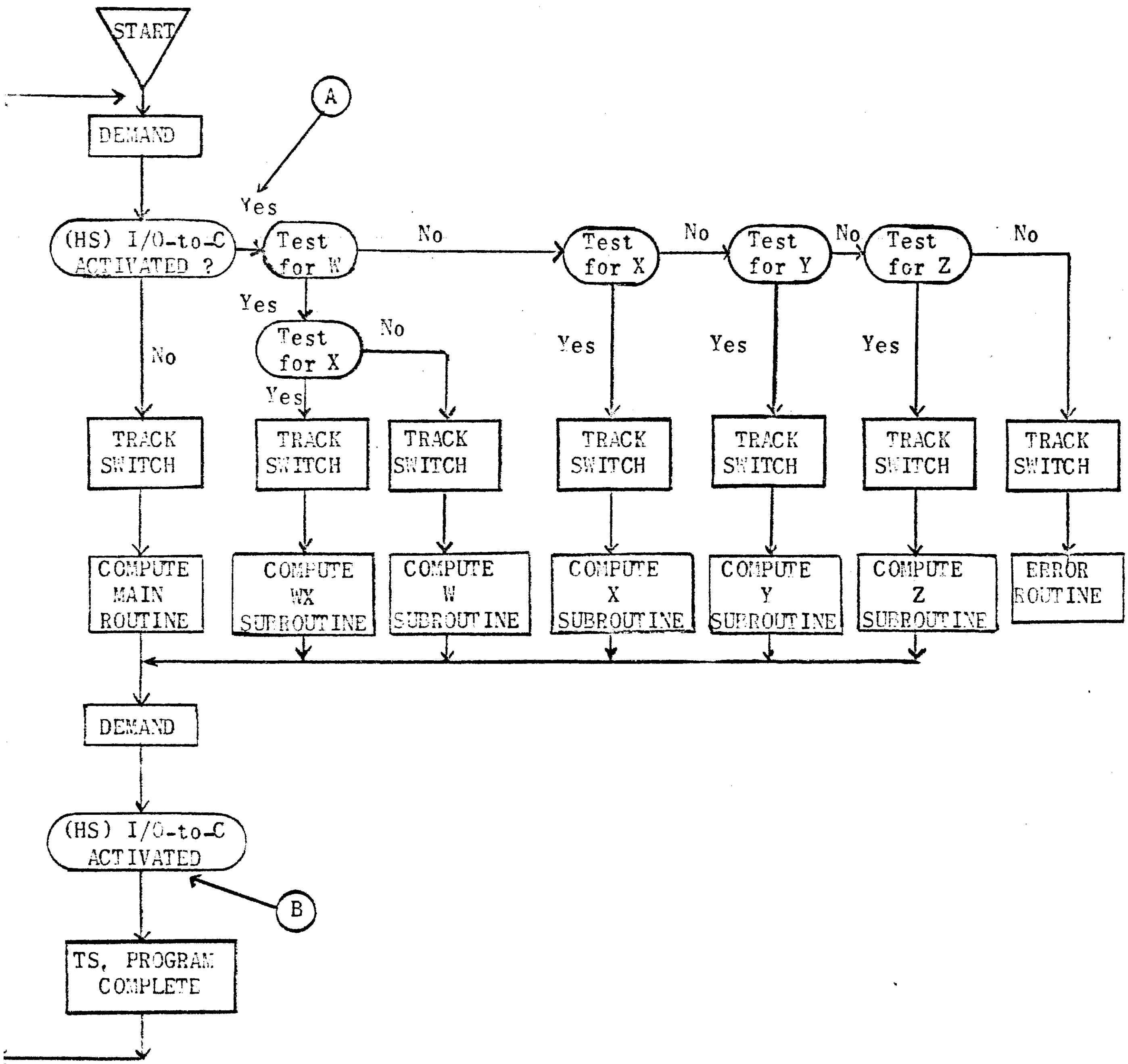

Fig. 5

UFC Model 1
Read and Punch in Same Card
Internal Program

Coding for Example 3. UFC Model 1 - Read and Punch in Same Card

Assumptions: 1. 90 Column Card Unit is on demand station 9.
2. There are 5 special conditions that can activate W, X, Y, Z or WX (HS) I/O-to-C control lines.

Instruction Word	U	V	W	OPS	Explanation
130	190	555	136	DE∆	Demand the unit. If Demand Out is produced, track switch (TS) and go to 131. If special out is produced, go to 136; in any event no C-to-I/O line is energized.
131, 132, 133	Compute Main Routine				
134	191	556	130	DE∆	At completion of computation of main routine, Demand, TS, give a program complete.
135	992	992	130	UJ∆	Go to 130
136	19W	∆∆∆	141	TI∆	Test for W. If found, TS and go to 141. If not found, go to 137.
137	19X	∆∆∆	148	TI∆	Test for X. If found, TS and go to 148. If not found, go to 138.
138	19Y	∆∆∆	151	TI∆	Test for Y. If found, TS and go to 151. If not found, go to 139.
139	19Z	∆∆∆	154	TI∆	Test for Z. If found, TS and go to 154. If not found, go to 140.
140	99Z	992	130	UJZ	If a special out has been indicated, and W, X, Y, or Z is not found, an error has occurred. This command will stop the computer and set PAK to 130.
141	19X	∆∆∆	145	TI∆	Test for X. If found, a WX combination exists, then go to WX subroutine at 145. If not found, a W condition exists; go to W subroutine at 142.
142, 143	W Subroutine				
144	191	556	130	DE∆	At the completion of W subroutine,[1] demand card unit, TS, send a program complete signal to the card unit. Because a special out will exist, set PAK to 130.

[1] At this time the (HS) I/O-to-C control lines will still be activated and a special out will always be produced because in IW 130 v=555.

Coding for Example 3, Cont'd

Instruction Word	U	V	W	OPS	Explanation
145 146	WX	Subroutine			
147	191	556	130	DEΔ	At the completion of WX subroutine,[1] demand card unit, TS, program complete, and go to 130.
148 149	X	Subroutine			
150	191	556	130	DEΔ	At the completion of X subroutine,[1] demand card unit, TS, program complete, and go to 130.
151 152	Y	Subroutine			
153	191	556	130	DEΔ	At the completion of Y subroutine,[1] demand card unit, TS, program complete, and go to 130.
154 155	Z	Subroutine			
156	191	556	130	DEΔ	At the completion of Z subroutine,[1] demand card unit, TS, program complete, and go to 130.

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[1] At this time the (HS) I/O-to-C control lines will still be activated and a special out will <u>always</u> be produced because in IW 130 v=555.

Example 4. UFC Model 1 - Read and Punch in Same Card - External Program (See Fig. 6)

Oper. No.	Operation	Explanation
1	Wire Start to Demand In Card Unit	
2	Wire Demand Out to one hub of a bus, wire other hub of that bus to (a) Track Switch, (b) Step In of main program. Wire Special Out to test for W, X, Y, and Z combinations and wire results to (a) Track Switch, (b) Step In of appropriate subroutine.	Using Demand and Special Out to track switch insures that the previous operation is completed. Track switch makes the input data available to computer.
3	Out of last computing step to (a) C-to-I/O Control line A (Program Complete), (b) to Track Switch, (c) to Demand In.	The card unit is Ready and On Demand at this point. The track switch makes the computer output data available to the card unit for punching. The Program Complete signal initiates another card cycle that causes the unit to assume the Not Ready status and a) punches the computed results on the card just processed by the computer, and b) reads in the next card. The Demand In circuits contain delays so that by the time the Step pulse which was bussed to Demand In is probing the status of the card unit, the card unit has already been set to Not Ready. Thus the Demand Out of operation no. 2 will not occur until the card unit again goes Ready after the last input transfer is complete.

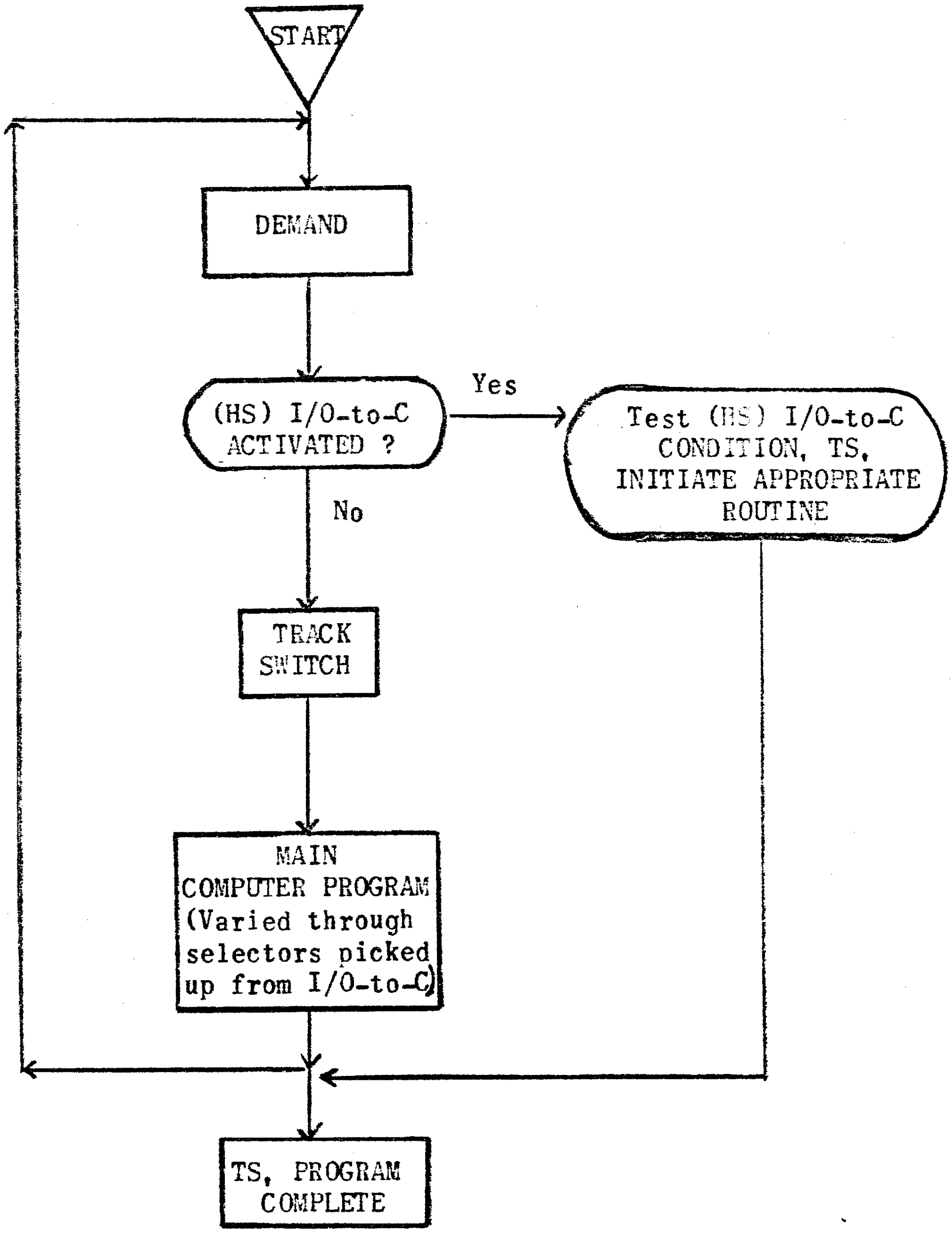


Fig. 6

UFC Model 1
Read and Punch in Same Card
External Program

Example 5. Model 1 - Read Only - Internal Program[1] (See Figure 7)

Oper. No.	Operation	Explanation
1	Demand, Track Switch, Program Complete.	To make data from first card available to computer; to initiate read-in of second card on the other input-output track.
2	Compute	
3	Go to Operation No. 1	Repeat steps 1, 2, and 3 until all cards have been processed.

[1] In this operation the B+ hub should be patch wired to Skip hub to effect "no punching" in every card.

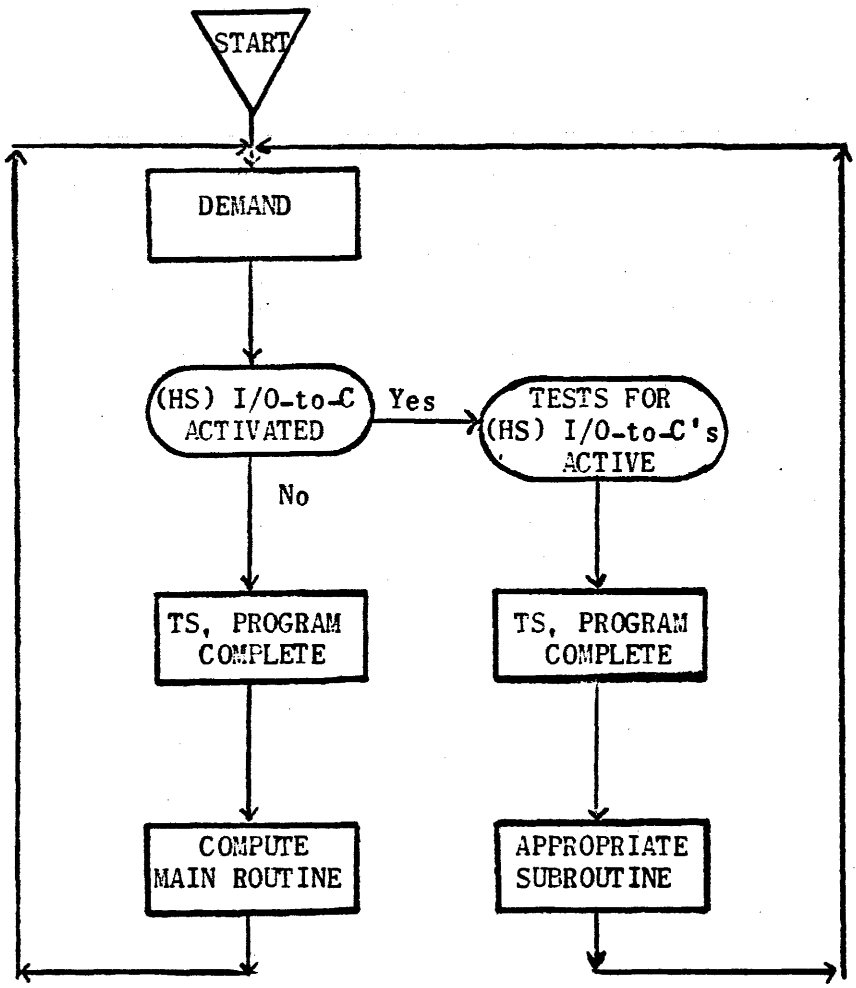


Fig. 7

Model 1 - Read Only
External or Internal Program

Coding for Example 5 Model 1 - Read Only

Assume that 1. The 90 Column Card Unit is on Demand Station 9.
2. There are 4 special conditions that can activate W, X, Y, or Z (HS) I/O-to-C control lines.
3. B+ hub is patch wired to Skip hub to effect no punching in every card.

Instruction Word	U	V	W	OPS	Explanation
130	190	556	135	DE△	Demand card unit. If no (HS) I/O-to-C control line is present, TS and program complete. If (HS) I/O-to-C is present go to 135.
131					
132	Main Routine				
133					
134	992	992	130	UJ	After computing the main routine, go to 130.
135	19W	△△△	140	TI△	Test for (HS) I/O-to-C control line W. If found go to 140.
136	19X	△△△	142	TI	Test for (HS) I/O-to-C control line X. If found go to 142.
137	19Y	△△△	146	TI	Test for (HS) I/O-to-C control line Y. If found go to 146.
138	19Z	△△△	149	TI	Test for (HS) I/O-to-C control line Z. If found go to 149.
139	992	992	130	UJ2	Error indicated. Computer should have found one (HS) I/O-to-C activated or should not have started testing (HL) I/O-to-C control lines.
140	W Subroutine				
141	992	992	130	UJ△	After W subroutine, go to 130.
142					
143	X Subroutine				
144					
145	992	992	130	UJ△	After X subroutine go to 130.
146					
147	Y Subroutine				
148	992	992	130	UJ△	After Y subroutine go to 130.
149					
150	Z Subroutine				
151	992	992	130	UJ	After Z subroutine go to 130.

Example 6. Model 1 - Read Only - External Program[1] (See Figure 7)

Oper. No.	Operation	Explanation
1	Wire Start to Demand In	
2	Wire Demand Out to Track Switch, Program Complete (C→I/O Line A) and to In of first computation step	If a step pulse is bussed to C-to-I/O Line A, and to Demand In, as is done in the Model 0 or when only one track in the Model 1 is used, the signal over the C-to-I/O line A will have caused the 90 Column Card Unit to go Not Ready before the Demand In pulse reaches the card unit. Therefore, in order to take advantage of both input-output tracks associated with the card unit, in the UFC-1 System, the C-to-I/O line A should be bussed to the Demand Out hub for a Read-Only (Input) operation.
3	Wire from last computation step to Demand In (operation no. 1)	

1 In this operation the B+ hub should be patch wired to the Skip hub to effect "no punching" on every card.

Example 7. Model 1 - External Feed Only - Computation After Checking
(See Figure 8)

Oper. No.	Operation	Explanation
1	Wire Start to Demand In	
2	Wire Demand Out to TS, Program Complete, and to Step In of Program Step which transfers input-output track to working storage #1.	Program Complete starts a new card cycle. Switch tracks and transfer data from the first card to working storage #1 (WS #1)
3	Wire Step Out of transfer to Demand In. Wire Demand Out to TS, Program Complete, transfer I/O track to working storage #2	Repeat Operation No. 2, except transfer data from 2nd card to working storage #2 (WS #2)
4	Wire Step Out of transfer to Demand In. Wire Demand Out to TS, Program Complete, and Program Select	I/O-to-C or (HS) I/O-to-C control lines may alter the program through selectors. Use the 20 ms"Delayed Out"of Program Select #1, to continue the program if the program altering signal is needed to determine the computer program starting step. The 20 ms delay is needed to allow the I/O-to-C control lines to reach the program altering selectors and pick them up.
5	Compute applicable routine	Determined by I/O-to-C control signals
6	Transfer WS #2 to WS #1	
7	Transfer data from new card to WS #2	If operations 5, 6, and 7 total over 235 ms, it may be advisable to review this program to eliminate some transfer processes. In this example working storage #1 could be the Block Transfer Buffer.
8	Return to Operation No. 4 and continue processing	

NOTE: If the card does not check in the post-sensing cycle, the computer will hang up since a demand out pulse will not be emitted. (See point 1 in the flow chart.)

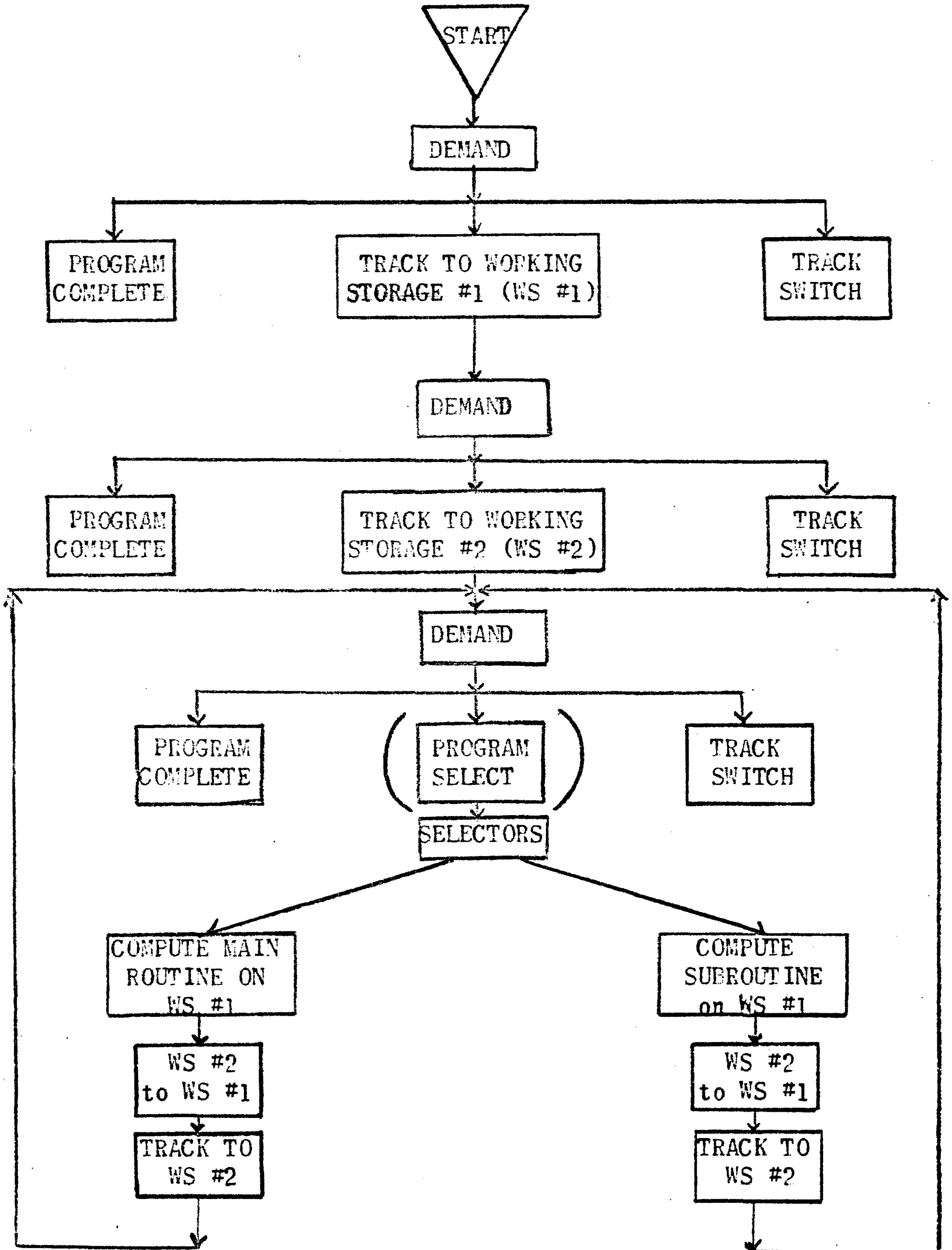


Fig. 8

Model 1
Read Only - Computation After Checking
External

() In some applications the 20 millisecond delay may not be necessary.

CONNECTION PANEL

The 90 Column Card Unit includes a plugboard (Figure 10) that permits format control, editing, checking control, and other editing control operations. Table I lists the hubs found on the plugboard. Certain groups of hubs (marked "R" in the table under "Current") are only to receive and reroute current. The other groups of hubs (marked "E" in the table) emit current. Under Type of Current, "EN" stands for Enable, "B+" for a B+ current, "INT B+" for Interrupted B+, and "PB+" for Pseudo-interrupted B+. A PB+ current has an effect and duration similar to interrupted B^+, except that it can pick up only one selector.

DESCRIPTION OF CONNECTION PANEL HUBS

TABLE I

Hub Title	Plug-board Coor-dinates	Current R or E	Current Type	No. of Hubs	Main Programming Use
(1) 1-9 Sensing	m-p 12-56	R	EN	90 Bussed Pairs	To represent 1-9 rows of 90-column card. Used in assigning card columns to input storage.
(2) Zero Sensing Commons	q-t 12-56	R	EN INT B+	90 Bussed Pairs	To represent zero row of 90-column card. Used in assigning card columns to input storage and for sensing of zero row of control holes.
(3) Zero Sensing Exit	u-v 12-56	E	EN INT B+	90	When there is a 0 punch sensed in a column, the current is brought out to the corresponding hub in this section so that it can be used for control purposes, over capacity input, or placing the 0 or a possible part of an alphabetic character in input storage.
(4) Zero Sensing Input	w-x 12-56	R	EN	90	To take current from the corresponding zero sensing exit to the internal circuitry when the punch is to go to input storage.
(5) Input Storage	k-l 5-64	E	EN	120	To represent the 120 input storage positions, used in assigning card columns to input storage.
(6) Output Storage	V-U 5-64	E	EN	120	To represent the 120 output storage positions, used in assigning output storage positions to card columns for punching.
(7) Checking Storage	D-E 5-64	E	EN	120	To represent the 120 input-output storage positions, used in assigning card columns that are to be checked.
(8) 1-9 Punching	a-b 12-64	R	EN	90 Bussed Pairs	To represent 1-9 rows of 90-column card. Used in assigning output storages to card columns for punching.

TABLE I (cont.)

Hub Title	Plug-board Coor-dinates	Current R or E	Current Type	No. of Hubs	Main Programming Use
(9) Zero Punching	c-f 12-64	R	EN	90 Bussed Pairs	To represent 0 rows of 90-column card. Used in assigning output storages to card columns for punching.
(10) 1-9 Checking	F-I 12-64	R	EN	90 Bussed Pairs	To represent 1-9 rows of 90-column card. Used in assigning card columns to be checked for 1-9 sensing and punching accuracy.
(11) Zero Checking Commons	J-M 12-64	R	EN INT B+	90 Bussed Pairs	To represent 0 rows of 90-column card. Used in assigning card columns to be checked for zero sensing and punching accuracy.
(12) Zero Checking Exits	N-O 12-64	E	EN INT B+	90	When there is a 0 punch sensed in a column, the current is brought out to the corresponding hub in this section so that it can be used for control purposes if desired.
(13) Zero Checking Input	P-Q 12-64	R	EN	90	To take current from the corresponding zero check exit hub to the internal circuitry when the zero is to be checked for sensing and punching accuracy.
(14) Selector Pickup	m-b <u>63-68</u> A-H 63-68	R	INT B + PB + or B +	48 Bussed Pairs	To energize or "pick-up" the corresponding selector.
(15) Selectors	h-j <u>11-57</u> R-T <u>13-51</u> A-C 13-53	R E	ANY ALL	48 Selectors 1 pole, 2 poles, 4 poles	To route a current one of two ways. Current goes in "common" hub and comes out "select" or "non-select" hub depending on whether or not the selector is energized.
(16) I/O-to-C control lines	b-e 57-62	R	INT B+ B+ PB+	12 Bussed Pairs	To transmit control signals from input unit to computer. These signals can be used on the computer control plugboard to pick up selectors.

TABLE I (cont.)

Hub Title	Plug-board Coor-dinates	Current R or E	Current Type	No. of Hubs	Main Programming Use
(17) (HS) I/O-to-C control lines	f-i 62	R	INT B+	4	To transmit control signals from input unit to computer. These signals set incoming control line storage so that the next internal program step can be determined. These signals are also available on the computer plugboard.
(18) C-to-I/O control lines	T-X 65-68	E	PB+	9 Bussed Pairs	These hubs are used to send signals from the computer to the input-output unit. (Control Line A is always used to initiate an Output Transfer and is not brought out to a hub on the card unit plugboard.)
(19) Combines in out	m-s 61-68	R E	ALL PB+	24 16 require 2 IN Pulses 8 require 3 IN Pulses	When all of the inputs of a given combine are present, an interrupted B+ current is emitted from the out hub.
(20) Sensing Control Probes	f-g 7-11 f-g 57-61 B-C 5-9 B-C 58-62	E	EN	20 Bussed Pairs	The 10 sensing control probe pulses are used to sense cards for control punches before regular input operation begins. A punch in the card, therefore, may be used to vary input format.
(21) Sensing Position Input	t-x 57-62 6-11	R	EN	12 sets of 5	The five hubs in a set represent the 1, 3, 5, 7, 9 rows of a 90 column card. The purpose of these hubs is to provide a means of converting zero row punches to 1, 3, 5, 7, 9 punches so that the zero row can be used for over capacity input.
(22) Sensing Position Output	t-x 64-68 1-5	E	EN	12 sets of 5	The five hubs in a set represent the 1, 3, 5, 7, 9 rows of a 90 column card. These hubs provide a means of determining which of the 1-9 rows were punched in any given column

TABLE I (cont.)

Hub Title	Plug-board Coor-dinates	Current R or E	Current Type	No. of Hubs	Main Programming Use
(22) cont.					and are used mainly for sensing control holes in the card.
(23) Checking Position Input	M-Q 6-11 57-62	R	EN	12 sets of 5	The five hubs in a set represent the 1, 3, 5, 7, 9 rows of a 90 column card. The purpose of these hubs is to provide a means of converting zero row punches to 1, 3, 5, 7, 9 punches so that when the zero row is used for over capacity input, the sensing and converting can be checked for accuracy.
(24) Checking Position Output	M-Q 1-5 64-68	E	EN	12 sets of 5	The five hubs in a set represent the 1, 3, 5, 7, 9 rows of a 90 column card. These hubs provide a means of determining which of the 1-9 rows were punched in any given column and are used mainly for checking and sensing of control holes in the card. They are electrically identical to checking Input hubs.
(25) Synthetic Zero Punching	g 12-26	R	EN	15	To provide a means of punching a zero without requiring corresponding data from the translator.
(26) Synthetic 1 Punching	g 27-32	R	EN	5	To provide a means of punching a 1 without requiring corresponding data from the translator.
(27) Synthetic 3 Punching	g 33-38	R	EN	5	To provide a means of punching a 3 without requiring corresponding data from the translator.
(28) Synthetic 5 Punching	g 39-44	R	EN	5	To provide a means of punching a 5 without requiring corresponding data from the translator.

TABLE I (cont.)

Hub Title	Plug-board Coor-dinates	Current R or E	Current Type	No. of Hubs	Main Programming Use
(29) Synthetic 7 Punching	g 45-50	R	EN	5	To provide a means of punching a 7 without requiring corresponding data from the translator.
(30) Synthetic 9 Punching	g 51-56	R	EN	5	To provide a means of punching a 9 without requiring corresponding data from the translator.
(31) Negative Sign Sensing	n-s 11 57	R	EN	12	To insert a negative sign in input storage position without having the 0-3-5-7 punched in the card.
(32) Negative Sign Checking	G-L 11 57	R	EN	12	To check the insertion of a negative sign in an input storage position by negative sign sensing.
(33) Over Capacity Special Checking	F-L 7-10	R	EN	14 Bussed Pairs	To check any storage position containing only a zero punch, such as a synthetically punched zero for control purposes or a zero punch in over capacity input or output.
(34) Sort	R-S 66	R	B+ INT B+ PB+	2	To segregate specified cards.
(35) Skip	R-S 68	R	B+ INT B+ PB+	2	To suppress punching in specified cards.
(36) Interrupt B+	m 59-64 F 59-64	E	INT B+	12	To emit B+ current from 070 of one cycle to 020 of the next. Used to hold in selectors which are dependent on card cycle.

TABLE I (cont.)

Hub Title	Plug-board Coor-dinates	Current R or E	Current Type	No. of Hubs	Main Programming Use
(37) B+	m 57-58 F 57-58	E	B+	4	To hold a selector in for more than 1 card cycle.
(38) Cycle Delay In Out	I-L 64-68	R E	INT B+ INT B+	10 sets of 2 1 in each 1 out each	To delay signals for 1 card cycle. A signal plugged to the IN hub is received at this OUT hub. As many as ten of the delays may be used in series to delay a signal for as many as ten cycles.
(39) No Check	R-S 67	R	B+ INT B+ PB+	2	To suppress all comparison checking, when such suppression is desired.
(40) Control Signal Amplifier	h-j 58-61 R-T 57-64	R E	PB+ INT B+	12 12 Bussed Pairs	To amplify PB+ for the purpose of picking up more than one selector at a time.
(41) Programmed Indicators	X-W 6-10	R	B+ INT B+ PB+	10	To light a corresponding indicator light on the 90 Column Card Unit panel.

WIRING EXAMPLES FOR 90 COLUMN CONNECTION PANEL

Following are 12 examples of problems in plugboard wiring, with procedures designed to accomplish certain basic operations and format control. By using these procedures in various combinations, numerous programming requirements can be fulfilled.

EXAMPLE 1

Assignment of Card Columns to Input Storage Positions - Numeric Data. (Diagram 1)

Problem: To store numeric data from card column 52 into Input Storage position 111; to store numeric data from card column 2 into Input Storages 57 and 114.

Procedure: a) Patch wire Input Storage 111 to 1-9 Sensing 52.
b) Patch wire Input Storages 57 and 114 to a bus which is patch wired to 1-9 Sensing 2.

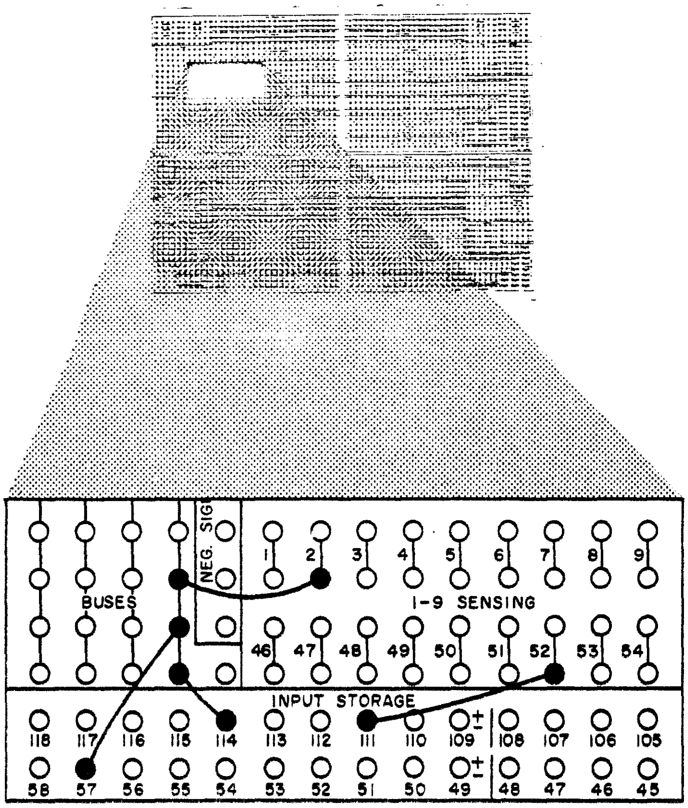


Diagram 1

EXAMPLE 2

Assignment of Card Columns to Input Storage Positions - Alphabetic and/or Numeric Data. (Diagram 2)

Problem: To store data from card column 16 into Input Storage position 40.

Procedure:
a) Patch wire Input Storage 40 to 1-9 Sensing 16.
b) Patch wire 1-9 Sensing (the other hub of the bussed pair) to Zero Sensing Common 16.
c) Patch wire Zero Sensing Exit 16 to Zero Sensing Input 16.

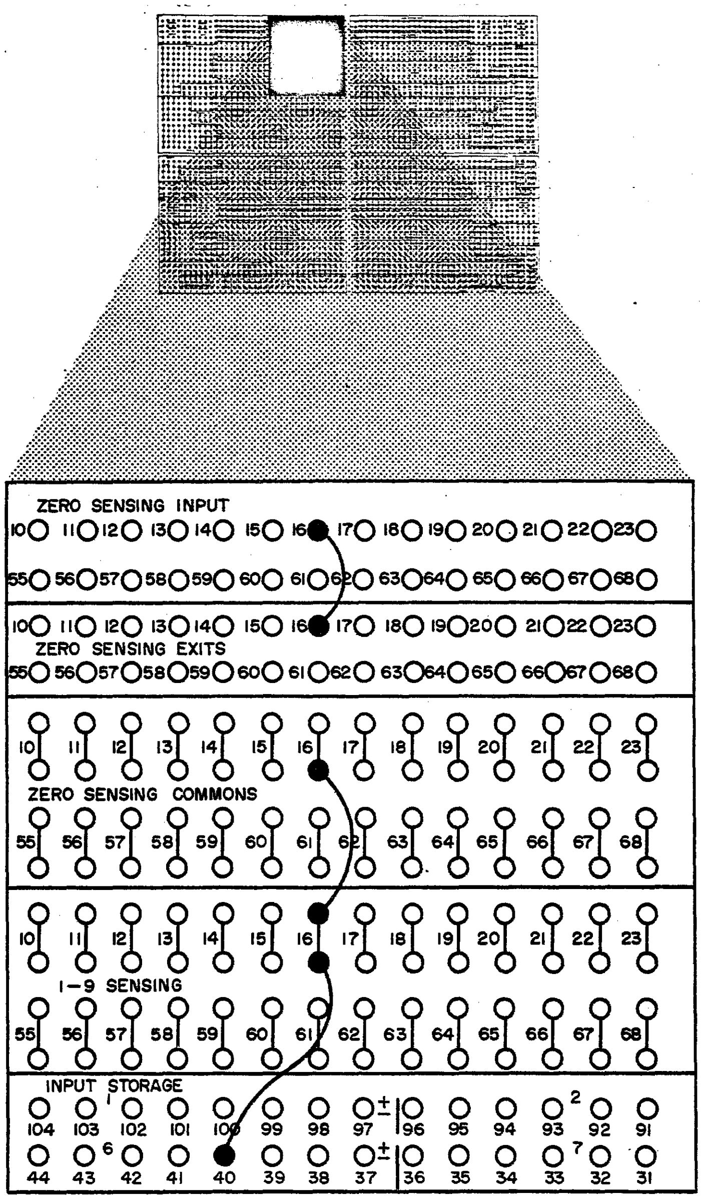


Diagram 2

EXAMPLE 3

Sign Position in Input Data always Negative. (Diagram 3)

Problem: If a certain field always contains negative data, a negative Sign Position is to be simulated in this field in Input Storage position 11.

Procedure: Patch wire Input Storage 11 to Negative Sign Sensing.

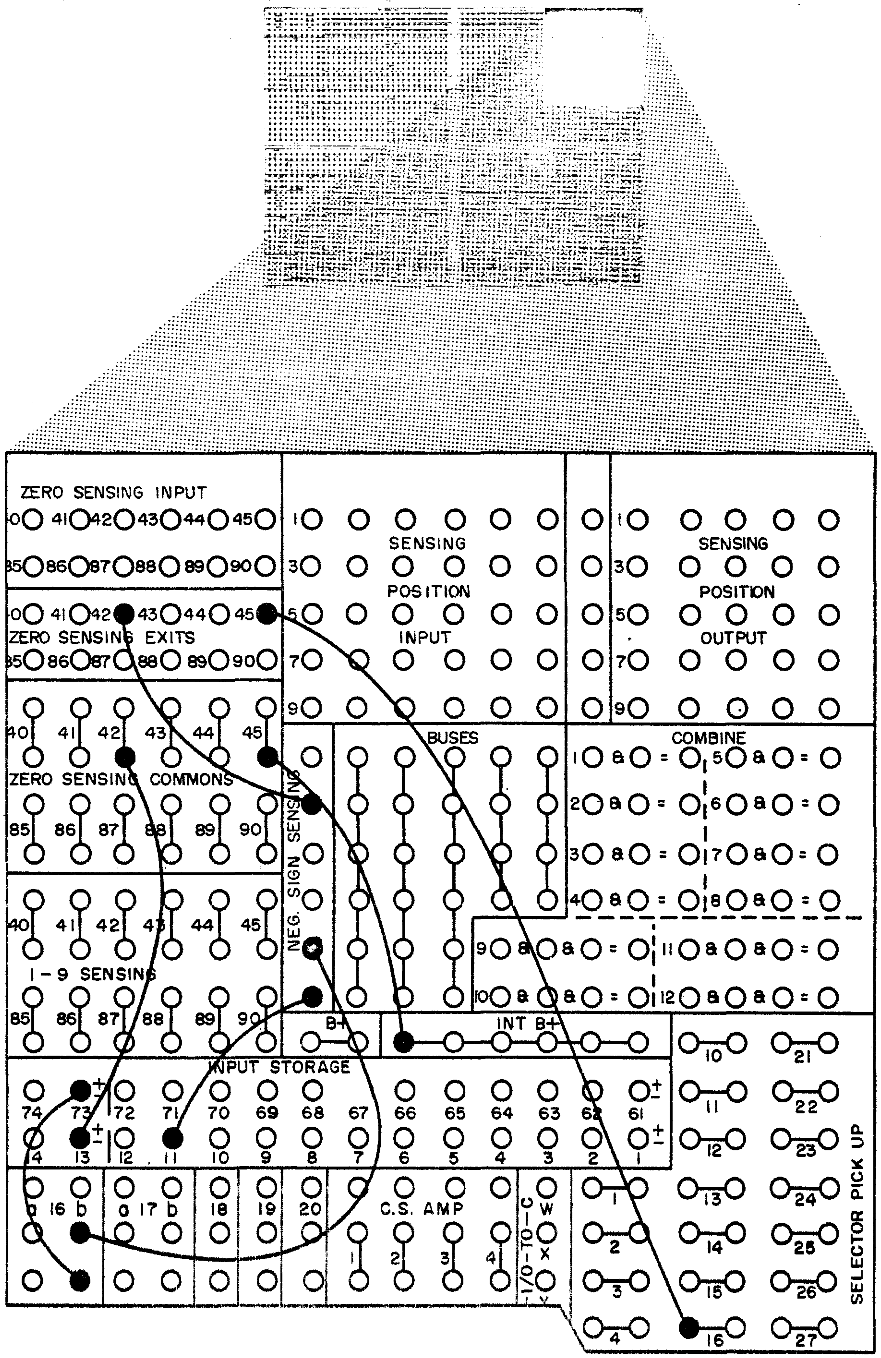


Diagram 3

EXAMPLE 4

Sign Position in Input Data either Positive or Negative. Method I. (Diagram 3)

Problem: When there is a Zero punch in column 42, a negative sign is to be stored in Input Storage 13.

Procedure: a) Patch wire Input Storage 13 to Zero Sensing Common 42.
b) Patch wire from Zero Sensing Exit 42 to Negative Sign Sensing.

Method II. (Diagram 3)

Problem: When there is a Zero punch in column 45 a negative sign is to be stored in Input Storage 73.

Procedure: a) Patch wire INT B+ to Zero Sensing Common 45.
b) Patch wire Zero Sensing Exit 45 to Selector Pick Up 16. Selector 16 will then be activated when there is a Zero in column 45.
c) Patch wire Input Storage 73 to the Select hub of Selector 16.
d) Patch wire the Common hub of Selector 16 to Negative Sign Sensing. Do not wire the non-Select hub of the Selector.

When the Selector is activated, a negative sign will be stored in Input Storage 73, and when the Selector is non-Select, a space code (interpreted as a +) will be stored in Input Storage 73.

EXAMPLE 5

Alpha Numeric Over Capacity Input. (Diagram 4)

In card fields wherein data being handled is strictly numeric, the zero rows of these card columns can be used to represent additional card columns for purposes of over capacity input. As many as 12 alphanumeric or 18 additional numeric digits of information can be put onto one card in this manner, making the capacity of the card 102 or 108 digits instead of 90.

Problem: The Zero Rows of columns 3, 4, 5, 6, 53 and 54 are to be used as an additional column of alphanumeric data, which is to be stored in input storage 52. (Note: card columns 53 and 54 were used to illustrate that any 6 zero rows are satisfactory, and that the zero rows do not have to be contiguous.)

Procedure:

a) In the Zero Sensing Commons Section, bus the 3, 4, 5, 6, 53 and 54 hubs together.

b) Patch wire from Input Storage 52 to one of the bussed Zero Sensing Common hubs.

c) Patch wire the Zero Sensing Exit hubs corresponding to the bussed Zero Sensing Exit 3 to Sensing Position Input 5. Patch wire Exit 4 to Input 7. Patch wire Exit 5 to Input 3. Patch wire Exit 6 to Input 9. Patch wire Exit 53 to Input 1. The order is intentionally mixed to illustrate that any zero now can be made to represent any one of the 1-9 rows. No special configuration is necessary, except that it should correspond to the card punching data.

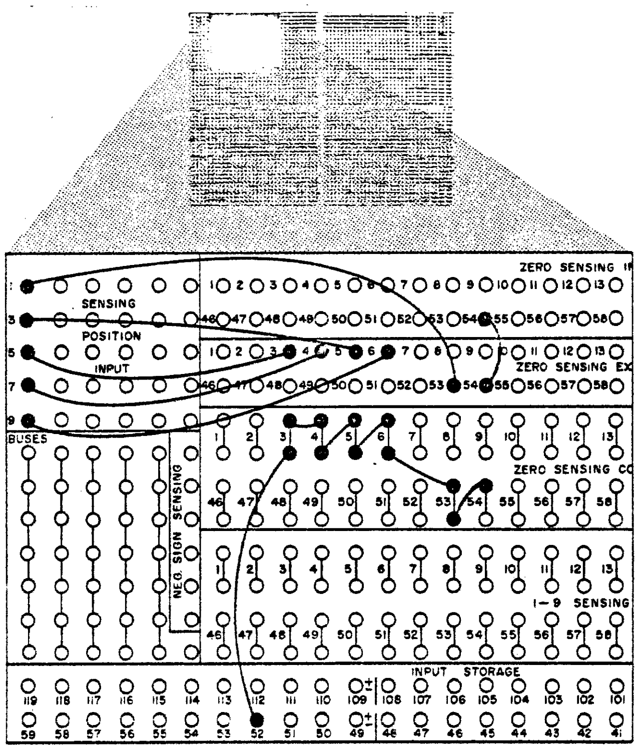


Diagram 4

EXAMPLE 6

<u>Assignment of Output Storage to Card Columns</u>. Alpha and/or Numeric Data. (Diagram 5)

Problem: The data from Output Storage Position 51 is to be punched in Card Column 6.

Procedure: a) Patch wire Output Storage 51 to 1-9 Punching 6.
b) Patch wire 1-9 Punching 6 (the other hub of the bussed pair) to Zero Punching 6.

EXAMPLE 7

<u>Sign in Output</u>. (Diagram 5)

Problem: The sign position of a certain field is to be Output Storage Position 44. If this field is negative, a Zero is to be punched in Card Column 55.

Note: In handling the sign position in output, a minus sign in output storage is translated to a card code 0357. The method used in this example requires that the programmer has previously made sure that a zero is not in the sign position when the sign is positive. The wiring for Example 7 will cause only the zero portion of the code to be punched in the card.

Procedure: Patch wire from Output Storage 44 to the zero section of Punching Column 55.

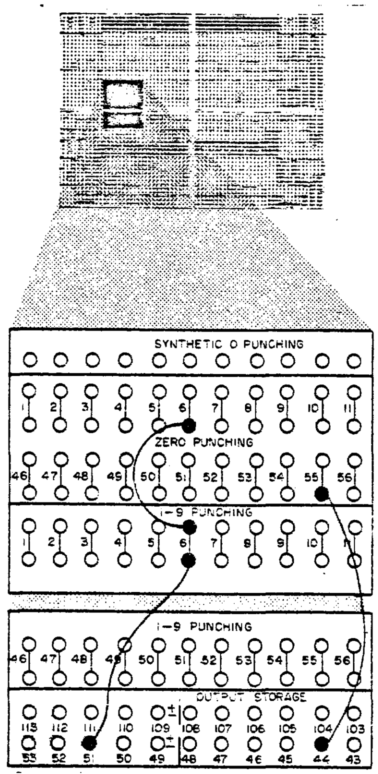


Diagram 5

EXAMPLE 8

<u>Synthetic Punching.</u> (Diagram 6)

Problem: It is desired to punch the date 7/16/57 into Card Columns 38, 39, 40, 41, and 42 of every card being processed.

Procedure:

a) Select any 5 output storage positions not used for sensing or punching. For this example assume 70, 71, 72, 73 and 74 are satisfactory.

b) Connect the 5 output storage hubs to one of the bussed pairs of the 1-9 punching hubs for columns 38-42 as shown in the diagram. (i.e., Output Storage 70 to 1-9 Punching, Column 42; Output Storage 71 to 1-9 Punching, Column 41; etc.)

c) From the other hub of the bussed pair in 1-9 Punching, wire to Synthetic Punching as follows (and as shown in the diagram):

1-9 Punching 38	to Synthetic	7 Punching
1-9 Punching 39	to Synthetic	1 Punching
1-9 Punching 40	to Synthetic	5 & 9 Punching
1-9 Punching 41	to Synthetic	5 Punching
1-9 Punching 42	to Synthetic	7 Punching

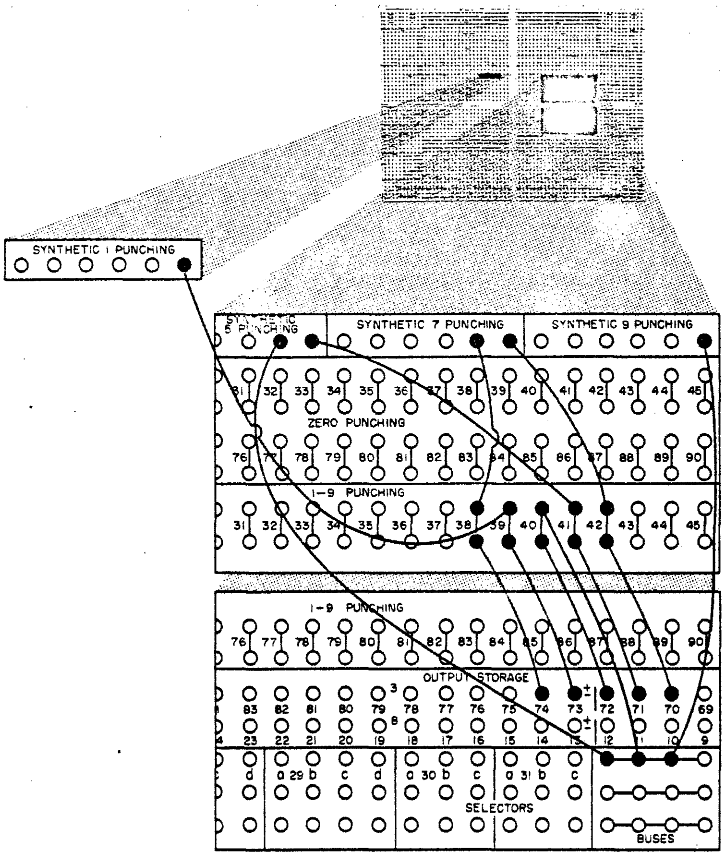


Diagram 6

EXAMPLE 9

Picking up Selectors with C-to-I/O Control Lines and Generating Control Punches. (Diagram 7)

Problem: A signal has been received by way of C-to-I/O control lines for generating a control punch. We wish to punch a zero hole in Column 88 of the card.

Procedure:

a) Pick up a selector. Connect the designated Output Control line (in this case, F) to the designated selector (in this case, 31).

b) Generate the punch. Wire from any Output Storage not being used (in this case, 74) to common of the specified selector (in this case, 31). From the "select" side of the selector wire to one hub of the bussed pair of the specified card column in Zero Punching. Wire from the other hub of the pair to the appropriate control punching hub (in this case Synthetic 0 Punching).

Result: The result of this wiring is to punch a Zero in a specified column without storing it in the Input-Output track of the computer.

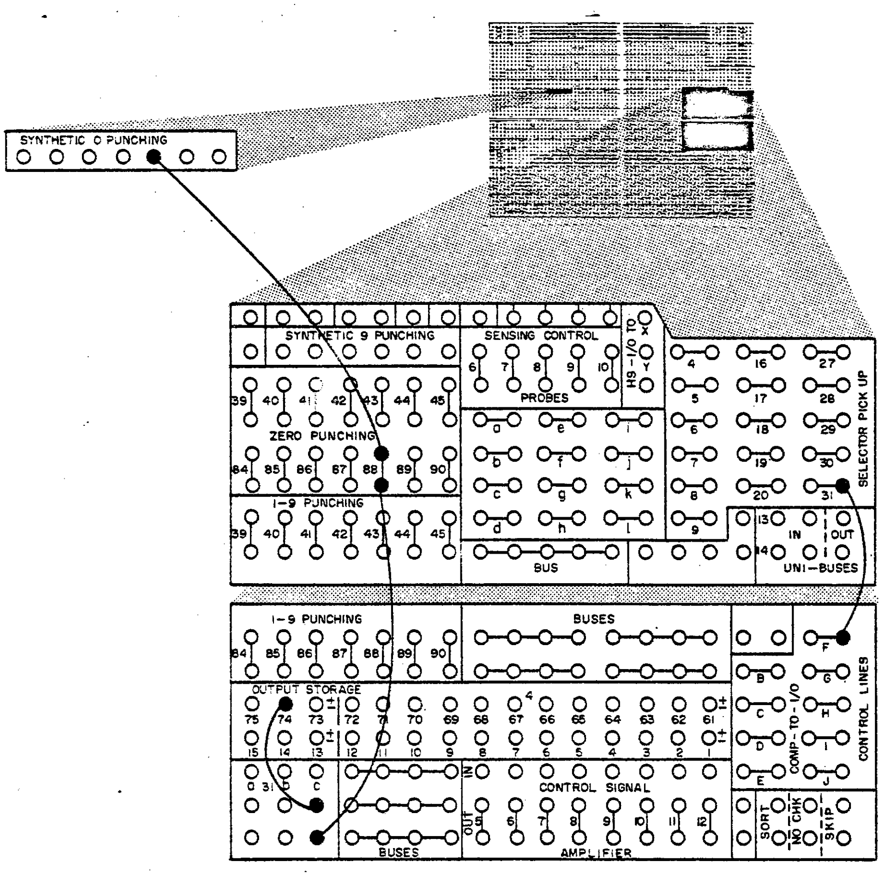


Diagram 7

EXAMPLE 10

Use of Combines. (Diagram 8)

When there is a specified combination of two or more punches in a specified column, we may pick up a selector, activate an I/O-to-C control line or activate an (HS) I/O-to-C control line. This example illustrates picking up a selector.

Problem: A 1 and a 7 are combined in Column 45. Selector 10 is to be picked up.

Procedure: a) Connect the specified card column (45) in 1-9 Sensing to one hub of any pair in the Sensing Control Probes Section. Connect the other hub of the pair in the Sensing Control Probes Section to the "in" of a combine (in this case "Combine" 9).

b) Connect the specified combination of punches (in this case, 1 and 7) in a column of the Sensing Position Output Section to the other "ins" of the Combine.

c) Connect the "out" of the combine to the designated selector pick up (in this case 10).

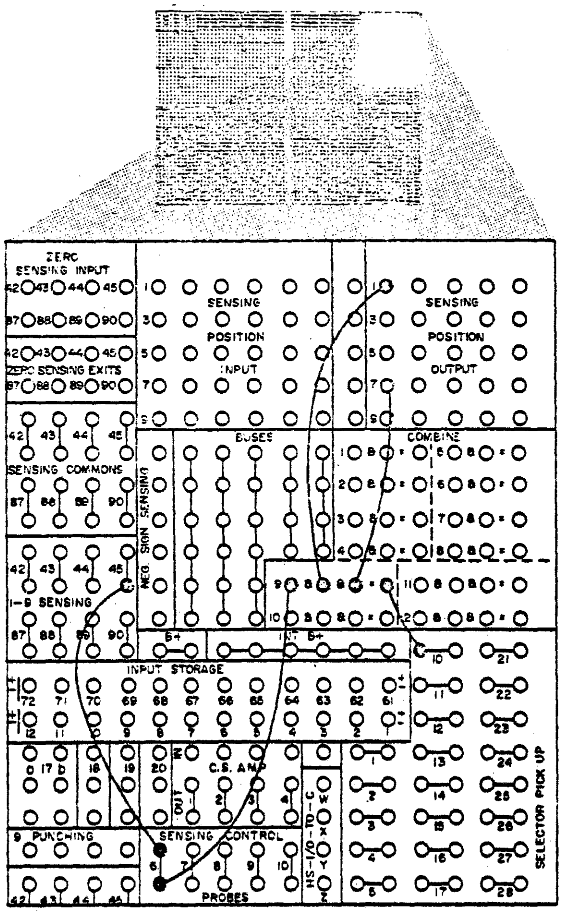


Diagram 8

EXAMPLE 11

Checking. (Diagram 2)

In the checking cycle the card is resensed in exactly the same manner as it was in the original sensing. The information from this sensing is compared with the information which was originally sensed, plus the information which was to be punched. The original sensing and punching information is stored in a buffer by Input-Output storage positions. The card columns sensed in the post checking cycle must be assigned to their proper storage positions, and the comparison is made storage position against storage position. Thus, all columns to be checked must be assigned storage positions by wiring the Checking Section using the same rules as in the Input Section.

Problem: The same wiring as was used in Example 2 is to be checked.

Procedure:
- a) Patch wire checking storage 40 to 1-9 checking position 16;
- b) Patch wire 1-9 checking (the other hub of the bussed pair) to zero checking commons 16.
- c) Patch wire zero checking exit 16 to zero checking input 16.

EXAMPLE 12

Over Capacity Checking. (Diagram 9)

To check over capacity input, the checking section must be wired in exactly the same manner as the input section, except that in wiring from Checking Storage to the Zero Checking Commons the wire must go through Over Capacity Special Checking. Anytime there are only zero column punches in the columns to be checked, Over Capacity Special Checking must be used to supply a special enable for the checking operation.

Problem: The Over Capacity Input wired in Example 5, Diagram 4, is to be checked.

Procedure:
a) In the zero checking commons, bus the 3, 4, 5, 6, 53 and 54.
b) Patch wire checking storage 52 to a over capacity special checking bussed pair. Patch wire the other hub of this pair to the bussed zero checking commons.
c) Patch wire the zero checking exits to the checking position input as follows: Exit 3 to Input 5, Exit 4 to Input 7, Exit 5 to Input 3, Exit 6 to Input 9, Exit 53 to Input 1. Patch wire zero checking exit 54 to zero checking Input 54.

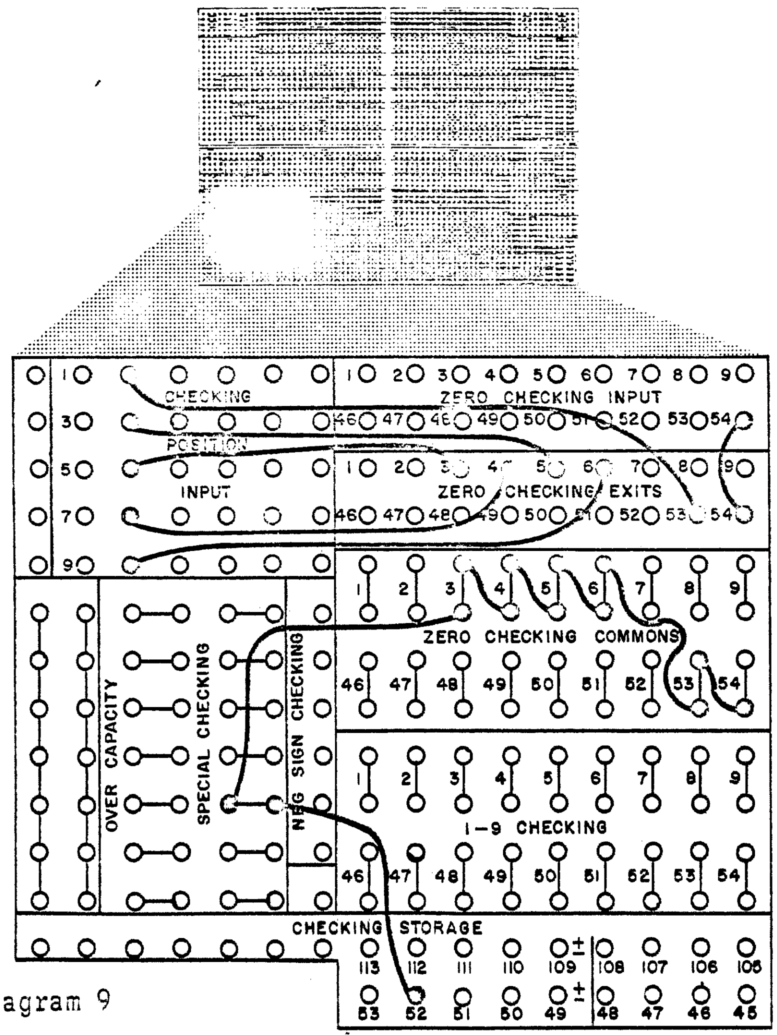


Diagram 9

SEQUENCE OF OPERATIONS

TABLE II

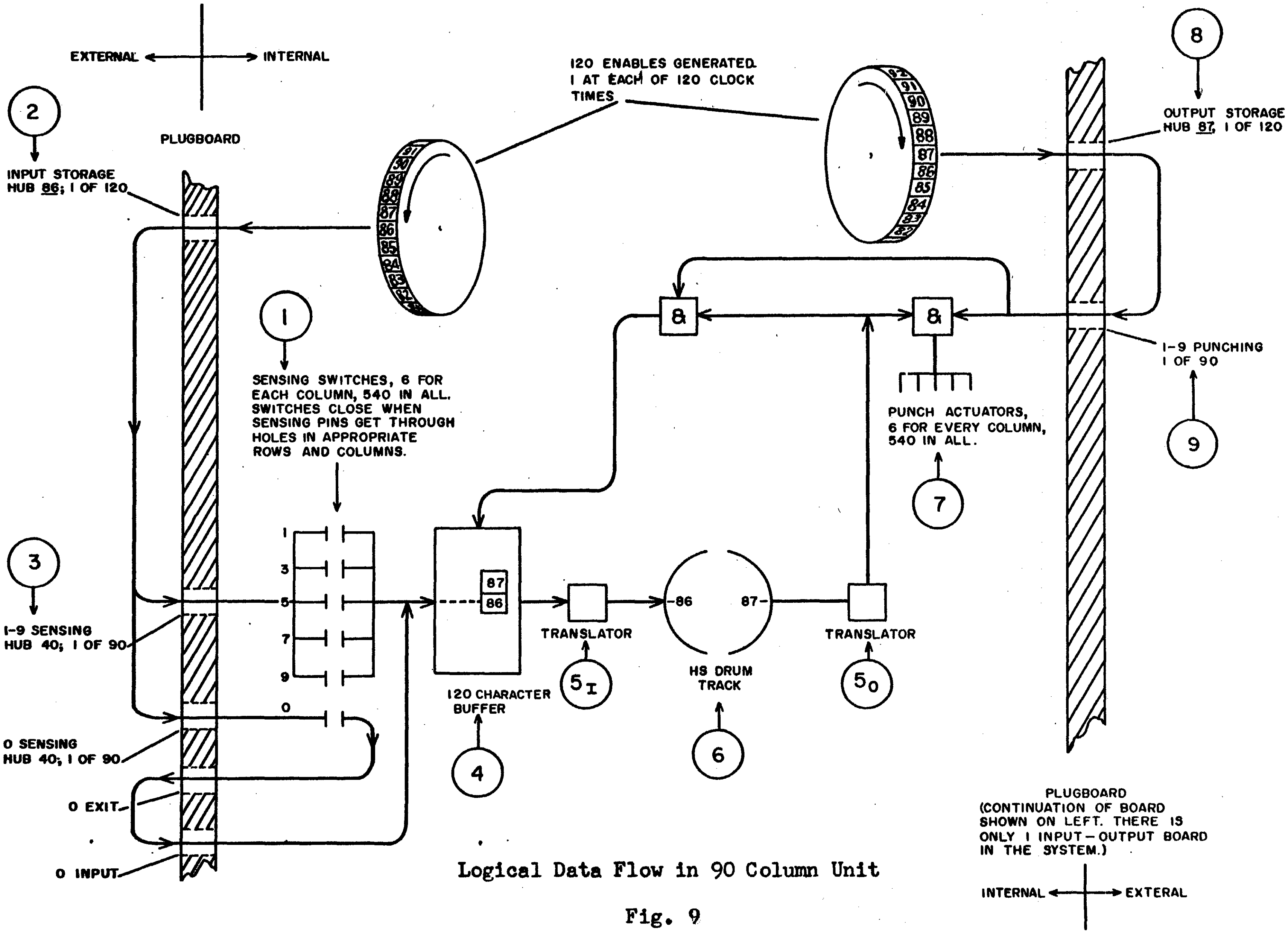
Operation No.	Card Cycle No.	Cycle Time ms	Actual Time ms	Description
1	1	0000	0000	Start
2	1	0400	0400	The card moves from the input hopper to the sensing station.
3	2	0055 to 0090	0455 to 0490	Sensing pins rise through the holes punched in the card, and cause sensing switches (#1 in Fig. 9) to close and lock. The image of the card is retained in the system.
4	2	0066 to 0080	0466 to 0480	Ten enables are generated and brought out to the plugboard at the sensing control probe hubs. These hubs are patch wired to any desired 1-9 column sensing hub (#3) providing a current which passes through the closed sensing switches (at Point #1 in Fig. 9) for that particular column. The current passing through the switch is brought out to the plugboard to Sensing Position Output hubs. These hubs are labelled 1, 3, 5, 7, and 9, representing the rows of a 90 card column, and current from the proper switch is routed to the corresponding hub. The net result of this is that the card is sensed for control punches and selectors can be activated by these control punches before the information from the card is transmitted to the core buffer and subsequently to the input-output track.
5	2	0081 to 0096	0481 to 0496	120 enables are generated, one at each of 120 clock times and are brought to the plugboard at 120 hubs labelled "Input Storage" (#2 in Fig. 9). These hubs are patch wired to any desired column sensing hub (#3 in Fig. 9) providing a current which passes through the closed sensing switches (at point #1 in Fig. 9) for that particular column. The signals passing through the switches are recorded (#4 in Fig. 9) in the desired input storage position of the core buffer. The data then passes from the buffer through various circuitry including a translator (#5 in Fig. 9) and on to the input-output track of the computer (#6 in Fig. 9). The data goes on to the drum in serial fashion, the sign position of word 9 first, LSD of word 9 to MSD of word 9, sign position of word 8 and etc. through the MSD of word 0.

TABLE II (con't)

Operation No.	Card Cycle No.	Cycle Time ms	Actual Time ms	Description
6	2	0096	0496	At this time the unit goes Ready. The computer can demand the unit, switch tracks and compute on the information previously loaded.
7	2	0247 to 0334	0745	When the computations have been completed and the output information positioned on the input-output track, the computer program calls for a track switch and sends a "trip" signal to the card unit initiating another card cycle. If this signal is sent by 334 milliseconds of the cycle (i.e., 235 milliseconds after the computation began) the card unit will operate at its top speed of 150 card per minute. Computation time over 235 milliseconds increases the 400 milliseconds card cycle time by an equivalent amount plus 10 milliseconds.
8	3	0000 to 0020	0800 to 0820	After the tracks have been switched the data is sent from the input-output track (#6) through various circuitry including a translator (#5) to two destinations; a) to set punch actuators (#7), and b) to the core buffer. 120 enables are generated, one at each of 120 clock times in synchronization with the transfer of the 120 characters from the output track. These enables are brought out to the plugboard at the 120 hubs labeled "Output Storage" (#8). These hubs are wired to any desired column punching hub (#9) providing an enable which allows the information from the drum to actuate the proper set of punching actuators (#7). The buffer (#4) is so constructed that both the data originally sensed and the data to be punched will be merged in the one buffer. Ordinarily input information and output information will not be sent to the same storage positions in the buffer, but if such occurs, the result is a combination of the two codes. For example, if a 1, 9 combination is sent to storage (buffer) position 86 in input and a 1, 7 combination is sent to the same position on output, the resulting code in 86 will be a 1, 7, 9 code.
9	3	0011	0811	All selectors activated by interrupted B+ current are now dropped out.

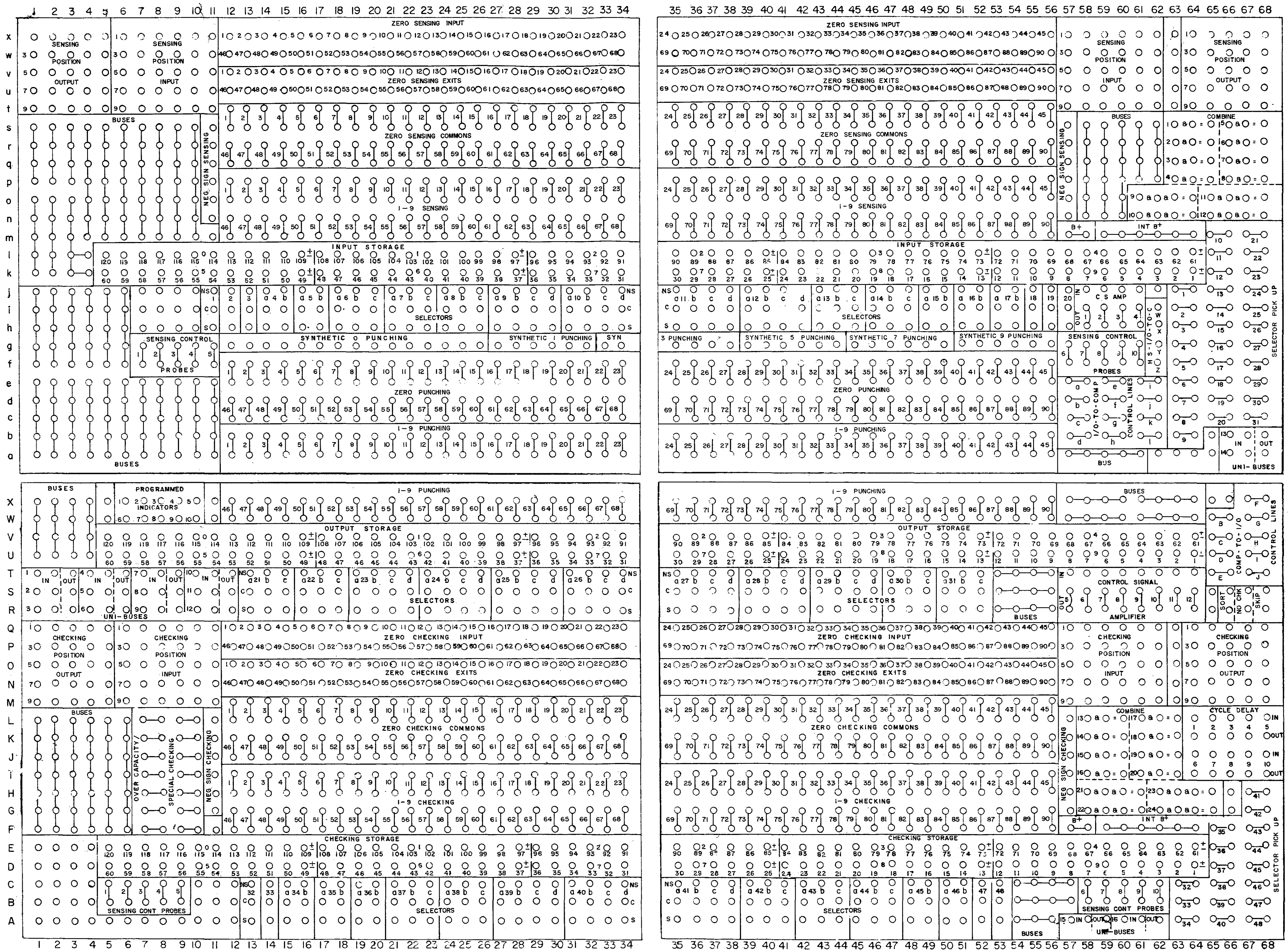
TABLE II (con't)

Operation No.	Card Cycle No.	Cycle Time ms	Actual Time ms	Description
10	3	0073 to 0119	0873 to 0988	The punching actuators previously set now activate the proper punching dies and the card is punched.
11	4	0000 to 0400	1200 to 1600	The card is now at the post-checking station and goes through almost the identical process as described in operation number 1, 2, and 3 above, except that the plugboard hubs are labeled Checking Storage, 1-9 Checking, etc. Instead of being sent to the buffer, signals from the sensing switches are sent to a comparator where the corresponding character from the buffer has also been sent and the comparison is made. An error will cause the unit to step at the end of the cycle. The card on which the error occurred will be the top card in the output hopper. Only columns receiving enables from checking storage will be checked. At the completion of this cycle the card is in the output hopper.



Logical Data Flow in 90 Column Unit

Fig. 9



PLUGBOARD

90 COLUMN CARD UNIT WITH POST READ SENSING

FIGURE 10

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