IV. CENTRAL PROCESSOR

GENERAL DESCRIPTION

The central processor (Figure IV-1) performs the computational (arithmetic), the storage, and the control functions for the GE-225 System. The processor is housed in three equipment racks which are bolted together.

The console indicating and control panel (usually termed the control console) is mounted on the side of the first rack. Below the panel is the console desk and above it is the half-length door covering a maintenance control panel. Inside of the first rack are the main power supply for the processor, the power distribution panel, and the electronic control logic for the card reader, card punch, paper tape reader, and paper tape punch.

Figure IV-1. The Central Processor

The second rack contains the majority of the electronic counters, registers, timing circuits, and control logic associated with the processor.

The third rack contains the remaining registers, the magnetic core memory and its associated timing and control logic, and the logic for the controller selector.

Cable Connections

All peripherals are connected to the central processor by cables. The typewriter is connected directly by cable to the first rack of the central processor. The card reader is also connected to the first rack, but through a junction box mounted in the rear of the console desk.

The peripheral equipments which have controllers are connected to the controller selector by cables so that each peripheral controller is connected in parallel with the controller selector and in series with every other controller. Cables are connected to two plugs in the third rack of the central processor. The output cable from the central processor is connected to one plug, and leads to the input plug of the first controller. Controllers are connected to each other by cables which lead from the output of one to the input of the next. The output of the last controller leads back to the controller selector, and connects to the second of the two plugs in the third rack of the central processor.

The card punch is connected to the central processor through a plug located on the same connector panel on the third rack as the two plugs for the controller selector. The punch cable is clamped in place by means of a 'shoe' connector attached to the end of the cable.

Controls and Indicators

The GE-225 System operator constantly watches and uses the controls and indicators of the central processor. Most of the control switches and indicator lights are on the control console which provides switches for manual control, indicates the status of equipment, and displays the contents of certain registers. In addition to the control console, there is a maintenance panel which has three areas of interest and use to the operator.

A. MAINTENANCE PANEL. The maintenance panel of the central processor, illustrated in Figure IV-2, is located inside the door which is above the control console. It is used mostly by service

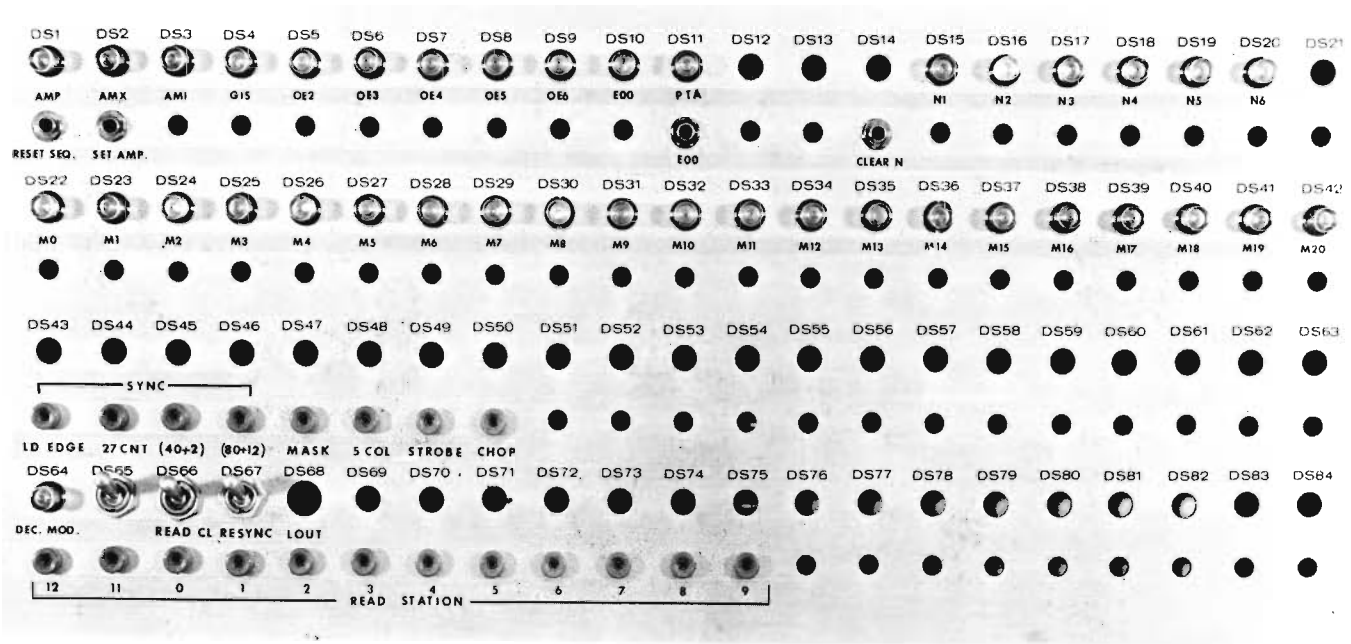

Figure IV-2. The Maintenance Panel of the Central Processor

engineers, but there are three items of concern to the operator. These are the N register indicators, the CLEAR N Switch, and the DEC MOD indicator.

N Register Indicators. These lights are located in the upper right corner of the maintenance panel and are labelled N1, N2, N3, N4, N5, and N6. They show the contents of the N register which is a BCD character representation of the input or output for either the paper tape reader, paper tape punch, or the typewriter.

CLEAR N Switch. This switch is to the left and slightly below the N register indicators. When depressed, it clears the contents of the N register to zero. The operator uses this switch , for example, when the typewriter is hung in a loop and depressing the space bar does not clear the N register. This could happen if someone turns off the typewriter while a program is running. Depressing the CLEAR N switch and manually entering a TON instruction will cause the typewriter to resume typing.

DEC MOD Indicator. This light is in the lower left corner of the maintenance panel. It is illuminated when the processor is in the decimal mode. When the light is out, the processor is in the binary mode. The operator can easily check the mode of operation by looking at the light.

B. CONTROL CONSOLE. The control console (Figure IV-3) is the most important and most used panel on the GE-225. It is sometimes referred to as having both an indicator panel and a control panel, for the upper two thirds of the console contains indicator lights and the lower third contains control switches. The indicators are alarm lights, ready lights, and register display lights for the A, I, and P registers. The controls are option switches and control switches.

Alarm Indicators. The six alarm indicator lights in the upper left hand corner of the console are danger signals that indicate error conditions have occurred during system operation, and the program may be aborted. The cause can be an operator error, a programming error, or a malfunction in the system equipment. All alarm indicators except the PRIORITY alarm can be turned off by the RESET ALARM switch. However, it must be remembered that use of the RESET ALARM switch can damage the program if used when not authorized to do so by the programmer. The conditions which cause these alarms to come on are as follows:

PRIORITY Alarm. This alarm is turned on under any of the following conditions:

1. The AUTO/MANUAL switch is in the MANUAL position.
2. The STOP ON PARITY ALARM switch is engaged and a parity error is detected.
3. The central processor does not have priority (access to memory).
4. A card punch or card reader alarm condition has occurred.

PARITY Alarm. If the STOP ON PARITY ALARM switch is engaged when a parity error is detected, the central processor will halt. The PARITY alarm can be turned off by pressing the RESET ALARM switch or by programmed instructions. The PARITY alarm is turned on under any of the following conditions:

1. The memory-checking circuits of the central processor detect a parity error while the AUTO/MANUAL switch is in the AUTO position.
2. The parity checking circuits associated with the paper tape reader detect a parity error.
3. A parity error is detected as information is received from a controller through the controller selector.

OVERFLOW Alarm. The central processor does not halt on an overflow alarm. The alarm may be reset automatically several times during a normal MPY instruction. The indicator also can be turned off by depressing the RESET ALARM switch or by programmed instructions. The OVERFLOW alarm is turned on under any of the following conditions:

1. The capacity of the A register is exceeded during arithmetic operations.
2. An illegal divide is attempted.
3. A one bit is shifted out of bit position one of the A register during a shift-left operation.

CARD PUNCH Alarm. This alarm is turned on any time a WCB, WCD, or WCF instruction is attempted when the card punch is not in the ready condition. As already noted, the PRIORITY alarm also comes on, and the central processor halts. The alarm can be reset only by pressing the RESET ALARM switch.

ECHO Alarm. This alarm is turned on when the central processor makes an unsuccessful at-

tempt to select a controller through the controller selector for an input/output operation. The ECHO alarm light can be turned off only by depressing the RESET ALARM switch. The alarm indicates the following conditions:

1. The selected controller is busy (delay not programmed).
2. An erroneous address was programmed, the addressed plug is not installed.

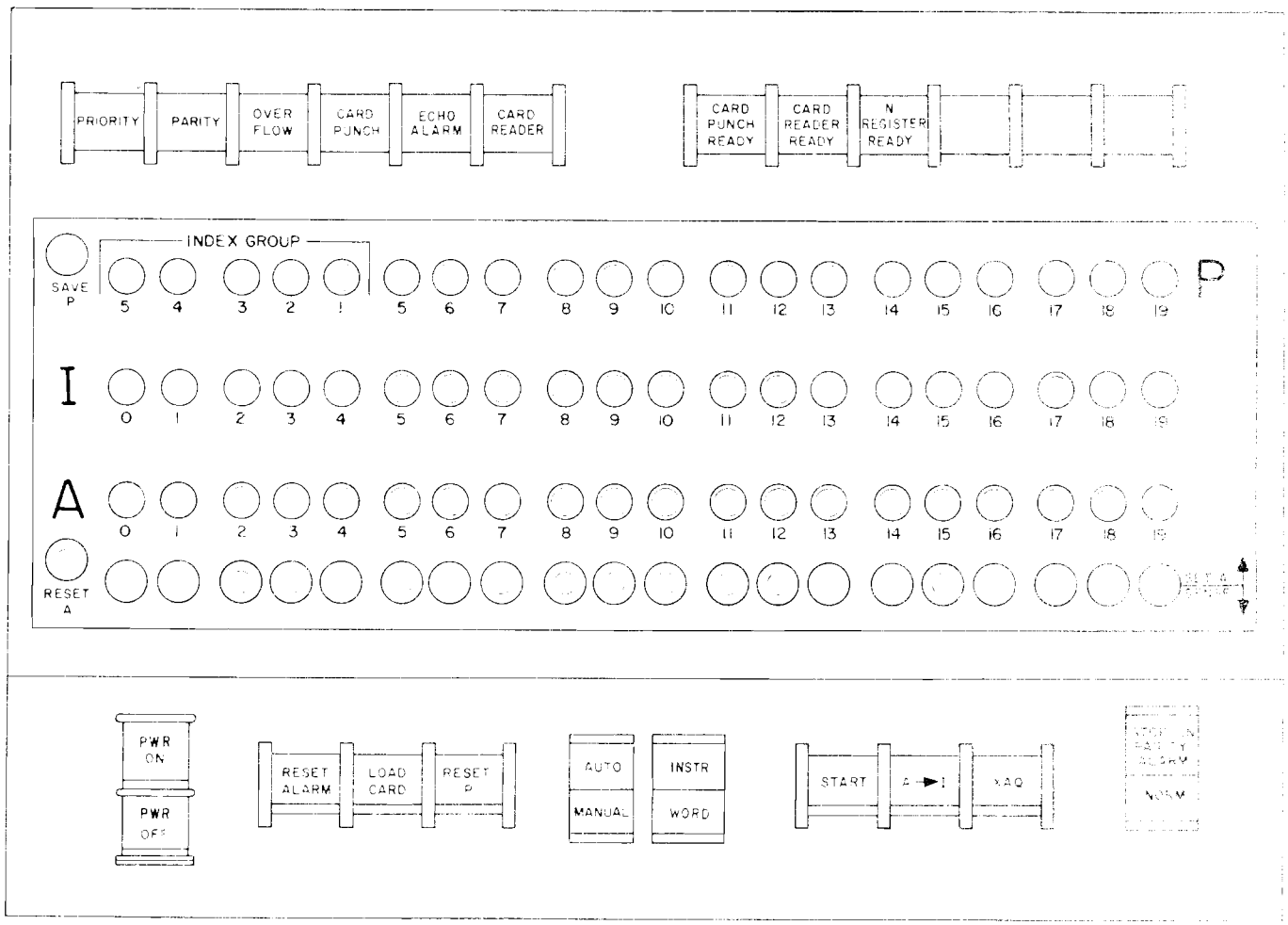

Figure IV-3. The Control Console

3. Controller is off line.

4. Power is off to controller.

5. Controller is malfunctioning.

CARD READER Alarm. This alarm is turned on when attempting to execute an RCB, RCD, or RCF instruction while the card reader is not in the ready condition. When the CARD READER alarm comes on, the PRIORITY alarm also comes on and the card reader and the central processor halt. The alarms in this combination are reset only by depressing the RESET ALARM switch. The reader can be 'not ready' for any of the following reasons:

1. Card Reader is not turned on.

2. Input hopper is empty.

3. A card is not positioned on the sensing platform.

4. Reader is busy (already reading a card).

5. A misfeed or card jam occurs.

Ready Indicators. The green ready indicator lights in the upper right corner of the control console give 'go-ahead' signals to the operator. With certain exceptions, these lights come on when the card punch and card reader are ready for use or when the N register is ready to receive information. If the equipment is not ready for operation, an attempt to use it will turn the ready light off and set an alarm indicator. There is room on the console for three additional ready indicators. For example, some GE-225 Systems have an optional indicator for the automatic interrupt mode (AIM). The standard ready indicators are the following:

CARD PUNCH READY. This light is turned on to indicate that, in five respects, the card punch is ready to punch cards. If the card punch is not otherwise in an operable condition when a punch instruction is attempted, the ready light will go off and the CARD PUNCH and PRIORITY alarms will come on. The five conditions of readiness which together turn on the CARD PUNCH READY light are:

1. The input hopper contains cards.

2. The stacker is not full.

3. A card is properly located at station 'one'.

4. A card is not currently being punched.

5. The chip box is properly seated.

CARD READER READY. This light is turned on to indicate that, in three respects, the card reader is ready to read cards. If the card reader is not otherwise in an operable condition when a read instruction is attempted, the ready light will go off and the CARD READER and PRIORITY alarms will come on. The three conditions of readiness which turn the CARD READER READY light on are:

1. The input hopper contains enough cards (or weight) to depress the hopper-empty switch.

2. A card is not currently being read.

3. No misfeed or card jam is detected.

N REGISTER READY. This light comes on to indicate that the N register is ready to receive input or output information. Specifically, it means that the register is not currently being used by the typewriter, paper tape reader, or paper tape punch. If an illegal code is placed in the N Register and a TYP command given, the N REGISTER READY light goes out and stays out until a space key is struck.

Index Group Indicators. The five INDEX GROUP display lights are located below the alarm lights and to the left of the P counter display lights. The lights are numbered one through five from right to left. These five lights, read as binary digits, indicate the index group that has been selected by the program (Groups 0 through 31). Each group has four registers, 0 through 3. When all lights are off, group zero is available without special selection. Only index group zero is standard on the GE-225 System; additional groups are optional. Any time a light is on in the index group, the operator knows that an index group other than zero has been selected.

P Counter Lights. The fifteen display lights for the P counter are located to the right of the INDEX GROUP indicators. They are numbered, left to right, from 5 through 19 , and are arranged in groups of three to facilitate reading the binary numbers in their octal representation. By reading these groups, the operator can know the location of the instruction which appears in the I register. The P counter is useful when debugging a program and when checking for correct operation after a manual branch command to a particular program location.

SAVE P Switch. This switch permits the operator to return to a particular position in the program after he has interrupted it to make a correction, such as to introduce an instruction manually. The SAVE P switch in the down position prevents the P counter from incrementing. When the operator returns the SAVE P switch to the up (normal) position after manual operations, the program is ready to continue from the

place of interruption. When the SAVE P switch is in the down position during the automatic mode of operation, the instruction in the I register is executed over and over again.

I Register Lights. The 20 I register display lights are located below the INDEX GROUP and P counter lights, and are number from 0 to 19. They display the contents of the instruction register. Like the other register display lights, they are read in their octal representation. The I register displays the current instruction, the instruction that has not yet been executed o r has been only partly executed.

A Register Lights. The 20 A register display lights are located below the I register lights. They are numbered from 0 to 19, and display the contents of the A register. These are also read in octal. By using the XAQ switch (described later), the A register lights can be used to display the contents of the Q register. All data and instructions fed manually into the central processor go through the A register, and are entered by use of the option switches.

Option Switches. The 20 option switches just below the A register display lights are used to feed information into the A register. Each o f these toggle switches enters information into the corresponding A register position. The numbers 0 through 19 below the A register lights may be thought of as also applying to the switches. When moved up, the switches are spring loaded and return automatically to the center (normal) position. When moved down, they remain in the down position until manually returned to the normal position.

When the central processor is in the manual mode of operation, moving an option switch up causes a one to be put into the corresponding position of the A register. This is indicated by an A register display light. Moving an option switch up has no effect when the central processor is in the automatic mode of operation.

Moving an option switch down when the central processor is in the automatic mode causes a one to be put into the corresponding position of the A register at the time of a programmed RCS instruction. Specified switches are left in the down position while running certain routines and while generating GAP assemblies. These and other special uses of the option switches are specified in the programmer's instructions to the operator.

RESET A Switch. This switch is to the left of the option switches. It is effective only when the central processor is in the manual mode of operation. Like the option switches, it is spring loaded in the up position but not in the down position. When moved either up or down, it clears to zero the contents of the A register, and turns off all of the A register display lights. When the operator makes a mistake while using the option switches, he can correct this mistake by clearing the A register with the RESET A switch and then starting over.

Toggle. When referring to the toggle switches, it has become customary to use the term toggle as a verb. When used in this way, it means to move the switch either up or down and immediately return it to its original position.

Control Switches

A strip of switches along the bottom of the control console, and the SAVE P and RESET A switches just described, give the operator manual control over the central processor and certain functions of peripherals. Eight of the switches are the pushbutton type that require only to be pressed momentarily to be activated. Three double-label switches are the rocker type with two positions. For instance, the AUTO MANUAL SWITCH is placed in the AUTO position by pressing the end that is labeled AUTO and leaving that end in the depressed position.

These switches, illustrated in Figure IV-4, are described as follows:

PWR. ON. Depressing the PWR ON pushbutton turns on DC power to the central processor, the control console, and the 400 card per minute reader. The pushbutton is also an indicator, for it lights when power is on.

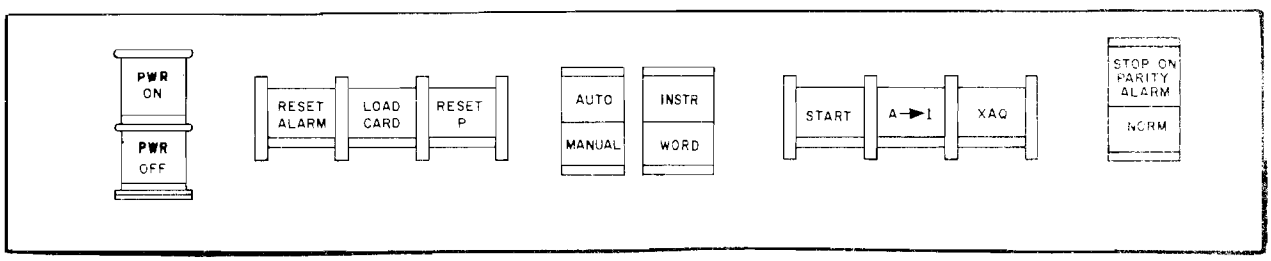

Figure IV-4. Control Switches on the Control Console

3. Controller is off line.

4. Power is off to controller.

5. Controller is malfunctioning.

CARD READER Alarm. This alarm is turned on when attempting to execute an RCB, RCD, or RCF instruction while the card reader is not in the ready condition. When the CARD READER alarm comes on, the PRIORITY alarm also comes on and the card reader and the central processor halt. The alarms in this combination are reset only by depressing the RESET ALARM switch. The reader can be 'not ready' for any of the following reasons:

1. Card Reader is not turned on.

2. Input hopper is empty.

3. A card is not positioned on the sensing platform.

4. Reader is busy (already reading a card).

5. A misfeed or card jam occurs.

Ready Indicators. The green ready indicator lights in the upper right corner of the control console give 'go-ahead' signals to the operator. With certain exceptions, these lights come on when the card punch and card reader are ready for use or when the N register is ready to receive information. If the equipment is not ready for operation, an attempt to use it will turn the ready light off and set an alarm indicator. There is room on the console for three additional ready indicators. For example, some GE-225 Systems have an optional indicator for the automatic interrupt mode (AIM). The standard ready indicators are the following:

CARD PUNCH READY. This light is turned on to indicate that, in five respects, the card punch is ready to punch cards. If the card punch is not otherwise in an operable condition when a punch instruction is attempted, the ready light will go off and the CARD PUNCH and PRIORITY alarms will come on. The five conditions of readiness which together turn on the CARD PUNCH READY light are:

1. The input hopper contains cards.

2. The stacker is not full.

3. A card is properly located at station 'one'.

4. A card is not currently being punched.

5. The chip box is properly seated.

CARD READER READY. This light is turned on to indicate that, in three respects, the card reader is ready to read cards. If the card reader is not otherwise in an operable condition when a read instruction is attempted, the ready light will go off and the CARD READER and PRIORITY alarms will come on. The three conditions of readiness which turn the CARD READER READY light on are:

1. The input hopper contains enough cards (or weight) to depress the hopper-empty switch.

2. A card is not currently being read.

3. No misfeed or card jam is detected.

N REGISTER READY. This light comes on to indicate that the N register is ready to receive input or output information. Specifically, it means that the register is not currently being used by the typewriter, paper tape reader, or paper tape punch. If an illegal code is placed in the N Register and a TYP command given, the N REGISTER READY light goes out and stays out until a space key is struck.

Index Group Indicators. The five INDEX GROUP display lights are located below the alarm lights and to the left of the P counter display lights. The lights are numbered one through five from right to left. These five lights, read as binary digits, indicate the index group that has been selected by the program (Groups 0 through 31). Each group has four registers, 0 through 3. When all lights are off, group zero is available without special selection. Only index group zero is standard on the GE-225 System; additional groups are optional. Any time a light is on in the index group, the operator knows that an index group other than zero has been selected.

P Counter Lights. The fifteen display lights for the P counter are located to the right of the INDEX GROUP indicators. They are numbered, left to right, from 5 through 19, and are arranged in groups of three to facilitate reading the binary numbers in their octal representation. By reading these groups, the operator can know the location of the instruction which appears in the I register. The P counter is useful when debugging a program and when checking for correct operation after a manual branch command to a particular program location.

SAVE P Switch. This switch permits the operator to return to a particular position in the program after he has interrupted it to make a correction, such as to introduce an instruction manually. The SAVE P switch in the down position prevents the P counter from incrementing. When the operator returns the SAVE P switch to the up (normal) position after manual operations, the program is ready to continue from the

place of interruption. When the SAVE P switch is in the down position during the automatic mode of operation, the instruction in the I register is executed over and over again.

I Register Lights. The 20 I register display lights are located below the INDEX GROUP and P counter lights, and are number from 0 to 19. They display the contents of the instruction register. Like the other register display lights, they are read in their octal representation. The I register displays the current instruction, the instruction that has not yet been executed o r has been only partly executed.

A Register Lights. The 20 A register display lights are located below the I register lights. They are numbered from 0 to 19, and display the contents of the A register. These are also read in octal. By using the XAQ switch (described later), the A register lights can be used to display the contents of the Q register. All data and instructions fed manually into the central processor go through the A register, and are entered by use of the option switches.

Option Switches. The 20 option switches just below the A register display lights are used to feed information into the A register. Each o f these toggle switches enters information into the corresponding A register position. The numbers 0 through 19 below the A register lights may be thought of as also applying to the switches. When moved up, the switches are spring loaded and return automatically to the center (normal) position. When moved down, they remain in the down position until manually returned to the normal position.

When the central processor is in the manual mode of operation, moving an option switch up causes a one to be put into the corresponding position of the A register. This is indicated by an A register display light. Moving an option switch up has no effect when the central processor is in the automatic mode of operation.

Moving an option switch down when the central processor is in the automatic mode causes a one to be put into the corresponding position of the A register at the time of a programmed RCS instruction. Specified switches are left in the down position while running certain routines and while generating GAP assemblies. These and other special uses of the option switches are specified in the programmer's instructions to the operator.

RESET A Switch. This switch is to the left of the option switches. It is effective only when the central processor is in the manual mode of operation. Like the option switches, it is spring loaded in the up position but not in the down position. When moved either up or down, it clears to zero the contents of the A register, and turns off all of the A register display lights. When the operator makes a mistake while using the option switches, he can correct this mistake by clearing the A register with the RESET A switch and then starting over.

Toggle. When referring to the toggle switches, it has become customary to use the term toggle as a verb. When used in this way, it means to move the switch either up or down and immediately return it to its original position.

Control Switches

A strip of switches along the bottom of the control console, and the SAVE P and RESET A switches just described, give the operator manual control over the central processor and certain functions of peripherals. Eight of the switches are the pushbutton type that require only to be pressed momentarily to be activated. Three double-label switches are the rocker type with two positions. For instance, the AUTO MANUAL SWITCH is placed in the AUTO position by pressing the end that is labeled AUTO and leaving that end in the depressed position.

These switches, illustrated in Figure IV-4, are described as follows:

PWR. ON. Depressing the PWR ON pushbutton turns on DC power to the central processor, the control console, and the 400 card per minute reader. The pushbutton is also an indicator, for it lights when power is on.

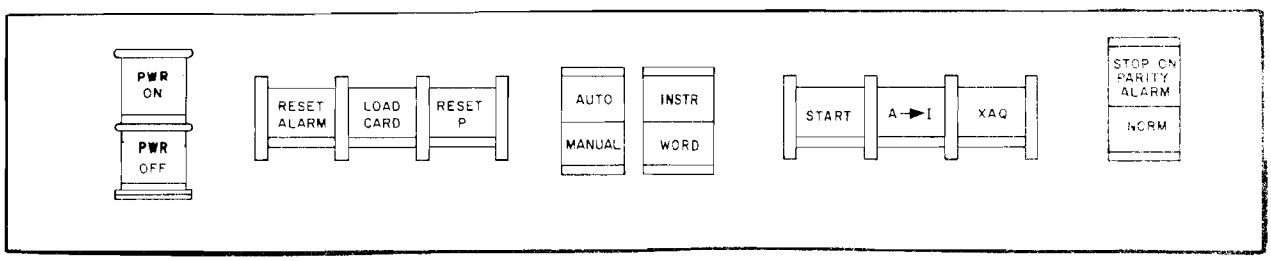

Figure IV-4. Control Switches on the Control Console

PWR. OFF. When DC power is on, depressing this pushbutton turns it off.

RESET ALARM. This switch is effective only in the manual mode of operation. Depressing the pushbutton clears any existing alarm condition. It turns off the alarm lights and resets flip-flops so the central processor can continue operation. It does not clear up the cause of the alarm.

LOAD CARD. This switch is effective only in the manual mode of operation. Depressing the pushbutton initiates card reader action and causes the reader to go through one load and read cycle. It is used most often to load the first card into memory during program startup operations. If no card was on the sensing platform, it moves one onto it. From there, the card is read into memory locations starting at 0000.

RESET P. This switch is effective only in the manual mode of operation. Depressing the pushbutton clears the P counter to all zeros. It is used most often to cause the first instruction to address memory cell zero, and is normally activated just before setting the AUTO/MANUAL switch to AUTO at the beginning of program operation.

AUTO/MANUAL. This two-position, rocker-type switch selects either the automatic or the manual mode of operation for the central processor. When the AUTO portion of the switch is depressed, the central processor is in the automatic mode, and instructions are processed in a continuous sequence under program control. When the MANUAL portion of the switch is depressed, the central processor is in the manual mode, and the program is executed only one step at a time as the START switch is depressed. Setting the AUTO/MANUAL switch to MANUAL during automatic operation causes the computer to halt operations at the end of the instruction or word being executed. The operator will recall that putting the central processor in the manual mode causes the PRIORITY alarm light to come on. The following operations can be performed only when the AUTO/MANUAL switch is set to MANUAL:

1. Clear or set information into A register with option switches.
2. Clear alarm conditions with RESET ALARM switch.
3. Reset P counter with RESET P switch.
4. Load a card manually using LOAD CARD switch.
5. Transfer contents of A register to I register using A to I switch.
6. Exchange contents of A and Q registers using XAQ switch.

INST/WORD. This is also a two-position, rocker-type switch which is effective only in the manual mode of operation. It determines the length of the cycle of the central processor during manual operations. When the INST portion of the switch is depressed, the central processor executes one complete instruction each time the START switch is engaged. When the WORD portion of the switch is depressed, only one word time is executed each time the START switch is engaged. The WORD position is used by the operator during system startup and shutdown.

START. In the automatic mode of operation, depressing the START pushbutton initiates action. After the operation begins, the program runs automatically and depressing the START switch again has no effect. In the manual mode of operation, depressing the START switch causes the execution of one instruction or one word time, depending upon the setting of the INSTR/WORD switch.

A ⟶ I (A to I). This switch is effective only in the manual mode of operation. Depressing the A to I pushbutton transfers the contents of the A register, including the sign bit, to the I register. The contents of the A register remain unchanged, and can be cleared by toggling the RESET A switch. The A to I switch is used to manually load an instruction into the I register or to correct an instruction already there.

XAQ. This switch is effective only in the manual mode of operation. Depressing XAQ causes an exchange of information between the A and Q registers. That is, the contents of A go into Q and the contents of Q go into A. This permits the operator to observe the contents of the Q register. By using the RESET A switch and the option switches, the operator can clear and correct the contents of the Q register while saving the contents of the A register.

STOP ON PARITY ALARM/NORM. This is a two-position, rocker-type switch. It determines the response of the central processor to the detection of a parity error. When the STOP ON PARITY ALARM portion of the switch is depressed, the central processor halts each

time a parity error is detected and the PARITY and PRIORITY alarm lights come on. When the NORM (normal) portion of the switch is depressed, the central processor continues operation regardless of parity errors, and the only indication of a parity error is the fact that the PARITY alarm light is turned on. The setting of the STOP ON PARITY ALARM/NORM switch is determined by the programmer. If he has included remedial action throughout the program to take care of parity errors and to reset the PARITY alarm light, he will specify the setting of the STOP ON PARITY ALARM/NORM switch to the NORM position. If he has not included remedial steps in the program, he will want the program to halt at time of a parity error, so will specify the setting of STOP ON PARITY ALARM.

Table I contains a summary of the controls and indicators of the maintenance panel and control console. It is recommended that the student operator remove the table from the manual and keep it in a handy place at the console for quick reference.

TABLE I.

FUNCTIONS OF CONTROLS AND INDICATORS

ON CENTRAL PROCESSOR

Group	Control or Indicator	Function
Alarm Indicator Lights	PRIORITY alarm light (red)	Indicates: 1. AUTO/MANUAL switch is in MANUAL position. 2. Parity alarm condition. 3. Central processor does not have priority. 4. Card punch or card reader alarm condition.
	PARITY alarm light (red)	Indicates: 1. Memory-checking circuits of processor detected parity error while processor in automatic mode. 2. Parity error connected with tape reader. 3. Parity error detected as data received from a controller through controller selector.
	OVERFLOW alarm light (white)	Indicates: 1. Capacity of the A register was exceeded. 2. Illegal divide attempted. 3. Data shifted, left out of the A register.
	CARD PUNCH alarm light (red)	Indicates card punching was attempted when card punch was not in a ready condition.
	ECHO ALARM light (red)	Indicates an unsuccessful attempt to select a controller for any of these reasons: 1. Controller busy 2. Incorrect address 3. Controller off line 4. Power off to controller 5. Malfunctioning controller.
	CARD READER alarm light (red)	Indicates card reading was attempted while the card reader was not ready (not set up, busy, misfeed, or card jam.)
Ready Indicator Lights	CARD PUNCH READY light (green)	Indicates when card punch is in 'ready' status.

TABLE I. (CONT.)

Group	Control or Indicator	Function
READY INDICATOR lights (cont.)	CARD READER READY light (green)	Indicates that the reader is ready to read a card.
	N REGISTER READY light (green)	Indicates that the N register is ready to receive data.
	ARM READY light (green)	
Register Display Lights and Switches	ENTRY GROUP indicator lights	
	P register display lights	
	SAVE switch	
	I register display lights	
	A register display lights	
	Option Switches	
	RESET A switch	
Control Switches	PWR ON switch	
	PWR OFF switch	
	RESET ALARM switch	

TABLE I. (CONT.)

Group	Control or Indicator	Function
Control Switches (cont.)		is engaged).
	LOAD CARD switch	Causes card reader to execute one Read Card Binary cycle (effective only when MANUAL switch is engaged).
	RESET P switch	Resets P counter to all zeros (effective only when MANUAL switch is engaged).
	AUTO/MANUAL switch	Selects automatic or manual mode of operation of central processor; MANUAL stops processor, turns on PRIORITY alarm.
	INSTR/WORD switch	Selects length of cycle of processor during manual mode of operations (instruction or word at a time).
	START switch	Initiates execution of one cycle of operation (instruction or word); in automatic, initiates execution of program.
	A ⟶ I switch	Transfers contents of A register to I register (effective only when MANUAL switch is engaged).
	XAQ switch	Exchanges contents of A and Q registers (effective only when MANUAL switch is engaged).
	STOP ON PARITY ALARM/NORM switch	Determines whether central processor stops when a parity error is detected.
Maintenance Panel	N register indicators	Shows contents of N register input or output for the paper tape reader, paper tape punch, or typewriter.
	CLEAR N switch	Clears contents of N register to zero.
	DEC MOD indicator	Indicates when lit that the central processor is in the decimal mode.

1. Set the INSTR WORD switch to the [illegible] position.

2. Set the AUTO MANUAL switch to the MANUAL position.

3. Toggle the REGISTER A switch to load the A register.

4. Load data into the [illegible] into the A register by [illegible] switches.

5. Depress the [illegible]

6. [illegible]

7. [illegible]

The [illegible] processor [illegible] 208.

The following are the [illegible] be mnemonics as [illegible]

Mnemonic	Description
TON	Typewriter On
RON	Paper Tape Reader On
PON	Paper Tape Punch On
WCD	Write Card Data
WCB	Write Card Binary
WCF	Write Card Format
RCD	Read Card Data
RCB	Read Card Binary
RCF	Read Card Format
BRU	Branch Unconditionally
SET DECMODE	Set Decimal Mode
SET BINMODE	Set Binary Mode
SXG Y	Select Index Register Y
STA	Store A
LDA	Load A

Loading Data Manually

When data is to be loaded manually, the following procedure is followed:

1. Set the INSTR WORD switch to the [illegible] position.

2. Set the AUTO MANUAL switch to the MANUAL position.

3. Toggle the RESET A switch.

4. Load an STA instruction in the A register (Store A is an octal 0300000), with the memory address where the data is to be stored replacing the righthand digits of the STA instruction.

5. Depress the A to I switch.

6. Toggle the RESET A switch.

7. Load the octal equivalent of the data to be stored into the A register.

8. Depress the START switch.

Load additional words by repeating steps 3 through 8.

Manual Branching

Prior to executing a program, the operator may perform such manual operations as checking memory, feeding constants into the memory, or correcting memory. To then transfer to automatic operation, the operator must manually enter a branch instruction which contains the location of the first instruction to be executed. This is done as follows: (Power is on and the INSTR/WORD switch is in the INSTR position.)

1. Set the AUTO/MANUAL switch to the MANUAL position.

2. Toggle the RESET A switch.

3. Load a BRU instruction into the A register (octal 26 in positions 0 through 4 and the memory location of first instruction to be executed in positions 7 through 19).

4. Depress the A to I switch.

5. Set the AUTO/MANUAL switch to the AUTO position.

6. Depress the START switch.

If the operator wishes to branch and remain in manual mode, he may use the above procedure omitting Step 5 (that is, leave AUTO/MANUAL switch in MANUAL mode). If the operator branches to the first instruction of a stored program, one instruction is executed each time the START switch is pressed,

Entering and Leaving Upper Memory

In order to get into upper memory (memory locations 8192 and above), it is necessary to use a basic branch instruction modified by index register 1, 2, or 3. The index register must contain a constant of 8192 (decimal). The octal equivalent of 8192 is 0020000, which means that bit position six is turned on and all others are turned off. Thus, any time bit position six is on in the P counter indicator lights, the operator will know the central processor is in upper memory.

The following steps transfer operations to upper memory:

1. Set the AUTO/MANUAL switch to the MANUAL position. (It is assumed that the INSTR switch is engaged).

2. Set a Store A instruction into the A register. (STA is an octal 030000X, where X is 1, 2, or 3 for the index register).

3. Depress the A to I switch.

4. Toggle the RESET A switch.

5. Set an octal 0020000 into the A register.

6. Depress the START switch. (Stores constant into index register selected).

7. Toggle the RESET A switch.

8. Set into the A register a BRU to the desired memory location modified by the selected index register used in step 2, above.

9. Depress the START switch.

To transfer from upper memory to lower memory, follow the above steps, except step 5. The effect then is that step 6 (START) stores zeros into the index register being used.

Reproducing Individual Cards

In an emergency, it may be necessary to reproduce a single card. The following describes a quick method of doing this with manual instructions. It is assumed that the card punch is ready for operation and that its input hopper is loaded with blank cards.

1. Feed the card to be reproduced into the feed rollers of the card reader to position it on the sensing platform.

2. Set the AUTO/MANUAL switch to the MANUAL position.

3. By using option switches, set a read-card instruction into the A register:

a. If a binary card, use RCB, octal 250YY01.

b. If a decimal card, use RCD, octal 250YY00.

YY is the starting address where the card is to be read. The handiest address is zero; if this cannot be used, remember that the address must be a multiple of 128 and less than 2048; that is, multiples of octal 200 and less than octal 4000.

4. Depress the A to I switch.

5. Hold down the hopper-empty switch on the card reader and press the START switch on the console. (reads cards)

6. By using option switches, set a write-card instruction into the A register:

   a. If a binary card, use WCB, octal 250YY03.

   b. If a decimal card, use WCD, octal 250YY02.

7. Depress the A to I switch.

8. Depress the START switch. (punches cards)

9. Depress the MANUAL CYCLE switch on the card punch twice to clear punched card into output hopper.

If more than one copy of the card is needed, repeat steps 7 and 8 as many times as there are cards needed (the write-card instruction remains in A and can be transferred to the I register and executed as many times as necessary.)

Saving Information in A

When an operator manually enters changes to a program, it is usually necessary to save information in the A register before entering new information. It must be remembered, however, that changes should never be made by this method without instructions to do so by the programmer. The procedure for saving the information in the A register and the location of the P counter is as follows:

1. Place in a down position the option switches corresponding to the ones (the lights) of the A register. These switches are now a reminder to the operator of what was originally in A.

2. Raise the RESET A switch to clear the A register.

3. Lower the SAVE P switch to save the information in the P counter.

4. Raise the option switches corresponding to the ones of the new information to be entered into A. Return to the down position any of the switches which were in that position (as a result of step 1.)

5. Move the new information now in the A register to wherever it will be used in the program, for example, move it to the I register by depressing A to I.

6. Raise the RESET A switch to clear the A register.

7. Raise to the up position all of the option switches which are down (as a result of step 1). Since the switches are spring loaded, they will automatically return to the normal position. This returns the original information to the A register by entering ones into A to correspond with the down switches.

8. Raise the SAVE P switch (lowered in step 3) to restore the original information to the P counter.

Extracting Data from Memory

After a series of instructions or data has been loaded, the operator may want to check the contents of memory. The following steps can be used any time the operator wishes to know what is in any particular cell in memory. Once the information is displayed, it is a simple matter to correct it and return it to memory (see 'Loading Data Manually'). It is assumed the AUTO/MANUAL switch is set to MANUAL and the INSTR/WORD switch is set to INSTR, and no alarms lights are on.

1. Toggle the RESET A switch, thus leaving an LDA instruction in the A register (Load A is an octal 00.)

2. Load the memory location of the information desired into bit positions 7 through 19 of the A register.

3. Depress the A to I switch.

4. Depress the START switch.

The contents of the memory location specified in step 2 now appears in the A register.

Sequencing through Programs

It is possible to manually sequence through a program, step by step, and examine each instruction by reading the instruction register. This is accomplished with the following steps. (Assume the INSTR switch is engaged):

1. Set the AUTO/MANUAL switch to MANUAL.
2. Branch to the starting location of the program to be examined:
   a. Set a BRU instruction into A register, including the address of the first instruction to be executed (BRU is octal 2600000).
   b. Depress A to I switch.
3. Press START switch once for each instruction to be executed; read the I register and P counter after each step.

Special Modes

Normally the program will set and clear out special modes, such as the decimal mode, index group select, and the automatic interrupt mode (AIM). The operator will seldom need to set these conditions, but may occasionally have to clear them manually. For instance, a program being debugged may be aborted, and the special options are left on.

The procedure for clearing AIM, index group select, and decimal mode are described in the following paragraphs. If these procedures fail, more elaborate procedures are given in the sections immediately following.

Clearing with PWR ON. A quick way to turn off the automatic interrupt mode, clear out index group select, and change from the decimal mode to binary is to use the PWR ON switch, following these steps (assume power is on to central processor):

1. Set the AUTO/MANUAL switch to MANUAL.
2. Set the INSTR/WORD switch to WORD.
3. Depress PWR ON switch.
4. Make visual checks to see if goal is accomplished.
5. Set the AUTO/MANUAL switch to AUTO when ready to resume automatic operation.

At step 4, note that the DEC MODE light on the maintenance panel will go out, AIM READY light on control console will go out (if on), and index group lights will go out. If these procedures fail, the operator can follow the procedures of the following section.

Setting and Clearing Decimal Mode. Normally, the program will set and clear the decimal mode. If for any reason the operator finds it necessary to do this manually, the following procedures may be used. As previously mentioned, the DEC MODE light on the maintenance panel will be on when the central processor is in the decimal mode.

A. TO SET THE DECIMAL MODE:
   1. Set the AUTO/MANUAL switch to MANUAL.
   2. Toggle the RESET A switch.
   3. Put the Set Dec Mode instruction (octal 2506011) into the A register.
   4. Depress the A to I switch.
   5. Depress the START switch.
   6. Check to be sure the DEC MODE light on the maintenance panel came on.

B. TO CLEAR DECIMAL MODE (SET BINARY MODE):
   1. Set the AUTO/MANUAL switch to MANUAL.
   2. Toggle the RESET A switch.
   3. Put the Set Binmode instruction (octal 2506012) into the A register.
   4. Depress the A to I switch.
   5. Depress the START switch.
   6. Be sure the DEC MODE light on the maintenance panel went off.

Automatic Interrupt Mode. The Automatic Interrupt Mode, which is present as an optional feature on some GE-225 Systems, is usually turned on and off by program control. Occasionally, however, it may be desired to turn this mode of operation on or off manually as follows:

A. MANUAL TURN-ON PROCEDURE
   1. Set the AUTO/MANUAL switch to the MANUAL position.
   2. If the program is to be resumed at the point of manual interruption, depress

the SAVE P switch to preserve the contents of the P register. Also, record the contents of the A register on the log sheet.

3. Introduce a SET PST instruction (octal 2506015) into the computer through the control console using the technique described under 'Loading an Instruction Manually.'

4. If the program is to be resumed at the point of manual interruption, return the SAVE P switch to its normal position and reinstate the contents of the A register (as recorded in step 2) through the option switches.

B. MANUAL TURN-OFF PROCEDURE

1. Set the AUTO/MANUAL switch to MANUAL position.

2. If the program is to be resumed at the point of manual interruption, depress the SAVE P switch to preserve the contents of the P register. Also, record the contents of the A register on the log sheet.

3. Introduce a SET PST instruction (octal 2506015) into the computer through the console switches using the technique described under 'Loading an Instruction Manually.'

4. After the SET PST instruction has been set and executed, follow that command with a SET PBK instruction (octal 2506016) through the console switches.

5. Next, set a branch instruction with the console switches to return to the program.

   a. If the program is to be started over again, set a BRU 0 1 instruction (octal 2620000.)

   b. If the program is to be resumed at the point of manual interruption, set a BRU Y instruction (where Y represents the memory location preserved in the P register by the action described in step 2).

6. If the program is to be resumed at the point of manual interruption, return the SAVE P switch to its normal position and reinstate the contents of the A register (as recorded in step 2) through the option switches.

Resetting the PARITY Alarm

Two methods of resetting a PARITY alarm will be described. The first method is to be used when the operator is starting a program and the parity error is in location zero. The second method is to be used when the program is beyond location zero.

A. RESETTING A PARITY ALARM IN LOCATION ZERO

When the central processor's power is first turned on, a parity alert frequently occurs. Also, a parity alert is apt to occur during the initial loading of a program, assembly, or compiler. The following procedure should be used to clear these alerts:

1. Depress the RESET ALARM switch. It must be remembered that the RESET ALARM switch can damage a program, so this action must be taken only when directed by programmer instructions or when the operator is sure that the error is in location zero. If the PARITY alarm light goes off, the correction is made. If the PARITY alarm light does not go off, continue with steps 2 through 9.

2. Set the STOP ON PARITY ALARM/NORM switch to NORM.

3. Set the AUTO/MANUAL switch to MANUAL.

4. Toggle the RESET A switch.

5. Load the STA instruction (0300000) into the A register.

6. Depress the A to I switch.

7. Toggle the RESET A switch (leaves all zeros in A).

8. Depress the START switch (loads zeros into memory location zero where the parity error supposedly occurred).

9. Depress the RESET ALARM switch.

B. RESETTING A PARITY ALARM NOT IN LOCATION ZERO

It must be understood that any time the STOP ON PARITY ALARM switch is set and

a parity alert is detected during a production run, the central processor halts and all peripherals halt after completing their latest instruction. At this time it is mandatory that the operator consult the operating instructions (run book) before doing anything to the equipment. It will usually be necessary to return the program to the nearest restart point. The occurrence of a parity alert in the central processor indicates that erroneous information is present. To depress the RESET ALARM and continue the program is apt to produce incorrect results. The RESET ALARM switch resets the overflow flip-flop and the carry flip-flop, and these could compound the problem rather than remedy it.

The procedure for resetting a PARITY alarm in a location other than at the beginning of a program is as follows: (See Section XVI for an explanation of the meaning and use of memory resetters.)

1. Set the AUTO/MANUAL switch to MANUAL.
2. Set the STOP ON PARITY ALARM/NORM switch to NORM.
3. Put a memory resetter, followed by 2 blank cards, into the input hopper of the card reader. (8K or 16K depending on the size of the central processor, and either a zero or a minue resetter.)
4. Depress the LOAD CARD switch.
5. Depress the RESET ALARM switch.
6. Depress the LOAD CARD switch.
7. Depress the RESET P switch.
8. Set the AUTO/MANUAL switch to AUTO.
9. Depress the START switch. (Resetter will now clear memory.)
10. After memory has been cleared and the central processor stops, set the AUTO/MANUAL switch to MANUAL.
11. Engage the STOP ON PARITY ALARM switch.
12. Depress the RESET ALARM switch which should cause the PARITY alarm light to go out.
13. If the above steps do not clear the parity error condition, call the service engineer.

Starting the Program

Most operators are principally concerned with only three types of program input: cards, magnetic tape, and paper tape. The procedures for starting a program from each of these types of input are described in this section.

Before loading the program into memory, the operator should check the programmer's instructions to see what kind of memory resetter to use, if any.

Memory Resetters. Two types of memory resetters are often used. These are zero resetters and minus resetters. There are advantages and disadvantages to both types.

The zero memory resetter resets memory locations to zeros. This resetter is handy when a zero-delete memory dump is used, for it saves time and paper when printing out the contents of memory. The operator may use the zero resetter, then load a program and start running. If the machine should jump out of sequeace for any reason, it may land in a location with all zeros, which is an LDA instruction. It will then proceed to continue loading the A register until it comes back around to the program. It may enter the program at the wrong place and abort the program. Some Service Routines such as the Input/Output routines require a zero resetter.

The minus resetter sets all memory locations with ones. If the central processor accidentally jumps out of sequence during a run when memory has been reset with a minus resetter, the machine will either jump into another part of the program or land in a location with all ones. Since all ones is a 37 which is an illegal instruction on most models, the central processor will halt.

Card Input. Procedures for loading cards into memory depend on whether the cards contain a program or merely data for use after the program is already loaded into memory. Assume that power is on to the central processor, the INSTR/WORD switch is set to INSTR. and the card reader has been made ready (see Section VI or VII). The following steps apply to the 400 card per minute reader.

The following procedure loads a program deck of cards into memory. The first card must be a loader card punched in binary format and the last two cards must be blank.

1. Set the AUTO/MANUAL switch to MANUAL.
2. Depress the LOAD CARD switch to move the first card, (assuming no alarms were on).
3. Depress the RESET ALARM switch.
4. Depress the LOAD CARD switch to read the first card into memory.
5. Depress the RESET P switch.
6. Return the AUTO/MANUAL switch to AUTO.
7. Depress the START switch to begin automatic feed of the cards under program control.

The following procedure loads data cards to a program already in memory. One or two blank cards must be at the end of the deck, as required by the programmer.

1. Set the AUTO/MANUAL switch to MANUAL.
2. Depress the LOAD CARD switch to move the first card.
3. Depress the RESET ALARM switch.
4. Manually introduce a branch instruction into the A register (octal 26XXXXX); put address of first instruction of program in positions 7 through 19 of the BRU instruction.
5. Depress the A to 1 switch (transfers BRU instruction to the 1 register).
6. Return the AUTO/MANUAL switch to AUTO.
7. Depress the START switch to transfer control to the program, which automatically feeds the rest of the cards.

Magnetic Tape Input. With system configurations having both a card reader and the magnetic tape system, it is a simple matter to read a call card, which calls a taped program into memory. The entire program and data input can be on tape, or the program can be on cards and the input data on tape. Without the card reader, instructions must be fed manually into the central processor to get the program started.

Paper Tape Input. When a card reader is available, paper tape programs and data can easily be called into memory with a call card. Otherwise, a series of instructions must be fed manually into the central processor to get the program started.

ERRORS AND OPERATOR CORRECTIVE ACTION

The central processor may fail to operate correctly and cause program halts when the operator neglects to do any of the following operations.

Operator Checklist

1. Reset alarms before attempting to start.
2. Put SAVE P switch in normal (up) position.
3. Put INSTR/WORD switch in appropriate position.

Program Recovery or Restart

Watching and interpreting the indicator lights on the console will tell the operator much about the source of troubles when a program halts or refuses to start. The red alarm lights in the upper left corner of the console panel are danger signals which indicate that errors have been made, erroneous information has been received or transmitted, and the program may be aborted. The CARD PUNCH and CARD READER alarm lights mean the operator must restart or recover the program (see following sections). In some cases, the operator can exercise care and save the program run. It is a good general rule to go into the manual mode of operation before attempting to correct error situations indicated on the console.

Whether a program can be saved or is aborted depends on the answer to the questions: has erroneous information been received or transmitted, or has information been missed in a read or write operation? False or missing information will usually abort a program. By studying the charts on error and corrective action in the sections on individual pieces of equipment, the operator will often be able to determine whether a program can be saved.

When erroneous information has gotten into a run, the operator will correct any operator error or have the service engineer correct any serious machine errors. The run book should indicate the nearest programmed recovery point. Successful recovery will save going back to the beginning of the run.

When a program is aborted and no recovery procedures have been programmed, the operator will usually have to restart the program at the beginning. A good operator always looks in the run book or in other operator instructional material for programmer's instructions.

TABLE II.

CONTROL CONSOLE ERROR CONDITIONS

Error Condition	Possible Cause	Corrective Action
PRIORITY alarm light (red) comes on	Central processor is in the manual mode	When ready to go into automatic mode, press RESET ALARM and the AUTO portion of the AUTO/MANUAL switch.
	Alarm condition has occurred in card reader or card punch	See error and restart procedure on equipment concerned
PARITY alarm light (red) comes on; if STOP ON PARITY ALARM switch is engaged, processor halts	A parity error was detected in memory	See run book for recovery or restart procedures; press RESET ALARM and START switches to start processing if run book so specifies
	A parity error was detected while receiving information via the controller selector	Return to nearest rerun point; press RESET ALARM and START switches to start processing if run book so specifies
	A parity error was detected in paper-tape reader operation	Check paper tape for damage; return to nearest rerun point; press RESET ALARM and START switches to start processing if run book so specifies
	Random parity errors caused by system room overheating were detected on information coming from memory	Call service engineer to correct air conditioning
OVERFLOW alarm light (red) comes on (no halt in program)	Capacity of the arithmetic unit has been exceeded	Normally this alarm will be reset by the program; if not, check run book for instructions
	The A register overflowed on a shift-left instruction	
	An illegal division was attempted	
ECHO alarm light (red) comes on; program stops	A peripheral controller that is operating through the controller selector was unable to respond when addressed; off line, addressed plug not installed; power off; malfunction	Check peripheral for operator's errors

TABLE II. (CONT.)

Error Condition	Possible Cause	Corrective Action
CARD PUNCH alarm light (red) comes on; computer halts	Card punch not ready when a WCB, WCF, or WCD instruction was given	Make card punch ready and consult run book for restart procedures
CARD READER alarm light (red) comes on; computer halts	Card reader not ready when an RCB, RCF, or RCD instruction was given (busy, inoperable, card jam, or feed error)	Make card reader ready and consult run book for restart procedures
Central processor hangs in a loop and all peripherals halt	Program is branching on a peripheral ready or not ready (determined by manually stepping through the loop)	Read I register to determine which peripheral is involved; refer to section of this manual on that peripheral for corrective action
Program executes same instruction over and over again (P counter does not increment)	SAVE P switch was left on (in down position)	Engage MANUAL switch, turn off SAVE P switch (to UP position) press RESET P, AUTO, and START switches
When loading a program deck of cards, the card reader reads one or two cards and halts; repeats condition on reruns	Processor may be in decimal mode	Check maintenance panel; if DEC MODE light is on, reset to binary mode, rerun deck
	An index group (other than zero) has been selected	If any INDEX GROUP lights are on, reset group to zero
Computer and peripherals halt	An illegal command is in I	Manually transfer contents of memory location indicated by P counter to the A register to determine if instruction is illegal. If programmer error, return program to originator. If machine error, try to rerun; if rerun fails, call service engineer
	Illegal command in I is all ones (a minus memory resetter was used), indicates machine has jumped out of the program	Restart and try to rerun program; if error recurs, call service engineer