OPERATING
MANUAL

SERIES II CNC

Bridgeport. TEXTRON

Bridgeport Machines Division of Textron Inc

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

The Series II CNC

iv

SECTION I

SERIES II CNC DESCRIPTION

1.1 MACHINE

The Series II CNC is a specially designed Bridgeport knee type Vertical
Milling Machine to enable its full dedication to the needs of Numerical
Control. It has special dual knee locks to bind the knee (Manually
adjusted) to the column. The Knee has additional way area at the top
to carry the extended deep saddle, and the table is designed for a
Numerical Control machine tool. The machine ways are square and chrome
plated for long life, and an automatic one-shot lubrication system is pro-
vided. The ballscrew X and Y axis drives are suspended clear of the
operator's working area and in such a way that they do not cause any
bending moment on the table. The modified (2J) head is rated with 2 HP
motor and includes the Z axis drive arrangement through the rotation of
the nut in a preloaded assembly. This ballscrew axis is concentric with
the quill and, therefore, concentric with the axis of rotation of the spindle
to give precise and repeatable control.

1.2 CNC CONTROL

The Bridgeport CNC incorporates micro-computer hardware and
Bridgeport Operating System Software (BOSS) to provide the user with
not only those features found in conventional hard wired NC controls,
but also an extremely powerful set of extended functions.

Features of the CNC system also found in conventional controls are:

> 3 Axis Continuous Path Contouring
>
> 2 Axis Circular Interpolation in switchable planes
>
> Word Address Variable Block Format to EIA RS 274C
>
> > Reference:
> > N5G2X+34Y+34Z+34I 34J 34K 34F 21T 2M2
>
> > Absolute/Incremental Data Input

Plus or Minus Programming. Zero reference may be at any point.

Controlled Feedrate programmed directly in IPM at Constant Vector Velocity.

Manual Feedrate override 1-120% infinitely variable.

Acceleration/Deceleration Override.

Canned Z Axis cycles (8) including a deep hole drilling peck cycle and a chip breaking cycle.

Feed hold and restart without loss of position.

Full Jog Control of any axis in any direction at 120 ipm.

Jog Increment Control in steps of 1.0, .1, .01, .0005.

Programmable Mirror Image Capability.

Block (/) Delete.

Optional Stop (M01).

Tool Length Offset (24 values).

Simplified Operating Controls including a 3 digit readout display of sequence number, feedrate, spindle speed, tool number. Also a 5 digit readout for absolute XYZ position, stored tool length offset value, and reference tool diameter.

Status lamps to indicate control mode and operating conditions.

Manual Data Input: A manual data input keyboard enables entering N/T, G, X/I, Y/J, Z,F,M data in part program format. In addition, an MDI store capability is included which enables the operator to repeat the program entered via the keyboard. The MDI feature also includes the ability to enter tool length offsets via the keyboard, to search the part program for a designated sequence number and to enter XYZ linear information or circular interpolation data in the XY plane. The MDI keyboard has the additional purpose of controlling the display of data on 3 digit and 5 digit displays.

Auxiliary Control Group: All program stop codes will automatically stop the spindle and illuminate a green light. A coolant receptacle is provided for the flood coolant system: power to this receptacle is turned on and off with the spindle ON/OFF. A dual receptacle is also provided for machine lights.

Spindle Speed Changer and Automatic Spindle Brake:
This is a power operated pushbutton controlled device
for increasing or decreasing the spindle speed. The
spindle brake will be applied automatically when power
to the spindle is removed. Full interlock of both devices
is provided.

Standard Extended features of the CNC Control with BOSS 6.0 include:

Part Program Store. A part program equivalent of
approximately 80 feet of paper tape can be stored by the
system. The Data Input Device is required only for part
program loading.

Macro Subroutine. Up to 36 subroutines can be defined,
each having variables that can be modified in the sub-
routine call statement.

Repetitive Subprogram Capability through the use of
looping techniques.

On Line Part Program Editing. A powerful part program
Editor residing in the micro-computer memory enables text
input, manipulation and modification via a local data input
device such as a teleprinter, CRT, etc. (The data input
device is not provided. A 20ma serial line interface is pro-
vided in the control to handle the device.) It is also
possible to execute a data block from the terminal device.

Special Canned Cycles. Three special canned cycles are
provided, one for face milling, another for pocket milling,
and a third for milling an internal bore.

Inch/Metric Programming. The normal "power ON" state
is inch output from stored data in inch dimensions (G70).
The modal preparatory function G71 will denote that the
system is to output metric data from metric stored data.

RS-232 Compatible Interface. This is a voltage dependent
device that has limited transmission distance. Cables up
to 25 ft. long are available and modifications to the control
are included.

Multi-Quadrant Circular Interpolation. G75 is a modal com-
mand in which the I, J interpolation parameters become the
absolute coordinates of the circle center. Any arc of up
to 360 degrees can be programmed in a single block.
Cancel with G74.

Cutter Diameter Compensation. A new tool path, at all times
equidistant from the programmed path, will be generated after
invoking the G41 or G42 code. The distance that the path is

separated from that programmed is the compensation dimension defined as half the difference between the actual tool diameter and the programmed tool diameter. The full diameter difference is the value input to the system either through the MDI Keyboard or embedded in the program.

Polar Coordinate Commands. The radius vector distance (R) and the angle it makes (A) with the polar axis will define any point relative to the pole. The pole is defined in absolute coordinates by its I and J distance from absolute zero. Positioning for Z axis cycles or milling around an arc can thus be generated. Milling an arc with increasing or decreasing Z depth (The Helix) can also be programmed by means of looping.

Cutter Path Transformation. The entire cutter path, and thus a part shape with symmetry, can be rotated through an angle (A) degrees. The initial angle may be preset (G92) and the programmed shape rotated an absolute number of degrees or in conjunction with looping techniques, rotated an incremental amount each time the program is looped. G73 with the (A) angle will turn transformation ON, G72 turns it OFF.

The cutter path can be transformed by increasing or decreasing its magnitude (Scaling) relative to its programmed dimensions. G73 followed by X (scale factor), and Y (scale factor) is permitted.

> NOTE: Although a micro computer is used with the control to make all these functions possible, what the operator sees is a simplified set of control switches and pushbuttons that enable him to set up the machine, run programs and recover from programming errors and tool breakages. The Bridgeport Operating System Software is embedded in non-volatile, read only memory. It takes control of the system as soon as power is applied and then executes an in-built diagnostic routine.

1.3 OPTIONAL EQUIPMENT

Tape Reader Input. A paper tape reader interface and real time control software is available. The software enables the tape reader to automatically overwrite a designated section of the program store while retaining a protected area for subroutine definition. The tape reader itself may be made portable and an adapter panel in the machine control will accept information from the cable attached to the tape reader.

Maintenance Diagnostic Routines. An on line debugging micro program enables examining all system registers via the local data input device. The diagnostic option includes the following set of tapes.

Micro computer instruction set test
Micro computer random access memory test
BOSS read only memory test
Control I/O communication test
Control functional performance tests

SECTION II

OPERATOR'S CONTROLS AND INDICATORS

2.1   MACHINE CONTROL EQUIPMENT (Figure 2-1)

The component breakdown of the Bridgeport CNC control is as follows:

Logic Control Cabinet

Contains the micro computer control and interface logic, logic power supply, axis drive power supplies and photo-electric tape reader (optional).

Power Control Cabinet

Mounted on the rear of the machine column. Contains fusible disconnect switches, control transformers and part of the Auxiliary Control Group.

Spindle Control Panel

Contains the spindle control electrics and emergency STOP button, and Spindle Stop lamp (part of the optional Auxiliary Control Group).

Operator's Main Control Panel

Contains controls for machine setup, automatic operation and Manual Data Input (MDI).

Special Operations Panel

Located in the Logic Control Cabinet, these controls are infrequently used and are intended for specific special operations.
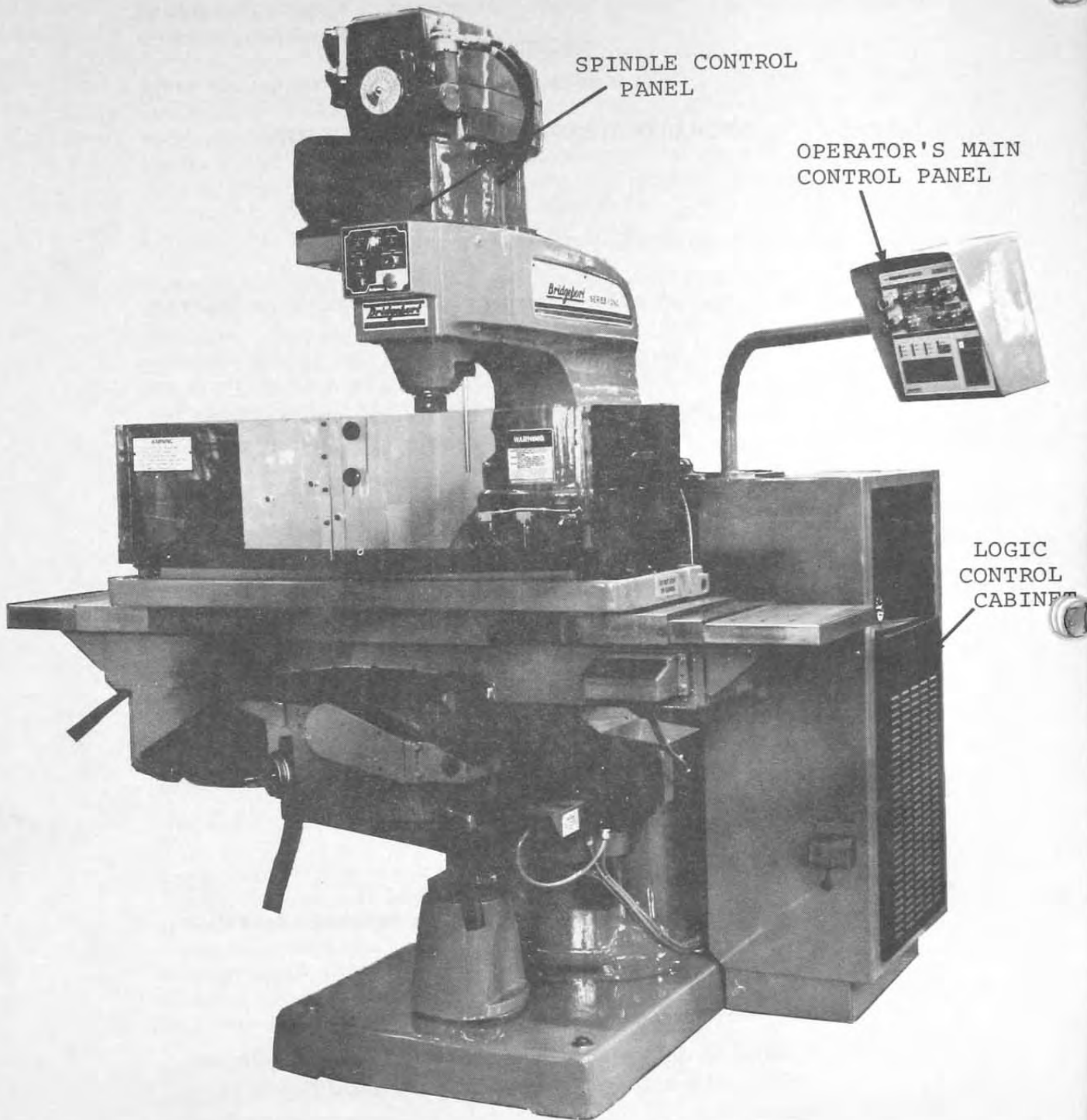
Figure 2-1. Machine Control Equipment

2.2   OPERATOR'S MAIN CONTROL PANEL (Figure 2-2)

The following description outlines the function of each of the controls available to the operator.

MODE SWITCH:

MDI STORE/MDI/AUTO/BLOCK/SET-UP

SET UP   enables the use of the AXIS MOTION setup
            controls and the ABS/TLO register controls.
            Also used to LOAD paper tape data (see
            paragraph 4.2) and to enable the EDIT
            feature.

AUTO   This enables fully automatic, continuous
            execution of the part program.

BLOCK   This permits part program execution, one
            instruction block at a time.

MDI   This enables using the MDI keyboard
            to enter and execute a block of part
            program data.

MDI STORE   This enables using the MDI keyboard
            as above. In addition, the operator
            can store the part program block and
            build up a part program from successive
            blocks for later re-use. For special in-
            struction see paragraph 4.1.4.

FUNCTION SWITCH:

There are two selector pushbutton switches, each with two positions which
are used to execute information. The following chart summarizes the
operation of the selector switches in normal operation when the FUNCTION
pushbutton is depressed.

TOP SWITCH

RESTART   This resets various system registers and
            flags. It is used to ensure that the system is
            ready to start execution from the beginning of
            the part program.

Figure 2-2. Operator's Main Control Panel

START   Program execution will begin if at the beginning
CONTINUE   of a program or resume after an interruption
             such as program stop (MO, M1), tool change
             (M6) or a system HOLD.

BOTTOM SWITCH

EDIT   This will transfer control to the system
             EDITOR (must be in SET UP mode).

NOTE: The EDITOR requires the use of a local data input device.

RDI   This will transfer control to a remote data link
             if the system is configured for this option
             (must be in SET-UP).

AXIS MOTION SWITCHES:

JOG/1/.1/.01/STEP
This 5 position selector switch allows the operator to control the increment
of motion of a selected axis in the SETUP mode in rapid traverse.

X/Y/Z
This 3 position selector switch controls the axis selected for JOG.
Move +/-
A 2 position selector pushbutton enabling the execution of a specific direction
of JOG motion.

ABS/TLO SWITCHES:

ZERO/GOTO/TNO/STORE/GET.
This is a five position selector switch which is effective only in SETUP mode
of operation and is used in conjunction with XY/T1//Z/TNO selector push-
button.

The following chart summarizes the operation of both this selector push-
button and the ABS/TLO selector switch.

	XY/T1	Z/TNO
ZERO	Zeroes the XY ABS registers.	Retracts the quill to the "home" position, then zeroes the ZABS register.

GOTO   Moves the XY axes to the
           X0Y0 position.

If the quill is "home", moves the quill down the distance that had been stored as a TLO. At this down point ZABS=0.

TNO   Sets the tool number = 1.

STORE

Stores the current contents of the ZABS register as a tool length offset.

GET

Fetches the value stored as a tool length offset and sets the ZABS register to that value.

Key to Short Form Used Here and On the Panel

ABS	=	Absolute
LED	=	Light Emitting Diode
MDI	=	Manual Data Input
QU	=	Quill Up
REW	=	Rewind
RDI	=	Remote Data Input
SU	=	Set Up
TLO	=	Tool Length Offset

HOLD

This is a momentary pushbutton which ends the part program execute mode and acts to interrupt axis motion without loss of position. The slides will decelerate to a smooth stop.

> NOTE: In RAPID traverse, motion may continue up to .2 inches after the HOLD button is depressed.

The unused portion of the block of data is not lost. To continue depress START/CONTINUE.

LIMIT OVERRIDE

This is a lighted pushbutton which is used to indicate power interruption, emergency stop or that a travel limit switch has been tripped. The axis limit switch will clear the system (see CLEAR special function). When power is first turned ON this light will be illuminated indicating that there

is no power to the axis drive system. Depressing this pushbutton enables the use of the jog controls by restoring power to the axis drive.

FEEDRATE OVERRIDE

This is a variable potentiometer which adjusts the programmed feedrate value from 1 to 120%.

2.3   STATUS

2.3.1   Status Indicators

A bank of LED's in the front panel indicate the internal set status of the control. The following conditions are inferred by the lamps being ON:

RUN: Operational status ready for any input or part program ready to be executed.

GOTO: Information in the active storage (arithmetic) registers.

HOLD: A condition in which the output of data to the drive systems is temporarily stopped pending the removal of the hold flag. This may have been imposed by manual operation of the HOLD button or by automatic means (spindle interlock).

WAIT: This is a special case of a HOLD in which the computer has been taught to WAIT for an external event, e.g. a switch closure. When the event takes place, the WAIT is lifted, e.g. M6 and waiting for the quill up switch.

ERR: Error found in the start-up diagnostic test.

TOOL: This lamp responds to the M6 tool change instruction in the program.

CYCLE: A G81-89 cycle is in process.

ABS: The system is in the ABS mode (G90).

METRIC: The system is in the METRIC mode (G71).

EDIT: The system is in the EDIT mode.

RDI: The system is in the RDI mode. (Factory Test only)

Bridgeport TEXTRON   2-7
Bridgeport Machines Division of Textron Inc.

Code No. 1040401
AUG. 81 Rev. 1

2.3.2   Displays

There are two display windows:

A 3 digit unit is for Sequence Number (last 3 digits only), Feed-rate, Spindle Speed (not controlled but only for operator information - dropping the last digit) or Tool Number.

There is a 5 digit display for XYZ absolute coordinates, for Tool Length Offset and for display of Tool Diameter information for the operator. The lamp after the thousandths (.000) digit represents data having a value between .0005 and .0009 when the lamp is on.

The display of these functions is controlled by the MDI Keyboard where the numerals have the additional duty of controlling which functions are to be displayed. Note that without the MDI option this display system will show Sequence Number and X absolute coordinates only.

When entering data in the MDI mode by depressing a letter key, the 5-digit display becomes blank and subsequence numerals entered by key operation are displayed starting from the right and shifted to the left. Another letter entry will cause the previous word to be stored and the display to become blank once again.

2.4   MDI KEYBOARD (Figure 2-3)

This is a 20 button keyboard that enables entering N,G,X,Y,Z,F,M data in part program format. The BLACK key marks EOB (end of block), execute data. The CE key will erase an incorrectly input numeric character. The following different duties are performed by this multipurpose keyboard:

a. In the SETUP mode three keys have additional labeling (T, TLO, DIA) in a green field. These are used for entering tool number, tool length offset and tool diameter (ref.). Data is entered thus: T (data) TLO (data) DIA (data) followed by the black key (EOB).

b. In the MDI mode all keys as labeled in their center are effective. Data should be entered in normal programming order: N,G,X,Y,Z,F,M (EOB) but functions may be omitted to yield a variable block format.

The letter addresses I and J are available for circular interpolation. These words are entered by a second operation of the X and Y keys respectively.

c. In the MDI STORE mode, the MDI block entered by (EOB) is automatically stored and executed. If the operator wishes to delete the block from the stored program, he should depress CE before entering the next MDI STORE data block.

d. SEARCH: In the AUTO mode, depressing the N key followed by up to 5 digits, then the black key will cause an automatic rewind of stored data, clear active registers and forward search for the keyed-in sequence number. The search will stop at the end of the last block before the sought sequence number. The status lamps will flicker during this process.

e. In SETUP, in MDI, MDI STORE, and AUTO the display panel data selection is controlled by this keyboard. Each of the numeric keys only has an additional label above that key. For example: depressing the key 4 (T) then the key 8 (TLO) will cause the tool number to be displayed in the 3 digit display and its TLO in the 5 digit display. Lamps in the display windows signify the data being displayed.
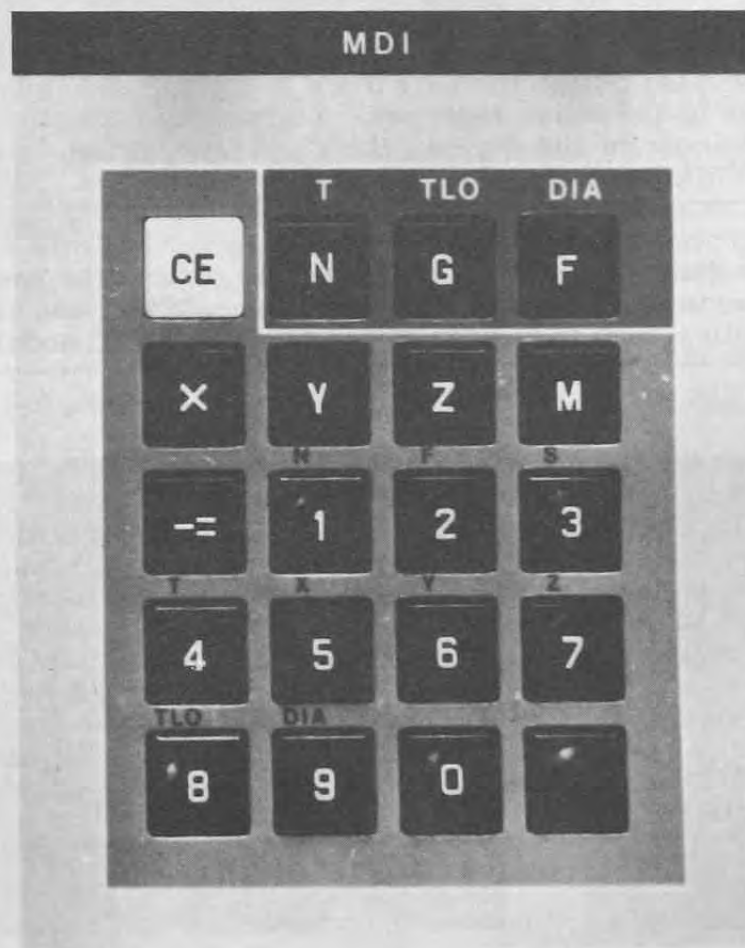

Figure 2-3. MDI Keyboard

2.5   SPINDLE CONTROL PANEL (Figure 2-4)

<u>SPINDLE HI RANGE/OFF/LO RANGE</u>

This is a 3 position selector switch which is used to turn the spindle motor ON and select the direction of spindle rotation (in conjunction with the gear selector lever). With the spindle selector switch on HI and the gear selector lever in HI or with the spindle selector switch on LO and the gear selector lever in LO, spindle direction will be clockwise. Any other combination of spindle selector and gear selector settings will cause counter-clockwise rotation.

The spindle selector switch is electromagnetically held in by system power. If power fails during operation of the machine, program execution will terminate as well as spindle rotation.

The auto lube pump for the slides is connected through the spindle selector switch. If the spindle is not on, the auto lube pump is disconnected.

NOTE:	The spindle selector switch is interlocked with the control. If the spindle is not on and the part program contains a block of data with a feedrate motion, system operation will be interrupted before the data block is transferred from the buffer to the active registers. To resume operation, turn the spindle on and depress the FUNCTION switch in the CONTINUE position.
CAUTION:	If the spindle selector switch is turned off with a feedrate motion in process, the system will assume the power fail mode, operation will terminate immediately, and the system will return to the top of the file (RESTART mode).

<u>EMERGENCY</u>

This is a momentary mushroom head pushbutton switch. When depressed, this switch will de-energize the spindle motor electrics, and set the system in the RESTART mode, thus causing the axis drives if moving to come to an abrupt stop. The red limit lamp will be illuminated.

NOTE:	Since EMERGENCY stop results in a non-recoverable condition (the control will lose XY slide position data if the XY slides were moving), it should not be used except for a true, "bail-out" emergency. In normal use, the HOLD pushbutton should be used to interrupt action. The part program and TLO's are not lost when the EMERGENCY stop button is depressed.

(SN 7000-7124)

(SN 7125 and Up)

Figure 2-4. Spindle Control Panels
Shown with Spindle Off Lamp (Part of Auxiliary Control Group)
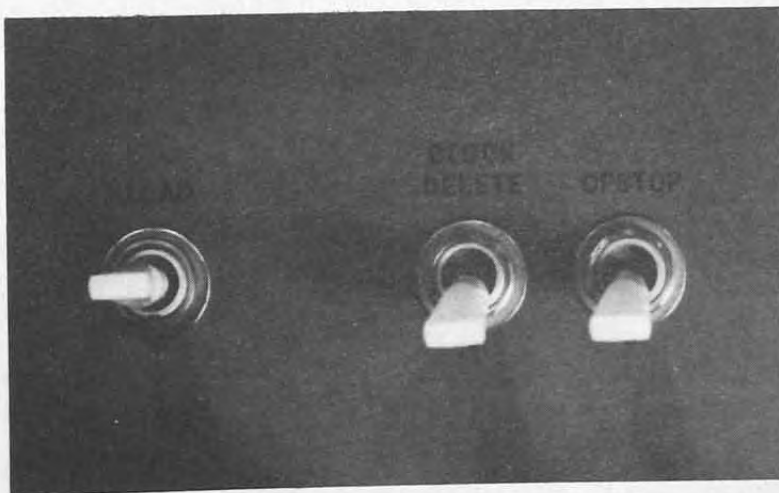

Figure 2-5. Special Operations Panel

SPINDLE STOP (lamp) part of Auxiliary Control Group.

This is a green lamp and will be illuminated by the system after executing any of the program stop commands (M0, M1, M2, M6). When the lamp is on it signifies that the spindle has been stopped by the system despite the fact that the drum switch is showing SPINDLE/ON. This is, however, a safe condition since the spindle cannot be turned on again until the drum switch is reset by switching SPINDLE/OFF and then switching to SPINDLE/ON.

2.6   SPECIAL OPERATIONS PANEL (Figure 2-5)

The following switches are located in the top lefthand side of the logic control cabinet.

RESET/CLEAR. RESET will re-boot the entire control and destroy all program text that may have been stored. It will also zero the XYZ ABS registers and TLO registers.

CLEAR. Clears the contents of the active and buffer system registers, however it does not clear the X, Y, Z absolute registers, the tool length offset registers, nor the part program storage.

Besides depressing the CLEAR switch, two other conditions will cause the system to CLEAR: The AXIS LIMIT SWITCH, and the EMERGENCY stop switch.

LOAD. If the system is in the SETUP mode, lifting this switch will cause the program tape to be read into storage. If a new tape is to be loaded (replacing a previously stored program), actuate the CLEAR switch before operating the LOAD switch. If a program is to be added after a previously stored program, only operate the LOAD switch.

XSYMM. YSYMM.

The symmetry feature acts to reverse the direction of motions commanded on an axis, e.g. +X motions become negative and vice versa. The effect on the finished part is as if its shape had been reflected in a mirror perpendicular to the reversed axis. Right and left handed versions of the part can thus be made from the same part program.

Since these functions are programmable, switches are not made available. The function, however, can be input or cancelled by MDI when on the axis of

symmetry. The following codes are used:

> G31   Reverses programmed direction of the X axis
> G32   Reverses programmed direction of the Y axis
> G30   Cancels all axes that were mirror imaged

The XY absolute display will show the correct values on the axis of symmetry only.

OP STOP ON/OFF

A two-position toggle switch available to the operator to select whether the M01 code in the program text is to be recognized (ON or toggle UP) or by-passed (OFF or toggle down).

BLOCK DELETE ON/OFF

A two-position toggle switch which will delete all data from the SLASH to the End of Block character when the switch is in the ON position (toggle up).

2.7   AUXILIARY CONTROL GROUP (Figure 2-6)

This assembly has three separate capabilities:

a. The green lamp (Figure 2-4) and its illumination under SPINDLE STOP data (M0, M1, M2, M6) has been described in paragraph 2-5.

b. A receptacle powered 115/1/60 and fused 4a is provided on the side of the power control cabinet as shown in Figure 2-6. It is a receptacle to drive the flood coolant pump or the mist coolant solenoid (fuse should be changed to 1a). Power is turned ON to this receptacle every time the spindle motor is started and turned OFF when the spindle motor is turned OFF. A selector switch (Figure 2-6) is also provided.

c. A dual 115/1/60 receptacle is provided and fused for standard machine lights.

2.8   SPEED CHANGER AND BRAKE

2.8.1   Speed Changer

This will not operate unless the spindle motor power has been turned ON (Figure 2-4). With the spindle rotating, select INCREASE or DECREASE to increase or decrease spindle speed, depress the operating pushbutton, and release when the desired speed has been reached. Since this is an air-turbine operating system from a pneumatic solenoid valve, make sure the shop air supply is set at approximately 80 psi and that the filter-lubricator system is working properly.

2.8.2   Spindle Brake

This is electro-pneumatically operated also and ports air to a cylinder which works through linkage to apply the mechanical spindle brake. In the AUTO position, the brake will be applied when the spindle power is shut OFF and will automatically release when the spindle power is turned ON (Figure 2-4). Selection of the OFF position permits the brake to be released for checking or set-up operations such as swinging an indicator.

2.9   TAPE READER (Option)

This equipment may be installed (Figure 2-8) or it may be a portable unit (Figure 2-9) which can be transported from one machine to the next as the need arises. In that case, the machine is equipped with an adapter panel (Figure 2-9) to enable operation of the tape reader.

    a. Connect the data cable

    b. Plug in the power cable to its receptacle

    c. Turn power ON

    d. Operate the tape reader normally as though it were built
        into the control

The tape reader is a high speed device for the fast loading of the program storage. It can also be used with long tapes when the program has been segmented into several lengths of approximately 80 feet of data.
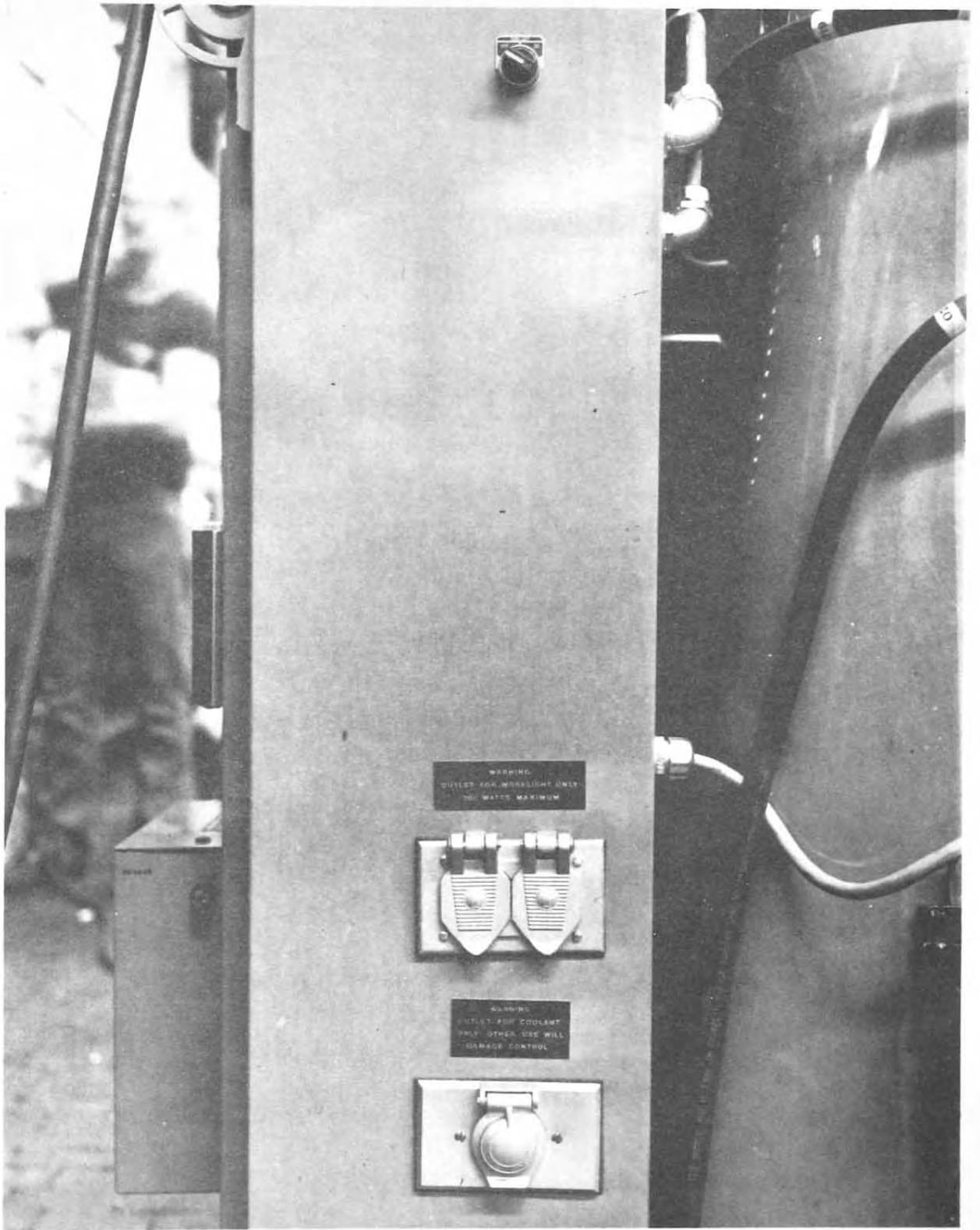
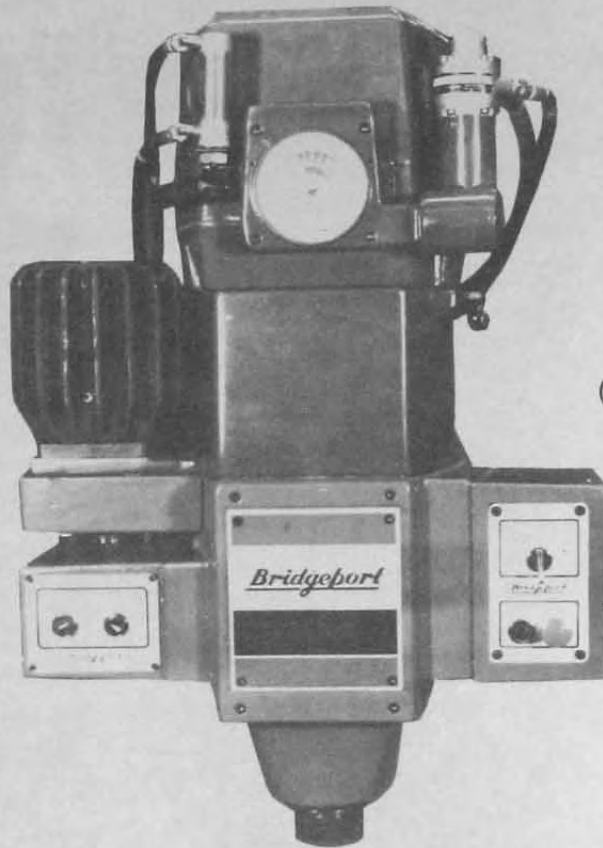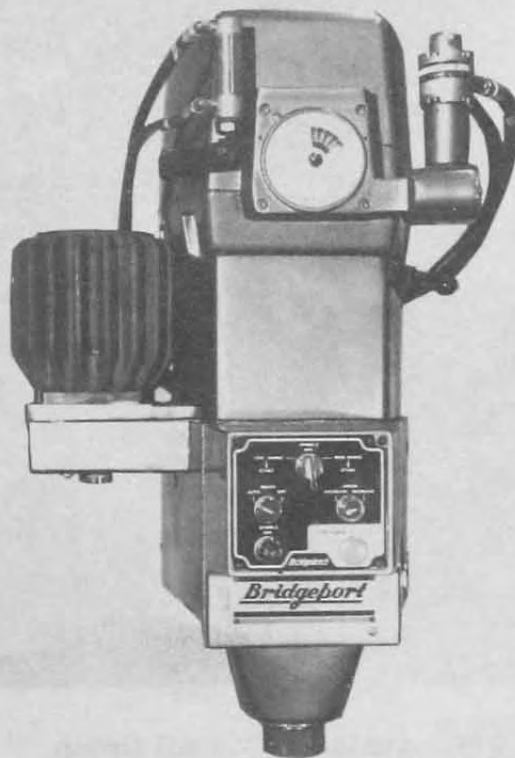Figure 2-6. Auxiliary Control Group

(SN 7000-7124)

(SN 7125 and Up)

Figure 2-7.   Speed Changer and Brake

Bridgeport **TEXTRON**
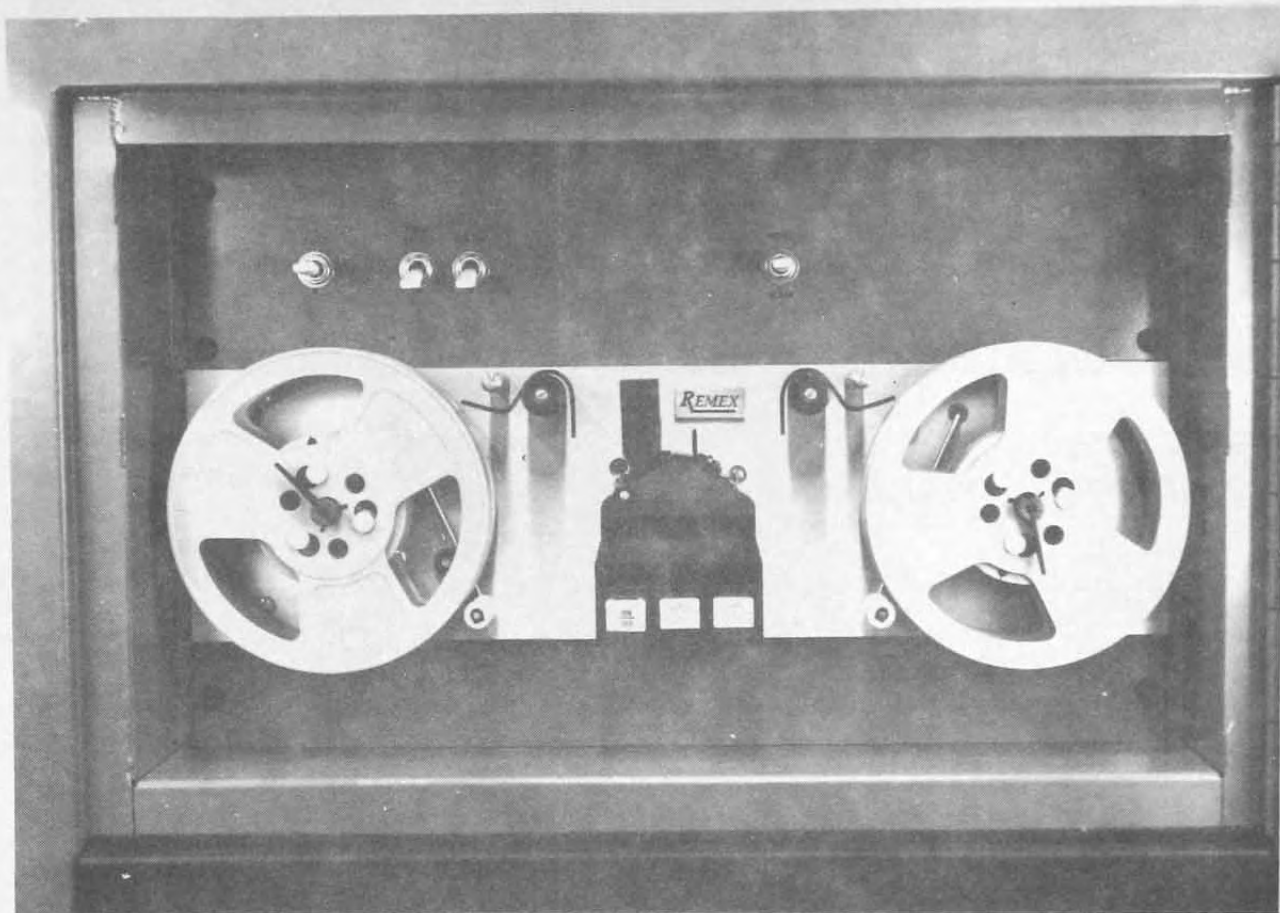Bridgeport Machines Division of Textron Inc.

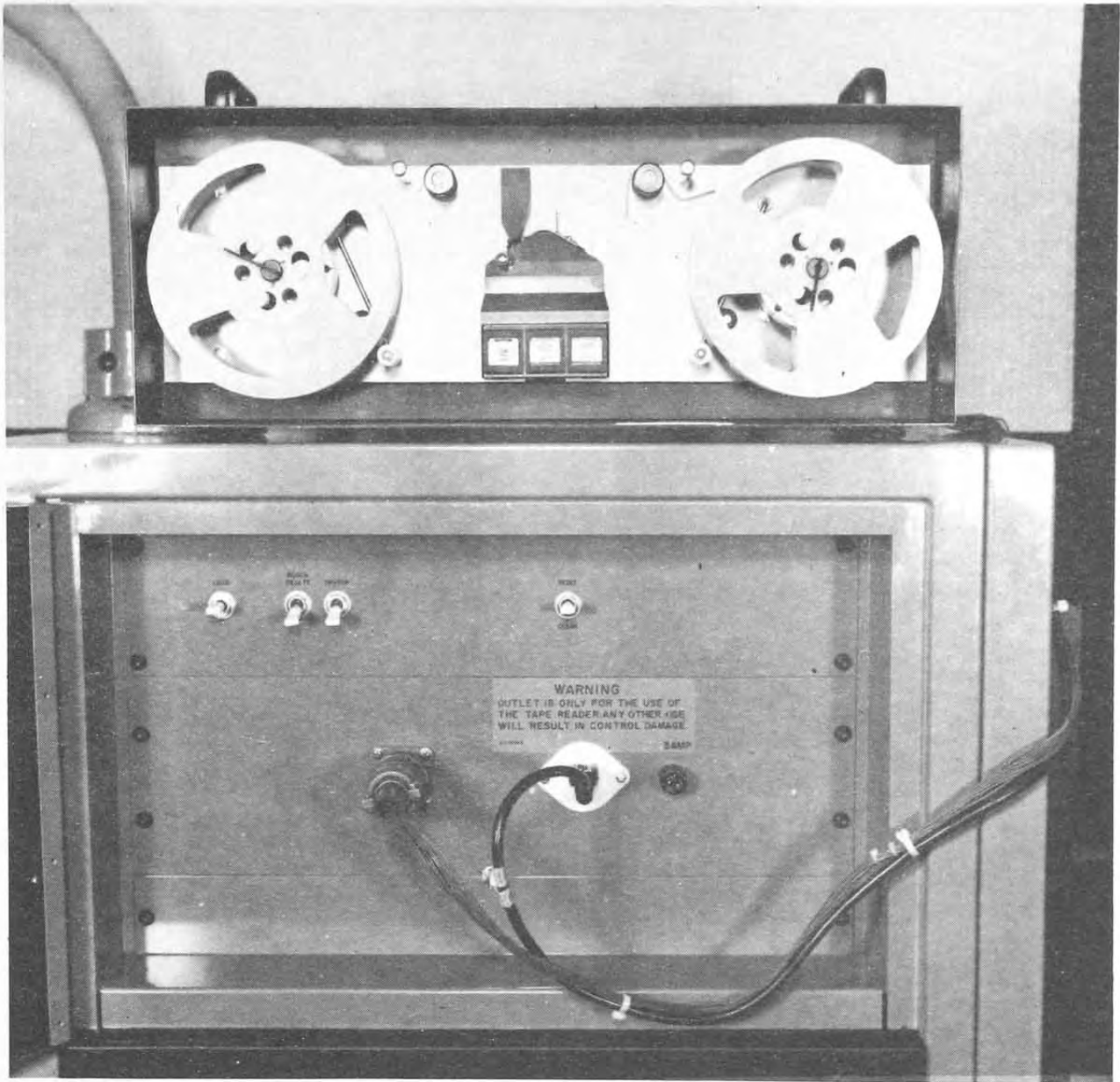Figure 2-8. Tape Reader Installed

Figure 2-9. Tape Reader Adapter Panel

SECTION III

OPERATION IN SETUP

3.1   INITIAL CONDITIONS AT POWER ON

Power is applied to the entire system by throwing the machine Disconnect Switch to the ON position. The switch is located on the Power Control Cabinet. When this occurs, the "red" travel limit light will go on, indicating that the limit detection electrics must be enabled before the system can be used. This is done by depressing the travel limit override pushbutton. With power on, BOSS (Bridgeport Operation System Software) will come up fully operational and with all registers cleared when the RESET switch located inside the console is actuated.

A self-test diagnostic routine is incorporated in the system with the object of checking all the bits in the BOSS to validate their operational status. This will be done automatically every time the system is booted up by depressing the RESET switch (total time approximately 5 seconds). If a component has failed, the ERR lamp on the front panel will be lit and the bank in which the component has failed will be indicated by number in the display (see M-141 Maintenance Manual). The routine will stop and no further operation is possible. If local data terminal is connected, depressing the P key will enable the user to check the rest of the BOSS for the possibility of errors.

Since all program text storage is volatile (i.e. lost when power was disconnected), it is necessary to reload the old program if more parts of the previous day's operation are to be manufactured. If the TLO's are not on the tape, it will also be necessary to reload the old tool length offset if the existing cutting tools are to be reused in the existing holders. If, however, power has been left ON, a review of subsequent paragraphs in the order in which they are presented will provide the operator with the quickest means of restoring production.

CAUTION: Since the lubrication system (Figure 3-1) is inoperative until the spindle is turned on, the operator is well advised to lift the plunger of the auto lube pump a few times before attempting to move the axis in JOG or by other means.

NOTE: If lubricating oil level is low, the spindle will not rotate when the switch is ON.
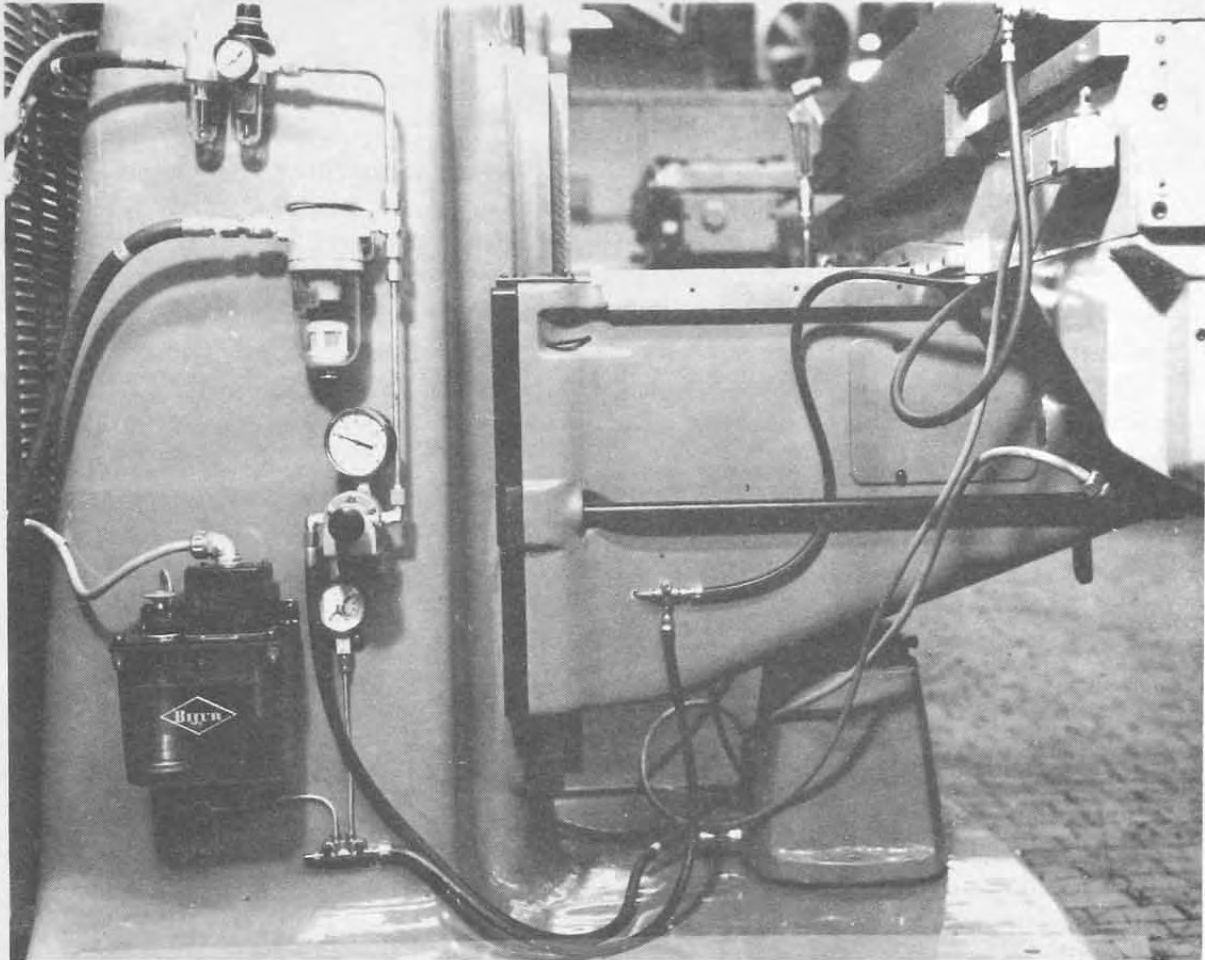
Figure 3-1.   Lubrication System

3.2   POSITIONING ALONG AN AXIS

In SETUP (See MODE, Figure 2-2)

1. Select the desired axis (X, Y, Z).

2. Select JOG, 1. , .1, .01, or STEP.

3. Select the desired direction (+ or -).

4. Depress the axis direction Pushbutton (Move Button). Each time the button is depressed, the axis will move 1. , .1, .01, or STEP as selected, or if in JOG, axis motion will continue until the pushbutton is released.

> NOTE: All pulses that go to the axis step motor drives enter the X, Y, Z axis absolute registers. After the axes are in position, the operator should rezero the registers (or preset them to their proper values). This method of jogging the axes to a position without the spindle turning is useful when using a dial indicator in the spindle, or when setting the slides to specific coordinates utilizing the digital axis displays on the control panel, or the mechanical counters on the machine.

Figure 3-2 shows the total travel envelope.

3.3   SETTING THE XY ABSOLUTE ZERO LOCATION

In SETUP (See MODE, Figure 2-2)

1. a. Using the AXIS MOTION Controls (See Paragraph 3.2), move the slides to the XY Zero point of the part coordinate system. An example of this method of setup might be indicating a bore diameter or boss on a part.

b. Set upper ABS/TLO Switch to ZERO.

c. Set lower Switch to XY/Tl position and depress.

This will set the XY absolute registers to ZERO.

To verify: On the MDI Keyboard, push "5" key (X), then the "6" key (Y). This will alternately display the absolute location of the X and Y axis. They should both display Zeros.

W = 13 3/16 IN MANUAL
ADJUSTMENT OF KNEE

Z = 5 IN.
QUILL TRAVEL

X = 30 IN.

Y = 15

TOTAL
OPENING

20 3/16 w/ERICKSON SPINDLE
20 9/16 w/UNIVER. SPINDLE
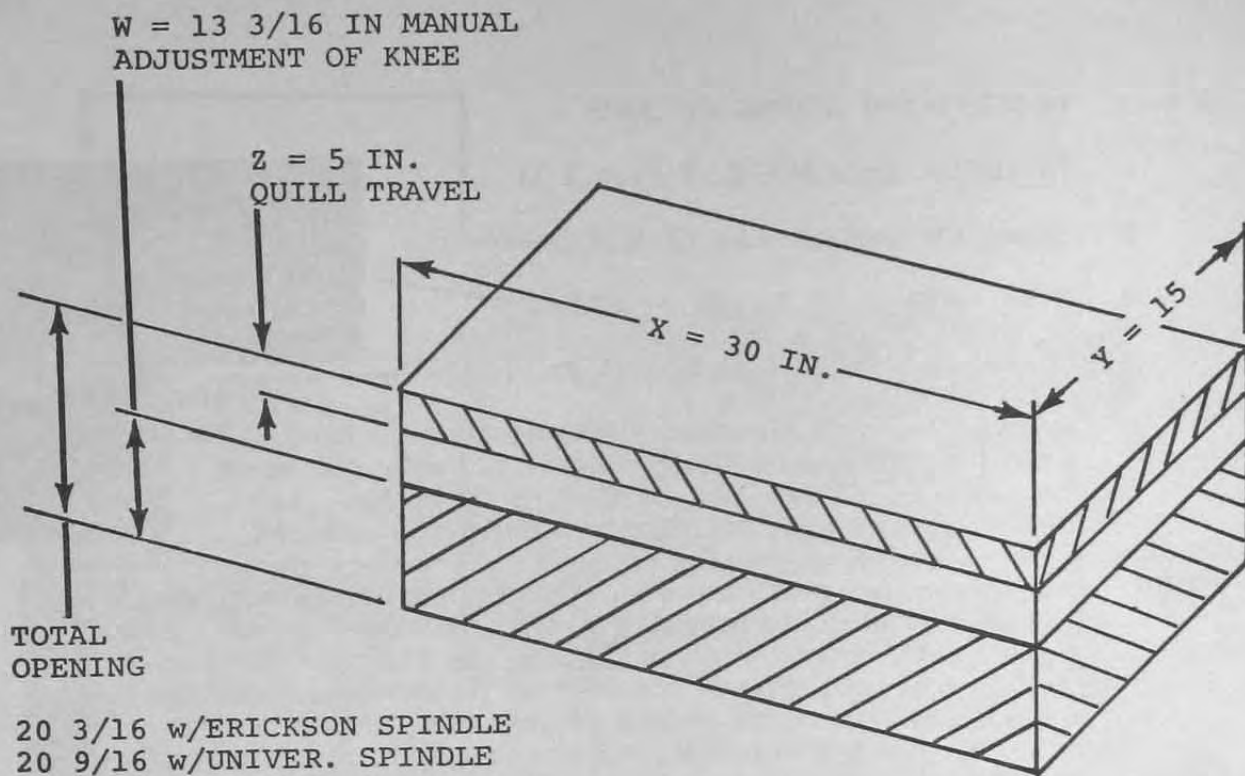
TOTAL MACHINE TRAVEL ENVELOPE

MECHANICAL DIGITAL
COUNTERS READ

X 15.00
Y 7.68

7 3/4

WORKING
SURFACE   15

X & Y MECHANICAL
DIGITAL COUNTERS
READ .0000

38

WORKING SURFACE

Figure 3-2.   Machine Coordinate System

2. If the setup point has a value other than X0, Y0, for example, if you are using an edgefinder or fixture locating hole, then the following method may be used for setting Zero.
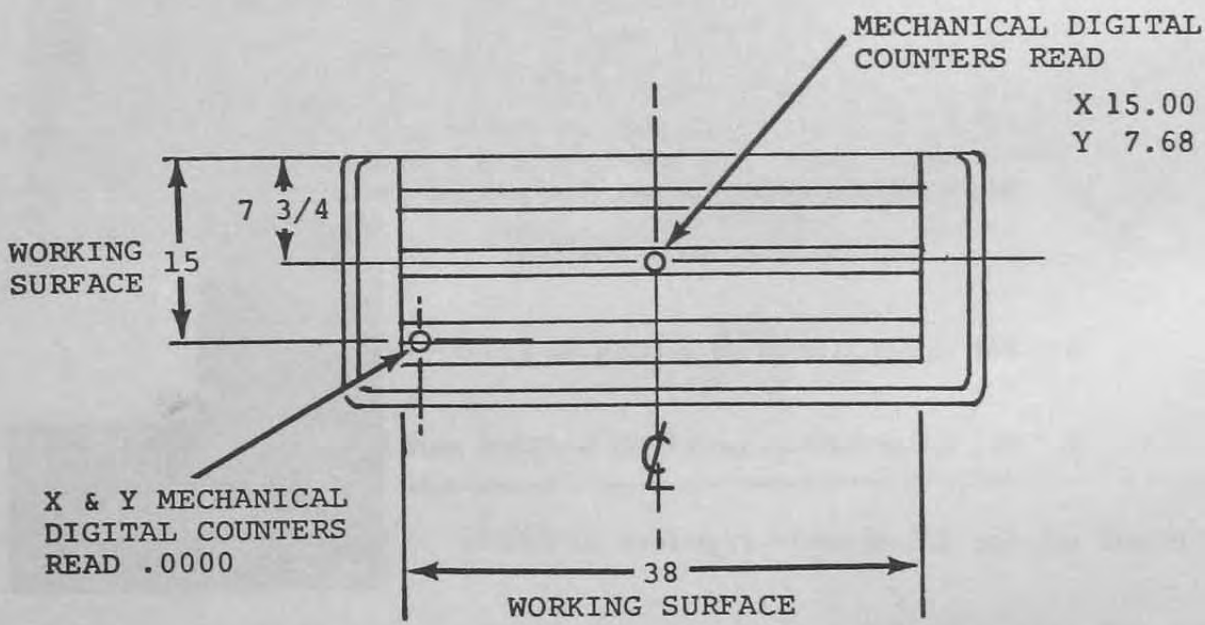
    a. Using the AXIS Motion Controls (See Paragraph 3.2), move the slides to the setup point.

    b. Set Mode switch to MDI position.

    c. Using MDI Keyboard, input G92 X(value), Y(value), then (EOB) black key. This will set the absolute Zero position, and the X,Y display will verify the current spindle location in reference to that absolute Zero.

3.4 TOOL LENGTH OFFSET

1. Tool Length Offset is a multi-functional device used to: Simplify "Z" axis programming; reduce tooling set-up procedures; and control minor discrepancies in depth for tight tolerance parts.

2. Tool Length Offset Value is the length from the tip of the tool, with the spindle in the home position, to the "Z" Zero plane; wherever it may be located by the programmer.

3. The Tool Length Offset Value is automatically specified with the coded tool select number (e.g. T 3), however, it is initiated only after the Control has read the M6 (Tool Change).

4. The tool length offset logic consists of a 24-position read/write memory into which data can be input or retrieved. This memory is volatile, i.e., the information it contains is destroyed when power is removed from the system.
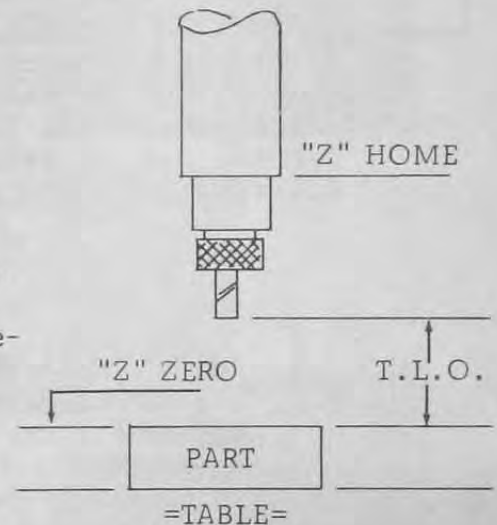
NOTE: The Z axis absolute register is set to the tool length offset value (always positive).

3.5 TOOL LENGTH OFFSET STORAGE

1. Machine POWER/ON and RESET: TLO values utilized by the machine are set to "Z" Zero and a value to be stored can be entered from any source.

2. TLO value stored from Program Entry: Only when the stored value of TLO is Zero, can a part program input value of TLO be entered and become effective in the machine. This

value of Zero is obtained by (a) above or by inputting a
value of "Z" Zero through the MDI panel in the SETUP
mode using "T" and "TLO" buttons.

3. <u>TLO value stored from Front Panel Entry</u>: In SETUP the TLO
value input will be stored and will be utilized by the machine
whether the existing stored value in zero or not.
Further, this value input in SETUP <u>will override</u> the value
input by any means except those embedded within a program.

3.5.1 Setting The Tool Length Offset

There are three methods of setting tool length offset as follows:

1. Utilizing the machine. (Sec. 3.5.1)
2. Inserting thru the MDI Keyboard. (Sec. 3.5.3)
3. Programming on a tape. (Sec. 3.5.4)

> Note: It is highly recommended that the longest tool be selected and
> a minimum TLO value of .5 inches be assigned by any of the
> above methods.

1. Utilizing the Machine
When using the machine, the longest tool's TLO should be
set first. (Sec. 3.5.3) The knee should then be positioned
for the job in relation to this tool at its TLO position.
All remaining TLO's may now be set by the following procedure:

Press y (T #)

a. Set the upper ABS/TLO switch on TNO;
set lower switch on Z/TNO position.
Depressing the lower switch will
increment the 3 digit tool number
display until the desired tool num-
ber is reached.

Store

b. Set the upper switch to Zero; leave
the lower switch on the Z/TNO position
and depress. This will retract the
quill to the "home" position and set
the "Z" absolute register to Zero.

c. Using the Axis Motion switches (Paragraph 3.2), move the
tool to the reference plane previously set when the knee was
cranked into position. (e.g. usually the top of the work
surface)

d. Set the upper selector switch to STORE, set lower switch to Z/TNO and depress. This will transfer the contents of the absolute register (which has tracked the quill from the uppermost home position to the reference surface) into TLO storage.

e. Set the upper selector switch to ZERO, set lower switch to Z/TNO and depress. This will drive the quill home.

To verify TLO value:

NOTE: Before the following procedure can be used, be sure: 1. Tool Number is correct (Refer to previous step a. if a change is required).
2. Quill must be in home position, refer to step e. above.

a. Set upper switch to GOTO and set lower switch to Z/TNO then depress. This will send the quill to the previously set TLO point. Recheck!

b. Set the upper selector switch to ZERO, set lower switch to Z/TNO and depress. This will drive the quill home.

Repeat steps a-e and verify for all remaining tools.

NOTE: GOTO will not work unless the quill is home when the lower Z/TNO pushbutton is depressed.

The values should be recorded for each tool after all tool length offsets have been set in the manner described.

3.5.2   Initiating Tool Length Offset

TLO may be initiated by the control in three modes of operation,
Set-up, MDI, or AUTO.

AUTO   In the AUTO or Block Mode, programming, e.g. T1M6, on
on tape, will first retrieve the offset value stored for the
tool number specified, and then set the Z absolute register
to that value (always positive).

MDI   Similarly, in the MDI Mode, entering e.g. T2M6 EOB
through the MDI keyboard will also initiate the TLO
for tool number two. (T is entered in MDI by second
operation of N key. See 4.1)

SET-UP   1.   In the Set-up Mode using ABS/TLO switches, set
upper switch on TNO and lower switch on Z/TNO. De-
press lower Z/TNO Button to increment the tool number
display to the desired tool number (See Sec. 3.5.5
items 1 and 2).

2. Next, set upper switch to GET, leave lower switch
in Z/TNO position and depress. This will "get" the
TLO value for the tool number selected, i.e. set the
absolute Z register to the TLO value.

3.5.3 Entering Tool Length Offset by the MDI Keyboard
(Reference Paragraphs 2.6 and 4.1)

NOTE: This method may be used only if the Tool Length Offset Values have been previously established. (Presetting, etc.)

    a. Set the mode select switch to SETUP.

    b. Depress the N key (T).

    c. Enter the tool number

    d. Depress the G key (TLO).

    e. Enter the tool length offset value.

    f. Depress the black key (EOB).

    g. Repeat steps a-f for all remaining tools.

NOTE: If very small adjustments in TLO are required for a particular tool to effect blending on a surface or due to previous error, complete the above procedure - Items (a) through (f). From the previous known TLO value, and the blending value required, the new TLO can easily be calculated.

3.5.4. Programming Tool Length Offset on Tape

Tool Length Offset values may be programmed at the beginning of the program text, or embedded within the program using the Tn/Z command coded in a part program.

For example:

    T1/1.505

    T2/1.673

    T4/1.379

CAUTION: TLO must be entered ONLY to the third decimal place, e.g. T14/0.4995 will be stored as 04.995.

For details, see programming manual under TOOL SELECT COMMANDS (M-139 Section 5.8).

3.5.5   Checking The Value of the Tool Length Offset Storage and/or the Cutter Diameter Compensation Storage Registers.

Using MDI Keyboard:

1. In any mode of operation (SETUP, MDI or AUTO), depress the 4 key (T) and the 8 key (TLO) on the MDI keyboard. This will cause a tool number to be displayed in the 3 digit display and the tool length offset value to be displayed in the 5 digit display. For diameter, depress the 4 key (T) and the 9 key (DIA).

2. Setting the desired tool number:

    a. In SETUP Mode:
    Set upper ABS/TLO switch in TNO position. Set lower switch in Z/TNO position. Depressing this lower switch will increment thru the 24 tool numbers and display their associated Tool Offset Value in the five digit display window.

    b. Also in the SETUP Mode, the MDI Keyboard may be used:

Operating the N(T) key followed by the tool number desired; then the EOB (black key).

3.6   TOOL DIAMETER REFERENCE

When cutter diameter compensation is not being utilized in any program, it is possible to use the following format to reference the particular tool diameters being used in a program.

This format is as follows:

        T1//.5
        T2//1.
        .
        .
        .
        .

CAUTION: Using this format as explained above can be extremely confusing to the operator, as it is the same method used for inputting the value of cutter diameter compensation. It is therefore highly recommended that specific instructions to the operator are included in the set-up procedure.

3.7 CUTTER DIAMETER COMPENSATION (BOSS 5 and BOSS 6 SYSTEMS)

Cutter Diameter Compensation has been defined as a displacement normal to the programmed cutter path. By its very title "Compensation" refers to a means whereby the operator allows for a difference between the nominal Cutter Diameter chosen by the programmer and the actual diameter of the end mill. It is then the purpose of the control to generate a new cutter path parallel to the old and perpendicular to the workpiece at all times.

Differences in cutter diameters are normally due to tool wear and/or a reground diameter, or due to other deviations found necessary as a normal part of production. The programmer assumes that the chosen cutter diameter, set length and other features of the geometry of the tool will be used. Tools must be to the programmer's specifications. Cutter Diameter Compensation becomes an aid in achieving and maintaining those tolerances on the finished part regardless of changes in the diameter of the tool actually being used. The programmer will allow for cutter diameter variations by special preparatory functions (G40/G41/G42) in the program text.

That portion of the Bridgeport Control containing Cutter Diameter Compensation fulfills the definition by computing new points for the tool ahead of the current tool motion. Such points generate new blocks of data internally within the control. This data is dependent upon the stored program text containing the preparatory functions and the use of stored values of Compensation.

3.7.1 Input Value of Cutter Diameter Compensation

The Compensation value to be entered is the algebraic difference:
ACTUAL CUTTER DIAMETER minus PROGRAMMED CUTTER DIAMETER.

E.G.

Programmed Cutter = 1/2 (.500) Dia. End Mill
Actual Cutter Used = .485 Dia. End Mill
The Compensation Value to be input would be:

```
 .485   Actual
-.500   Programmed
-.015   Dia. (Algebraic Difference)
```

Enter: -.015 as a Compensation Value.

An alternate way of remembering this signed value might be:

If the actual cutter used is smaller than that programmed, the input value is always negative.
Conversely, using a larger cutter than was programmed, will always produce a positive compensation value.
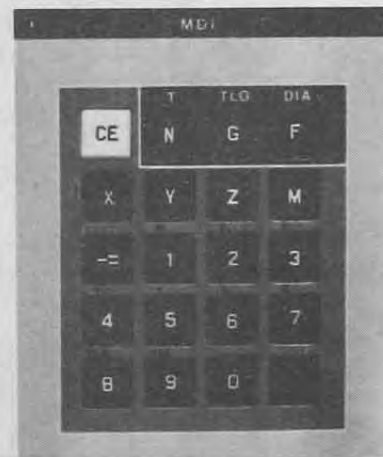
3.7.2 Cutter Diameter Compensation Storage

The tool diameter storage consists of a 24-position read/write memory into which data can be input or retrieved. This memory is volatile, i.e., the information it contains is destroyed when power is removed from the system. Operation is as follows:

    a. Machine POWER/ON and RESET: Diameter values are set to zero and a value to be stored can be entered from any source.

    b. Diameter value stored from Program Entry: Diameter values for various tool numbers may be coded in the program at the beginning of the text or they may be embedded in the program. If coded at the beginning, the value can be changed by MDI; however, if they are embedded in the program, and a change is required, it must be done through the EDITOR.

    c. Diameter value stored from Front Panel Entry: In SETUP the diameter value input will override any old value and become stored under all circumstances except when the diameter value is embedded in the coded part of the program text.

3.7.3 Using the MDI Keyboard to Enter Tool Diameter Compensation Values

    a. Set the mode select switch to SETUP

    b. Depress the N Key (T)

    c. Enter the tool number

    d. Depress the F Key (DIA)

    e. Enter the Tool Diameter Compensation

    f. Depress the black key (EOB)

3.7.4 Program Entry of Tool Diameter Values

Cutter Diameter Compensation values may be programmed at the beginning of the program text, or embedded within the program using the TN//d command coded in a part program.

For example:

T1//.5

T2//.25

T3//.187

For details, see programming manual under TOOL SELECT COMMANDS (M-139 Section 5.8).

3.7.5 <u>Changing the Stored Values of Cutter Diameter Compensation</u>

1. When power is turned ON all values are zero.

2. Keyboard entry will store the new value.

3. Further keyboard entry will override the above.

4. <u>If the compensation value was entered as a listing at the beginning of the program</u>: a new keyboard entry will override that value at any time. The only time that the Cutter Diameter Compensation value listed at the beginning of the program can be reused after a keyboard modification is first, to deliberately set to zero the stored value. Various ways of setting stored values to zero are:

     - Turning Power OFF
     - Operating the RESET switch
     - Keyboard entry of zero
     - Embedding a last value of zero within the program

5. <u>If the Cutter Diameter Compensation value is embedded within the program</u>: This value will override the compensation listed at the beginning of the program or a value entered earlier by keyboard. The only way to change a value embedded within a program is through the use of the EDITOR.

3.8 TURNING POWER OFF

The main disconnect switch on the back of the machine is the only means of removing power anywhere in the system. When power is turned off, the stored TLO and program text data in storage is lost. BOSS is non-volatile and will control the machine when power is turned ON again.

REMINDER

Record all:

TLO Values
CDC Values
Zero Locations

DATA INPUT

4.1   MANUAL DATA INPUT * (Reference 2.6)

The 20 keys on the MDI keyboard (Figure 2-3) enable entering N,G,X,Y, Z,I,J,F,T, and M data in part program format, entering tool number and tool length offset values, and searching for particular part program sequence data blocks. Additionally, it is possible to store the MDI data, so that the manually input set of data blocks can be repeated automatically.

The letter addresses I and J are available for circular interpolation. These words are entered by a second operation of the X and Y keys respectively. Also a second operation of the "N" key will enter a "T" for tool number selection.

When entering data in the MDI mode by depressing a letter key, the 5-digit display becomes blank and subsequent numerals entered by key operation are displayed starting from the right and shifted to the left. Another letter entry will cause the previous word to be stored and the display to become blank once again.

4.1.1. To Manually Enter and Execute a Block of Data

a. Set the MODE switch to MDI. In the MDI mode, data blocks may be input and executed without destroying the previously input part program. However, modal values set from the MDI panel will remain in effect.

b. Depress an N,G,X,Y,Z,F,M word address. The readout display will be blanked (no display) indicating word address has been keyed in.

c. Depress the numeric keys to input the desired value. The readout will display the MDI value.

> NOTE: If X, Y, or Z is input, the decimal point will appear when the first numeric key is operated, i.e., "0.004". MDI resolution is .001", .01mm.

d. If a wrong numerical character is input, depress the CE (clear entry) key twice. This will wipe out the line being input. The readout will indicate "0000". Re-input the entire line.

e. Depress the BLACK key (EOB) to execute the MDI block.

> NOTE: To enter tool number, tool length offset and tool diameter Compensation values (see paragraphs 3.5.2 and 3.7.3).

4.1.2 Limitations

There are no provisions for entering "R" or "A" words. From this information it is evident that Polar Coordinates and rotation cannot be entered via the MDI Keyboard.

Also, there is no /, #, or $ on the MDI Keyboard, hence it becomes evident that Loops and Macros cannot be entered through the MDI Keyboard.

4.1.3 Input and Store a MDI Part Program

a. Set the MODE switch to MDI STORE; set the function switch to RESTART and depress. In this mode, the previously input part program is destroyed.

b. Follow steps b-e in paragraph 4.1.1 to manually enter a block of data and execute.

> NOTE: The MDI STORE routine automatically stores and executes all MDI program input with the operation of the BLACK KEY (EOB).

c. After the black key stores the data and executes the MDI move, the operator may wish to erase the data. This can be done by operating the CE key before entering any data for a new block.

d. End the program with an M02 (rewind) code and EOB.

To repeat the input part program:

a. Set the MODE Switch to AUTO. Set the function switch to RESTART and depress. This will re-initialize various control registers.

b. Set the FUNCTION switch to START/CONTINUE and depress. This will begin execution of the MDI part program.

c. If an M02 command terminates the part program, subsequent reruns require only a START/CONTINUE command.

> NOTE: An MDI part program which has been stored can be listed, manipulated and modified by the TEXT EDITOR.

4.1.4 Examples

All other functions described in the Programming Manual such as Multi-hole Drilling Routine, Cutter Diameter Compensation, etc., can be input; however the same programming rules apply as if a tape were being generated.

The four examples below will illustrate some of these functions, and the method of input that would be required when entering through the MDI Keyboard.

a. The first line of a program might be:

N1G0G90X(2.)Y(2.)T1M6

To enter that line via the MDI Keyboard would require the following format:

N1G0G90X2.000Y2.000N1M6

Note that a second operation of the "N" Key is required to input the "T" word.

b. Drilling a straight line of equally spaced holes may be input as follows:

1. Enter the X and Y coordinates for the first hole:

N5X1.000Y5.000Z.050

2. Enter a Multi-hole Drilling Routine which has the following format:

N10G81X2.000X.250Z.500F100

This line will cause 5 holes to be drilled; one at X1., three holes .25 apart, and the last hole at X2."

c. Cutting a circle may be entered as follows:

N10 G2orG3X(value)Y(value)X(I Value)Y(J Value)F(100)

NOTE: The second operation of the X and Y keys would be the I & J entry values.

d. To input a G79 Rough Boring Cycle, the following would be required:

N(25) G79 Y Y (1.000)F(100)

The first time the Y key is operated, it sets up the machine to look at the next entry as a J value.

4.1.5 To Search for a Particular Part Program Block

GUIDELINES:

Do not search for a sequence number within a macro definition.

Do not search for a sequence number within a loop range.

Do not search for sequence number 0.

CAUTION: Search operation sets the system in the RESTART condition (i.e. G0, G90, G70, G74) and clears all active registers.

It is recommended that the search block be a tool change data block, the most useful block when restarting. See special provisions in the Programming Manual under "Definition Block". (M-139 Section 5.1)

If two data blocks contain the same sequence number, the system can only find the first block.

Search will end at the end of the data block prior to the block being searched.

The sequence number displayed will be that of the last sequence number read into the system. If a sequence number is not available, the search will stop at the end of the program text displaying the last available sequence number.

OPERATION:

a. Set the MODE switch to AUTO.

b. Depress the N key, followed by the sequence number of the desired block.

c. Depress the BLACK key. The system will automatically REWind, then search for the required block starting at the top of the part program storage.

d. Set the FUNCTION switch to START/CONTINUE. Depress that pushbutton to begin operation. The system will execute the block containing the sequence number that had been searched and found.

NOTE: Spindle must be running with the correct tool and its TLO.

4.2.   LOADING PROGRAM INTO STORAGE

4.2.1   Tape Reader Entry *

a. ˙ Place the MODE switch in SETUP.

b. Mount paper tape into reader. (Reference Figure 2-8) If tape is between spools, place switch to spool position. If tape is short, place switch in loop position.

c. Using Slew control at reader (< >) run tape until read head is over the leader before the data portion of the tape.

* (Tape Reader Option)

```
B   -   Bottom
C   -   Change
D   -   Delete
F   -   Find
I   -   Insert
K   -   Kill
L   -   List
N   -   Number
P   -   Print
R   -   Replace
T   -   Top
```

> **NOTE:** The necessary 20-MA and RS-232C compatible communication
> interface is provided. For connections, see the Section VI
> of the Installation Manual (M-142).

4.4.1   Modes Of Operation

   a.   COMMAND MODE: This is used to control the operation of
   EDITOR. When the EDIT button is operated and a program is
   in storage, the EDITOR will always become active in the COMMAND
   mode. The mode is used to list stored data, to alter and to manipu-
   late the data and, being line oriented, the COMMAND characters
   can place a pointer at a specific line for these purposes.

   b.   TEXT MODE: This Mode refers to INPUTTING programs or
   adding text blocks to storage. One of two Command characters
   are used to set up the system to accept that text data. They are
   the Command characters I and K.

4.4.2   Editor Responses

   Two way communication has been built into the Editor. This means,
   the Editor will respond with various symbols and/or error messages.
   For example, with a program in storage, the editor will prompt,
   first with a description of the system, then an asterisk (*), e.g.

           BOSS (6.0)   ( )   Bracketed information will indicate
           EDIT   BOSS Level of the machine
           *

   A prompt * is a signal from the control, requiring Operator entry
   of an Edit Command. All Edit Commands are terminated by a
   carriage return (cr). Additional Editor responses follow:

*--   1.   If the Command is typed correctly and the Editor can execute
           the Command requested, it will do so; then print an appropri-
           ate response corresponding to that Command; then prompt (*)
           for another Command.

?--　　2.　If the Command is typed wrong (Syntax error) the Editor will print a (?) meaning that it did not understand the Command and then prompt (*) for another command.

NF--　　3.　If the command is typed correctly, but the datà (TEXT) cannot be found, the data (TEXT) is either not in memory or in some position before the current line pointer. The Editor will print (NF) meaning NOT FOUND, then prompt (*) for another command.

TL--　　4.　If the proposed text block exceeds 47 characters, the Editor will print (TL) meaning LINE TOO LONG, then prompt (*) for another Command.

AF--　　5.　If the next text entry has been calculated by the Editor to leave less than 47 characters left in memory, the Editor will print (AF) meaning ALMOST FULL then prompt (*) for another Command.

NR--　　6.　If the available memory space will be exceeded by the proposed text entry, the Editor will type (NR) meaning NO ROOM and the insertion will not be made.

4.4.3 Edit Command Characters

The following section describes the use and format(syntax) of the Edit Command Characters.

> NOTE:　The Editor is line-orientated; i.e., most Edit Commands will be in reference to the current line pointer location and many Commands will move this line pointer to a particular line in the program. An arrow (>) (not printed by the computer) will be used in the examples for clarification to show line pointer location before and after an Editor Command. The program shown below will be edited in the explanation of each command character.

```
N1G0G90X2.Y3.T1M6
N5X1.Y1.Z.05
N10G1Z-.1F100
=N25/5
N15G91X2.F150
N20Y.25
N25Y-.5
N30G0G90X2.Y3.M2
```

1.　Command Character: B
　　Meaning: Set line pointer to end (bottom) of text buffer. (i.e. after the last line of program text)
　　Syntax: Must be the only character in command line.

```
    * B (cr)
>  *
```

2. Command Character: C
   Meaning: Change Text
   Syntax: C/old text/new text

   The first occurence of the string between the slash (/)
   characters is replaced by the string following the second
   slash. The replacement occurs for the current line only.
   If there are no occurences of "old text" in the current
   line, the error message NF (not found) is printed. The
   new text may be a null string but the old text must not.
   If the length of the line after the change exceeds 47
   characters, the error message TL (line too long) is
   printed. If the new line requires more room than the
   current free text space, the message NR (no room) is
   printed.

   The line containing the changed text is printed.

   > N15G91X2.F150
     *C/2/1 (cr)
   > N15G91X1.F150
     *

3. Command Character: Dn
   Meaning: Delete text.
   Syntax: Character D followed optionally by an argument in
           range 0-999. If the argument n is missing, zero, or
           1, the current line only is deleted. If the argument
           n exceeds 1, n lines are deleted starting at the
           current line. The line following the deleted text
           will be printed.

   > N25Y-.5
     *D (cr)
   > N30G0G90X2.Y3.M2
     *

4. Command Character: F
   Meaning: Find Text.
   Syntax: F followed by a valid text string.

   The text buffer is searched for the first occurence of
   the string specified by the argument. The search
   starts at a line following the current line. The search
   is in the forward direction only. If the string is
   found, the line containing that string is printed and
   becomes the current line. If the search is unsuccess-
   ful, the message NF (not found) is printed.

   > N1G0G90X2.Y3.T1M6
     *FN20 (cr)
   > N20Y.25

5. Command Character: I
    Meaning: Insert new program text data in front of line
             pointer location.
    Syntax: Must be only character on command line

             Before each insertion of a line, a check is made to
             determine if enough room is available for the entire
             line. If not, the message "NR" (no room) is
             printed. After each insertion, the available text
             space is calculated. If it is less than 47 characters,
             the message AF (almost full) is printed. When a
             line is inserted it is inserted preceding the current
             line. The current line remains current after the in-
             sertion.

NOTE: To return the COMMAND mode after inserting text, a NULL line
       must be entered (CR).

> N20Y.25
*I (cr)
N16Z-.1 (cr)
(cr)
> *

6. Command Character: K
    Meaning: Kill text buffer.
             This will set the system in the text buffer mode and
             allow new data to be written over the existing pro-
             gram. For this reason it is important the new program
             contain an M2 on the last line to prevent the control
             from continuing into previously stored data. It will
             print out INPUT placing the system in the text mode
             for keyboard entry of new data.

    N30G0G90X2.Y3.M2
    *K (cr)
    INPUT

7. Command Character: L n
    Meaning: List entire TEXT
    Syntax: The entire contents of the buffer are listed on the
             terminal. The operator may abort the listing by
             typing CTRL/O at the keyboard. This will stop the
             listing after completion of the current line. Leader
             is output at the beginning and end of the text as a
             function of the argument n inches. If n is greater
             than 2, a rewind stop code (%) will be output at the
             beginning of the tape and an E code at the end of
             the tape before the trailing leader.

```
> N15G91X2.F150
*L10 (cr)
(10 inches leader)
%N1G0G90X2.Y3.T1M6
N5X1.Y1.Z.05
N10G1Z-.1F100
=N25/5
> N15G91X2.F150
N20Y.25
N25Y-.5
N30G0G90X2.Y3.M2
E
(10 inches of trailer)
*
```

> **NOTE:** The List Command does not advance the line pointer.

8. **Command Character: N n**

   Meaning: Move the line pointer forward or backward an integral number of times.

   Syntax: Character N followed optionally by an argument. If there is no argument, the pointer is moved forward one line. The argument n may be in the range -999 to 999. If the argument is negative, the pointer is moved backward. Only the character 0 through 9 and the minus sign are valid. Leading zeros are allowed but the maximum length argument is 3 characters (plus the minus sign). If the argument exceeds the actual number of lines in the text buffer, the pointer will be set at the bottom or top of the current text depending on the direction the pointer has been moved. The new current line is printed. If the line pointer now points to the end of the text buffer, no line is printed.

```
> N30G0G90X2.Y3.M2
*N-3 (cr)
> N15G91X2.F150
*
```

> **NOTE:** <u>Carriage Return (cr)</u> as a command character in the EDIT mode will advance the line pointer to the next line which it will then proceed to print.

9. **Command character: CTRL/O**

   Meaning: Abort printout

   During Command P or Command L, the printout will cease at the end of the current line.

10. Command character: P n
    Meaning: Print line on the terminal.
    Syntax: Character P followed optionally by an argument. If the argument n is missing, the current line is printed. If the argument is present, n must be 1 to 3 characters in a range from 1 to 999. Only numeric characters are valid. The text buffer is listed starting at the current line. The number of lines listed is equal to the argument. If the end of the text is reached before the number of lines specified in the argument is printed, or if the printer is currently at the end of the text buffer, no error is printed. The command is terminated.

    The user can abort printing by typing CTRL/0 during printing. This will cause the listing to be terminated at the end of the current line.

> NOTE: The P Command does not advance the line pointer.

```
> N20Y.25
  *P  (cr)
> N20Y.25
  *P3  (cr)
> N20Y.25
  N25Y-.5
  N30G0G90X2.Y3.M2
  *
```

11. Command Character: CTRL/Q
    Meaning: Input new program text (external device only) ahead of the current line pointer location.
    Syntax: This is the only character in the line. The message X ON is output as a prompt to the operator to start the external tape reader. The EDITOR must be in the input text mode so that data containing EOB and line feed can be read in from the terminal tape reader (after command character I or K or if storage is empty).

    See Note in Paragraph 4.2.2. Null character at start of tape.

RUBOUT

Typing RUBOUT causes the last character typed to be erased. The Editor will print \ . Rubout may be used several times to erase as many characters as desired.

12. Command Character: CTRL/R
    Meaning: Print the current line now before it is stored.
    Syntax: Must NOT be followed by a carriage return.

        The Editor will print the last input text block
        following the previous carriage return. If the
        operator is satisfied a carriage return will then
        cause the text to be stored.

EXAMINE LINE

Typing CTRL/R causes the Editor to type out a repeat of the line
being typed. When typing a line, after putting in some characters,
rubbing some out, and adding others, it is useful to be able to read
the line as the Editor will see it. Typing CTRL/R will cause the
line to be printed out exactly as the Editor will read it. Typing
(cr) will enter the line into storage.

    > N20Y.25
      *C/..\26\5/.24 (CTRL R)
      C/.25/.24 (cr)
    > N20Y.24
      *

13. Command Character: R
    Meaning: Replace line.
    Syntax: R followed by new text.

        The current line is replaced by the new line specified
        by the argument string. An error is detected if the
        text buffer is empty or the current line pointer points
        to the end of the text buffer. If the room needed to
        store the new line exceeds the current free text
        buffer space, the message NR (no room) is printed
        and no change occurs. After the replacement occurs,
        the new line becomes the current line.

            *F=N (cr)
          > =N25/4
            *R=N25/6
            *P (cr)
          > =N25/6
            *

14. Command Character: T
    Meaning: Set line pointer to beginning (top) of text buffer.
             The top line in the file is printed out.
    Syntax: Must be the only character in command line.

            *T (cr)
          > N1G0G90X2.Y3.T1M6
            *

15. Command Character: CTRL/U
    Meaning: Delete current line being typed.
    Syntax: This is the last character in the line. The complete
              line word is deleted and confirmed by terminal
              echo with the symbols $\ll$.

> N15G91X2.F150
  *C/2./4.25   (CTRL U)
  *P (cr)
> N15G91X2.F150
  *

16. Command character: CTRL/Z
    Meaning: Exit the editor.
    Syntax: Must be the only character in command line.

4.4.4   Mode Transfers

To get into the TEXT mode

----------------   initial operating of the EDIT switch when
                         no program is stored.

I (insert)----   for keyboard entry of data

K (Kill)------   To delete stored data preparatory to new input

To get into the COMMAND mode

----------------   initial operation of the EDIT switch when a
                         program is already stored.

----------------   (cr) (cr) when in the TEXT mode

Operator ERROR

? -----------   Output by the EDITOR in the COMMAND
                         mode signifying a syntax error or the
                         typing of an illegal character.

Gettting Out Of Edit mode

Typing CTRL/Z will take the CNC out of the Edit mode and set it to
the beginning of the program. The Editor will print out EXIT as it
departs.

Operating the CLEAR switch on the CNC will do the same thing, but
will not print out anything on the terminal.

4.5   EDITOR SUMMARY

B   -   Set line pointer after the last line of program

C/old text/new text - Change character or character string

D   -   Delete current line
Dn   -   Delete n lines starting at current line (n=0-999)

F text string   -   Search for first occurence of text string starting next line

* I   -   Insert text in front of current line (Text Mode CR, CR to Exit)

* K   -   (Kill) Deletes entire program and enters text mode

L   -   List entire text
Ln   -   List entire text and output n inches of leader with % and E for n=>3

N   -   Move line pointer forward one line
Nn   -   Move line pointer forward n lines (n=2 to 999)
N-n   -   Move line pointer backward n lines (n= -1 to -999)

P   -   Print current line
Pn   -   Print n lines starting at current line (Note: Line pointer does not advance)

R text   -   Replace current line with new text

T   -   Set line pointer to top of program

*Ctrl Q   -   Input text from peripheral device. (Can only be used in conjunction with I or K at which time the keyboard is locked out.)

Ctrl R   -   Print current line before storing (NO CARRIAGE RETURN)

Ctrl U   -   Delete current line being typed

Ctrl Z   -   Exit the editor

CR   -   Advance line pointer one line and print

Rubout   -   Erase last character typed (consecutive rubouts may be used)

* NOTE: Text Mode Insertion Characters.

4.6   TEXT ENTRY BY TERMINAL READER

For the purposes of this discussion, we shall assume that TTY33 (Catalog No. 3320/3JE or equivalent) suitably altered for 20 ma service is connected to 115/1/60 power and that the local/off/line switch is selected to line, however, many other peripheral devices may also be used. There are three possible occasions when program text must be entered:

1. **After turning power ON to the machine:**

   Prepare the machine for proper operation by depressing LIMIT OVERRIDE. Operate RESET and CLEAR. Place FUNCTION switch to EDIT and depress. The terminal will respond with its introductory message.

   ```
   BOSS 6.0
   INPUT
   ```

   Since the editor comes up in the TEXT INSERT mode, key in CTRL/Q, the operator may then place the tape to be input into the terminal reader and operate the reader START switch. After the program text has been read into the system, stop the reader and operate the terminal carriage return twice to place the editor in the Command Mode. This will become evident by the Command Prompt (*) in the left-hand margin.

   At this point, the operator may list or print to verify the stored data as being correct.

   NOTE: There is only one reason for the tape reader to stop during the TEXT INSERT operation; Storage full. When this happens, transfer to the Command Mode and determine the last lines stored.

   ---

2. **Entry of Replacement Program:**

   Since the machine has been operating, place the MODE switch to SETUP and the FUNCTION switch to EDIT and depress.

   The terminal will respond with its introductory message:

   ```
   BOSS 6.0
   EDIT
   *
   ```

   Since the system is in the Command Mode and the stored data is no longer required, operate the EDIT Command K and carriage return. Operate the EDIT Command CTRL/Q. Proceed as under (a) above.

3. Entry of Additional Program to existing Stored Text

Since the machine has been operating, place the MODE
switch on SETUP and the FUNCTION switch on EDIT,
then depress. The terminal will respond with its in-
troductory message:

```
BOSS 6.0
EDIT
*
```

Since the system is in the Command Mode,
operate the EDIT Command B and carriage
return. The prompt (*) will appear allow-
ing the EDIT Commands I (cr) followed by
CTRL/Q to be used. Proceed as under (1)
above.

To enter data at the beginning of the program, use the
EDIT Command T, etc.

To enter data elsewhere in the program, find the line
which must later be after the new data. Command I
and then proceed with keyboard entry. If it is tape
entry, use CTRL/Q.

4.7   SYSTEM RESET

If a system RESET occurs, the NFST lamps will illuminate, the system will
automatically CLEAR and RESTART, i.e., the active registers are cleared
and the system is ready to begin execution of the beginning of the part
program. To reset these lamps, select either one of these functions (NFST)
for display by operating the appropriate numeric key.

NOTE: Occasionally the system may crash where all functions become inop-
erable. At this time it would be necessary to RESET the system at
the Special Operations Panel (Figure 2-5).

SECTION V

AUTOMATIC OPERATION

5.1 NORMAL OPERATION

To operate the system in the AUTO mode, set the MODE switch on AUTO for continuous operation or BLOCK for block-by-block operation.

Operate the lubricator plunger (Figure 3-1).

NOTE: In the BLOCK mode, operation will be interrupted at the end of every block of executable input part program. For example, a macro subroutine definition is non-executable. A loop call or a macro call is considered an executable block.

a. The part program may be loaded by any of four methods:

A punched tape via the tape reader. See paragraph 4.2.1 Tape Reader Control.

A MDI stored part program. See paragraph 4.1.4 Manual Data Input.

Via the text editor. See paragraph 4.2.2 Text Editor.

No matter how the program is input, AUTO/BLOCK operation is the same.

b. Note the readings on the mechanical counters and the X, Y absolute registers. Make any necessary moves to place the tool in correct position relative to the workpiece by using the JOG/Incremental SETUP controls.

c. It is recommended that the first time through the AUTO part program that RESTART be used to initialize various control registers.

d. Set the function to START/CONTINUE. Depress that FUNCTION pushbutton to start the program.

NOTE:	RESTART sets the sequence number to 0, the program will advance to the first executable sequence number and proceed. If the sequence number was not returned to 0, then AUTO operation will not begin.

e. If M0, M1 or M6 codes are programmed in the middle of a part program, operation will be interrupted. To resume part program, depress the FUNCTION pushbutton START/CONTINUE.

NOTE:	The first block in a part program may typically be: %N1G0G90X0Y0T1M6 which initializes various programming registers. START/CONTINUE will cause this block to execute, then the part program will be interrupted by the M6 code. No visible machine function will have occurred if the Quill is "home." The status display will illuminate the tool lamp at each Tn M6 command.

NOTE:	If the operator forgets to turn the spindle on, rapid traverse moves will be executed. However, operation will be interrupted at the first FEED block. To resume operation, turn the spindle on, then depress the button associated with the START/CONTINUE function.

At the end of a run, an M2 command automatically resets the sequence number to 0 and resets the program block pointer to the first programmed block. Depressing the START/CONTINUE pushbutton will start the program.

After the run is complete, the readings on the mechanical digital counters and the X, Y, Z absolute registers should be noted and checked against the initial recorded values.

The program can be interrupted at any time by pressing the HOLD button. The program can then be resumed without error by depressing the START/CONTINUE pushbutton.

NOTE:	When in HOLD, if the system mode is changed from MDI or AUTO to SETUP and a SETUP pushbutton (MOVE, ABS/TLO) is depressed, the system will automatically RESTART before initiating the SETUP move. It now may be necessary to search for the sequence number that was previously being operated.

5.2 SPECIAL CONDITIONS

5.2.1 Travel Limit Switch

If a motion takes place causing a travel limit to be reached, program operation will STOP and the system will be cleared except for the contents of the X, Y, Z absolute registers, the tool length offset registers, and the part program storage.

NOTE: The axes that were traveling could have "lost" up to .1" with reference to the absolute count since the STOP was abrupt without deceleration. CHECK and RE-ZERO IF REQUIRED. (See below)

To resume operation:

a. Set the system in the SETUP mode. First depress and hold the TRAVEL LIMIT OVERRIDE switch to restore power to the step motors and then depress the direction "+" or "-" JOG/pushbutton to move off the limit switch.

b. Set the ABS/TLO selector on GOTO and depress the XY/pushbutton. This will return the system to near the X=0, Y=0 point. Compare the readings on the mechanical counters with the initial readings. Make any necessary moves to place the tool in correct position relative to the work piece by using the AXIS MOTION setup controls.

c. If the MDI keyboard option is available, search for a convenient restart point, preferably a tool change position. See paragraph 4.1.3.

5.2.2 Emergency Stop

If the EMERGENCY STOP pushbutton is depressed, or if the power fails during part program operation, or if the operator inadvertently switches the spindle off while a feed move is taking place, then the system will STOP and be cleared as described above. To resume operation, repeat steps (b) and (c) in paragraph 5.2.1.

5.2.3 Spindle Feed Hold

If a programmed feed block is transferred from buffer to active registers and the spindle has not been turned on, the system will go into a "hold" condition with both HOLD and WAIT lamps ON. To resume operation: switch the spindle on and depress the START/CONTINUE pushbutton.

> **NOTE:** If the START/CONTINUE button is depressed before turning the spindle ON, the HOLD lamp will go out. To continue, turn the spindle ON, then operate START/CONTINUE button.

If the machine is in a feed motion, and the spindle is shut off, the feed will stop and the system will be placed in a RESTART condition (NFST Lamps ON). Since RESTART places the system at the top of the program, depressing START/CONTINUE will cause the machine to read the first executable line; which should be a Tool Change. A search might be necessary at this time to resume the operation where the machine stopped.

5.2.4 Feed Override and Feed Hold Limitations

Feed HOLD may not interrupt multi-axis motion at feed rates greater than 51 IPM unless the OVERRIDE is turned down below 120%.

5.2.5 Search

See proper instructions in Paragraph 4.1.5.

TOOL HOLDERS

6.1 GENERAL DESCRIPTION

Figure 6-1 illustrates a typical holder of many available for the 2 HP spindle. For a complete listing see Manual M-122. These holders have an integral extension for a manual drawbar, their taper is a #30 MMT and they have two key ways outboard of the gage line enabling its installation in the spindle in two possible positions. These holders are similar to that supplied by the Erickson Tool Company as #30 Quick Change Tooling for use without a drawbar.

6.2 INSTALLATION

Figure 6-2 shows how the assembly of the Quick Change Lockout controls how the holder must be installed in the spindle. See instruction 6 of Figure 6-2.

6.3 RANDOM SET CUTTING TOOLS

Setting of Tool Length Offset for these tools has been described in Section 3.5. Note that in choosing the minimum TLO, the longest tool of the group for a job must be used to set the knee height. The knee will be locked at this time and not moved throughout the job unless called for by the programmer after a program stop.

6.4 PRESET CUTTING TOOLS

The Tooling Manual, M-122, contains preset tool holder drawings and the equipment available for the presetting of tools. Preset tool drawing pads (F-143) and tool listing sheets (F-115) are also available as shown in Figure 6-4 and 6-5. A preset fixture (PN1570480) is shown in Figure 6-3 which illustrates the setting of Tool Length Offset when the measured tool length does not equal the desired preset amount. It is this TLO which becomes stored within the main control logic that permits the programmed depth to be maintained despite the inability (in many cases) to preset to the exact desired value.

#30 TAPER

GAGE LINE
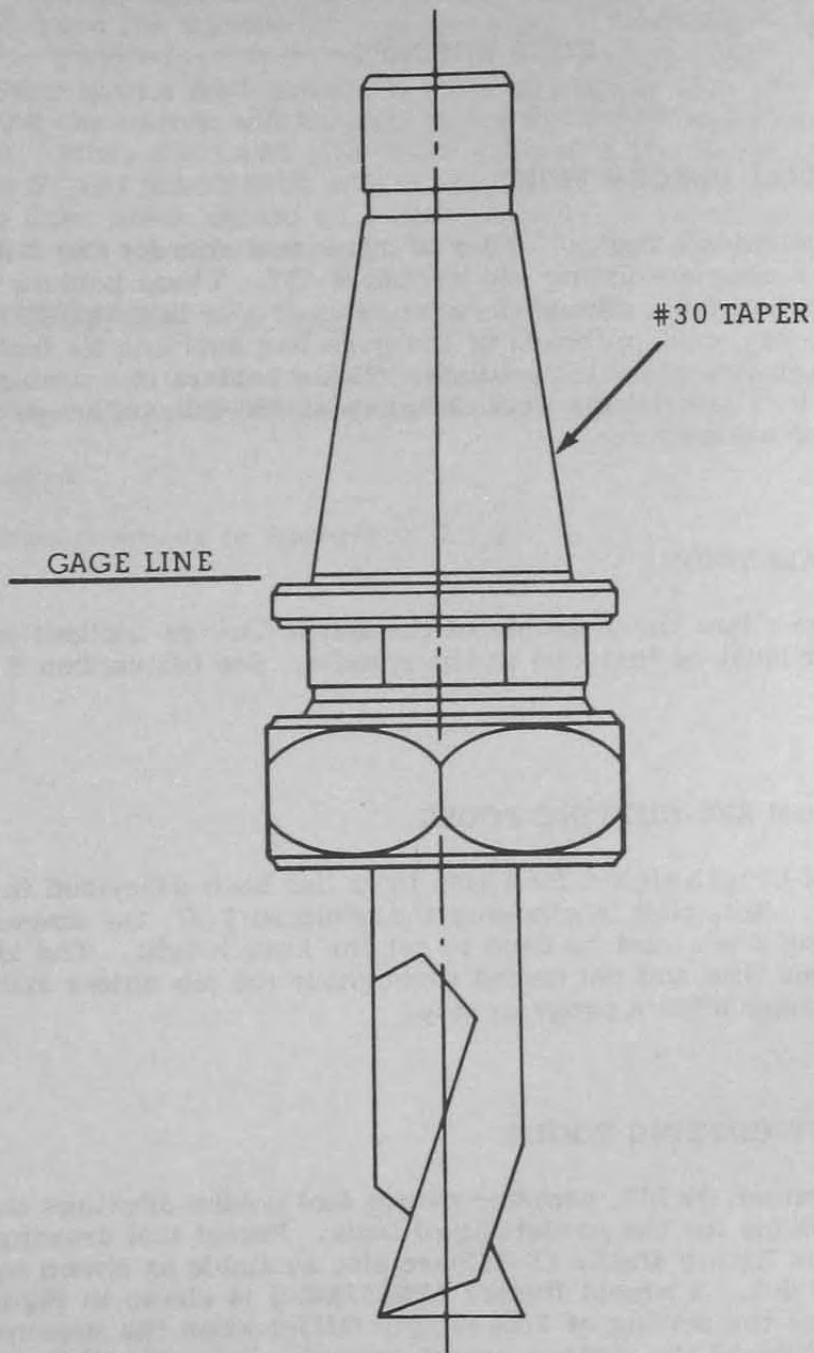
Figure 6-1. Typical Tool Holder

The Bridgeport Quick Change Unit has been preset and inspected at the factory before shipment. If you should encounter any difficulty with tool adapters releasing from the tool holder, follow these instructions for assembling the Quick Change Locknut.
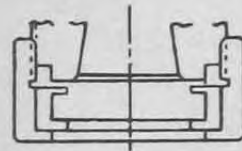
Bridgeport QUICK CHANGE LOCKNUT
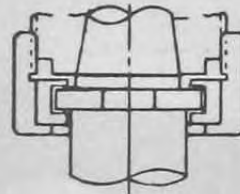## Assembly Instructions
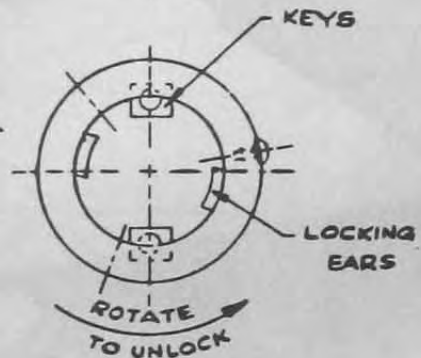
1. Remove 3 screws from locknut.
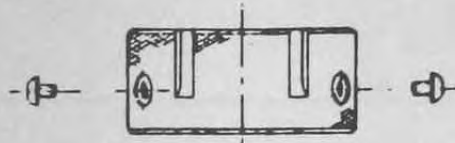
2. Screw on nut assembly as far as possible, then back off 1 turn.

3. Insert standard Quick Change adapter and tighten locknut until tight.

4. Screw in longest button head screw (dog pt) in hole that permits greatest amount of rotation for unlocking. (This is usually the hole closest to a locking ear.)

5. Rotate nut back to load position. This is when locking ears and keys are in line.

6. Insert cadmium plated screw in hole that is in line with locking ear. This is identifying screw so operator will know how to load adapters.
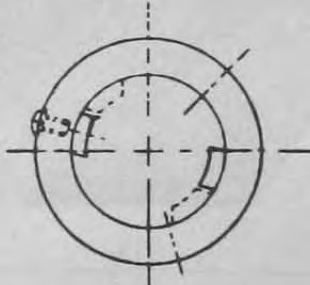
7. Put remaining screw in only open hole. Spindle is now ready to use.

KEYS

LOCKING EARS

ROTATE TO UNLOCK

Figure 6-2. Quick Change Locknut Assembly

OPTIONAL EQUIPMENT

7.1 ROTARY TABLE 12" DIA.

7.1.1 General

The 12 inch diameter Rotary Table is driven by a worm gear arrangement with a 180:1 ratio. Power is supplied by a stepmotor compatible with the drive systems of all Bridgeport CNC machines (Rotary Table assembly Code No. 2521000). The counter incorporated into the drive system is capable of being read to $0.01°$, the resolution of the total system. The rotary table can be driven from the control output to one of the linear axes. Suitable special provision has been made to utilize the Y-axis output to drive the rotary table instead of its normal output to the saddle drive motor. A special Y-axis clamp (3656002) and disconnect (3770789) are then made available and installed at the factory. For field installation 2656002 and 2770789 respectively are used.

Depending on the requirements, the table can be mounted vertically on the left side of the machine table or with its working surface horizontal. Note that when the table face is mounted vertically (axis of rotation horizontal), mounting holes are provided to suit the T-slot spacing.

Bridgeport Tailstock (2520003) may be used when the rotary table is used vertically.

> CAUTION: Do not apply excessive end load with the tailstock and ensure that the table face is not distorted when clamping the workpiece.
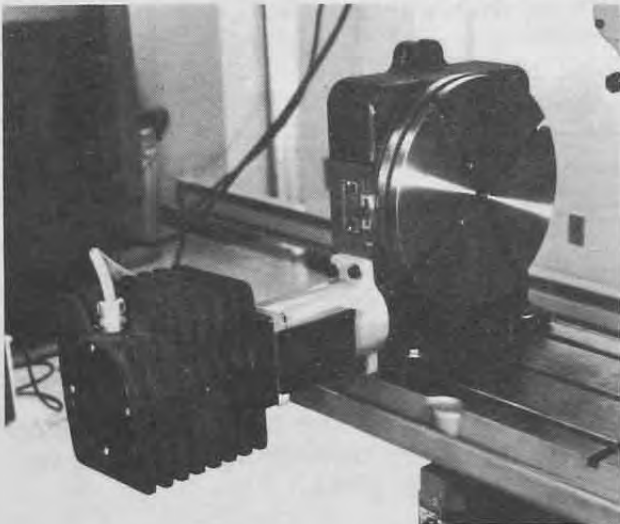
Vertical Application	Y-Axis Clamp
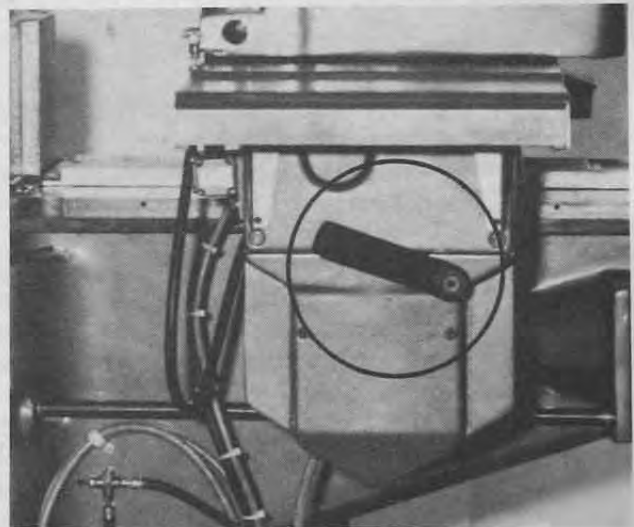
7.1.2   Specifications

```
TABLE DIAMETER............ 12"
T-SLOTS (4)................ 9/16" Wide
KEYWAYS................... 11/16" Wide
WEIGHT (Approx.)........... 150 Lbs.
LOAD CAPACITY
     Horizontal................150 Lbs.
     Off Center.............. 150 Lbs. @ 3"
     Vertical.................. 600 Inch Lbs.
MAX. BACKLASH
   (Adjustable)............. .002" @ 6" Radius
SQUARENESS OF TABLE
  TO VERTICAL.............. .002" in Total Height
CENTER BORE DIAMETER.... 1.000"
CENTER BORE-RUNOUT....... .0008" TIR
CENTER BORE TO
  VERTICAL MOUNT.......... 8.50"
STATIC AND ROTARY
  FLATNESS................. .0005" TIR
DRIVE RATIO............... 1.80:1
ANGULAR ACCURACY....... 25 Secs.
RESOLUTION............... 0.01 Deg. (36 Secs.)
REPEATABILITY............ 25 Secs.
```

Cable and 6-pin MS-Connector provided.

7.1.3   Mounting Workpiece to Rotary Table

NOTE: Most troubles in the use of a Bridgeport (or any other) Rotary
       Table can be traced to three causes:

       1.   Trying to accommodate pieces much too large for the
            tables.

       2.   Trying to mount workpieces with surfaces which are
            not flat.

       3.   Improper clamping or mounting.

If possible, the best way to mount a workpiece is by bolting or clamping
it directly to the table through drilled holes or milled slots.

When conditions prohibit direct mounting, a strap or clamp may be used.
However, it is important that the strap or packing be kept as close to the
workpiece as possible to prevent bowing of the clamp and consequent
scoring or slipping of the piece.

Caution must be used to keep the strap parallel with the table top and also
to keep from over tightening the strap bolt. Over tightening will tend to
bind the table, and in some cases may damage the piece.

The illustration below shows the proper mounting of a normal workpiece. For assistance with unusual applications, see your Bridgeport Dealer.
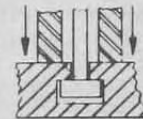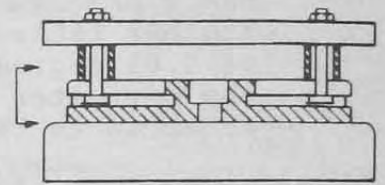
RIGHT WAY
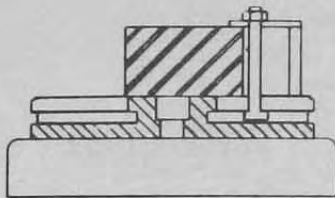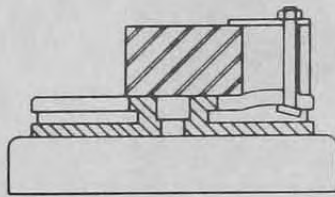
Holding bolt mounted close to work piece
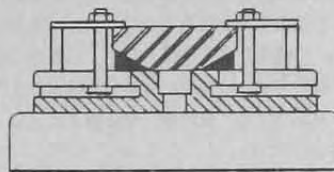
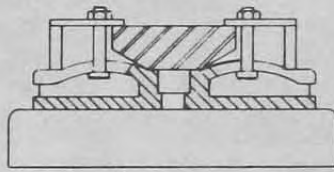**Irregular piece shimmed to provide flat bottom surface**

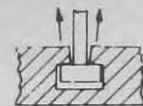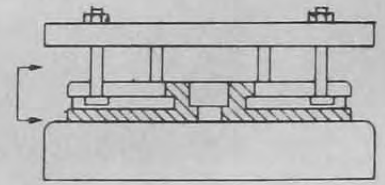**Workpiece blocked under overhang to prevent distortion of piece**

WRONG WAY

Bolt too far away from piece allows overtightening

**Chamfered piece unshimmed allows bolts to be overtightened and distort table top**

Unblocked Piece allows overtightening and distortion of slots

7.2 ROTARY TABLE 10" DIA.

7.2.1 DESCRIPTION

This option consists of a general purpose Kit for rotary milling purposes. There is a 10" diameter rotary milling table with step motor drive, a 3-jaw chuck of 160mm (6.3") diameter and a tail stock of fixed elevation of 160mm (6.3") height with adjustable dead center.

The motor drives a worm screw through a 2:1 reduction by a toothed belt, the worm screw in turn drives its gear with a 90:1 reduction. Therefore, the overall ratio of 180:1 makes programming compatible with options A1 and A3 for another table. Setup positioning to the output resolution of 0.01 degrees can be verified by degree increments on the perimeter of the table and 200 scribed lines on a dial attached to the motor shaft and visible through a sight glass.
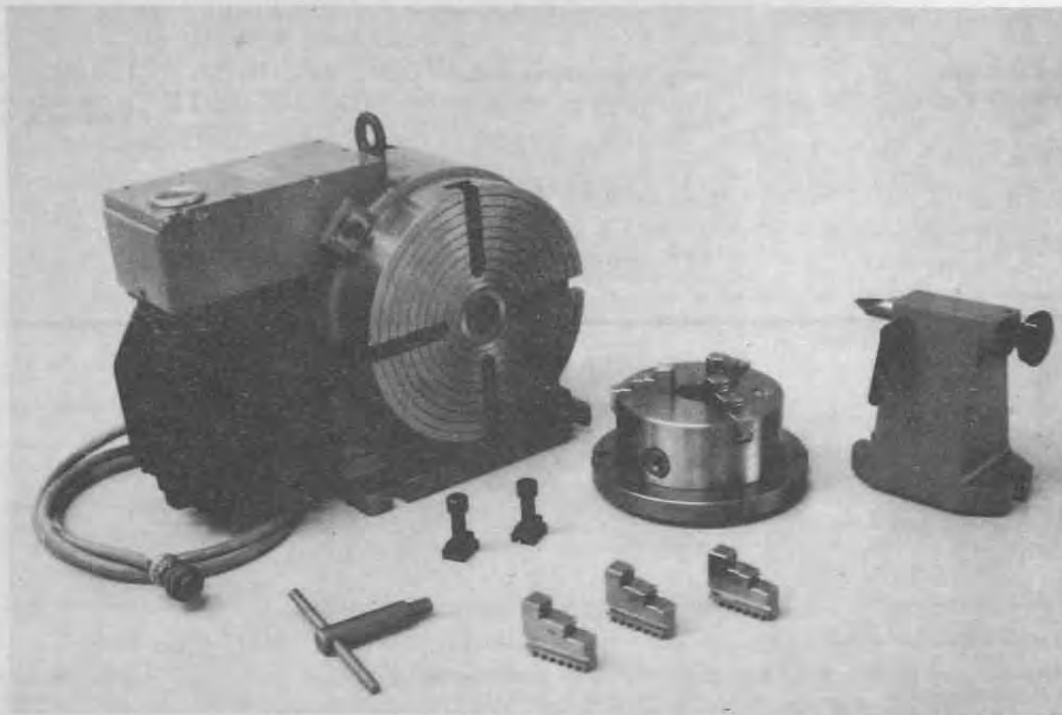
7.2.2 INSTALLATION

The rotary table may be mounted with its axis vertical or horizontal. In the case of the latter, hole spacing for securing to the T-slots is on 8.75" centers and therefore suited to all Bridgeport N/C products. Since the latter have 3-axis controls only, one must be used to drive the rotary table. The Y-axis is the generally accepted output to the table drive motor. The following table summarizes the additional equipment required for Y-axis clamping and Y-axis electrical disconnect:

	DISCONNECT	CLAMP
CNC II (B6, B6.2)	2/3-80-0031	2/3-65-6002

```
NOTES: 1. The code numbers shown in the above table show
          a 2 or 3 as the first digit representing a Kit
          of parts for field installation or factory in-
          stalled, respectively.
       2. See paragraph 7.1.3 for installation of workpiece
          on rotary tables.
```

SPECIFICATIONS

Table Diameter	9.843" (250 mm)	3-Jaw Chuck Dia.	6.299" (160 mm)
T-Slots (4)	5/8" wide	Chuck ID Jaws	1.5" - 6.75"
Keys (2)	5/8" wide	Chuck OD Jaws	.125" - 7.0"
Table Weight	180 lbs.	Chuck Weight	25 lbs.
Lifting Eyes	2 supplied	Chuck Key	1 supplied
Table Depth	8.071" (205 mm)	Axis Height	6.299" (160 mm)
Drive Ratio	180:1	Tailstock	1 supplied
Max. Thrust on Spindle	800 lbs.	Max. Vert. Load on CTRS	330 lbs.
Faceplate C'Bore	1.500" dia.	Max. Bending Moment	750 in. lbs.
C'Bore Runout	.0005" TIR		
Spindle Thru Hole	1-1/8" Dia.	PERFORMANCE UNLOADED	
Thru Hole Mount	#4 Morse	Angular Accuracy	± 30 ARC SECS
Backlash @ 4.5" R	.0005" TIR	Repeatability	20 ARC SECS
Face Square to Base	.0005" TIR	Resolution	36 ARC SECS
Face Parallel to Back	.0005" TIR	PERFORMANCE METAL CUTTING	
Rotary Flatness	.0005" TIR	Equiv. Metal Removal	1 H.P.

```
NOTE:  Motor Cable and 6-pin MS-connector supplied.
```
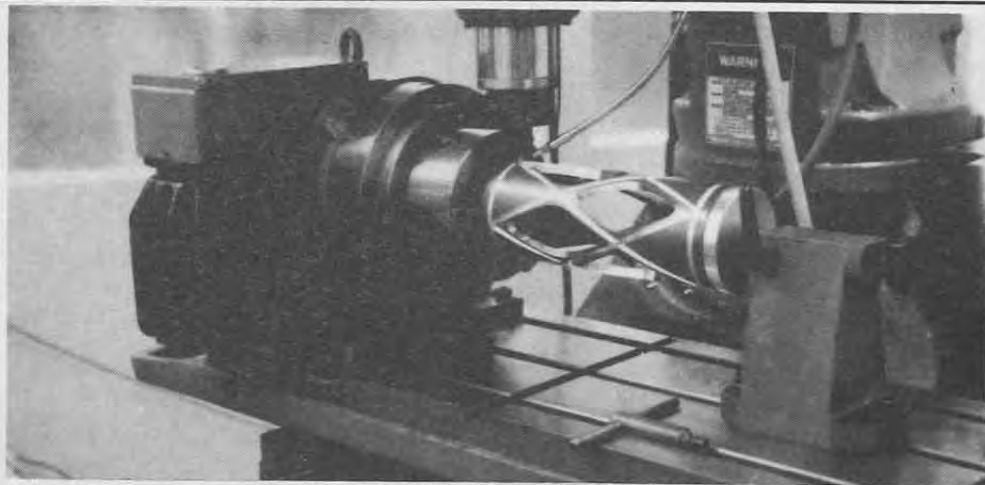

7.2.3 MANUAL DATA INPUT

Although the full programming details are shown in Option
sheets A1 and A3, a summary is shown below. This summary
assumes INCH only (except B6.2 in which metric is shown in
parenthesis) and the use of Y-axis output data:

Linear Ref:	B6	B6.2
Resolution	0.0005"	0.00039" (.01mm)
Rapid ipm	100	96 (2400 mm/min)
Feed ipm	.2-51.0	.2-40.0 (5-1000)
Max Departure	32.768"	825.65" (20971-52 mm)

Rotary Data		
Resolution	0.01°	0.01°
Rapid RPM	5.55	6.66
Feed deg/min	40-1020	5-1000
Max Departure	655.36°	20971-52°

```
NOTES:  1. Maximum departure is defined as maximum direct
           incremental input or the maximum incremental
           difference between two absolute numbers.
        2. Surface feedrate in rotary milling must be
           established by adjustment of the feedrate
           input as a function of the radius at which
           the cut is taking place.
```

7.3   INDEX OPTION FOR CNC MACHINES

7.3.1 PURPOSE

To permit the programming of miscellaneous function M51 to be
programmed in conjunction with the use of a suitable Indexing
Table on Series II CNC machines. A suitable Index Table is one
that inhibits data transfer and therefore, prevents operation
of the machine axes while the indexing operation takes place
(e.g. Erickson 450 or 600 Indexer with oil tight limit switches
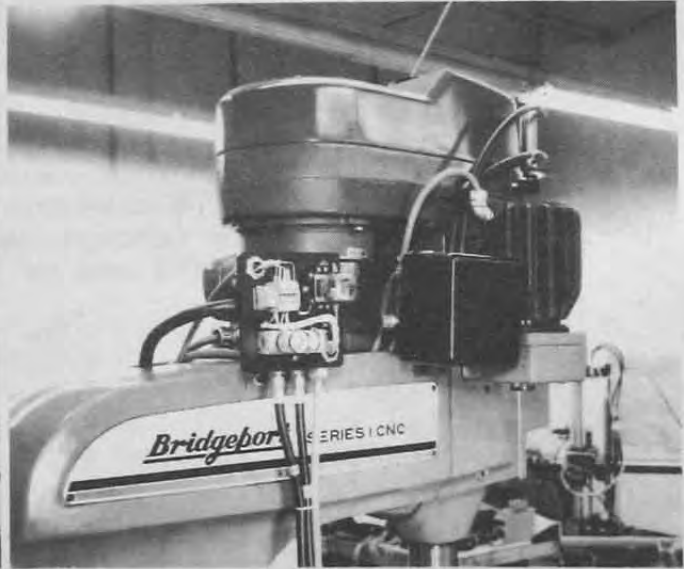LS-1 and LS-2).

7.3.2 COMPATIBILITY

This function can be installed on any BOSS 6. or 6.2 machines,
provided that the interface is supplied on the data transfer
card as follows:

   ZDI Card (B6, 6.2) Part no. 1928110 BL2 or higher (S/N 675
                            or higher)

This indexing interface supplied on these cards became standard
equipment on: -

   Series II CNC S/N 7275 and higher

7-6

7.3.3 INSTALLATION

The unit is designed similar in appearance and is located approximately eight inches behind the pneumatic brake manifold. It incorporates the same cover, mounting plate dimensions, mounting bracket, and hardware.

The mounting plate has been designed to use a single solenoid valve, a 24 VDC DPDT relay, and a terminal strip. The control cable is fed through the ram with existing cables and will terminate in the control cabinet. This cable will enter near the quill switch cable, and workspace is available in the control cabinet to make retrofitting possible.

Main air supplied to the index control by a tee located in the main air line. A 7.5" hose has been fabricated to continue the main air to the brake manifold.

Field retrofit kit: 1932415 R-Ram

7.3.4   OPERATION

A programmed M51 code will cause SOL to be energized before executing axes motion in the same block. The energization of SOL will cause the valve spool to shift and "cock" the indexer. This "cocking" action changes the state of LS-2 first, throwing an INHIBIT into the system (WAIT status lamp ON) and preventing the system from executing any axes motion data in the block. At the end of the cocking stroke, LS-1 changes state, thus resetting the function and de-energizing SOL. SOL will now port air to the index cylinder which permits the shotpin to engage at the end of its stroke. The shotpin restores LS-2 to its original state, removing the INHIBIT and permitting the machine to proceed by allowing the execution of motion data in the same block.

Wire list and typical diagram for M51:

M51

|		
CR	Control Relay	
	Relay Coil 24 VDC	
	Reset NC	
294	Reset NO	
40	Common	
230	Inhibit NC	
295	Inhibit NO	

M51 TIMING SEQUENCE
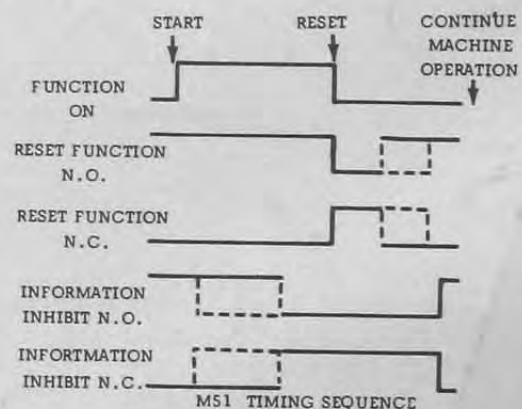
WARNING: Transients caused by non-suppressed reactive loads connected to the relay contacts may cause control malfunction. Transient suppression of external equipment is the responsibility of the user.

7.3.5   OPERATING DIAGRAM

The complete schematic and wiring diagram of this function
is as follows:

NOTE: It is assumed here that the NO contacts are used on
        the Indexer. When ordering indexer, be sure it has
        oil-tight limit switches LS-1 and LS-2. The Bridgeport
        supplied kit includes Relay, Solenoid Valve, Cables and
        Hoses.
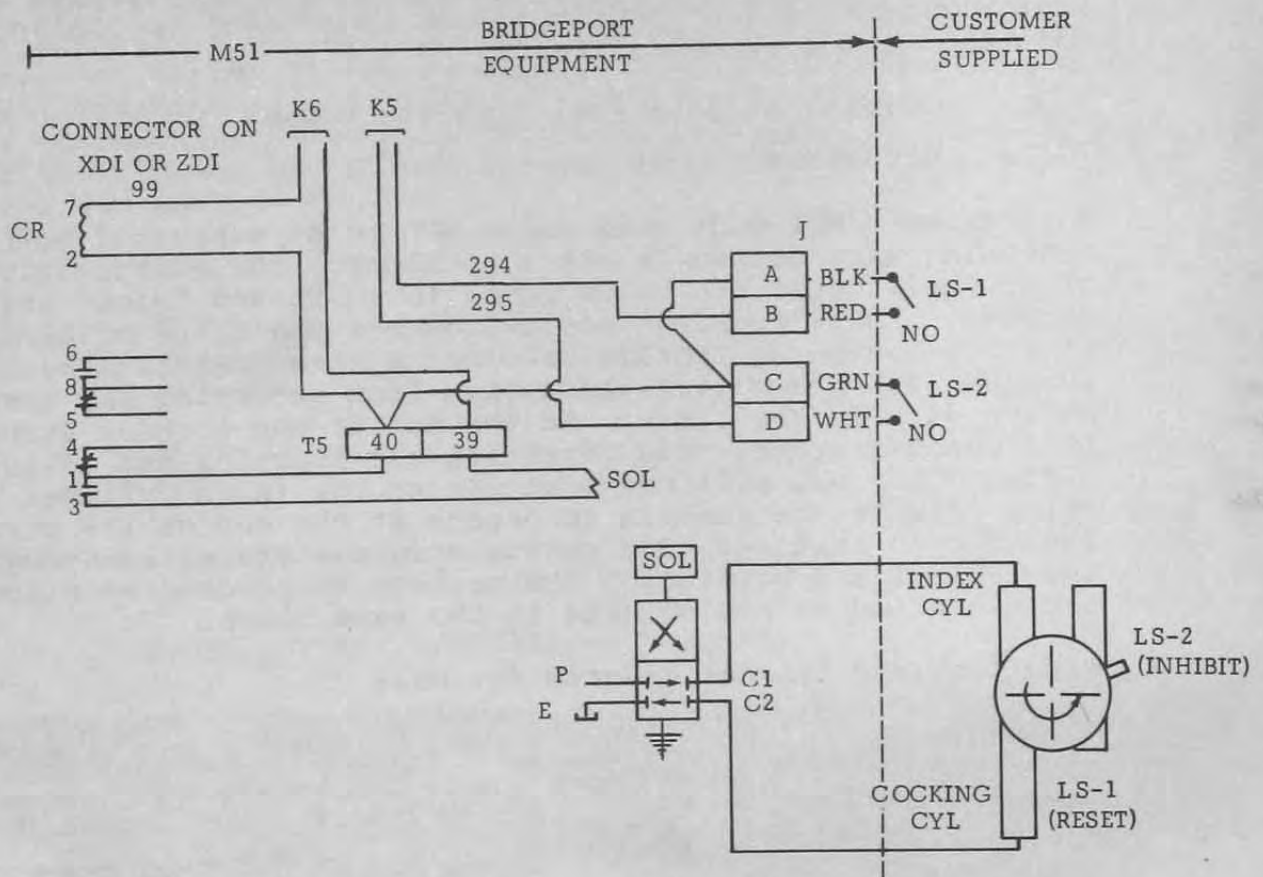
The only field connections are to the switches (cable sup-
plied) and the connection of the pneumatic hoses which are
also supplied.