BULLETIN 5023
NOVEMBER 1959

HANDBOOK OF OPERATING PROCEDURES FOR THE BURROUGHS 220 ELECTRONIC DATA PROCESSING SYSTEMS

BURROUGHS CORPORATION
ELECTRODATA DIVISION

FOREWORD

The technical information contained in this manual is correct to the best of our knowledge. It is released at this time in preliminary form for the convenience of people in the field. A formal, typeset document will be released at a later date.

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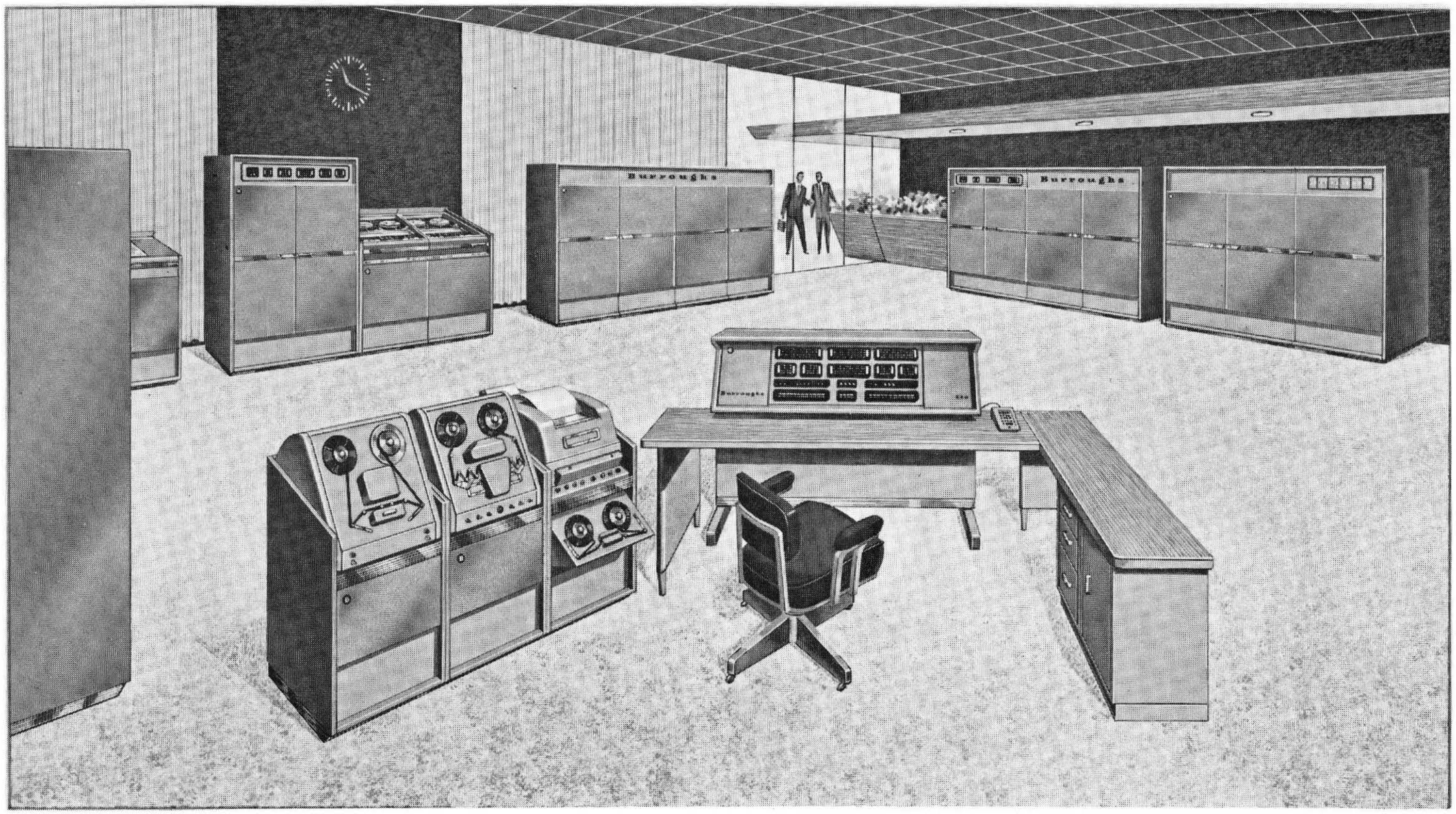

BURROUGHS 220

Figure 1-1. The BURROUGHS 220 Electronic Data-Processing Systems.

1 INTRODUCTION

This Handbook is intended to encompass procedures for operating the BURROUGHS* 220 Electronic Data Processing Systems. Its contents are the concern of two classes of personnel:

1. System operators who must be familiar with the operation of all the components of a BURROUGHS 220 Electronic Data Processing System. Included in this class are: Console Operators, Tape handlers, Electronic accounting machine operators and clerical personnel.

2. Programmers and coders who need a working knowledge of system operation to provide an intelligent set of instructions for operators who will be running their programs.

In addition to the instructions and procedures for basic operation of a system there are procedures which will facilitate the detection of programming and coding errors; procedures for correcting errors detected during the check-out process and for reducing the possibility of error during the correction process. All criticism, comments, etc. regarding this Handbook should be directed to:

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PERIPHERAL EQUIPMENT

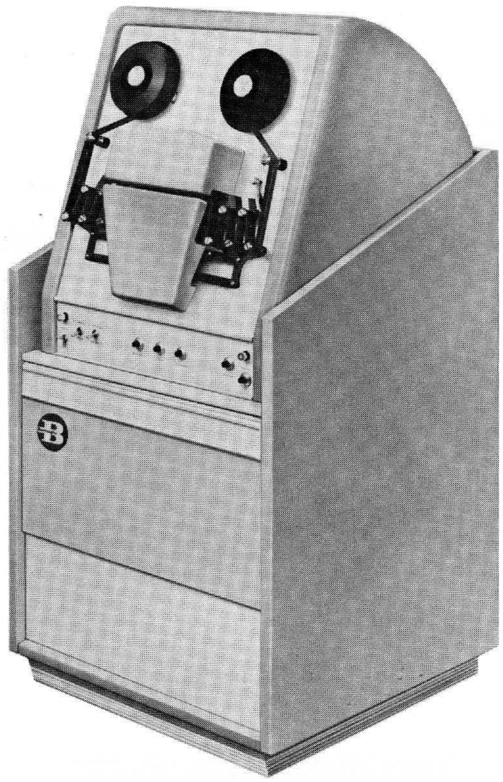

Figure 2-1. Paper-Tape Photoreader.

Physical Characteristics:

Width:	23¼ inches	Weight:	290 pounds
Depth:	23 inches	Power:	0.7 kw
Height:	47 inches	208V. 3Ø 60~ 4 wire	
		Heat Dissipation:	2,380 BTU/hour

Operating Characteristics:

Paper tape reading rate:	1000 characters/second
Paper tape feeding rate:	100 inches/second
Paper tape stop time:	Stops on a character
Paper tape start time:	5 milliseconds
Reel size:	5½ and 7 inches diameter
Information Density:	10 characters/inch

System Characteristics:

Paper tape code:	Seven-level code (046–1 character/frame)
Number of units:	A maximum of ten per Burroughs 220 System
Storage capacity:	40,000 characters/reel

Special Features:

Automatic alphabetic bi-decimal translation
Automatic emergency reel braking
Automatic parity checking
Automatic or manual rewind
Automatic program "float in" with B-register modification
Automatic termination of reading by word count or by control information from the paper tape

2 PERIPHERAL EQUIPMENT

2-1 PAPER-TAPE SUBSYSTEM

A BURROUGHS 220 system may include up to 10 Photoreaders and 10 Paper-Tape Punches. Character-at-A-time printers (section 3-3) may be substituted for any of the punches; each printer can also be driven as an off-line reader mounted in the lower section of the printer.

2-1.1 PHOTOREADER

The BURROUGHS 220 Photoreader reads seven-channel, 7/8-inch paper tape, punched in the BURROUGHS 220 code, at either 1000 or 500 characters per second. A maximum of ten units may be used with a BURROUGHS 220 system. The tape is moved from left to right at either 100 or 50 inches per second, depending on the setting of the HI-LOW switch. It can be stopped in the space of a single character, with the next character in position to be read.

Paper tape can be mounted on either 5.5-inch or 7-inch plastic reels, storing a maximum of approximately 3500 and 7000 computer words respectively. The contents of a full 5.5-inch reel can be read in 42 seconds; a 7-inch reel, in 84 seconds. The unit is 47 inches high, 23 1/4 inches wide, and 23 inches deep.

Figure 2-1 lists additional specifications and characteristics of the Photoreader and shows various components when the unit is in a ready for operation status.

INDICATORS AND CONTROLS

All but one of the indicators and controls used by the operator appear on the control panel of the Photoreader. The one exception is the control for unit designation, a rotary switch mounted behind the lower panel on the front of the unit. This panel or the one above it must be removed to redesignate the unit; the panels are not hinged, but they can be lifted out without the use of tools.

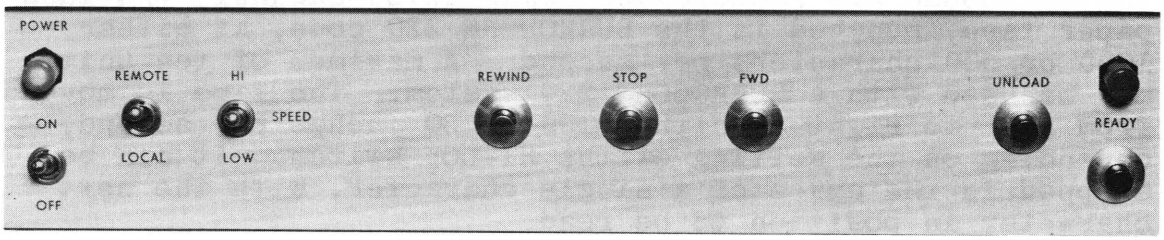

Figure 2-2. Photoreader Control Panel.

The control panel indicators and controls have the following functions:

POWER ON-OFF This switch is pushed UP to turn the power on, DOWN to turn power off.

POWER INDICATOR This blue light comes on when the power is on to the unit.

REMOTE-LOCAL When this switch is in the REMOTE position,UP, the Photoreader is under computer control; in the LOCAL position,DOWN, the unit's operation is directed from the Photoreader control panel.

HI LOW SPEED When this switch is in the HI UP position, the tape is driven at the rate of 100 inches (equivalent to 1000 characters) per second; in the LOW DOWN position, the tape is driven at 50 inches (500 characters) per second.

REWIND Depressing this push button causes the tape to move from right to left when the unit is in LOCAL status.

STOP Depressing this push button stops the tape.

FWD Depressing this push button causes the tape to move in the forward direction (left to right) if the unit is in LOCAL status.

UNLOAD Depressing this push button de-energizes the reel system and applies brakes to the reels.

READY INDICATOR This blue light comes on when the READY push button is depressed and loading has been completed properly.

READY Depressing this push button drops the arm assemblies, energizes the reel servos, releases the reel brakes, and turns on the READY indicator, if loading and other preparation procedures have been completed properly.

UNIT DESIGNATION This rotary switch is located behind the lower panel on the front of the Photoreader. It can be reached by removing this panel or the panel above; either can be lifted out without the use of tools. The dial settings are 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 and OFF. Under computer control, a Photoreader is selected by the correspondence between this setting and the most significant digit (u) in a paper tape read instruction. If two should be given the same designation by mistake, the one cabled closest to the console would respond to the instruction, since the units are connected in series.

OPERATING PROCEDURES

REFLECTOR STRIPS

To position strip at end of information for automatic rewind:

1. Mount and read the tape.

2. When the tape stops, place a strip of 1/2-inch adhesive aluminum foil on the side of the tape that contacts the sensing arm. Position the foil between the left guidepost and the first spool, and about 2/3 of the way down from the left guidepost--or about 24 inches from the last punch in the tape.

To position strip at beginning of information to cause automatically rewound tape to stop in position to be read again:

1. Mount the tape.

2. Manually take four turns on the right-hand reel.

3. Turn power on and depress the READY button.

4. Make absolutely sure that the first punches are to the left of the read assembly housing.

5. Place a strip of 1/2-inch aluminum foil below as close as possible to the right guidepost. Place the foil on the side of the tape that comes in contact with the guidepost.

Tape with foil on both ends can be wound off the right-hand reel by depressing and holding the REWIND button.

<u>LOADING</u> Paper tape can only be read by the 220 Photoreader when the reel systems are used. The tape must be long enough to reach from one reel to the other and still allow adequate slack for full release of the arm assemblies. The following steps should be followed in order to prepare the Photoreader for operation (Figures 2-3 and 2-4):

1. Turn power on.

2. Set REMOTE-LOCAL Switch to LOCAL.

3. Set HI-LOW SPEED switch to speed wanted. (LOW might be preferred for moving tape less than its full length under LOCAL control.)

4. Lift both arm assemblies until they latch into position.

5. Mount reel of tape to be <u>read</u> on <u>left</u> hub, with the reel flange toward the Photoreader, and with the tape coming off the top to the right. (If tape must be rewound in order to be ready for reading, the reel would be mounted on the right hub, coming off the top to the left.) When the grooves on the reel are lined up with the detents on the hub, the reel can be pressed firmly onto the hub as far as it will go. Mount an empty reel on the other hub.

6. Thread the tape around the outside of the <u>left</u> guidepost, straight through horizontally between the spools on the <u>left</u>, between the covers of the read assembly, between the spools on the <u>right</u>, and around the <u>right</u> guidepost. The <u>left</u> reel may be turned by hand to provide enough slack tape. The tape then goes to the <u>left</u> of the <u>right</u> reel; the end can be crimped and inserted into the reel slot.

7. Turn the <u>right</u> reel clockwise by hand, four revolutions, to take up about two feet of tape (beginning of information reflector strip must be to the <u>right</u> of the reader head).

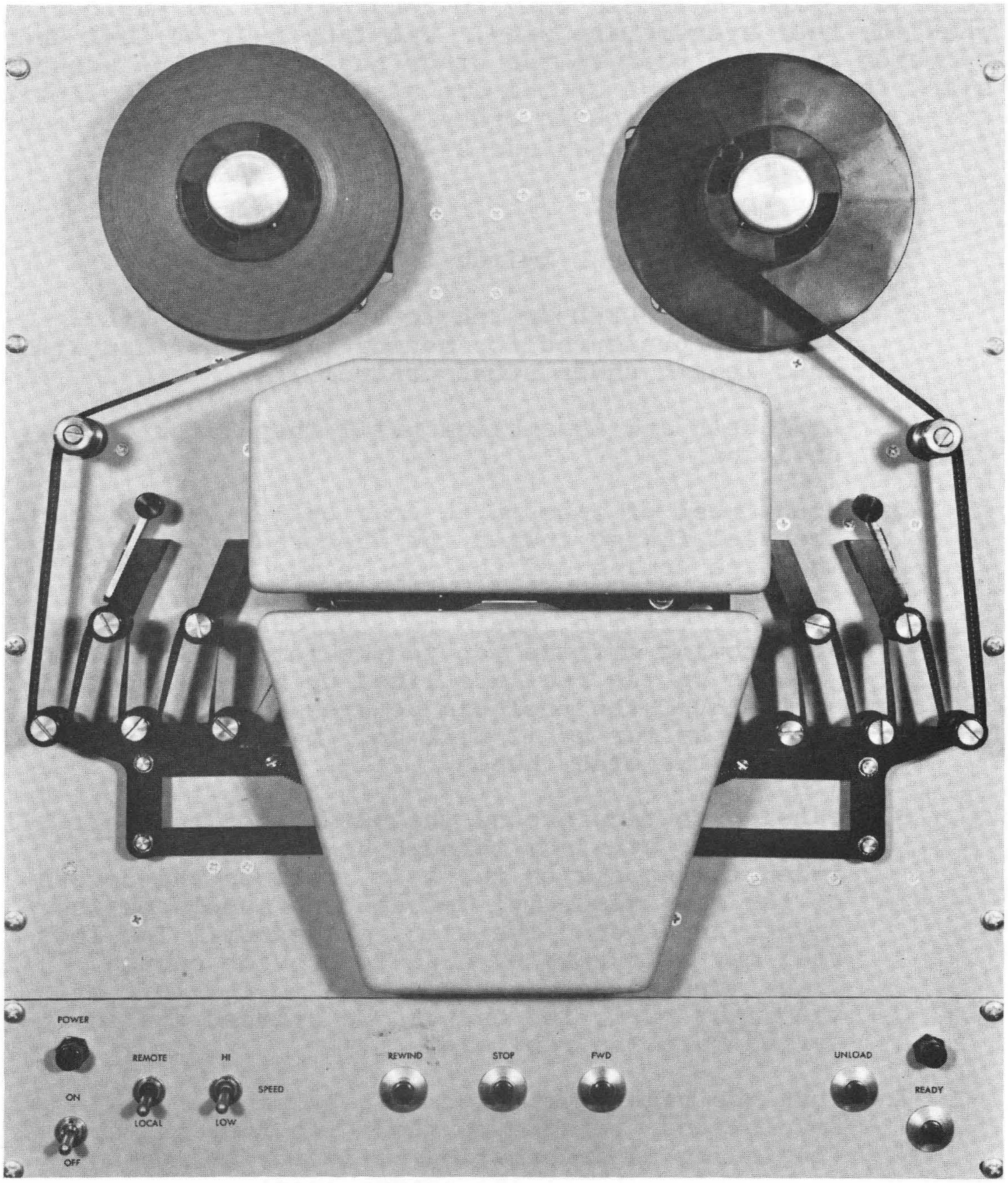

Figure 2-3. Loading the Photoreader.

8. Press the two arm latch release buttons to release the arms. They will drop down part way.

9. Press the READY button. If loading has been completed properly, the arms will drop the rest of the way into operating position, the reading light will be turned on, and the READY indicator will come on. The Photoreader is now ready to operate from the Photoreader control panel.

10. To operate the Photoreader under computer control, check that the unit designation dial is set properly and put the REMOTE-LOCAL switch in the REMOTE position.

<u>CHECKING TAPE MOUNTING</u> The sprocket holes divide the tape into unequal parts. The narrow side may have up to three holes punched per character; the wider side may have up to four holes. The wider side should be toward the operator when the tape is mounted and ready to read.

<u>STOPPING TAPE MOVEMENT</u> With the REMOTE-LOCAL switch in the LOCAL position, the tape can be moved forward (with the FWD button) or rewound whenever necessary. The STOP button will stop tape movement in either direction.

<u>UNLOADING</u> After a tape has been read, it can be removed from the Photoreader by the following procedure:

1. Put REMOTE-LOCAL switch in LOCAL.

2. Rewind, if necessary. Press REWIND button again and hold it down until the tape runs off the right reel. The arms will drop and the READY indicator will be turned off.

3. The reels may then be removed.

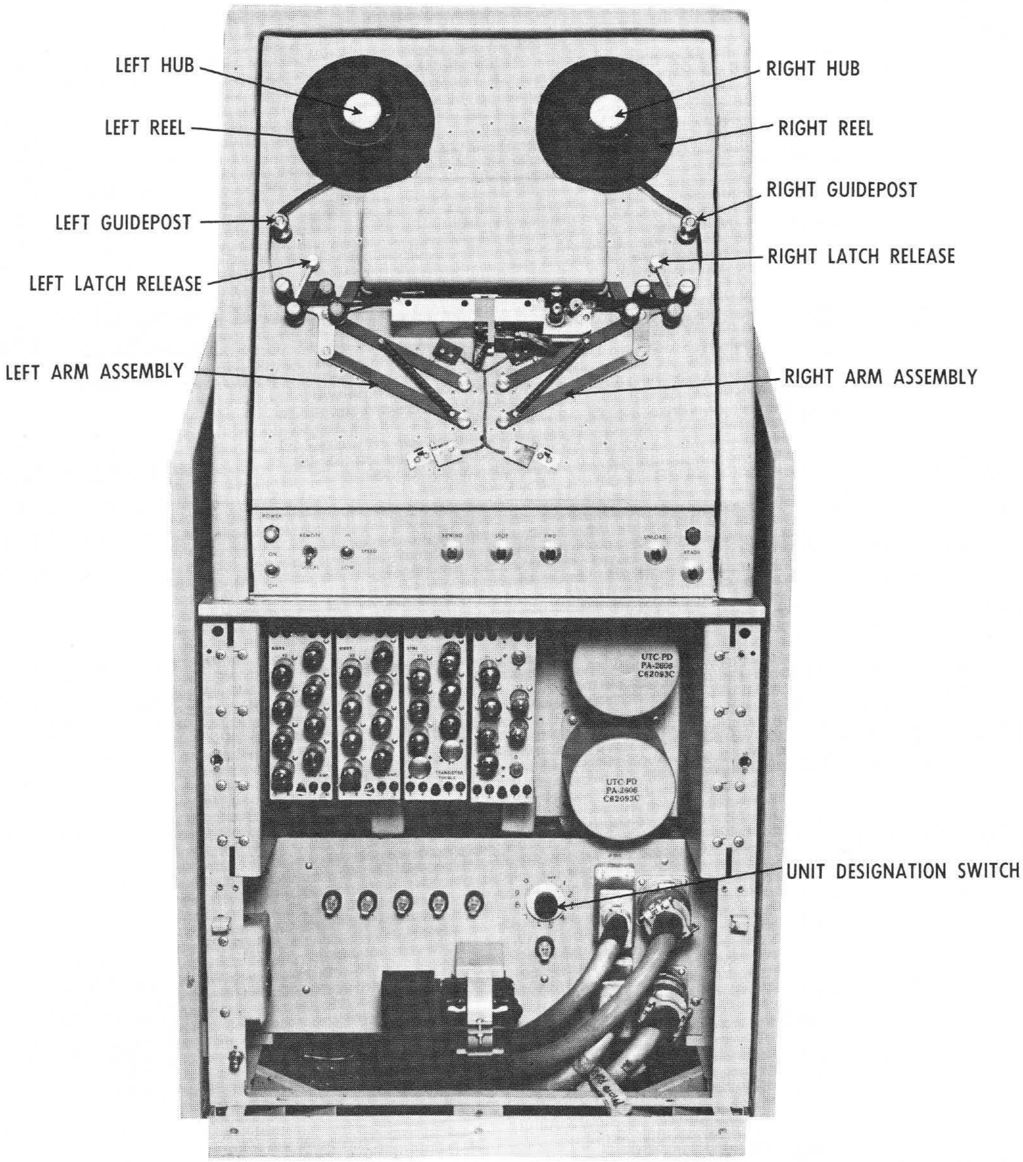

Figure 2-4. Photoreader, Front Panels
Removed, Not-Ready Status.

<u>AUTOMATIC REWIND</u> The left guidepost is an automatic sensing device which will initiate automatic rewind, provided that it is activated by a strip of conductive material on the paper tape. A 1/2-inch strip of adhesive aluminum foil is used for this purpose. If the foil is placed 22 to 26 inches beyond the last punch, the tape will rewind automatically and stop when the tape pulls off the right-hand reel. (When the foil is sensed, a permissible condition is set up, but rewind cannot begin until the last character has been sensed, so there is no danger of placing the foil so as to cause rewind before tape read is complete.)

Similarly, the right guidepost is a sensing device that can be used to cause rewind to stop with the tape in position to be reread.

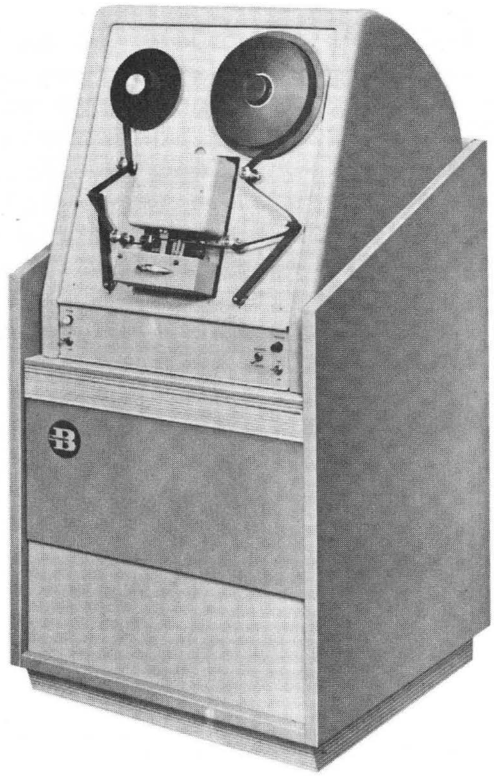

Figure 2-5. Paper-Tape Punch.

Physical Characteristics:

Width: 23¼ inches
Depth: 23 inches
Height: 47 inches

Weight: 190 pounds
Power: 0.3 kw
208V. 3Ø 60~ 4 wire
Heat Dissipation:
800 BTU/hour

Operating Characteristics:

Paper tape punching rate:	60 characters/second
Paper tape feeding rate:	6 inches/second
Reel size:	8 inches in diameter
Information density:	10 characters/inch

System Characteristics:

Paper tape code: Seven-level code (046—1 character/frame)
Number of units: A maximum of ten per Burroughs 220 System

Special Features:

Automatic alphabetic bi-decimal translation
Automatic reeling and rewinding
Automatic parity generation
Selective zero suppression

2-1.2 PAPER-TAPE PUNCH

The BURROUGHS 220 Paper-Tape Punch (Figure 2-5) is used to punch out information from core storage at the rate of 60 characters per second. A maximum of 10 units may be used with a BURROUGHS 220 system.

The unit is the same size as the Photoreader and produces punched paper tape directly acceptable to the Photoreader. Paper tape used by the punch is available in rolls 1000 feet long which can be mounted on the front of the unit. Each word punched is followed by an end-of-word character.

INDICATORS AND CONTROLS

The following paragraphs describe the functions and locations of the controls and indicators used by the operator. All but the last two are on the Paper-Tape Punch control panel.

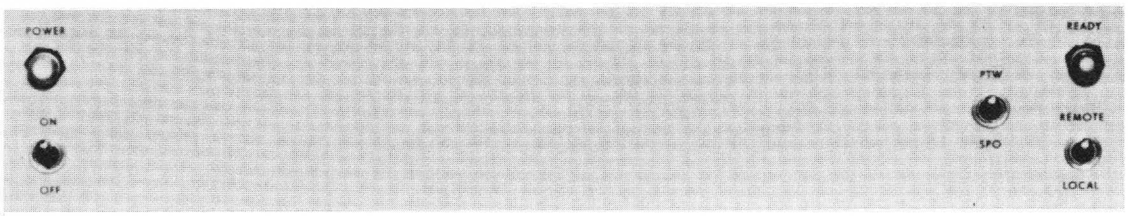

Figure 2-6. Paper-Tape Punch Control Panel.

ON-OFF This switch turns on power to the Paper-Tape Punch.

POWER INDICATOR This blue light comes on when the power is turned on.

PTW-SPO When this switch is set to PTW UP, the Paper-Tape Punch will respond to a PAPER-TAPE WRITE instruction; when it is set to SPO DOWN, the punch will respond to an SPO (SUPERVISORY PRINT-OUT) instruction, provided that the supervisory printer REMOTE-LOCAL switch is set to LOCAL. If the printer is under computer control, and if it is connected into the system between the control console and the punch, print-out will occur on an SPO command, rather than punchout.

REMOTE-LOCAL When this switch is set to REMOTE, the unit is under computer control; when set to LOCAL, the unit is under control of the Paper-Tape Punch control panel.

READY INDICATOR This blue light comes on when power is on, the REMOTE-LOCAL switch is set to REMOTE, and the punch is ready to operate under computer control.

UNIT DESIGNATION This rotary switch is located behind the lower panel on the front of the Paper-Tape Punch. It can be reached by removing the lower panel. It is more conveniently reached by removing the panel above also. The panels can be lifted out without the use of tools.

The switch has 10 unit designation settings, 1 through 0, and an OFF setting. The switch must be set to correspond with the most significant digit (u) in a PAPER-TAPE WRITE instruction. If two units are given the same designation by mistake, the one cabled closest to the Control Console will respond to the instruction.

TAPE FEED LEVER This lever, located above the punch cover is depressed to advance the tape when the unit is in LOCAL status. As the tape moves, sprocket holes are punched. (When the punch is under computer control, sprocket holes are punched automatically.)

OPERATING PROCEDURES (Figure 2-7)

LOADING The following steps should be followed in sequence:

1. If the supply of unpunched tape on the right reel is low, mount a new roll by loosening the knob on the right hub. Slip a new roll of tape over the hub so that the tape comes off the top of the reel on the right side; tighten the knob.

2. Mount an empty reel on the left hub, with the flange toward the unit. The reel will slide on with moderate pressure when the grooves on the reel are lined up with the detents on the hub.

3. Turn power ON.

4. Put REMOTE-LOCAL switch in LOCAL position.

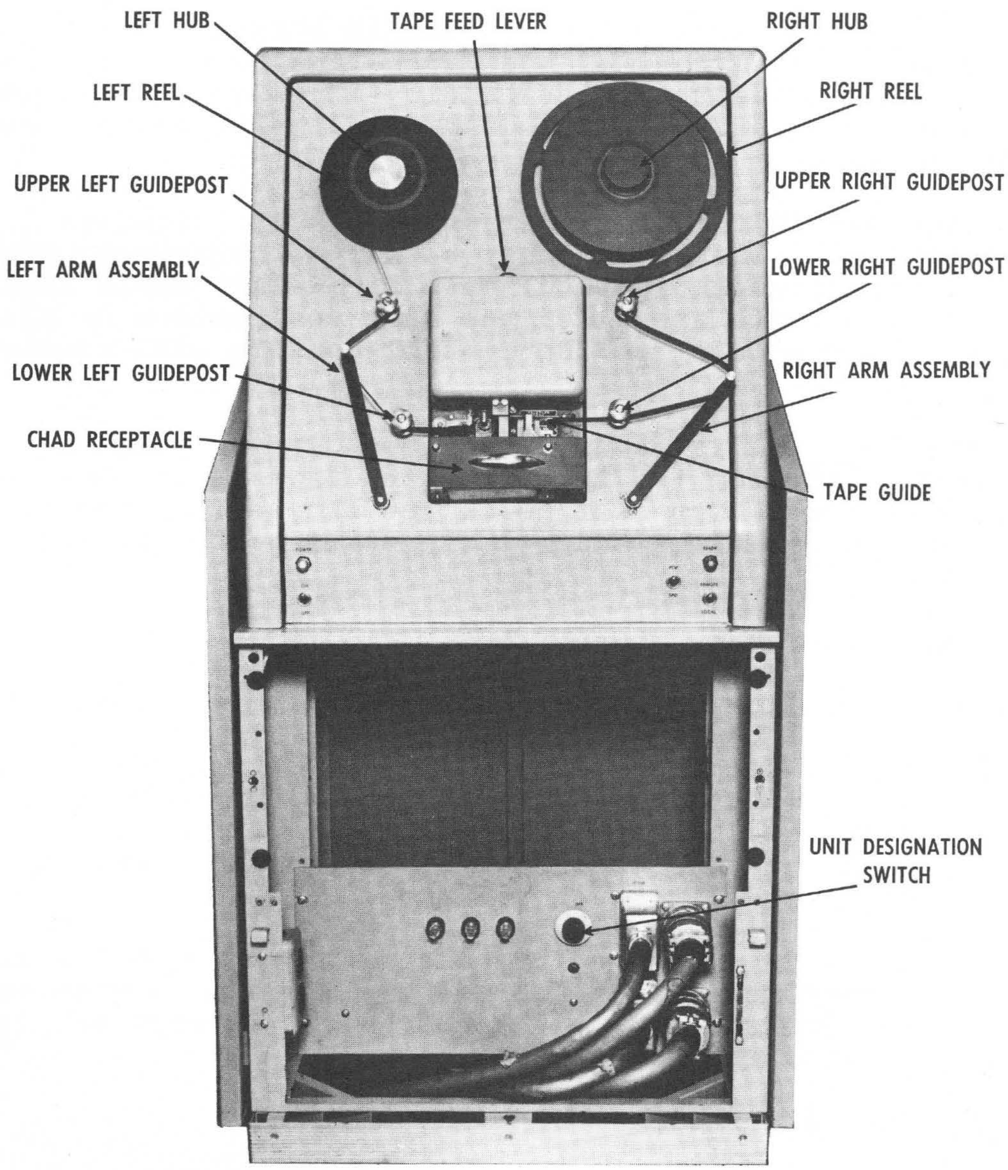

Figure 2-7. Paper-Tape Punch, Front Panels Removed.

5. Unwind enough tape, turning the reel by hand, to lead to the left of the guidepost below the right reel, to the right of the right arm assembly, and under the lower right guidepost. Then insert the end of the tape into the tape guide as far as it will go. Hold down the tape feed lever and continue feeding tape manually into the tape guide until tape with sprocket holes punched comes out of the left side of the punch assembly. The tape will advance as long as the tape feed lever is held down.

6. When enough tape has been fed to reach the left reel, release the tape feed lever and lead the tape under the lower left guidepost, to the left of the left arm assembly, and to the right of the upper left guidepost.

7. Turn power OFF to stop rotation of left reel.

8. Run the tape around the left side of the left reel crimp the end of the tape, and slide it into the reel slot.

9. Turn power ON. Hold down tape feed lever to punch about four feet of leader.

10. To operate the punch under computer control, put the REMOTE-LOCAL switch in the REMOTE position.

UNLOADING To remove the punched tape, set the REMOTE-LOCAL switch to LOCAL. Then hold down the tape feed lever to run out about four feet of tape. Turn power OFF. Cut the tape on the left side of the punch assembly, leaving a stub long enough to be grasped to simplify rethreading. The left reel can then be pulled off the hub.

The tape must be wound onto another reel before it can be used. Usually, this is done the first time it is to be read. The loaded reel is placed on the right-hand side of the Photoreader, and then rewound onto an empty reel on the left-hand side. The tape is then ready to be read.

CHAD RECEPTACLE This drawer, below the punch, catches the punched-out paper. It should be emptied regularly to prevent jamming of the punch.

2-1.3 PROCEDURE FOR SPLICING 220 PAPER TAPE

Tape may be spliced with Scotch Tape, when necessary, to add leader, to repair tears, etc. The recommended procedure for doing this is to over-lap the pieces of tape to be spliced and then cut through both simultaneously so as to give a clean, matched butt joint. While the pieces of tape are being held together, Scotch Tape should then be applied to both surfaces of the tape. Any excess Scotch Tape which extends beyond the width of the paper tape should be trimmed flush with the edge. If the Scotch Tape covers information areas, the information holes and sprocket holes should be punched out with a hand punch. A build up in the thickness greater than the thickness of the paper tape plus two thicknesses of Scotch Tape should be avoided.

To supplement the above, the following suggestions should also be considered:

1. The paper tape should be cut diagonally rather than straight.

2. The Scotch Tape should be applied diagonally. The purpose of this is that the brake has a "floatable tension" which will allow it to accommodate a thickness of tape (paper tape plus two thicknesses of Scotch Tape) slightly above the normal. If the Scotch Tape is applied straight across the tape, it will hit the brake at its widest part; while if the Scotch Tape is diagonal, the leading edge will allow the brake to adjust to the additional thickness before the full width is encountered.

3. When trimming excess Scotch Tape from the width of the paper tape, it is suggested that slightly more than the excess be cut off leaving a slight concave effect on each side. Difficulty has been experienced with the paper tape jumping out of the tape guides if not trimmed properly.

Using the above method will not cause difficulty when splicing an area in tape other than on "information".

Certain general concepts for splicing in an information area are suggested:

1. If splicing must be done, extreme care should be taken to assure that the splicing method is performed correctly. The slightest space between the spliced ends, or failure to completely punch out the information area, will cause trouble.

2. No more than one pass should be made. This one pass will fill memory so that a new tape can be punched.

3. When a pass is made to fill memory after splicing, the information should not be read digit by digit since this will cause the splice area to stop on the brake. Stopping on the brake could cause a bad read.

From the above it is evident that several precautions must be taken if splicing is required and it is recommended that splicing should be done only when absolutely necessary.

2-2 MAGNETIC-TAPE SUBSYSTEM

The various magnetic tape instructions associated with the subsystem are divided into two categories: independent and dependent instructions. Independent instructions, such as search and scan, release the Data Processor for other operations. Dependent instructions operate in conjunction with the Data Processor, and, in most cases, when an error occurs during the execution of these instructions the entire system is affected. Since these two categories exist, the effect of the error and the corrective action to be taken will vary according to the type of instruction being executed.

Of great importance to the operator when operating the Magnetic-Tape Subsystem is a complete understanding of the magnetic tape instructions, the various indicators and switches on the Magnetic-Tape Storage Unit (TSU) (Figure 2-8) control panel, the Datafile (Figure 2-14) Control Panels and the Magnetic-Tape Control Unit (TCU) (Figure 2-12) control panel. This understanding will aid him in determining the type of error, its effect, and finally, the action he should take to correct the existing condition.

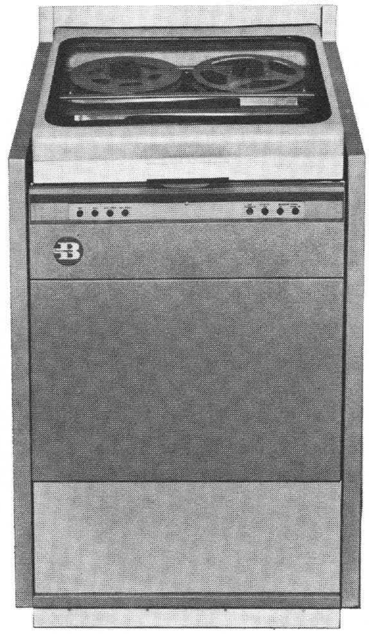

Figure 2-8. Magnetic-Tape Storage Unit.

Physical Characteristics:

Width:	28 inches
Depth:	31 inches
Height:	52 inches

Weight: 650 pounds

Power: 5.0 kw (d.c. 0.5 kw) 208V. 3Ø 60∼ 4 wire

Heat Dissipation: 17,000 BTU/hour

Blower volume: 1000 CFM

Operating Characteristics:

Magnetic tape reading rate:	25,000 digits/second
Magnetic tape feeding rate:	120 inches/second
Information Density:	416 2/3 digits/inch of tape
Magnetic tape start time:	4.5 milliseconds
Magnetic tape turn-around time:	7.0 milliseconds (independent operation)
Reel size:	10½ inches in diameter

System Characteristics:

Recording code:	Binary-coded decimal with parity check
Format:	Two channels of information (density 208 1/3 digits/inch/channel) are intermixed on magnetic tape
Storage capacity:	16,000,000 digits/reel of 3500 feet

Number of units: A maximum of ten per Burroughs 220 system

Bi-directional independent search on recorded information

Forward independent "scanning" on recorded information

A variety of independent positioning operations

Facility to vary block lengths

Facility to write over recorded information selectively

Special Features:

Automatic error detection methods

Facility to automatically examine magnetic tape for quality of material and to screen away imperfect recording areas (independent of any processing operation)

Automatic emergency reel braking

The magnetic tape is completely "air floated" except for engagement on the magnetic read-write head

Special file protection devices are incorporated

Automatic program "float in" with B-Register modification

2-2.1 TAPE STORAGE UNIT (Figure 2-8)

TSU CONTROL PANEL (Figure 2-9)

Edit Push Button - Indicator

When this button is pushed simultaneously with the edit button in the LOGIC group, an editing cycle starts. The indicator, when on, indicates that the unit is in an edit cycle.

Rewind-Lockout Indicator

The RWL indicator comes on when the unit has been rewound by a MAGNETIC TAPE REWIND-DE-ACTIVATE (MDA) instruction. It remains on until the rewind-lockout release (RWLR) button in the LOGIC group is depressed manually.

Not Write

This indicator is on when the unit is in the local state, the not-write push button in the LOGIC group has been depressed, or there is a file protective ring on the reel. The write push button in the LOGIC group must be depressed to turn off the indicator.

Not Ready

This indicator is on when the unit is in standby or local condition.

Unit Designate

This indicator operates in conjunction with the ten push buttons just below it. It is on when a magnetic tape instruction is being executed and the unit designation digit in the instruction corresponds with the unit designation push button that has been depressed. One and only one of these push buttons may be depressed at one time. Depressing one of these buttons releases any other button that may be down and removes the unit from local state.

Logic D.C. On

When this indicator is on, the unit is receiving direct current from the power supply.

Transport Power On

This indicator is on when the servo in the unit is operating.

Transport Power Stand By

This indicator is on when the unit is in a standby condition.

Reel Brake

When this toggle is down, the reel brake is released for loading purposes.

Local

This button removes the unit from Tape Control Unit control. It must be depressed in order to edit tape; tape can be driven in either direction by manual control. The not-ready indicator is on at this time.

Logic

There are four push buttons in the LOGIC group:

Edit - This button operates in conjunction with the edit pushbutton indicator. The two must be depressed simultaneously in order to edit tape.

Rewind-Lockout Release - The RWLR button releases the unit from the rewind-lockout condition caused by an MDA instruction and turns the RWL indicator off.

Write - This button must be depressed before information can be written on tape. It is not operative when the unit is in the not-ready condition.

Not-Write - This button releases the write push button and prevents writing on tape loaded in the unit. The Not-Write indicator is on.

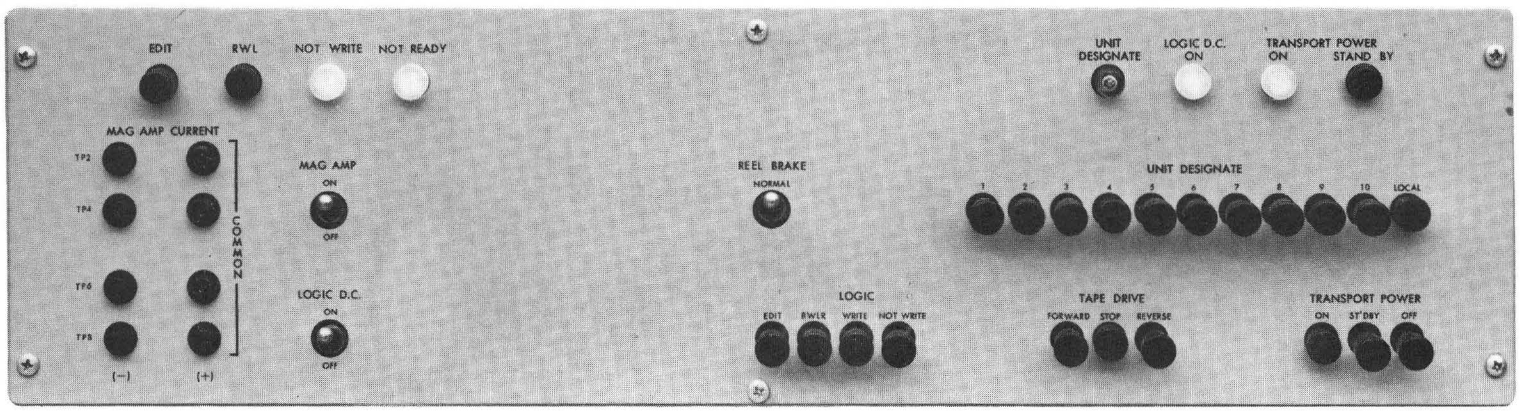

Figure 2-9. Magnetic-Tape Storage Unit Control Panel.

Tape Drive

These buttons function only when the unit is in local status:

Forward - Depressing this button moves the tape in the forward direction until it reaches physical end-of-tape or until the stop button is depressed.

Stop - This button stops movement of tape in either direction.

Reverse - This button moves the tape backward until physical beginning-of-tape is reached or the stop button is depressed.

Transport Power

There are three push buttons in the TRANSPORT POWER group:

On - This button turns on power if unit is loaded properly.

Standby - The STANDBY button allows reel changing without shutdown by turning off the servo and the vacuum systems.

Off - This button turns off the unit.

TAPE LOADING AND UNLOADING PROCEDURES

1. Place unit in local status by depressing LOCAL push button.
2. Depress the tape drive stop push button.
3. Depress the standby push button, placing the unit in standby.
4. Turn the reel brake toggle down to release the reel brake.
5. Place full reel on the right hand hub, so that tape will unwind from the inward side (counterclockwise).

6. Place empty reel on left hand side.

7. Pull hub levers down to lock reels.

8. Manually unwind enough tape to reach around vacuum slots to empty reel.

9. Attach end of tape to empty reel. (Use Masking Tape).

10. Wind up slack by turning left hand reel counterclockwise until the end of the conductive strip is past the end-of-tape post. Unwind slightly and thread. See Figure 2-10.

11. Turn reels by hand until tape is taut across vacuum column openings. DO NOT STRETCH TAPE.

12. Set reel brake toggle to NORMAL. Brake sets and holds reels.

13. Push the transport power ON push button. After a 30 second delay, the vacuum motor will start and the tape loops will move in toward the center of the vacuum columns.

14. Alternately depress the FORWARD and REVERSE push buttons to assure that tape has been loaded properly.

CAUTION

DO NOT touch tape reels when power is on. Smoking regulations should be observed when operating on or near the tape units.

TAPE UNLOADING

1. Check to see that the tape has been rewound. (End of conductive leader is on the end-of-tape post. If the tape is not rewound, this can be accomplished manually by putting the unit in local status and depressing the reverse button.)

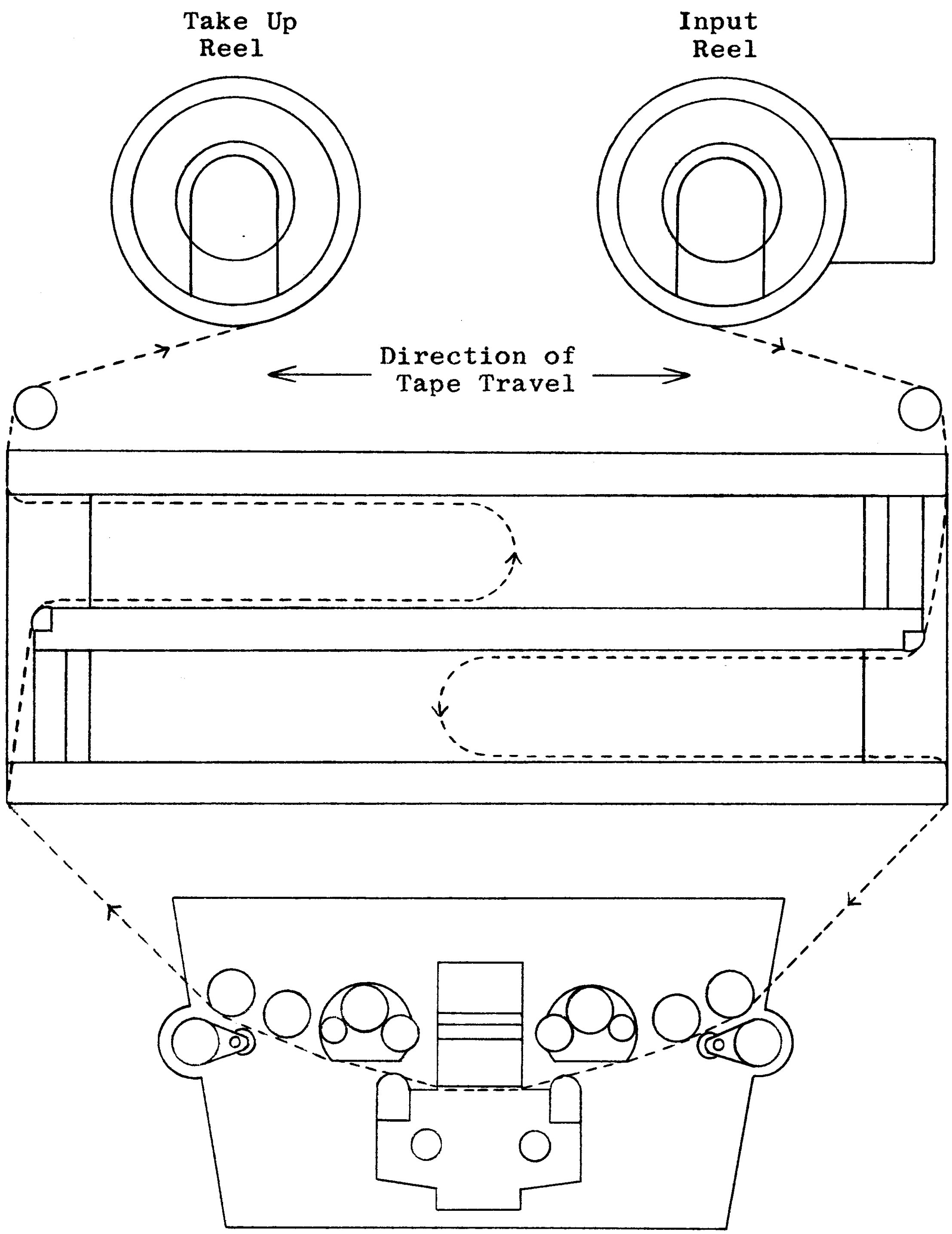

Figure 2-10. Magnetic-Tape Threading.

2. Push the local and transport power STANDBY buttons and set the reel brake toggle down.

3. Turn the right hand reel clockwise until the slack from the columns has been taken up and the conductive leader has been unwound from the left hand reel.

4. Unthread tape from heads, remove conductive leader from the left hand reel, and wind up end to right hand reel. (Do not allow masking tape at the end of the conductive leader to pass over the read-write heads.)

5. Release the hub locking lever and remove the reel.

TAPE EDITING (REEL UNITS)

After the reel has been loaded, depress the edit push button in the LOGIC group and the edit push button indicator simultaneously. Editing will be performed in two phases:

PHASE I - During this phase, the tape moves in a forward direction. A magnetic beginning-of-tape marker is written as shown in Figure 2-11 and then the entire tape is pre-magnetized in one direction. When the physical end-of-tape is encountered, tape movement is reversed and editing then goes into Phase II.

PHASE II - In this phase a magnetic end-of-tape marker is written on tape as shown in Figure 2-11 and a check is made for flaws or imperfect areas. When a flaw is detected, a flaw marker is written on 10 inches of tape, as shown in Figure 2-11. Phase II is completed when all flaws have been detected and the tape is completely rewound. The unit designate push button in the LOGIC group must now be depressed to ready the TSU for on-line operation.

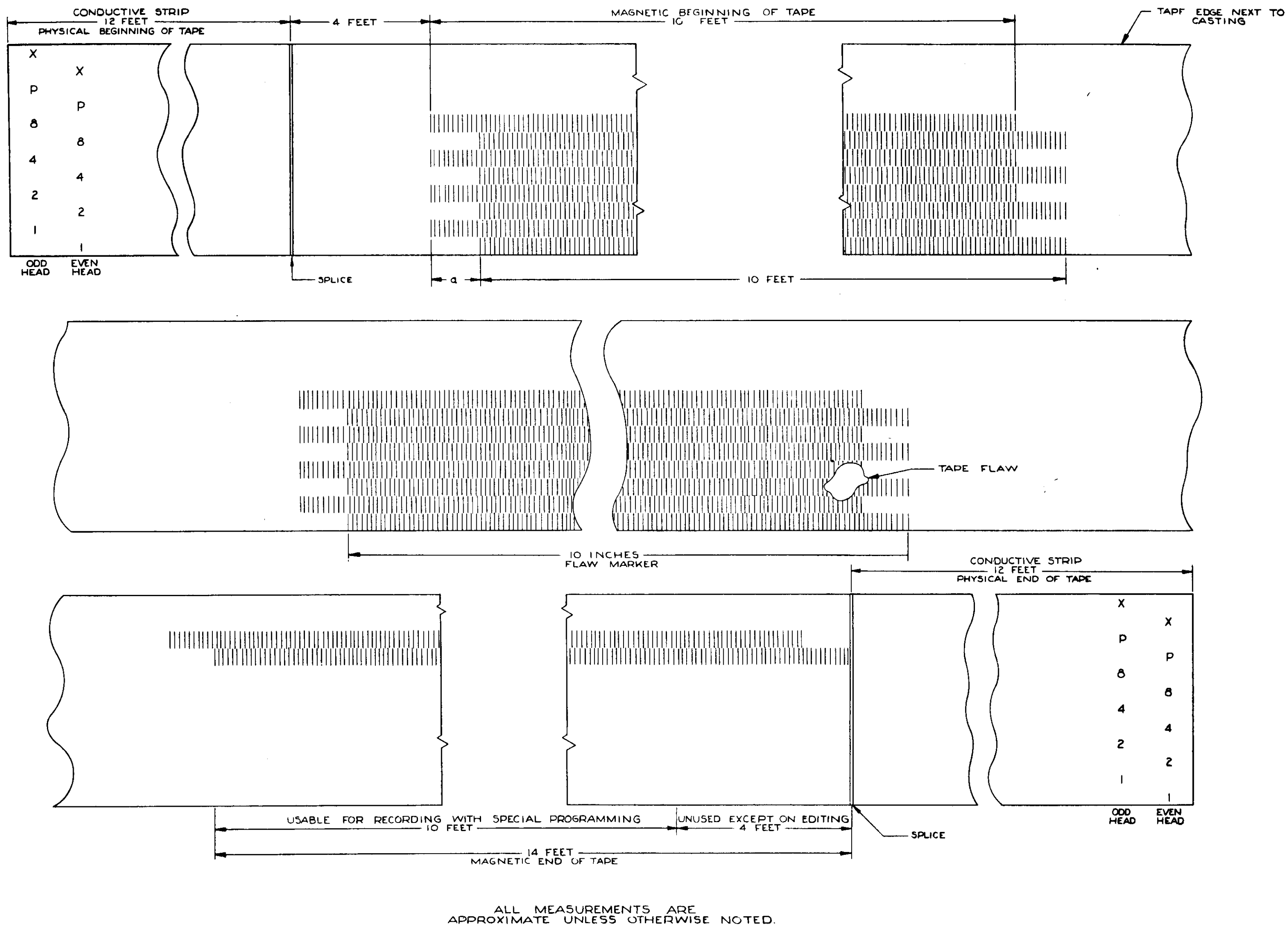

Figure 2-11. Magnetic-Tape Format.

2-2.2 TAPE CONTROL UNIT (Figure 2-12)

TCU CONTROL PANEL

The indicators of the TCU Control Panel are shown in Figure 2-13.

Clear

Depressing this button clears the Tape Control Unit for operation. After a magnetic tape alarm, the TCU must be cleared before another tape instruction can be executed from either the Control Console or the TCU Control Panel. This switch operates simultaneously with the TCU clear switch on the Control Console, so that the TCU may be cleared from either the Control Console or the TCU, whichever is more convenient.

"Yozzle" Toggles

The TYC toggles are used during tape turn around time for Retry. Retries are made twice after the first pass and at the end of the retries both TYC indicators will be on (TYC = 3).

Tape-Preface Check

The TPC indicator is on whenever the machine has stopped on an invalid preface.

X Counter

Various combinations of the TX1, TX2, TX4, TX8 and TX10 indicators are lit during certain alarm conditions.

C Register

The indicators representing this register are divided into six digit positions as follows:

C1 and C2 each normally contains the unit designation (u) of the instruction being executed. However, on certain error conditions, C1 and C2 decades will each equal 15.

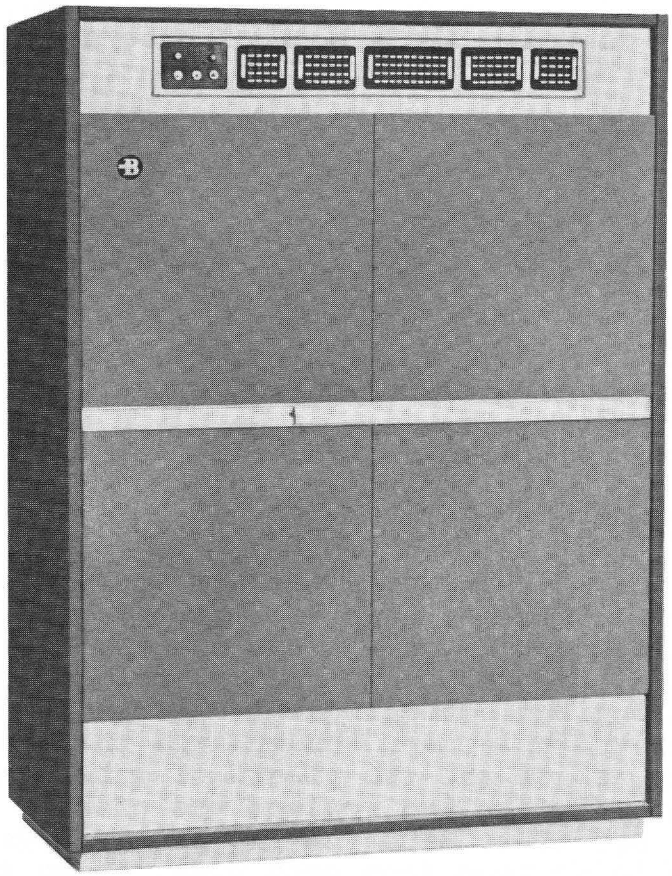

Figure 2-12. Magnetic-Tape Control Unit.

Physical Characteristics:

Width:	53½ inches	Weight:	850 pounds
Depth:	29 inches	Power:	2.0 kw (d.c. 2.4 kw) 208V. 3Ø 60∼ 4 wire
Height:	76 inches	Heat Dissipation:	15,000 BTU/hour
		Blower volume:	1300 CFM

Operating Characteristics:

Transfers information between Datafile or Magnetic Tape Storage Units and Data Processor at 25,000 digits/second

Provides control for searching, scanning, and positioning

Controls and checks the record lengths and parity

Performs numerous checks on information and format

System Characteristics:

Number of units: One per Burroughs 220 System

Special Features:

Provides automatic retrials in all reading operations

C3 normally contains the number of blocks (n) of the instruction being executed, if relevant.

C4 and C5 normally contain the number of words per block (kk) of the instruction being executed, if relevant.

C6 contains the unit position of the operation code.

Tape Comparison Failure

The TCF indicator comes on if the number of words per block (kk) specified in the instruction does not agree with the number of words specified on the block preface on the tape.

2-2.3 SPLICING MAGNETIC TAPE

Place the two ends of magnetic tape to be spliced in the splicing jig so that they overlap. The glossy (non oxide) side of the tape must be up. After putting the two clamps in place to hold the tape, cut through both pieces with a razor blade along the perpendicular slot in the splicing jig. Then remove the clamps, brush away the two loose edges cut away, slide the two pieces of tape apart to leave a gap of about 1/8 inch and replace the clamps. Use Scotch splicing tape No. 41 to tape the two pieces together; trim the excess splicing tape from each side, using the edges of the splicing jig as a guide. If it becomes necessary to attach a conductive leader to the beginning or end of the tape the procedure is to take a 12 foot length of black conductive strip and splice it onto the end of the tape, following the manner described above.

CAUTION

Insure that the dull or conductive side is attached to the glossy side of the magnetic tape so that the dull side is outward when the tape is completely wound on the reel.

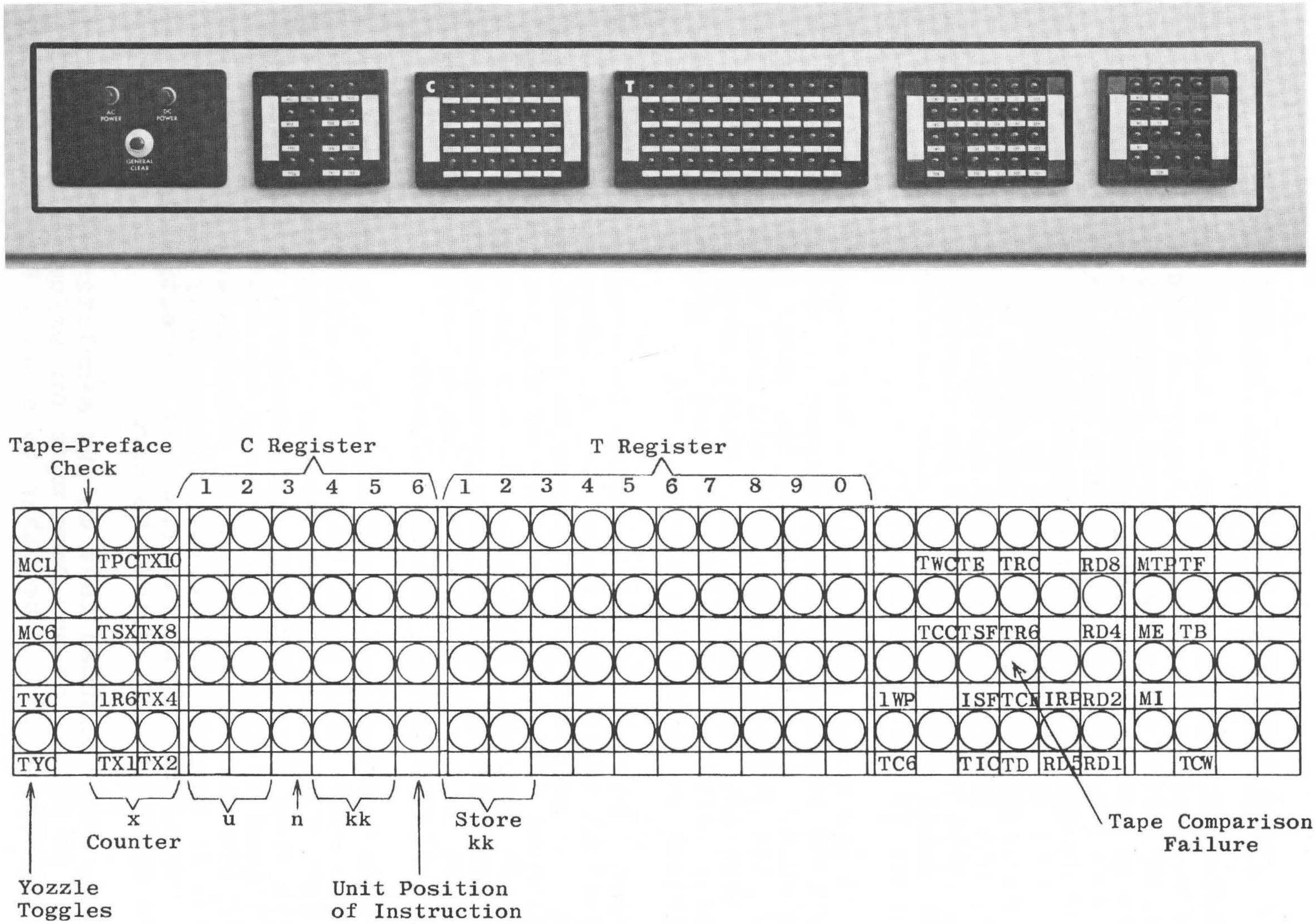

Figure 2-13. Magnetic-Tape Control Unit Control Panel.

2-2.4. ERROR CONDITIONS AND CORRECTIVE PROCEDURES

The BURROUGHS 220 Magnetic Tape Sub-System has been designed to offer maximal flexibility, combined with a high degree of reliability. As with all such complex systems, there is the possibility of system malfunction or operator error. When an error occurs because of a system malfunction or incorrect operation action a condition will be established which will enable the operator to identify the error and take corrective action. An explanation follows which points out some of these error conditions - their effect on the rest of the system, and the corrective action which can be taken to eliminate the error condition, and, where possible, to continue processing.

Some of the error conditions that may occur, together with corrective procedures, are discussed in the following paragraphs. In all cases where the error could be simulated, the corrective procedure has been checked, using the reset-and-transfer button. Those errors that have not been machine tested because they do not readily lend themselves to simulation are so noted.

In those instructions which enable tape-unit operation independent of the Data Processor, no alarm stops will occur, but an error condition may be established that will be detected during the execution of the next tape instruction. In dependent instructions, the alarm will usually occur immediately, causing data processor operation to stop. It is possible, however, for an error condition to be established during turn around time.

All of the errors and correction procedures are discussed from the operator's point of view. No attempt is made to take into consideration the various instructions he may receive from the programmer, or procedures which have been established as standard practice at the installation. The use of standard error-correction routines and restart procedures is recommended, however, especially in those cases where considerable intervention and correction are required by the operator to correct the error.

Further, it is assumed that during simulation of these errors, no provision has been made for using the reset-and-transfer switch, other than to place a HALT instruction in location 0001. The operator was therefore required to use manual entry to the location to which he wished to transfer after using the switch.

In the discussion that follows, the means of identifying the error, the cause and effect of the error, and the operator action to be taken are given in each error condition described.

NOT-READY CONDITION*

IDENTIFICATION. TX10 and TX2 on; instruction in TCU and C Register on Control Console.

CAUSE. There are a number of possible causes of a Not-Ready condition:

Non-existent Unit (not designated).

Power Off.

Unit in Not-Write status when indexed by a write instruction.

Unit previously deactivated by MDA instruction.

Attempt made to move tape forward when positioned at physical end-of-tape.

Tape broken (power off).

EFFECT

Control Console. Any tape instruction except MIB or MIE in C Register.

TCU Console. X counter set to 12 (TX10 and TX2 on).

Tape Position. Tape has not moved.

NOTE

If unit is interrogated, error condition will not be recognized as such, and processing will continue.

OPERATOR ACTION. Determine cause of Not-Ready condition:

1. Check unit designation with C1, of TCU Console.

*Subject to revision

2. If instruction in rC is a Write instruction, check for Not-Write status: Not-Write light on.

3. Check for previous MDA instruction: RWL light on.

4. Check for power on: power light not on.

After cause of Not-ready condition has been determined, and corrected, processing may be continued by the following procedure:

1. Clear TCU.

2. Depress Reset-and-Transfer switch.

3. Set P Register to location of instruction on which alarm stop occurred.

4. Depress start button.

NOTE

The Operator is cautioned against indiscriminately removing the Not-Ready condition since it may be occurring for a definite purpose. For example, rewind lockout (RWL) may be set after rewind, requiring the Operator to change reels, or the Not-Write condition may have been established to protect the master file.

READ CHECK

IDENTIFICATION. TYC = 3 (TYC1 and TYC2 on).

CAUSE

MOW or MRR

Parity check within block

Incorrect number of digits (not 11) between two beginning-of-word markers.

Discrepancy between number of words specified in the preface and the actual number of words in the block.

EFFECT

Control Console

Magnetic-tape-alarm indicator on.

MOW

rC: 44 = rC: 04 = location of key word of next block to be written
rC5 rC6 = 56

MOR

rC: 44 = rC: 04 = location of preface of next block to be written
rC5 rC6 = 57

No information has been written on tape for error blocks.

MRD

rC: 44 = rC: 04 = location of key word from error block.
rC5 rC6 = 52

MRR

rC: 44 = rC: 04 = location of preface of error block.
rC5 rC6 = 53
Block causing the error will have been read into storage.

TCU Console

TYC = 3

C1 = C2 = u
C3 = n - (number of blocks read or written +1)

MOW

C4 C5 = T1 T2 = 15, 9
C6 = 6

MOR

C4 C5 = T1 T2 = 15, 9
C7 = 7

MRD or MRR

Parity check:	C4 C5 = 15, 9
Digit check:	C4 C5 = 15, 9
Word-count check:	C4 C5 = 15, 9 or 00
C6 = 2 (MRD) or 3 (MRR)	

Tape Position. There will be two automatic retries to correct the error. If not corrected, the tape will stop and will be positioned so that the head is in front of the error block.

OPERATOR ACTION. In order to retry, the following steps are necessary:

1. Clear TCU
2. Depress reset-and-transfer switch.
3. Execute a read or write instruction, setting n equal to the number of blocks yet to be written or read, and aaaa = rC:44 at the time of the alarm condition.
4. If error condition is corrected, set P register equal P- register setting at time of alarm.
5. Depress the start button.

If the error cannot be corrected by retry, it will be necessary to proceed as follows in order to continue processing:

MOW or MOR. Restart from the last check point.

MRD or MRR. Either skip the record or reconstruct the error tape and restart from the last check point.

NOTE

Since this error does not lend itself to manual stimulation, the correction procedure has not been machine tested.

PARITY ERROR DURING SEARCH OPERATION

IDENTIFICATION. TYC = 3 (TYC1 and TYC2 on); C6 = 0.

CAUSE. A parity error has occurred in the key word of a record under the following conditions: the key word of the record preceding the error record is less than the search key, and the key word of the record following the error record is greater than the search key. If the instruction being executed is a field-search instruction, the error digit may or may not be in the field specified by the instruction.

EFFECT

Control Console

Magnetic-tape-alarm indicator on.

C register may contain any tape instruction.

TCU Console

C6 = 0

T register contains the search key.

TYC = 3

Tape Position. When a parity alarm is signaled, the record is passed and the key word of the following record is compared with the search key. If the following record is greater than the search key:

The tape backs up and the preceding record (error record) is rechecked during backup.

The key word of the previous block is again checked and found to be low.

The key word of the error record is again checked.

Upon finding the error the third time, the tape stops within the error record.

PARITY ERROR DURING SCAN

IDENTIFICATION TYC = 3 (TYC1 and TYC2 on); C6 = 1.

CAUSE. Parity-error condition in either the record key word, scan word, or the preface of any record passed over during the scan operation.

EFFECT

Control Console

Magnetic-tape-alarm indicator on.

C register may contain any tape instruction.

TCU Console

TYC = 3

C6 = 1

T register contains scan key.

Tape Position. Two retries will be made on the block in question; then the tape will stop in front of the error block, ready to read. The data processor will continue to operate independently until a tape instruction is fetched, at which time the alarm condition will be recognized.

OPERATOR ACTION. If the scan instruction is followed by a read instruction and the category code is program checked for equality, the operator may take the following action:

1. Clear TCU
2. Depress reset-and-transfer switch.
3. Set P register to location of instruction on which alarm stop occurred.
4. Start.

This will allow the program to continue the read instruction on the unit being scanned. If the error condition still exists, an alarm condition will be established by the read. (Refer to READ CHECK error condition for description of parity error - on - read conditions.)

If the error condition has been corrected, no alarm will occur during read, and the category-code check in the program can determine if this is one of the records in the specified category.

NOTE

Since this error condition does not lend itself to manual simulation, the correction procedure has not been machine tested.

PREFACE CHECK

IDENTIFICATION. TPC on.

CAUSE. Invalid preface read from tape. (Preface = 02-09 or incorrect preface identification on tape.)

EFFECT.

Control Console

Magnetic-tape-alarm indicator on.

MOW

rC: 44 = rC: 04 = location of key word of next block to be written.

rC5 rC6 = 56

MOR

rC: 44 = location of preface of next block to be written.

rC5 rC6 = 57

rC: 04 = location of key word of next block to be written.

MRD

rC: 44 = rC: 04 = location where key word of the next block would be stored.

rC5 rC6 = 52

MRR

rC: 44 = location where preface of the next block would be stored.

rC5 rC6 = 53

rC: 04 = location where key word of the next block would be stored.

D1 D2 = invalid kk.

TCU Console

TPC on.

MOW

C1 = C2 = u
C3 = n - (number of blocks written +1)
C4 C5 = T1 T2 = kk from instruction
C6 = 6

MOR

C1 C2 = u
C3 = n - (number of blocks written +1)
C4 C5 = T1 T2 = kk from storage
C6 = 7

MRD OR MRR

C1 = C2 = u
C3 = n - (number of blocks read +1)
C4 C5 = ii from instruction
C6 = 2 for MRD
= 3 for MRR

If on a read instruction, C1 C4 $\neq$ C7 C0, preface failure occurred during turn around.

Tape Position. Tape will start and write correct blocks until the invalid preface is reached; the tape will then stop in the block with the invalid preface.

OPERATOR ACTION In order to retry reading or overwriting the error block, the following action is required:

1. Clear TCU.

2. Depress Reset-and-Transfer switch.

3. Execute an MPB one block.

4. Enter and execute the read or write instruction as follows:

	+unkk	MOW	aaaa
or			
	+unii	MOR	aaaa
or			
	+univ	MRD	aaaa
or			
	+univ	MRR	aaaa

where

n = the number of blocks yet to be written or read.

aaaa = setting of rC: 44 at the time of the alarm.

5. If the retry is successful, set PRegister to setting at time of the alarm and continue.

If a number of retries are not successful, it will be necessary to remove the tape causing the error and to edit the tape before it can be re-used. To continue processing, it will be necessary to either skip the error record, or to reconstruct or restart depending on the type of processing.

PREFACE MISMATCH

IDENTIFICATION. TCF on.

CAUSE

MOW. Preface specified by instruction does not match preface read from tape.

MOR. Preface taken from storage does not match preface read from tape.

EFFECT

Control Console

Magnetic-tape-alarm indicator on.

MOW

rC: 44 = rC: 04 = location of key word of next block to be written.

rC5 rC6 = 56

MOR

rC: 44 = rC: 04 = location of key word of next block to be written.

rC5 rC6 = 57

TCU Console

MOW

C1 = C2 = 15
C3 = n - (Number of blocks actually written +1)
C4 C5 = T1 T2 = kk from tape
C6 = 6

MOR

C1 = C2 = 15
C3 = n - (number of blocks actually written +1)
C4 C5 = T1 T2 = kk from tape

Tape Position Tape will start, write correct blocks until the mismatch is reached. It will then stop, back up, and position itself in front of the block in which the prefaces do not compare.

OPERATOR ACTION

Check T1 and T2 on TCU Console for kk digits. If the kk digits are incorrect, and can be corrected, the following steps are required to continue processing:

MOW

1. Clear TCU.

2. Depress Reset-and-Transfer switch.

3. Enter and execute +unkk MOW aaaa instruction where

   n = the number of blocks to be written
   aaaa = setting of rC: 44 at the time of the alarm.

4. Set P Register to location after MOW instruction.

5. Start.

MOR

1. Clear TCU

2. Depress Reset-and-Transfer switch.

3. Enter and execute +unii MOR aaaa instruction where
   n = the number of blocks yet to be written
   aaaa = setting of rC: 44 at the time of the alarm.

4. Set P Register to location after MOR instruction.

5. Start.

IMPROPER BLOCK LENGTH

IDENTIFICATION. TX = 6

CAUSE

MIW kk digits specified by the instruction = 02-09.

MIR kk digits brought from storage = 02-09.
(This type of error should not occur on a properly debugged program. If it does occur, it is probably due to a storage failure.)

EFFECT

Control Console

Magnetic-tape-alarm indicator on.

MIW

rC: 44 = rC: 04 = storage location of key word of first block.

rC 5 rC6 = 54

MIR

rC: 44 = rC: 04 = storage location of key word of error block.

rC5 rC6 = 55

TCU Console

TX = 6

T1 = C4 = n (MIW) or n (number of blocks written for MIR)

C6 = 4 (MIW or 5 (MIR)

C2 = 0, C3 = 1, T2 = 0, C5 = 0 (MIW); C5 = 15 (MIR)

C1 = 11

Tape Position

MIW Tape will start movement then stop in blank tape.

MIR Tape will stop in blank tape.

OPERATOR ACTION

If the kk digits can be corrected, the following procedure is required to continue processing:

MIW

1. Clear TCU.

2. Depress Reset-and-Transfer switch.

3. Enter and execute an MPE instruction.

4. Set P Register to location of MIW instruction and start.

MIR

1. Clear TCU.

2. Depress Reset-and-Transfer switch.

3. Enter and execute an MPE instruction.

4. Enter and execute +unii MIR aaaa instruction where

    n = the number of blocks yet to be written.
    aaaa = setting of rC: 44 at the time of the alarm.

5. Set P Register to next location after MIR instruction.

6. Start.

FORBIDDEN COMBINATION FROM STORAGE

IDENTIFICATION. Digit-check and magnetic-tape-alarm indicators on.

CAUSE. There are two possible causes for this condition:

1. Forbidden combination (FC) in search or scan key brought from storage. (Though not used, a storage access will be made on MLS, MRW, and MDA.)

2. FC in information brought from storage to be written on tape.

EFFECT

Control Console

Digit-check indicator on.

Magnetic-tape-alarm indicator on.

1. rC: 04 = address of search or scan key containing FC.

2. rC: 04 = location of word containing FC.
   rC: 44 = location of key word of block containing FC.

TCU Console. Under the conditions cited above:

1. C1 = C2 = u
   MTS, MFS, MLS, MRW, MDA (C6 = 0)
   MTC, MFC (C6 = 1)

2. MIW, MIR, MOW, MOR
   C3 = n - (number of blocks written +1)
   C6 = 4, 5, 6, or 7

Tape Position

1. Tape will not have started.

2. Transfer of information to tape stops immediately, and the tape will coast to a stop.

OPERATOR ACTION

MTS or MTC

1. Remove FC from register.

2. Depress reset-and-transfer switch.

3. Examine location specified by rC: 04 for FC. If location is correct, or can be corrected, set P register to location of search or scan instruction and start.

   If location contains FC which cannot be corrected, it will be necessary to return to the last check point and restart.

MIW, MIR, MOW, or MOR. Under certain conditions it is possible to correct the FC and continue operation, but generally the processing should be restarted from the last check point.

FIELD OVERFLOW

IDENTIFICATION. Program-check and magnetic-tape-alarm indicators on.

CAUSE. sL digits of instruction are incorrectly specified, that is $s < L$. (This type of error should not occur on a properly debugged program. Therefore, if it does occur, it is probably due to a storage failure.)

EFFECT

Control Console

Program-check indicator on.

$B7 < B8$

rC5 rC6 = (50) MFS or (51) MFC

TCU Console. During testing, TCU console readings varied.

Tape Position. Tape will not have moved.

OPERATOR ACTION. If the (sL) B-register setting can be corrected, the following action is required to continue processing:

1. Clear TCU.

2. Depress reset-and-transfer switch.

3. Set P register to location of search or scan instruction.

4. Start.

NON-EXISTENT ADDRESS

IDENTIFICATION. Storage-alarm indicator on.

CAUSE. The storage-alarm indicator may come on for one of the three reasons following:

1. The address portion of the instruction brought from

storage is greater than the capacity of the storage.

2. Multiple-block read or write instructions: the address portion of the C register has been counted up and is greater than the capacity of the storage.

3. The value of iiii digits of the instruction code 50 is greater than system storage capacity (MLS, MRW or MDA).

EFFECT

Control Console

rC: 04 = non-existent address

Storage-alarm and system-alarm indicators on.

TCU Console

n will have counted down to the block on which the alarm occurred.

Tape Position. Under the conditions cited above:

1. Tape will not have moved.

2. Tape will stop following the last block read or written.

OPERATOR ACTION. For type-1 error conditions, proceed as follows:

1. Check the instruction located at P-1.

2. If the address portion is incorrect and the correct address is known, it may be changed and processing continued by following steps 3 through 6.

3. Clear TCU.

4. Depress reset-and-transfer switch.

5. Set P register to address of instruction on which error occurred.

6. Start.

Another type of error can cause a wrap-around and destroy the first part of memory; it will be necessary to return to the last check point and restart.

The third type of error can be corrected by changing the value of iiii so that it is within the storage capacity of the system.

IMPROPER BEGINNING- OR END-OF-TAPE CONDITIONS

IDENTIFICATION. Computer stops without completing a magnetic-tape instruction. There is no magnetic-tape alarm.

CAUSE. Tape positions to physical beginning- or end-of-tape before the magnetic-tape instruction has been completed. Some of the possible causes of this are:

Search Instruction

No end-of-tape block.

Search key of last block on tape less than search key of instruction being executed.

Search key of first block on tape greater than search key of instruction being executed.

Error in search key or preface of first or last block on tape, when that is the block being searched for.

Scan Instruction

No end-of-tape block or no control block to limit file.

Last block is in magnetic end-of-tape and scan key is the one desired.

Position-Forward Instruction

If the last block on tape has been passed and n has not been counted down to zero, or, if n is counted down to zero and the last block was in magnetic end-of-tape.

Position-Backward Instruction

If the first block on tape has been passed and n has not been counted down to zero.

Initial-Write Instruction

Attempt made to initial write with the head positioned in blank tape.

Over-Write Instruction

Last block on tape has been overwritten and n has not been counted down to zero, this can occur even if an end-of-tape block is present, if the end-of-tape block is overwritten.

Read Instruction

No end-of-tape block to limit file, and the last block on tape has been read and n has not been counted down to zero.

This type of error could be the result of improper programming, incorrect tape procedures, operator error or system malfunction.

OPERATOR ACTION. The operator should attempt to identify the specific cause of the error. This will require the following procedure:

1. Check the C register of the TCU to determine the instruction being executed and the unit.

2. Check the unit to determine if the tape is positioned at either physical beginning- or end-of-tape.

3. Check the unit for ready conditions.

Figure 2-14. DATAFILE.

Physical Characteristics:

Width: 86 inches	Power: Approx. 3 kva from 220 power system
Depth: 36 inches	
Height: 57½ inches	Blower Volume: 800 CFM
Weight: Approx. 1,300 lbs.	Heat Dissipation: 9,200 BTU/hour

Operating Characteristics:

Large capacity multiple-bin magnetic tape storage unit containing fifty separate lengths of dual-lane tape

Free-hanging tapes and vacuum manifold control insure stable strain-free tape feed with rapid start/stop time

Magnetic tape reading rate: 25,000 digits/second

Magnetic tape feeding rate: 120 inches/second

Information density: 416⅔ digits/inch

Magnetic tape start time: Approx. 5 milliseconds

Magnetic tape turn-around time: Average 13.5 milliseconds (independent operation)

System Characteristics:

Machine-controlled searching process leaves computer free to continue other operations

Rapid access to bulk on-line storage of up to 50 million digits

Any combination of Datafiles and Tape Storage Units may be used in one system

Recording code: Binary-coded decimal with parity check

Format: Two channels of information (density 208⅓ digits/inch/channel) are intermixed on magnetic tape

Number of storage units: A maximum of ten per Burroughs 220 system

Bi-directional independent search on recorded information

Forward independent "scanning" on recorded information

2-2.5 DATAFILE* (Figure 2-14)

The DATAFILE is a large-capacity multiple-bin magnetic-tape storage unit. The unit contains fifty separate lengths of tape hanging freely between metal partitions. Each tape contains two lanes of information, making a total of 100 lanes. Information is read from, or written on, these tapes by a magnetic head assembly, which is positioned, under system control, beneath the selected tape.

Control and operation of the DATAFILE is through the Tape Control Unit, by Data Processor instructions. Up to ten DATAFILES or Tape Storage Units (or any combination totaling ten) may be used with the BURROUGHS 220 system.

TAPES-DATAFILE tapes are addressed by lane number, the lanes for each DATAFILE being numbered 00 through 99. Otherwise, the tape information structure and format are the same as for the Tape Storage Units.

When the physical beginning or end of any one of the DATAFILE tapes is sensed, the tape stops and can be repositioned only by an operation that causes it to move away from the marker. Since this condition does not inhibit carriage movement to another tape, all DATAFILE instructions which result in carriage movement or positioning of the tape away from the end-of-tape marker are permissible. All other DATAFILE instructions to the same unit, except interrogate, will light the alarm indicator on the DATAFILE and cause a DATAFILE not ready condition.

OPERATIONAL CHARACTERISTICS

Within a DATAFILE, there are 50 (Sandwich type) tapes, each 3/4-inch wide and 270 feet long. These 50 tapes are driven by constantly rotating drive rollers over three tape guides, and fall free on either side of the guides down into the body of the unit. There are 52 vertical perforated partitions within the unit, including one at each end. These partitions separate the unit into 50 bins, one for each tape.

* Trademark of the Burroughs Corporation

Along the top of the DATAFILE, from end to end, there is a horizontal support rod. A carriage assembly travels on rollers from one end of this support rod to the other, and selects whatever tape is desired at a given time. When the carriage assembly is positioned properly, pinch rollers on the carriage assembly engage the selected tape, so that the tape travels in either the forward or reverse direction. Each tape is stored in loose folds between a pair of perforated partitions. The partitions are treated to minimize electrostatic buildup caused by tape travel, while the perforations permit the tape to fall freely without forming air pockets between successive layers.

Information is recorded serially, by digit, in blocks of 10 to 100 computer words. Recording is done in two separate lanes, each containing six interlaced tracks (channels). This interlacing doubles the information storage capacity.

Four of the tracks are used for storing binary-coded decimal information. The fifth track is used for parity checking, and the sixth is used for control purposes.

The parity checking track is used to detect flaws in the tape. An odd number of information flux changes must have an accompanying parity flux change in the fifth track. If there is no parity flux change for an odd number of flux changes, an alarm sounds.

Control channel flux changes, when present, indicate that the information tracks next to the control channel contain information pertaining to the number of words in a block and block address. The block address is used to locate a word-block of information.

Information is recorded on the tape using the non-return-to-zero system. A 0 is indicated by a change in magnetic flux, and a 1 is indicated by the lack of a change in magnetic flux.

DATAFILE CONTROL PANEL (FRONT)

Write Lock Out This indicator is on when the unit is in the local state, the not write master lock out switch is in the UP (Lockout) position, or whenever the head is selected under a lane whose corresponding not write switch is in the UP (lockout) position.

Not Ready This indicator is on when the unit is in local condition.

Unit Designate This indicator operates in conjunction with the Unit Designate rotary switch. It is on when a magnetic-tape instruction is being executed and the unit-designation digit in the instruction corresponds with the Unit Designation Switch setting.

Alarm Power This indicator is on when DC power is off to the DATAFILE.

Emergency Stop When this button is depressed, all tape operations to the DATAFILE are stopped.

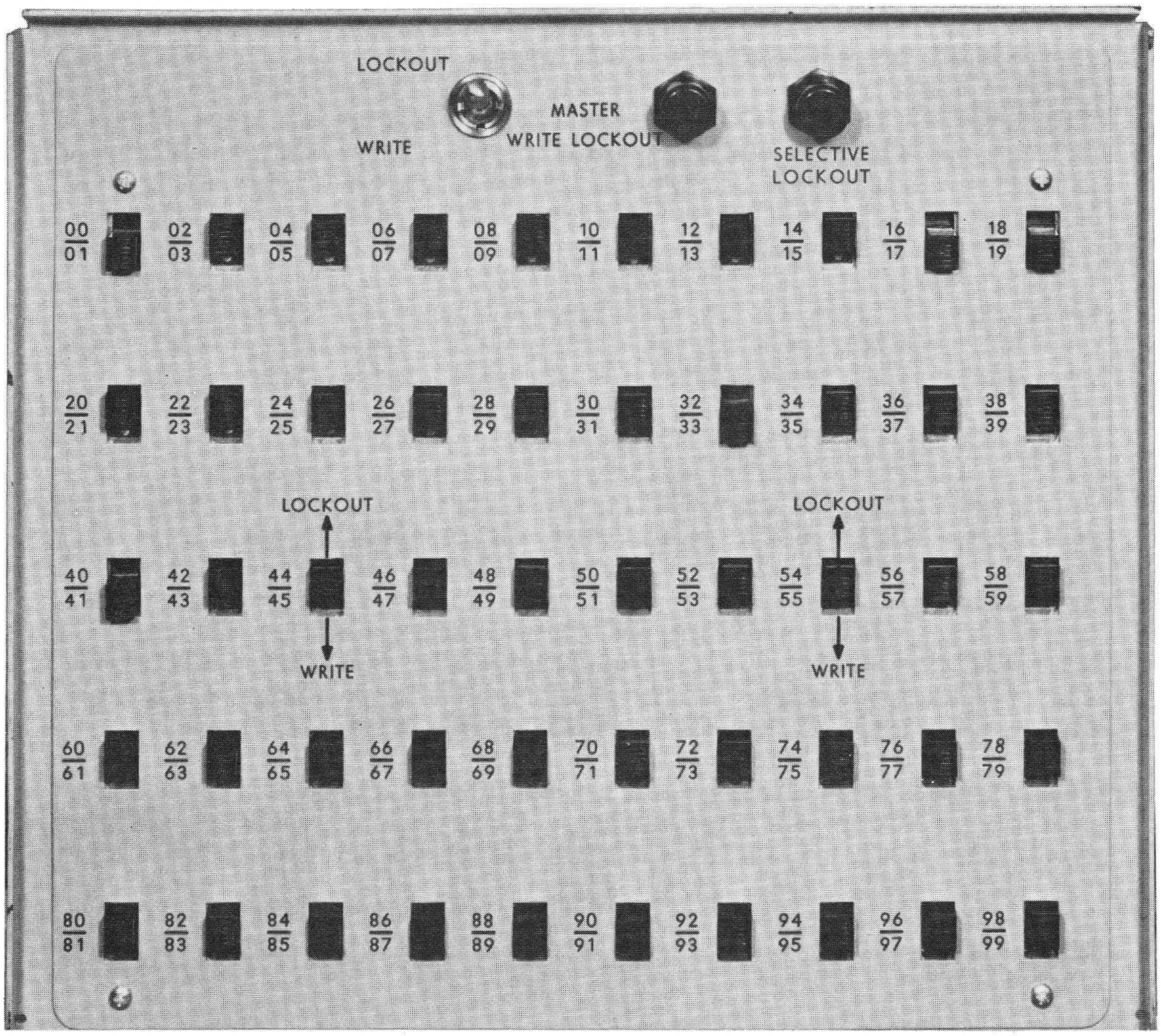

Figure 2-15. DATAFILE, Right-Hand Control Panel.

RIGHT-HAND CONTROL PANEL (Figure 2-15)

LOCKOUT/WRITE SWITCH - This is a two-position toggle switch (located top, left of panel). This switch controls the write operation. When the switch is in the LOCKOUT Position (UP), the entire 50 tapes are locked out, and writing is inhibited on all of the 100 lanes.

The MASTER WRITE LOCKOUT INDICATOR comes on when this switch is in the LOCKOUT position. If a magnetic tape write instruction is transmitted to a unit which has a lockout condition, the computer will stop with the instruction in the C Register and tape will not have moved.

When the switch is in the WRITE position (DOWN), information can be written on any tape provided the individual tape lockout/write switch is not in the lockout position.

LANE LOCKOUT/WRITE SWITCHES - Each pair of lanes is provided with a LOCKOUT/WRITE switch. There are two positions for each switch - UP or DOWN. This switch when in the LOCKOUT position (UP), both lanes corresponding to the switch are locked out, thus prohibiting writing on either lane. These switches are sometimes referred to as file protection switches. When any one of these switches is in the LOCKOUT position (UP), the SELECTIVE LOCKOUT INDICATOR is lit (this indicator is not lit if all tapes are locked out - the MASTER WRITE LOCKOUT INDICATOR is ON).

When these switches are in the DOWN position, information can be written on the tapes. This is providing, of course, that the LOCKOUT/WRITE SWITCH is also in the DOWN position.

A white dot is visible on each LANE LOCKOUT/WRITE SWITCH whenever any of these switches are in the LOCKOUT or UP position.

MASTER WRITE/LOCKOUT INDICATOR - This indicator is lit whenever the LOCKOUT/WRITE toggle is in the LOCKOUT position.

SELECTIVE LOCKOUT INDICATOR - This indicator is lit whenever one or several of the LANE LOCKOUT/WRITE SWITCHES are in the LOCKOUT position.

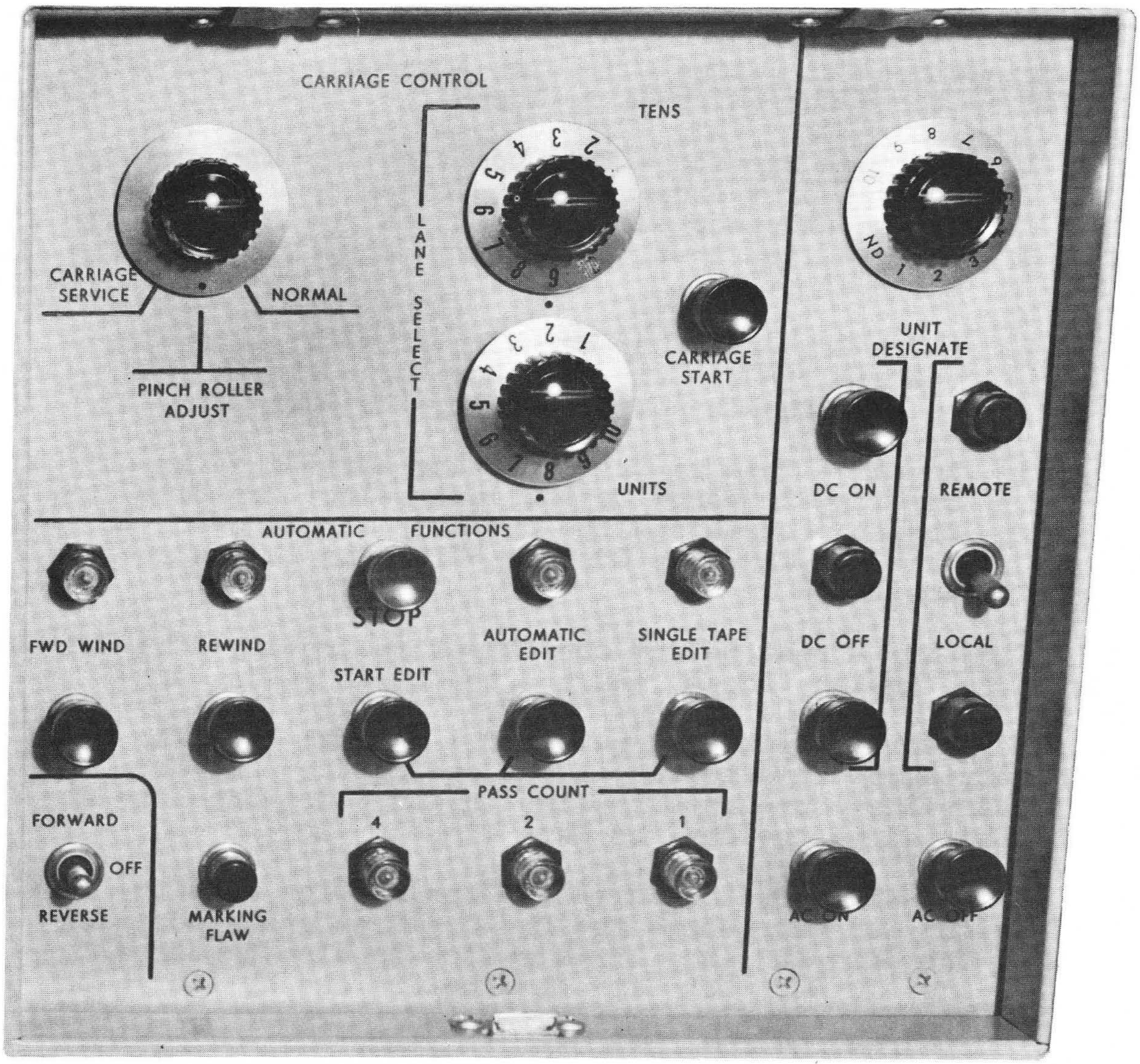

Figure 2-16. DATAFILE, Left-Hand Control Panel.

LEFT-HAND CONTROL PANEL (Figure 2-16)

CARRIAGE CONTROL GROUP - This group consists of three rotary dial switches and one pushbutton with the function of each described below.

Carriage Control Switch - This is a three position rotary dial switch functioning as follows:

1. Carriage Service - This position setting permits removal of the carriage and other component parts for maintenance purposes. It is not for Operator Use. Switch must be in normal position during all processing.

2. Pinch Roller Adjust - This dial setting enables the Field Engineers to check the roller. This setting should not be used by the Operator.

3. Normal - This is the operating setting in which the carriage responds to the lane select instructions. Before processing, the Operator should check to see that the CARRIAGE CONTROL SWITCH is in the normal position.

LANE SELECT - Lane Select consistsof two rotary dial switches with one designated as Tens and the other as Units.

Tens - This switch is numbered 1 through 10. The setting of this switch at any one of the numbered positions represents the 1st digit position or tens position of the desired lane.

Units - This switch is set in conjunction with the Tens switch and represents the 2nd digit or units position of the desired lane. This switch is also numbered 1 through 10 and the setting is determined by the lane to be designated.

CARRIAGE START - This is a pushbutton that when depressed will cause the read-write to be driven to the tape containing the lane selected by the tens and unit switches. This switch is operative only when the REMOTE-LOCAL switch is set to LOCAL.

UNIT DESIGNATE - This is a rotary dial switch with numbered positions of 1 through 10 and one position labeled ND. This switch is used to designate a particular DATAFILE to correspond to the "u" position in the Magnetic Tape Command. If two units are designated the same number, the first in line will respond to the command. The ND position signifies NOT DESIGNATE. A DATAFILE with this setting is not designated and will not respond to the "u" position of a Magnetic Tape Command.

DC ON - When this push button is depressed, DC power is applied to the DATAFILE.

DC OFF - When this push button is depressed, DC power to the DATAFILE is turned off.

DC INDICATOR - This indicator is lit when DC to the DATAFILE is ON.

REMOTE INDICATOR - This indicator is ON when the REMOTE-LOCAL switch is in the REMOTE position (UP). It is OFF when the switch is in the LOCAL position (DOWN).

REMOTE-LOCAL SWITCH - This is a two position toggle switch. When in the UP position, it is in REMOTE and the Unit is under control of the Data Processor. In the DOWN position the DATAFILE is in a LOCAL status which allows the operator to control movement of the tapes, for example, rewind, edit, or to drive tapes in a forward or reverse direction.

LOCAL INDICATOR - This indicator is ON when the REMOTE-LOCAL switch is in the LOCAL position.

AC ON - When this push button is depressed, AC power is supplied to the DATAFILE.

AC OFF - AC power is turned off when this push button is depressed.

AUTOMATIC FUNCTIONS GROUP

FWD Wind Indicator - This indicator comes on when the FWD Wind Push button just below it is depressed.

FWD Wind Push Button - When this push button is depressed, all tapes are rewound in a forward direction (away from the operator) one at a time to physical end of tape. This is performed sequentially 00 through 99. REMOTE-LOCAL switch must be in the LOCAL position.

Rewind Indicator - This indicator is on when the tapes are being rewound.

Rewind Push Button - When this push button is depressed, all tape, sequentially, are rewound to the physical beginning of tape (toward the operator). REMOTE LOCAL switch must be in the LOCAL position.

Stop Push Button - When this push button is depressed, tape rewind or forward wind operations stop. (DC does not drop but all functions of the AUTOMATIC FUNCTIONS GROUP are halted).

Automatic Edit Indicator - This Indicator is lit when the DATAFILE is automatically editing tape for all lanes (caused by simultaneous depression of the START EDIT and AUTOMATIC EDIT push buttons).

Automatic Edit Push Button - When this push button is depressed simultaneously with the START EDIT push button, automatic edit of all tapes will be performed. REMOTE-LOCAL switch must be in the LOCAL position.

Single Tape Edit Indicator - This Indicator is lit when the SINGLE TAPE EDIT and START EDIT push buttons have been depressed and a single tape is being edited.

Single Tape Edit Push Button - This push button, when depressed simultaneously with the START EDIT push button, causes a single tape to be edited. The REMOTE-LOCAL must be in the LOCAL position. The tape to be edited is determined by the setting of the TENS and UNITS switches in the CARRIAGE CONTROL GROUP.

Start Edit - This push button is depressed with either the SINGLE TAPE EDIT or the AUTOMATIC TAPE EDIT push button to perform a DATAFILE edit operation.

Forward/Reverse/Off Switch - Three position toggle switch allows operator to drive tape forward or backward, depending on setting of switch. Center is the OFF position. This switch can be used only when the Remote/Local switch is set to LOCAL. If this switch is in the Forward position, the tape will be moved forward (away from the operator). If this switch is in the Reverse position, tape will be moved backward (toward the operator).

If a specific tape is to be moved in a forward or backward direction, the read-write head must be positioned under that tape before the forward-reverse switch is turned to the desired position.

Marking Flaw Indicator - During edit, the MARKING FLAW INDICATOR comes on whenever a flaw marker is written.

Pass Count - When edit is executed, tape is actually driven back and forth 8 times (4 times per lane).

DATAFILE EDITING

DATAFILE editing consists of machine controlled examination of selected DATAFILE tapes. All flaws are so marked that a maximum block may be written without entering the flaw area. There are two methods of editing.

Depressing the AUTOMATIC EDIT button on the control panel of the DATAFILE will cause all of the tapes to be rewound and edited, except those under write lockout control. When more than 10 or 15 tapes are to be edited, use of the write lockout control in combination with the AUTOMATIC EDIT control is recommended to reduce operating time.

Depressing the SINGLE TAPE EDIT button will cause both lanes of the tape on which carriage then rests to be edited.

The editing process is independent of both the Data Processor and the Tape Control Unit. A not ready condition is established for the DATAFILE on which the selected tape is being edited.

The time required to edit a single rewound DATAFILE tape is approximately 3.5 minutes. The time required to edit a full rewound DATAFILE (50 tapes) is approximately 2.9 hours.

2-3 BURROUGHS 220 CARDATRON SUBSYSTEM (Figure 2-17)

The CARDATRON* is designed for applications which deal with masses of punched-card input and corresponding amounts of printed-report and punch-card output. This punched-card input-output system uses IBM punch-card equipment to support a BURROUGHS 220 Electronic Data Processing System.

The CARDATRON System fully buffers both card input from readers and computer output to card punches and line printers. This results in independent and simultaneous multiple input-output operation.

Alphabetic, numeric, and alphanumeric information are handled with equal facility, and all data is automatically edited.

The CARDATRON System is built around the CARDATRON Control Units, which controls any combination of up to seven CARDATRON Input and/or Output Units. Each of these units handles one punched-card device. For example, a full CARDATRON System could consist of a CARDATRON Control Unit, four Input Units connected to four card readers, and three Output Units connected to two line printers and a card punch.

* Trademark of the Burroughs Corporation

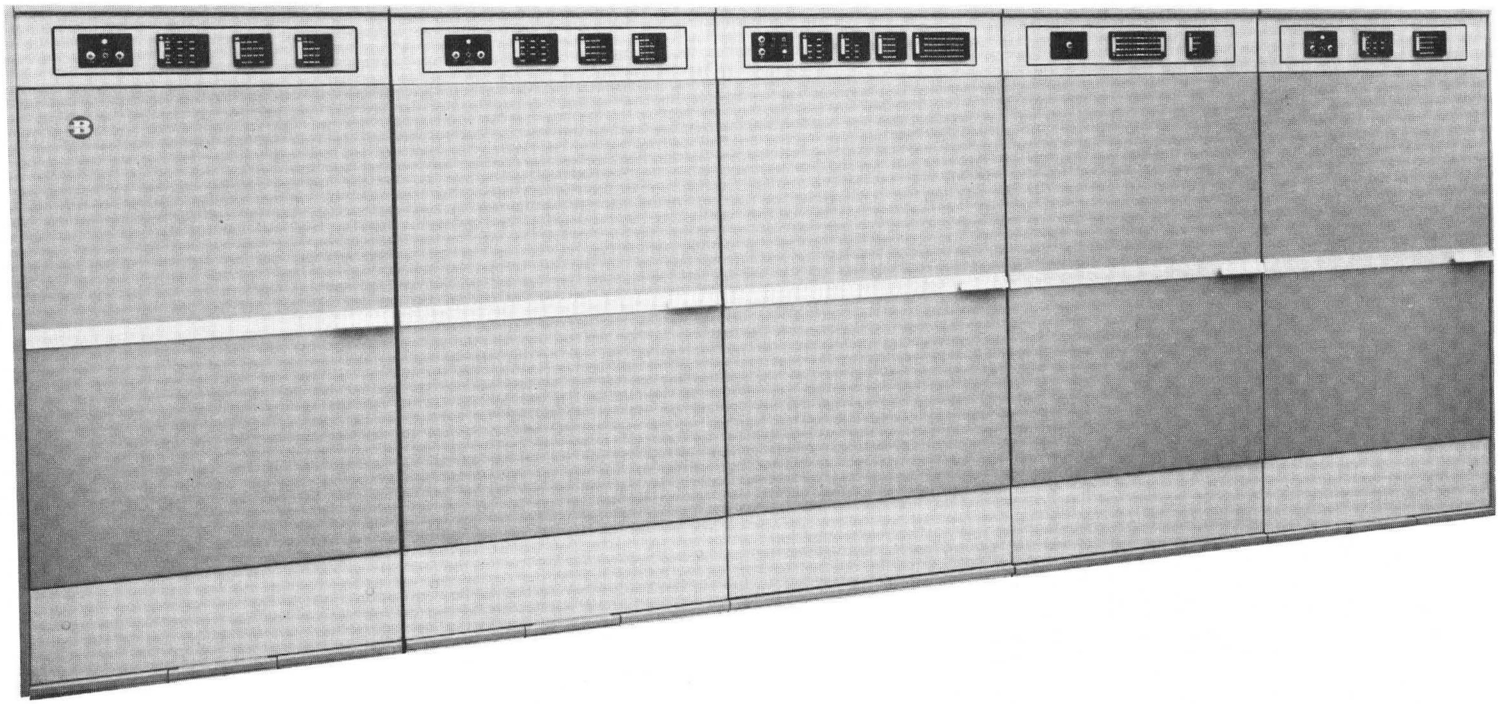

Figure 2-17. **BURROUGHS** 220 CARDATRON Subsystem.

CARDATRON CONTROL UNITS (Figure 2-18)

These units provide the necessary control required to govern the functions of the CARDATRON Subsystem. This control consists of synchronizing the operation of a single input or output unit with the computer during the transfer of information from one to the other. Once this is completed, the control units release the input or output unit from the computer and provide control over this unit, or associated unit, and the card device cabled to it. Therefore, the computer is free to operate independently while the card device is reading in or printing and/or punching out other information. All indicators and controls required for efficient operation of these units are explained in detail on the following pages.

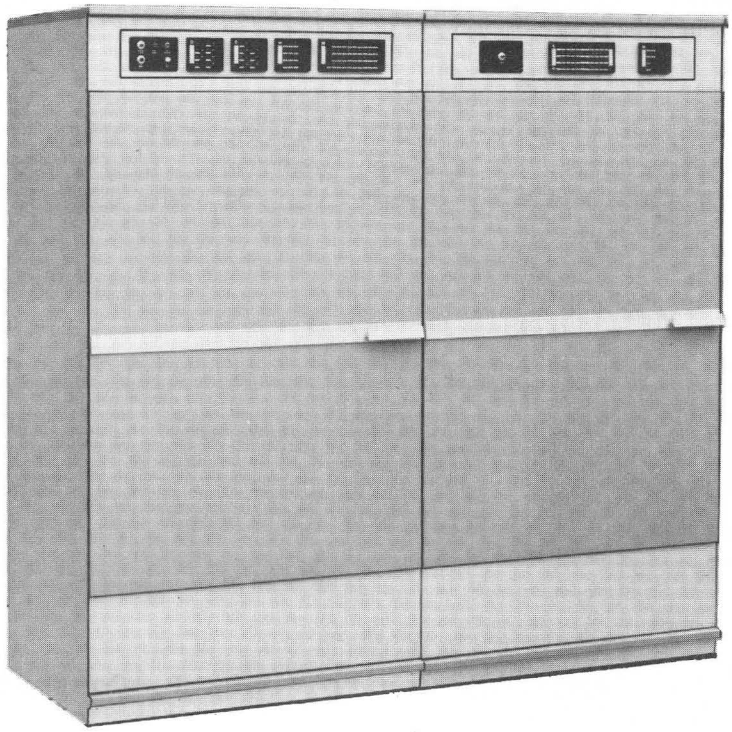

Figure 2-18. CARDATRON Control Units I and II.

Physical Characteristics:

Width:	80 inches	Weight:	1550 pounds
Depth:	28½ inches	Power:	1.7 kw (d.c. 2.0 kw)
Height:	75 inches	208V. 3Ø 60~ 4 wire	
		Heat Dissipation:	12,600 BTU/hour
		Blower volume:	1400 CFM

Operating Characteristics:

Transfers information between input units and Data Processor and Data Processor and output units at a rate of 45,000 digits/second
Controls the operation of up to 7 input or output units
Controls the translation of information to and from the Data Processor

System Characteristics:

Number of units: A maximum of one per Burroughs 220 System

2-3.1 CARDATRON CONTROL UNIT

Control Unit I

The panel display (Figure 2-19) on Control Unit I is comprised of indicators, switches, buttons, and registers, which reflect the overall condition of the CARDATRON Subsystem.

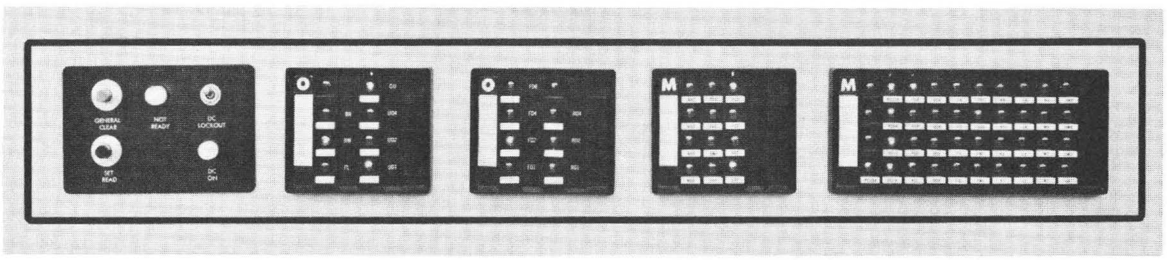

Figure 2-19. CARDATRON Control Unit I, Control Panel.

Indicators, Switches and Buttons

Gen. Clear - A pushbutton which clears the CARDATRON Subsystem (Control, Input and Output Units).

Not Ready - A red indicator when "ON" indicates the Control Unit is in a non-operative condition.

D. C. L. O. - D. C. Lockout - A switch which controls D. C. is NOT used by the operator. Direct current cannot be brought on until the D. C. lockout switch is in an "UP" position.

D. C. On - A blue indicator when "ON" indicates D. C. voltage is applied to the CARDATRON Subsystem.

Set Read - This pushbutton, when depressed, turns on the buffer read (BR) toggle and is used to restart a card reading operation.

REGISTERS

O Register - An 8 neon register which represents the following toggles:

BR - Buffer Read Toggle which indicates that a Card Read operation is taking place within an Input Unit.

BW - Buffer Write toggle which indicates that a Card Write operation has been called for.

FL - Format Load toggle which indicates that an Input or Output format band is being loaded.

OU - Output Unit toggle which indicates that an Output Unit has been addressed by the Data Processor.

UD - Unit Designate - Three toggles (UD4, UD2, and UD 1) which hold the number of the unit designated by the Data Processor instruction.

O Register - An 8 neon register which represents the following toggles:

FD - Format Designate Toggles - A toggle decade (FD8, 4, 2 and 1) which holds the configuration of the Format Control digit of a Card Write instruction.

RD - Relay Designate Toggles - Three toggles (RD4, 2, and 1) which hold the Tab Select information received from variant digit position 3 of a Card Write Instruction.

M Register - A 12 neon register used primarily for maintenance purposes.

M Register - A 40 neon register used primarily for maintenance purposes.

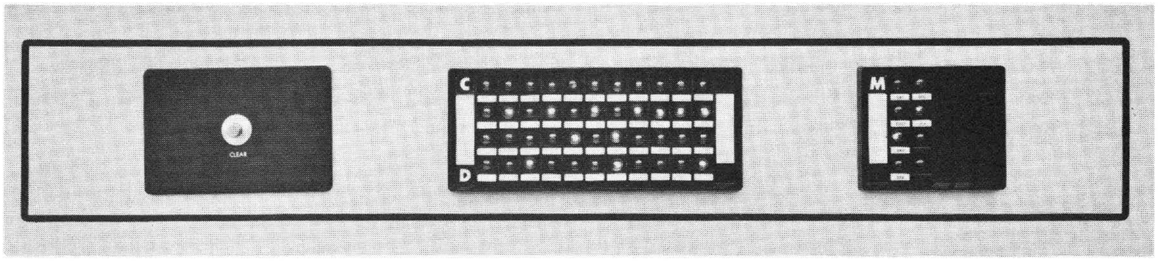

Figure 2-20. CARDATRON Control Unit II, Control Panel.

CONTROL UNIT II (Figure 2-20)

Clear - A red pushbutton which clears the CD Register on the Control Unit II panel.

CD Register - Copy of the D register an 11, digit, 44 neon register which is used to hold the CARDATRON instruction currently being performed.

M Register - an 8 neon register used for maintenance purposes.

DESIGNATION OF CARDATRON INPUT-OUTPUT UNITS

The seven Cannon connectors of the Control Unit are used to connect the Input and Output Units to the Control Unit and to designate their numbers. These connectors are located on the front of the Control Unit at the bottom and are covered by a removable panel. Since the same row of seven connectors is used for either input or output, and the connectors are not labeled, it is necessary to assume the following numbering system:

1. For Input Units, connectors are numbered from 1 through 7, going from left to right.

2. For Output Units, connectors are numbered from 1 through 7, going from right to left.

Thus, an Input Unit attached to the first connector on the left becomes Input Unit 1. If the same unit were, instead, attached to the second connector from the left, it would become Input Unit 2.

The same procedure applies to Output Units, but starting from the right. An Output Unit attached to the first connector on the right becomes Output Unit 1. The second connector from the right would designate Output Unit 2.

CARDATRON INPUT UNIT (Figure 2-21)

The CARDATRON Input Unit serves as a buffer between the computer and the card-reading device. Information is read onto the buffer within the Input Unit and stored there until the computer is ready to process it. During the transfer of the information from the Input Unit buffer to the computer, the information is edited according to a format band previously stored on the buffer. While processing is going on within the computer, other information can be read onto the buffer from the card reader. This is advantageous since the processing speed of the computer exceeds the speed of the card reader and the computer is therefore not delayed by the slower speed. Up to 7 input and/or output card devices may be cabled to one CARDATRON Sub-System but for each card device an Input or Output Unit must be added. A detailed explanation of the indicators and controls may be found on the following pages.

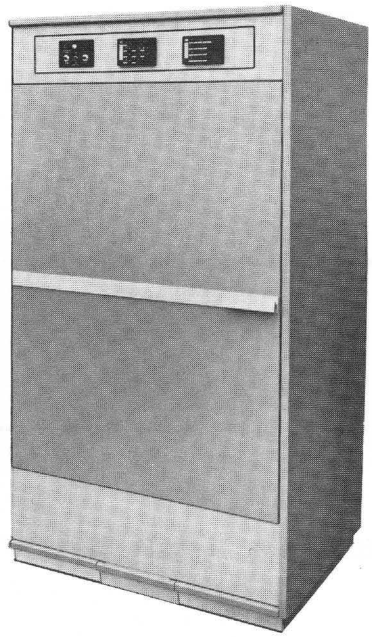

Figure 2-21. CARDATRON Input Unit.

Physical Characteristics:

Width:	40	inches	Weight:	750 pounds
Depth:	28½	inches	Power:	1.8 kw
Height:	75	inches	208V. 3Ø 60~ 4 wire	

Heat Dissipation:
6000 BTU/hour
Blower volume: 700 CFM

Operating Characteristics:

Transfers information to the Cardatron Control Unit at 45,000 digits per second

Receives information from a card reader at a maximum of 240 cards per minute

Stores information on a buffer drum, permitting the Data Processor to perform useful work during the slower card reading operation

System Characteristics:

Number of units: Up to seven Cardatron Input Units with the Cardatron Control Unit

Transfer time from Cardatron Input Unit to Data Processor (via Cardatron Control Unit): 7.20 milliseconds

Card information is independently edited (columns deleted, zeros inserted, and information scaled) automatically under electronic format control. All 80 columns of information may be edited

Alphabetic information is automatically translated into bi-decimal form. All 80 columns of information may be translated. Alphabetic information may be randomly mixed with numeric

Special Features:

Several card readers may be multiplexed under Data Processor control, eliminating the merging of card files

Any one of five electronic format bands may be selected by a card so that several different card formats may be included in one card file

The format bands are changed under Data Processor control

2-3.2 CARDATRON INPUT UNIT

Figure 2-22 is a layout of the Control Display Panel for the CARDATRON Input Unit. A description of this panel is as follows:

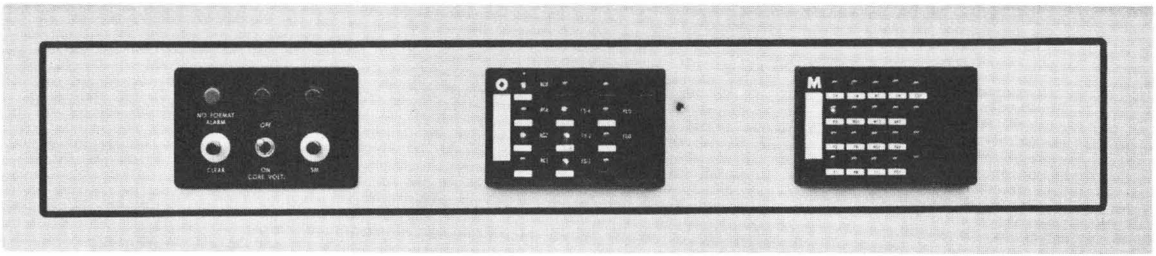

Figure 2-22. CARDATRON Input Unit Control Panel.

Pushbuttons, Indicators and Switches

No. F. A. - No Format Alarm - a red indicator when "ON" indicates that no format has been selected for the card about to be read onto the CARDATRON information buffer drum.

CL - Clear Button - A red pushbutton, when depressed, that clears the registers of the corresponding Input Unit.

CV - Core Voltage - A switch and associated blue indicator which controls voltage to the Input Buffer drum. Under normal operating conditions, this switch is set to ON and the indicator is lit.

SM - Start Machine - A pushbutton which manually controls the starting of the corresponding card reader. When depressed, the blue indicator is lit, indicating that the Start Machine Toggle is turned on. The operator will not, under normal conditions, use this pushbutton.

REGISTERS

O Register - A 12 neon register which represents the following toggles:

RC - Row Counter - Four Toggles (RC8, 4, 2, and 1) used to sequence the input operation so that the Input Unit maintains a count of the card rows.

FS - Format Select Toggle - Three toggles (FS4, 2, and 1) that show which format band was selected from the card.

RLO - Reload Lockout - A toggle which, during input, inhibits the start of the card reader so that format bands may be loaded, prior to reading the next card. The inhibition is removed by the next Card Read instruction.

FLO - Format Lockout - A toggle used to inhibit the transfer of information to the buffer drum of the card following the one that imposed FLO. Inhibition is removed by the following Card Read instruction.

M Register - A 20 neon register used primarily for maintenance purposes.

CARDATRON OUTPUT UNIT (Figure 2-23)

The CARDATRON Output Unit performs the same basic function as the Input Unit - that is, as a buffer between the computer and the card device. The only exception is that the flow of information is from the computer to the Output Unit and then to the card device. The card device for each Output Unit may be either a printer or a punch depending on the type of output desired. The variation of speeds between the computer and the card device sets up the function of the Output Unit as a buffer so that information from the computer can be stored on the buffer, thus releasing the computer for other operations while the information from the buffer is being printed and/or punched. The information is edited by the Output Unit during the output operation. A combination of up to 7 input and/or output card devices may be cabled to the CARDATRON Sub-System but for each card device another Input or Output Unit must also be added. The following pages contain a detailed explanation of all of the indicators and controls on the Output Unit.

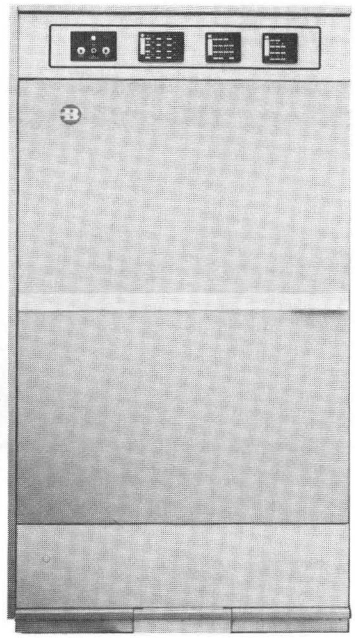

Figure 2-23. CARDATRON Output Unit.

Physical Characteristics:

Width:	40	inches
Depth:	28½	inches
Height:	75	inches

Weight: 750 pounds

Power: 2.2 kw

208V. 3Ø 60~ 4 wire

Heat Dissipation: 7500 BTU/hour

Blower volume: 700 CFM

Operating Characteristics:

Receives information from the Cardatron Control Unit at 32,000 digits per second

Controls card punching at 100 cards per minute maximum

Controls line printing at 150 lines per minute maximum

Stores information on a buffer drum, permitting the Data Processor to perform useful work during the slower card punching or printing operation

System Characteristics:

Number of Units: Up to 7 Cardatron Output Units with the Cardatron Control Unit

Transfer time from Data Processor (via Cardatron Control Unit) to a Cardatron Output Unit: 9.99 milliseconds

Information from the Data Processor is edited (words or selected portions of words) automatically under electronic format control. Alphabetic and numeric information may be mixed. Up to 80 card columns may be punched or up to 120 characters printed per line

Special Features:

Several card punches and/or line printers may be multiplexed under Data Processor control

Any one of five electronic format bands may be selected on any Cardatron Output Unit under Data Processor control

The format bands are changed under Data Processor control

2-3.3 CARDATRON OUTPUT UNIT

Each Output Unit has a control panel which displays items of importance to the operator. (Figure 2-24)

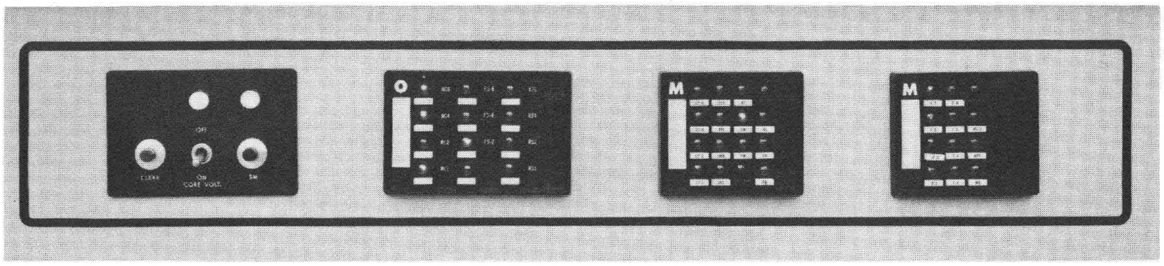

Figure 2-24. CARDATRON Output Unit Control Panel.

Pushbuttons, Indicators and Switches

CL - Clear Button - A red pushbutton, when depressed, that clears the registers of the corresponding Output Unit.

CV - Core Voltage - A switch and associated blue indicator which controls voltage to the Output Buffer drum. Under normal operating conditions, the switch is set to ON and the indicator is lit.

SM - Start Machine - A pushbutton which manually controls the starting of the corresponding card punch or printer. When depressed, the blue indicator is lit indicating that the Start Machine Toggle is turned on. The operator will not, under normal conditions, use this pushbutton.

REGISTERS

O Register - A 12 neon register which represents the following toggles:

RC - Row Counter - Four toggles (RC8, 4, 2, and 1) used to sequence the output operation so that the Output Unit and its associated card handling equipment maintain the same row count.

FS - Format Select Toggle - Three toggles (FS 8, 4, and 2) which store the number of the format band designated.

EIL - Early Interlock - A toggle used to prevent erasure of the Output Buffer drum until the last row of information is punched or transferred to the printer.

RS - Relay Select - Three toggles (RS 4, 2, and 1) which contain the tab select information from the Card Write instruction during an output operation.

M Registers

A 9 neon register and a 12 neon register which are primarily used for maintenance purposes.

2-3.4 CARD HANDLING EQUIPMENT

INPUT DEVICES

Type 87 Card Reader

There are two card feed units in the collator - a primary feed unit and a secondary feed unit. Each unit has a capacity of 800 cards, and cards must be fed into the machine face down, 9 edge leading. Normally the primary feed is used as input to the BURROUGHS 220 System via the CARDATRON Input Unit.

The primary unit consists of:

80 Primary Read Brushes (one for each column of the card). The maximum of 80 brushes can be used to read the card. When a card passes under these brushes, each row is read and transferred to the CARDATRON Input Buffer. In this way the Card Reader communicates with the Data Processor.

Type 87 Board Wiring

The numbers used below refer to the index numbers shown in Figure 2-25. The wiring shown will perform the following functions:

1. This wiring enables the 80 card columns of information to be read from the card, and written onto the input-unit buffer.

2. This wire may be placed into any one of the sequence-read hubs to sense the punch that is to be used for format-band selection.

3. These eight wires from digit-selector positions one through eight are wired to format select, which actually selects the format band. A one-punch sensed at sequence read hub will cause format band one to be selected; a two punch selects format band two, etc.

4. The plug-to-C impulse through the start machine contacts causes a card to feed in the primary feed.

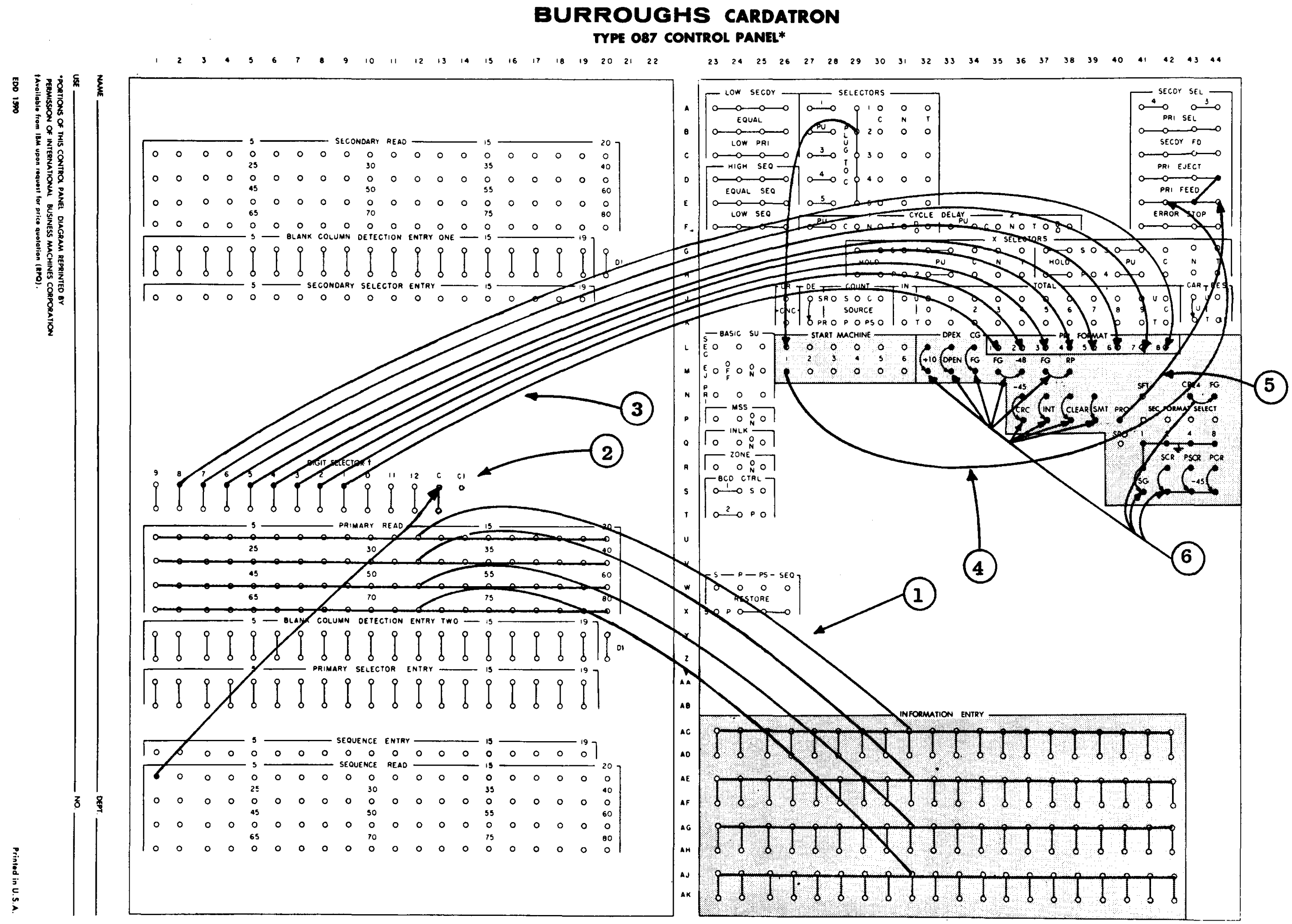

Figure 2-25. Basic 87 Control-Panel Wiring.

5. This wire allows the operator to run out the primary feed, or, in other words, to feed out all remaining cards from the primary feed.

6. These hubs must be wired to make the Type 87 compatible with the BURROUGHS 220 CARDATRON system.

OUTPUT DEVICES

Type 407 Control Panel Functions

The 407, like the computer, must be told what to do and when to do it. The computer is guided by a program; the 407 by control panel wiring.

The control panel has two kinds of hubs, Exits and Entries. The Exit hubs emit impulses, the Entry hubs accept impulses.

Pilot Selectors

Pilot Selectors are relays, whose contact points are wired internally to the control panel. There are three means of transferring these points; by DPU hubs, and IPU hubs.

The XPU hubs will accept 11 or 12 impulses, which will cause the respective contact points to transfer for the following cycle. This is sometimes referred to as a delayed pickup.

The DPU hubs, often referred to as digit pickup hubs, will accept any impulse 0 through 9, 11, and 12. Any of these impulses will cause the respective contact points of the selector to transfer for the following cycle.

The IPU, or immediate pickup hubs, will accept any impulse, causing the respective contact points of the selector to transfer immediately and remain transferred until the end of the cycle in which it was impulsed.

Each Pilot Selector has two sets of contact points. The hubs connected to these points are located on the control panel immediately below the pickup hubs.

Co-Selectors

Co-Selectors are also relays, but they differ from Pilot Selectors in that there is only one pickup hub per selector and five sets of contact points.

The pickup of a Co-Selector works like the IPU of a Pilot Selector in that it will accept any impulse to transfer the respective contact points; they remain transferred until the end of the cycle in which the Co-Selector was impulsed.

Printing

There are three separate sets of hubs that will accept impulses to cause printing: Normal Print Entry, Transfer Print Entry, and Counter Controlled Print.

Only the first two will be explained here; the third is not normally used. The Normal Print Entry is self-explanatory in that under normal conditions impulses directed to these hubs cause printing of information.

The Transfer Print Entry hubs are isolated from the print magnets by a relay point. Therefore, in order to cause printing with these hubs, this isolation relay must be closed. The relays are closed by impulsing TR PR hub (at R-39 and 40). This allows the Transfer Print Entry hubs to become inactive.

Digit Selectors

A Digit Selector is a device used for the selection of impulses or groups of impulses. For example, column 1 of a card could have several punches, such as 12, 8, and 4. By wiring column 1 to the common of the Digit Selector, any one of the three impulses is available at its respective hub, at its respective time.

Carriage Control

The Carriage Skip hubs (located at I-J, K and L-31 through 40) are used to control the movement of paper through the 407 carriage.

I-31 through 40 will accept a 12 or 11 impulse which causes the paper to skip out to a predetermined line of print. An X impulse wired to hub I-31 causes the paper to skip to any hole encountered in channel 1 of the carriage control tape, I-32 a skip to any hole in channel 2, etc. The skip will not take place until the cycle in which it was impulsed has printed. Therefore, this is a "skip to" after print. J and K-31 through 40 will accept any impulse 0 through 9 and 11 or 12 for the same results as just described. The I or immediate hubs when impulsed will cause the paper to skip immediately, before printing can occur.

The impulses sent to the XPU, DPU, or IPU of Carriage Skip start the paper moving. It is stopped by the carriage tape, according to the punches in the tape channel previously selected by the plugboard wiring.

Spacing is accomplished by wiring from the space hub (K 74-75) to the 1 or 2 hub directly below it. This causes the paper to space either one or two spaces before each line of print.

Overflow on the 407 occurs when a 12 punch in the carriage tape is sensed. This indicates the last line of the page is about to be printed; therefore, overflow to the first line of the next page is initiated.

Alteration Switches

Alteration switches are toggle switches, located on the right hand side of the 407, whose contact points are wired internally to the hubs of the control panel. These switches are used to alter the functions of the 407 without resorting to control panel wiring changes.

Control Panel For 220 CARDATRON

Alteration switches 1 and 2 are used to operate the 407 either on or off-line. When both switches are in the normal position, the Type 407 will operate with the CARDATRON as described on the next page. When both switches are in the transferred position, the Type 407 can be used as an off-line printer for listing cards.

The list operation permits the reading of any cards put into the feed. Each card column is printed in the corresponding printing position. Type wheel positions can easily be changed by rearranging the control panel wires.

Basic Control Panel Wiring (Figures 2-26 & 27)

When a CARD WRITE command is executed, the following operations occur to cause a line to be printed by the 407.

1. The CARD WRITE command causes the computer to load the buffer drum in the CARDATRON Output Unit.
2. After the buffer drum is loaded, the Start Machine Relay (SM) in the Output Unit is energized.
3. With the SM relay energized, a synchronizing pulse CW (AX-80) from the Type 407 passes through the now closed points of SM, returns to the 407 and picks up Pilot Selector 1, which is energized immediately and remains so until 285^{o} of the print cycle.
4. Digit impulses are directed to the common Pilot Selector 1.
5. Since the CW impulse caused Pilot Selector 1 to transfer, the impulses pass through the transfer point of Pilot Selector 1 to the common Pilot Selector 2. Pilot Selector 2 is under the control of a Tab Select Relay and will be explained later.
6. With Pilot Selector 2 in its normal position, the digit pulses will pass to the common of the Digit Selector.
7. The 12 output hubs of the Digit Selector are directed to the digit entry hubs at AY 67-78 to serve as the required synchronizing digit pulses for the CARDATRON Output Unit.
8. Since the Type 407 must be in a ready condition at all times, it is necessary to have MLR activated while the Type 407 is being used with the

CARDATRON. The Multiple Line Read (MLR) keeps the print unit in print status, activates necessary control panel hubs and prevents card feeding.

9. A Card Cycle impulse (which comes every cycle) is passed to the IPU of Pilot Selector 15.

10. A 12 impulse is required to start MLR. A character A (12-1) impulse goes through the normal position of Alteration Switch 1, through the now transferred points of Pilot Selector 15, over to start MLR.

11. The Type 407 will stay in MLR until the Release hub of MLR is impulsed. It should be noticed at this point that by moving Alteration Switch 1 to the transferred position, the Character A impulse will pass through the transferred points of Alteration Switch 1 to MLR Release hub. When this occurs, cards can be run out of the 407 feed.

12. The 407 is idling in MLR cycles while waiting for a CARD WRITE command to be executed. It is normal machine operation for the ribbon feed to operate at this time, which may cause smudging of the paper. To stop ribbon motion during these idle cycles,the Non-Print hub (AJ 51-52) must be impulsed. Pilot Selector 1 will be de-energized as will Co-Selector 5 (which is explained later), thereby allowing the digit impulses to go through the normally closed points of Pilot Selector 1 and down to the Non-Print. The ribbon feed then becomes inoperative.

13. The information exit hubs pass the information from the CARDATRON to Normal Print Entry.

Skip to 1 After Printing: Tab Select Relay 1

Tab Select Relay 1 is energized by the c position of the command word in the 220 and is used to cause a "skip to one" after print. The carriage will skip the paper to the first line of the next page, designated by the punch in channel one of the carriage control tape.

1. Tab Select Relay 1 is transferred during a CARDATRON cycle.

2. The skip function is synchronized with the CARDATRON cycle by a digit 11 impulse from the Digit Selector. These impulses are available only during a CARDATRON print cycle.

3. The digit 11 impulse passed through the transferred points of Tab Select Relay 1-1 will impulse the carriage skip to 1 X hub. The impulse also goes through a filter to the DPU of Pilot Selector 6. After the line of information has been printed, the carriage will skip to tape channel 1.

4. Once the carriage has skipped to the proper line of the next page, it is necessary to keep the paper from spacing until the next line of information has been printed. During the next 407 cycle, Pilot Selector 6 will transfer. If the CARDATRON is not ready to print another line, Pilot Selector 1 and Co-Selector 4 will not be transferred, since Pilot Selector 1 was not impulsed. Therefore, an emitted 5 pulse passes through the normally closed points of Co-Selector 4, through the now transferred points of Pilot Selector 6 to repick Pilot Selector 6. An emitted 7 is passed through the transferred points of Pilot Selector 6 to Space Suppress, which prevents paper spacing.

5. When the CARDATRON is ready to print another line, the emitted 7 pulse will prevent the paper from spacing during this line of print. This permits skip after printing.

Extra Space Control: Tab Select Relay 2

Tab Select Relay 2 is used to cause a single extra space following printing of a line from the CARDATRON.

1. This function is synchronized with the CARDATRON, using the Digit Selector 5 pulse in the same way as the digit 11 pulse was used to control skip to 1.

2. The digit 5 impulse passes through the transferred points of Tab Select Relay 2 to impulse Extra Space. This causes a single extra space after printing a line - in addition to the normal space before printing.

Skip to 1 Before Printing: Tab Select Relay 3

Tab Select Relay 3 is used to cause the carriage to skip to 1 before printing:

1. In order to utilize the built-in interlocks of the Type 407 which prevent double pulsing of the skip hubs, skip must be initiated prior to 285^{o}.

2. The CW impulse which tests the CARDATRON for readiness occurs at 322^{o}. The Immediate Skip must be impulsed prior to the time that the CARDATRON is tested for readiness so that skipping can be initiated before the print cycle begins.

3. Therefore, the Immediate Exit impulse is used since it occurs at 225^{o}, which satisfies both of the above conditions.

4. The Immediate Exit impulse passes through the Tab Select Relay 3-1 (now transferred), through Tab Select Relay 5-3, normal, to impulse the skip to 1 immediate hub.

5. This same pulse passes through a filter and impulses Pilot Selector 3 (DPU). Pilot Selector 3 is tested later in the cycle to determine whether the skip has been initiated.

6. That portion of the Decimal impulse which occurs at 338^{o} will then pass through the transferred points of Tab Select Relay 3-2, through the normally closed points of Tab Select Relay 5-1, testing the condition of Pilot Selector 3. The Decimal impulse comes at two different times, once at 12 time and then at 338^{o}. The impulse at 12 time must be ignored, because it occurs at reading time; therefore, it is passed through a column split.

7. Had the skip been started normally, Pilot Selector 3, would have been transferred (at 292^{o}) and the Decimal pulse would have terminated at the common of Pilot Selector 3.

8. If the skip had not occurred, Pilot Selector 3 would not have been transferred and the Decimal impulse would have passed through the normally closed points of Pilot Selector 3 to the IPU of Pilot Selector 2.

9. Pilot Selector 2 prevents the digit pulses from reaching the common hub of Digit Selector A, thereby preventing a CARDATRON cycle.

Single/Double Space Control: Tab Select Relay 4

Tab Select Relay 4 is used to select either a single or double space before printing.

1. The Digit 5 impulse from the Digit Selector A will pass through the transferred points of Tab Select Relay 4 and to the IPU of Pilot Selector 10.

2. Space hub and Space 2 hub are impulsed through the transferred points of Pilot Selector 10, which will cause a double space before printing.

3. If Tab Select Relay 4 had not been energized, Space hub and Space 1 hub would then be connected through the normally closed points of Pilot Selector 10, causing one space before each print cycle.

Skip to 2 Before Printing: Tab Select Relay 5

Tab Select Relay 5 is used to cause a skip to 2 before printing.

1. This is the same procedure as described in the Skip to 1 - except that Tab Select Relay 5 must be energized instead of Tab Select Relay 3.

The skip to 2 is used to eject the paper to a predetermined position indicated by a punch in channel 2 of the carriage control tape.

Skip to 3 Before Printing: Tab Select Relay 3 and 5 (c digit=7)

Tab Select Relays 3 and 5 may be energized simultaneously to cause a skip to 3 before printing. This is controlled in the same way as the skip to 1 before printing.

Triple Space: Tab Select Relays 2 and 4 (c digit=6)

Tab Select Relays 2 and 4 can be energized simultaneously to combine the functions of both relays - double space before printing and extra single space after printing.

Note that in the execution of all the 407 functions mentioned, Tab Select Relays drop out at digit 11 time, which is prior to immediate Exit Time, preventing duplication of the function.

Listing Off-Line

Cards placed in the Type 407 feed will be read and will cause printing in an 80-80 format with the control panel wiring described below.

1. The first 80 positions of Second Read are wired to the first 80 positions of Transfer Print Entry.

2. Transfer Print is basically one large Selector. When impulses are wired to Transfer Print, no action can take place until the Transfer Print relays are energized.

3. Alteration Switches 1 and 2 must be in the transfer positions. Alteration Switch 1 will allow the emitted A impulse to release MLR, and allow the 407 to feed cards.

4. Alteration switch 2 will permit A Card Cycle impulse to pass through and energize Pilot Selector 8, and Co-Selectors 5, 10, 13 and 14.

5. When Pilot Selector 8 is in a normal position, digit impulses suppress spacing while the 407 is idling. When Pilot Selector 8 is picked, the 407 will space normally as controlled by the normal points of Pilot Selector 10.

6. When Co-Selector 5 is transferred, the Card Cycle impulse is allowed to pick up Transfer Print; this suppresses the Normal Print Entry and allows Transfer Print Entry to become active.

7. Co-Selectors 10, 13, and 14 are used to de-activate the circuits required for control of the 407 by the CARDATRON.

8. If the 407 is regularly used only with CARDATRON, the following hubs will be jackplugged as shown by the heavy jackplug lines on the control panel diagrams.

   BE 43 BF 43, BE 45 BF 45, BE 46 BF 46, BE 47 BF 47, BF 60 BF 61, BF 62 BF 63, BF 65 BF 66, BF 67 BF 68, BF 69 BF 70, BF 71 BF 72, BF 73 BF 74, BF 75 BF 76, BF 77 BF 78, BF 79 BF 80.

   In order to simplify changing to off-line operation, the above hubs can be instead wired to the Normal points of Co-Selectors. This allows use of alteration switches for conversion. Co-Selectors 10, 13, and 14 are used in this way and are controlled by Alteration Switch 2. An additional modification control, BE 44 BF 44, is wired to the transferred points of Co-Selector 13; when energized, the two hubs are connected.

   BF 65 BF 66, BF 67 BF 68, BF 69 BF 70 develops the Thyratron Plate supply. It is desirable to make this inactive during idle time. They are, therefore, wired to the transferred points of Co-Selector 4.

Notes of Interest

1. With a carriage skip after printing, Pilot Selector 1 returns to normal. After Pilot Selector 1 returns to

normal, Co-Selector 4 will also return to normal. With Co-Selector 4 de-energized, the emitted 5 impulse passes through the normally closed points of Co-Selector 4, causing Pilot Selector 6 to remain energized. This allows the 7 impulse to prevent paper spacing after the normal Type 407 interlocks have returned to a normal state.

2. When the DPU or XPU of Skip Control (Carriage Skips) is impulsed, a delay in skipping action occurs until a line of information has been printed.

3. When the IPU of Skip Control (Carriage Skips) is impulsed, the carriage causes the paper to skip immediately.

4. When the IPU of a Pilot Selector is impulsed, the Pilot Selector is transferred immediately and remains so until 285° of the same cycle.

5. The X or DPU of a Pilot Selector will cause that Pilot Selector to transfer at the end of the same cycle. It remains transferred until 285° at the following cycle.

6. Each Pilot Selector has a Coupling Exit hub just above the XPU hub which emits an impulse when that Pilot Selector is energized.

7. The Overflow is wired to the DPU of Carriage Skip to 1 to permit the paper to skip to the first line of the next page after the last line on the page has been printed.

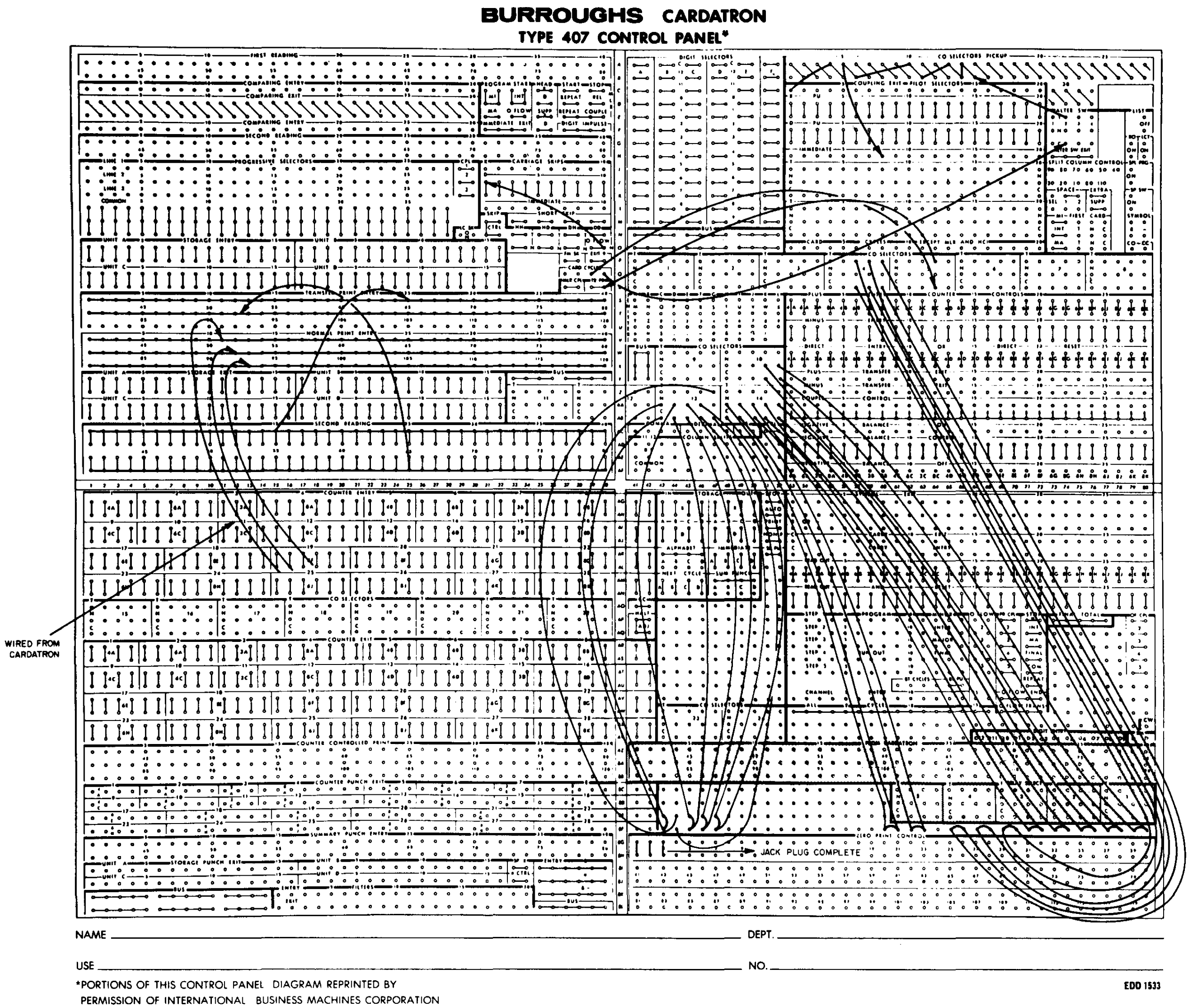

Figure 2-26. Typical 407 Control-Panel Wiring-A.

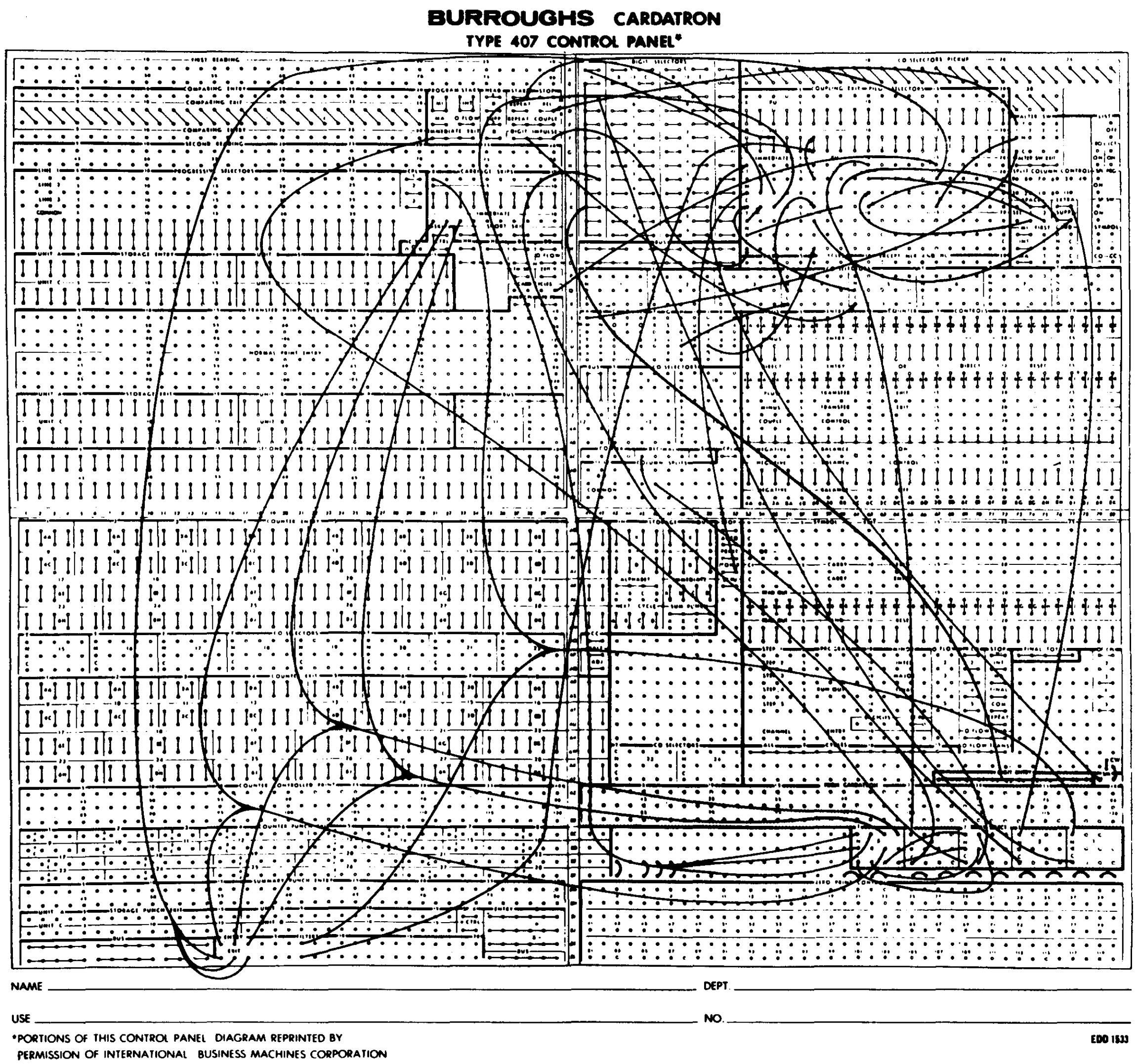

Figure 2-27. Typical 407 Control-Panel Wiring-B.

2-3.5 OPERATING PROCEDURES

Preparation of Card Handling Equipment

1. Insert the required plugboards in the readers (87), punches (523), and printers (407). Be sure that these units are not idling when plugboards are inserted.

2. Check the cable connections between the punched card devices and the Input or Output Units.

Clearing the CARDATRON

1. Clear the Control Unit by depressing the general clear button on Control Unit 1.

2. Clear the Input by depressing its clear button. This will set the Row Counter (RC) to a setting of 10 for the Type 87. The Format Select decade will be set to a reject format setting of 7. All other toggles in the Input Unit will be cleared.

3. Clear the Output Units by depressing the clear buttons. This will set the Row Counter on the Output Control Panel to a ready-for-computer setting of 13 for the 407 and 10 for the 523. All other toggles in the Output Unit will be cleared.

Starting the Card Handling Equipment

407 Printer

Although the 407 is used for on-line printing, a few blank cards must be used to get the machine started. Place these cards in the 407 hopper 9 edge face down and hold the start button down until one blank card appears in the stacker. The 407 is now in an idling state of readiness (commonly called MLR). At this time, there is a card at both the first and second read stations of the 407. These cards remain in place for all on-line printing operations. Once they are in place, it is unnecessary to hold the start button down for several cycles; merely touching it will place the 407 in MLR. The cards must be checked only when it is necessary to run them out in preparation for an off-line printing operation.

523 Punch

Place a sufficient quantity of blank cards in the hopper 9 edge down and depress the start button through three card cycles. The machine will remain in an idling state.

87 Collator

1. Precede the input card deck with a reject card (either a blank card or a 7 punch in the format select column on an 87 with digit selection). Place two reject cards at the end of the input card deck.

2. Make sure the 87 does not contain any cards between the hopper and the reject pocket by depressing simultaneously for several cycles the two runout buttons. One button is located on the main button display of the 87 while the other is situated at the lower left hand corner of the reject pockets. Clear the Input Unit by depressing the clear button.

3. Place the input card deck in the primary feed hopper 9 edge face down. Depress the start button on the 87. Verify that the reject card, and only that card, has been ejected into the second pocket. This signifies that information from the first program, or data card, has been loaded on the buffer drum, ready to be read into the Data Processor. The 87 will now idle, waiting for a Card Read instruction. At this time the Row Counter on the Input Unit will be set to 13.

4. Check that the format band indicated by the Format Select decade is the one that should have been selected by the punch in the first data or program card.

5. Load other desired input data, if any, into the Data Processor.

6. If the program calls for a card deck to be boot-strapped in from the 87 (that is, if the instruction to read the information or the cards are punched

in the cards), insert a Card Read (60) to 0000 in the D Register, cause a D to C transfer and depress the start button.

Run-Out Procedure for the 87

The 87 may stop during a program run while reading a card deck. The stop may be caused by a key-punching error, program malfunction, a failure to select format, etc. To run out the cards left in the 87 and start again:

1. Remove the remaining portion of the card deck from the primary feed hopper.

2. Depress the two run-out buttons on the 87 until all cards within the device have dropped into the second pocket.

3. Clear the Input Unit and reload the card deck, making sure the proper reject cards are provided. Restart the program.

2-4 BURROUGHS 220 HIGH-SPEED PRINTER SYSTEM (Figure 2-28)

The BURROUGHS 220 High-Speed Printer system is a tape-fed, transistorized, buffered system designed for large-volume, complex-editing applications. It operates either on-line with the BURROUGHS 220 Data Processor, or off-line with one or two standard BURROUGHS 220 Magnetic Tape Storage Units.

Editing and control of format are independent of the Data Processor. The system prints directly from master tapes or records. Therefore, the preparation of special print tapes for off-line operation is usually eliminated. Whether operating on-line or off-line, data manipulation within the Data Processor is reduced.

The system includes a printer control unit and a printing unit. The printer control unit houses a 100-word, 1100-digit random access core storage used as a buffer. It also contains the system's control circuitry, a 120-character print register, a 120-position bit register, the transistor power supply, and the plugboard.

The printing unit contains a drum-type high-speed printer having 120 print positions with a total of 51 different characters available for each print position. It also contains paper-motion control and the power required to drive the printing mechanism. The carriage is controlled by a punched paper-tape loop. Line spacing and skipping are plugboard controlled.

OPERATING BUTTONS, LIGHTS, AND SWITCHES

There are three Operator Control Panels on the BURROUGHS 220 High Speed Printer System:

1. Printer Control Unit, Operator's Panel.
2. Printer Unit, Left bay.
3. Printer Unit, Right bay.

In addition, there is a program plugboard on the Control Unit.

Figure 2-28. BURROUGHS 220 High-Speed Printer System.

Physical Characteristics:

Control Unit

Width: 60 inches
Depth: 31 inches
Height: 76 inches maximum*
Weight: Approx. 2,000 lbs.
Blower volume: 200 CFM

Power: 4.7 kw from 220 power system

Heat Dissipation: 16,000 BTU/hour

Printing Unit

Width: 56 inches
Depth: 36 inches
Height: 57½ inches maximum*
Weight: Approx. 1,200 lbs.
Blower volume: 225 CFM

*Both heights include a 3" allowance for levelling.

Operating Characteristics:

Control Unit

Provides buffering of information from magnetic tape or Data Processor to printer

Under plugboard control provides for off-line editing of information

Printer Unit

Produces up to 1,500 lines per minute and controls paper feed

System Characteristics:

On-line or off-line high speed printing system with printing speeds of 624-1,500 lines per minute

Performs complete off-line editing of information

Handles alphanumeric information

Complete checking of all information transfers provided

Allows merging of information when used off line from two standard Burroughs 220 Tape Storage Units

2-4.1 PRINTER CONTROL UNIT- OPERATOR'S PANEL (figure 2-29)

RESET BUTTON - Depressing this button enables the operator to turn off the individual toggle indicators on the maintenance control panel provided their set buttons are depressed simultaneously.

FILAMENT - The FILAMENT indicator comes on when filament voltage has been applied to the printer system.

OVERHEAT - The OVERHEAT indicator comes on if any one of the overheat contacts should close due to extreme heat. At this point a 15-minute timer is activated, allowing the operator time to find the contact and reset it. At the end of 15 minutes the timer will cause the power to be turned off in sequential stages.

DC ON - Whenever DC voltages are applied to the system, this indicator comes on.

DC FAIL - This indicator comes on when any one of the DC voltages fails.

TAPE READ ALARM - This indicator comes on if an incorrect digit count or an incorrect word count is detected during an off-line load cycle. The light remains on if the error is not corrected after two retries (systems operation stops).

TAPE STORAGE UNIT (TSU) - The TSU indicator comes on when a "not ready" condition exists in the TSU, or when excessive blank tape is encountered during a tape read (after blank tape has fed for approximately 5 ms.).

NO PAPER - The NO PAPER indicator will come on when the printer is about to run out of paper.

SYNCHRONIZATION (SYNC) - The SYNC indicator comes on when the print drum is not in synchronization with the internal counter. Printing cannot continue unless synchronization is maintained.

RESET CONTROL ERROR - This is a combination light and push button. The indicator comes on when a Buffer Error, Register Error, Translator Error, Tape Parity or Forbidden Combination (F.C.) Error occurs. Depression of the RESET button will clear the error indicator and turn off the light.

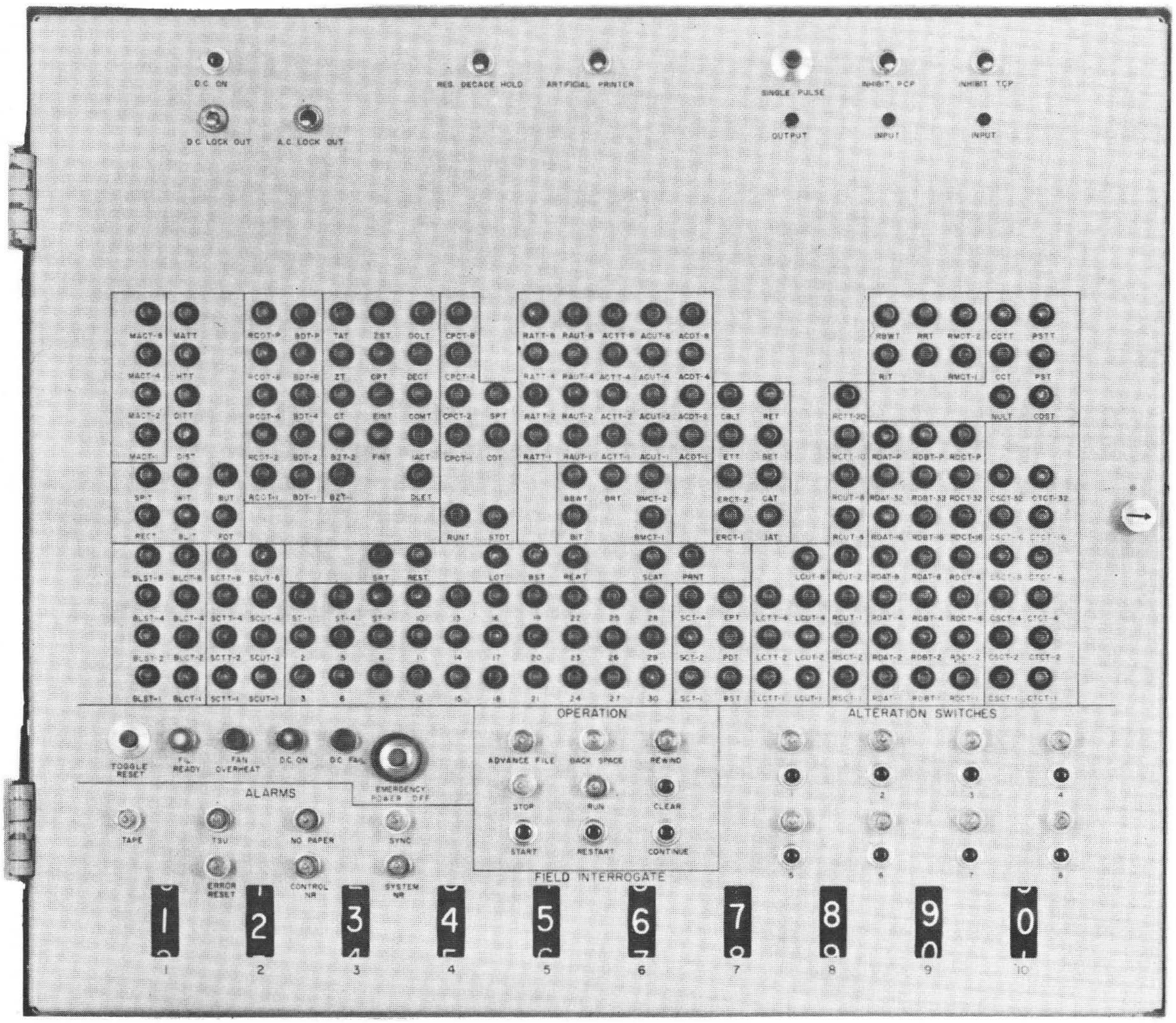

Figure 2-29. High-Speed Printer Control Unit, Operator's Panel.

NOT READY CONTROL - This indicator comes on when any of the test switches on the control unit are not properly set, indicating the unit is not ready.

SYSTEM NOT READY - The SYSTEM NOT READY indicator comes on when any "system not ready" condition is in effect.

FIELD INTERROGATE SWITCHES - These ten rotary switches are set to a predetermined value to be used in conjunction with the field interrogate hubs on the control panel.

ADVANCE FILE - This is a combination light and push button. The ADVANCE FILE indicator will come on when the ADVANCE FILE button is depressed: it will remain on until the tape unit has reached the next file on that tape, as determined by a control block with a 7 in the sign position of the first word

BACKSPACE - This is a combination light and push button. When the BACKSPACE button is depressed, the tape unit selected by the control panel will backspace one block. The indicator will be on during the backspace period. No pulse is available from the backspace hub on the plugboard.

REWIND - The REWIND indicator is on all during the time a tape unit is rewinding, or until lockout has become effective

STOP - This indicator comes on when there are no cycles in progress. The light may be turned on by depressing the STOP button.

RUN - The RUN indicator comes on when the printer is in the process of executing any tape cycle, on-line load cycle, scan cycle, or print cycle.

CLEAR - When the CLEAR button is depressed, all elements are restored to their normal state, as follows:

a.	Character address counter	Word zero, sign digit
b.	Blank counter	Zero
c.	Line counter	Zero
d.	Relative address register	Zero
e.	Zero suppress	Off
f.	All inserts	Off
g.	All errors	Off
h.	Selectors	Dropped
i.	Unit is set to transfer numeric	
j.	Audible alarm	

START - The START button, when depressed, will cause a start pulse to be emitted from the start hub on the control panel. As soon as this button is depressed, the line counter is set to 1.

RESTART - The RESTART button, when depressed, will cause a pulse to be emitted from the restart hub on the control panel.

CONTINUE - The CONTINUE button, when depressed, will automatically cause the printer system to begin operation at the point at which it had been stopped.

ALTERATION SWITCHES - These push-button switches, when depressed, set their respective Alteration Switch Relays to either their normal or transferred state. Rows 1 and 3, when depressed, cause them to transfer. Rows 2 and 4, when depressed, cause them to be restored to normal.

PLUGBOARD CONTROL SYSTEM

The Plugboard Control System for the High Speed Printer is the control center for the entire system. All program logic is contained on the plugboard. This logic is sufficient to edit most magnetic tape files, thus releasing the 220 for many special editing programs.

The plugboard is color coded to facilitate recognition of hubs. The row of hubs are labeled in alphabetical order from top to bottom and in numerical order from left to right. Any hub can be identified by the letter and number coordinates. (See Figure 2).

Before the logic can be used, the actual board must be wired according to either a coded program or a conventional wiring diagram. (For a detailed explanation on coding the High Speed Printer, see the BURROUGHS High Speed Printer System Handbook.)

2-4.2 PRINTER UNIT

LEFT BAY (Figure 2-30)

DC ON - The DC indicator is on so long as all DC voltages are applied to the printer unit.

SYSTEM NOT READY - See Printer Control Unit.

PRINTER NOT READY - The PRINTER NOT READY indicator comes on when any of the controls are not properly set, notifying the operator that the printer unit is not ready.

NO PAPER - See Printer Control Unit.

NOT RESETTABLE ERROR - This indicator comes on when a non-resettable error occurs. Non-resettable errors include a TSU alarm (see control unit), a TAPE READ alarm (see control unit), or a printer SYNC alarm (see control unit).

SPEED SELECT - This switch permits the operator to select any one of the four drum speeds (750 rpm, 900 rpm, 1500 rpm, and 1800 rpm)

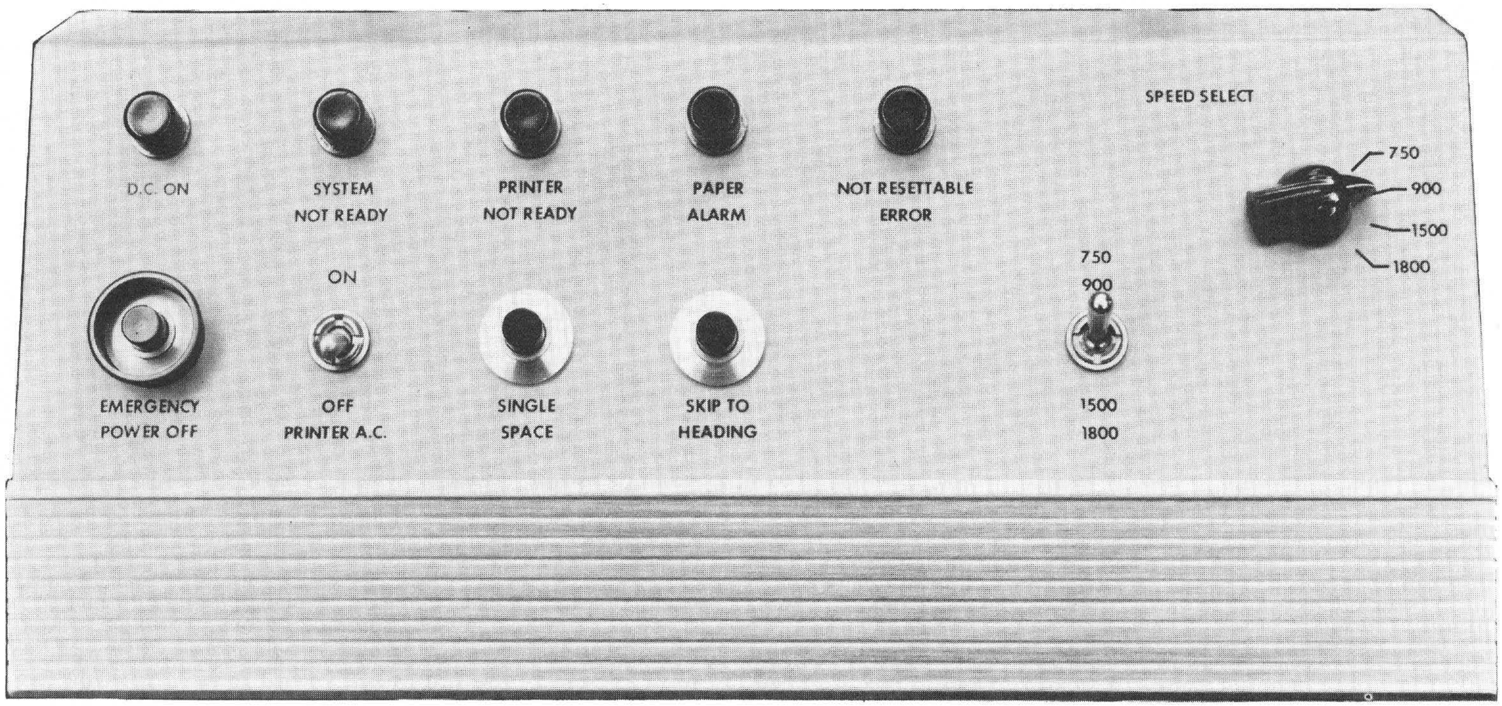

Figure 2-30. High-Speed Printer Unit, Left Bay.

EMERGENCY POWER OFF - When the EMERGENCY POWER OFF key is depressed all power is removed from the printer system immediately.

PRINTER AC - This is a toggle switch which provides AC voltage to the carriage motor.

SINGLE SPACE - When the SINGLE SPACE key is depressed it causes the carriage to move one single space on the paper.

SKIP TO HEADING - When the SKIP TO HEADING key is depressed it causes the printer carriage to skip to the "one" hole in the paper tape. If no paper tape has been inserted, the carriage will continue to run until the STOP key is depressed.

PAPER RELEASE - Depression of this key releases the carriage clutch, allowing the operator to reposition the printing forms. When released, the key will restore the clutch to normal.

RIGHT BAY (Figure 2-31)

RUN - See Printer Control Unit.

CONTROL ERROR RESET - See Printer Control Unit.

START - See Printer Control Unit.

REWIND - See Printer Control Unit -- Button only.

ADVANCE FILE - See Printer Control Unit -- Button only.

STOP - Depression of the STOP button will cause a stop in the following ways:

1. If depressed during a scan cycle, the stop will occur at the end of the digit time in which it was depressed.

2. If depressed during a print cycle, any tape cycle or on-line load cycle, the stop will occur at the completion of that cycle.

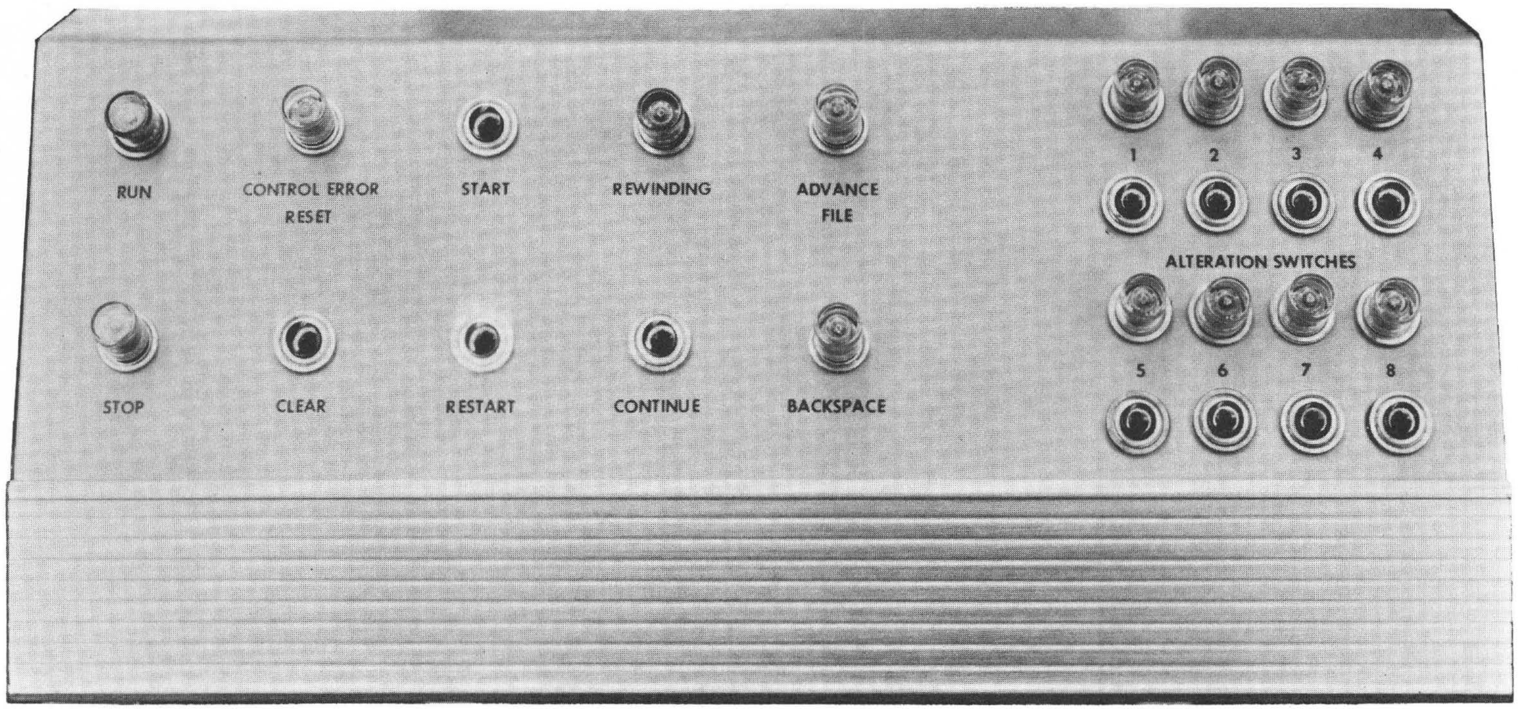

Figure 2-31. High-Speed Printer Unit, Right Bay.

CLEAR - See Printer Control Unit.

RESTART - See Printer Control Unit.

CONTINUE - See Printer Control Unit.

BACKSPACE - See Printer Control Unit -- Button only.

ALTERATION SWITCHES - See Printer Control Unit.

2-4.3 OPERATING PROCEDURES

CARRIAGE TAPE

The control tape has seven columnar positions, called channels. A maximum of 22 inches can be used for control of a form. Holes in the center of the tape are prepunched for a pin feed drive in a tape sensing mechanism which controls the carriage. A photoelectric device senses the control tape punches. The following functions are normally controlled by tape channels:

1. First Printing Line Stop. Channel 1 is normally punched for the first printing line of a form. This is the starting position.

2. Normal Skip Stops. Channels 2 through 6 are used to stop a form at one of five positions including first body line. They may be used in any order or sequence.

3. Overflow Control. Channel 7 of the control tape is normally used to cause overflow skipping. It will usually be punched in a position corresponding to the last printing line of a form.

SPACE IMMEDIATE

Under normal conditions, a space occurs as soon as the print cycle is completed.

TAPE FORMAT

Standard 220 system seven-channel paper tape may be used to make a format tape.

Each sprocket (feed) hole in the tape equals one line space on the printed form.

The sprocket holes are 1/10 inch apart (10 holes per inch). A printer line space is 1/6th (six lines per inch).

Therefore, the ratio of tape length to form length is 3:5.

The format tape must be between 6.6 inches and 13.2 inches in length and formed into a loop by splicing the ends. For short forms it may be necessary to duplicate the tape to make its total length equal to or greater than the minimum 6.6 inches.

PREPARING A CARRIAGE TAPE

For example, a 5 inch form is to be used. Lines 5 through 10 and lines 20 through 28 are to be printed.

This format tape will be three inches long. Therefore, in this case it is necessary to make three duplicate tapes, end to end.

Each sprocket hole in the tape represents one line space on the form. The tape should be prepared in the following way:

1. Punch a hole in channel 1 in alignment with sprocket hole 5 to indicate the first line of print after skipping.
2. Punch a hole in channel 2 in alignment with sprocket hole 20 to indicate the first line of print after skipping.
3. Punch a hole in channel 7 in alignment with sprocket hole 23 to indicate the last line to be printed.

INSTALLING CARRIAGE TAPE

Loosen tape roller retaining screw and place format tape around tape guide, tape roller, and drive sprocket.

Fit sprocket perforations (smallest holes) over sprocket pins. Make sure that tape channels 1 through 7 coincide with photocells 1 through 7.

Take up slack by adjusting tape roller on a support arm and tighten tape roller retaining screw.

PRINTER ADJUSTMENTS

PAPER GUIDES

Two parts of paper tractors, one set above and one set below the ribbon and print drum assembly, clamp the paper and guide it past the print drum.

Sprocket holes in each margin of the paper (or form) fit over sprocket pins on the tractors. Clamps fit over the sprocket pins providing a firm alignment for adjusting margins and paper tension.

When the paper tractor lateral adjustment now is turned, both the upper and lower tractors are affected simultaneously. For example, if the knob marked LEFT-BOTH-RIGHT is positioned with LEFT at the bottom, both the left and right upper and lower tractors are moved.

INSTALLING PAPER

Loosen the two print clamps and swing printing mechanism out until held by the chain.

Open both the upper and lower pairs of paper tractors.

Insert paper from bottom of printer and pull upward, under the no-paper detection flaps, and between the ribbon and hammers to the upper tractors.

Engage sprocket holes in paper with lefthand tractors. Engage corresponding sprocket holes with righthand tractors.

If space between left and righthand tractors is not correct, adjust as described in POSITIONING TRACTORS.

Apply downward tension to paper until it becomes taut; then engage sprocket holes with lower set of tractors.

POSITIONING TRACTORS

Turn paper tractor lateral adjustment knob marked LEFT-BOTH-RIGHT so that LEFT is at the bottom.

Turn crank adjacent to knob and locate lefthand tractors in approximately correct printing position.

Clamp paper to be printed in the left hand set of tractors.

Turn the adjustment so that RIGHT is at the bottom. Turn crank adjacent to knob, adjusting righthand tractors to accommodate width of paper to be used; then clamp paper in righthand tractors.

To align paper vertically with the row of print hammers, set the adjustment knob so that BOTH is at the bottom. Turn crank adjacent to knob as required to align column with print hammers. The transparent scale located just below the upper pair of tractors indicates print positions and is provided for this purpose.

ADJUSTING PAPER TENSION

Paper can be adjusted within 1/2 a line space during printing operations to position the printing exactly on the line of the forms.

The paper form vertical adjustment knob is marked TO RAISE FORM - TO LOWER FORM.

To lower paper, turn this knob clockwise. To raise paper, turn the knob counterclockwise.

ADJUST PRINT IMPRESSION

The print impressions adjusting screws may be adjusted for lighter or darker printing and to accommodate different thicknesses of paper.

To produce a darker line of print, loosen the two wing nuts associated with the impression adjusting screws.

Turn the print impression adjusting screws counterclockwise one position. This moves the print mechanism about 1/1000 of an inch.

Tighten both wing nuts and test printing.

Repeat process if printing is still too light.

When the impression adjusting screws are fully turned counterclockwise, the print drum is closest to the print hammer.

INSTALLING PRINTED FORMS

This procedure consists of adjusting the carriage (format) tape and paper tractors so that the first line of print will appear on the desired line on the printed form.

Locate the first line to be printed on the form. Measure exactly six inches above the first line to be printed, and place a pencil mark on the tear strip of the form.

Lift the clamps on the upper paper tractors and place paper forms on tractors so that the locating mark aligns with or falls just below (1/2 line space maximum) the black line on the lower part of either of the upper tractors.

Engage sprocket holes with nearest sprocket and then close tractor clamps.

If the locating mark falls below the blank line on the tractor in excess of 1/2 line space, depress the single space button until the lines are within 1/2 of a space of each other.

By adjusting the paper form vertical adjustment knob, precise printing can be obtained.

Install the carriage tape so that the channel 1 hole is just past the reading position.

NEW RIBBON INSTALLATION

Turn OFF the power to the printer unit.

Lift off the ribbon-feed assembly cover.

Release the two print clamps and swing the ribbon-feed assembly backward until it is stopped by two small chains.

Remove the lower ribbon roller by turning its release knob lock nut counterclockwise one or two turns. Hold the lower ribbon roller firmly in the right hand while pulling out the release knob with the left hand. Turning the release knob clockwise will hold it out of engagement with the roller.

Unwind the ribbon from the lower roller.

Unwind the ribbon from the upper roller by pulling downward and forward on the feed end of the ribbon.

Thread the new ribbon through the lower ribbon guide (from front to back), behind the print drum, and through the upper ribbon-guide (from back to front.)

Insert the leading edge of the ribbon into the slot in the upper roller. Align the ribbon edge with the score mark on the roller. Wrap the ribbon on the upper roller by rotating the roller toward the front. Be sure the ribbon winds evenly on the roller. Leave about two feet of ribbon hanging below the lower ribbon guide.

Replace the lower roller and lock it in place.

Insert the trailing edge of the ribbon into the slot in the lower roller and take up the ribbon slack by rotating the lower roller toward the back.

Return the ribbon-feed assembly to printing position and tighten the print clamps.

Replace the ribbon-feed assembly cover.

ADJUSTING THE DRUM SPEED PULLEY

The drum speed pulley is located on the right side of the printer unit.

The pulley slides on its shaft and will lock itself into one or two positions. The lateral distance between these two positions is about 1/4 inch.

Printer AC must always be turned OFF while changing the pulley position.

To change pulley positions, stand in front of the pulley (on the right side of the printer) and pull (or push) the pulley while rotating it back and forth until it locks into the new position.

If splines are visible protruding through the pulley shaft hole, past the outer side of the pulley, the pulley is in the high position.

If the splines are flush with the other side of the pulley, the pulley is in the low position.

THE DATA PROCESSOR

Figure 3-1. Control Console.

Physical Characteristics:

Console:

Width:	59 inches	Weight:	500 pounds
Depth:	35 inches	Power:	Negligible
Height:	49 inches	Heat Dissipation: 340 BTU/hour	

Desk:

Width:	78 inches
Depth:	18 inches
Height:	29 inches

Operating Characteristics:

Displays all electronic registers of the Data Processor in binary-coded decimal form

Provides special register display for check-out

Provides a ten-key keyboard for register alteration

Provides an "L"-shaped modern desk and a chair for operator use

Includes an Interval Timer (a running-time clock) used in program time checking

Register display configuration is designed for ease of operation

System Characteristics:

Each register may be separately cleared or any bit may be separately set or cleared

Data is entered or examined quickly using an automatic storage address sequencing feature built into the Control Console

Special registers used solely for check-out provide simplified control of the entire Burroughs 220 System

All maintenance controls are located in the Control Console

Indicators set by the Data Processor under program control are displayed

Several indicators reveal unusual conditions if they occur anywhere in the Burroughs 220 System

3 THE DATA PROCESSOR

3-1 CONTROL CONSOLE

3-1.1 BRIEF DESCRIPTION

All programs normally require a certain amount of manual intervention. Also, some programs require periodic entry of variable information and manual change of control to various routines based on the data being entered. To meet these needs, the Control Console is an integral part of the 220 System. (See Figure 3-1).

Based on the requirements of the program and guided by the display of registers, switches, pushbutton indicators and indicators, it is a simple matter for the console operator to take whatever action is necessary.

The console is divided into three separate panels with the central panel considered as the central operator panel, and the other two as the left and right maintenance panels. The greater majority of the operator's activity is centered around the central panel, although there are a certain number of switches on the left and right maintenance panels useful to the operator. This section covers all of the Control Console components pertient to the operator's activity.

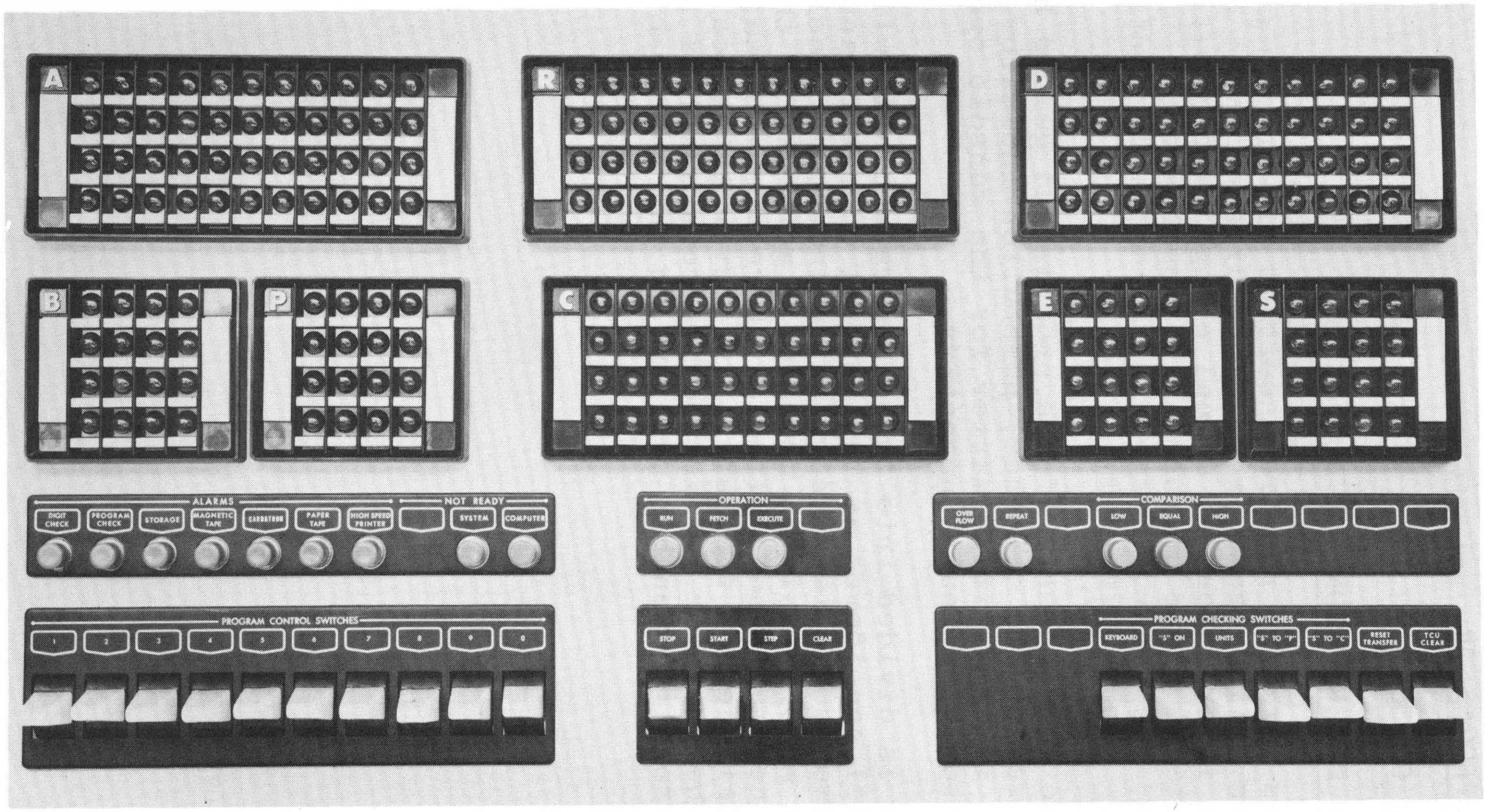

Figure 3-2. Control Console Operator's Panel.

3-1.2 CENTRAL OPERATOR PANEL (Figure 3-2)

The Central Panel contains eight register displays, thirty-eight indicators, twelve pushbutton indicators, twelve two-position organ switches and nine momentary organ switches.

Register Displays

The electronic registers of the BURROUGHS 220 are electronic circuits called flip flops as the main numerical and logical elements. These circuits (or toggles) are called flip flops because they may be in one of two possible states, either zero or one. The sets of neon bulbs indicate the contents or state of these registers. Each neon bulb is on for the one state of the numerical toggle, and is off for the zero state. Each vertical column of neon bulbs is a four-toggle decade that represents a decimal digit, the value of the digit being the sum of the values of the lighted bulbs. Reading from top to bottom the bulbs represent the values 8, 4, 2, and 1. No greater value than 9 normally appears in any decade.

Example:

	Decade	Decade	Decade	Decade
8	0	●	0	0
4	●	0	0	●
2	●	0	●	●
1	●	●	0	0
Decimal Digit Value	7	9	2	6

A Register - This register contains eleven decimal digit positions. Ten positions are for the number or instructions, and one for the algebraic sign of the number or instructions. This register acts as an accumulator, and the results of most operations appear here at the end of the operation.

R Register - This register contains eleven decimal digit positions; ten digits plus sign-digit position. In several operations it serves as an extention of the A Register, holding the least significant digits of the number contained in the combined A and R Registers.

D Register - This register contains eleven decimal digit positions; ten digits plus sign-digit position. In operations involving two operands, the operand whose address is specified by the instruction is brought from core storage and placed in the D Register before the operation begins. When an instruction word is brought from core storage and sent to the C Register for execution, a copy of the instruction word as it appeared in core storage is contained in the D Register.

B Register - This register contains four decimal digit positions. It is used for tallying and to facilitate the modification of instructions. The contents of the B Register can be added by coding, to the address part of any instruction just before the word is executed, leaving the word unchanged in core memory and the D Register.

P Register - This is a four decimal digit position register. Its function is to provide a means of sequential program operation. It contains the address of the next instruction to be placed in the C Register for execution. The sequential mode of operation can be interrupted by changing the contents of P by a transfer control instruction.

C Register - This register contains ten decimal digit positions. It does not have a sign position. Any word entering this register is interpreted as an instruction and executed. The register is divided into three parts:

1. The four high order positions (digit positions 1, 2, 3, and 4) of the C Register contain the control digits of the instruction.

2. Digit positions 5 and 6 contain the operation code.

3. The low order positions (digit positions 7, 8, 9, and 0) contain the address part of the instruction.

	CONTROL				OP		ADDRESS			
Digit Positions	1	2	3	4	5	6	7	8	9	0

E Register - Contains four decimal digit positions; it has a duplicate in the memory control unit and is used for control purposes. It will always contain the address of the word in storage being referenced under computer or manual control.

S Register - This is a four decimal digit position register. It is used for program checking by the operator. When it is desired to halt computer operations during a debugging phase, the operator manually sets the S Register to the desired cell location of this program and when this instruction word is referenced program operation will cease with the desired instruction waiting in the C Register to be executed.

There are two vertical clear bars for each register described--one on the left and the other on the right of each register. When the right vertical bar is depressed, the entire register is cleared. To clear a binary position within a decade of a register, the left vertical bar and the set button below the respective binary position, must be depressed simultaneously.

ALARM INDICATORS

Digit Check

Although the BURROUGHS 220 uses only the ten decimal digits, each decade of four bits in the 8, 4, 2, and 1 code might have been used to count to 15. The occurrence, for any reason, in the low order position of certain of the control registers of a configuration corresponding to any one of the decimal numbers from 10 to 15 is detected automatically. The detection of such a configuration results in a Digit-Check Alarm Stop. The computer stops and the Digit Check Alarm Indicator comes on. If the Audible Alarm Switch had been turned on previously, a bell signal would have sounded. This condition can be corrected by clearing the decade responsible for the alarm, or clearing the computer. Before using the above procedure determine, if possible, the cause for digit check. If the digit check persists, notify the BURROUGHS Service Engineer.

Program Check

This is a pushbutton indicator which, when on, indicates computer errors other than forbidden combinations. The stop is always in or after an execute cycle. The types of alarms sensed are Forbidden order, Field overflow and Branch on Compare when no comparison has been made.

You will interpret these types of errors by looking further for the forbidden order in the C Register, checking in the field specified on a field select command for the presence of zeros in the S/L portions of the variant digit position of the C Register, or the high, low equal indicators off with a Branch on Compare instruction in the C Register. To recover, remove the alarm condition, depress the PROGRAM CHECK indicator, then depress START.

Storage

This pushbutton indicator is normally on when a non-existent address is given by an instruction, i.e. CAD 5000 (memory capacity is only 2000 words), or a forbidden combination. To restart, clear the alarm condition, depress the STORAGE indicator, and depress the START Switch.

Magnetic Tape

This pushbutton indicator is lit when an alarm condition has been detected in the Magnetic Tape System. To restart the Computer clear the alarm condition, and depress the MAGNETIC TAPE indicator.

Paper Tape

The paper tape alarm indicator turns on when an alarm condition exists in the paper tape system. It occurs when a selected unit is not ready, when a parity error happens, or when an improper word format to or from paper tape appears. To restart, clear the alarm condition, simultaneously depress the PAPER TAPE indicator and the START switch.

Cardatron

When an alarm condition exists in the CARDATRON System this indicator comes on. To restart the computer determine and correct the cause, depress the CARDATRON indicator and transfer to an appropriate location in the program. If the programmer has included proper restart procedures, refer to his notes for instructions on the procedure to follow.

NOT READY INDICATORS

If either of the Not Ready Indicators is on, the cause should be checked to be sure that machine operations will proceed as desired.

System

This indicator is on when Magnetic Tape, Memory Control or Data Processor has no power or is being operated in test conditions.

Computer

When a computer test switch is not in normal operating position or when the computer has not been cleared after bringing power up, the computer is inoperative and the COMPUTER indicator is on. The cause in this case is corrected by the BURROUGHS Service Engineer.

OPERATION SUB PANEL

This is a group of two pushbutton indicators and one non-pushbutton indicator.

Run

This indicator comes on when the computer is running under program control.

Fetch

If the computer has stopped during the fetch phase of a command, this pushbutton indicator comes on.

Execute

This is a pushbutton indicator that will come on if the computer stops during an execute phase of an instruction. By depressing the Fetch or Execute indicators we are able to change the phase i.e., Fetch on or bring next instruction from core memory to C Register, reference Register P for next instruction. Execute on act upon instruction in C Register.

COMPARISON SUB PANEL

Overflow

Pushbutton indicator comes on if an overflow condition occurs. It will remain on until a Branch on overflow instruction is used, or when the clear button is depressed.

Repeat

This is a pushbutton indicator and comes on only if the machine has stopped and the repeat toggle has been set.

Comparison

Pushbutton low, equal, high indicators come on as the result of a compare instruction. Only one of the indicators can be turned on at any one point in time. This indicator is turned off by depressing the Console CLEAR switch.

PROGRAM CONTROL SWITCHES

The console is equipped with ten clear plastic organ switches. The status of each switch is determined by the Pre-Run Check Sheet supplied by the programmer. The switches can be interrogated with any one computer instruction. Flexible manual control is provided by these switches. It is important that the operator refrain from depressing these switches while a program is running. If the program was written to interrogate the switches as a check on the system set up, a Supervisory Printer notice should indicate the switches improperly set. However, in case the program has started and improper set up is discovered, the operator should stop the running program, set the switches to their proper configuration and should normally restart the program from the beginning.

STOP-START-STEP-CLEAR SWITCHES

Stop Organ Switch

By depressing this momentary contact switch causes the computer to stop and the "RUN" light to go off upon completion of an execute cycle. After the computer stops the "FETCH" light will come on and be ready to fetch the next instruction.

Start Organ Switch

When this momentary contact switch is depressed, it causes the computer to start and places it under program control.

Step Organ Switch

Depressing this momentary switch when the computer is stopped will cause performance of either a fetch or an execute cycle. Repeated depression of the switch will cause the Data Processor to perform these cycles alternately. In this way we may step through a section of the program.

Clear Organ Switch

The depression of this switch, whether the computer is running or not, will clear all registers and toggles. When this occurs the computer will be stopped with the Fetch light on.

PROGRAM CHECKING SWITCHES

This group of five switches is used as an aid to program checking and to facilitate intermittent manual entry of variable data.

Keyboard

This momentary contact switch must be depressed if any information is to be entered into the Data Processor via the Keyboard. The run light must be off, and the computer stopped, in order to activate the keyboard.

"S" On

Operation of this switch causes the computer to stop when a stop compare is made. The comparison is made with either the address portion of the C Register or the P Register, as determined by other switches in this group.

Units

Operation of this switch causes the computer to compare only the units decade (low order digit) of the Stop (S) Register to either Address portion of the C Register or the Program (P) Register. The indicator light signals the ON condition.

S to C

Operation of this switch causes the stop compare to be made between the Stop (S) Register and the Address portion of the C Register. The stop occurs at the end of the execute cycle using the stop address. The S to C "ON" condition is signaled by the indicator light.

S to P

Depressing this switch will cause the Data Processor to stop each time the contents of S is equal to the contents of P, will fetch contents of S into C, count P up one. Thus, when the stop occurs, P is one greater than S.

Reset and Transfer

Depressing this switch stores the contents of P in cell location 0000 low order four positions and C (low order four positions) in cell location 0000 6:4 positions, then transfers control to 0001. Used for regaining program control after a system halt without losing information in the registers and without entering a branch instruction from the keyboard.

TCU Clear

Depressing this switch will clear the Tape Control Unit. Allows restart operation after a Magnetic Tape Subsystem error halt.

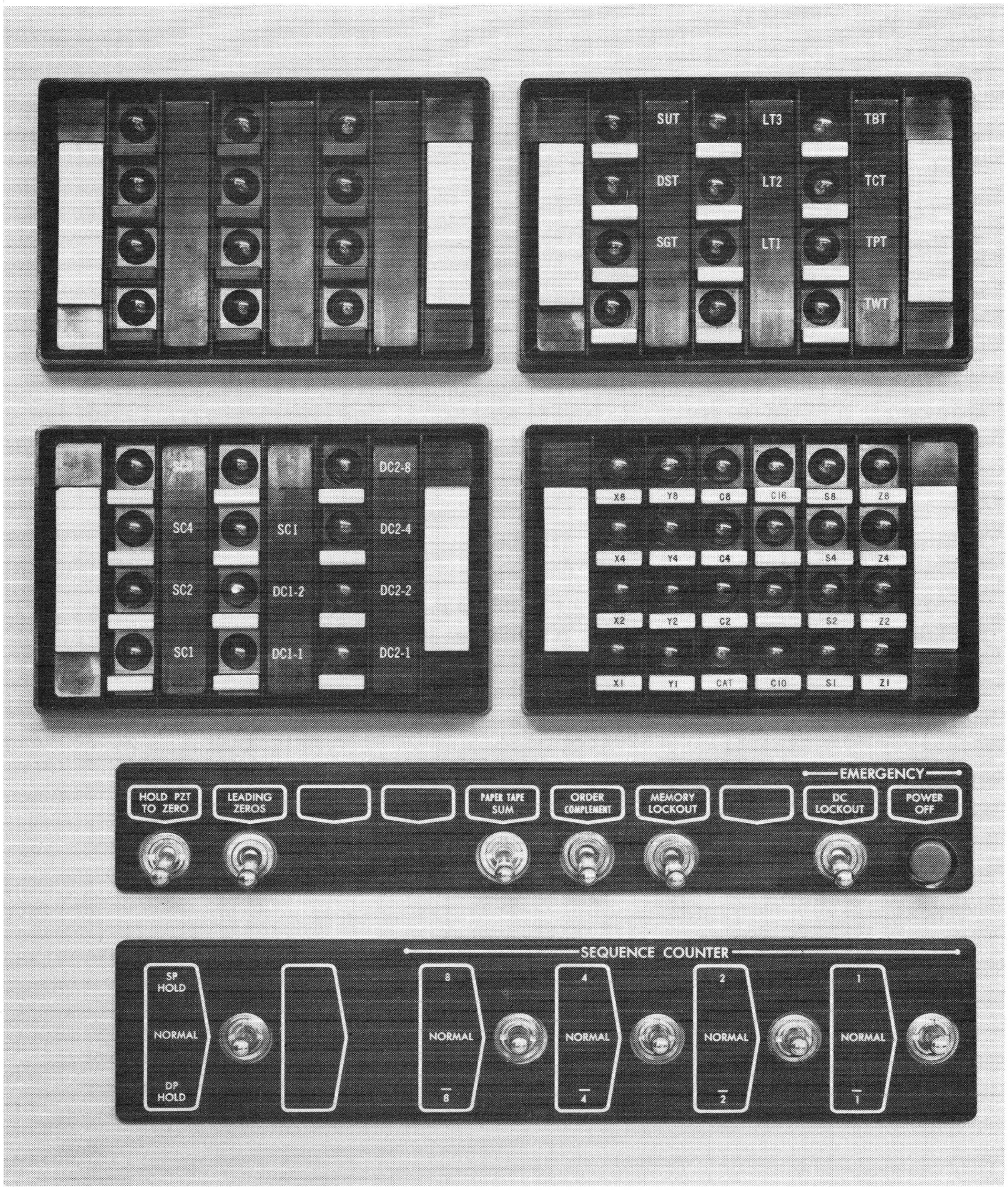

Figure 3-3. Left-Hand Maintenance Panel.

3-1.3 LEFT-HAND MAINTENANCE PANEL (Figure 3-3)

PAPER TAPE CONTROL SWITCHES

Two-position toggle switches which control Paper Tape Operation.

Hold PZT to Zero

Placing this switch in the UP position sets and holds the Paper Tape Zone Toggle (PZT) in the OFF state.

This position forces the computer to treat all paper tape operation as straight numeric.

Leading Zeros

Placing this switch in the UP position causes suppression of leading zeros in a word. The Paper Tape Write commands cover the functional details.

Paper Tape Sum

Placing this switch in the UP position causes the Paper Tape Read command to be treated as a special operation.

In this case, words read from tape pass from the D Register through the adder to form a sum with the A Register contents.

ORDER COMPLEMENT

Placing the switch in the UP position causes the number in the Order Register to change from an odd to the next lowest even number or from even to the next highest odd number at the end of each execute cycle. The switch is normally used with the computer locked in the execute state. For example:

CAD 1000 CSU 1000
or
10 1000 changed to 11 1000

MEMORY LOCKOUT

Placing the Memory Lockout switch in the UP position disconnects the computer from the memory unit. The switch is frequently used to permit independent test of either unit, or to permit computer operation when no memory is present.

When memory is locked out, the computer uses the D Register to represent memory. The computer fetches the word in the D Register. The execute cycle stores words in the D Register. Not to be used by console operators.

DC LOCKOUT

When this switch is UP, DC power cannot be turned on. Circuit details are in the Power Supply Section. NOTIFY Burroughs Field Engineers of Switch Setting.
DO NOT RESET SWITCH.

EMERGENCY POWER OFF

Operation of the Emergency Power Off switch shuts off all power in the system. It is, as the name denotes, for emergency use only.

SP HOLD/DP HOLD

This is a three position, center off switch. In the UP position, it holds a digit counter twenty toggle (DC1-2) "ON" to cause emission of Space Pulses (SP's) only. The down position holds DC1-2 in the "OFF" state which allows emission of digit pulses (DP's) only. When in the Center position, the switch permits normal digit counter operation. For use of Burroughs Field Engineers only.

HOLD SEQUENCE COUNTER SWITCHES

Each of the four 3-position, center off toggle switches controls sequence counter (SC) toggle. When in the UP position each switch holds the associated toggle in the OFF state. The center position permits normal sequence counter operation. The switches in combination with the SP HOLD switch allows repetition of a chosen condition. Burroughs Field Engineers' use only.

NEON DISPLAY

The following is a list of toggles and inverters displayed on the left maintenance panel. Each group of toggles has a Zero Bar on the left. Each toggle has an individual set bar. The clear bar is inoperative.

Adder

X Decade (X1, X2, X4, X8)
Y Decade (Y1, Y2, Y4, Y8)
Carry Inverters (C2, C4, C8, C16)
Sum Inverters (S1, S2, S4, S8)
Decimal Carry Inverter (C 10)
Carry Toggle (CAT)
Decimal Sum Inverters (Z1, Z2, Z4, Z8)

Sequence Counter (SC1, SC2, SC4, SC8)

Digit Counter (DC1-1, DC1-2, DC2-1, DC2-4, DC2-8)

Subtract Toggle (SUT)

Logical Toggles

Logical Toggle One (LT1)
Logical Toggle Two (LT2)
Logical Toggle Three (LT3)

Sign Toggle (SGT)

Tape Busy Toggle (TBT)

Tape Clock Toggle (TCT)

Tape Pulse Toggle (TPT)

Tape Write Toggle (TWT)

Sequence Counter Inverter (SCI)

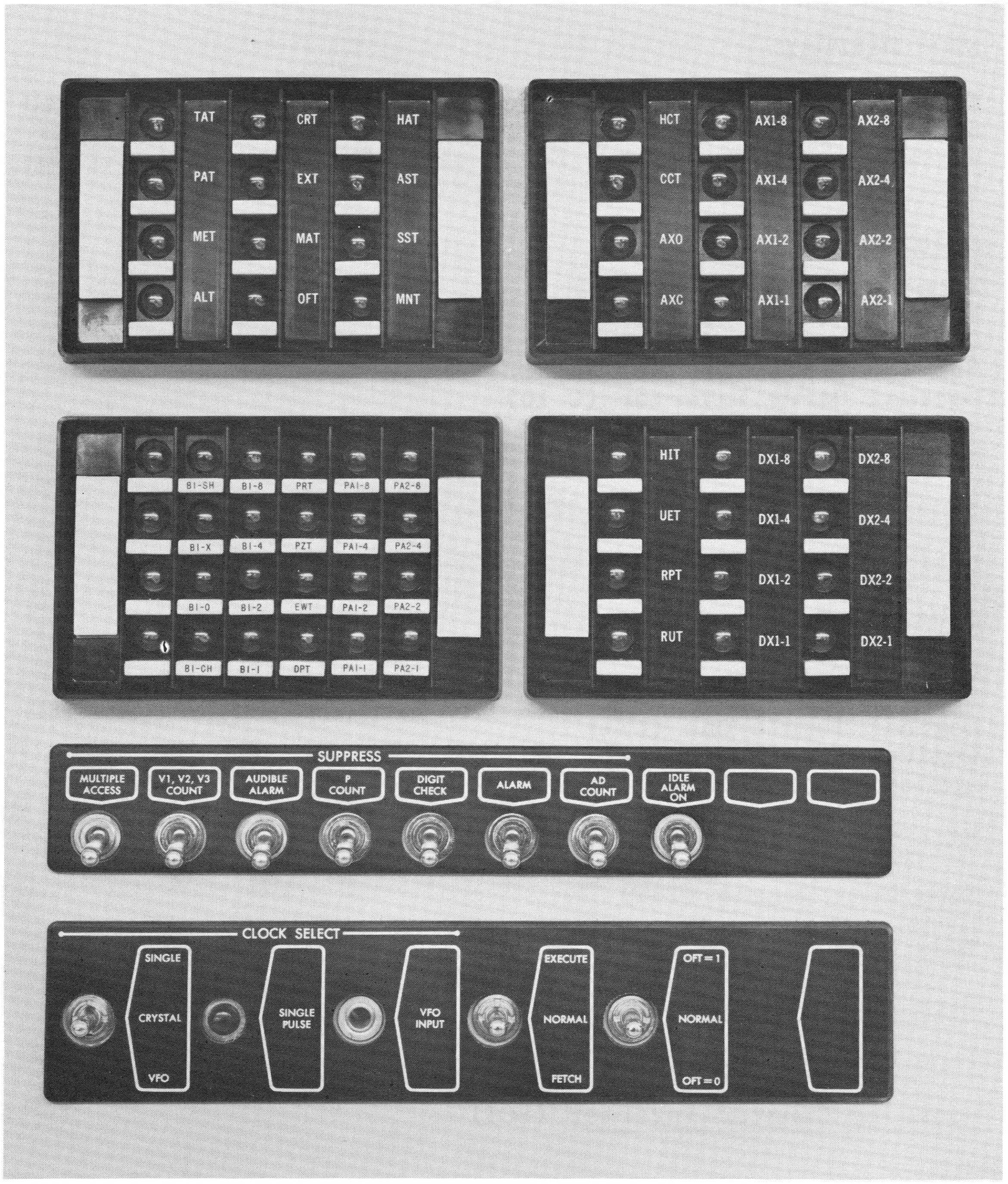

Figure 3-4. Right-Hand Maintenance Panel.

3-1.4 RIGHT-HAND MAINTENANCE PANEL (Figure 3-4)

SUPPRESS SWITCHES

Multiple Access

The Multiple Access Toggle switch in the UP position sets and holds the Multiple Access Toggle (MAT) in the OFF state. Used by Burroughs Field Engineers only.

V1, V2, V3, Count

The switch in the UP position suppresses all counting in the V1, V2, and V3 decades. Burroughs Field Engineers use only.

Audible Alarm

The Audible Alarm switch in the UP position suppresses the audible alarm when the computer stops on an alarm condition.

P Count

The P Count switch in the UP position suppresses count of the program (P) Register. The suppress condition causes repetitive fetches from a given address when the Fetch/Execute Lock switch is in either Normal or Fetch position. For maintenance purposes only.

Digit Check

Placing the Digit Check switch in the UP position suppresses forbidden combination sensing in the computer unit. For maintenance purposes only.

Alarm

When the UP position is set, the alarm switch suppresses all alarm detection by holding the alarm toggle in the OFF state. For system maintenance only.

AD Count

The AD Count switch in the UP position suppresses count of the Address Register (AD). The condition is useful in Record Transfer to hold a given address. The switch when used with V1, V2, V3 count suppression clears all memory locations. For system maintenance only.

IDLE ALARM

The Idle Alarm Switch in the UP position permits operation of the Audible Alarm when the Run Toggle (RUT) is "OFF", MAT is "ON" or the machine is in Single Pulse Operation. Burroughs Field Engineers use only.

FREQUENCY SELECT

The Frequency Select switch permits selection of the pulse source for the computer. The center position (XTAL) selects the computer clock, the UP position (S.P.) selects Single Pulse and the DOWN position (VFO) selects the variable Frequency Oscillator. For maintenance purposes only.

SINGLE PULSE SWITCH

If clock select is on SP depression of this pushbutton switch causes emission of one pulse. Burroughs Field Engineers use only.

VFO INPUT

The phone jack serves to connect an external Variable Frequency Oscillator (VFO, Hewlett Packard Model 200 CD) to the computer for use as a clock generator. The circuit is active when the frequency select switch is at VFO position. For maintenance purposes only.

FETCH/EXECUTE LOCK SWITCH

The 3-position, center OFF toggle switch controls the condition of the Execute toggle (EXT). Placing the switch in the DOWN position holds EXT in the OFF state (FETCH). The UP position sets and holds the EXT in the ON state (EXECUTE). The center position permits normal operation of the EXT. For maintenance purposes only.

NEON DISPLAY

The following is a list of the toggles and toggle inverters displayed on the Right-Hand Maintenance Panel. Each group of toggles has a Zero Bar on the left. Each toggle indicator has a Set Bar. The Clear Bar is inoperative.

Magnetic Tape Alarm Toggle (TAT)

Paper Tape Alarm Toggle (PAT)

Memory Alarm Toggle (MET)

Alarm Toggle (ALT)

CARDATRON Alarm Toggle (CRT)

Execute Toggle (EXT)

Multiple Access Toggle (MAT)

Overflow Toggle (OFT)

Asynchronous Toggle (AST)

Single Step Toggle (SST)

Manual Toggle (MNT)

Paper Tape Decoder (2 Decades)

Paper Tape Read Toggle (PRT)

Paper Tape Zone Toggle (PZT)

End of Word Toggle (EWT)

PA Register (2 Decades)

AX Register (2 Decades + AXO and AXC)

High Toggle (HIT)

Unequal Toggle (UET)

Repeat Toggle (RPT)

Run Toggle (RUT)

DX Register (2 Decades)

Figure 3-5. Keyboard.

3-2 KEYBOARD (Figure 3-5)

3-2.1 KEYBOARD FORMAT

The Keyboard is part of the Console. A cable connects the manual Keyboard to the Console proper. The Keyboard has ten digit keys and six control keys as shown in Figure 3-5. To activate the Keyboard, depress the Keyboard Organ Switch when the computer is in a stop condition or during the manual portion of the Keyboard Add Command. The Keyboard indicator shows the active state.

Digit Keys

Depression of the digit keys enters the digits in the D Register. The digit enters the D Register most significant digit first. If more than eleven digits are entered, the last eleven digits appear in the D Register. The control keys can further manipulate the information.

Keyboard Add (ADD)

The Keyboard carries out the Keyboard Add Command. When the Keyboard Add Command stops, the Keyboard must be activated before keying digits into the D Register. Depression of the ADD key restores control to the computer.

Enter Command (C)

Depression of this key transfers the contents of the D Register to the control register. If the D sign decade is an odd digit, B modification occurs. The information remains in the D Register.

Enter Address (E)

Depression of the E key causes the computer to transfer the four least significant digits (four low order) of the D Register to the Address Buffer Register (E). The D Register clears.

Enter Memory (Enter)

Depression of Enter Key causes the computer to transfer the contents of the D Register to the memory location specified by the Address Buffer Register (E). E counts up one.

Examine Memory (Exam)

Depression of Exam key causes the computer to read from memory location specified by the E Register. The E Register counts up one.

The contents of the memory location appear in D.

Step

The Step Key performs the same operation as the Step Organ Switch on the operator's section of the console, i.e., Fetch, Execute, Fetch, Execute, etc.

3-2.2 OPERATING PROCEDURES

DISPLAYING THE CONTENTS OF CORE STORAGE

To examine a specific storage location or succession of storage locations, the "Examine" feature of the console is used.

First, the Data Processor is placed under control of the numeric Keyboard. Next, the address of the first storage location to be displayed is keyed into the E Register. Depressing the "EXAM" key of the numeric Keyboard will now display, in the D Register, the contents of the location specified by E, and each successive depression of the "EXAM" key will display a successively higher location.

ENTERING CHANGES INTO CORE STORAGE

The "ENTER" feature of the Console is used to change the contents of core storage. First, the computer is placed under control of the numeric Keyboard. Next, the address of the storage location to be revised is keyed into E, and the first replacement word is keyed into the D Register.

Depressing the "ENTER" key on the numeric Keyboard will now transfer the word from the D Register to location in core storage specified by E. Consecutive locations can now be revised by successively keying a replacement word into D and depressing the "ENTER" key.

3-2.3 INTERVAL TIMER (Figure 3-6)

The Timer connects to the Console by cable. Five decimal digit wheels register computer running time. Time measurement is in increments of one-tenth of a second, with a maximum permissible recorded time of 9999.9 seconds before the indicator recycles to zero. The Timer is operative only when RUN indicator is on. The Timer may be reset to zero from the front of the case. The Interval Timer is useful in aiding programmers to measure the machine operating time of program subroutines.

Figure 3-6. Interval Timer.

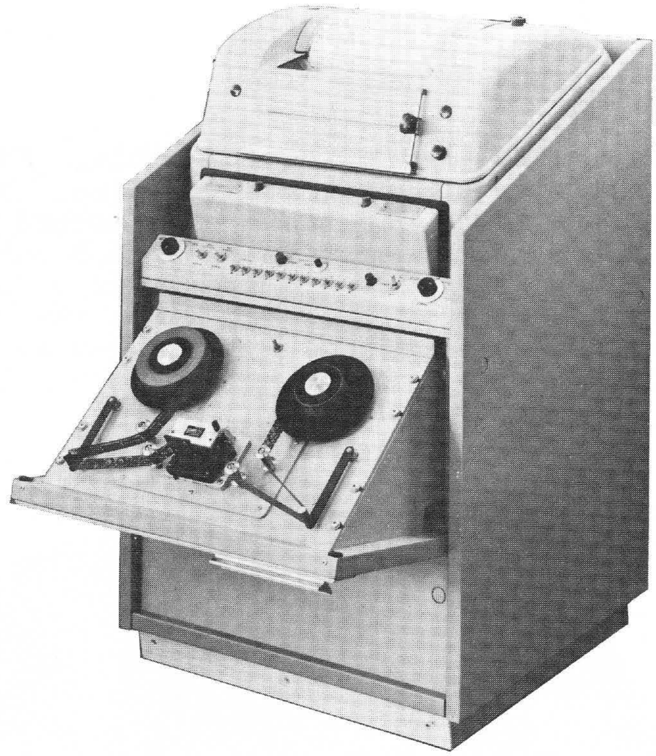

Figure 3-7. Supervisory Printer With Off-Line Reader.

Physical Characteristics:

Width:	23¼ inches	Weight: 300 pounds
Depth:	36 inches	Power: 0.6 kw
Height:	39 inches	208V. 3Ø 60~ 4 wire

Heat Dissipation:
2,040 BTU/hour
No blowers

Operating Characteristics:

Types information from a paper tape reader or from the Data Processor at 10 characters per second

Feeds paper tape in the Off-Line Reader at 10 characters per second

System Characteristics:

One Supervisory Printer with Off-Line Reader is supplied with the Burroughs 220 Primary System

Number of units: Up to 10 additional Supervisory Printers (with Off-Line Readers) per Burroughs 220 System

The Off-Line Reader transmits 7-level alphanumeric code for printing

Automatic alphabetic bi-decimal translation

Special Features:

Carriage control, tabular stops, etc., are controlled by the information from paper tape or the Data Processor

Automatic zero suppression

3-3 SUPERVISORY PRINTER (Figure 3-7)

3-3.1 GENERAL DESCRIPTION

The BURROUGHS 220 character-at-a-time printer is one component of the extremely flexible printing and punching output system. This system consists of one Supervisory Printer and up to ten paper-tape punches. An auxiliary character-at-a-time printer may be substituted for any one of the punches. The fact that more than one printer may be used enables the printout of different formats or different types of related data.

The Supervisory Printer can monitor the punches; that is--it can be switched into the circuitry so as to print out information that otherwise would be punched. One model of the printer can also be used off-line to print out data from paper tapes. In both on-line and off-line applications, the printer provides format control, parity checking, and alphabetic printout.

There are two models of the BURROUGHS character-at-a-time printer. Model 465 consists of a printer and tape-operated mechanical reader. This model is used for the supervisory and off-line printers. It may also be used as an auxiliary on-line printer. The 465 prints numeric, alphabetic, and special characters at the rate of ten per second. The reader pin-senses paper tape punched in the standard BURROUGHS 220 code and converts this code for alphanumeric printout. Model 464 consists of the printer without the reader. It is optionally available for on-line auxiliary use only.

When the controls are set so that the Model 465 printer will function as the Supervisory Printer, it will respond to any SUPERVISORY PRINTOUT (SPO) instruction. It can also intercept a PAPER TAPE WRITE (PWR) instruction so that the information is printed by the Supervisory Printer instead of being punched on the designated punch. Similarly, if an auxiliary printer has been substituted for the punch, the Supervisory Printer can intercept the PWR instruction to the designated printer, and cause the information to be printed on the Supervisory Printer instead, provided that the tab settings are the same on both printers. (When a printer is substituted for a punch, it responds to a PWR instruction.)

The auxiliary printers may be designated units 1 through 10 by means of controls on the various units. The control settings correspond to the unit designation in a PWR instruction.

The printers and punches are cabled in series from the Control Console of the computer. For this reason, the printer designated the Supervisory Printer can intercept instructions only to those units cabled beyond itself in the system. Also, if two units should be given the same designation, the one closer to the console would respond to a PAPER TAPE WRITE or SPO instruction. The units need not be designated in order of cabling. (Punch number 3 could be cabled in closer to the console than the Supervisory Printer, the only effect being that the Supervisory Printer could not then monitor punch 3.) It is suggested that new installations consider designating the units in order of cabling, simply to help every one concerned to remember that order.

The reader included with Model 465 is used for off-line printout of paper tape. It is housed in the lower half of the printer cabinet. It accepts either 5.5-inch or 7-inch reels of tape punched in the standard 220 code. After the code is pin-sensed, it is converted by relay circuitry before printout.

To use the reader, the power must be on, the REMOTE-LOCAL switch set to LOCAL, and paper tape loaded. The format and parity switches are used to control operation in the same manner as for operation under computer control. The format controls can be used to perform the basic functions. When the MAP MEMORY-NORMAL switch is set to MAP MEMORY, data will be printed out exactly as it appears in the tape. That is, the sign digits will not be translated into + or -, nor will the alphanumeric flag (2) be suppressed. Two-digit combinations representing letters of the alphabet will be printed out as letters, however.

3-3.2 INDICATORS AND CONTROLS

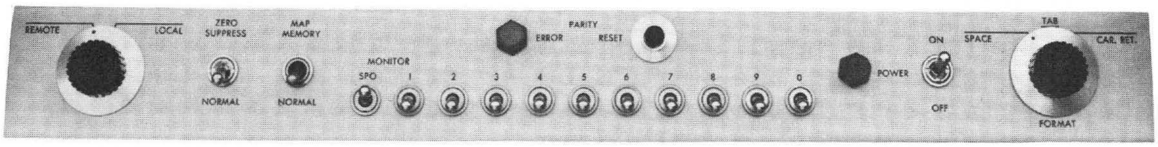

Figure 3-8. Supervisory Printer Control Panel.

PRINTER OPERATING INDICATORS AND CONTROLS

Power Switch

Connects power to the printer when in the UP position.

Power Indicator

Lights when power comes on.

Remote-Local

When this switch is in the REMOTE position, the printer is under computer control. The LOCAL setting is used when loading paper or paper tape, and when the printer is under reader control.

Parity Error Reset

Restarts the printer after a parity error stop.

Parity Error Indicator

Comes on when the printer detects a parity error in the information coming from the computer or the reader.

Line Feed

This control is used for loading paper into the printer. With power on and the REMOTE-LOCAL switch set to LOCAL, depressing this button will cause the paper to advance as long as the button is held down.

Carriage Return

With the REMOTE-LOCAL switch set to LOCAL, this button is used to return the carriage to the left margin stop to prepare for printing the first line.

PRINTER SELECTOR CONTROL SETTINGS

In order to designate a printer the Supervisory Printer, the SPO switch is set to SPO. If the Supervisory Printer is to monitor any of the auxiliary punches or printers, the appropriate monitor switch is moved to the UP position. These are the toggles labeled 1 through 0 (that is, 1 through 10). To designate an auxiliary printer unit, one of the numbered toggle switches is set UP. The setting of the SPO switch on an auxiliary printer is not significant, since another printer cabled closer to the Control Console has already been designated the Supervisory Printer.

PRINTER FORMAT CONTROLS

Format Switch

This 3-position rotary switch functions as follows:

> Space setting causes a space to appear between words.
>
> Tab setting causes the carriage to move under control of the TAB stops. These stops are set with a special tool by a maintenance engineer.
>
> Car Ret setting causes the carriage (the printer platen is stationary, only the carriage for the type box moves) to return after each word on the end-of-word signal.

Zero Suppress - Normal

Zero Suppress settings cause the leading zeros of each numerical computer word to be suppressed and replaced by spaces. Zeros may also be suppressed from the Control Console. See Left-hand Maintenance Panel Section.

Map Memory - Normal

When this switch is set to NORMAL, an odd number in the sign-digit position is printed as a minus sign and an even digit is printed as a plus sign, except in the case of the digit 2, which is the flag for the alphanumeric mode. The digit 2 is suppressed, and alphanumeric translation takes place. When the switch is in the MAP MEMORY position, the regulated output from the Control Console is printed exactly as it is received by the Supervisory Printer.

READER CONTROLS (Figure 3-9)

Forward-Rewind

When this 3-position switch is set to forward DOWN the reader is turned on and tape begins to advance. When this switch is set to rewind UP the tape will move in reverse direction.

CAUTION

Before the tape can be rewound, it must be disengaged from the read head and the control arms and rethreaded around the guide spools.

Manual Feed

This switch enables initial threading of the tape during loading operations.

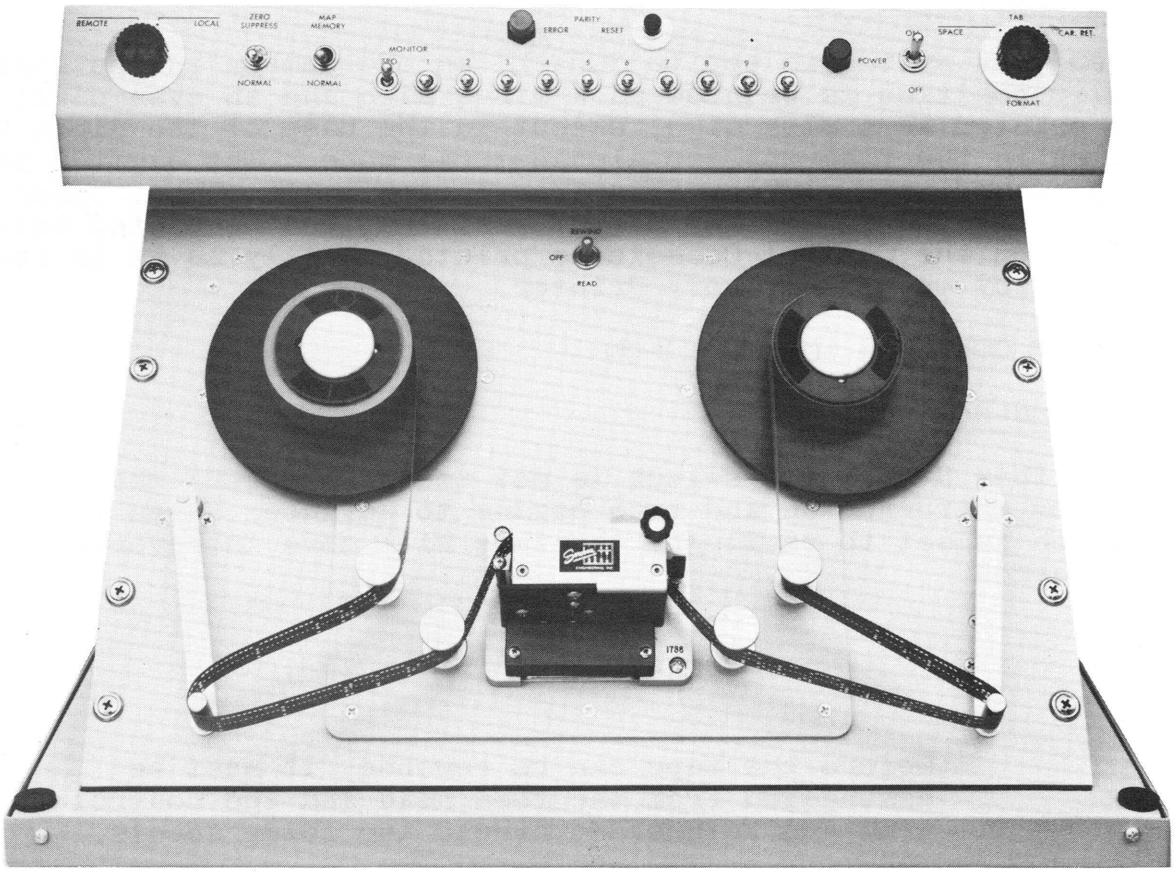

Figure 3-9. Supervisory Printer Control Panel and Paper-Tape Reader.

3-3.3 OPERATING PROCEDURES

PAPER SUPPLY (Figure 3-10)

The printer uses continuous fan-fold pin-feed forms, which are stacked on the bottom shelf of a metal stand attached to the back of the unit. The paper is stacked so that the lined side will be down when the paper is fed into the back of the printer. Printed paper is fed from the printer onto the top shelf of the stand and falls into the original fanfolds.

The following loading and stand-up procedures are used for both models of the printer and to prepare the printer for all three modes of operation:

1. Check paper supply.

2. Open dome and cover.

3. Insert the end of the paper into the slot on the back of the printer and under the platen. Align the paper against the flange on the left side of the platform in back of the platen so that the holes at the sides of the paper fit over the sprocket wheels at the ends of the platen. The paper can be advanced manually by turning the hand wheel on the left end of the platen; the wheel must be pushed down to engage. Push the paper release lever near the right end of the platen to raise the paper guide bar on the top of the platen. Thread the paper under the guide and return the guide to position.

4. Close the cover, leaving the dome open.

5. Set POWER switch to ON.

6. Hold Down the LINE FEED button long enough to advance the paper about 1 foot.

7. Close dome, while holding the leading edge of the paper toward the front of the unit to guide it through the over slot.

8. Press carriage-return button.

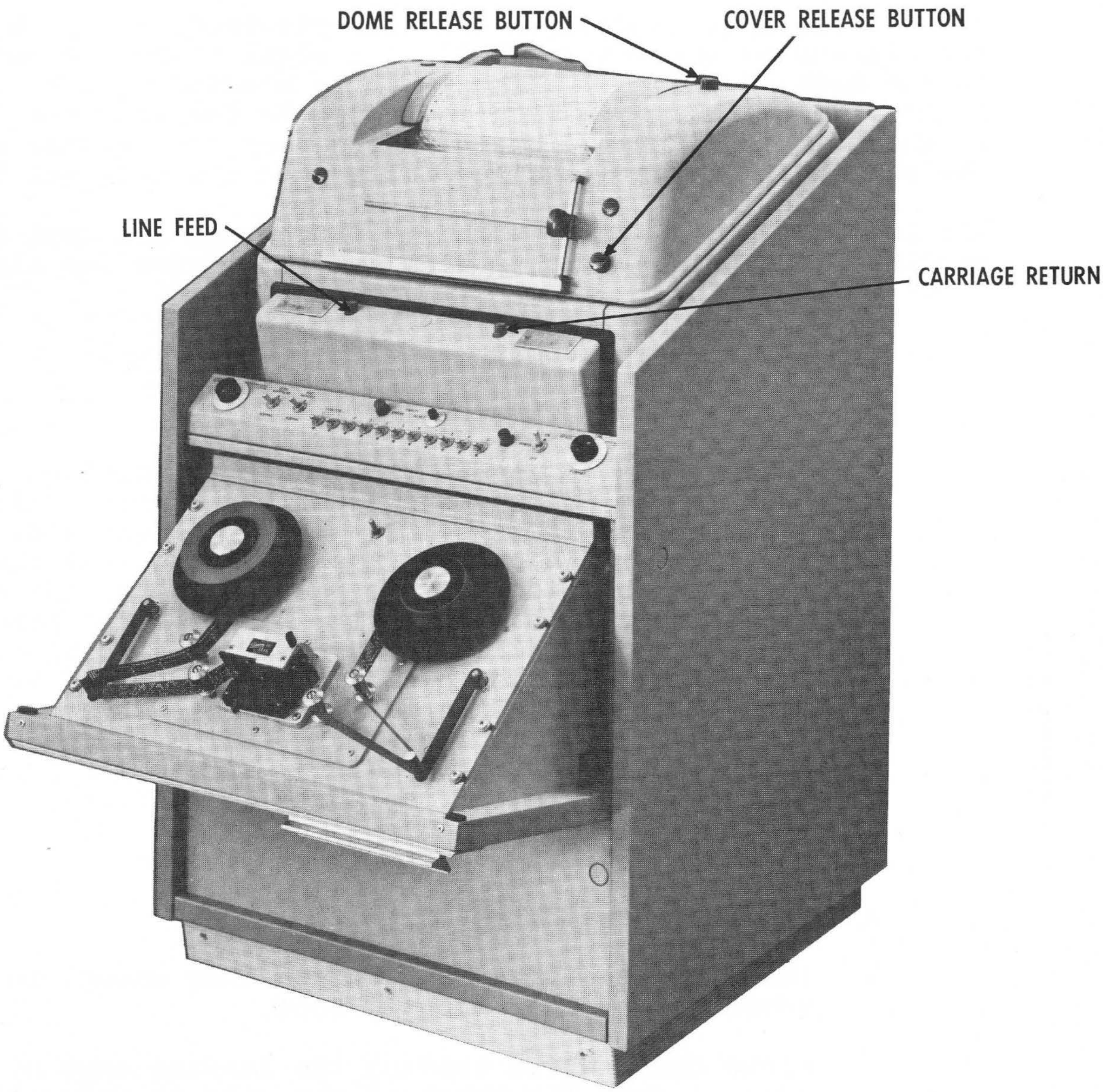

Figure 3-10. Supervisory Printer Controls
Used in Loading Paper.

ON-LINE PRINTER

To prepare the printer for use as a supervisory printer, proceed as follows:

1. Set REMOTE-LOCAL switch to REMOTE.
2. Set monitor switch to SPO.
3. If punches or auxiliary printers are to be monitored, set to the UP position the numbered toggle switches corresponding to the unit designations of the units to be monitored. (Normally, the instructions to the operator from the programmer will state which toggles are to be set on the pre-run checksheet.)
4. Set the ZERO SUPPRESS - NORMAL -- the MAP MEMORY - NORMAL, and the FORMAT switches to the positions specified by the programmer.

NOTE

When the REMOTE-LOCAL switch is set to REMOTE, power to the printer will be cut off. It will be supplied again, however, when an instruction requires the use of the Supervisory Printer.

AUXILIARY PRINTER

1. Set REMOTE-LOCAL switch to REMOTE.
2. Set to the UP position the numbered toggle corresponding to the unit designation the printer is to have. (Toggle 1, if the unit is to be designated 1, for example.)
3. Set the ZERO SUPPRESS - NORMAL -- MAP MEMORY - NORMAL and FORMAT switches as specified by the programmer on the pre-run checksheet.

OFF-LINE PRINTER

1. Set LOCAL-REMOTE switch to LOCAL.
2. Open lower section of the unit, for access to the mechanical reader, by pulling the lower panel out, using the handle at the right just below the control panel.
3. Mount reel of tape to be read on left hub so that the tape comes off the top of the reel to the right. (The wider side of the tape, measured from the sprocket holes to the edge, should be toward the operator.) Mount empty reel on right hub.
4. Unwind about three feet of leader (unpunched tape). Lead the tape to the right of and under the upper left spool, around the left arm assembly, and under the lower left spool. Then pull up the lever on the right side of the reading unit. Feed the tape under the guide on the left of the reading unit, through the reading unit, and over the sprocket wheel. Push down the lever on the right side of the reading unit to engage the sprocket wheel. (If enough leader has not been unwound to reach the right reel, the tape can be advanced by turning the manual feed knob clockwise.) Lead the tape under the lower right spool, around the right arm assembly, under the upper right spool, and around the left side of the reel. Slip end into slot on reel.
5. Set ZERO SUPPRESS, MAP MEMORY, and FORMAT switches according to output format requirements.
6. Set forward-rewind switch for forward operation DOWN. Reading and printing will begin when the punched information area reaches the reading unit.

To rewind the paper tape, proceed as follows:

1. With rewind-forward switch off, lift the tape hold-down lever located on the read head.
2. Remove tape from control arms and read head.
3. Pass the tape to the left of the upper lefthand guide spool, under the two lower spools, and to the right of the upper right-hand guide spool. Take up slack by manually rotating the right switch to rewind.

3-3.4 POWER REQUIREMENTS

When operated from the computer power supply, the printer must be connected to the Control Console by a cable not more than 220 feet long.

The printer has the transformers and rectifiers necessary to supply the required voltages and can be operated independently of the computer power supply from a standard 115-volt a-c outlet. Insure that the outlet is marked 115 V a-c, before connecting.

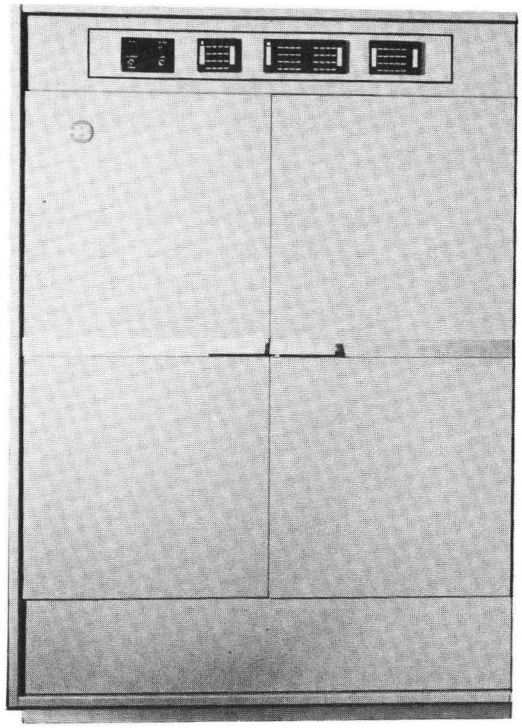

Figure 3-11. Memory Control Unit.

Physical Characteristics:

Width:	52½	inches
Depth:	29	inches
Height:	76	inches

Weight: 870 pounds

Power: 2.5 kw (d.c. 2.0 kw)

208V. 3Ø 60~ 4 wire

Heat Dissipation:

15,300 BTU/hour

Blower volume: 1310 CFM

Operating Characteristics:

Controls the transfer of information between core storage and the Data Processor

Controls the addressing of information in core storage as directed by the Data Processor

System Characteristics:

Number of units: One Memory Control Unit is available to each Burroughs 220 System

3-4 MEMORY CONTROL UNIT AND INTERNAL STROAGE UNIT (Figures 3-11 and 3-12)

The Memory Control Unit contains a panel with associated indicators, buttons, switches and neon display registers which represent the condition of the core memory. This control panel is discussed on the following pages since the operator may have occasion to refer to it.

The Internal Storage Unit which is housed in the Memory Control Unit consists of several matrix arrays of magnetic cores. These cores which are made of ferro-magnetic material can be magnetized in one of two directions. Two wires are fastened to each core allowing pulses to travel to the core and magnetize it in either the positive or negative direction. The positive direction represents a binary one while the negative direction represents a binary zero. Therefore, with each core representing a binary digit, an array or decade of four cores can represent any binary-coded decimal digit 0 through 9. Forty-four cores are needed to store 11 decimal digits or one 220 word. The Internal Storage Unit is available in different word sizes with the maximum capacity of 10,000 words.

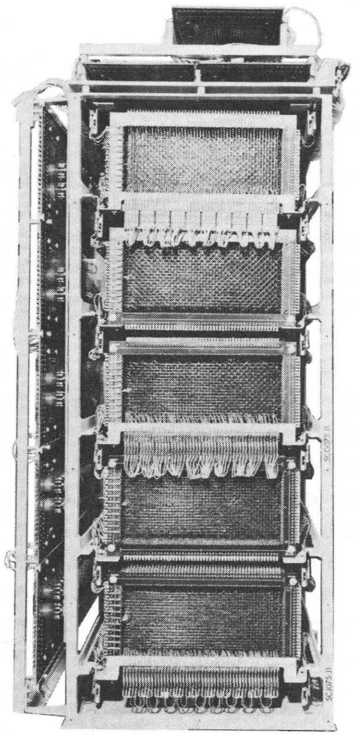

Figure 3-12. Core Assembly.

Physical Characteristics:

Width:	11 inches	Weight:	15 pounds
Depth:	22 inches	Power:	negligible
Height:	7 inches	Heat Dissipation:	negligible

Operating Characteristics:

Read-in or Read-out time:	10 microseconds
Method of access:	parallel
Cores/word:	44
Size:	3/32″ in diameter
Type:	square-loop ferrite torroidal

System Characteristics:

Number of units: Ten units (1000 words each) may be associated with the Burroughs 220 System. Two units (2000 words) are standard with the Burroughs 220 Primary System. Up to and including five units (5000 words) may be associated with any one Core Storage Unit (Models 381-1 or 381-2). Core Assembly Units are available in increments of 1000 words only.

The maximum is ten units (10,000 words) for any one Burroughs 220 System.

3-4.1 INDICATORS AND CONTROLS

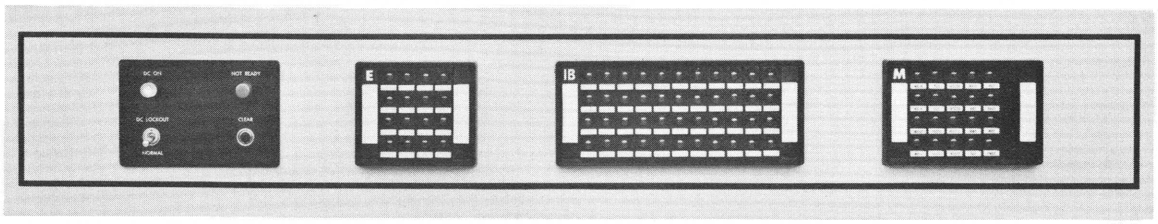

Figure 3-13. Memory Control, Control Panel.

MEMORY CONTROL PANEL

D.C. On

A blue indicator when "ON" indicates that d-c voltage is applied to the Memory Control and Storage Unit.

Not Ready

When this red indicator is "ON" the Memory Control is in a non-operative condition.

D.C. Lockout

A switch which controls D.C. to the Memory Control Unit. It is not used by the operator. Direct current cannot be applied until the D.C. Lockout Switch is in the "NORMAL" position. If other than normal call the system engineer. Do Not Reset Switch

Clear

The Clear button provides a means of clearing all Memory Control toggles. It is not used by the Operator.

REGISTERS

E Register

A 4-digit, 16 neon register which is a duplicate of that found on the Console. E displays the address of the storage location to which access is being made under machine or manual control.

IB Register

An 11-digit, 44 neon register which functions as an intermediate buffer between the Data Processor (D) and core memory.

M Register

A 16 neon register used exclusively for maintenance purposes.

NOTE: Insure that the IB Register is clear after bringing up power.

3-5 POWER SUPPLY (Figures 3-14 and 3-15)

The Power Supply is comprised of two main frame cabinets which are bolted together. The left side cabinet is the Mag. Amp. Control Unit; the other is the Mag. Amp. Power Supply.

An operator should never have occasion to investigate the condition of the Mag. Amp. Power Supply. Therefore, its functions and operation will not be discussed.

3-5.1 MAG. AMP. CONTROL

With the Mag. Amp. Control doors closed, only the panel at the top is visible. This panel is comprised of five panels displaying, in the main, red and blue indicators. Each panel monitors a subsystem; namely, Magnetic Tape, Data Processor, Power Supply, Memory and CARDATRON.

The Power Supply Panel, in addition to displaying the general Mag. Amp. condition, indicates the status of the 400 cycle alternator (M-G) and contains the emergency shut-down button.

Under normal operating conditions, all blue indicators will be ON. Should a power failure (overheat, filiment, fan or D.C.) occur, the corresponding red indicator will be turned on. This will show the operator what subsystem has failed as well as the type of failure. Call the BURROUGHS system engineer immediately.

A corresponding and more detailed panel for each of the subsystem panels is located inside the Mag. Amp. control door. The unitized sliding control panels are named:

1. M-G Remote Control
2. Data Processor Power Control
3. Mag. Tape Power Control
4. Master Power Control
5. Core Memory Power Control
6. Card Data Processor Power Control

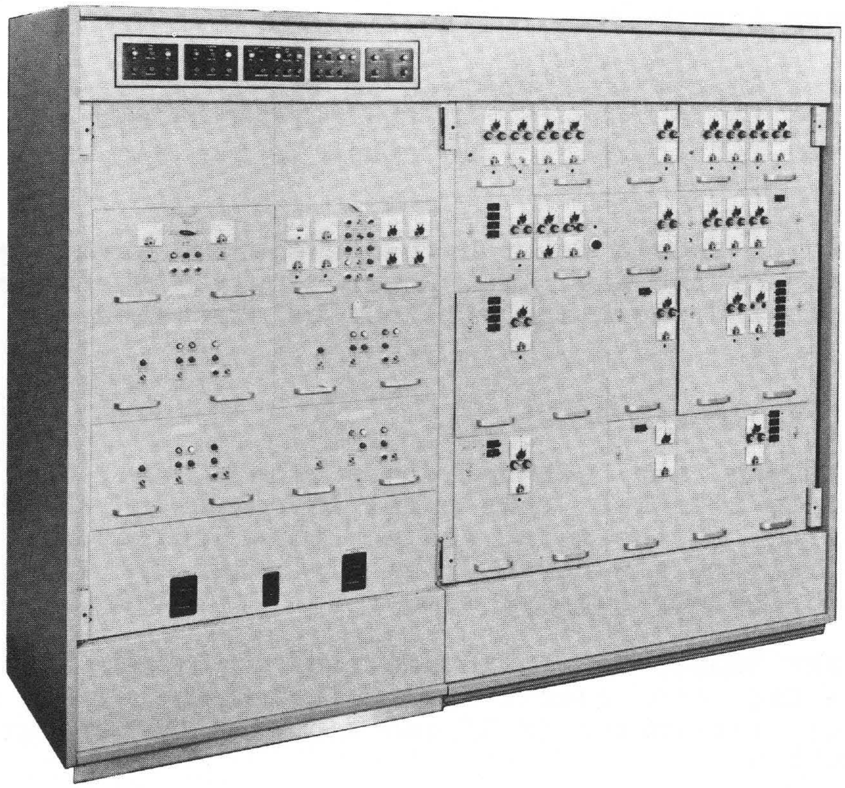

Figure 3-14. Power Control and Power Supply.

Physical Characteristics:

Width:	92½	inches	Weight:	2300 pounds
Depth:	29	inches	Power:	0.5 kw a.c. 5.0 kw d.c.
Height:	76	inches	208V. 3Ø 60~ 4 wire	
			Heat Dissipation:	19,000 BTU/hour max.
			Blower volume:	1500 CFM

Operating Characteristics:

Supplies power to all sections of the Burroughs 220 System

Controls safety circuits, metering facilities, and regulated DC voltages

A motor-alternator is used to generate 200 volts of 400~ current. This current is supplied to the Power Supply Unit, which in turn regulates and rectifies it, thus supplying the various DC voltages to the Burroughs 220 System

System Characteristics:

System shut-down and turn-on procedures are semi-automatic to insure safety to the system

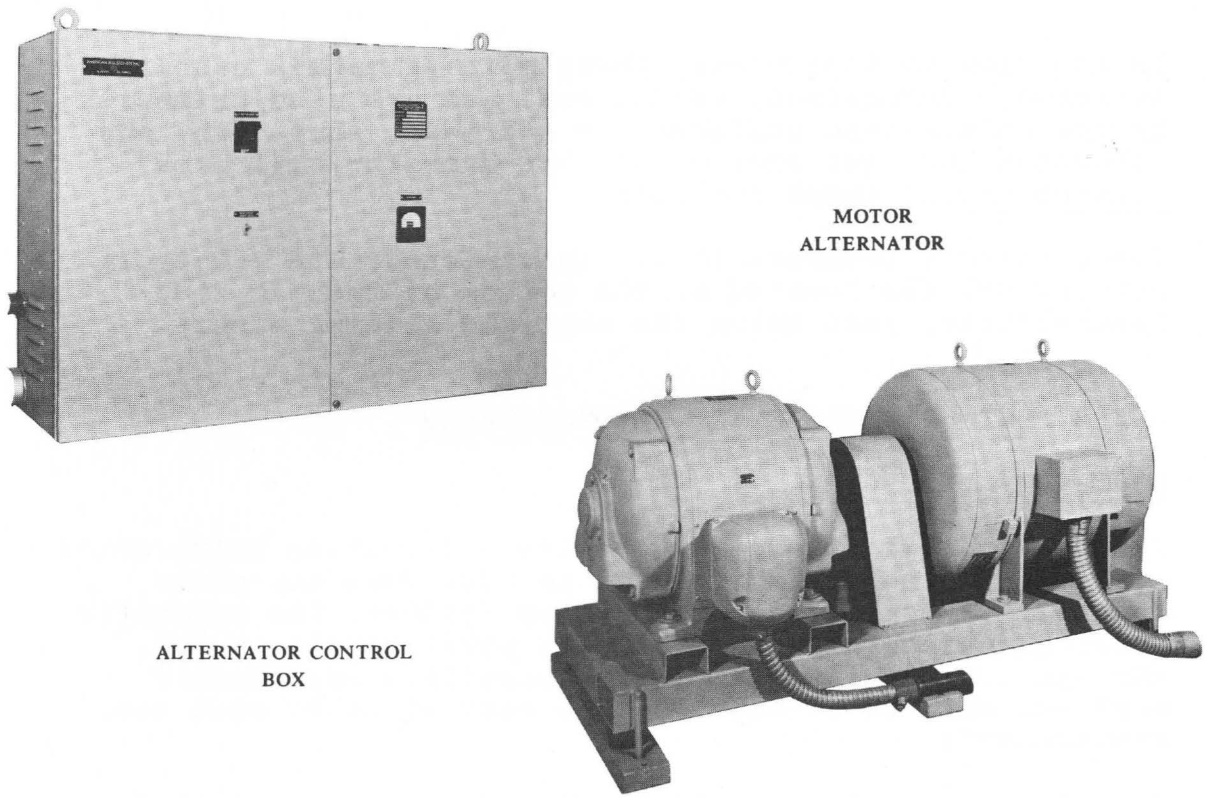

Figure 3-15. Motor Alternator.

MOTOR ALTERNATOR

Physical Characteristics:

Width:	67 inches
Depth:	33¼ inches
Height:	33½ inches
Weight:	2000 pounds

Motor Description:

75 Horse Power
440/480V. 3Ø 60~
40°C Rating
1800 RPM

CONTROL BOX

Physical Characteristics:

Width:	48 inches
Depth:	13 inches
Height:	31 inches
Weight:	200 pounds

Alternator Description:

40 kw
115/200V. 3Ø 400~
0.8 P.F. 40°C Cont. Raise & Duty
1800 RPM

Heat Dissipation—Basic system: 21,000 BTU/hour

Characteristics:

Supplies 200 volts of 400~ power to the Model 400 Power Control Unit

Blower volume: M-A room should receive cooling air at 1000 CFM for basic system, 2000 CFM for max. system.

In addition to indicators, these sliding panels contain switches, pushbuttons, and meters, and are used primarily by the maintenance engineer for start-up, shut-down, and subsystem lock out procedures. An operator will have <u>limited</u> <u>use</u> of these controls.

Three circuit breakers (A.C., convenience, and 400 cycle alternator) are located at the bottom of the Mag. Amp. Control Unit, just below the unitized sliding panels.

3-5.2 SHUT-DOWN AND START-UP PROCEDURES

SHUT-DOWN PROCEDURE

The operator will very seldom have a situation arise which will make it necessary for him to shut down the power supply. In most cases of a system failure, the automatic sensing devices will turn off the power supply in D.C. through A.C. cycling fashing. Normally a maintenance engineer will be on hand to take care of other shut down requirements.

In the absence of a maintenance engineer on the system, shut-down procedures are as follows:

Normal

Where the time to turn off the power supply is of no great importance. Examples might be evidence of motor, capacitor, or other component smoldering; repeated D.C. failure in a subsystem; or desire to turn all power off system.

1. Depress "SHUT DOWN" button on Master Power Control Panel. (Figure 3-16)

Emergency

Where all power should be turned off as soon as possible. Examples might be an individual being electrocuted, explosion, or fire in a subsystem.

1. Flip "EMERGENCY" switch on left hand maintenance panel of Console or:

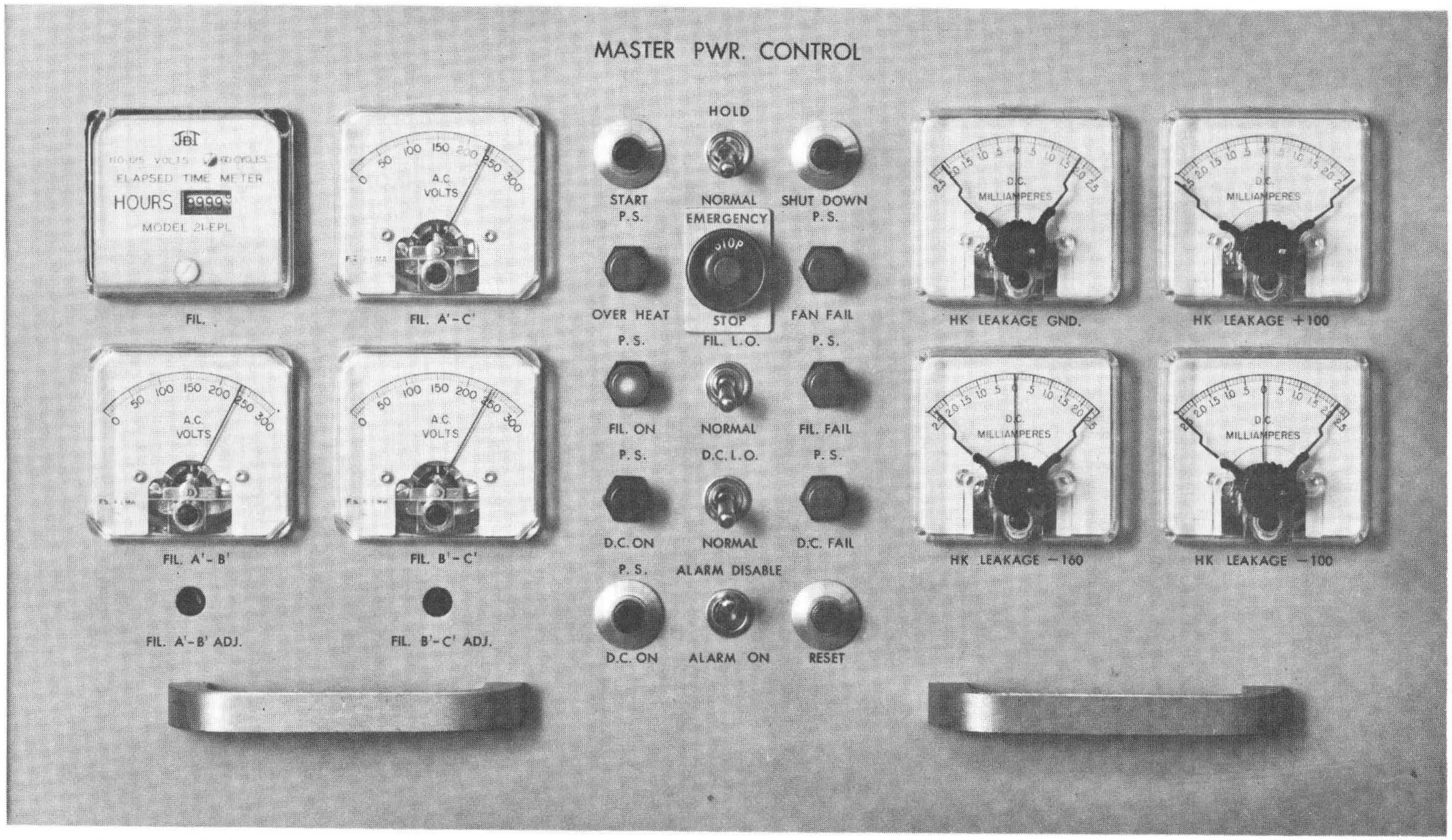

Figure 3-16. Master Power Control Panel.

2. Depress "EMERGENCY" button on visible Power Supply panel (Figure 3-17) or Master Power Control Panel.

<u>START-UP PROCEDURE</u> (Assuming D.C. power is available at unit)

1. Turn on (DCLO or UP position) the D.C. Lockout toggle switches on the following control panels in the Power Control Unit. (Reference should be made to Figure 3-18 for all Power Control Panels listed below since all panels are identical)

   a. Data Processor Power Control
   b. Magnetic Tape Power Control
   c. Core Memory Power Control
   d. Card Data Processor Power Control
   e. Tape Feed Printer Power Control

   (<u>NOTE</u>: Not all of the above panels may be present in any one system.)

   These switches must remain in the DCLO (or ON) position for a minimum of two minutes after the D.C. power supply has been turned on. During this two minute period the D.C. meters should be observed for any abnormal indications.

2. All toggle switches on the Master Control panel in the Power Control Unit must be in the Normal (Down) position.

3. Push Start button on Master Control Panel in the Power Control Unit. As noted in 1 above, a two minute interval must be observed prior to turning off D.C. Lockout switches.

4. At end of two minute period the D.C. Lockout toggles can be turned to the Normal (or OFF) position.

   Push in D.C. ON button on each control panel after the D.C. Lockout on that panel is turned to Normal (OFF).

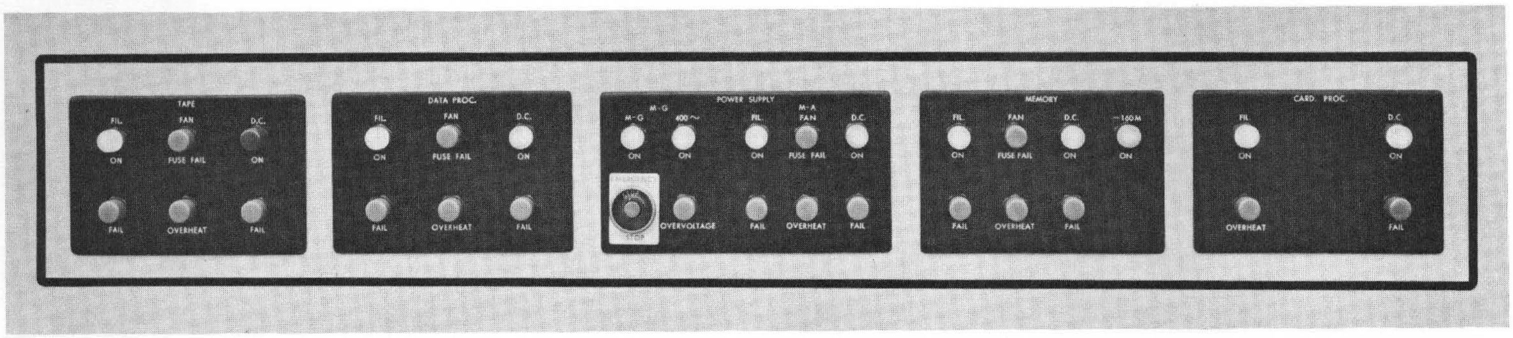

Figure 3-17. Power Supply Control Panel.

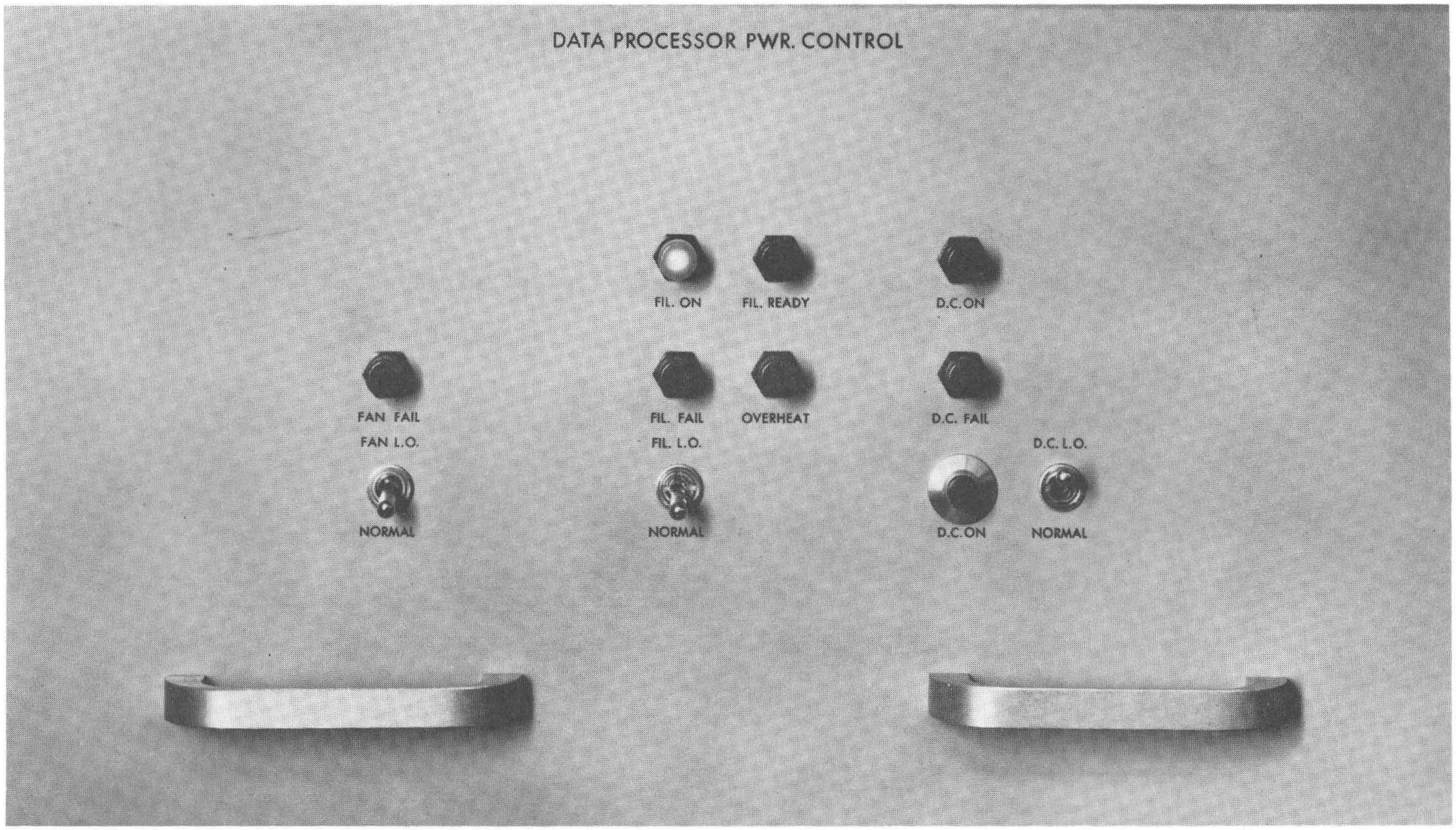

Figure 3-18. Data Processor Power Control Panel.

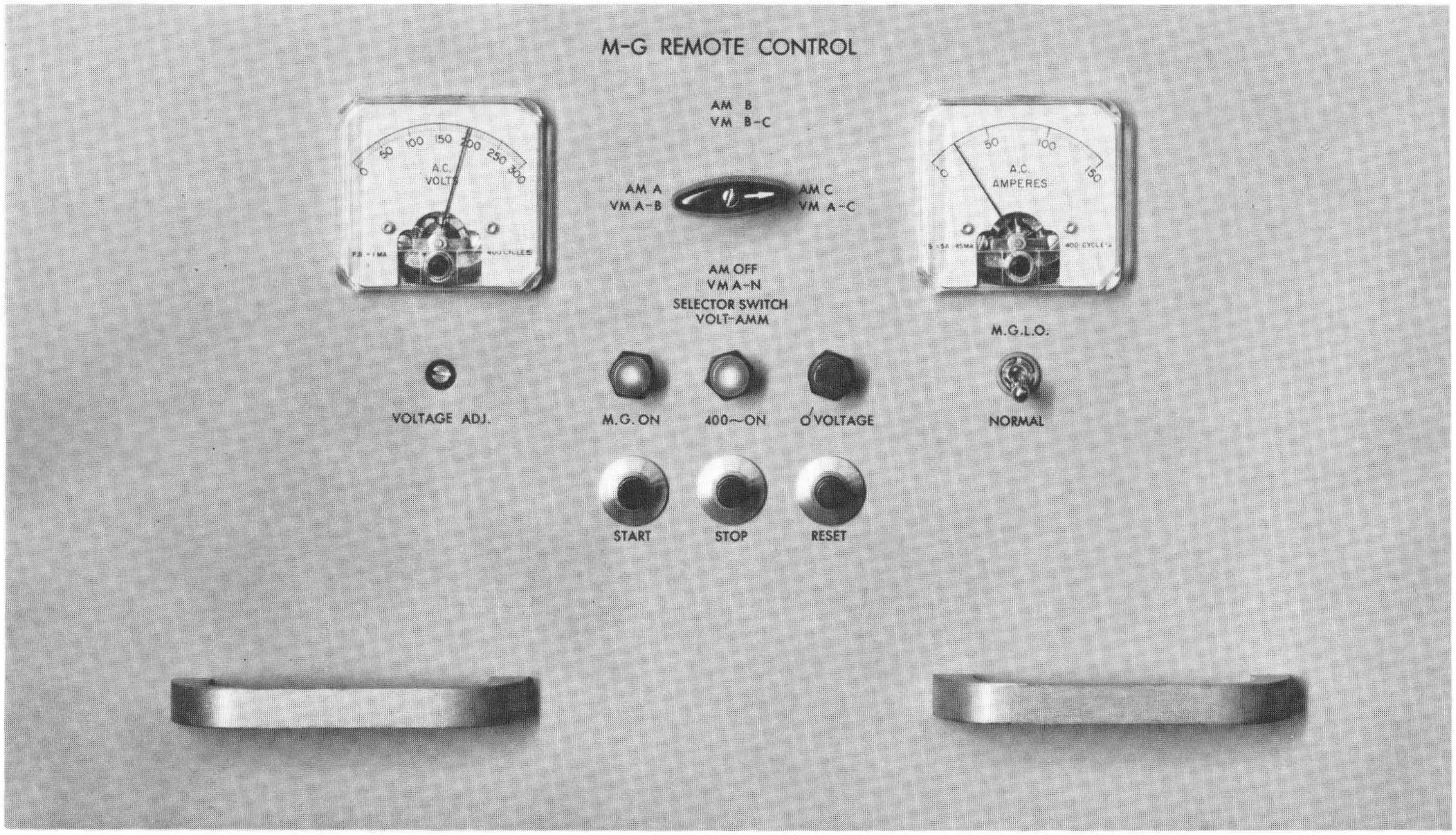

Figure 3-19. M-G Remote Control Panel.

PRE-RUN PREPARATION

4. PRE-RUN PREPARATION

4-1. PREPARATORY OPERATIONS

In discussing the operating procedures for the 220 System and the duties which should be performed by the operator, it is difficult to cover all the various elements which will effect either or both. This is due to the high degree of programming versatility of the System. Therefore, the duties of the operator are more clearly defined by the Programmer for each computer run. This is dependent on how the Programmer has set up his problem and how he desires to have it processed.

As a result, the operating techniques described in this section are not stated as standardized procedures, but only as the more acceptable ones. It is believed that each installation will adopt its own techniques to best suit their needs.

INITIAL RUN PROCEDURES

It is assumed that the necessary Input-Output Units have been set up correctly.

If Paper Tape is used as Input:

Program Beginning with a Fixed Location - To store a program beginning with a fixed location, the Programmer should have as the first command on Paper Tape: 6 u i i i 0 4 x x x x and the last word should also contain a 6 in the Sign Digit Position. The control digits represented by ii are irrelevant; the 6 in Sign Digit Position of the last word will cause the Photo-reader to stop unless a rewind has been sensed. As a result of the first word on Tape mentioned above the Operator has only to do the following:

1. Key into the D Register by means of the Keyboard a Paper Tape Read Branch Command.

2. Depress the C Key on the Keyboard and the Paper Tape Read Branch Command will enter the C Register.

3. Depress the Start Switch and the Paper Tape Read Command will be executed.

4. There is no B-Register Address Modification. Therefore, the B Register does not have to be loaded.

5. The fourth Control Digit Position does not have to contain an 8.

Floating in a Program - In Floating in a program, the same procedure as above is followed with a few exceptions.

1. A 7 should be in the Sign Digit Position of the first word on Paper Tape rather than a 6.

2. There is B-Register Address Modification. Therefore, the B-Register does habe to be loaded.

3. The fourth Control Digit Position of the first word on Tape must contain an 8.

The 7 in the Sign Digit Position of the first word on Tape will cause this word to go directly to the C Register where it is executed. Since the first word is a Paper Tape Read Command, it will read the rest of the program into storage. The 7 in the Sign Digit Position will also cause a B-Register Address Modification. The B Register must be loaded so that the program will position itself correctly. This setting can be completed within the program and handled automatically, or the Programmer can instruct the Operator as to the B Register setting and the Operator can manually load the register by means of the set buttons. The 8 in the fourth Control Digit Position will cause the designated Input, which in this case is the Program, to be B-Register Address Modified.

NOTE: There are other methods for reading a Program from Paper Tape, but the two examples stated are the most commonly used.

If Punched Cards are used as Input:

In using Punched Cards, a program can be floated in or a fixed location can be designated. Again this is determined by the programmer. Also he must determine whether or not the program is to be "bootstrapped" in or a Loading Routine to be used.

"Bootstrap" - By this method, each card that is read will contain a Read command to read in the next card. This is continued until the entire program has been read into storage. The functions of the Operator are similar to those when Paper Tape is used:

1. Key into the D Register by means of the Keyboard a Card Read Command (7 u i i i i 6 0 x x x x).

2. Depress the C Key on the Keyboard and the contents of the D Register which is the Card Read Command will enter the C Register.
   (Unlike the Paper Tape Read), the Card Read Command must be in both the D and C Registers. The Paper Tape Read Command need be in the C Register only.

3. Depress the Start Switch and the Card Read Command is executed.

4. From this point on all Card Reads are automatic.

The operation which takes place is that the first card containing the initial Card Read Command is read into C Register from the Unit designated by u in the Command set up on the Console by the Operator. This Card Read Command must contain a 6 or 7 in the Sign Digit Position depending on whether or not it is a program to be floated in or a fixed location program as in the case of the Paper Tape Read Command. This digit specifies the beginning location of the program. The last card must also contain a 6 or 7 in the Sign Digit Position.

NOTE: The first card in the deck should have only one word in it, the initial Card Read Command.

Standard Loading Routine - If a loading routine is used, the operator need only set up on the Console the same Card Read Command as stated above. After the Operator depresses the Start Switch,all operations are automatic.

NOTE: In both of these methods attention must be given to unit designation. Either the loading routine or boot-strap cards must be set up for a given unit designation or the initiating CRD command must be stored in memory rather than in the "C" register. Again it must be stated that these are not the only methods for reading into the System a program from a punched Card Deck, but they are the most acceptable ones at the present time.

4-1.1 PRE-RUN CHECK SHEET

The BURROUGHS 220 is a General Purpose computer. Because of its flexability as a system, it is capable of handling large volumes of data, economically and efficiently; therefore it may require various configurations of equipment. It is at this point that a form providing set-up information should be furnished the computer operator. This form titled Pre-Run Check Sheet, is designed to provide the operator with the maximum amount of information required to properly set-up a BURROUGHS 220 system prior to the actual operating instructions. The existence of this sheet compliments the program in that it provides positive identification of input/output equipment and the files or forms being used with them. It eliminates the time consuming communication between the programmer and the operator to determine the proper equipment configuration and eliminates the chance of mis-interpretation of this configuration. If properly used, the Pre-Run Check Sheet will prove itself a valuable tool in the efficient running of the installation.

PRE RUN CHECK SHEET
CONSOLE

A REGISTER

± 1 2 3 4 5 6 7 8 9 0

R REGISTER

± 1 2 3 4 5 6 7 8 9 0

D REGISTER

± 1 2 3 4 5 6 7 8 9 0

B

7 8 9 0

P

7 8 9 0

C REGISTER

1 2 3 4 5 6 7 8 9 0

E

7 8 9 0

S

7 8 9 0

Compare

OFT RPT

L E H

Program Control Switches

1	2	3	4	5	6	7	8	9	0	
										OFF
										ON

KB	S	U	S-P	S-C	
					OFF
					ON

NOTES:

PROGRAM ____________ DEPT. ______________

DATE ______________

JOB # ______________ OPERATOR ____________

PERIPHERAL EQUIPMENT
PRE-RUN CHECK SHEET

CARDATRON SYSTEM

INPUT

UNIT	INPUT DESCR	CONTR PANEL	

OUTPUT

UNIT	TAPE OR CARD or PAPER FORM	CONTR PANEL	CARR. TAPE	ALT SW.

MAGNETIC TAPE SYSTEM

UNIT	WRITE NOT W.	REEL NO.	FILE DESCR	DATAF. PRJ.TBS

UNIT	WRITE NOT W.	REEL NO.	FILE DESCR	DATAF. PRJ.TBS

SUPERVISORY PRINTER

REM	SUP. ZERO	MAP MEM	UNIT	ON	SPACE
Loc.	Norm.	Norm.		Off	Carr. Ret.

PHOTOELECTRIC READER

UNIT	ON	REM	HI	TAPE #
	Off	Local	Low	Reel #

HI SPEED PUNCH

ON	PW	REMOTE
OPP	SPO	LOCAL

NOTES:

PROGRAM ____________

DATE ____________

DEPT. ____________

JOB # ____________

OPERATOR ____________

4-1.2 PRE-RUN PROCEDURE

The users of an installation may find it useful to compile standard procedures for computer operation, including a check list of things to do before starting to run a program. Such a check list might include the following procedures:

1. Fill out the Pre-Run sheet. The Pre-Run Check Sheet contains a listing of all equipment that may possibly be used on a run, and the set-up configuration for each machine. The Pre-Run Check Sheet should help the operator plan machine set-up before entering the machine room.

2. Compile the Console Notebook. This notebook, to be taken to the machine room by the operator, contains the following:

   a. Stop Listing.
   b. Coding Sheets (optional).
   c. Console Stop Sheet - this sheet is filled out to record the contents of the registers, and the setting of switches and indicators when an unexpected stop occurs.
   d. A description of what program checkout routines (traces, memory printouts, etc.) are to be used if program stops unexpectedly; and instructions telling how to use these programs.
   e. The selected portions of memory to be printed.

3. Fill out the Computer Log.

4. Check all connections and clear all units of the system.

5. Set up equipment according to Pre-Run Check Sheet.

6. Begin job run.

4-1.3 PROGRAM STOP LISTING

Devise a Stop Listing. This is a sequential listing of all programmed stops. The Stop Listing is used as a reference during machine sessions to tell the operator the cause of a stop, and the corrective action to take after the stops.

As part of the stop procedure, the address portion of the STOP instructions might have been coded with certain configurations to permit operator to tell the type of programmed stop by the STOP instruction in the C register. These configurations will be included in the Stop Listing -- for reference purposes.

Example:

a. 7's, 8's, or 9's in address portion of STOP instruction indicate loading stops.

b. 1's, 2's, or 3's in address portion of STOP instruction indicates stops for checking interim results.

c. A STOP instruction with a 9669 configuration indicates End-of-Job.

	STOP #	Mem.Loc.	Flo-Cht.Loc.	Cause	Corr. Action
1.	8888	2148	PRL-3-62	Prog.	Prog.deck loaded set B=3900-start
2.	9999	0968	DCB-2-1	Prog.	Card Reader Ready Load Deck 2.
3.	7777	5014	CHR-1-36	Prog.	Prog.tape loaded Read cards from 87
4.	2222	3683	TED-32-3	Prog.	Check interim results a reg. 0 0000 47 1310 if ok insert data P.10 by keyboard.
5.	9669	2100	PAF-1-26	Prog.	End of job. Remove tape no.3.

The programmer should also compile a list of those programmed stops that are scheduled to occur during the next Computer run. This should be made a part of the Stop Listing to aid the operator.

Besides programmed stops, the Stop Listing should include a list of error stops, and instructions to the operator, telling him the steps to take as the result of the error stop. Error stops occur when internal checks within a program reveal that error conditions have arisen at some point in the program. Some examples of causes of error stops would be:

1. Non-existent cable numbers.

2. Inadmissible data.

3. An invalid check sum.

4. Punched cards out of sequence.

As an aid in locating error stops within the program, some programmers write the address of the STOP instruction in the address portion of that instruction.

Example:

STOP#	MEM.LOC.	FLO-CHT.LOC.	CAUSE	CORR. ACTION
1000	1000	PAF-3-66	Prog.	Punched card out of sequence BUN 2075
3054	3054	PRL-6-64	Prog.	Sq. root of x--x negative. Restart location 1050
2530	2530	EDD-1-23	Prog.	Non-existent account number Read in next card. BUN 2000

4-2.1 OPERATING SUGGESTIONS

Non-programmed or unexpected stops.

1. Check Stop Listing to verify that it is a non-programmed stop.
2. Fill out Console Stop Sheet.
3. Take total or selective memory and/or magnetic tape dump (printout).
4. Unless the trouble area is obvious, get off Computer and analyze program using memory and tape printouts, coding sheets or listings, and Stop Sheet data.
5. If error(s) can not be determined away from Computer, decide what areas of program to trace.
6. Run program under trace routine.

When stops occur during program the operator should:

1. Examine Stop Listing to determine reason for Stop.
2. If an interim stop, check intermediate results, if results are satisfactory, follow directions on Stop Listing. If the results are unsatisfactory, the operator should fill out Console Stop Sheet.
3. Print out selected portions of memory.

4-2.2 POST RUN PROCEDURES

1. Steps in getting off machine because of program error, end of run, or end of job.

   a. Unload Tape Storage Units.
   b. Remove listing from 407.
   c. Run out cards in 523. Remove cards.
   d. Run out cards in 87. Remove cards.
   e. Remove plugboards.
   f. Remove paper tape that has been used.
   g. Remove Supervisory printout.
   h. Restore abnormal switch settings, etc. to normal.

2. Evaluate results of program run. This is accomplished away from machine room.

3. If punched paper tape is being used, have new tapes punched and/or corrections made to previously used tape, as required. List tapes on Supervisory Printer offline. Make identification notations on tapes, as necessary.

4. If punched cards are being used, prepare necessary patch cards (correction cards) for next run.

    a. Use cards whose color is different than that of main deck for patch cards. This is for identification purposes.
    b. Be sure that correct format select digits are punched into patch cards.
    c. Number each patch card.
    d. Have contents of each patch card listed on a coding sheet for referencing. Or, list patch cards on the 407. If listings are used, be sure to keep the listings accurate and up to date. They must show all changes that have been made to date.

SYSTEM UNLOADING AND RUN EVALUATION

CONTROL STOP   CONSOLE SHEET

A REGISTER

± 1 2 3 4 5 6 7 8 9 0

R REGISTER

± 1 2 3 4 5 6 7 8 9 0

D REGISTER

± 1 2 3 4 5 6 7 8 9 0

B Reg.

7 8 9 0

P Reg.

7 8 9 0

C REGISTER

1 2 3 4 5 6 7 8 9 0

E Reg.

7 8 9 0

S Reg.

7 8 9 0

Compare

D P STB MT CD PT SYS CP RUN F E OPT RPT

REMARKS:

TIME ________________ JOB # ______________ DATE / / ______

OPERATOR ___________ PROGRAM ___________

DEPT _______________

MAGNETIC TAPE LOG
REEL NUMBER

File Description ______________ No. Reels in File __________

Date Edited __________________ Person Editing _____________

Even Lane Blocks Initially Written _________________________

Odd Lane Blocks Initially Written __________________________

Unit Edited On _____________ Manufacturer __________________

Department or Division Authorized __________________________

ERRORS DETECTED

UNIT	DATE	TYPE	CORRECTION MADE	BY	REMARKS

COMPUTER LOG

SYSTEM NO:

JOB NUMBER ____________ DATE ____________ TIME OFF ____________

AUTHORIZED ____________ TIME ON ____________

TYPE RUN* ____________ ELAPSED ____________

PAPER TAPE			CARDATRON						MAGNETIC TAPE									
			INPUT			OUTPUT												
IN OPT	OUT PCH	OUT PRT	1	2	3	1	2	3	1	2	3	4	5	6	7	8	9	10

REMARKS:

____

____

____

____

* D - DEBUGGING
PM - PREVENTATIVE MAINTENANCE
UM - UNSCHEDULED MAINTENANCE
S - DEMONSTRATIONS OR SPECIAL
E - EDITING

I - IDLE
R - RERUN
P - PRODUCTION
O - OTHER (Explain in remarks)

OPERATOR ____________

Page No.____

HIGH-SPEED PRINTER

SYSTEM LOG

Tape Unit 1 Reel #	Tape Unit 2 Reel #	Job #	Job Descr.	Error Detect. and Corr.	Dept.	Oper.	Time		
							on	off	elapsed

PAPER TAPE LOG

Page No. ______

Reel #	Tape #	No. of reels in file	Date Punched	Device Used	Opr.	Verified Date	File Descr.	Dept. #	Auth.	Dupl. Avail.	Corr.

APPENDICES

APPENDIX A

A Summary of Operations in Operation-Code Order

Instruction Format				Operation	
±	1234	56	7890	Abr.	Name
±	iiii	00	iiii	HLT	HALT
±	iiii	01	iiii	NOP	NO OPERATION
±	unnv	03	aaaa	PRD	PAPER-TAPE READ
±	uiiv	04	aaaa	PRB	PAPER-TAPE READ, BRANCH
±	unnv	05	aaaa	PRI	PAPER-TAPE READ, INVERSE FORMAT
±	unni	06	aaaa	PWR	PAPER-TAPE WRITE
±	uiii	07	aaaa	PWI	PAPER-TAPE WRITE, INTERROGATE BRANCH
±	iiii	08	iiii	KAD	KEYBOARD ADD
±	dnnv	09	aaaa	SPO	SUPERVISORY PRINT-OUT
±	iii0	10	aaaa	CAD	CLEAR ADD
±	iii1	10	aaaa	CAA	CLEAR ADD ABSOLUTE
±	iii0	11	aaaa	CSU	CLEAR SUBTRACT
±	iii1	11	aaaa	CSA	CLEAR SUBTRACT ABSOLUTE
±	iii0	12	aaaa	ADD	ADD
±	iii1	12	aaaa	ADA	ADD ABSOLUTE
±	iii0	13	aaaa	SUB	SUBTRACT
±	iii1	13	aaaa	SUA	SUBTRACT ABSOLUTE
±	iiii	14	aaaa	MUL	MULTIPLY
±	iiii	15	aaaa	DIV	DIVIDE
±	iiii	16	iiii	RND	ROUND
±	iiii	17	aaaa	EXT	EXTRACT
±	sLf0	18	aaaa	CFA	COMPARE FIELD A
±	sLf1	18	aaaa	CFR	COMPARE FIELD R
±	iiii	19	aaaa	ADL	ADD TO LOCATION
±	nnnn	20	aaaa	IBB	INCREASE B, BRANCH
±	nnnn	21	aaaa	DBB	DECREASE B, BRANCH
±	iii0	22	aaaa	FAD	FLOATING ADD
±	iii1	22	aaaa	FAA	FLOATING ADD ABSOLUTE
±	iii0	23	aaaa	FSU	FLOATING SUBTRACT
±	iii1	23	aaaa	FSA	FLOATING SUBTRACT ABSOLUTE
±	iiii	24	aaaa	FMU	FLOATING MULTIPLY
±	iiii	25	aaaa	FDV	FLOATING DIVIDE
±	sLnn	26	aaaa	IFL	INCREASE FIELD LOCATION
±	sLnn	27	aaaa	DFL	DECREASE FIELD LOCATION
±	sLnn	28	aaaa	DLB	DECREASE FIELD LOCATION, LOAD B

A Summary of Operations in Operation-Code Order

Instruction Format				Operation	
±	1234	56	7890	Abr.	Name
±	inni	29	aaaa	RTF	RECORD TRANSFER
±	iiii	30	aaaa	BUN	BRANCH, UNCONDITIONALLY
±	iiii	31	aaaa	BOF	BRANCH, OVERFLOW
±	iiii	32	aaaa	BRP	BRANCH, REPEAT
±	iiin	33	aaaa	BSA	BRANCH, SIGN A
±	iii0	34	aaaa	BCH	BRANCH, COMPARISON HIGH
±	iii1	34	aaaa	BCL	BRANCH, COMPARISON LOW
±	iii0	35	aaaa	BCE	BRANCH, COMPARISON EQUAL
±	iii1	35	aaaa	BCU	BRANCH, COMPARISON UNEQUAL
±	sLnn	36	aaaa	BFA	BRANCH, FIELD A
±	sLnn	37	aaaa	BFR	BRANCH, FIELD R
±	uiii	38	aaaa	BCS	BRANCH, CONTROL SWITCH
±	iii0	39	aaaa	SOR	SET OVERFLOW REMEMBER
±	iii1	39	aaaa	SOH	SET OVERFLOW HALT
±	iii2	39	aaaa	IOM	INTERROGATE OVERFLOW MODE
±	sLf0	40	aaaa	STA	STORE A
±	sLf1	40	aaaa	STR	STORE R
±	sLf2	40	aaaa	STB	STORE B
±	iiii	41	aaaa	LDR	LOAD R
±	iii0	42	aaaa	LDB	LOAD B
±	iii1	42	aaaa	LBC	LOAD B COMPLEMENT
±	iiin	43	iiii	LSA	LOAD SIGN A
±	iiii	44	aaaa	STP	STORE P
±	iii1	45	iiii	CLA	CLEAR A
±	iii2	45	iiii	CLR	CLEAR R
±	iii3	45	iiii	CAR	CLEAR, A, R
±	iii4	45	iiii	CLB	CLEAR B
±	iii5	45	iiii	CAB	CLEAR A, B
±	iii6	45	iiii	CRB	CLEAR R, B
±	iii7	45	iiii	CLT	CLEAR A, R, B
±	iiii	46	aaaa	CLL	CLEAR LOCATION
±	iii0	48	iinn	SRA	SHIFT RIGHT A
±	iii1	48	iinn	SRT	SHIFT RIGHT A AND R
±	iii2	48	iinn	SRS	SHIFT RIGHT A WITH SIGN
±	iii0	49	iinn	SLA	SHIFT LEFT A

A Summary of Operations in Operation-Code Order

Instruction Format				Operation	
±	1234	56	7890	Abr.	Name
±	iii1	49	iinn	SLT	SHIFT LEFT A AND R
±	iii2	49	iinn	SLS	SHIFT LEFT A WITH SIGN
$\bar{0}$	uhh0	50	aaaa	MTS	MAGNETIC-TAPE SEARCH
4	uhh0	50	aaaa	MFS	MAGNETIC-TAPE FIELD SEARCH
±	uhh4	50	iiii	MLS	MAGNETIC-TAPE LANE SELECT
±	uhh8	50	iiii	MRW	MAGNETIC-TAPE REWIND
±	uhh9	50	iiii	MDA	MAGNETIC-TAPE REWIND, DE-ACTIVATE
$\bar{0}$	uhhk	51	aaaa	MTC	MAGNETIC-TAPE SCAN
4	uhhk	51	aaaa	MFC	MAGNETIC-TAPE FIELD SCAN
±	univ	52	aaaa	MRD	MAGNETIC-TAPE READ
±	univ	53	aaaa	MRR	MAGNETIC-TAPE READ, RECORD
±	unkk	54	aaaa	MIW	MAGNETIC-TAPE INITIAL WRITE
±	unii	55	aaaa	MIR	MAGNETIC-TAPE INITIAL WRITE, RECORD
±	unkk	56	aaaa	MOW	MAGNETIC-TAPE OVERWRITE
±	unii	57	aaaa	MOR	MAGNETIC-TAPE OVERWRITE, RECORD
±	uni0	58	iiii	MPF	MAGNETIC-TAPE POSITION FORWARD
±	uni1	58	iiii	MPB	MAGNETIC-TAPE POSITION BACKWARD
±	uni2	58	iiii	MPE	MAGNETIC TAPE POSITION AT END OF INFORMATION
±	uii0	59	aaaa	MIB	MAGNETIC-TAPE INTERROGATE, BRANCH
±	uii1	59	aaaa	MIE	MAGNETIC TAPE INTERROGATE END OF TAPE BRANCH
±	uiir	60	aaaa	CRD	CARD READ
±	uicf	61	aaaa	CWR	CARD WRITE
±	uiif	62	aaaa	CRF	CARD READ, FORMAT LOAD
±	uiif	63	aaaa	CWF	CARD WRITE, FORMAT LOAD
±	uiii	64	aaaa	CRI	CARD READ INTERROGATE, BRANCH
±	uiii	65	aaaa	CWI	CARD WRITE INTERROGATE, BRANCH
±	inni	66	aaaa	HPW	HIGH-SPEED PRINTER WRITE
±	iiii	67	aaaa	HPI	HIGH-SPEED PRINTER INTERROGATE

APPENDIX B

A Summary of Operations in Alphabetic Order

Instruction Format				Operation	
±	1234	56	7890	Abr.	Name
±	iii0	12	aaaa	ADD	ADD
±	iii1	12	aaaa	ADA	ADD ABSOLUTE
±	iiii	19	aaaa	ADL	ADD TO LOCATION
±	iii0	35	aaaa	BCE	BRANCH, COMPARISON EQUAL
±	iii0	34	aaaa	BCH	BRANCH, COMPARISON HIGH
±	iii1	34	aaaa	BCL	BRANCH, COMPARISON LOW
±	iii1	35	aaaa	BCU	BRANCH, COMPARISON UNEQUAL
±	uiii	38	aaaa	BCS	BRANCH, CONTROL SWITCH
±	sLnn	36	aaaa	BFA	BRANCH, FIELD A
±	sLnn	37	aaaa	BFR	BRANCH, FIELD R
±	iiii	31	aaaa	BOF	BRANCH, OVERFLOW
±	iiii	32	aaaa	BRP	BRANCH, REPEAT
±	iiin	33	aaaa	BSA	BRANCH, SIGN A
±	iiii	30	aaaa	BUN	BRANCH, UNCONDITIONALLY
±	uiir	60	aaaa	CRD	CARD READ
±	uiif	62	aaaa	CRF	CARD READ, FORMAT LOAD
±	uiii	64	aaaa	CRI	CARD READ INTERROGATE, BRANCH
±	uicf	61	aaaa	CWR	CARD WRITE
±	uiif	63	aaaa	CWF	CARD WRITE, FORMAT LOAD
±	uiii	65	aaaa	CWI	CARD WRITE INTERROGATE, BRANCH
±	iii1	45	iiii	CLA	CLEAR A
±	iii5	45	iiii	CAB	CLEAR A, B
±	iii0	10	aaaa	CAD	CLEAR ADD
±	iii1	10	aaaa	CAA	CLEAR ADD ABSOLUTE
±	iii3	45	iiii	CAR	CLEAR A, R
±	iii7	45	iiii	CLT	CLEAR A, R, B
±	iii4	45	iiii	CLB	CLEAR B
±	iiii	46	aaaa	CLL	CLEAR LOCATION
±	iii2	45	iiii	CLR	CLEAR R
±	iii6	45	iiii	CRB	CLEAR R, B
±	iii0	11	aaaa	CSU	CLEAR SUBTRACT
±	iii1	11	aaaa	CSA	CLEAR SUBTRACT ABSOLUTE
±	sLf0	18	aaaa	CFA	COMPARE FIELD A
±	sLf1	18	aaaa	CFR	COMPARE FIELD R
±	nnnn	21	aaaa	DBB	DECREASE B, BRANCH
±	sLnn	27	aaaa	DFL	DECREASE FIELD LOCATION

A Summary of Operations in Alphabetic Order

Instruction Format				Operation	
±	1234	56	7890	Abr.	Name
±	sLnn	28	aaaa	DLB	DECREASE FIELD LOCATION, LOAD B
±	iiii	15	aaaa	DIV	DIVIDE
±	iiii	17	aaaa	EXT	EXTRACT
±	iii0	22	aaaa	FAD	FLOATING ADD
±	iii1	22	aaaa	FAA	FLOATING ADD ABSOLUTE
±	iiii	25	aaaa	FDV	FLOATING DIVIDE
±	iiii	24	aaaa	FMU	FLOATING MULTIPLY
±	iii0	23	aaaa	FSU	FLOATING SUBTRACT
±	iii1	23	aaaa	FSA	FLOATING SUBTRACT ABSOLUTE
±	nnnn	20	aaaa	IBB	INCREASE B, BRANCH
±	sLnn	26	aaaa	IFL	INCREASE FIELD LOCATION
±	iiii	00	iiii	HLT	HALT
±	iiii	67	aaaa	HPI	HIGH-SPEED PRINTER INTERROGATE
±	inni	66	aaaa	HPW	HIGH-SPEED PRINTER WRITE
±	iii2	39	aaaa	IOM	INTERROGATE OVERFLOW MODE
±	iiii	08	iiii	KAD	KEYBOARD ADD
±	iii0	42	aaaa	LDB	LOAD B
±	iii1	42	aaaa	LBC	LOAD B COMPLEMENT
±	iiii	41	aaaa	LDR	LOAD R
±	iiin	43	iiii	LSA	LOAD SIGN A
4	uhhk	51	aaaa	MFC	MAGNETIC-TAPE FIELD SCAN
4	uhh0	50	aaaa	MFS	MAGNETIC-TAPE FIELD SEARCH
±	unkk	54	aaaa	MIW	MAGNETIC-TAPE INITIAL WRITE
±	unii	55	aaaa	MIR	MAGNETIC-TAPE INITIAL WRITE, RECORD
±	uii0	59	aaaa	MIB	MAGNETIC-TAPE INTERROGATE, BRANCH
±	uii1	59	aaaa	MIE	MAGNETIC-TAPE INTERROGATE END OF TAPE, BRANCH
±	uhh4	50	iiii	MLS	MAGNETIC-TAPE LANE SELECT
±	unkk	56	aaaa	MOW	MAGNETIC-TAPE OVERWRITE
±	unii	57	aaaa	MOR	MAGNETIC-TAPE OVERWRITE, RECORD
±	uii2	58	iiii	MPE	MAGNETIC-TAPE POSITION AT END OF INFORMATION
±	uni1	58	iiii	MPB	MAGNETIC-TAPE POSITION BACKWARD
±	uni0	58	iiii	MPF	MAGNETIC-TAPE POSITION FORWARD
±	univ	52	aaaa	MRD	MAGNETIC-TAPE READ
±	univ	53	aaaa	MRR	MAGNETIC-TAPE READ, RECORD

APPENDIX B

A Summary of Operations in Alphabetic Order

Instruction Format				Operation	
±	1234	56	7890	Abr.	Name
±	uhh8	50	iiii	MRW	MAGNETIC-TAPE REWIND
±	uhh9	50	iiii	MDA	MAGNETIC-TAPE REWIND, DE-ACTIVATE
0	uhhk	51	aaaa	MTC	MAGNETIC-TAPE SCAN
0	uhh0	50	aaaa	MTS	MAGNETIC-TAPE SEARCH
±	iiii	14	aaaa	MUL	MULTIPLY
±	iiii	01	iiii	NOP	NO OPERATION
±	unnv	03	aaaa	PRD	PAPER-TAPE READ
±	uiiv	04	aaaa	PRB	PAPER-TAPE READ, BRANCH
±	unnv	05	aaaa	PRI	PAPER-TAPE READ, INVERSE FORMAT
±	unni	06	aaaa	PWR	PAPER-TAPE WRITE
±	uiii	07	aaaa	PWI	PAPER-TAPE WRITE, INTERROGATE, BRANCH
±	inni	29	aaaa	RTF	RECORD TRANSFER
±	iiii	16	iiii	RND	ROUND
±	iii0	49	iinn	SLA	SHIFT LEFT A
±	iii1	49	iinn	SLT	SHIFT LEFT A AND R
±	iii2	49	iinn	SLS	SHIFT LEFT A WITH SIGN
±	iii1	39	aaaa	SOH	SET OVERFLOW HALT
±	iii0	39	aaaa	SOR	SET OVERFLOW REMEMBER
±	iii0	48	iinn	SRA	SHIFT RIGHT A
±	iii1	48	iinn	SRT	SHIFT RIGHT A AND R
±	iii2	48	iinn	SRS	SHIFT RIGHT A WITH SIGN
±	sLf0	40	aaaa	STA	STORE A
±	sLf2	40	aaaa	STB	STORE B
±	iiii	44	aaaa	STP	STORE P
±	sLf1	40	aaaa	STR	STORE R
±	iii0	13	aaaa	SUB	SUBTRACT
±	iii1	13	aaaa	SUA	SUBTRACT ABSOLUTE
±	dnnv	09	aaaa	SPO	SUPERVISORY PRINT-OUT

APPENDIX C

Alphanumeric Codes and Their Representation

Symbol		Code									
		Computer and Magnetic Tape	Paper Tape							CARDATRON Buffer	Punched Card
			Channel								
Datatron	046		X	0	Parity Check	8	4	2	1		
(space)	(space)	00			✓					0 - 0	(blank)
.	.	03	X	0		8		2	1	1 - 11	12,8-3
		04	X	0	✓	8	4			1 - 12	12,8-4
&	&	10	X	0	✓					1 - 0	12
$	$	13	X		✓	8		2	1	2 - 11	11,8-3
*	*	14	X			8	4			2 - 12	11,8-4
-	-	20	X							2 - 0	11
/	/	21		0	✓				1	4 - 1	0,1
,	,	23		0	✓	8		2	1	4 - 11	0,8-3
%	%	24		0		8	4			4 - 12	0,8-4
#	#	33				8		2	1	0 - 11	8-3
@	@	34			✓	8	4			0 - 12	8-4
A	A	41	X	0					1	1 - 1	12,1
B	B	42	X	0				2		1 - 2	12,2
C	C	43	X		✓			2	1	1 - 3	12,3

Alphanumeric Codes and Their Representation

Symbol		Code									
			Paper Tape								
			Channel								
Datatron	046	Computer and Magnetic Tape	X	0	Parity Check	8	4	2	1	CARDATRON Buffer	Punched Card
D	D	44	X	0			4			1 - 4	12,4
E	E	45	X	0	✓		4		1	1 - 5	12,5
F	F	46	X	0	✓		4	2		1 - 6	12,6
G	G	47	X	0			4	2	1	1 - 7	12,7
H	H	48	X	0		8				1 - 8	12,8
I	I	49	X	0	✓	8			1	1 - 9	12,9
J	J	51	X		✓				1	2 - 1	11,1
K	K	52	X		✓			2		2 - 2	11,2
L	L	53	X					2	1	2 - 3	11,3
M	M	54	X		✓		4			2 - 4	11,4
N	N	55	X				4		1	2 - 5	11,5
O	O	56	X				4	2		2 - 6	11,6
P	P	57	X		✓		4	2	1	2 - 7	11,7
Q	Q	58	X		✓	8				2 - 8	11,8
R	R	59	X			8			1	2 - 9	11,9

APPENDIX C

Alphanumeric Codes and Their Representation

Symbol		Code									
		Computer and Magnetic Tape	Paper Tape							CARDATRON Buffer	Punched Card
			Channel								
Datatron	046		X	0	Parity Check	8	4	2	1		
S	S	62		0	✓			2		4 - 2	0,2
T	T	63		0				2	1	4 - 3	0,3
U	U	64		0	✓		4			4 - 4	0,4
V	V	65		0			4		1	4 - 5	0,5
W	W	66		0			4	2		4 - 6	0,6
X	X	67		0	✓		4	2	1	4 - 7	0,7
Y	Y	68		0	✓	8				4 - 8	0,8
Z	Z	69		0		8			1	4 - 9	0,9
0 (zero)	0 (zero)	80		0						4 - 0	0
1	1	81							1	0 - 1	1
2	2	82						2		0 - 2	2
3	3	83						2	1	0 - 3	3
4	4	84					4			0 - 4	4
5	5	85					4		1	0 - 5	5
6	6	86					4	2		0 - 6	6

APPENDIX D

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total time (Fetch + Execute) (μs)/Remarks
ADA	12	185 /No decomplement 245 /Decomplement
ADD	12	185 /No decomplement 245 /Decomplement
ADL	19	255 /No decomplement 315 /Decomplement
BCE	35	105 /No branch 125 /Branch
BCH	34	105 /No branch 125 /Branch
BCL	34	105 /No branch 125 /Branch
BCS	38	105 /No branch 125 /Branch
BCU	35	105 /No branch 125 /Branch
BFA	36	165 /No branch 185 /Branch
BFR	37	165 /No branch 185 /Branch
BOF	31	105 /No branch 125 /Branch

APPENDIX D

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total Time (Fetch + Execute) (μs) / Remarks	
BRP	32	105	/No Branch
		125	/Branch
BSA	33	175	/No Branch
		195	/Branch
BUN	30	125	
CAA	10	185	
CAB	45	100	
CAD	10	185	
CAR	45	100	
CFA	18	240	
CFR	18	240	
CLA	45	100	
CLB	45	100	
CLL	46	115	
CLR	45	100	
CLT	45	100	
CRB	45	100	

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total time (Fetch + Execute) (μs)	Remarks
CRD	60	5855	/Minimum
		7270	/Average
		9110	/Maximum
CRF	62	8635	/Minimum
		10050	/Average
		12030	/Maximum
CRI	64	335	/Minimum, no branch
		355	/Average, no branch
		375	/Maximum, no branch
		355	/Minimum, branch
		375	/Average, branch
		395	/Maximum, branch
CSA	11	185	
CSU	11	185	
CWF	63	8635	/Minimum
		10050	/Average
		12030	/Maximum
CWI	65	335	/Minimum, no branch
		355	/Average, no branch
		375	/Maximum, no branch
		355	/Minimum, branch
		375	/Average, branch
		395	/Maximum, branch

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total time (Fetch + Execute) (μs)	/ Remarks
CWR	61	8635	/Minimum
		10050	/Average
		12030	/Maximum
DBB	21	130	/No branch
		150	/Branch
DFL	27	250	
DIV	15		/Quotient is $(rA)_a$
		180	/Minimum, overflow
		1285	/Minimum, $(rA)_a = \pm$ 0909 09 0909
		3985	/Average, $(rA)_a = \mp$ 5555 55 5555
		6685	/Maximum, $(rA)_a = \mp$ 9090 90 9090
			/Execution time -- exclusive of fetch time -- may be calculated with the aid of the following formula: $T = 3895 + 60 \sum_{k=0}^{4} (rA:2k+1,1)_a - (rA:2k,1)_a 1$
DLB	28	250	
EXT	17	235	
FAA	22	280	/Sum = 0
		325	/Minimum, underflow
		410	/Maximum, underflow
		215	/Sum $\neq$ 0, no decomplement, minimum
		360	/Sum $\neq$ 0, no decomplement, maximum
		280	/Sum $\neq$ 0, decomplement, minimum
		415	/Sum $\neq$ 0, decomplement, maximum

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total time (Fetch + Execute) (μs) / Remarks	
FAD	22	280	/Sum = 0
		325	/Minimum, underflow
		410	/Maximum, underflow
		215	/Sum ≠ 0, no decomplement, minimum
		360	/Sum ≠ 0, no decomplement, maximum
		280	/Sum ≠ 0, decomplement, minimum
		415	/Sum ≠ 0, decomplement, maximum
FDV	25	175	/Quotient or divisor = 0
		260	/Underflow
		175	/Overflow, minimum
		6775	/Overflow, maximum
		4075	/Quotient ≠ 0, average
		6775	/Quotient ≠ 0, maximum
FMU	24	175	/Product = 0
		255	/Overflow
		255	/Underflow, minimum
		2915	/Underflow, maximum
		1735	/Production ≠ 0, average
		2915	/Production ≠ 0, maximum
FSA	23	280	/Difference = 0
		325	/Underflow, minimum
		410	/Underflow, maximum
		215	/Difference ≠ 0, no decomplement, minimum
		360	/Difference ≠ 0, no decomplement, maximum
		280	/Difference ≠ 0, decomplement, minimum
		415	/Difference ≠ 0, decomplement, maximum

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total time (Fetch + Execute) (μs) / Remarks
FSU	23	280 /Difference = 0 325 /Underflow, minimum 410 /Underflow, maximum 215 /Difference ≠ 0, no decomplement, minimum 360 /Difference ≠ 0, no decomplement, maximum 280 /Difference ≠ 0, decomplement, minimum 415 /Difference ≠ 0, decomplement, maximum
HLT	00	100
HPI	67	
HPW	66	
IBB	20	130 /No branch 150 /Branch
IFL	26	250
IOM	39	
KAD	08	/Manual operation
LBC	42	180
LDB	42	180
LDR	41	175
LSA	43	105
MDA	50	195 /Data Processor time, unit ready
MFC	51	245 /Data Processor time, unit ready

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total time (Fetch + Execute) (μs) / Remarks
MFS	50	245 /Data Processor time, unit ready
MIB	59	100 /No branch, TCU not ready 230 /No branch, TCU ready, TSU not ready 250 /Branch
MIE	59	100 /No branch, TCU not ready 230 /No branch, TCU ready, TSU not ready 250 /Branch
MIR	55	160 /Fetch + setup; see Section IV for other details
MIW	54	160 /Fetch + setup; see Section IV for other details
MLS	50	195 /Data Processor time, unit ready
MOR	57	160 /Fetch + setup; see Section IV for other details
MOW	56	160 /Fetch + setup; see Section IV for other details
MPB	58	160 /Fetch + setup; see Section IV for other details
MPE	58	160 /Fetch + setup; see Section IV for other details
MPF	58	160 /Fetch + setup; see Section IV for other details
MRD	52	160 /Fetch + setup; see Section IV for other details

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total time (Fetch + Execute) (μs)	/ Remarks
MRR	53	160	/Fetch+setup; see Section IV for other details
MRW	50	195	/Data Processor time, unit ready
MTC	51	245	/Data Processor time, unit ready
MTS	50	245	/Data Processor time, unit ready
MUL	14		/Multiplier is $(rA)_b$
		230	/Minimum, $(rA)_b$ = $\pm$ 0000 00 0000
		2095	/Average, $(rA)_b$ = $\pm$ 0123 45 6789
		3480	/Maximum, $(rA)_b$ = $\pm$ 5555 55 5555
			/Execution time -- exclusive of fetch time -- may be calculated with the aid of the following formula:

$$T = 90 + 5\sum_{k=0}^{9} M_k,$$

where M_k assumes the values shown in the table below:

rA:kl	0	1	2	3	4	5	6	7	8	9
M_k	1	14	27	40	53	66	65	52	39	26

Abr.	Op Code	Total time (Fetch + Execute) (μs)	/ Remarks
NOP	01	100	
PRB	04		/Photoreader speed, nominally 1000 characters per second

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total Time (Fetch + Execute) (μs)	/ Remarks
PRD	03		/ Photoreader speed, nominally 1000 characters per second
PRI	05		/ Photoreader speed, nominally 1000 characters per second
PWI	07	105 125	/ No branch / Branch
PWR	06		/ Punch speed, nominally 60 characters per second
			/ Printer speed, nominally 7 - 10 characters per second
RND	16	105 165	/ $(rR:11) < 5$ / $(rR:11) \geq 5$
RTF	29	$130 + 60$ (nn) 130	/ $01 \leq nn \leq 99$ / $nn = 00$
SLA	49	$160 - 5N_1$	/ nn N_1, mod 10
SLS	49	$160 - 5N_1$	/ nn N_1, mod 10
SLS	49	$210 - 5N_2$	/ nn N_2, mod 20
SPO	09		/ Printer speed, nominally 7 - 10 characters per second
SRA	48	$110 + 5N$	/ nn N, mod 20
SRS	48	$110 + 5N$	/ nn N, mod 20
STA	40	190	

A Summary of Execution Times in Operation-Abbreviation Order

Abr.	Op Code	Total Time (Fetch + Execute) (μs) / Remarks
STB	40	190
STP	44	185
STR	40	190
SUA	13	185 / No decomplement 245 / Decomplement
SUB	13	185 / No decomplement 245 / Decomplement

APPENDIX E

GLOSSARY

Listed below are some of the terms and abbreviations used in this manual that may be helpful to the reader. It is possible that some have been overlooked and that more will be added in the Second Edition of the manual. This is to say the list is not complete and the reader may find it desirable to add to it.

Binary-coded decimal - A decimal digit made up of four binary bits either 0 or 1 (i.e., 1001 is the decimal digit 9).

Blank Tape - Magnetic tape which has not been written on. Blank tape is the result of editing Magnetic Tape.

Bootstrap - A program card deck is punched so that each card contains a Read Command and each card will, therefore, read into the Data Processor the information contained in the card following it.

Buffer - A small capacity memory in either the Input or Output Unit of the CARDATRON Subsystem which stores information during read-in as in the case of the Input Unit or during print-out or punch-out through the Output Unit.

C1 - 6 - The decade positions of the C Register located on the TCU Control Panel.

Chad - Punched out paper accumulated during the punching operation on the Paper Tape Punch.

Control Block - Sign digit of the keyword is a 7 and the control word is the last word of the Control Block. This word is used for transfer of control under certain conditions.

CW - Card Write.

Decade - Four binary bit positions required to make up a decimal digit. These decades are displayed on the various control panels of the System.

DPU - Digit Pickup hubs on a 407 plugboard.

Editing - The order in which information is transferred from the CARDATRON Input Unit to the Data Processor or from the Data Processor to the CARDATRON Output Unit. In Magnetic Tape it is the erasing of information during the edit cycle.

FC - Forbidden Combination.

Flaws - Defects in Magnetic Tape which are detected during the Edit cycle and flaw markers are written so that these flaws will be by-passed during tape operation.

Flip Flop - An electrical circuit with two possible settings 0 or 1. Many times referred to as a toggle.

Floatable tension - Vertical movement of the brake on the Photoreader which allows paper tape of a thickness slightly greater than normal to pass under the brake.

Floating in a program - Reading a program into memory locations determined at the time of read-in. The program was not programmed to occupy any fixed memory locations.

FLO-CHT. LOC. - Flow Chart Locations.

Flux Changes - Magnetized spots on Magnetic Tape.

Format - The digits on the Format Band used in editing.

Format Band - A track on the buffer drum of the Input or Output Unit of the CARDATRON Subsystem. The digits on this track edit the information on the information tracks of the buffer.

Format Select - A punch in a card selects the format on one of the six format bands to be used for editing.

iiii - Irrelevant digit positions in a 220 instruction.

Interlaced Tracks - Tracks on Magnetic Tape. Magnetic Tape has two lanes and all the tracks of the two lanes are interlaced with each other.

IPU - Immediate Pickup hubs on a 407 plugboard.

Keyword - First word of a block and in many instances will contain the block address of the block or the search key during a Magnetic Tape search operation.

kk - Number of words contained in a particular block on Magnetic Tape.

Magnetic Beginning-of-Word Marker - Flux change in all tracks of one lane on Magnetic Tape except the Parity track. This marker is at the beginning of each word on tape.

Magnetic Beginning-of-Tape - Flux changes in all information tracks at the beginning of tape recorded during the edit cycle.

Magnetic End-of-Tape - Flux changes in only the parity track at the end of tape. These flux changes are recorded during the editing cycle.

Magnetic End-of-Tape Block - Contains one word of information and 159 erase codes. This word will cause transfer of control under certain conditions.

MLR - Multiple Line Read.

Parity - A flux change in the parity track of Magnetic Tape. This flux change is recorded whenever there is an odd number of flux changes in the four numeric tracks of the tape.

Patch Cards - Cards which are inserted in a program deck as corrections to the program.

Preface - An eight digit word which precedes each block on Magnetic Tape and contains the number of words within that block.

PTW - Paper Tape Write.

PZT - Paper Tape Zone Toggle.

rC:aa - Digit position of the C Register on the Control Console (i.e., rC:04 is four digit positions to the left from and including digit position 0.)

Read Brushes - A series of brushes in the Card Handling Equipment which senses the punches in a card.

RWL - Reload Lockout.

Sandwich Tape - Two-ply Magnetic Tape.

Search Key - A word located in the first word of a block which is used to locate a certain block during a search operation.

S/L Positions - Digit positions of a word which represent a portion or field of the word. S is the first digit of the field and L is the number of digits to the left and including the first digit.

SPO - Supervisory Printer Print-out.

Sprocket Holes - Small holes slightly off center in paper tape. These holes are produced by depressing the Tape Feed Lever on the Paper Tape Punch.

Tab Select Relays - Hubs on a 407 plugboard that may be wired to permit a variation of spacing during printing.

TCU - Magnetic Tape Control Unit.

TSU - Magnetic Tape Storage Unit.

XPU - Hubs on a 407 plugboard which allows 11 and 12 punches in a card to be accepted by the printer.