

N130 G01X28

N140 X32 Z-32

N150 Z-60

N160 X40

N55 G71etc.

U - Depth of cut

R - Tool relief amount

N60 G71 etc.

P - Sequence number of the first block defining the contour.

U - X Axis stock allowance for finishing.

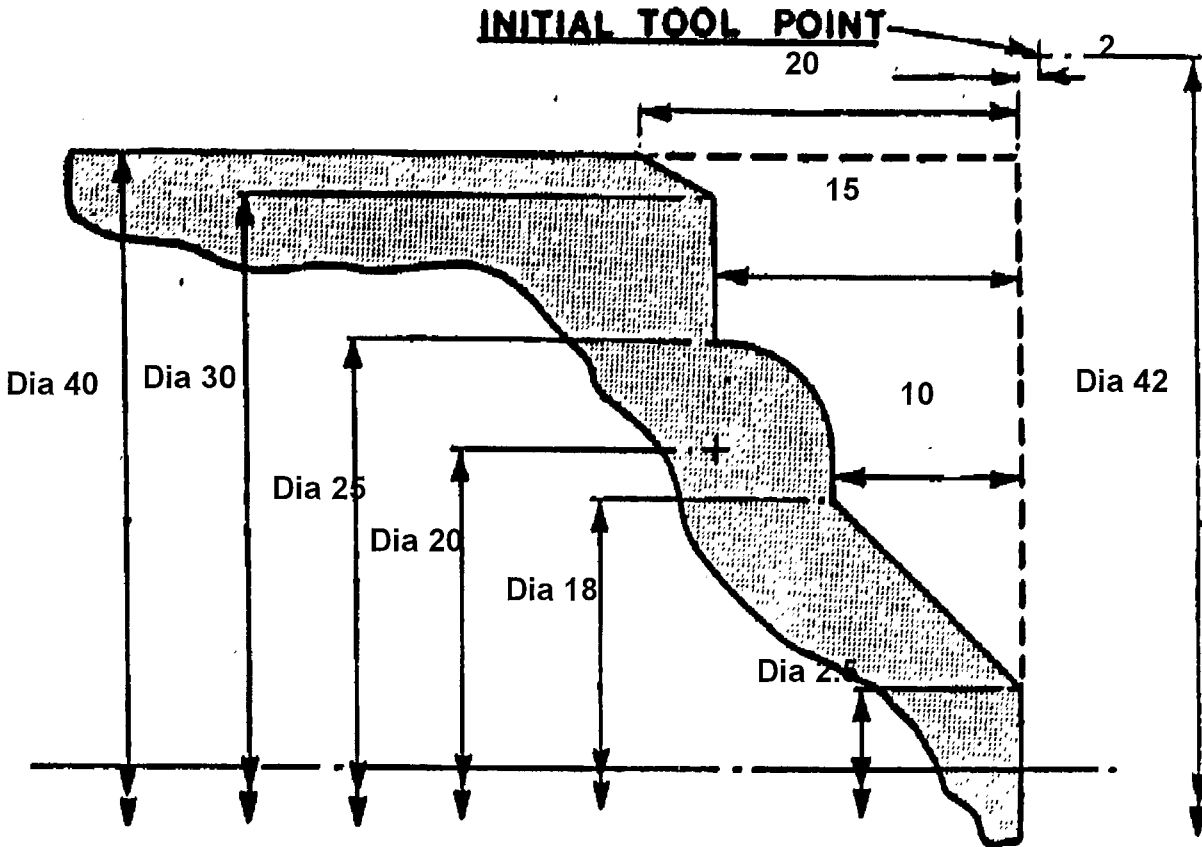
Q - Sequence number of the last block defining the contour.

W - Z axis stock allowance for finishing.

F - Feedrate for roughing cycle.

G72 STOCK REMOVAL FACING

This cycle is similar to G71 and is used when the major direction of cut is in the "X" axis.



N40 M06 T0 808

N50 G00 X40 Z2.0

N55 G72 W1.0 R1

N60 G72 P70 Q130 U0.1 W1.0 F0.15

N70 G00 Z-20.

N80 G01 X40.0

N90 X30.0 Z-15

N100 X25.

N110 G02 X20.0 Z-10 R5

N120 G01 X18.0

N130 X2.5 Z0

G70 P70 Q130

N55 G72etc.

W - Depth of cut

R - Tool relief amount

N60 G72 etc

P - Sequence number of the first block defining the contour

Q - Sequence number of the last block defining the contour

U - X axis stock allowance for finishing (diameter).

W - Z axis stock allowance for finishing

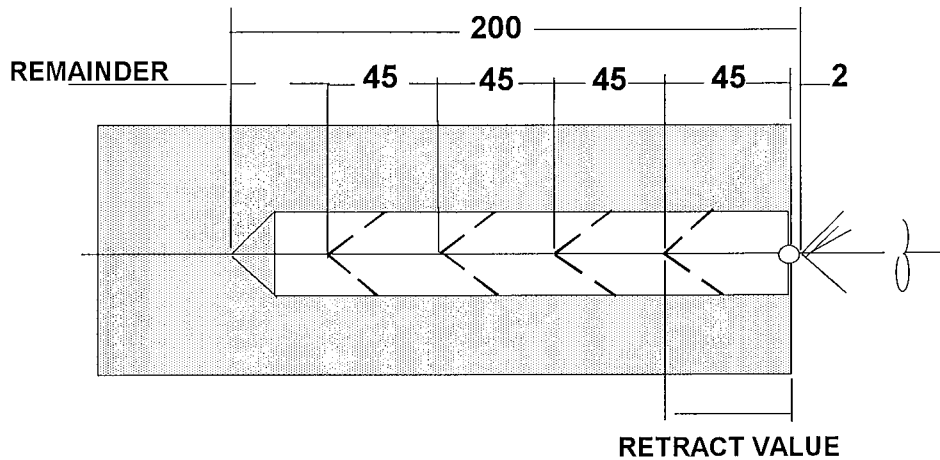
F - Feed rate for roughing cycle.

G70 FINISHING CYCLE

N200 G70 P70 Q120

P & Q - As above. Feed rates included in the blocks are active.

G74 PECK DRILLING



N700 G00 X0 Z2.0 T020 M08

N705 G74 R45

N710 G74 Z -200.0 Q45000 F.15

N705 G74

R - Retract Value

N710 G94

Z - Final Hole Depth

Q - Peck Increment, measured in microns, (No Sign Needed)

F - Feed Rate

PROGRAMMING SHEET

N10 G50 S2500

N20 G96 S200

N30 G21 G99 G40 M13

N40 M06 T01

N50 G00 X44 Z0

N60 G01 X-1 F0.15

N70 X44 Z2

N80 G71 U1.5 R1

N90 G71 P100 Q190 U0.5 W0.1 F0.1

N100 G01 X23 F0.4

N110 Z0

N120 X25 Z-1

N130 Z-21

N140 X20 Z-28

N150 Z-30

N160 G02 X30 Z-42 R30

N170 G01 Z-52

N180 X38 Z-56

N190 Z-64

N200 G70 P100 Q190

N210 G28 G97 U0 W0

N220 M06 T02 S2000

N230 G00 X0 Z2

N240 G01 Z-6 F0.1

N250 G00 Z5

N260 G28 U0 W0

N270 M06 T04 S1200

N280 G00 X0 Z2

N290 G01 Z-20 F0.15

N300 G00 Z2

N310 Z-19

N320 G01 Z-30

N330 G00 Z2

N340 G28 U0 W0

N350 M06 T05 S325

N360 G00 X25.25 Z5

N370 G76 P030060 Q100 R0.02

N380 G76 X23.773 Z-10 P0613 Q250 F1.0

N390 G28 U0 W0

N400 M06 T06 S2000

N410 G00 X11.75 Z2

N420 G71 U1.5 R0.5

N430 G71 P440 Q480 U-1 W0.1 F0.075

N440 G01 X19 F0.4

N450 Z0 F0.1

N460 X17 Z-1

N470 Z-25

N480 X11.75

N490 G70 P440 Q480

N500 G28 U0 W0

N510 M06 T03 S1500

N520 G00 X26 Z-17

N530 G01 X21 F0.07

N540 G00 X26

N550 Z-15

N560 G01 X25

N570 X21 Z-17

N580 G00 X26

N590 Z-19

N600 G01 X25

N610 X21 Z-17

N620 G00 X31

N630 Z-48

N640 G01 U-5

N650 G00 U5

N660 W2

N670 G01 U-1

N680 U-4 W-2

N690 G00 U5

N700 W-2

N710 G01 U-1

N720 U-4 W2

N730 G00 X40

N740 Z-63

N750 G01 X36 F0.08

N760 G00 X40

N770 Z-62.5

N780 G01 X38

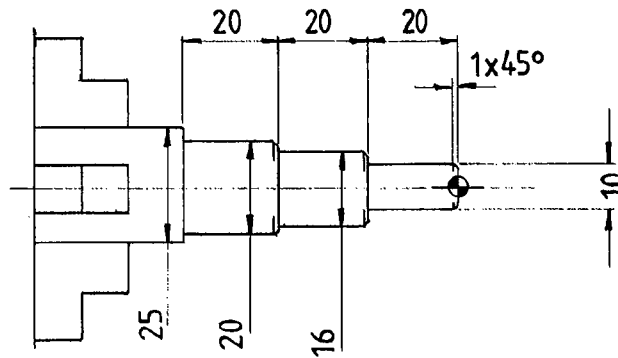
N790 X37 Z-63

N800 X-0.5

N810 G28 U0 W0 M05

N820 M30

SAMPLE PROGRAMS



SAMPLE PROGRAMNo. 1001

[BILLET X25 Z65.	-----	Billet Size
O 1001	-----	Program Number
G 99 G21 G40 G97 S 2000 M13	---	Set Cuting Conditions
M06 T0101	-----	Tool Call
G00 X26 Z2	}-----	Face and Retract
G01 Z0 F0.3		
X-1 F0.1		
G00 X25 Z1	-----	
G71 U1.5 R0.5	}-----	Set Parameters for Canned Cycles
G71 P1 Q2 U1 W0.1 F0.125		
N1 G00 X8		
G01 Z0 F0.1		
X10 Z-1 F0.05		

Z-20 F0.1

X14

X16 Z-21 F0.05

Z-40 F0.1

X18

X20 Z-41 F0.05

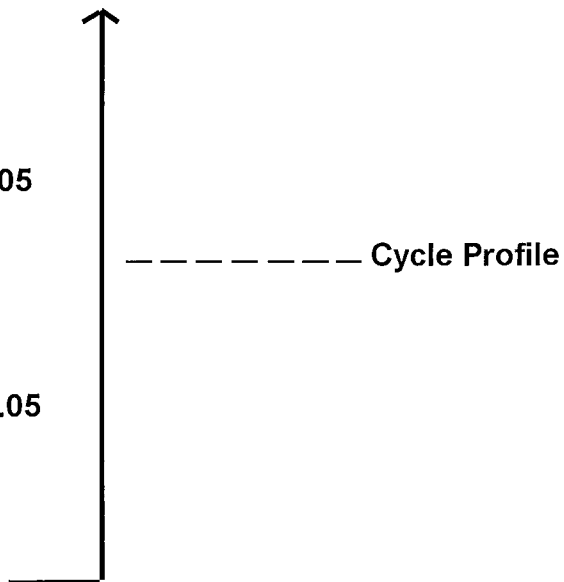
Z-60 F0.1

N2 X25

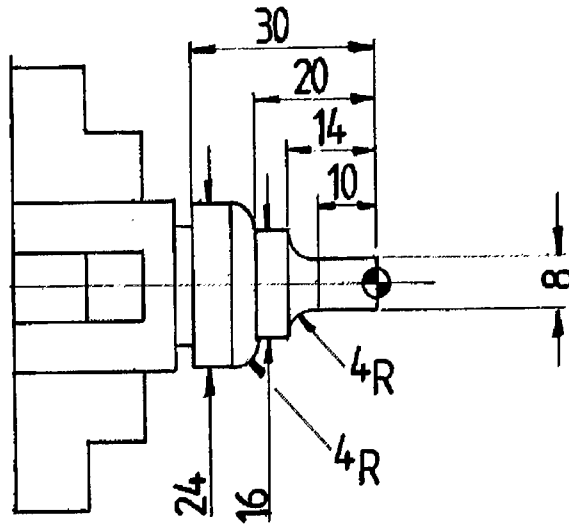
G70 P1 Q2 ----- Finish Profile

G28 U0 W0 ----- Reference Point Return

M30 ----- Program Reset and Rewind



SAMPLE PROGRAM No 1002

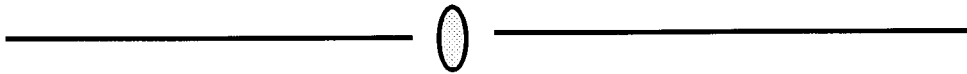
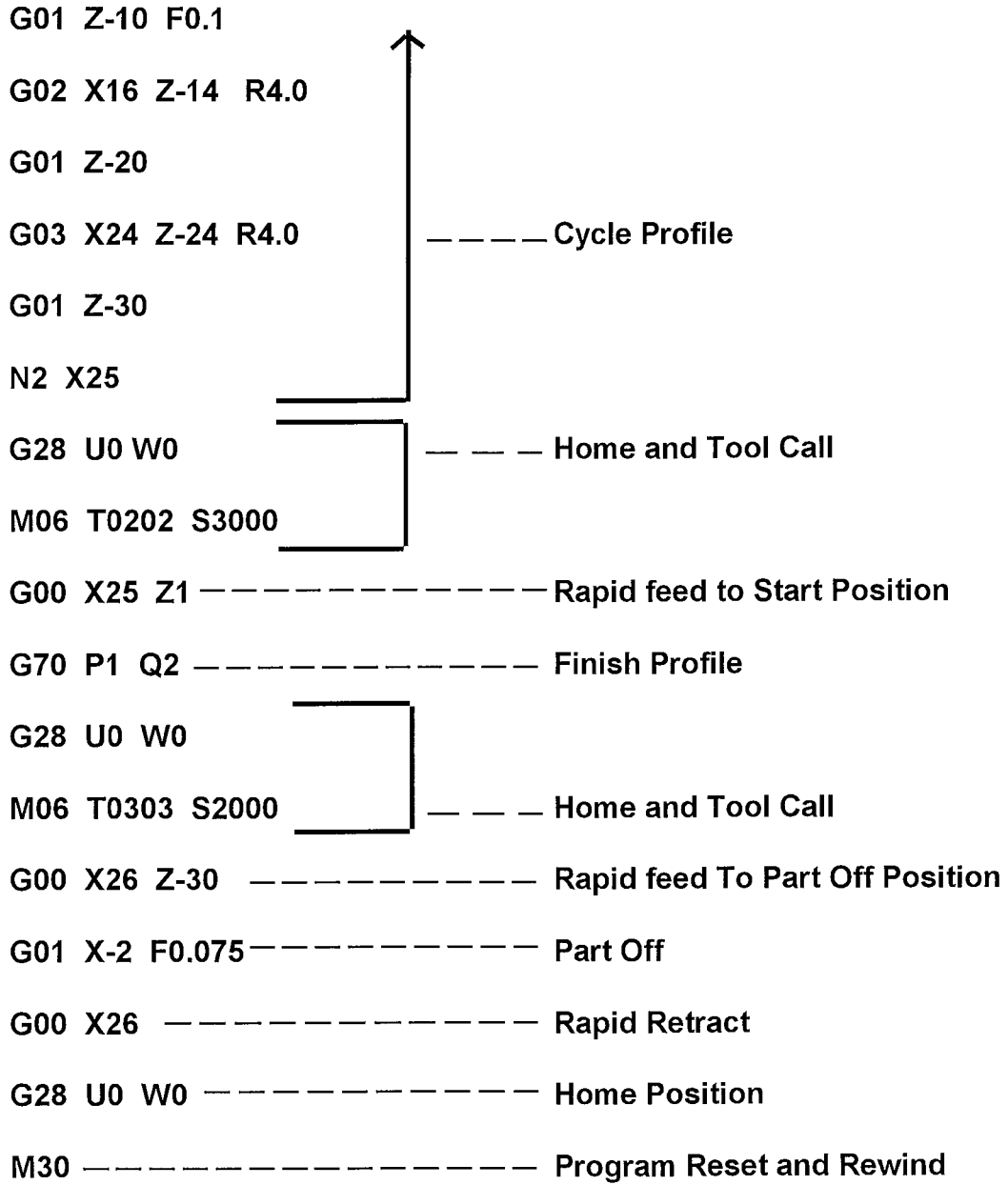


```

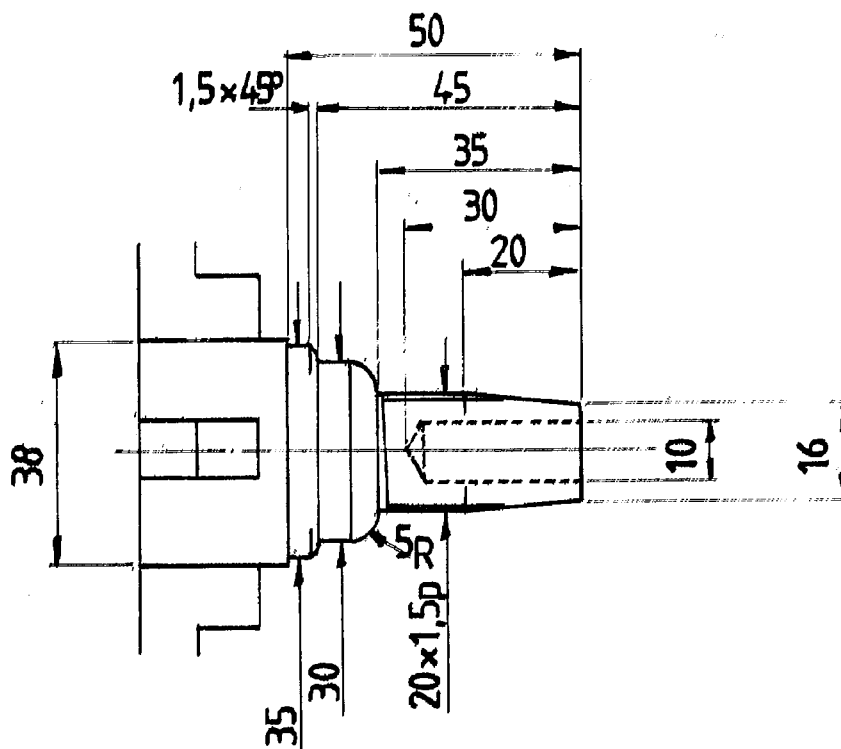
[BILLET X25 Z35 ----- Billet Size
O 1002 ----- Program Number
G99 G21 G40 G97 S2500 M13 ----- Set Cutting Conditions
M06 T0101 ----- Tool Call

G00 X26 Z2
G01 Z0 F0.2 ----- Face and Retract
      X-1 F0.1
G00 X25 Z1

G71 U1.5 R0.5 ----- Set Parameters for Canned
G71 P1 Q2 U1 W0.1 F0.125 ----- Cycle
N1 G00 X8
  
```



SAMPLE PROGRAM No. 1003



[BILLET X38 Z55 ----- Billet Size

O 1003 ----- Program Number

G99 G21 G40 G50 S3000----- Set cutting Conditions, Max RPM

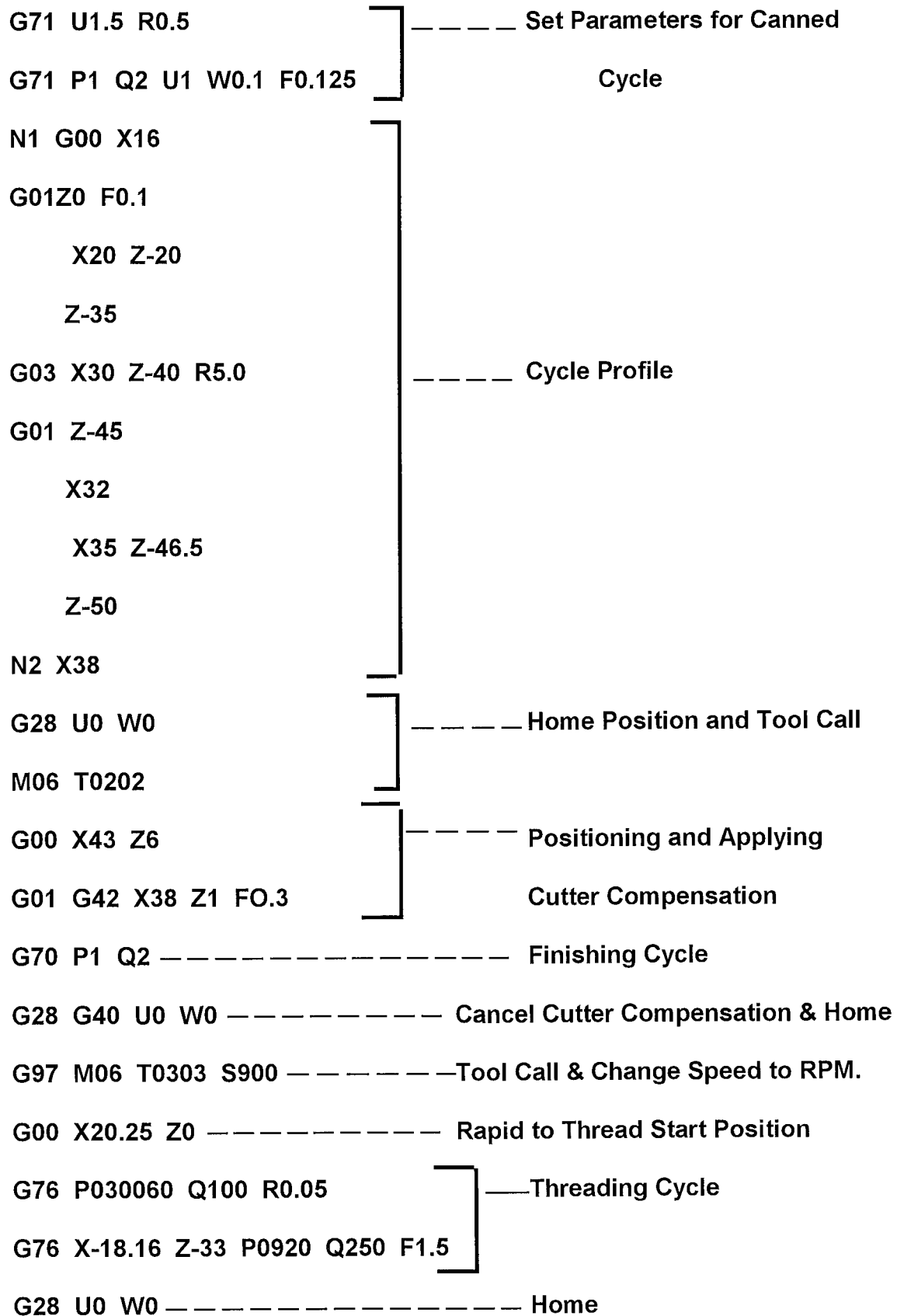
G96 S150 M13 } ----- Constant Surface Speed, Start

M06 T0101 } ----- Spindle, Coolant on, Tool Call

G00 X39 Z2 ----- Rapid feed to Start Position

G01 X-1 F0.125 } ----- Face and Retract

G00 X38 Z1 } -----



M06 T0404 S1500 -----Tool Call
 G00 X0 Z2
 G01 Z-6 F0.1 ----- Centre Drill and Home
 G00 Z2
 G28 U0 W0
 M06 T0505 S1200 ----- Tool Call
 G00 X0 Z2----- Start Position of Drill
 G74 R1.0 ----- Canned Cycle for Drilled Hole
 G74 Z-30 Q10000 R0.0 F0.125 ----- Including Peck
 G28 U0 W0 ----- Home
 M30 ----- Program Reset and Rewind

19. APPENDIX 1. **HELP FILES AND TOOLSHAPES.**

HELP SCREENS

All the Help Screens which appear in the software can be configured, amended and added to by the end user. This is not, however, an easy task and care must be taken to produce good results.

All the Help is stored in two files on Disk:-

- 1 - The compiled version is "TU150.MSG" extension.
- 2 - The text version is "TU150.TXT" extension.

The Text file can be loaded into any word processor, or even into the CNC Editor. Changes can be made and the new file can be saved to Disk.

IMPORTANT

Keep the original copy of TU150.TXT, in case the changes you have made result in errors during compilation.

Once the changes have been made and a new file has been saved to disk, it is possible to produce a compiled version. It is the compiled version which is integrated within the software- simply changing the Text file will not alter the Help used by the software.

HOW TO COMPILE A NEW HELP FILE.

On the Drivers Disk supplied with system, there is a file called "MESSAGES.EXE". This will have been copied over when you installed the system if you are on a Hard Drive.

COMPILING FROM HARD DRIVE.

Make sure that the new file is stored in the same Directory as the software, and that you are in that Directory. For example if you have created a Directory called "HARRISON" then type :-

CD\HARRISON

Then Type:-MESSAGES TU150

You will have to wait a few seconds before a compilation of the completed message appears. If you are successful run the software again to see the changes. If an error shows, read the following section on How Help Screens Work.

COMPILING FROM FLOPPY DRIVE

Make sure the new file is saved on the Drivers Disk where the MESSAGES.EXE file exists.

Type:-MESSAGES TU150

A new TU150.MSG file will be created which can be copied over on to the main program Disk, overwriting the original Help.

HOW HELP SCREENS WORK

The Help file contains different types of information. to locate a particular entry, it is necessary to understand the structure of the Help file.

HELP FILE STRUCTURE

Comments example :- (THIS IS A COMMENT

Comments start with an open bracket and can be inserted anywhere in the Help file. They are ignored by the compiler, and are only there to help the end user document the Help file.

Page Start Example |HELP PAGE1 A|

Example |G and M Code Errors|

Each Page Start begins with a tramline character followed by the page name. Actual Help Pages have a designated letter from A to Z. A page start can be :- help, start of error messages, or information text.

IMPORTANT

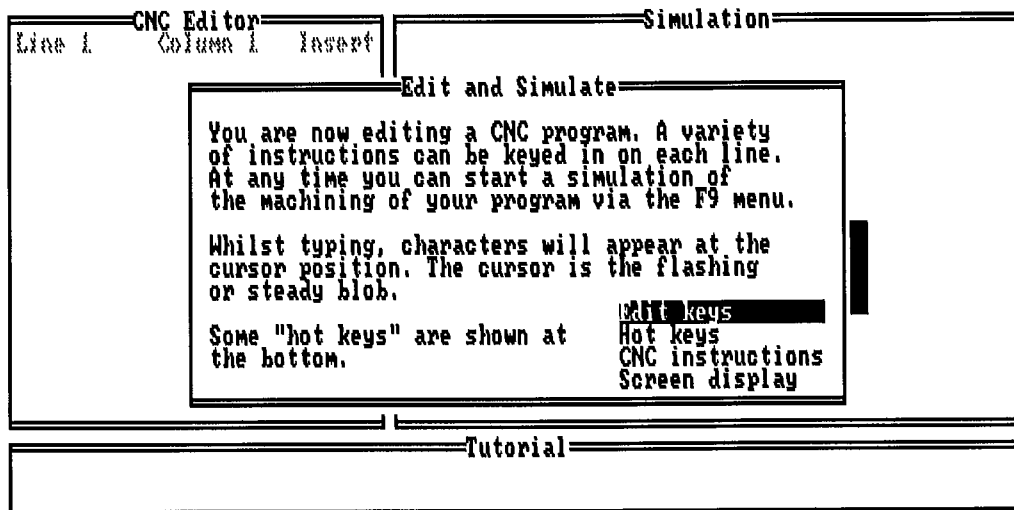
It is vital that the pages relating to error messages, fast key strips and text which are used directly by the software are not altered. The software relies on each line being in sequence. Help screens that are used with the F1 key can be placed anywhere, but we suggest you put them at the end of the program.

CONTEXT SENSITIVE HELP (FOR HELP SCREENS ONLY)

HOW IT WORKS

To insert a new Help Page you must first decide what type of Help you require and where in the program the Help should be placed.

For example, we might like a lesson on CNC programming to be available by pressing the F1 key during edit mode. At the moment pressing the F1 key during edit displays:-



HOW TO ADD A CNC LESSON AS A SUB MENU:-

- 1 - Decide what the menu option should be called. In this case, we shall call it "CNC Lessons".
- 2 - Choose a name for the Help Page we want to display when we select CNC Lessons. In this case LESSON1.
- 3 - Load the Help File into the CNC Editor and locate the Help page displayed above. You will find the start of the page near to line 676. The page start is |EDIT AND SIMULATE|which is called up by pressing F1 when in the Edit and Simulate Mode.
- 4 - At the bottom of the Help Text, you will see the sub menus being referenced.
- 5 - Add #CNC Lessons#LESSON1 A to list.
- 6 - Go to the end of the file to write the Help screen for LESSON1.
- 7 - Type |LESSON1 A|. This is the start of Lesson1 and the page number is "A". Always use capital letters for Page Starts.
- 8 - On the next line, write a title for the Help Screen-try CNC Lesson One.
- 9 - Now you can write the actual text - making sure the lines are no longer than 47 characters.
- 10 - If you want more room for the CNC Lesson, you can start a new page by typing |LESSON1 B|

CNC Lesson one Page 2 - Followed by the Text.
- 11 - If you want sub-menus to be displayed on your new Help Page, simply place the referencing commands at the bottom of the Help Page. Example #G and M code#HELP PAGE1 A
- 12 - Upon completion, save the new Help File and compile to Disk. Run the software to test the changes.

FAST KEYS

To help with software operation there are several Fast Keys that can be used. These are displayed at the bottom of the screen on the Fast Key Strip.

The Fast Keys change during menu changes and are constantly updated by the Key Strip. The following is a list of FAST KEYS:-

- F1 Get Context Sensitive Help
- F2 Quick save CNC program
- F3 Quick load CNC program
- F5 Get information
- F9 Check/run CNC programs
- F10 Get main menu

HELP SCREENS

Context sensitive Help is available at all times, with sub-related topics.

The following keys are used:-

- F1 To select Help
- Ctrl F1 To select G and M code Help.
- F1 To select Sub Related Help.
- Arrow Keys To select from Help Options.
- PageUp/Down To display Help Pages.
- RESET To exit.

INFORMATION WINDOW

Press F5 to display the Information Window.

Press Page Down to view additional information window.

Press RESET key to clear.

DEFINING TOOLSHAPES.

Toolshapes can be written in text format or passed over to the system from CAD, using the DXF interface.

Each toolfile contains the following:-

Any number of comments, preceded by the open bracket "("; and a name for the tool (this can be a tool reference number, or a short description).

Two lines may be used for an information title. This will be displayed with the toolshape. It is advisable to record the sizes of the toolshape, especially boring bars.

The geometry of the toolshape in absolute will follow. These are all line or arc moves. This format is compatible with DXF geometry. Simple shapes can be typed in. A drill, for instance, changes in diameter, so taking an existing drill shape and changing the diameter can be done in the editor.

CONVERTING TOOLSHAPES

Load TU150.GRT file into an editor and add a toolshape at any position in the file before or after an existing toolshape.

Save the file to disk.

DXF TO TOOLSHAPE FILE

To convert from DXF to a toolshape data, use the file DXF_TEXT.EXE. It is only possible to convert one shape at a time. Type DXF_TEXT.EXE followed by the Drive letter, Directory and DXF filename. Example :- DXF_TEXT.EXE C:\ACAD\TOOL1

Once the DXF file has been converted, it can be merged into the toolfile, and the toolshape name and information added.

20. APPENDIX 2 CUSTOMISING SETTINGS FILE.

TYPICAL SETTINGS FILE

Most of the settings are self explanatory, but selecting from the Menu Options is easier than editing the file. Some settings options can only be changed by loading a Settings file, and adding the extra options. Because a control might have changed over the years, it is possible to change various settings, to make the software compatible with all controls.

The vast majority of end users won't have any modifications at all.

An example of a setting change that might be required can be seen below, where the HIGHSPINDLE has a value of 5000rpm. The same control might be on a machine with a faster spindle motor, so the top spindle speed will be higher. If the traverse distance on the "X" axis is different this can be changed by editing the MOVERANGEX value.

IMPORTANT

The parameters in the Settings file are always in Metric.

Fanuc Lathe Settings File

UTILS_MENU_1 Dos Access

UTILS_GO_1 dos

AUTOERROR 0

LOWSPINDLE 100

HIGHSPINDLE 5000

MOVERANGEX 82.5

MOVERANGEZ 178

MACHINEEXTENTX 130

MACHINEEXTENTZ 202

BILLETX 70

BILLETZ 200

CHUCKX 170

CHUCKZ 20

JAWSX 15

JAWSZ 10

CHUCKCENTREX 75

SHAPE1 TOOL15

SHAPELR1 1

SHAPEFB1 1

SHAPE2 20MMDRL

SHAPELR2 1

SHAPEFB2 1

SHAPE3 TOOL26

SHAPELR3 1

SHAPEFB3 1

SHAPE4 TOOL25

SHAPELR4 1

SHAPEFB4 1

SHAPE5 TOOL14

SHAPELR5 1

SHAPEFB5 1

PRINT_DEVICE 0

PRINT_DDEVICE PRN

PRINT_BAUD 1200

PRINT_PARITY 2

PRINT_PROTOCOL 2

PRINT_STOPBITS 2

PRINT_USELF 1

PRINT_FFNULLS 0

PRINT_PW 80

PRINT_PL 64

PRINT_LM 10

PRINT_TM 20

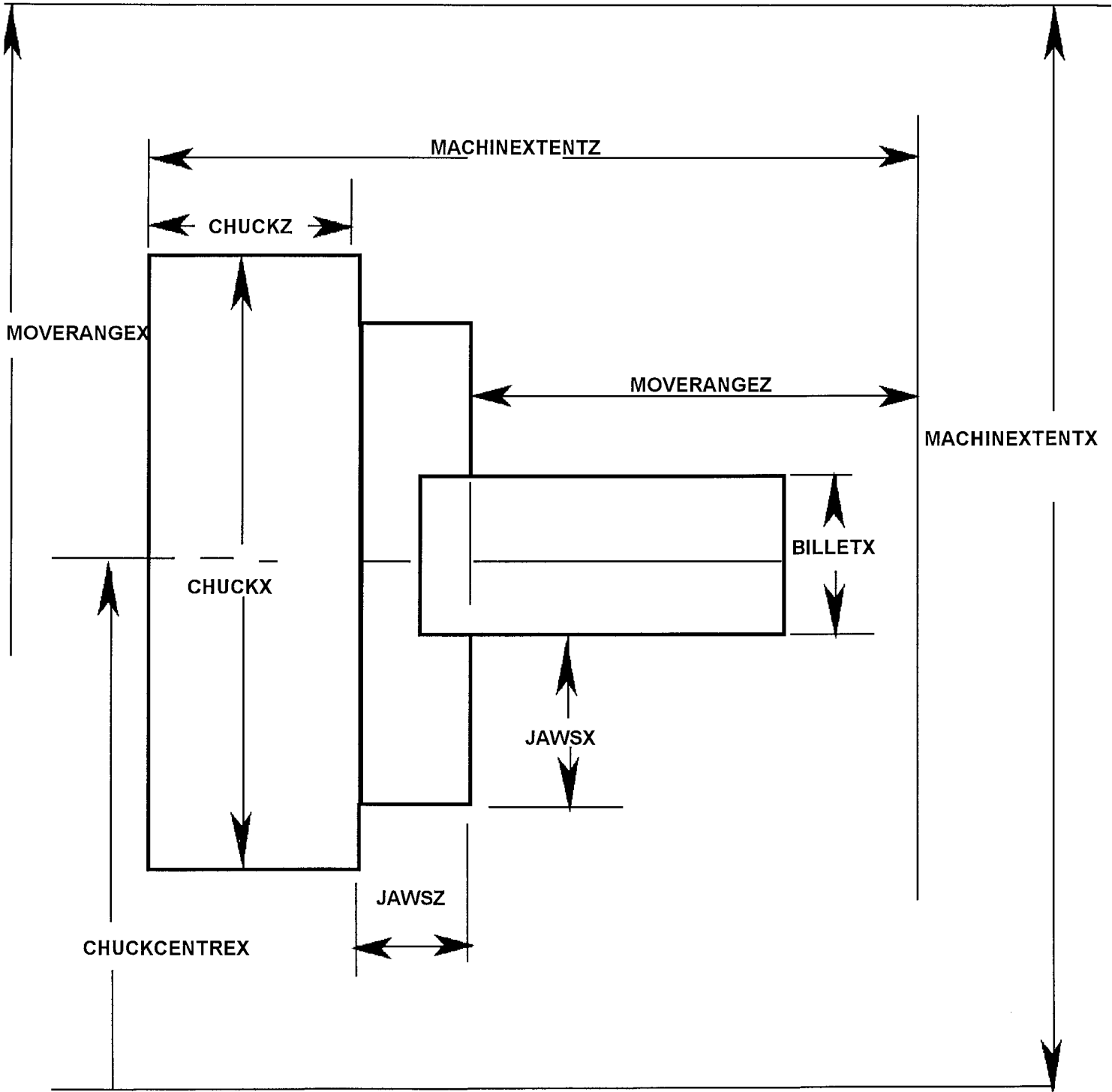
PRINT_BM 10

PRINT_CRNULLS 0

COMPUTER_SDEVICE COM1

METRIC 1

DISPLAYSIZE 1



OPTIONS FOR LATHE SIMULATION

21. APPENDIX 3 GLOSSARY OF TERMS

ARC A portion of a circle

ARC CENTRE OFFSET The incremental distance between the programs cutter path and the arc centre in the X and/or Z direction. The X and Z values are written as the I and K amounts without a directional sign.

ASCII American Standard for Information Interchange.

AUTOMATIC CYCLE Is a mode of control operation that continuously runs the cycle or stored program until a program stop or end of program word is read.

AUXILIARY FUNCTION The function of a machine other than the co-ordinate commands.-eg:- F00, S100, T0100, M08.

AXIS X axis: Line perpendicular to the spindle centre- line (absolute).

U axis: Line perpendicular to the spindle centre -line (incremental)

Z axis: Line parallel with the spindle centre -line (absolute)

W axis: Line parallel with the spindle centre -line (incremental)

BINARY A system for describing numbers using only two digits.

BIT The smallest programmable unit (i.e 1 or 0) in machine code. 8 Bits = 1 Byte

BLOCK A word or words that collectively provide sufficient information for a complete operation. The block is separated from other blocks by an end of block character.

BLOCK DELETE Is a feature which provides means for skipping blocks (which have been preceded by a slash/code) at the discretion of the operator.

BUFFER STORAGE Is an information storing area which is utilised to transfer the

stored data to active storage almost instantaneously.

CANNED CYCLE Is an automatic motion cycle which is held in buffer storage for the duration of the amount of cycle repeats programmed.

CHARACTER A number, letter or symbol as entered into a CNC program.

CIRCULAR INTERPOLATION A means of programming an arc by providing a few basic statements.

CLOSED LOOP A system in which the result of the output is measured and fed back for comparison with the input.

CNC Computer numerical control See **SOFTWARED N.C**

COMMAND A signal or group of signals initiating one step in the execution of a program.

CONTOURING (CONTINUOUS PATH) Co-ordinated simultaneous motion of two or more axes.

CORNERING The effect at the machine due to the difference of electrical commands and slide positioning whilst commanding an abrupt change of direction.

C.S.S. Constant Surface Speed. A feature in a control system which tracks the point of a cutting tool so that the spindle can be constantly monitored to give the correct peripheral speed condition.

C.P.U. Central Processing Unit.

DECODE The traslation from tape coded language to control recognisable language.

DRY RUN The use of this function enables the operator to run through the program replacing the programmed feed rates with the maximum jog feed, to test run the program and check tool clearance.

DWELL A programmed time delay.

EDIT Having put the program into memory, the machine can then be operated from memory and suspect blocks of data can then be displayed for examination. The faulty block can then be erased or correct information put in its place by means of MDI and the EDIT facility. The batch can then be run off entirely from the memory. The

program information can then be stored on disk.

EIA Electrical Industries Association has been responsible for setting many N.C standards, one being tape coding information.

ENCODER A device connected to the leadscrew for comparing the position with the control input instruction.

END OF BLOCK A character inputted in the program which denotes the end of a block of data.

EXECUTIVE In CNC systems the executive software determines the manner in which the program data is processed.

FEED HOLD At any stage in the cycle, the operator can stop the machine movements using the cycle stop key.

FEEDRATE Is commanded in the C.N.C. program by the F word and used by the control to drive the slides. The rate of feed may be programmed as FEED/MIN or FEED/REV.

FEEDRATE Is an interrupt used to hold slide motion.

FEEDRATE OVERRIDE A manual function can be used by the operator to override the programmed feed rate within certain limits.

FOLLOWING ERROR The lag distance between the actual machine position and the command position.

FORMAT The arrangement and overall pattern in which the input data is organised (formatted).

G CODE A preparatory code in the program which determines the control mode.

HARDWARE The physical components of a control system or computer.

HARDWIRED A numerical control system which is dedicated to driving a machine through committed circuit connections, and requiring the input data to be in a fixed format.

I REGISTER A value which when programmed is used by the control as an X axis arc centre offset or as a velocity rate for feed and threading.

INCREMENTAL PROGRAMMING A method of programming in which the motion statements relate from the previous programmed position. The signs which accompany the departure commands in this system are directional in meaning.

INPUT The transfer of external information into the control system.

INTERGRATED CIRCUIT A complete circuit constructed within or on the surface of a silicon chip.

INTERFACE The medium through which the control or computer directs the machine tool.

INTERPOLATION The method used by the control system to achieve a series of approximations via straight lines to enable an acceptable execution for tapers or arcs.

ISO International Standards Organisation.

K REGISTER A value which when programmed is used by the control as a Z axis arc centre offset or as a velocity rate for feed and threading.

M CODE (Miscellaneous Function) The M words are used by the machine tool builder to indicate certain auxiliary functions such as coolant on, turret index, speed range etc.

MANUAL DATA INPUT (MDI) A means of inserting data into the control system manually. The data entered is identical to that entered from a disk or stored program.

MEMORY The storage capacity of a system to retain a part program or Programs.

MODAL Information that is entered into the control and retained until changed.

N WORD A word comprising a unique sequence number which is used to identify a complete block of information.

OCTAL NUMBERS A numbering system which operates to a base of 8. Octal is more readily convertible to the decimal system than is the binary system.

OPEN LOOP A system in which the output cannot be measured and feedback for comparison with the input.

OPTIONAL STOP A miscellaneous command which is given by the programmer to stop the spindle, and feed at a specific point in the program at the discretion of the

operator.

PROGRAM STOP A miscellaneous command which is given by the programmer to stop the spindle, and feed at a specific point in the program.

RESOLVER A device geared to the leadscrew for comparing the position with the control input instruction.

RECTANGULAR CO-ORDINATES A component graphically shown as two perpendicular axes (X and Z) along which any point can be described in terms of distance and direction from any other point. The part program is written from this source.

RESOLUTION The smallest increment of distance that will be developed by the control system in order to command machine motion.

S ADDRESS A word used in commanding the spindle speed.

SEQUENCE NUMBER See N Word.

SOFTWARED N.C. A control system that has been pre-programmed with software to enable it to drive a machine tool.

STEP-BY-STEP OPERATION An extension of MDI permits the machine to operate block-by-block, to permit the checking of each stage of the job, if required.

SUB-ROUTINE A stored sub program which is called from the main program.

TAB Tab characters may be used to space out the words in a program manuscript in columns if required.

TOOL OFFSET A feature that allows the operator to make tool adjustments to compensate for the difference between the actual and the programmed setting dimensions.

U WORD The U Word is used to command motion perpendicular to the spindle centre-line (incremental).

W WORD The W Word is used to command motion parallel to the spindle centre line (incremental).

WORD A combination of the letter address and digits.

ADDRESS	DIGITS	WORD
X	+002.0000	X+002.0000
F	1.9990	F1.9990

X WORD On 2 and 4 axis machines X Word is used to command motion perpendicular to the spindle centre line (absolute).

Z WORD On 2 and 4 axis machines Z Word is used to command motion parallel to the spindle centre line (absolute).

ZERO In absolute programming, zero is the point from which all other dimensions are referenced.

22. APPENDIX 4

LIST OF ABBREVIATIONS

G.B.T. NO.	=	Group Block Terminal
EXECUTE OR MDI	=	Manual Data Input
MSD	=	Machine Set Up Data (or Parameters)
RAM	=	Random Access Memory
ROM	=	Read Only Memory
PROM	=	Programmable Read Only Memory
EPROM	=	Erasable Programmable Read Only Memory
PCI	=	Program Controlled Interface (i.e. Ladder Diagram in Software).
PWM	=	Pulse Width Modulated G.E Servo Drive or Hi-Ak Drives.
SCR	=	Silicon Controlled Rectifier (i.e Thyristor Drives used on Spindle)
TRIAC	=	Solid State Relay
I.P.	=	Initial Position or Zero Ref. Point
BCD	=	Binary Coded Decimal
LED	=	Light Emitting Diodes
IC	=	Input Conditioner or Input Filter

OD	=	Output Driver
+VE	=	Positive
-VE	=	Negative
DVM	=	Digital Voltmeter
POT	=	Potentiometer or Variable Resistor
LSI	=	Large Scale Integration
PCL	=	Programmable Controller Language
MCL	=	Machine Control Logic

23. APPENDIX 5 TRIGONOMETRY WITH EXAMPLES

The following pages of trigonometrical formulae are intended as an aid to working out angles and distances when planning a CNC Program.

APPENDIX 5 TRIGONOMETRY WITH EXAMPLES

a) Tangent

In Fig. 2 AOB is an angle of say 30 Degrees. The triangles LPO, MQO and NRO are similar because they all share the common angle of 30 Degrees. Therefore a common ratio for the three triangles can be shown as:

$$\frac{LP}{OP} = \frac{MQ}{OQ} = \frac{NR}{OR}$$

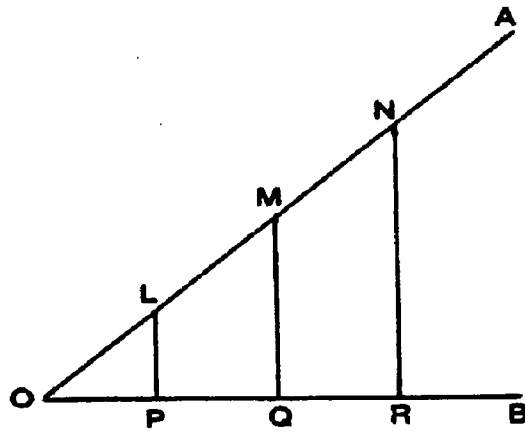


Fig. 2

If these sides were known, then dividing LP by OP and MQ by OQ and so on will produce the same common ratio.

If side LP is 5 mm and OP is 8.66 mm then LP/OP produces a ratio of .5774 or tangent value for 30 Degrees, a set of tangent tables are compiled in this way.

In the triangle LOP, side LP is opposite to the angle AOB, side OP is adjacent to the angle LOP, so to calculate a tangent ratio for the triangle LOP may be shown as:

$$\text{Tangent value} = \frac{\text{Opposite Side}}{\text{Adjacent side}}$$

b) Sine

In Fig. 2 the triangles LPO, MQO, NRO are similar because they all share the same angle (90 Degrees) at P, Q and R. Therefore a common ratio for three triangles can be shown as:

$$\frac{PL}{OL} = \frac{QM}{OM} = \frac{RN}{ON}$$

Therefore the ratio of PL/OL depends on the angle value of AOB only, and dividing these two values will always produce the same common ratio.

If side PL is 5 mm and OL is 10 mm then PL/OL produces a ratio of .5000 or sine value for 30 Degrees, a set of sine tables are compiled in this way. In the triangle LOP, side PL is opposite to the angle AOB, side OL is the hypotenuse of the triangle LOP, so to calculate a sine ratio for the triangle LOP may be shown as:

$$\text{Sine Value} = \frac{\text{Opposite Side}}{\text{Hypotenuse}}$$

C) Cosine

It is also true that in Fig. 2 the ratios:

$$\frac{OP}{OL} = \frac{OQ}{OM} = \frac{OR}{ON}$$

Therefore the ratio of OP/OL depends on the angle value of AOB only and dividing these two values will always produce the same common ratio.

If side OP is 8.66 mm and OL is 10 mm then OP/OL produces a ratio of .866 or cosine value for 30 Degrees, a set of cosine tables are compiled in this way. In the triangle LOP, side OP is adjacent to the angle AOB, side OL is the hypotenuse of the triangle LOP, so to calculate a cosine ratio for the triangle LOP may be shown as:

$$\text{Cosine Value} = \frac{\text{Adjacent Side}}{\text{Hypotenuse}}$$

SUMMARY

Tangent

$$\text{TAN} = \frac{\text{Opposite Side}}{\text{Adjacent Side}}$$

also Opposite Side = Tan x Adjacent Side

$$\text{Adjacent Side} = \frac{\text{Opposite Side}}{\text{TAN}}$$

Sine

$$\text{SIN} = \frac{\text{Opposite Side}}{\text{Hypotenuse}}$$

also Opp. Side = Sin. x Hypot.

$$\text{Hypotenuse} = \frac{\text{Opposite Side}}{\text{SIN}}$$

Cosine

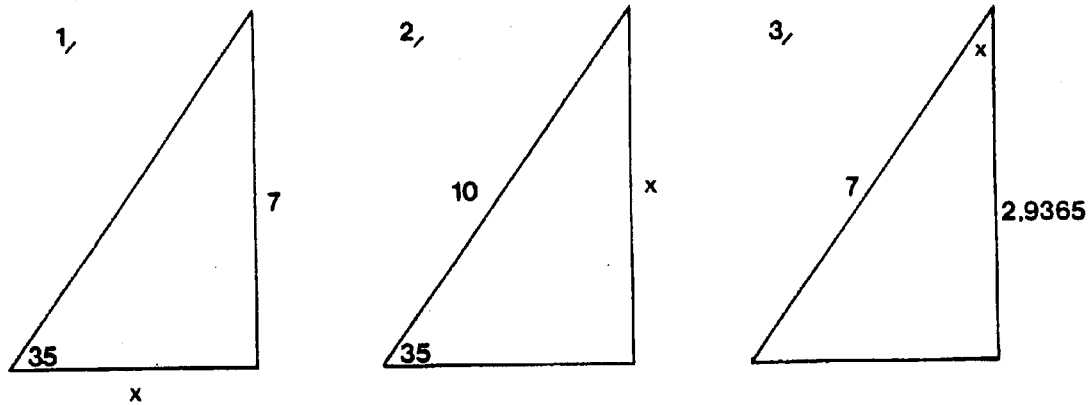
$$\text{COS} = \frac{\text{Adjacent Side}}{\text{Hypotenuse}}$$

also Adjacent Side = Cos x Hypotenuse

$$\text{Hypot.} = \frac{\text{Adjacent Side}}{\text{COS}}$$

EXAMPLES:

Determine X values



1) Solution

Find adjacent side knowing opposite.

$$\text{Adj} = \frac{\text{Opposite}}{\tan 35 \text{ Degrees}}$$

$$\text{Adj} = \frac{7}{0.7002}$$

$$\text{Adj.} = 9.9971 = X$$

2) Solution

$$\text{Opposite} = \sin 35 \text{ Degree} \times \text{Hypotenuse}$$

$$\text{Opposite} = .5736 \times 10$$

$$\text{Opposite} = 5.7360 = X$$

3) Solution

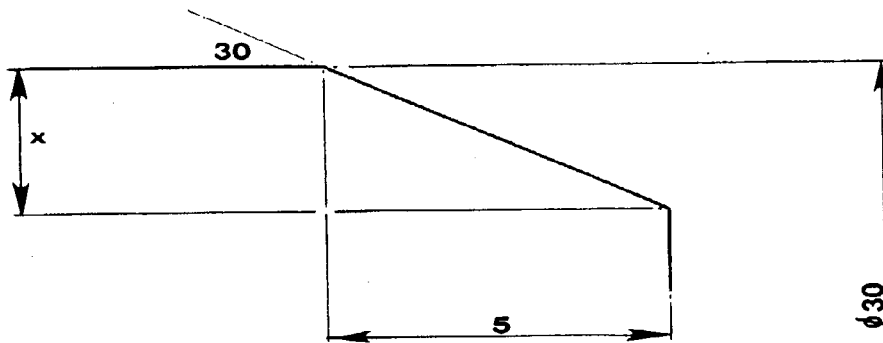
Find angle knowing adjacent side and hypotenuse.

$$\text{Cos} = \frac{\text{Adjacent}}{\text{Hypotenuse}}$$

$$\text{Cos} = \frac{2.9365}{7} = 0.4195 \text{ (as cosine ratio)}$$

0.4195 from cosine tables = 65 deg 12' = X

4,

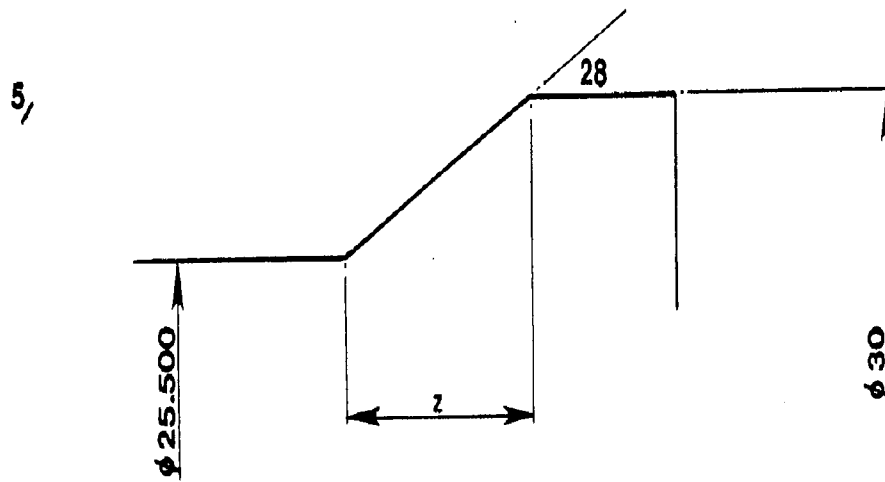


4) Solution

Find X distance on component chamfer

$$X = \text{Tan } 30 \times 5$$

$$X = 2.887 \text{ mm}$$

5) Solution

Determine Z distance on thread relief.

$$Z = 2.250$$

$$\frac{\quad}{\tan 28}$$

$$Z = 4.232 \text{ mm}$$

GEOMETRY

DEFINITION Right Angle

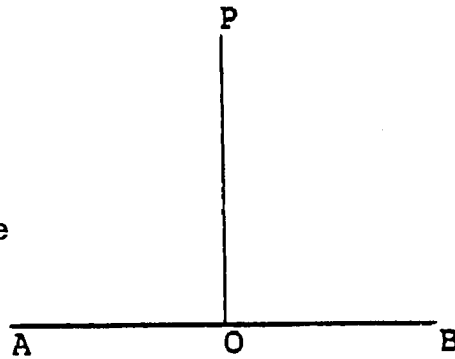


Fig. 1

If a straight line OP meets another straight line AOB as shown in Fig. 1, so as to make the adjacent angles POA , POB equal, each angle is called a right angle.

Acute Angle.

An acute angle is an angle less than a right angle.

Obtuse Angle.

An obtuse angle is an angle greater than a right angle but less than two right angles.

Reflex Angle.

A reflex angle is an angle between two and four right angles. Any two angles whose sum is two right angles are called supplementary. Two angles whose sum is one right angle are called complementary.

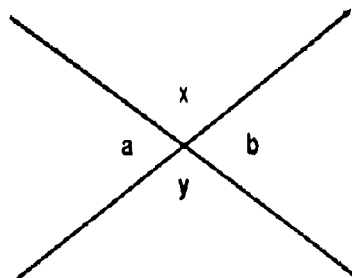


Fig. 2

If two straight lines intersect, the vertically opposite angles are equal. In fig. 2, where two lines intersect, a is equal to b and x is equal to y .

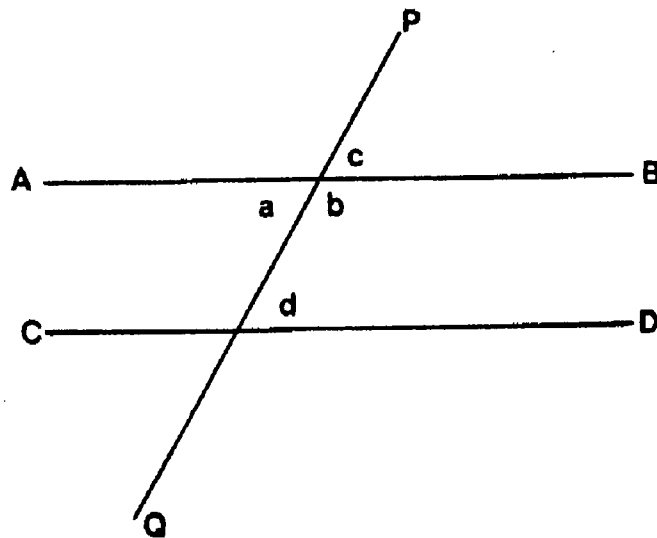


Fig.3

If two straight lines in the same plane do not meet they are called parallel lines. In fig. 3 the line is called a transversal line, angles a and d are called alternative angles; angles c and d are called corresponding angles; angles b and d are called interior angles.

Therefore if a transversal line PQ cuts two parallel lines, angles a and d are equal, angles c and d are equal.

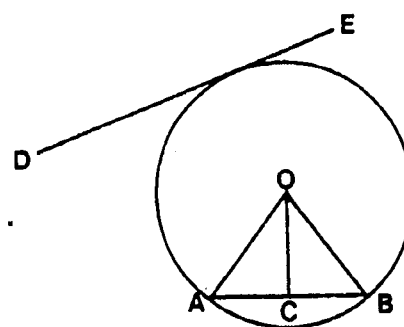


Fig.4

Angle properties of the circle .

In figure 4, line DE is tangent to circle 1, because it only touches the circle at one point, line AB is a chord of circle 1, if OC is perpendicular to the chord AB from the centre of circle 1 then AC is equal to BC.

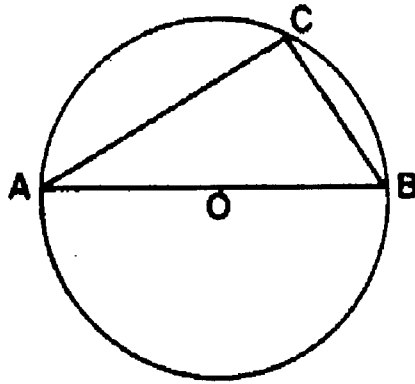
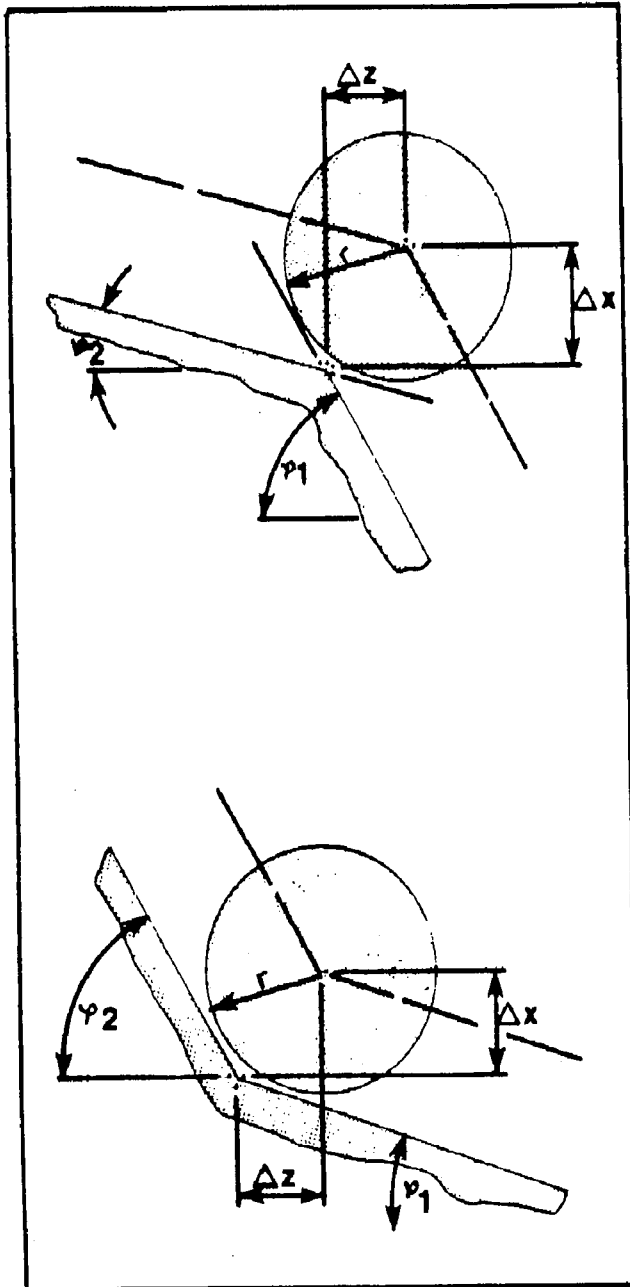


Fig. 5

The angle in a semi circle is a right angle. In fig 5 line A B passes through the centre of circle 2 at O. Any point chosen within the semi circle at C will produce a right angle ACB.

.USEFUL FORMULAE FOR DETERMINING CONTOUR CHANGE POINTS

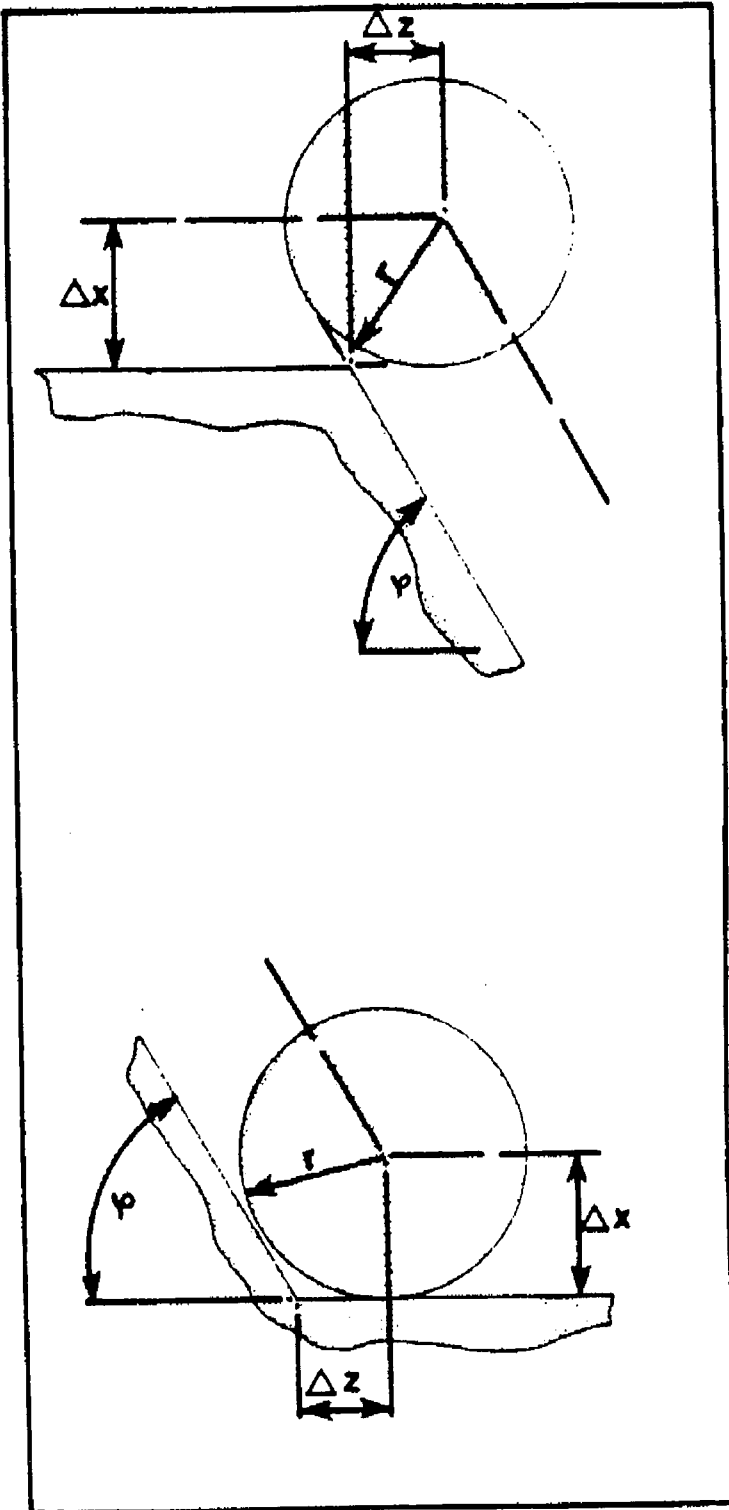


$$\frac{\Delta X = r \cdot \cos^{\alpha} 2^{\alpha+1}}{2}$$

$$\frac{\cos^{\alpha} 2^{-\alpha+1}}{2}$$

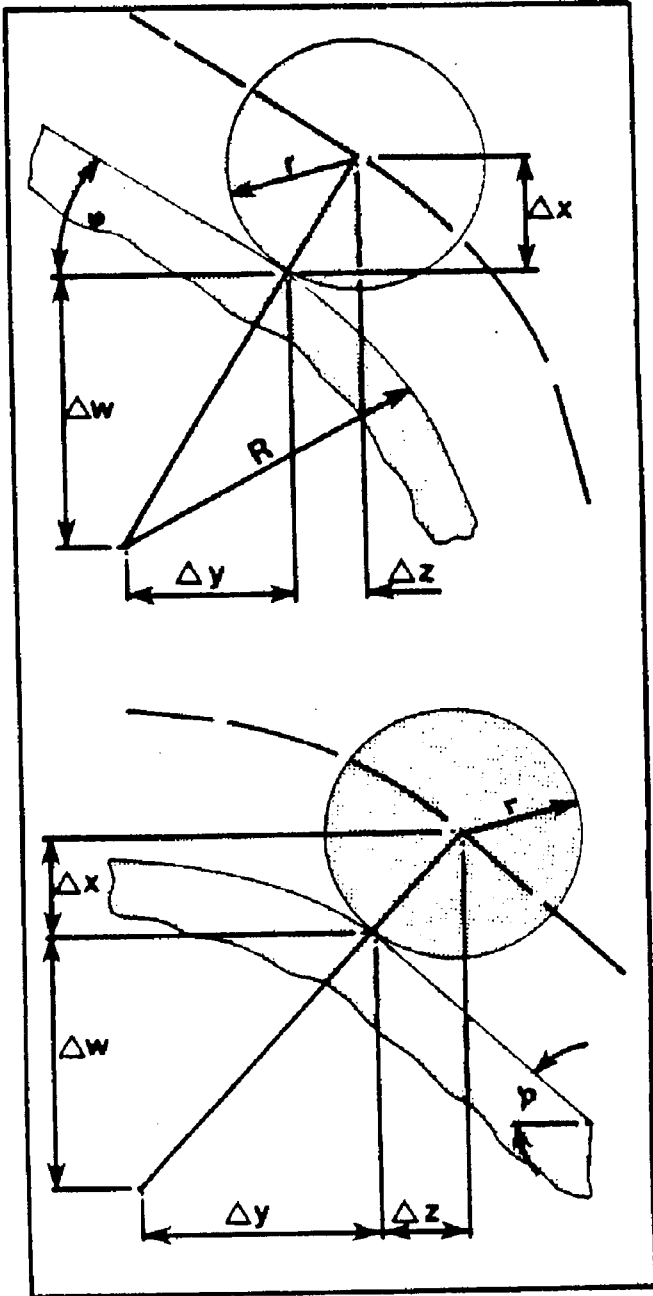
$$\frac{\Delta Z = r \cdot \sin^{\alpha} 2^{\alpha+1}}{2}$$

$$\frac{\cos^{\alpha} 2^{-\alpha+1}}{2}$$



$$\Delta X = r$$

$$\Delta Z = r \cdot \frac{\tan \alpha}{2}$$

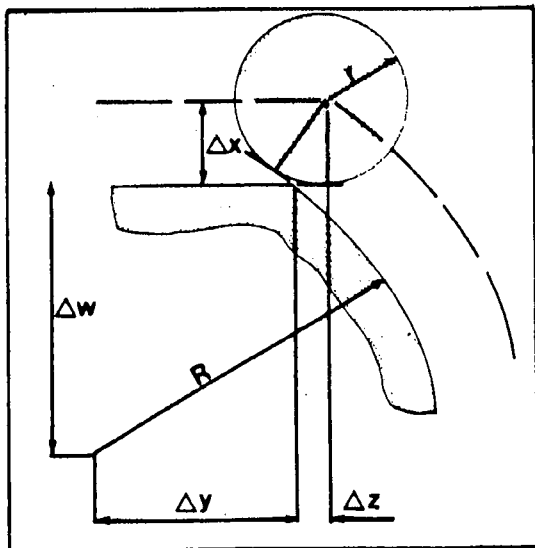


$$\Delta W = R \cos \alpha$$

$$\Delta X = r \cos \alpha$$

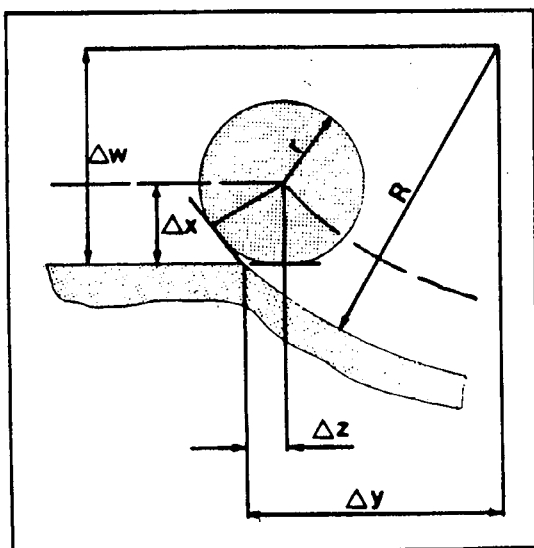
$$\Delta y = R \sin \alpha$$

$$\Delta Z = r \sin \alpha$$



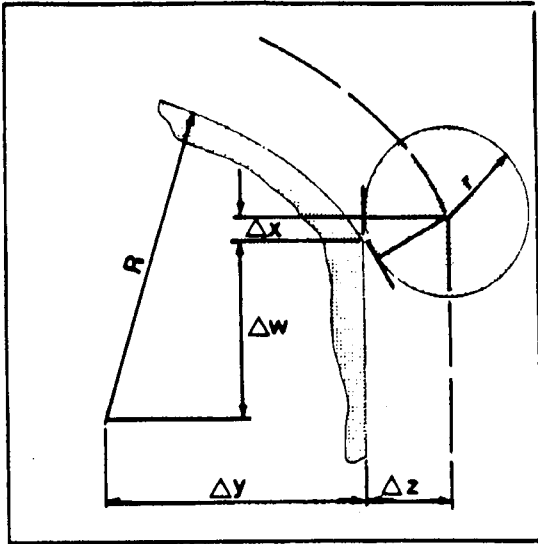
$$\Delta X = r$$

$$\Delta Z = \sqrt{[(R+r)^2 - (\Delta W + r)^2]} - \Delta y$$



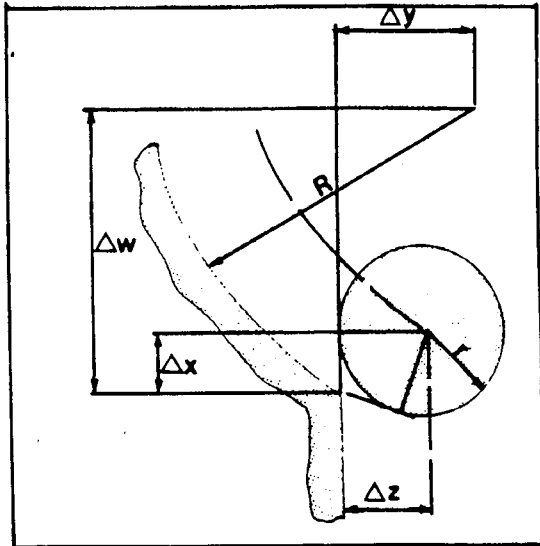
$$\Delta X = r$$

$$\Delta Z = \Delta y - \sqrt{[(R - r)^2 - (\Delta W - r)^2]}$$



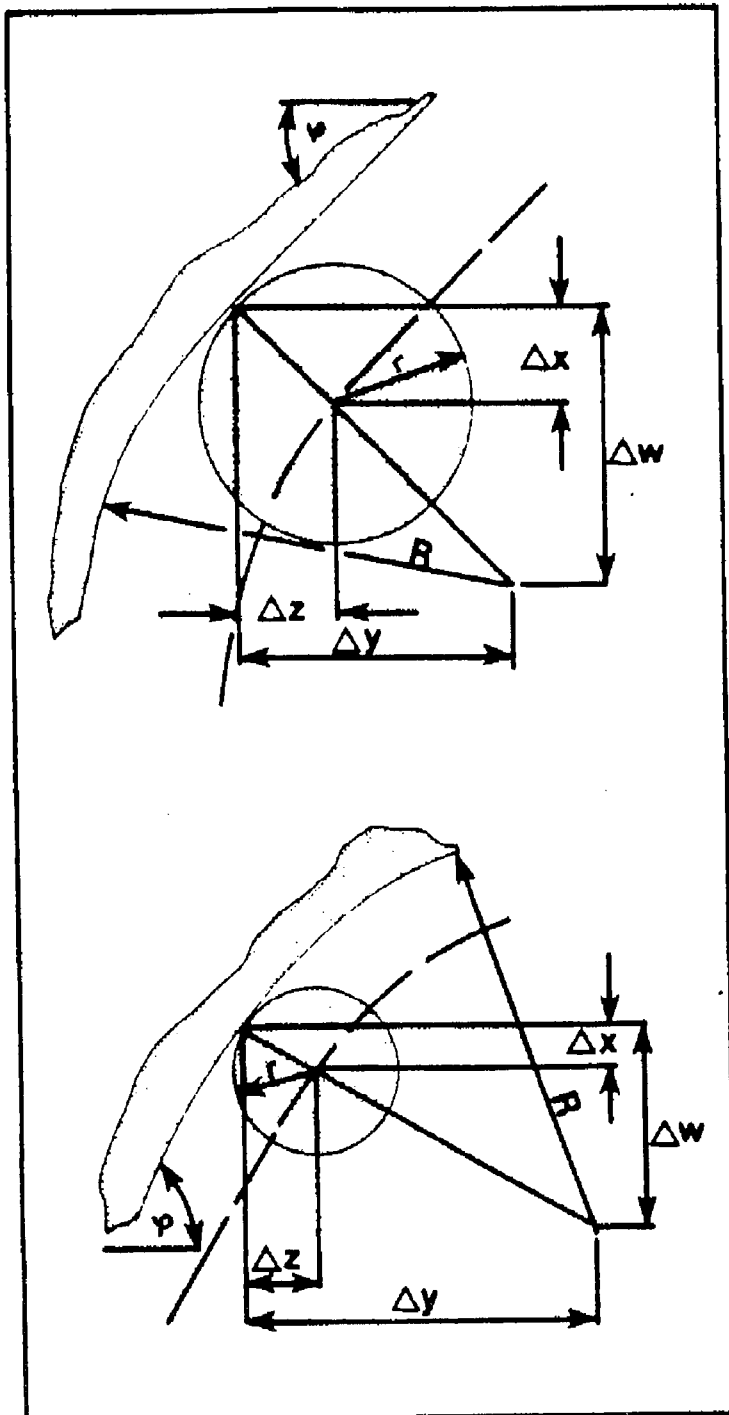
$$\Delta y = r$$

$$\Delta X = \sqrt{[(R + r)^2 - (\Delta y + r)^2]} - \Delta W$$



$$\Delta Z = r$$

$$\Delta X = \Delta W - \sqrt{[(R - r)^2 - (\Delta y - r)^2]}$$



$$DW = R \cos a$$

$$DX = R \cos a$$

$$Dy = R \sin a$$

$$Dz = r \sin a$$

PLANNING PROCEDURE FOR MAINTENANCE WORK

When carrying out maintenance work, pay special attention to the following items to ensure safe and correct procedures.

1. Before starting any maintenance work, define the task and obtain the information relevant to carry out the maintenance to a successful conclusion.
2. Prior to commencing any maintenance task, define the work period to do the necessary work, obtain the correct tools, order the spare parts needed to complete the task.
3. During the maintenance work period put up a notice in a place easily seen, to the effect that the machine is under maintenance and should not be used until the notice is removed.
4. Safety should be a priority when carrying out any maintenance, covers and safety guards that are removed during the maintenance period should be replaced after the work is completed and all interlocks and micro-switches reset.
5. All maintenance work should be carried out by suitably qualified personnel.
6. When replacing electrical components ensure that they are the ones specified.
7. All maintenance work done on the machine whether progressive or preventative should be logged so that a complete service record can be kept for future referral.
8. When the maintenance is completed, check that the replaced and serviced parts are working correctly, and that the machine runs efficiently.

MAINTENANCE SCHEDULE

Routine inspection and maintenance of the machine should be carried out to the the following schedule.

DAILY

Check oil level in the reservoir (see diagram and lubrication chart)

Clean out swarf.

WEEKLY

Clean machine thoroughly.

Check coolant level and top up or change as neccessary.

BI-ANNUALLY

Check adjustment of saddle strips.

Check adjustment of crosslide strip.

ANNUALLY

Grease axis bearings (see lubrication chart).

Check machine alignments and accuracy.

Check headstock bearing adjustment. (NOTE., Lock-nut is LH).

Check spindle drive belt.

Check axis drive belt for wear.

Change air filters.

IF IN DOUBT ABOUT ANY OF THE ABOVE PROCEDURES, CONTACT T. S. HARRISON & SONS LTD. FOR ASSISTANCE.

COOLANT FILLING AND DRAINING

Capacity : 25 Litres

Recommended Type: Cincinnati Millacron Simcool C 60

FILLING

Mix the coolant as prescribed by the manufacturer.

Pour in through the work area at the front of the machine.

Watch the coolant sight glass at the RH side of the machine (see diagram - tailstock end).

Stop filling when the coolant level is reached.

DRAINING

The drain plug is found on the RH Side of the machine beneath the coolant sight glass. See RH end of machine diagram.

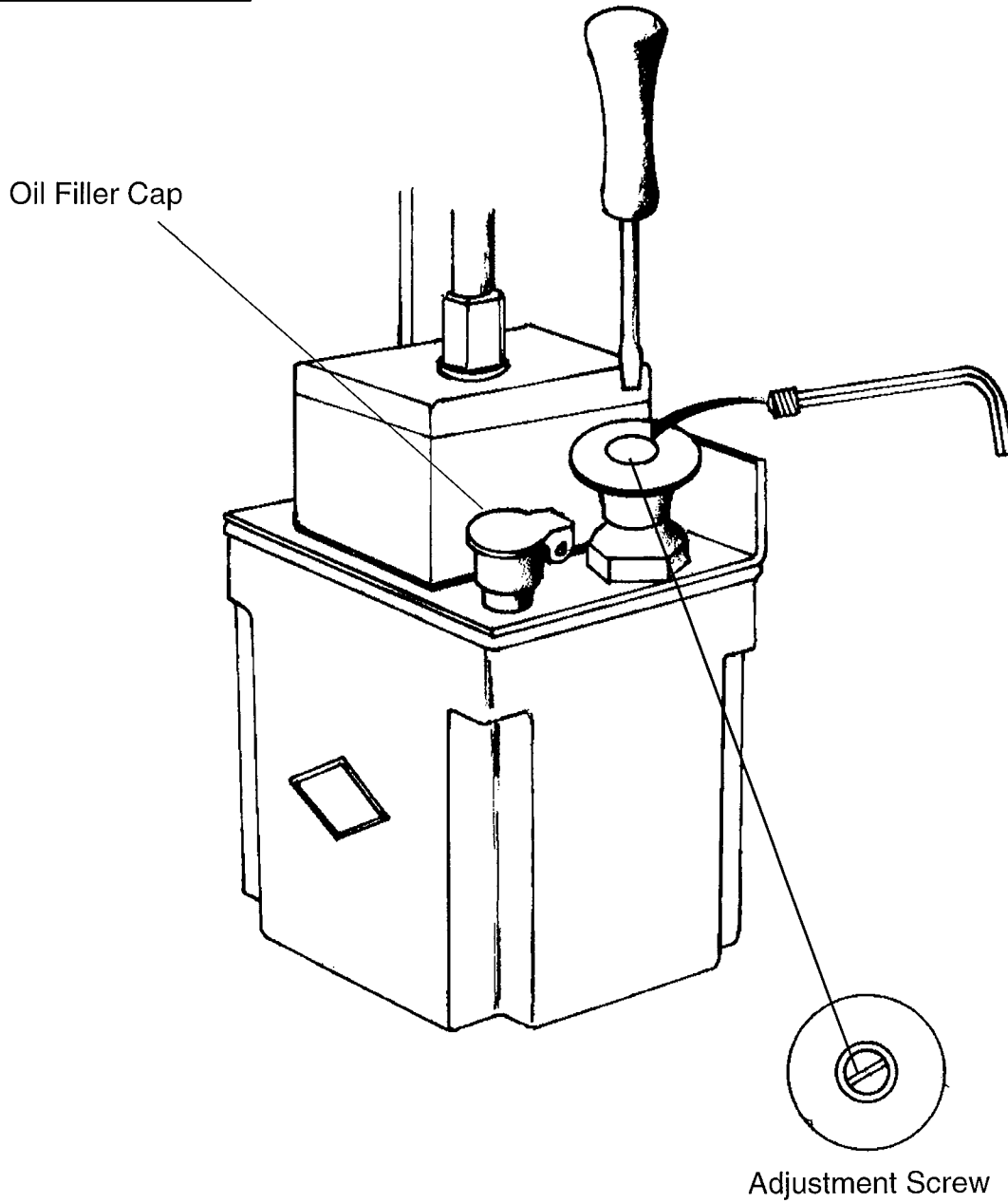
To drain, remove the drain plug after first placing a receptacle beneath the drain point and allow to drain off. Remember to reseal the plug after refilling.

NOTE :- The recommended dilution for Simcool C 60 is 2.5 - 5% , any increase in the dilution percentage could have a detrimental effect on the paintwork and seals.

LUBRICATION PUMP

The lubrication reservoir and pump are found at the tailstock end of the machine

RH END OF MACHINE



ADJUSTMENT OF OIL FLOW

The oil flow from the lubrication pump can be altered by first removing the allen screw (see diagram on the previous page) then turning the cross head screw clockwise will lessen the flow of oil from the pump.

NB. The pump is only active when the spindle the spindle is running.

LUBRICATION CHART

LUBRICATION POINT	LUBRICATING SYSTEM	FREQUENCY	RECOMMENDED OIL / GREASE	QTY
SLIDE WAYS AND BALLSCREWS	AUTO PUMP UNIT	AS REQUIRED	BP : CS 68 SHELL : VITREA 68 CASTROL : PERFECTO NN	0,5 litre
HEADSTOCK	GREASE SEAL	ON MAINTENANCE OF HEADSTOCK	KLUBER ISOFLEX NBU 15	4 cc/BEARING
AXIS BEARINGS	GREASE SEAL	ONCE A YEAR	BP : LS 3 SHELL : ALVANIA No.3	2cc/BEARING
COOLANT	ELECTRIC PUMP		CINCINNATI MILLACRON SIMCOOL C60	25 litre

MECHANICAL TROUBLE SHOOTING

PROBLEM : Poor surface finish.

Corrective Action:

- 1. Ensure that the tool tip is in good condition and that the grade is suitable for the material being cut.**
- 2..Check feeds and speeds, are they compatible with the material being cut and the grade of carbide being used for cutting?.**
- 3. Ensure that the tool tip, tool body, tool turret or toolpost are rigid and secure. Do not overhang the tool too far from the turret or toolpost body.**
- 4. Ensure that the axis gib strips are correctly adjusted.**
- 5. Ensure the spindle drive belt is not worn and is correctly adjusted for tension.**

PROBLEM : Coolant not flowing.

Corrective Action :

- 1. Has the coolant ON been programmed - M08 - COOLANT ON, or M13 COOLANT ON and SPINDLE FORWARD.**
- 2. Check the level of the coolant in the tank and top up if necessary.**
- 3. Check that the pump is working - observe flow in pipe connected to the pump.**
- 4. Check all pipes for leakages and replace if necessary. If accumulated swarf is causing an obstruction remove the pipe and clear the obstruction and replace the pipe ensuring a good seal without leaks.**

ISOLATE MACHINE BEFORE MAINTENANCE COMMENCES

MECHANICAL CORRECTIVE PROCEDURES

1. PROCEDURE FOR ADJUSTMENT OF SPINDLE DRIVE BELT TENSION.

Tools required: - Tension rod - 8mm dia, 8mm A\F Allen Key, 4mm A\F Allenkey.

a) Remove eight M6 button head screws from headstock end cover and remove the cover.

b) Release the three M10 Allen cap head screws holding the motor plate to the lathe bed.

c) Place the tension rod through the top RH slot and lever plate towards the back of the machine to tension the spindle drive belt.

d) Whilst still under tension tighten the bottom RH screw then release and remove the tension rod, tighten the remaining M10 screws.

e) Run the spindle and observe the belt to ensure there is no excessive slack, fluctuation or bulging away from the drive pulley.

f) Replace the headstock end cover and secure with the eight M6 button head screws.

2. PROCEDURE FOR ADJUSTING THE THE GIB STRIPS.

Z AXIS

Tools required:- Long reach screw driver,

a) Remove eight M6 button head screws from the headstock end cover and remove the cover.

- b) Remove M6 knurled headed screw from lubrication pump door at the tailstock end of the machine and open the door to full extent.
- c) Release the gib strip lock screw at the headstock side of the saddle. This is accessible through the headstock housing and under the bed guards.
- d) Adjust the gib strip by turning the lock screw which is accessible through the lubrication pump door.
- e) Turn the screw clockwise to tighten the strip. Do not overtighten.
- f) Lock the strip with the lock screw at the headstock side of the saddle.
- g) Move the saddle up and down the bed to ensure smooth and continuous movement.
- h) When correctly adjusted replace headstock end cover and close lubrication pump door and secure with appropriate screws.

X AXIS

- a) Remove the crossslide cover by releasing the two M8 grub screws at the rear of the indexing turret base.
- b) Release with a screwdriver the gib strip lock screw at the rear of the crossslide.
- c) Using the same screwdriver turn the screw at the front of the crossslide clockwise to tighten the gib strip. Do not overtighten.
- d) Lock the strip in position by tightening the lock screw at the rear of the crossslide.
- e) Move the crossslide up and down the saddle to ensure a smooth and continuous movement.
- f) When correctly adjusted replace the crossslide cover.

3. PROCEDURE FOR CHECKING LIMIT SWITCH

Tools required: 4mm AIF Allen key.

a) Z Axis limit switches are accessible through the headstock end cover and lubrication pump door. Remove and open these covers - as previously described.

b) X Axis limit switches are accessible by removing the cross slide cover - as previously described.

c) Ensure that the limit switches are clean and dry, and the switch pillars are not sticking.

d) If the switch is found to have failed contact HARRISON SERVICE DEPT.

AIR FILTERS

The air filters on the side of the machine control box, should be changed either annually or when “black” in colour.

When ordering quote reference :

Air Inlet Filter, 120mm Ref: RS 507-876

LED STATUS AND FAULT DISPLAY

Display	Meaning
-	Servo Power Off
0	Servo Power Up and Idle
C	Cam Profiling
C	Cam Table (Superscript)
C	Circular Interpolation
3	Encoder Following Mode
F	Flying Shear (No Flashing Dot)
H	Homing (Datuming)
J	Jogging (Velocity) Mode
O	Offset Mode
P	Linear Positional Move
Q	Torque Control Mode
S	Stop Asserted
U	Pulse Following Mode

LED STATUS DISPLAY - ERRORS

Errors are shown for all axes with a flashing dot

Display	Meaning
E	External Error
E	Software Abort or Interpreter Error
F	Maximum Following Error Exceeded
L	Limit Switch Open

See rack assembly drawing for position of LED Display

ASSEMBLY DRAWINGS

&

PARTS LISTS

TU150E HEADSTOCK AC7/100

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/101	HEADSTOCK	1
102A	MAIN SPINDLE	1
103	GREASE RING	1
104	BEARING FRONT PLATE	1
105A	BEARING BACKPLATE	1
106A	SPACING SLEEVE	1
107	REAR BEARING SPACER	1
108	REAR COVER PLATE	1
109A	SPINDLE PULLEY	1
110	PRE-LOAD OUTER SHIM	1
113	SPINDLE LOCKNUT LH	1
504	SPINDLE ENCODER PULLEY	1
BI 00102H	FRONT BEARING	2
BI 00108B	REAR BEARING	2
BI 00186K	TAB WASHER	1

TU150E BED & SADDLE DRIVE AC9/200

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/201	BED	1
202	BEARING HOUSING	1
203	BEARING SUPPORT BLOCK	1
204	Z AXIS BALLSCREW	1
206	SPACER	1
211	BALLNUT SHIM	1
806	DOWEL PIN	2
ZT2/310	GIB STRIP LOCKING SCREW	2
AC8/205	SADDLE DRIVE BRACKET	1
207	MOTOR PULLEY 10T	1
AC7/208A	AXIS PULLEY 20T	1
BI 00102A	BEARING	2
BI 00110	BEARING	2
BI 00421 D	STEPPER MOTOR MHY	1
BI 00186A	LOCKNUT	1
BI 00186B	TAB WASHER	1
BI 00646	TIMING BELT	1
BI 00381G	MICRO-SWITCH	1
BI 00381H	MICRO-SWITCH	1
BI 00178A	BALLNUT	2
1400/10MM	CIRCLIP	1

TU150E SADDLE & CROSS SLIDE AC9/300

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/301	SADDLE	1
302A	CROSS SLIDE	1
303A	TOOL TURRET BASE	1
304	Z BALLSCREW BRACKET	1
306	BALLSCREW	1
305	BEARING HOUSING	1
307	SADDLE GIB STRIP	1
308	SADDLE GIB STRIP	1
309	SADDLE TAPER STRIP	1
310A	GIB STRIP	1
311	CROSSLIDE DRIVE BRACKET	1
312	CAM TRIP BAR	1
313	KNOCK OFF CAM	3
314A	DRIVE COVER	1
316	DATUM TRIP BAR	1
319	MICRO-SWITCH BRACKET	2
320	PLUG	1
321	CROSS SLIDE FRONT COVER	1
323	GIB STRIP SCREW	1
325	FLANGED BEARING HOUSING	1

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC4/315	CROSS SLIDE REAR COVER	1
AC4/316A	TERMINAL BOX BRACKET	1
AC4/317	TERMINAL BOX	1
AC4/318	TERMINAL BOX SPACER	1
AC7/208A	X AXIS MOTOR PULLEY 20T	1
310	CROSS SLIDE WIPER	1
AC8/207	MOTOR PULLEY 10T	1
AC8/311	CROSSLIDE DRVE BRACKET	1
TR1/110	JIB STRIP LOCK	
BI 00421D	STEPPER MOTOR	1
BI 00102A	BEARING	2
BI 00106	BEARING	2
BI00178A	BALLNUT 1605UF	2
BI 00186A	LOCKNUT	1
BI 00186B	TAB WASHER	1
BI 00646	TIMING BELT	1
BI 00380C	MICRO-SWITCH	2
BI 01443D	CABLE CARRIER	1
1400/10MM	CIRCLIP	1
BI 00364E	KLIPPON TERM AKZ4	20
BI 00364G	END PLATE 36336	1
BI 00364F	EW15 TERM 038268	1
BI 00406C	GLANDS NC16/M16/D	1
BI 00439D	ECG/1 COMP GLAND	1

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
BI 00439E	ECG/3 COMPRESSION GLAND	1
RS 507-933	HOUSING SEALED	1

TU150E CONTROL BOX AC9/400B

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/401	CONTROL BOX	1
402A	CONTROL BOX DOOR	1
403B	BACKPLATE	1
408	CONTOL BOX SUPPORT	2
411	SUPPORT BUSH	2
413	REAR DOOR CABLE	2
416	CONTROL BOX BACKPLATE	1
AC4/403	THERMAL SWITCH BRACKET	1
ZT1/647	ISOLATOR SUPPORT	1
BI 00339Z	SD 15 STEPPER DRIVE	2
BI 00362A	RELAY BASE 8 PIN	2
BI 00362C	RELAY 24V DC 11 PIN	2
BI 00362D	RELAY BASE 11PIN	2
BI 00362E	RELAY 24V DC 8 PIN	2
BI 00362H	RELAY MODULE 24V DC	12
BI 00362II	I/FACE UNIT 54206	2
BI 00365T	FAN 109S074UL	1
BI00366A	ISOLATOR DETL 40D1	1
BI 00365U	FINGER GUARD 109-091C	2
BI 00366X	C/BREAKER C60 HD304	1

BI 00366Z	C/BREAKER C60 HD210	4
BI 00374A	TRANSFORMER 300VA	1
BI 00374G	TRANSFORMER 600VA	1
BI 00374J	TRANSFORMER FOR SD15	1
BI 00381M	CONTACTOR SUPP 20101	4
BI 00381N	100A09ND3 A.BRADLEY	3
BI 00381U	O/LOAD 2,8/4.2A A/B	2
BI 00381W	193BPM A/B O/LOAD	1
BI 00381X	CONTACTOR 100A18ND3	1
BI 00391	140-MN1000 6.0/10.0	1
BI 00391A	140-MN0100 0.6/1.0	2
BI 00392A	3 WAY COMBI 140-L13	1
BI 00393	TERM BLOCK 140-L2	1
BI 00415K	TRANSFORMER FOR 55500415J	1
BI 00425D	CA-10 A369	1
BI 00430C	SUPPRESSOR 23006	2
BI 00430D	SUPPRESSOR 23110	1
BI 00432L	COMBIVERT 2.2KW KEB	1
BI 00432M/24	AUXILLIARY INPUTS	1
BI 00432N	UNIVERSAL STEPPER	1
BI 004492	56-506-9053 EARTH	2
BI 00450	57.503.0053 WK2.5/32	31
BI 00450A	57.910.5053 FUSE FIT	1
BI 00450B	Z5.522.7453 END STOP	3

BI 00450C	07.311.0153 END SECT	8
BI 00450D	56.504.9053 EARTH	16
BI 00450F	07.311 0353 END TERMINAL	1
BI 00450G	57.510 0053 MAIN TERMINAL	3
BI 00450J	07.311.4153	1
BI 00463	PRO CARD EC386-1S20	1
BI 00463A	PT-1 STE-BUS	1
BI 00463B	EC386-BP15	1
BI 00463C	PSU-SMP8171	1
BI 01229	HINGE E6-10-501-20	4
BI 01229B	LOCK AND KEY	1
RS 239-056	ABSORBER 6.35mm	3
RS 466-208	SUB MIN SOCKET	1
RS 467-194	CHASSIS SHELL 8WAY	2
RS 469-566	'D' CONNECTOR HOOD	1
RS 470-910	CONNECTOR 25 WAY PLUG	1
RS 472-837	CONNECTOR 9 WAY PLUG	1
RS 477-876	PLUG DIN 5 WAY 180DEG	1
RS 478-273	SOCKET 5 WAY 180DEG	1
RS 507-905	FILTER UNIT FAN (1)	1

TU150E OPERATORS PANEL AC9 / 400A

<u>Part NO.</u>	<u>Description</u>	<u>Qty</u>
BI 00356B	12" MONITOR VGA	1
BI 00356C	12" CTR BEZEL	1
BI 01811	MULTI-PURPOSE TUTOR	1
BI 00365D	EMERGENCY STOP KEY OPER	1
BI 00364S	HINGED GUARD 593032	1
BI 00364W	SWITCH BODY 503008	2
BI 00364X	CONT BLCK 593560. 100	2
BI 00364Y	CAP WHITE 463022	1
RS 481-465	SKT HOUSING 15 WAY	1
RS 481-493	SOLDER PLUG	10
BI 00357M	HART 09160243001	1
BI 00357P	HART 0930060301	1

TU150E SPINDLE DRIVE AC8/500

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/503	SPINDLE ENCODER BRACKET	1
505	ENCODER PULLEY	1
AC4/501A	SPINDLE MOTOR PLATE	1
502	MOTOR PULLEY	1
506	PULLEY RETAINING PLATE	1
AC5/501	ENCODER BRG. HOUSING	1
502	BEARING SHAFT	1
503	ENCODER ADAPTOR PL	1
BI 00102	BEARING 7203B FAG	2
BI 00442S	ENCODER HARR CYCLONE	1
BI 00319	SPINDLE MOTOR 2.5 KW	1
BI 00628N	SPINDLE DRIVE BELT 460J16	1
BI 00645A	TIMING BELT 225LO50	1
BI 00185	LOCKNUT FU02SS	1
BI 00186	MB2 LOCK WASHER	1

TU150E CABINET ASSEMBLY AC8/600

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/601C	CABINET BASE	1
605B	REAR PANEL	1
606B	TOP HOUSING	1
608A	CONTROL PANEL HOUSING	1
609	SLIDING DOOR	1
610	END DRIVE COVER	1
612	LIFTING HOOK BRACKET	4
613A	ACCESS PANEL	1
614A	BED COVER EXTENSION	1
615	BED COVER	1
616	SADDLE SIDE PLATE (RH)	1
617	SADDLE SIDE PLATE (LH)	1
618	BED COVER HOUSING	1
619	INSPECTION WINDOW	1
620	DOOR WINDOW	1
621	FOOT SUPPORT	3
621A	FOOT SUPPORT	1
622	COOLANT PUMP BRACKET	1
625	HEADSTOCK RING	1
629A	MOUNTING PLATE	1

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/638	REAR PAD	1
630A	MOUNTING PLATE	1
633A	COOLANT DRAIN	1
636	COOLANT PIPE BLOCK	1
639	GUARD WIPER	1
641	ACCESS PANEL SCREW	1
642	DIVIDING WALL	1
643	TOP GUARD WIPER	1
644A	DOOR WIPER	1
644B	DOOR WIPER	1
645	DOOR GUARD RAIL	2
646	DOOR GUARD ROD	6
650A	DOOR SLIDE ANGLE	1
651	COOLANT LEVEL TUBE	1
652	DOOR SLIDER	2
AC3/631	BED FILL IN PLATE	1
AC7/646	TOP RAIL SPACER	1
648	SLIDE GUARD	1
649	BOTTOM SLIDE ANGLE	1
AC9/610	INSPECTION PANEL	1
TR5/513	PENDANT HOUSING	1
514A	REAR PANEL	1
514B	REAR PANEL	1
527	PENDANT ARM BRACKET	1

SP 183	PLUNGER	1
183A	PLUNGER	1
191	1/2" TAIL PIECE ADAPTOR	1
201A	CYCLONE HANDLE	1
202	HANDLE SCREW CYCLONE	2
203	FIXING BLOCK CYCLONE	2
BI 00381J	DOOR SWITCH	1
BI 00398	COOLANT PUMP	1
BI 00448	CABLE CLEAT N08	4
BI 01102C	1/2" COOLANT PIPE	1
BI 01102D	COOLANT NOZZLE	1
BI 01116C	COOLANT TAP	1
BI 01102E	COOLANT PIPE ADAPTOR	1
BI 01202	DOOR CATCH	1
BI 01425A	BED COVER WIPERS	2
BI 01431D	RAIL & SLIDERS	1
BI 01435B	WINDOW SEAL	2.3 metres
BI 01435C	CHROME INSERT	2.3 metres
BI 01451Z	34-0321-27	
NIPPLE 3/8"	NIPPLE 3/8" BSP HEX	1
BI 01115B	OIL SIGHT	1
BI 01428B	ADJUSTABLE FEET No. 2	4
BI 01229	HINGE E6-10-501-20	4

TU150E TAILSTOCK (PNEUMATIC) AC7/700

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC7/701	TAILSTOCK BED	1
702	SHOE	1
703	BODY	1
704	LOCKING BOLT	1
705	CLAMP	1
AC2/704A	BARREL	1
707A	LINK	1
BI 01131	AIR CYLINDER	1
BI 01131A	REGULATOR	1
BI 01131C	REGULATOR BASE	1
BI 01131F	FLOW CONTROL VALVE	1
BI 01129Y	SOLENOID VALVE	1
BI 01128U	1/8 BSP ADAPTOR	1
BI 01128T	SILENCER	1
BI 01128N	4MM-1/8 BSP ADAPTOR	1
BI 01451Y	PRESSURE SWITCH	1
BI 01123S	BULKHEAD ADAPTOR	2
BI 01123Q	LOCKNUT	1
BI 01126G	BRAIDED PIPE	1
BI 01126F	NYLON PIPE 4MM	4.0 metres

TU150E LUBRICATION SYSTEM AC2/1200

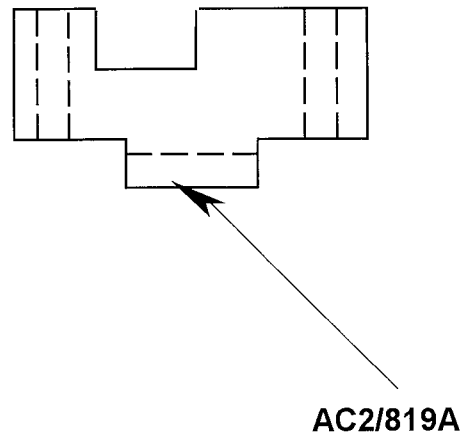
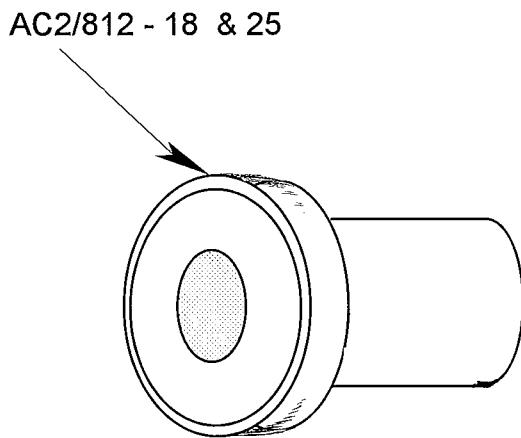
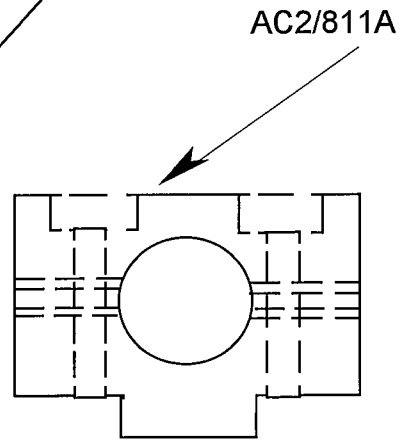
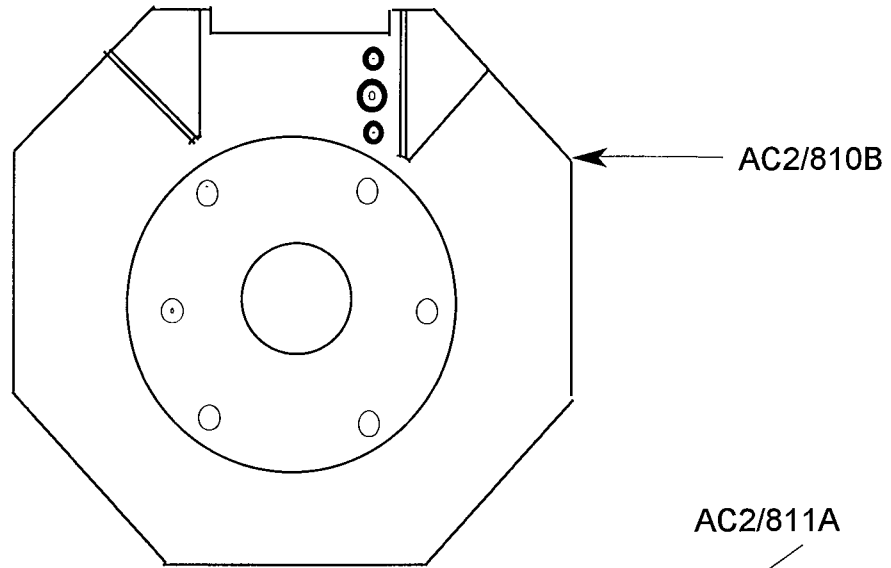
<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
BI 01120	OIL PUMP	1
BI 01123E	METER UNIT IB21	5
BI 01123F	METER UNIT IM21	1
BI 01123H	SLEEVE NUT	9
BI 01123J	COPPER PIPE	0.5 metres
BI 01123N	BLANKING PLUG	2
BI 01123V	JUNCTION 8 WAY	1
BI 01125	PIPE CLIP SINGLE	6
BI 01126F	NYLON PIPE	3.0 metres
BI 01123I	CONES	12

TU150E PARTS CATCHER AC7/1550

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/1505	PIVOT BUSH	2
1506	SPIGOT	1
1507	BEARING HOUSING	1
1508	COLLAR	1
1509	TRIP CAM	1
1510	DRIVE SHAFT	1
1511	SUPPORT BRACKET	1
1512	DRIVE ARM	1
1513	LINK	1
1514	WASHER	2
1517	ANCHOR PLATE	1
1519	CYLINDER STOP	1
1520	CYLINDER SUPPORT	1
AC2/1551	BUCKET	1
1552	BUCKET ARMS	2
1553	ARM SUPPORT	1
AC2/1557	ROD	1
1558	TRIP CAM SPACER	2
1559	COLLECTION BOX	1

AC2/1560	COLLECTION BOX LID	1
1561	COLLECTION BOX PLATE	1
BI 01128J	AIR CYLINDER	1
BI 01415C	SPRING	2
BI 00195C	OILITE BUSH	3
BI 01229A	HINGE	2

TU150E TOOLING (8STATION) AC8/800



TU150E TOOLING (8 STATION) AC8/800

<u>Part No.</u>	<u>Description</u>	<u>Quantity</u>
AC2/802	TOOL CLAMP	8
810B	TOOL TURRET	1
811A	TOOL SLEEVE HOLDER	4
812	BORING BAR HOLDER 6 DIA	1
813	BORING BAR HOLDER 8 DIA	1
814	BORING BAR HOLDER 10 DIA	1
815	BORING BAR HOLDER 12 DIA	1
816	BORING BAR HOLDER 16 DIA	1
817	BORING BAR HOLDER 20 DIA	1
818	CENTRE DRILL HOLDER	1
819A	AXIAL TOOL HOLDER	1
825	DRILL CHUCK HOLDER	1
BI 00968B	INDEXING TOOLPOST	1