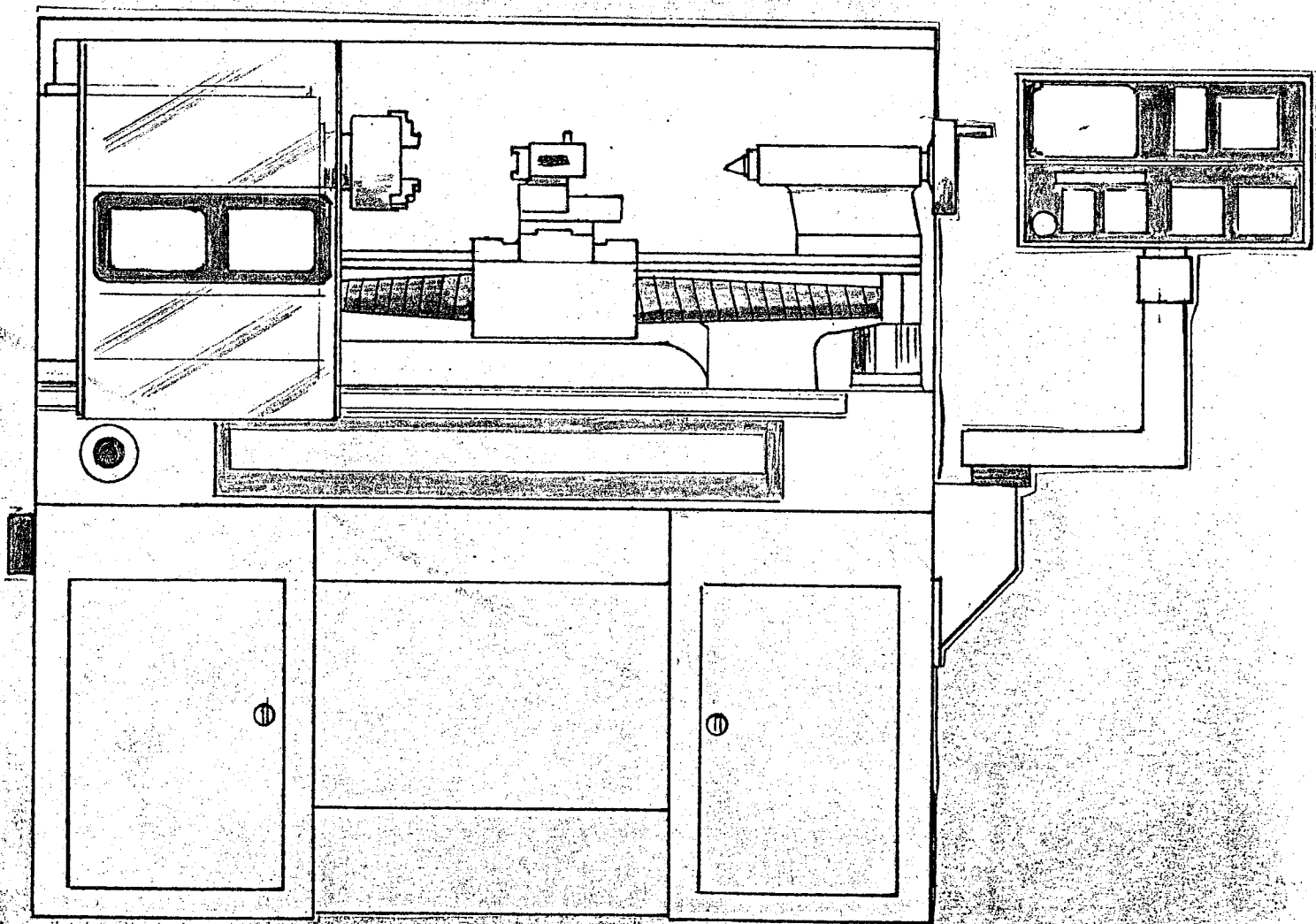


# MICROMASTER<sup>®</sup>

## CNC TRAINER

### INSTALLATION, PROGRAMMING AND MAINTENANCE MANUAL



# DENFORD

MACHINE TOOLS

# I N D E X

## SECTION 1

## INSTALLATION

LIFTING OF MACHINE  
FOUNDATION  
LEVELLING  
CLEANING  
FITTING CONTROL UNIT (PNC 3)  
ELECTRICAL CONNECTION  
LUBRICATION

## SECTION 2

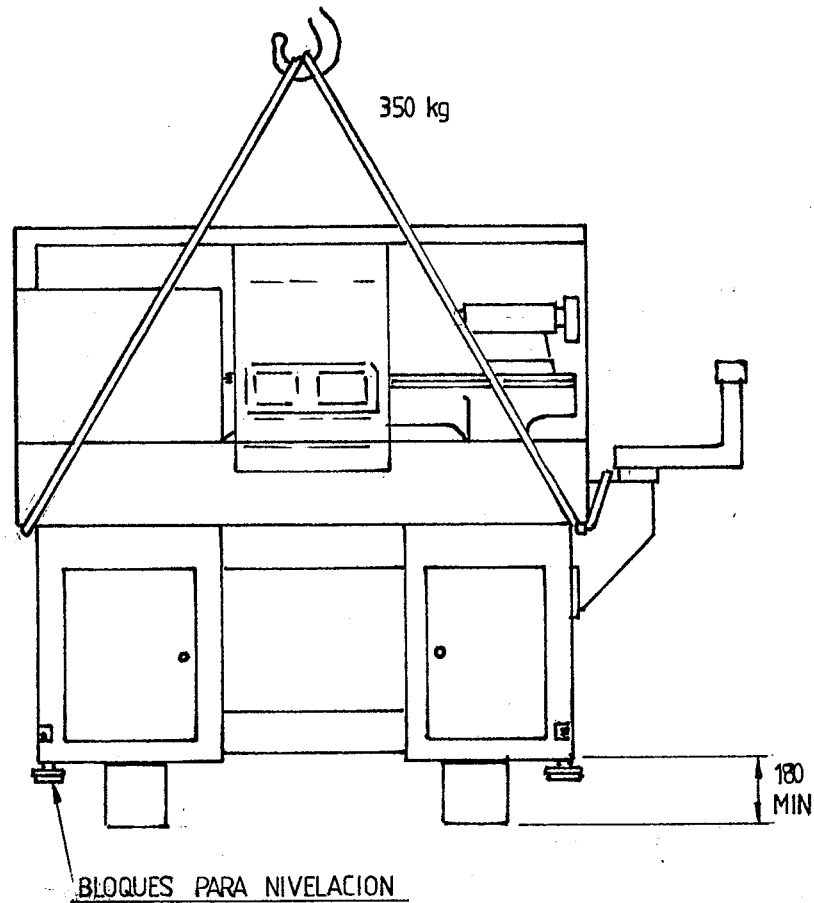
GENERAL SPECIFICATION  
STANDARD EQUIPMENT  
CHUCK MOUNTING  
TOOLPOST  
TAILSTOCK  
MAINTENANCE SCHEDULE  
HEADSTOCK BEARING ADJUSTMENT  
MACHINE AXIS FORMAT.

## SECTION 3

PROGRAMMING

## LIFTING MACHINE

A ROPE SLING CAN BE LOOPED UNDER BOTH ENDS OF THE SWARF TRAY.  
CHECK TO ENSURE THE ROPE SLING IS OF CORRECT CAPACITY TO LIFT  
THE WEIGHT OF THE MACHINE AND THAT THE SLING IS IN GOOD CONDITION.  
ALTERNATIVELY, A FORK LIFT TRUCK MAY BE USED. PLACE THE FORKS  
IN THE GAP BETWEEN THE STORAGE CABINET AND SWARF TRAY.

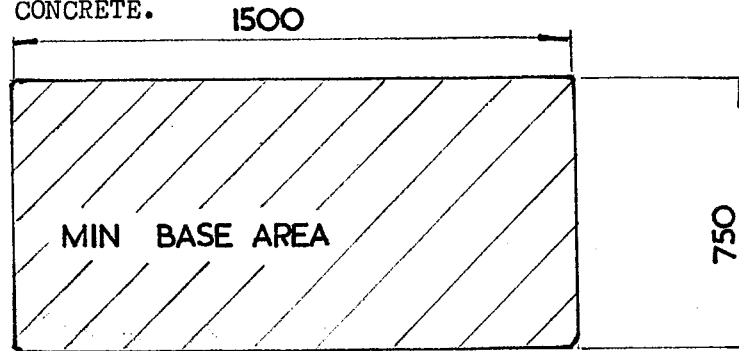


(SPACE THE FORKS AS FAR APART AS POSSIBLE AND TEST FOR BALANCE BEFORE MOVING).

IT IS ADVISABLE AT THIS STAGE TO FIT THE JACKING PADS - SEE SECTION ON LEVELLING.

FOUNDATION

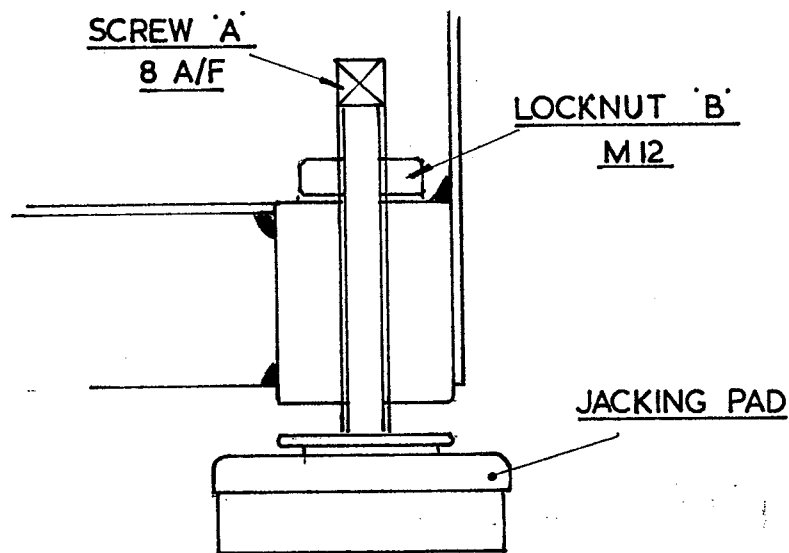
THE LATHE SHOULD BE POSITIONED ON A FIRM LEVEL BASE,  
PREFERABLY CONCRETE.



SEE INSTALLATION DRG. SK.726

LEVELLING

FOUR JACKING PADS MUST BE FITTED AT EACH CORNER OF THE  
CABINET. BOSSES ARE WELDED INTO THE CABINET BASE FOR THIS  
PURPOSE.



THOROUGHLY CLEAN THE BEDWAYS AND, USING A PRECISION MACHINE  
LEVEL AT BOTH ENDS OF THE BED, LEVEL THE MACHINE USING THE  
JACKING PADS THUS :-

WITH LOCKNUT 'B' SLACK, ROTATE SCREW 'A' UNTIL THE BEDWAY IS  
LEVEL. TIGHTEN LOCKNUTS 'B'

CLEANING

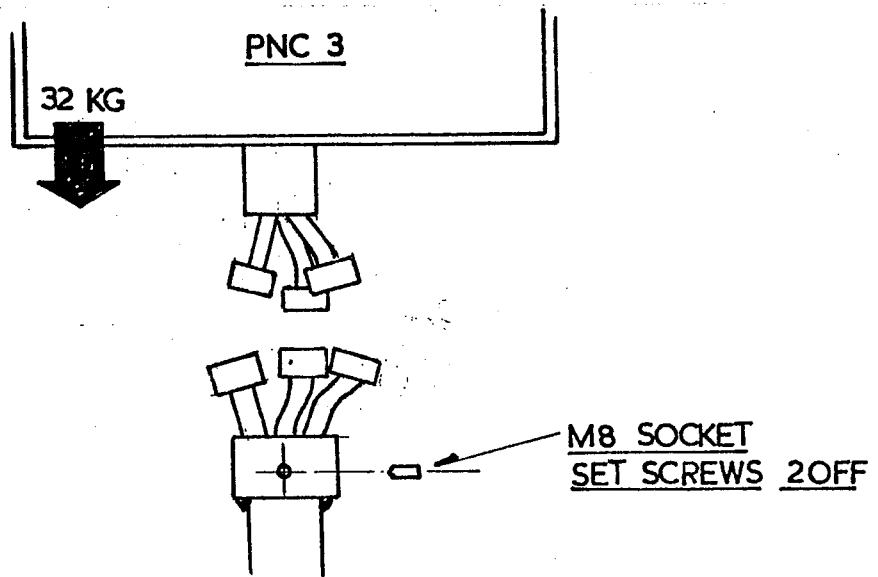
ON DELIVERY THE MACHINE WILL HAVE THE BRIGHT SURFACES COATED WITH  
A PROTECTIVE SOLUTION. THIS MUST BE REMOVED USING KEROSENE BASE  
SOLVENT BEFORE ANY ATTEMPT IS MADE TO MOVE THE SLIDES OR OPERATE  
THE MACHINE

/CONTINUED -

### FITTING CONTROL UNIT (PNC.3)

THE CONNECTION BETWEEN THE LATHE AND THE PNC.3 CONTROL UNIT IS MADE THROUGH ONE 24 PIN AND TWO 12 PIN PLUG AND SOCKETS.

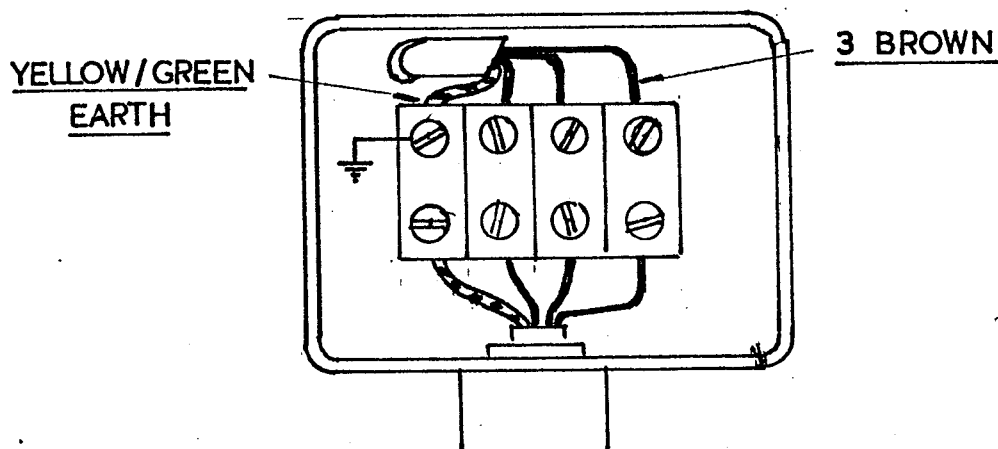
THE TWO 12 PIN PLUGS ARE ARRANGED SO THEY CANNOT BE CROSS CONNECTED.



### ELECTRICAL SUPPLY CONNECTION

THE REGULAR ELECTRICAL MAINS POWER SUPPLY TO THE MACHINE IS 3 PHASE 220V/60HZ.

CONNECT THE MAINS SUPPLY TO THE ISOLATOR BOX LOCATED AT THE REAR LEFT OF THE MACHINE.






ONLY A COMPETENT ELECTRICAL ENGINEER SHOULD COMMISSION THE MACHINE.

/CONTINUED -

LUBRICATION

LUBRICATION TO THE BEDWAYS, SADDLE, CROSS SLIDE AND BALL SCREW IS SUPPLIED BY THE AUTOMATIC LUBRICATION SYSTEM.

ENSURE THAT THE RESERVOIR ON THE SYSTEM IS FULL.

<u>LUBRICATION</u>		
	<u>SHELL</u>	<u>CASTROL</u>
	VITREA 68	PERFECTO NN
	VITREA 68	PERFECTO NN
	ALVANIA Nº 3	SPHEEROL AP3

ALL SLIDEWAYS SHOULD BE LIGHTLY OILED BEFORE MOVEMENT OF THE SADDLE AND TAILSTOCK.

-oOo-

CNC CONTROL SYSTEM

1. 486 x 292 x 335 mm Self Contained Console mounted on swivel base.
2. Green on Black 9" V.D.U. with Anti-glare screen and outlet to external T.V. Monitor.
3. Alpha numeric keyboard allowing full Manual Data Input.
4. Mini Magnetic Cassette Unit for Multi Program Storage.
5. M.D.I. Single Step and Auto Selector for programs.
6. RS.232C Interface with 7 Din Pin connection to computers and paper tape punch units.
7. Parallel Printer Interface for obtaining hard copy of programs.
8. I.S.O. Format - allowing 'G' and 'M' Code Programming from DIN 66025 extract.
9. Full 'G' and 'M' Code Listings on V.D.U. when required to assist programming.
10. Single Mode Selection Keys.
11. Axis Jog on both Axes with variable feedrate and 0.01 mm step.
12. Feedrate over-ride from 1mm/min. to 750 mm/min.
13. Programmable Spindle Speed 0-2000 rpm. Programmable Feedrate 0-1500 mm/min.
14. Linear Interpolation with vectorially correcting feedrates.
15. Circular Interpolation.
16. Absolute/Incremental, Inch/mm programming throughout program build-up.
17. Manual and Programmable Program Stops.
18. Repeat facility allowing build-up of canned cycles-subroutines, Do-loops for turning and facing cycles, pecking and grooving cycles (Repeats available - 10').
19. Screwcutting from .1mm-6mm pitch (4-80 TPI) Alleviating the necessity of an undercut.
20. Floating Datum Facility.
21. 500 Block Memory (1000 blocks available)
22. Tool Offset for up to 16 tools with Tool Wear Compensation.
23. Programmable Coolant
24. Programmable Dwell from 0.1 to 9999.9 secs.
25. 4 Auxiliary Outputs.
26. 6 Programmable Inputs.
27. System Resolution 0.01 mm (0.0004").
28. Program Offset allowing for dry run facility.

MECHANICAL

Swing Over Bed .....	280 mm (11")
Swing Over Saddle Wings .....	240 mm (9 1/2")
Swing Over Cross-slide .....	170 mm (6 3/4")
Spindle Bar Capacity .....	26 mm (1.1/16")
Optional extra .....	38 mm (1 1/2")
Spindle Nose (Camlock) .....	D1/3
Optional extra .....	D1/4
Spindle Taper .....	No. 4
Optional extra .....	No. 5
Distance between centres .....	500 mm (20")
Spindle Speeds .....	0-2000 rpm.
Tailstock Taper .....	No. 3
Bed .....	Hardened and Ground Ways
Cross Slide Travel .....	125 mm (5")
Optional Extra with Gangtool Cross Slide	175 mm (7")
Z Axis Ballscrew .....	25 mm Dia. 5 mm Pitch
X Axis Ballscrew .....	3/8" Dia. 1/8" Pitch
Base Height to Centre line .....	1195 mm (47")
Toolpost - Multifix Quick Change with Drop In	
Repeatability 0.0001" with 40 different points	
Mechanical Resolution .....	0.01mm (0.0004")
Machine Dimensions :-	
Height 1680 mm (66")	Length 1370 mm (54")
Width 610 mm (24")	Weight 350 Kilos (770 lbs.)

ELECTRICAL

50 Hz - 1 phase 240 volts.  
60 Hz - 3 phase 220 volts

Spindle Motor

2 H.P. A.C. 1.5 kW 1420 RPM 6.7 Amps.

Axes Motors

Stepper Motors - 200 Steps/Rev. 3.5 Amps. 1.1 Ohms.

Automatic Lubrication System to all Slides and both Ballscrews.

STANDARD EQUIPMENT

125 mm 5" 3 jaw Self Centering Chuck.

Multifix Quick change Toolpost and One Holder.

Totally Enclosed Sliding Chuck Guard.

Coolant - Electric.

10 Vo Light - Halogen.

Automatic Lubrication System.

Tool Kit Including Centres, Wrenches, etc.

Operation and Instruction Manual.

2 Days Operator Training.

EXTRA EQUIPMENT

1 1/2" Spindle Bore, Spray Mist Coolant, Power Chucking.

5c Collet Attachment, Gangtool Cross-Slide, Printer, CAD/CAM and Off Line Computer Programming, Desk Top Programmer Additional Tools and Holders. Robot Work and Toolchanger (FMS)

SAFETY

2 Emergency Stop Buttons Ergonomically Placed.

Adjustable Overtravel Limits on Longitudinal Axis.

Telescopic Covers on Ballscrews.

STANDARD EQUIPMENT

5" 3 JAW CHUCK INT. & EXT. JAWS

MULTIFIX TOOLPOST

MULTIFIX TOOLHOLDER

SET METRIC ALLEN KEYS

GREASE GUN

HARD CENTRE NO. 3 M.T.

SOFT CENTRE NO. 4 M.T.

MINI CASSETTE

TOOLPOST KEY

2 - 1 AMP 20 MM FUSE

3 - 15 AMP 20 MM FUSE

CAMLOCK KEY

OIL CAN

2 POTS OF PAINT



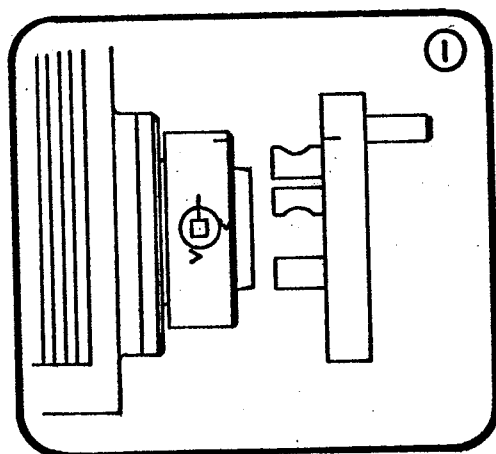
## CHUCK AND FACEPLATE MOUNTING

Before mounting chuck or faceplate first ensure that the spindle taper and the internal taper of the chuck or faceplate is clean and free from dirt or protective covering.

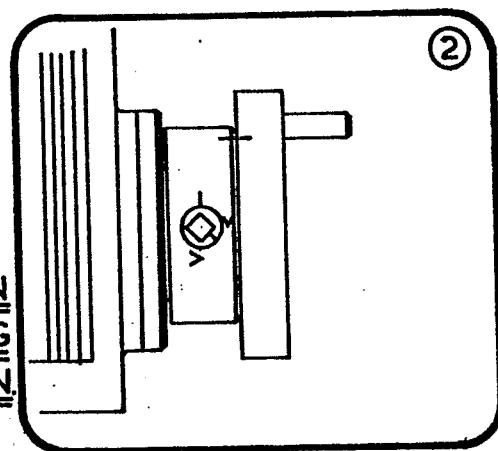
The line on the camlock cams in the spindle should be in line with the mark on the spindle o/d when the chuck is loaded to the spindle. Load the chuck and turn the cams with the key provided in a clockwise direction to tighten and lock the chuck to the spindle nose. The correct position of the cams in the lock position is shown in diagram 2 - Fig. 4.

It may be necessary on chucks supplied without the camlock studs fitted to adjust the studs so that the required cam action is obtained. This can best be set by screwing the studs to the bottom thread and then removing one complete turn. Adjustment for locking should then be carried out.

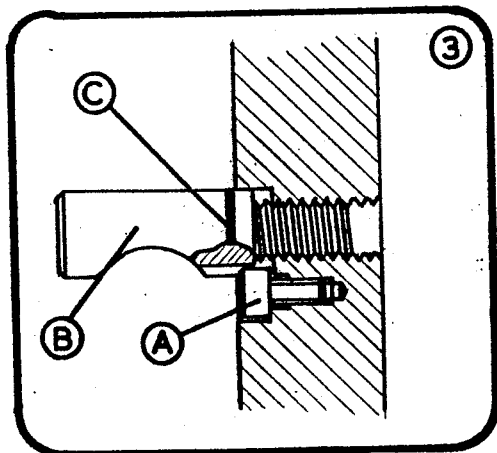
**FIG 4.**



**CAMS IN  
RELEASE  
POSITION.**



**CAMS IN  
LOCKING  
POSITION.**



### **TO ADJUST 'CAMLOCK STUDS'**

REMOVE LOCKSCREW (A) TURN STUD (B) ONE FULL TURN, IN OR OUT AS REQUIRED, REPLACE LOCKSCREW AND TIGHTEN.

**NOTE :- A DATUM RING (C) ON EACH STUD DENOTES THE ORIGINAL SETTING.**

### THE QUICK CHANGE TOOLPOST

To change tools in the toolpost either pull or push the clamping lever to the central position and lift out the tool holder. Insert the new tool holder ensuring the height adjusting screw is firmly down on the base body, and clamp the holder by either pulling or pushing the clamping lever to the locked position.

To set the centre height of the lathe tool slacken off the clamping handle, and loosen the locking nut - then either screw the height adjusting screw clockwise to raise the tool holder or vice-versa. The manufacturers repeatable accuracy on clamping is 0.01 mm.

## TAILSTOCK

The tailstock is of solid cast iron construction mounted on a cast iron shoe for adjustment and the turning of shallow tapers.

The tailstock quill is self ejecting and is graduated for direct reading for drill depths etc. The quill has a 3MT bore and may be locked in position by the locking handle as shown in Fig.5.

### LOCKING

The tailstock is locked to the bed by means of a bed clamp operated by lever (B) Fig.8 The quill is locked by moving lever (A) away from the headstock in a clockwise direction.

### ADJUSTMENT

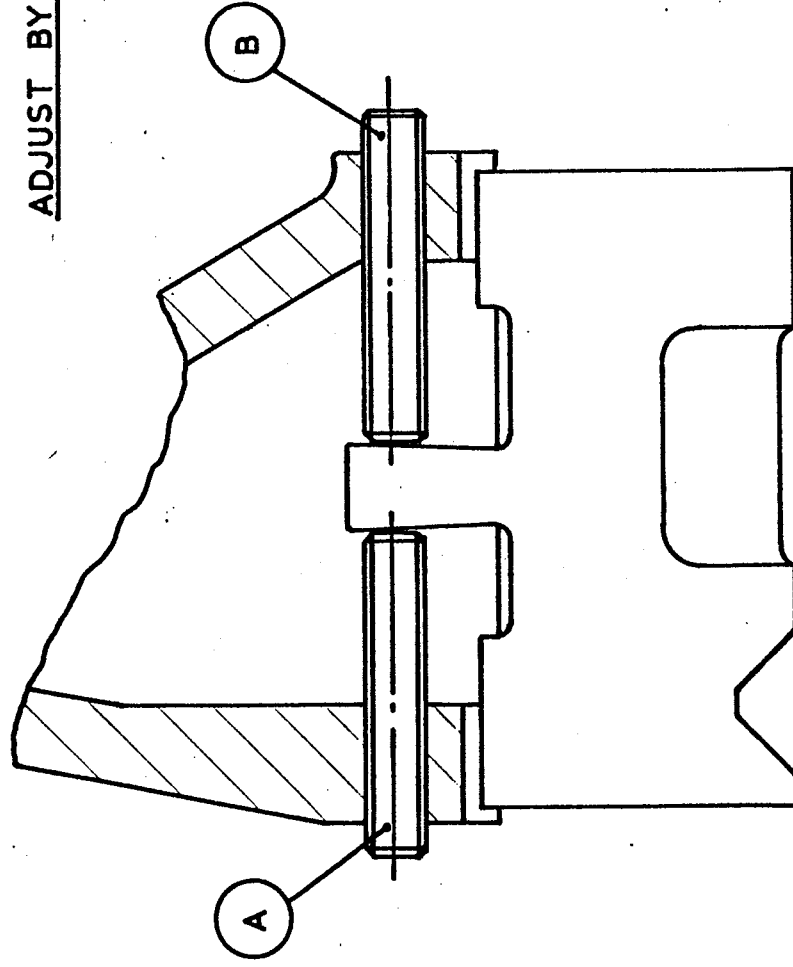
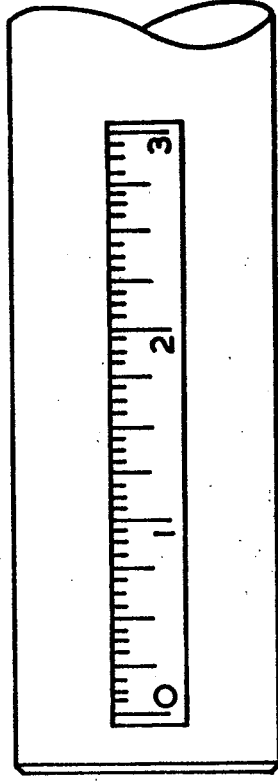
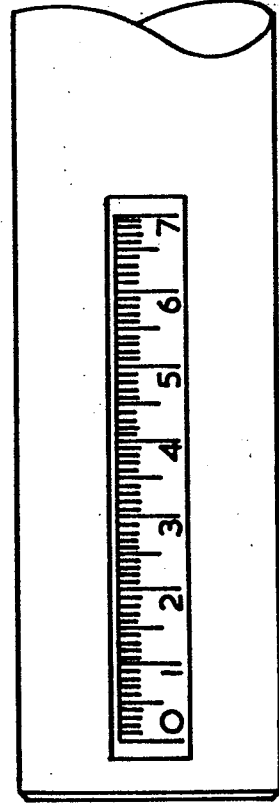
The tailstock is set to turn parallel to the bed. Should any adjustment be required i.e. taper turning - adjustment is made by the two grub screws at the front and back of the tailstock. To adjust, loosen off one of the grub screws A and B and tighten the other until the desired taper is achieved. Fig.5.

NB. Ensure that the two screws are tight before reclamping the tailstock to the bed. The amount of set over required for a given taper may be calculated as follows :-

$$\text{Set over required (mm).} = \frac{\text{Length (mm)} \times \text{taper (mm)}}{2}$$

$$\text{Set over required (inches)} = \frac{\text{Taper per foot on dia.} \times \text{length (ins)}}{24}$$

METRICMM. ————— GRADUATIONS ————— ENGLISH INCHES.



ADJUST BY FACING HANDLE.

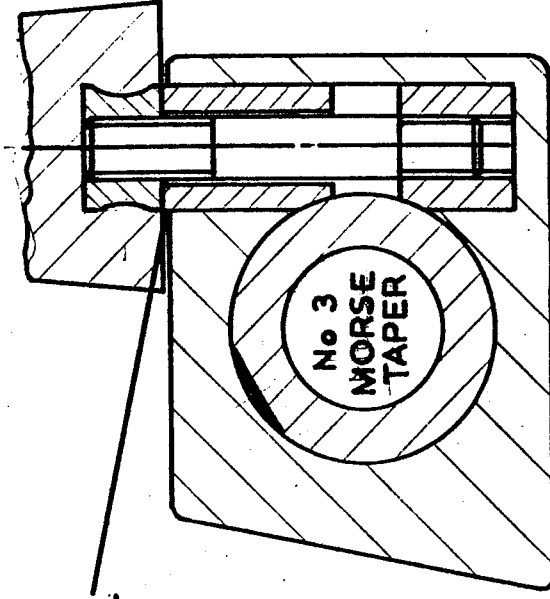


FIG 5

TAILSTOCK ADJUSTMENT.

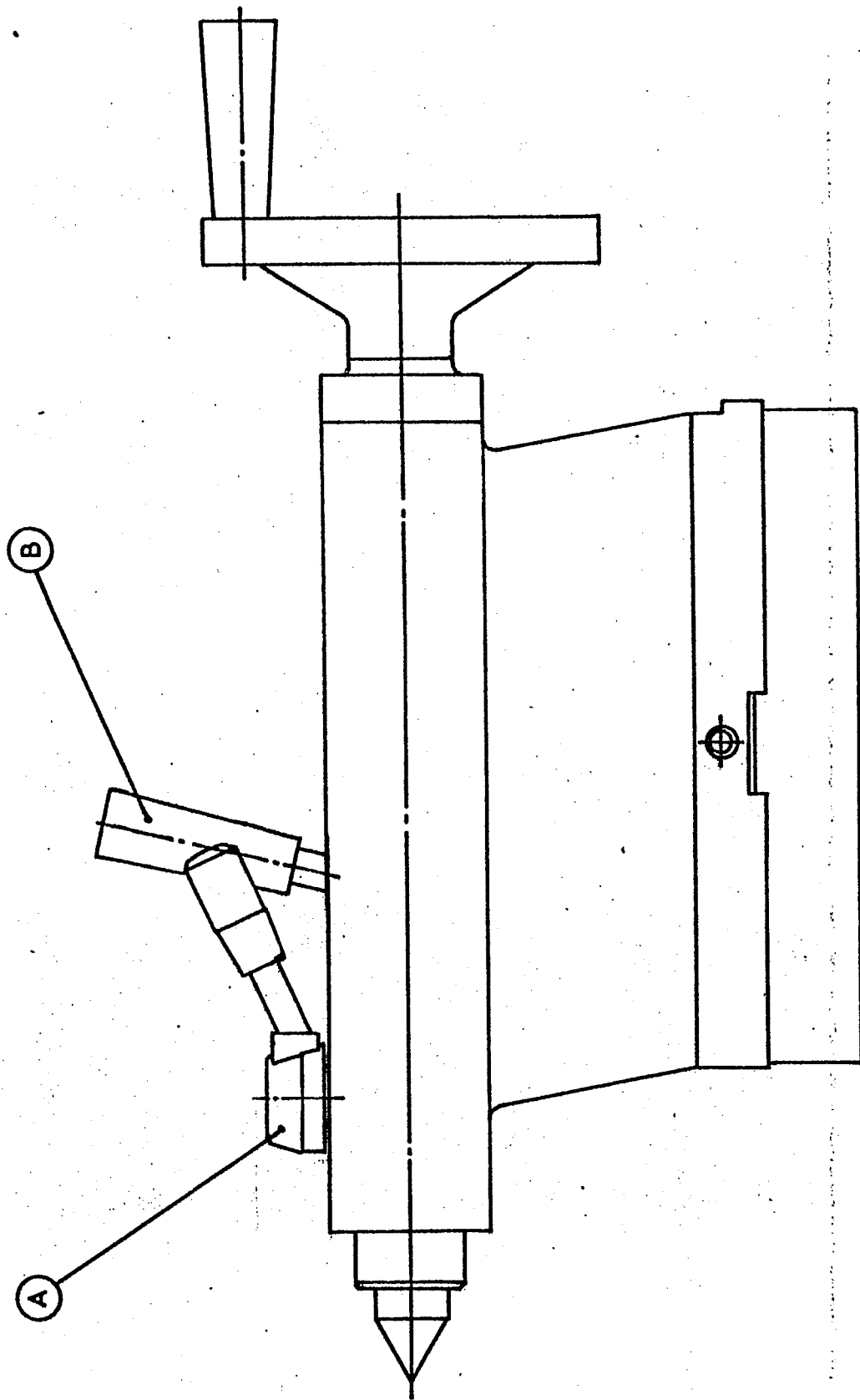


FIG 8.

## MAINTENANCE

ROUTINE INSPECTION AND MAINTENANCE OF THE MACHINE SHOULD BE CARRIED OUT TO THE FOLLOWING SCHEDULE :-

<u>PERIOD</u>	<u>MAINTENANCE REQUIRED</u>
DAILY	CHECK OIL LEVEL IN RESERVOIR. CLEAN OUT SWarf
WEEKLY	CLEAN MACHINE THOROUGHLY CHECK COOLANT LEVEL
SIX MONTHLY	CHECK ADJUSTMENT OF SADDLE STRIPS CHECK ADJUSTMENT OF CROSS SLIDE STRIP GREASE HEADSTOCK BEARINGS LUBRICATE TAILSTOCK BARREL
ANNUALLY	CHECK MACHINE ALIGNMENTS AND ACCURACY CHECK HEADSTOCK BEARING ADJUSTMENT CHECK SPINDLE DRIVE BELT

### HEADSTOCK BEARING ADJUSTMENT

REMOVE THE GREEN RUBBER MAT ABOVE THE HEADSTOCK, THEN THE INSPECTION COVER WHICH LIES BENEATH.

SLACKEN OFF THE TWO SCREWS 'C' (4MM ALLEN KEY), THEN SLACKEN LOCKNUT 'B' AND ADJUST THE PRE-LOAD ON THE BEARINGS WITH LOCKNUT 'A'.

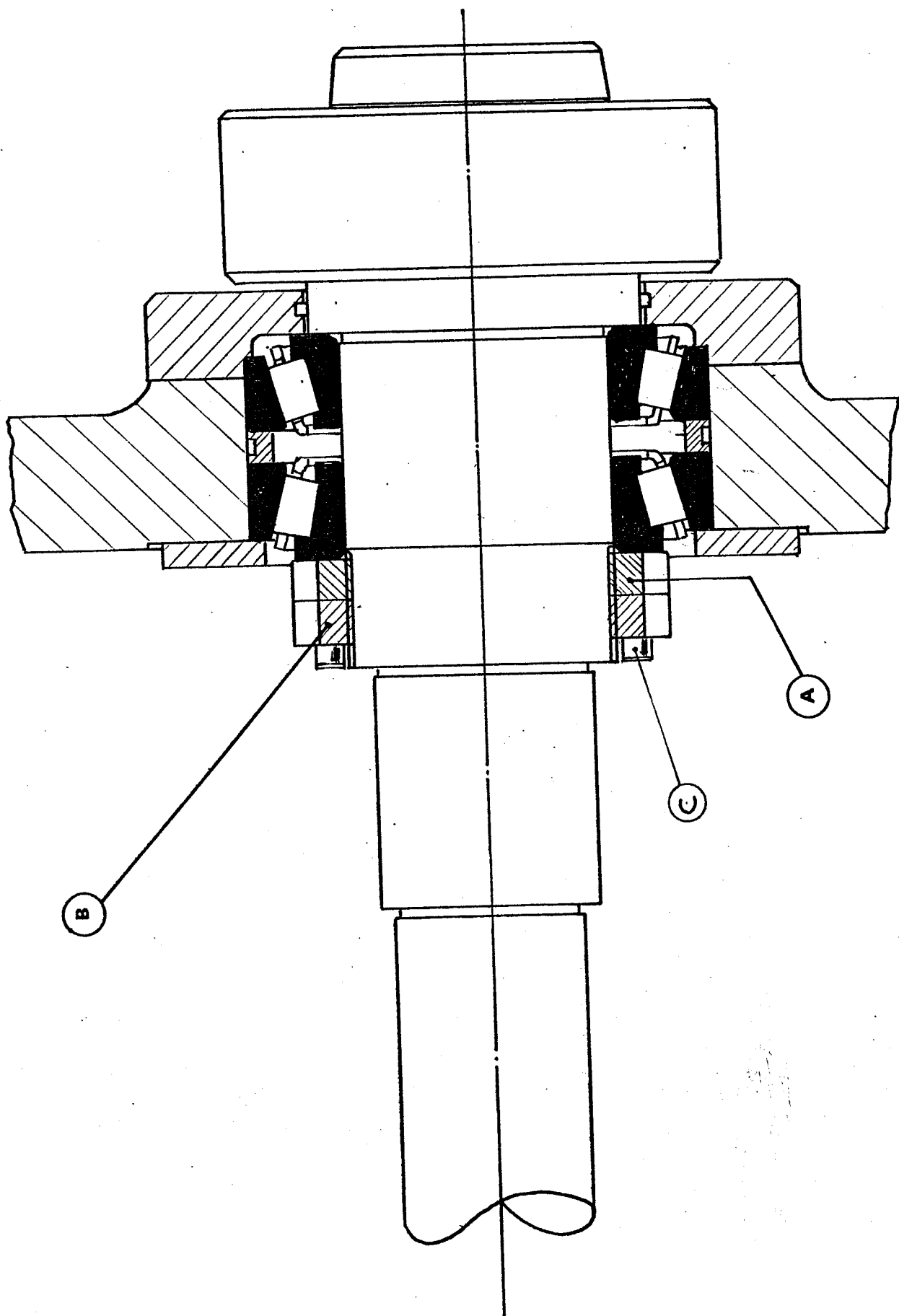
NOTE THE THREAD IS LEFT HAND.

AFTER EACH TIGHTENING OF LOCKNUT 'B' CHECK THAT THE PRE-LOAD IS NOT EXCESSIVE.

THE MACHINE SHOULD RUN AT TOP SPEED AND THE BEARINGS SHOULD NOT EXCEED 65° (150°F)

NOTE: A CERTAIN AMOUNT OF TEMPERATURE RISE MUST BE EXPECTED WHEN RUNNING THE LATHE AT HIGH SPEED BUT IT SHOULD BE POSSIBLE TO PLACE THE HAND ON THE SPINDLE NOSE AFTER AN HOUR'S RUNNING WITHOUT DISCOMFORT.

CHECK THAT LOCKNUT 'B' IS TIGHT UP AGAINST LOCKNUT 'A' AFTER ADJUSTMENT, THEN RE-TIGHTEN THE TWO SCREWS 'C'.



## MACHINE AXIS FORMAT

FIG.5 illustrates the plan view. The Z axis runs along the length of the bed and the X axis along the cross slide at 90° to the bed. The plus and minus signs indicate the direction of the tool.

FIG.5A ABSOLUTE

(Z axis) To the left hand side of Z0 towards the chuck is negative.

To the right hand side of Z0 away from the chuck is positive.

(X axis) X0 is on the centre line of the spindle. Away from X towards the splash guard the movement is negative and towards the operator from X0 is positive.

FIG.5B INCREMENTAL

(Z axis) Towards the chuck is negative.

Away from the chuck is positive.

(X axis) Away from the operator is negative.

Towards the operator is positive.

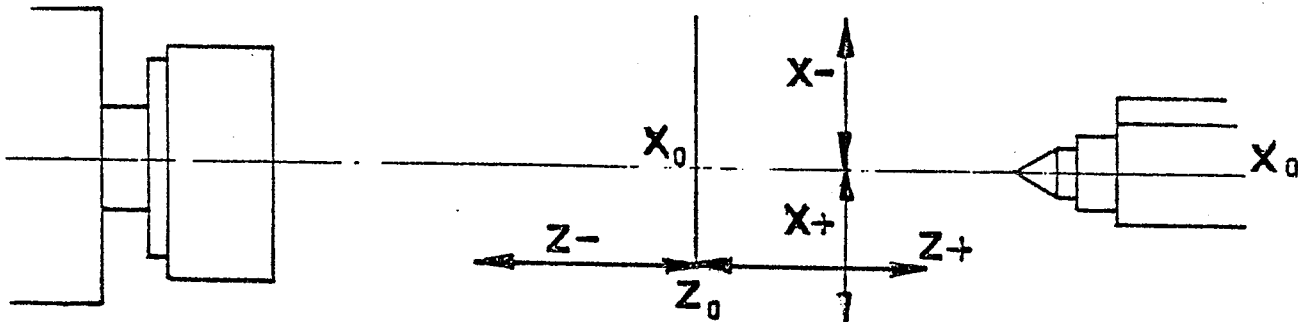


FIG.5A

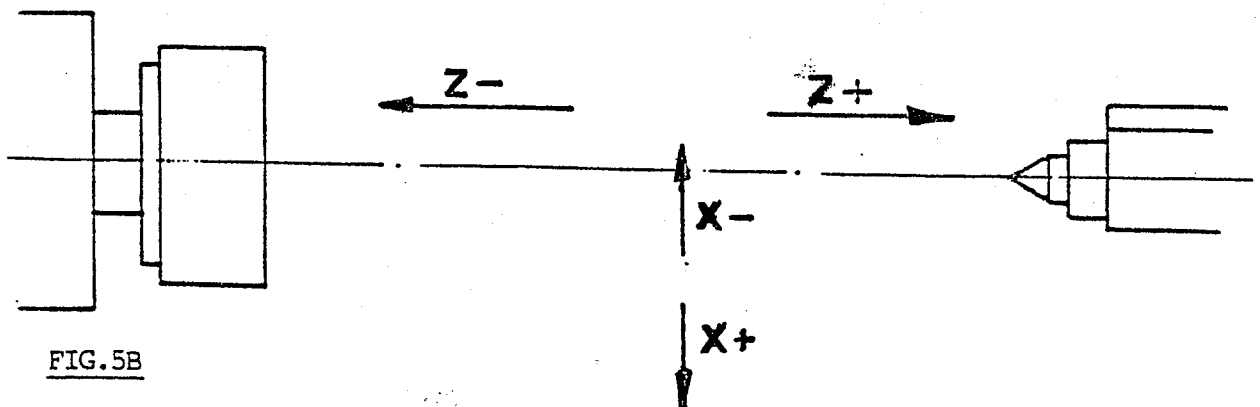


FIG.5B



PNC 3

IMPORTANT

The PNC 3 should be electrically isolated from the supply if its cover is removed.

Before applying power to the system ensure that a) the input power is at the correct voltage and b) the drives/machine switches and auxiliary connectors are correctly connected.

The PNC 3 should be properly earthed (grounded) at all times.

The stepper motor drive boards in the drive unit may sustain severe damage if the motor connections are made or broken with the power still on.

PNC 3's with integral stepping motor drives are equipped with a fan which keeps the drives cool ensuring high reliability. The fan filter must be kept clear, this may be done by using a vacuum cleaner (do not use an air line) to remove the dust etc. The fan filter outer cover may be removed, and the filter changed if necessary.

The digital cassette unit and cassettes may be adversely affected by dust/swarf etc. in consequence care should be taken to keep the cassettes and cassette unit as free from dust as possible. The cassettes should be stored in their cases after first being rewound to the clear leaders.

Index.

Introduction

PNC3 Description

General information.

MACHINE codes (M function and G codes)

MOVEMENTS and associated FEED data input

CIRCULAR movements

AUXILIARY functions (Use of the 16 programmable auxiliary functions)

INPUT facilities (Use of the 8 programmable inputs)

BLOCK SEARCH (to run to any point of program that is in PNC 3 memory)

DATA LINK (to use the interface to a computer or printer)

RS232C INTERFACE Specification (format information)

LOAD facility (to load PNC 3 memory from the PNC 3 Keyboard)

CASSETTE operations (use of the integral cassette program storing system)

EDIT facility (to edit a program that is in PNC 3 memory)

JOG facility (single step movement or feed override of each axes)

SCALE facility (overall and program scaling)

MIRROR facility (Mirroring of axes)

OFFSET facility (Use of the PNC 3 offset facility to 'offset' programmed dimensions)

REPEAT facility (Use of the repeat facility to repeat sections of a program a number of times)

Introduction.

We are pleased to introduce you to this programmable numerical control, which has been designed, developed and manufactured by North East Electronics Ltd.

This low cost, reliable, accurate system is ideal for a wide range of applications which require precise positioning, for example on a variety of machine tools, drilling, milling, engraving, welding and profile burning by laser or conventional methods using rotary and/or x-y tables.

At the heart of this system is a powerful NEE designed computer which gives the PNC 3 the ability to precisely control up to 4 axes of movement with linear and circular interpolation at programmable feedrates. The PNC 3 can also act as a process controller by giving up to 4 programmable auxiliary outputs and monitoring 6 programmable user assigned input signals.

It is North East Electronics policy to continually review and upgrade its products. This PNC 3 is the latest in a line of controllers whose forerunners are working in diverse applications with no small measure of success.

NEE will be pleased to discuss any application not only on existing machines or in production/batch lines or on original equipment but work at the design stage as well.

PNC 3 Description.

The PNC 3 is an extremely versatile continuous path, computer based programmable numerical control unit designed to control via stepper motors a wide variety of machinery where precise control and positioning is required. Related processes and functions can also be controlled by the PNC 3. The programming of stepper motor movements and the process control element is explained fully in this manual. The PNC 3 we are confident will be found to be very easy to operate.

From the front panel total control is obtained by the following features:

An easy to use keyboard system for the input of data and commands by the keyword system or by the machine code system.

The 9" Display provides the user with prompts for programming, and shows the status of the machine and associated functions.

Integral fast magnetic tape system providing unlimited storage space.

Keyswitch to give manual programming, or single step program execution or automatic program operation.

Jog system giving manual control in all axes with plus and minus keys for speed override control.

There is a range of stepper motor drives which can be supplied, on some systems drives can be supplied as an integral feature making the PNC 3 a self contained compact unit. For the larger range of drives an individual housing is required.

North East Electronics provide "tailor made" as well as "standard" control systems by offering a range of optional facilities which will give flexibility over a broad range of applications. PNC control systems are now in use in many different situations ranging from the manufacture of engine components to the manufacture of advanced microchips. The PNC is an ideal system where repeatability of operations are required with accuracy and dependability.

General Information.

The PNC 3 has been designed with the user in mind. It is a versatile control system which is very easy to use and does not require a special course to learn how to use it.

The PNC 3 has numerous facilities all accessed by the keyboard in M.D.I. (Manual Data Input) mode. The majority of keys are self explanatory, being dedicated keys their functions are engraved on the key.

A list of keys follows:-

Reset - to reset out of current mode or cancels the most recent entry.

T 1) upon switching PNC 3 on pressing the T key will give a test sequence for the engineer.

2) After the machine has been datumed the T key is used for tool selection, tool setting and tool offset editing.

M For machine code M function selection (By pressing M then the Enter key a list of the M functions will be displayed).

G For machine code G function selection (By pressing G then the Enter key a list of G codes will be displayed).

For Mill Manual.

X for X axis moves  
Y for Y axis moves  
Z for Z axis moves  
W for W axis moves (OPTION)

For Lathe Manual.

X for X axis moves  
Z for Z axis moves

BLOCK

SEARCH to enable a program to commence from a specific point in program.

EDIT

permits full editing facilities of the programmed sequence of instructions in memory

**S. Subroutines (OPTION)**

**ZERO** to move machine to zero i.e. machine datum position.

**DATA**  
**LINK**

RS232c Serial interface. Used also for printers having standard Centronics parallel interface.

**AUX**  
**INPUT**

The PNC 3 control can act as a process control having 4 relay closure outputs (Auxilliary functions) and can monitor 6 switch closures (inputs).

**FEED** Input key for axes feeds.

**PROG**  
**STOP**

Operation of 'Program Stop' will stop current block from being executed. Additionally this key is used to program a STOP.

**CASS** Permits use of the cassette system.

**LOAD**  
**END**

to start loading or complete loading a program.

**EOB** End of Block or end of line of instructions..

**ENTER** When keying in information it is echoed first on the display, after verification the data is then accepted by pressing "Enter".

The group of 10 keys to the bottom left of the control select the JOG function, the arrow keys indicating direction, the circular arrow key with a W is for the fourth axis if fitted, the + and - keys are for JOG speed control, and are also used as 'feedrate override' keys.

**MIRROR (Mill only)** The X and Y axes can be mirrored in the program. When the mirror key is pressed, a menu of 4 options is displayed.

**REPEAT** Any number of blocks in program can be repeated 99 times with specified offsets and feeds to 4 levels.

CW  
 CCW For circular movements

SCALE (Mill only) Movements inside or outside the program can be scaled in the range from 0.01 to 650%.

FLOAT  
 DATUM Enables a selected position to be used as zero in all axes.

DWELL Selects programmable dwell in the range of 0.1 to 9999.9 seconds

OFFSET Selects machine offset OR program offset.

COMP Selects tool radius compensation.

THREAD (Lathe only) Selects screwcutting facility 0.1mm to 6.4mm pitch.

INCH  
 MM Selects input of data in imperial or metric units.

ABS  
 INC Selects input of data in absolute or incremental format.

The group of 7 keys immediately under the display from left to right are

+ to manually increase the spindle speed

- to manually decrease the spindle speed

FWD selects forward rotation of spindle

REV selects reverse rotation of spindle

OFF selects spindle off

ON Sets coolant on

OFF Sets coolant off

The spindle rotations and coolant controls can be used directly or used during programming.

**Program control switches.**

There are 3 program control switches namely:

- 1) STOP
- 2) START
- 3) MANUAL/SINGLE STEP/AUTO (MODE)

The third switch is a 3 position key switch in manual position enables manual data input (MDI), in single step position 1 depress of the start SWITCH will cause the next block of the program to be executed and in automatic (3 above) 1 depress of the start switch will give automatic operation of program in memory.

The status of this 3 position switch is indicated on the display (top right hand of display)

By depressing STOP (or PROG STOP) execution of the current block will stop. Execution may be restarted using the START key.

**MACHINE codes (M Function and G codes)**

The PNC 3 can be programmed by using both M and G codes or programmed direct using the dedicated keys (keyword system). A complete list of M and G codes follows.

**M functions for use outside of Program**

M03 Spindle forward  
M04 Spindle reverse  
M05 Spindle stop  
M08 Coolant on  
M09 Coolant off  
M20 Auxiliaries  
M21 Input

**M functions available inside the Program**

M00 Program stop  
M02 End of program  
M03 Spindle forward  
M04 Spindle reverse  
M05 Spindle stop  
M08 Coolant on  
M09 Coolant off  
M20 Auxiliaries  
M21 Input



**G codes for use outside of program**

G01 Linear  
G02 Circular CLW  
G03 Circular CCLW  
G04 Dwell  
G10 Mirror X  
G11 Cancel Mirror X  
G12 Mirror Y  
G13 Cancel Mirror Y  
G21 Machine Scale  
G55 Machine Offset  
G70 Imperial Units  
G71 Metric Units  
G90 Absolute Input  
G91 Incremental Input

**G codes for use inside the Program**

G01 Linear  
G02 Circular CLW  
G03 Circular CCLW  
G04 Dwell  
G10 Mirror X  
G11 Cancel Mirror X  
G12 Mirror Y  
G13 Cancel Mirror Y  
G20 Program Scale (replaces G21)  
G54 Program offset (replaces G55)  
G70 Imperial Units  
G71 Metric Units  
G81 Repeat Function  
G90 Absolute Input  
G91 Incremental Input  
G99 Floating Datum

**MOVEMENTS AND ASSOCIATED FEED INPUT**

A movement in one or more axes can be input by pressing the desired axis key followed by the required dimensions. These coordinate dimensions and associated FEEDS may be input either as a single block of data which is to be executed immediately or as blocks of data which forms part of a programmed sequence.

When coordinate dimensions are keyed into the PNC 3 a check is made to ensure that the maximum machine movements are not exceeded, should any be exceeded a warning message is displayed. RESET restores normal operation

The required FEED is keyed in as millimetres per minute or inches per minute. If no feed is programmed the default feed of 234mm/min is assumed.

CIRCULAR movements

Circular movements are defined by using the CW/CCW key, 1 press for clockwise, 2 presses counterclockwise (or by using G02 or G03) then defining the end points of the circular movement then pressing CW/CCW and inputting the circle centre coordinates.

Circular movements are limited to 1 quadrant per block.

When circular movements of less than one quadrant are being made it is not necessary to precisely know the coordinates of the end point of the movement in both axes. The PNC 3 can 'find' one of the coordinates. If this facility is to be used it must be arranged that the movement passes through the coordinate point of the unknown axis dimension before reaching the coordinate point of the known axis dimension at which point movement ceases, e.g. if the present position is X=0,Y=0 and we wish to make a circular clockwise movement to X=1 when Y is unknown, centred on X=3,Y=0 the Y end point programmed should be between Y=0.1 and Y=2.236 the true end point.

If incorrect i.e. impossible end points, are programmed the PNC 3 will move the table continuously in a circle attempting to find the programmed end point, the movement may be stopped by depressing either the movement STOP switch or the PROG STOP key on the PNC 3 Keyboard.

AUXILIARY functions

Auxiliary functions allow user assigned devices to be controlled i.e. switched on and off by the 4 integral PNC 3 auxiliary functions. Three types of auxiliary functions may be supplied.

The three types are:

- a) ON/OFF            Auxiliary No. 3 and 4
- b) MOMENTARY        Auxiliary No. 2
- c) PULSED            Auxiliary No. 1

a) ON/OFF auxiliaries are set when programmed immediately before any associated movement in the same block is made. If the auxiliary is programmed ON it will remain ON until programmed OFF. Such auxiliaries could be used to for example control lubricant.

b) MOMENTARY auxiliaries are switched ON if programmed to be on only when the machine is at a programmed position. When the axes are moving momentary auxiliaries are always OFF. This type of auxiliary can be used to for example provide a table locking signal or to activate the main drilling head on a drilling machine.

c) PULSED auxiliaries provide a pulse output of 20 milliseconds if programmed ON each time the machine completes a program block.

### INPUT facilities

The PNC 3 is equipped to be able to monitor 6 user assigned input signals from external switches. The condition of the switches may be checked to see if they are open or closed during program execution. If the switches are not in the programmed state, sequence execution waits until the switch signals are as programmed before proceeding. Switch levels may be programmed to be closed (ON), open (OFF).

The auxiliary outputs and the inputs enable the PNC 3 to function not only as a precise positioning control system but also as a sequence controller.

### BLOCK SEARCH facility

A program that is in PNC 3 memory may be run i.e. executed either from the start of the program i.e. block 1, or from any point in the program.

### DATA LINK facility

Four operations are possible using the Data Link they are:

- 1) Load Program from Data Link.
- 2) Continue Program load from Data Link.
- 3) Transmit program to data link
- 4) Print program i.e. transmit program to printer.

Note options 2,3 and 4 are possible only if the PNC 3 Memory is loaded.

Option 1) Enables a program to be loaded into PNC 3 memory from an external device either 1 block at a time or as a full program. Any Program previously contained in PNC 3 memory is overwritten i.e. destroyed. The format of the program data is shown below.

Option 2) Enables an additional program to be added to a program that already exists in PNC 3 memory via the external device. The format of the program data is shown below.

Option 3) Enables the contents of PNC 3 memory to be transmitted to an external device. The memory contents are transmitted as 'ASCII' characters in a similar format to that used by Serial Load.

Option 4) Enables the contents of PNC 3 memory to be transmitted to any printer with 80 columns or more which has a standard Centronics parallel interface.

PNC 3 RS232 Interface Specification

The PNC 3 only needs 3 wires to implement an RS232 link. They are Data Transmit, Data Receive and Signal Ground. The connection to the PNC 3 is via a 7 pin DIN socket using pins 7, 6 and 2 for TxDa, RxDa and Ground respectively.

1. All information on the RS232 link is in the form of ASCII characters.
2. The PNC 3 will recognize the following characters:-

<STX>	02	start of transmission
<ETX>	03	end of transmission
E	45H	
A	41H	
C	43H	
X	58H	
Y	59H	
Z	5AH	
F	46H	
+	2BH	
-	2DH	
.	2EH	
0 to 9	30H to 39H	
L	4CH	
R	52H	
S	53H )	
P	50H )	lathe only
D	44H )	
T	45H )	

3. The PNC 3 will use the following ASCII characters when transmitting:-

<ACK>	06	acknowledge
<NAK>	15H	not acknowledge
?	3FH	

4. Any information transmitted to the PNC 3 must be preceded by <STX> and terminated by <ETX>.

5. When the PNC 3 has processed the data and carried out the instructions contained therein, it will respond with either <ACK> (if everything was okay) or <NAK> if some error occurred.

6. If the PNC 3 responds with <ACK> then this also indicates that it is waiting for more data from the interface.

7. If an unrecognised character is received by the PNC 3 (see 2, above) then it will cause the PNC 3 to transmit a "?" once the <ETX> has been received. In this case the PNC 3 will not take any action on the received data but will wait for more data from the interface.

8. The PNC 3 will respond with (NAK) if the data received constitutes a move to a position outside the table limits.

9. The maximum amount of data transmitted to the PNC 3 in one go will be one program block.

10. A program block can contain any of the following (to a maximum of 140 characters):-

<u>Data</u>	<u>Meaning</u>
X<d>	Move in X axis to position <d>
Y<d>	Move in Y axis to position <d>
FX<p>	Set XY feedrate to <p>
Z<d>	Move in Z axis to position <d>
FZ<p>	Set Z feedrate to <p>
A<n>+	Turn auxiliary <n> on
A<n>-	Turn auxiliary <n> off

where <n> is a number in range 0 to 15

<d> is a decimal number in range 0 to table limit

<p> is a decimal number in range 0.005 to 100

Leading and trailing zeroes are not necessary when specifying <n> <d> <p>.

Note that PNC 3 auxiliary on/off blocks cannot be mixed with positional blocks.

11. If the program block contains L as the last character (i.e. the character before the <ETX>) then that program block will not be directly executed but will be loaded into the next available slot in the PNC 3's memory. By sending a succession of blocks with L as the last character a complete program can be built up. Each successive block will be automatically loaded into the next available slot in the PNC's memory. If there are no more free slots in memory then the PNC will respond with <NAK>.

12. If the transmitted data consists of <STX> R <ETX> then the PNC 3 will execute the current program held in its memory and will not respond with <ACK> until the program has been successfully run. The PNC 3 will respond with <NAK> if any error occurs during program execution

N.B. The PNC 3 must be switched to AUTO for the complete program to be run.

13. If the program block transmitted to the PNC 3 does not contain the character L, then that block will be directly executed and the PNC 3 will respond with <ACK> on successful completion of the block or <NAK> if any error occurred. Directly executable blocks can be interspersed with loadable blocks if so desired.

14. If the transmitted data consists of <STX> E <ETX> then the PNC 3 will clear out any program currently in its memory.

#### 15. Example

Suppose the following data was transmitted to the PNC 3

<STX>X12.94Y15FX25.7Z140FZ100<ETX>

This would result in the PNC 3 moving from its current position to

X = 12.94

Y = 15.0

Z = 140.0

The XY axis would move at a feedrate of 25.7% and the Z axis would move at a feedrate of 100%. When the last axis reaches position the PNC 3 would respond by transmitting <ACK> to the interface.

16. To specify a circular move the following basic format must be adhered to:-

X<d> Y<d> CCX<XCENTRE> Y<YCENTRE> for Clock Wise Moves

or X<d> Y<d> CAX<XCENTRE> Y<YCENTRE> for Anti C.W. Moves

This basic format can be followed by feedrate specifiers, Z axis moves, etc in the normal way.

17. If the PNC 3 is controlling a lathe then the following format can be used to specify a screwcutting move.

<STX> S<diameter> P<pitch> D<depth> C<no. of outs> L<length> Z<start posn>  
<ETX>

18. If the PNC 3 is controlling a lathe then the following format can be used to specify a tool change block.

<STX> T<tool No. 0 to 15> <ETX>

LOAD facility (LOAD)key  
END

This enables PNC 3 memory to be 'loaded' using the PNC 3 Keyboard. The task to be accomplished by the machine is broken down into a sequence of blocks which are then executed consecutively. A block may consist of a point to which the machine should move which is defined using 1,2,3 or 4 coordinates (dependant upon the PNC 3 options fitted), or the auxiliary setting required or the level(s) of input signals required. (Auxiliary functions and the input facility are described elsewhere). A block may also consist of a REPEAT instruction, or a Float Datum instruction, or an OFFSET instruction, or a SUBROUTINE call, (Option) or a 'SCALE' instruction, or in fact any G OR M code facility.

Two different LOAD operations are possible:

- 1) LOAD memory from keyboard
- 2) CONTINUE memory load from keyboard

1) LOAD is used to enter a new program into PNC 3 memory. Any previously loaded program is overwritten i.e. destroyed.

2) Continue memory load from keyboard enables an existing program to be continued i.e. extended.

Upon completion of a LOAD or a CONTINUE memory load the PNC 3 displays the program number, how many blocks there are in memory and how much memory remains for a period of 6 seconds after which the PNC 3 displays show normal data, any key press clears the display.

Should too much program data be keyed into the PNC 3 such that the memory becomes full, "memory is full" is displayed and no more data can be entered. Normal operation can be restored by using the RESET Key.

**CASSETTE operations**

The integral magnetic cassette recorder enables programs to be permanently stored for future use

Six different cassette operations are possible:

- 1) Rewind cassette
- 2) Erase cassette
- 3) Find the end of cassette data
- 4) Load program from cassette
- 5) Continue program load from cassette
- 6) Store program to cassette.

When the CASSETTE facility is initially selected a check is made to see if there is a cassette in the unit, if not 'NO TAPE LOADED' is displayed, depression of RESET restores normal operation. If the cassette tape 'clear leader' is detected when a cassette operation is selected the PNC 3 runs the cassette for 5 seconds, if the clear leader is still detected Tape Error is displayed, depression of RESET restores normal operation. If the clear leader has passed the cassette read head the selected cassette operation continues. Some cassette tapes have very long clear leaders and it may be necessary to reselect the cassette operation required thus giving the cassette tape a further 5 seconds to pass the clear leader. If the end of tape clear leader is detected during a cassette operation e.g. during a cassette load "TAPE ERROR" is displayed, depression of RESET restores normal operation.

1) REWIND CASSETTE enables a cassette to be rewound to the start, i.e. to the clear leader, this operation should be performed prior to recording onto a new cassette and it should be performed before a cassette program is loaded into PNC 3 memory. The rewind operation may be stopped by pressing the RESET key.

If important data is to be stored which must not be overwritten, cassettes can be protected by punching out two holes at the top of the cassette.

If a cassette having had the two holes made is placed in the PNC 3 and effort is made to record a program, the message "CASSETTE IS WRITE PROTECTED" will be displayed.



2) **ERASE CASSETTE** enables a cassette to be erased i.e. cleared of programs. The cassette should first be rewound using option 1, i.e. rewind cassette. When a cassette is erased 'PROGRAM END' is recorded at the start of the cassette to indicate that this is the end of the cassette. The cassette erase operation takes approximately 3 minutes for a 50 ft long cassette tape.

3) **FIND END OF CASSETTE DATA.** This command brings the tape to the end of the recorded programs i.e. to the message "Program end found" the cassette is then ready for other programs to be stored.

4) **LOAD PROGRAM FROM CASSETTE** enables a program which is on the cassette tape to be loaded from the cassette into PNC 3 memory. The operator may now look for the next cassette program identifier located by depressing Key 4. The program number is requested and by giving the program number and pressing the ENTER key the PNC 3 will search for the number, displaying in turn the numbers on tape which are found, until the program required is found or until the tape end is found.

If the program number is not known, by pressing key 4 followed by ENTER the first program on tape will be found and its program number is displayed. Press ENTER key to load into memory or press any other key to proceed to the next program on tape. This procedure may be carried on until tape end is found. Depression of RESET restores the cassette menu.

When data is loaded from the cassette unit into PNC 3 memory a check is made on the validity of the data and if an error was detected during the load process "TAPE ERROR" is displayed, and the memory will not be loaded. If RESET is pressed normal operation is resumed.

Cassette data is validated as follows: when a program or an identifier is stored onto the cassette tape an algorithm is computed the result of which is dependant upon the precise data stored. The numerical result of this algorithm is recorded at the end of the data. When the program or identifier data is subsequently loaded into PNC 3 memory the same algorithm is computed and the numerical result is compared with the prerecorded value, if a difference is detected "TAPE ERROR" is displayed.

5) **CONTINUE PROGRAM LOAD FROM CASSETTE.**

This facility enables program data contained in PNC 3 memory to be continued i.e. extended, by a program previously recorded onto tape. This facility enables programs to be 'merged' to form larger programs.

6) **STORE PROGRAM TO CASSETTE.**

This facility enables program data contained in PNC 3 memory to be stored using the integral cassette recorder onto cassette tape. The program is stored after a cassette identifier has been keyed in. The cassette identifier (Program number) can be from 1 to 6 numerals.

Each program is stored as 3 elements separated by blank tape

- i) The cassette program identifier
- ii) The program
- iii) A cassette end 'END'

The cassette end is stored to enable the end of the recorded tape to be found when additional programs are to be stored, as each cassette tape can contain many programs. When a program is stored the cassette tape is initially rewound for a short time and then the 3 elements are recorded, this removes any previously recorded cassette END.

#### EDIT facility

This facility enables a program that is in PNC 3 memory to be edited. When the edit mode is selected the operator may choose to display any block of data. Should a block number which does not exist be requested the block number is ignored. The number of blocks in a program can then be found by entering too large a number and then reducing the number to a figure that the PNC 3 accepts.

Seven operations are possible in Edit mode, they are:

- 1) Previous
- 2) Next
- 3) Replace
- 4) Delete
- 5) Add
- 6) Alter
- 7) Search

During edit operations generally 3 blocks are displayed. The selected operation is performed on the bottom block displayed.

- 1) Previous - Depression of key 1 decrements the block numbers displayed by 1
- 2) Next - Depressing key 2 increments the block numbers displayed by one
- 3) Replace - The bottom block displayed may be replaced. This facility differs from the Alter facility in that the replaced block is completely deleted and the new block is inserted.
- 4) Delete - The bottom block displayed may be deleted by using the delete
- 5) Add A new block of data may be added to a programmed sequence. The data is inserted into the sequence immediately before the bottom block displayed, before ADD was depressed, and all subsequent block numbers in the programmed sequence will be incremented by 1.

Note: If it is desired to add a block or a number of blocks to the end of a programmed sequence "The continue memory from keyboard" facility should be used.

6) Alter - The data programmed in the bottom displayed block can be altered using the ALTER facility. The data to be replaced is Keyed in together with its identifier, other data contained in the block will remain unchanged. If an attempt is made to change non existing data a warning will be displayed. If this occurs the replace function, key 3 will have to be used. RESET restores normal edit operation.

7) Search - The search facility enables any block in the program to be displayed.

#### JOG facility

The machine can be jogged into position by depressing the directional arrow in the jog button cluster found bottom left on the panel. One press will give one step. If a jog key is held continuous movement is made. More than one axes may be moved at once. The + or - keys allow the jog speed to be increased or decreased.

#### SCALE facility

Program Scaling can be accomplished outside of a program i.e. overall scaling, or inside a program i.e. program scale. Program scale allows the user to key in a value in the range of 0.01% to 650% as a scaling factor for all subsequent X & Y dimensions, Z axis dimensions remain unchanged. Its effect can be cancelled by inserting a Program Scale of 100%.

Overall scale is permitted outside program loading sequence. It allows the user to key in a value in the range 0.01% to 650% as a scaling factor for the complete program. It is automatically set to 100% whenever a new program is loaded.

NOTE Any program scales active in the program will be further scaled by this overall scale function so dimensions can be reduced by up to  $0.01 \times 0.01\%$  i.e. 100,000,000 times or increased by up to  $6.5 \times 6.5$  i.e. 42.25 times.

#### MIRROR facility

The mirror program menu includes:

- 1) Mirror X
- 2) Cancel Mirror X
- 3) Mirror Y
- 4) Cancel Mirror Y

**Mirror X:** This function is only permitted as part of a program loading sequence. It causes the PNC to establish an axis of symmetry at its current X position. All succeeding blocks are then reflected about this axis.

**Note:-** This function uses the actual X position that it has attained as its axis of symmetry taking into account all scaling factors, any previous X negates and all offsets including repeat offsets.

**Mirror Y:** This function is identical to 1) Mirror X except that it acts about the Y axis.

#### OFFSET facility

The PNC 3 offset facility enables programmed dimensions to be offset to any point within the machine movement limits. Separate offsets within and outside the programmed sequence are permitted.

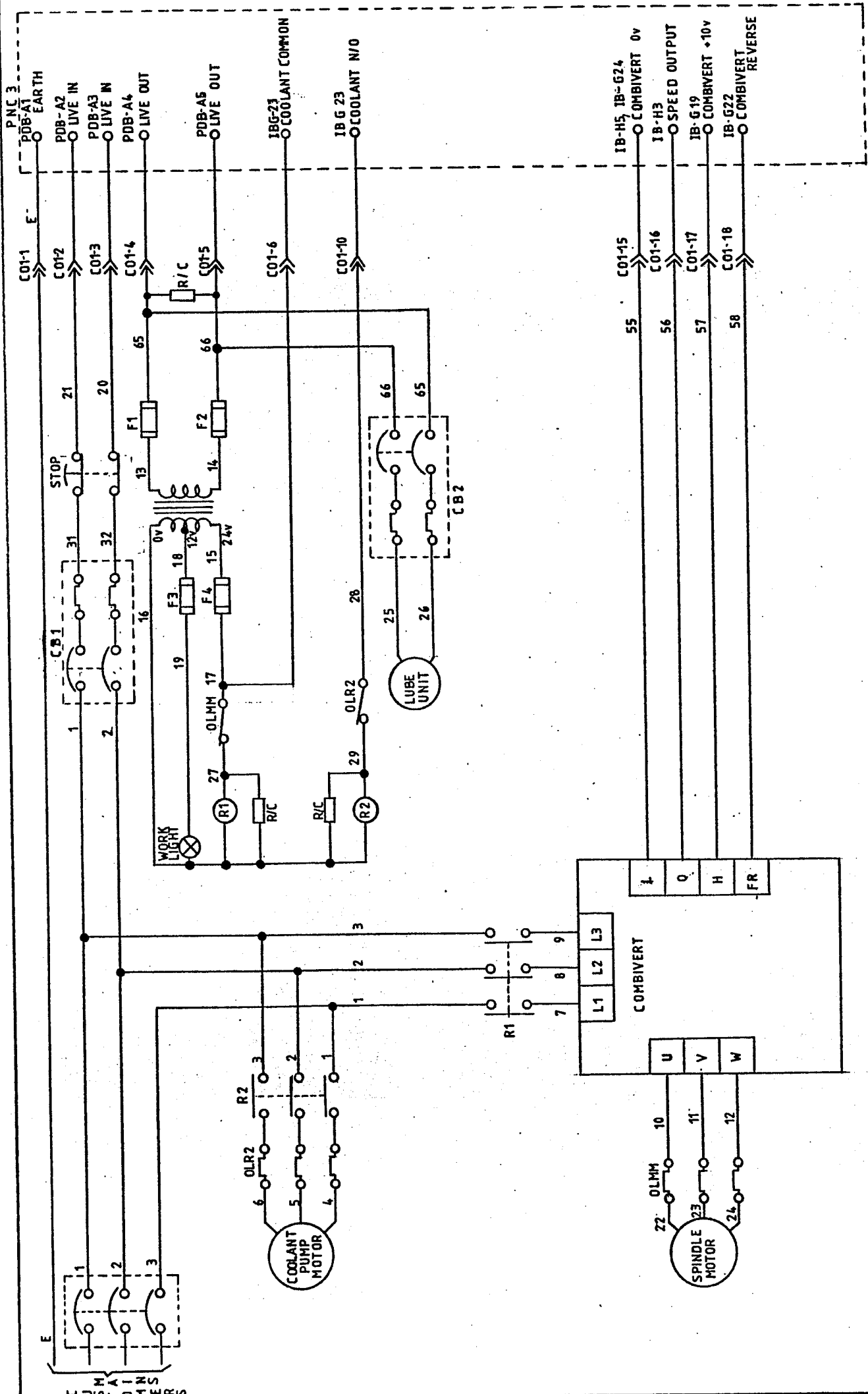
#### REPEAT facility

The repeat facility enables specified sections of a programmed sequence to be repeated with specified offsets. The repeat facility is only available within a programmed sequence. The data required to specify a repeat is:

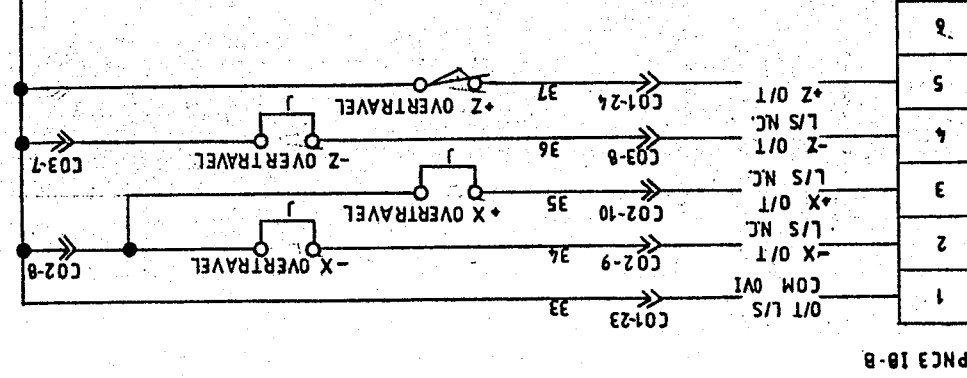
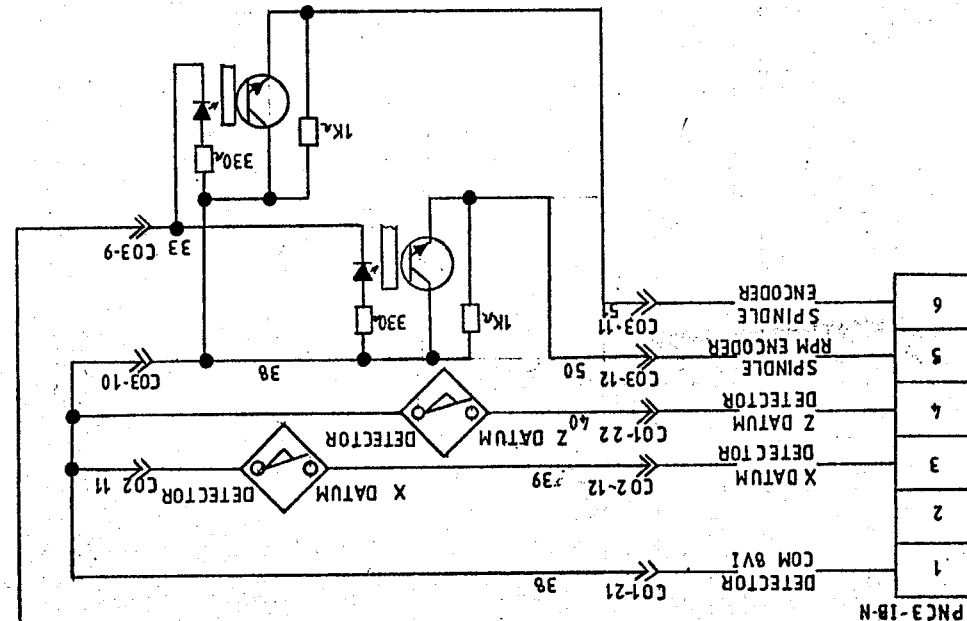
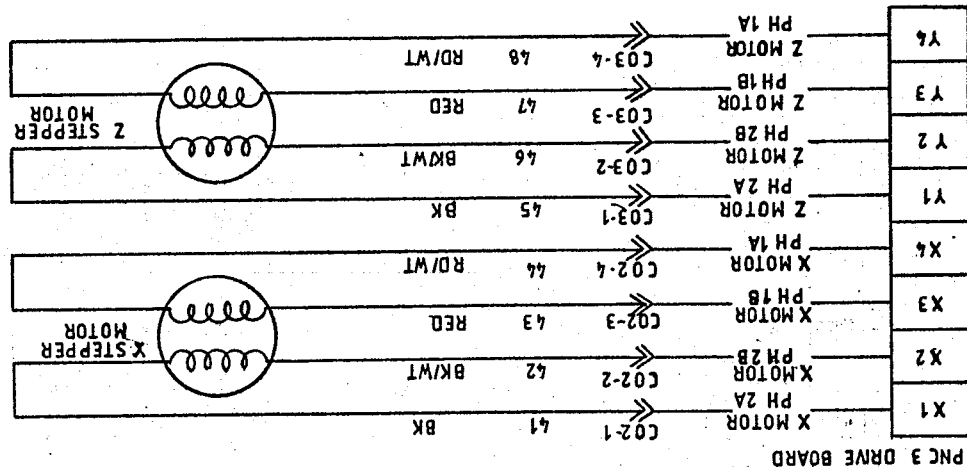
- 1) The start block number to be repeated
- 2) The end block number to be repeated
- 3) The number of repeats required
- 4) The required offset dimensions with required FEED changes if any.

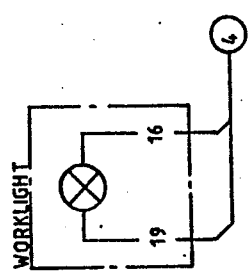
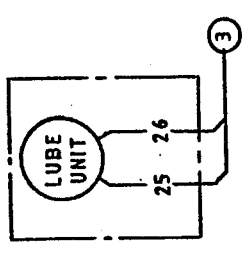
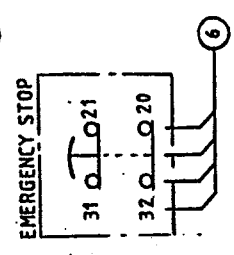
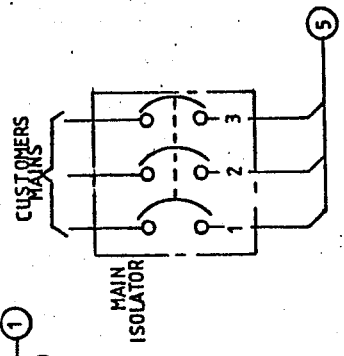
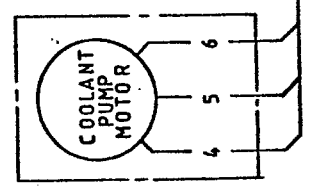
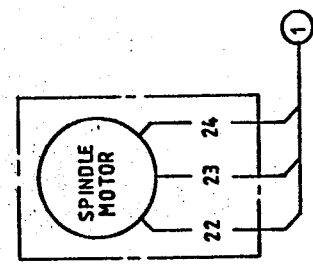
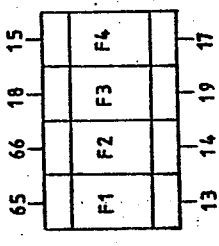
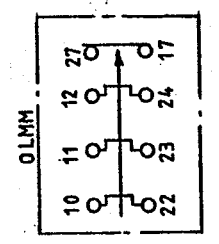
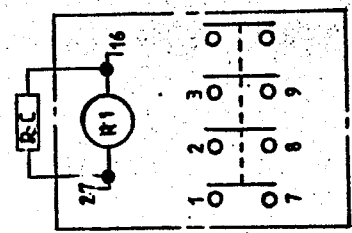
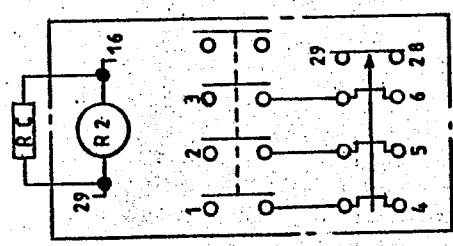
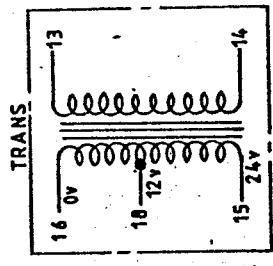
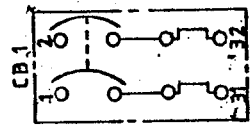
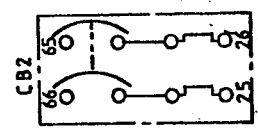
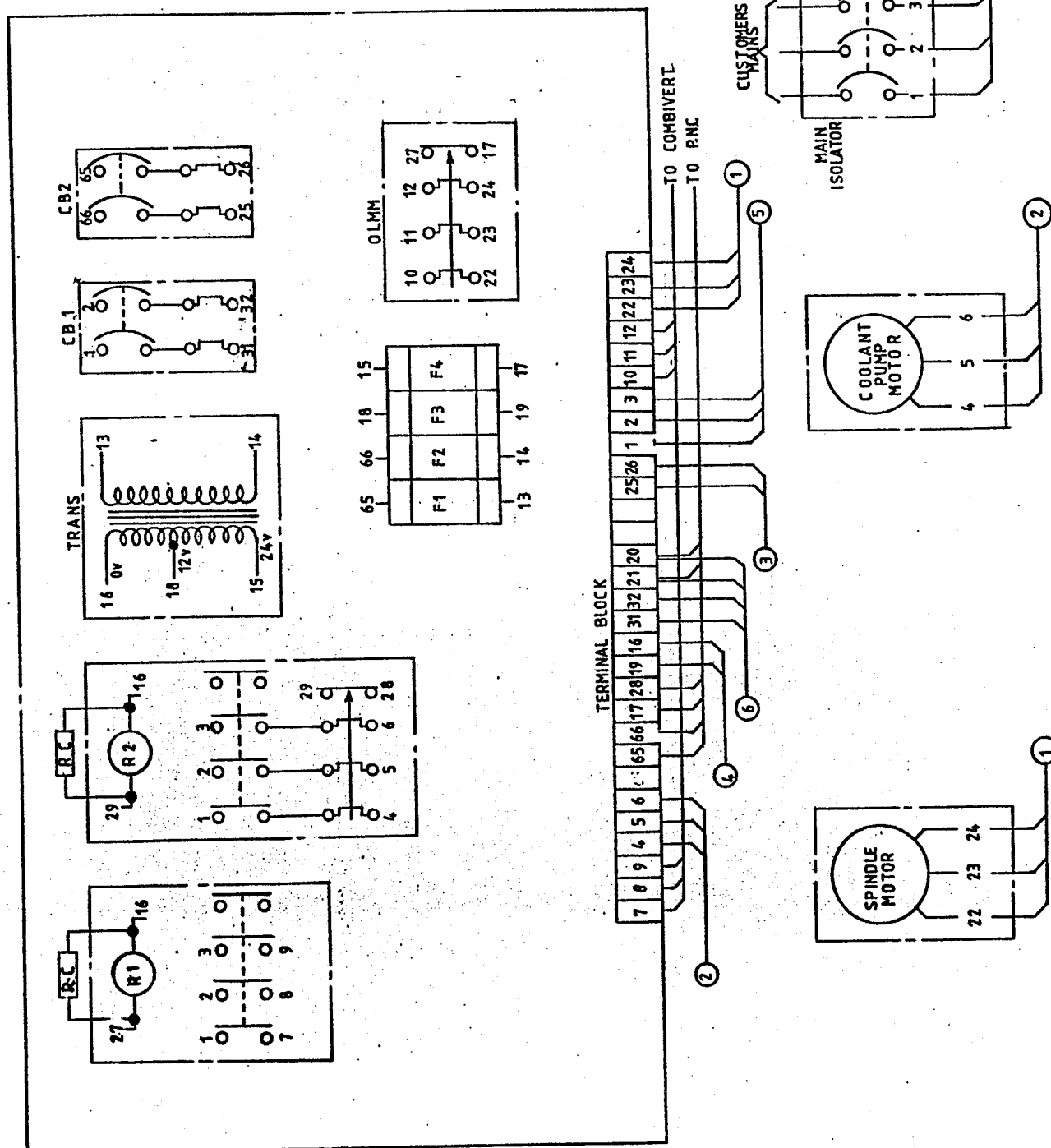
Repeats may be programmed up to a nested level of 3, should this level be exceeded "Nest error in repeat levels" is displayed. RESET restores normal operation.

When each repeat is programmed the PNC 3 checks all the dimensions being repeated, adding the programmed offset to the programmed number of times to ensure that the machine movement limits are not exceeded. This process may take a few seconds. Should the limits be exceeded "Move exceeds machine limit" is displayed. When program is attempted to be run RESET should be depressed and corrected data be Keyed in.

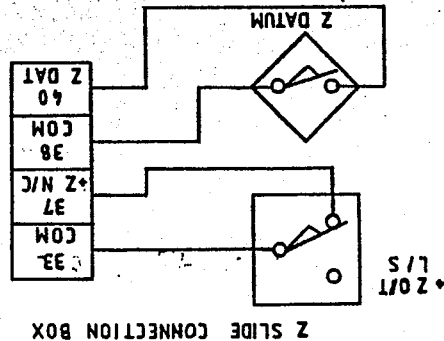
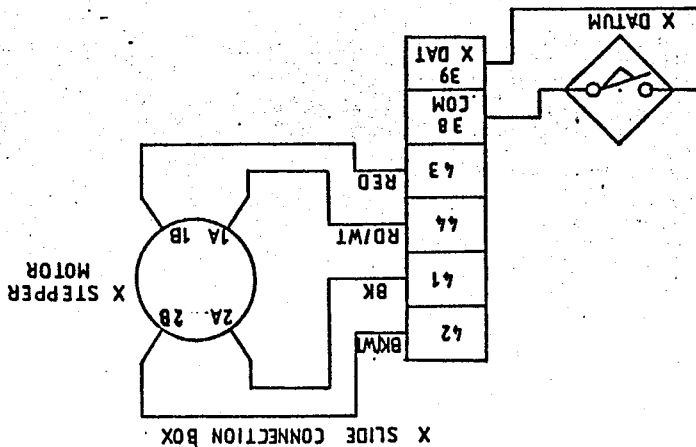
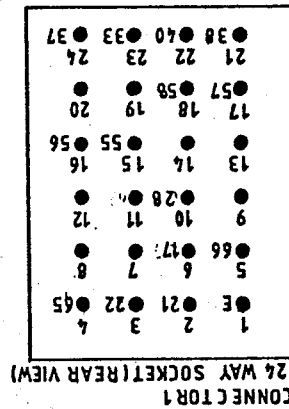
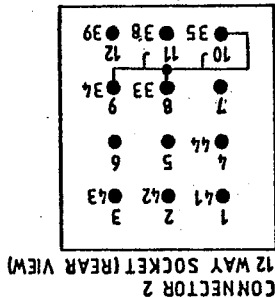
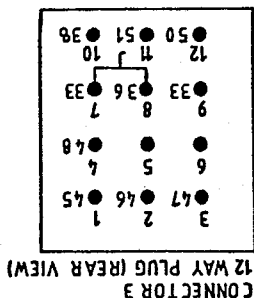
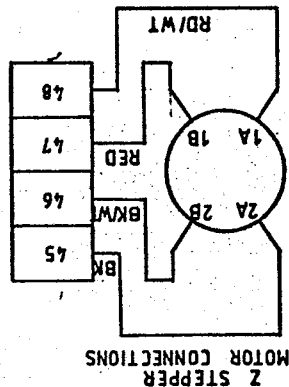
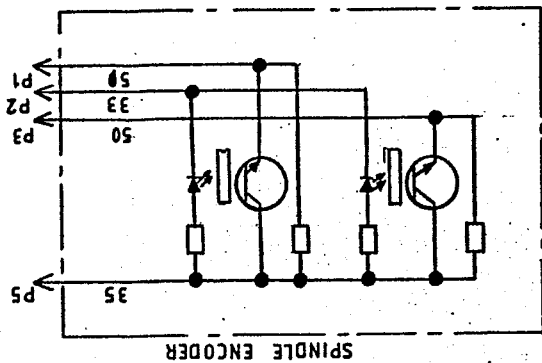


MICROMASTER (MEXICO)  
WIRING DIAGRAM SCHEMATIC N°1

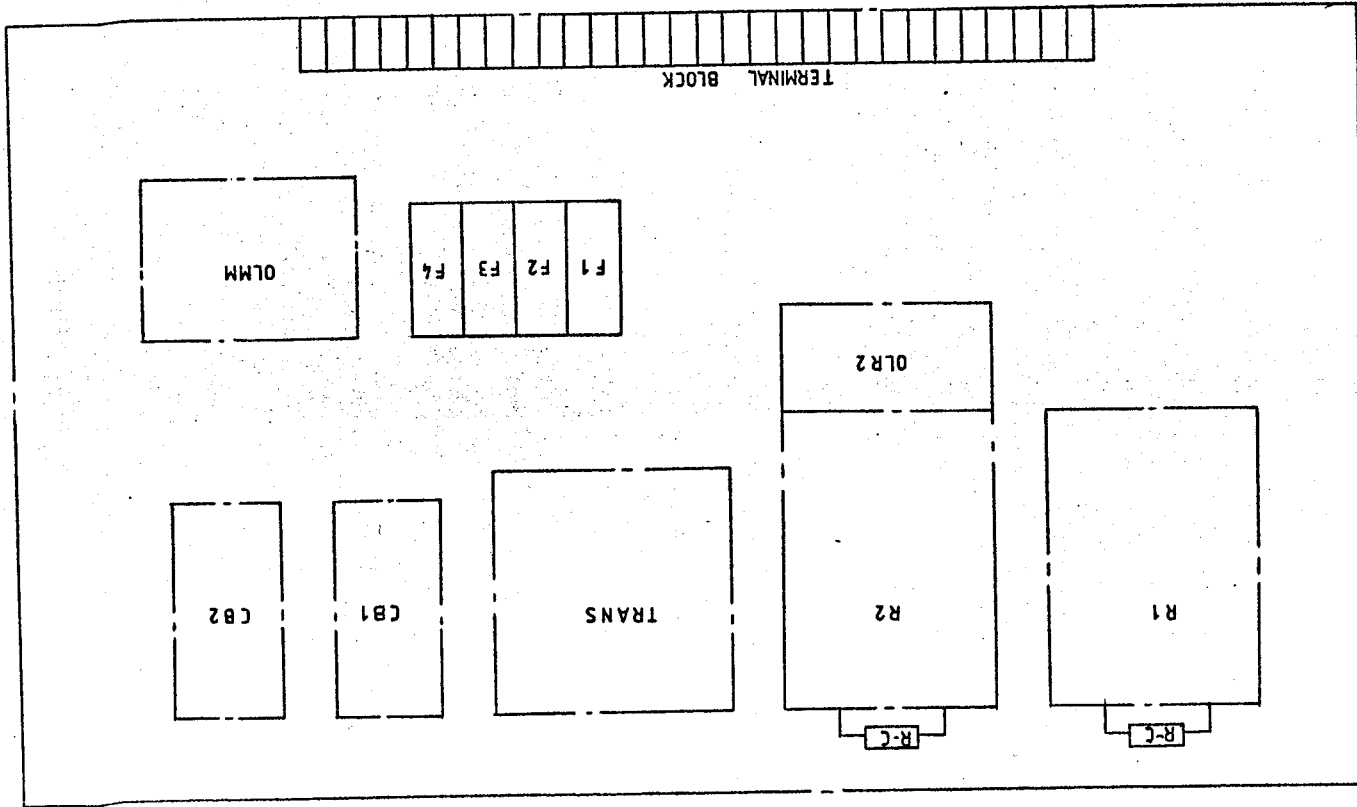




MICROMASTER (MEXICO)  
WIRING DIAGRAM MAGNETIC PANEL







PARTS LIST

ITEM W/D N°	DESCRIPTION	MANUFACTURER AND CATALOGUE NUMBER	QTY
1	PANEL PLATE	A3 - 300004	1
2	CONTRACTOR	BBC CAT N° 105 830	2
3	OVERLOAD RELAY	BBC CAT N° ROS 8AM045	1
4	OVERLOAD RELAY	KLOCKNER MOELLER Z0 6-7 3-7- 6-7A	1
5	TRANSFORMER	220V 1PH TO 12/24V	1
6	CIRCUIT BREAKER	BBC CAT N° S162 K10A	1
7	CIRCUIT BREAKER	KLOCKNER MOELLER CAT N° FAZG 0.5-2	1
8	KLIPPON FUSE RAIL		70mm
9	FUSE FITTING	KLIPPON CAT N° SAK S3 2689	4
10	END INSULATOR	KLIPPON CAT N° SAK S 3	1
11	END SECTION	KLIPPON CAT N° SAK S 3	2
12	FUSE	5A x 1 1/4	2
13	FUSE	2A x 1 1/4	2
14	TERMINAL BLOCK	2435-2	30
15	DIN RAIL	DIN RAIL	

MAGNETIC PANEL ASSEMBLY  
FOR MICROMASTER (MEXICO)