MICROMASTER 280 CNC

OPERATOR'S INSTRUCTION MANUAL

INDEX

DENFORD MACHINE TOOLS LIMITED

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CONTROL SYSTEMS

Since the industrial revolution engineers have striven to produce automatic machines. The initial need was to speed up operations and to produce long production runs of the same components economically also taking the drudgery out of repetetive work. This type of machine has been with us for a long time from simple cam auto's to sequence control machines using a plugboard or dial setting to achieve the operational sequence and desired dimensions.

The sequence control machines were the forerunner of the present NC (numerical control) and C.N.C. (computer numerical control) machines. However, the sequence control machines required quite lengthy setting up which restricted their use to long production runs to recoup the down time spent in setting.

This was one of the reasons for developing NC machines which could be utilized for a simple operation, such as drilling a series of holes in a fixed position at pre-set centre distances, to a much more sophisticated set up which involved a multi-control sequence of operations.

The first NC machines were drilling machines which allowed no carriage movement whilst the tool was cutting. Once this type of operation had been successfully achieved by NC then the need arose to produce machines to allow the travel of the slides during cutting operations, i.e. milling, turning and profiling and also tool changes built into the program. This type of NC machine was usually controlled by a punched tape which was read by a tape reader on the machine. This transferred the information on the tape by a series of electrical impulses to the control system, which in turn moved slides and

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tools to the program supplied.

Two types of systems are used to control the NC function:

(1) Closed loop control

(2) Open loop control

Fig. 1. Block diagram (simplified) of an NC CLOSED LOOP CONTROL.

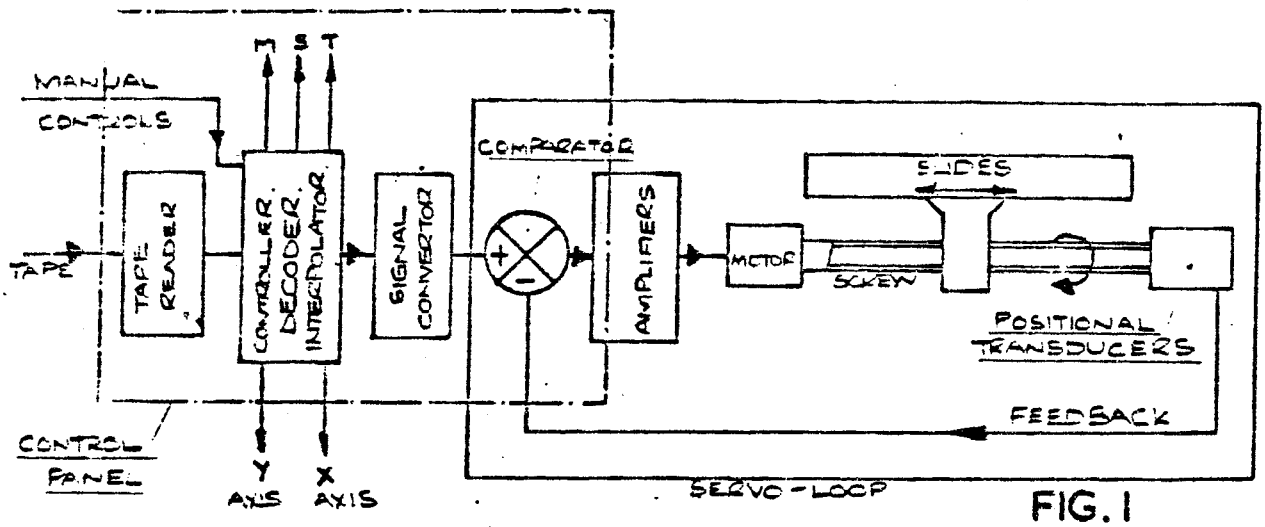

FIG. 1

This is a very expensive form of control which is used where a very high degree of accuracy is required i.e. in such machines as jig borers, machining centres, etc.

Fig. 2. NC System using OPEN LOOP CONTROL

Since no feedback is used this eliminates the need for a zero system. This system uses stepping motors which require pulses to rotate i.e. a fixed number of pulses per rev means 1 pulse rotates the motor a fixed number of degrees (a step) and which moves the slides a fixed increment using an accurately pitched screw.

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FIG. 2 OPEN LOOP CONTROL

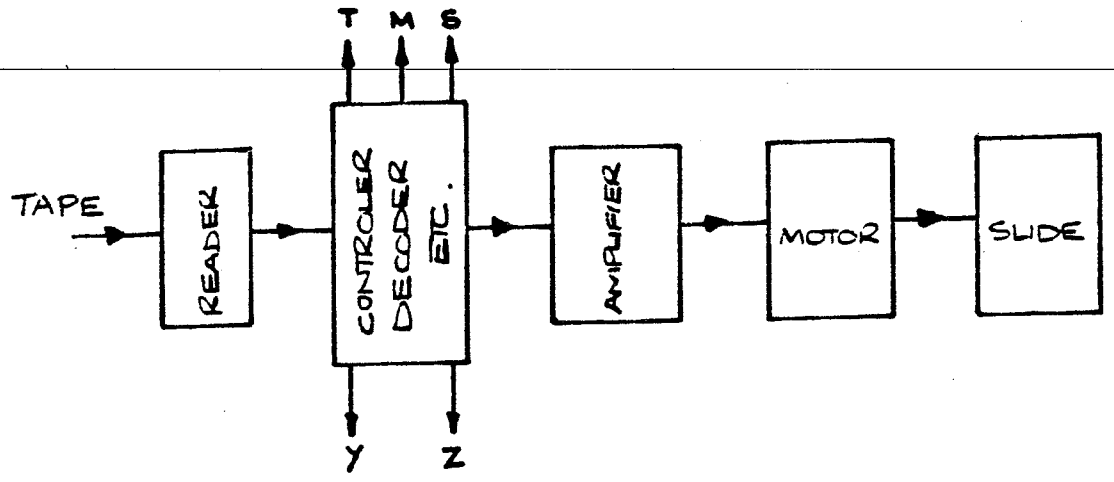

FIG.2

This is a much simpler system and is used on the 'Micromaster' CNC Lathe.

CNC (COMPUTER NUMERICAL CONTROL)

With the advent of the silicon chip, computers no longer need to be huge expensive installations. This has brought them into the field of machine control where space and ease of operation are at a premium.

A mini-computer using the silicon chip and magnetic tape, instead of paper tape, has instigated a new generation of control systems with new advantages which are included in the new 'Micromaster CNC Package'.

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TECHNICAL SPECIFICATIONS

Capacities:	Metric	Imperial
Swing over bed	280mm	11"
Swing over saddle and wings	240mm	9½"
Swing over cross slide	170mm	6 5/8"
Spindle bar capacity	25mm	1"
Distance between centres	500mm	20"
Headstock:		
Spindle nose	D1/3 camlock	
Spindle bore	27mm	1 1/16"
Spindle nose internal taper	No. 4 M taper	
Spindle bearings	Taper roller	
Spindle speeds: Low Range	75 to 350 rpm	
High Range	350 to 2000 rpm	
Threads & Feeds:		
Number of threads and feeds	72	
Leadscrew	3mm pitch	8 TPI
Feedscrews (CNC)	19mm (Ballscrew)	
Carriage & Bed:		
Length	915mm	36"
Cross slide movement	130mm	5 1/8"
Top slide movement	105mm	4 1/8"
Swivel slide graduations left/right	0°90°	
Top slide to spindle C/L	27mm	1 1/64"
Bed width	150mm	6"
Ground ways	2 Vees - 2 flats	
Tailstock:		
Barrel taper	No. 3 morse taper	
Barrel movement	70mm	2 ¾"
Barrel graduations	1.0mm	1/32"

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Motors:	
Main drive	1500 rpm at 50HZ
Speed change motor	0.056 KW
Stepper motors	0.28 KW
Machine:	
Length	1780mm 70"
Height	1730mm 68"
Width	710mm 28"
Weight	457 KG 1008 lbs.
CNC Consol:	
Accuracy	0.01mm (.0005")
Resolution	0.01mm (.005")
Feed rate	Preset up to 327mm/min. 12 ins/min
Rapid traverse	365mm/min.
Spindle speeds	75 - 2000 rpm stepless
Tool offset	Up to 10 pairs
Program length	Up to 99 blocks
Program storage	Magnetic tape mini cassette display
Method	32 x 16 line VDU (10")
Control system	GSM LC 80 Microprocessor based
CNC Feedrates	Code 1 0.630" per min 16.0 mm/min
	" 2 1.250" " " 31.7 "
	" 3 1.870" " " 47.6 "
	" 4 3.750" " " 95.2 "
	" 5 5.540" " " 141 "
	" 6 7.350" " " 186 "
	" 7 9.200" " " 233 "
	" 8 10.910" " " 277 "
	" 9 12.870" " " 327 "
	" 0 14.400" " " 365 "

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Machine Standard Equipment:

'Multifix' Quick-change tool post and 4 toolholders

Back splash guard and tool tray

Cantilever chuck guard

Lathe maintenance tools - single shot lubrication system

Hardened and ground bed

'Griptrue' 125mm 3 Jaw S.C. chuck

Leadscrew and feedshaft cover

Precision ball screws

Toysteel rigid foam sample

Installation, operation and service manual

Flow chart

Video instruction film

Machine and control unit nylon covers

Electrical Specifications and Standard Equipment:

Speed change motor .56 kw

Drive motor 1.2kw (3 phase only)

Electric coolant pump and fittings

Emergency stop and key lock isolator

Stepper motor drives to "X" and "Z" axis

Fluorescent Lo-vo lighting

Lo-voltage control circuit

CNC Control Unit Specifications:

LC80 microprocessor based by G.S.M. Ltd.

Visual Display Unit 10" (250 mm)

Data key board

Feedrate override

Magnetic Mini Tape Cassette

Spindle speed readout

Absolute or incremental programming

Metric or imperial selector

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INSTALLATION

Lifting

Remove the chip guard and back splash guard. Remove 4 plugs from the lifting points (Fig. 3) and insert bars, adjust ropes for balancing before moving. (Replace plugs after machine is installed.

Fork Lift

To lift the machine using a fork lift truck, place the forks in the gap between the storage cabinet and the electric control cabinet under the tray. (Space the forks as far apart as possible and test for balance before moving).

Erection on Site

The machine must be situated to allow free access for operating and maintenance (see layout diagram). There are three bolting down bosses on the base of the machine. Care must be taken when the machine is bolted down not to overtighten the bolts and distort the cabinet. After installation the machine must be accurately levelled with a precision level to ensure the accurate running of the lathe.

Cleaning

Before wiring the machine to the mains supply, first remove all anti-corrosive coatings from the slideways and working parts including all bright surfaces using a kerosene based cleaner. After cleaning, oil all bright surfaces with a light machine oil. Regular cleaning and oiling will ensure a long life for the machine with the minimum of maintenance.

Electrical Supply Connection

The regular electrical mains power supply to the machine is 3 phase

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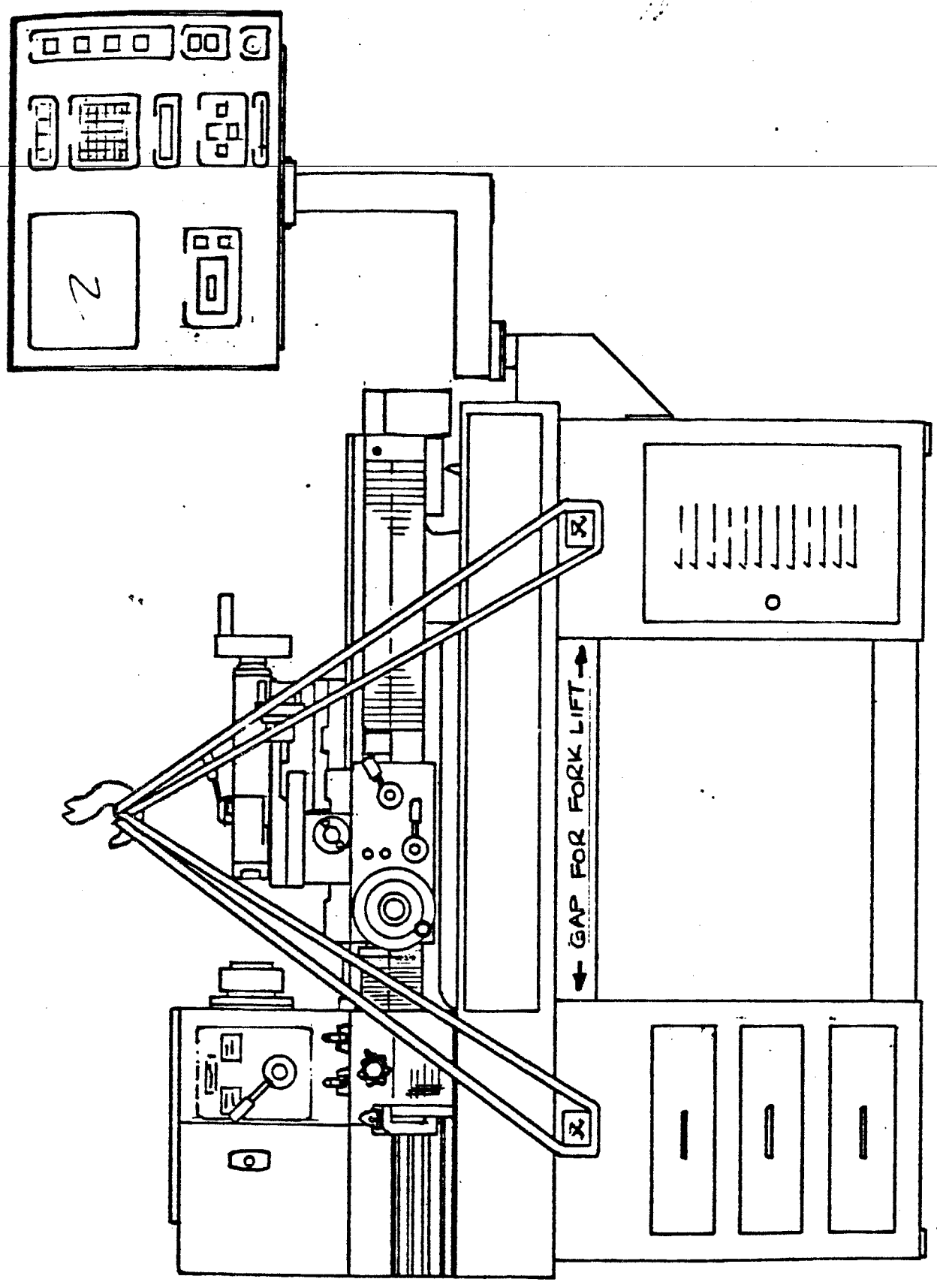

FIG. 3

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380v 50HZ. Single phase is not suitable for this product and cannot be supplied. Alternative three phase electrics can be supplied on request.

Connect the mains supply to the isolator. Machine connections are colour coded three phases, live (brown) and neutral (green).

When connected ensure correct direction of rotation to coincide with the forward and reverse switch on the panel.

N.B. The machine should only be commissioned by a qualified electrical engineer.

IMPORTANT

Ensure machine is wired in correct rotation by operating the spindle forward button on manual control. Do not overrun machine in incorrect rotation as this will cause damage to the VARIABLE SPEED DRIVE. CONTROL.

Lubrication

All oiling and greasing points have been fitted prior to despatch. Before the machine is switched on, check the oilsite levels in the headstock, gearbox and the apron and fill to the correct levels. Ensure single shot lubrication sump fitted to side of machine cabinet is full. Pull up plunger DAILY for lubrication to cross slide and ball screws. All slideways and screws should be lightly oiled before movement of the saddle and tailstock. Ensure the end-drive is lubricated and free to move. For frequency of lubrication and correct grade of oil refer to chart.

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LUBRICATION CHART

1.	Gearbox	- fill to oilsight level
2.	Apron	- fill to oilsight level
3.	Headstock	- fill to overflow at rear of headstock. Single stop lubrication reservoir to saddle, cross slide and ball screws
4.	End drive	- oil all gears in engagement, oiler through reversing bracket casting
5.	Leadscrews	- clean and light film of oil
6.	Feedshaft	- clean and light film of oil
7.	Leadscrew & feedshaft bracket	- two oilers to leadscrew and feedshaft bearings
8.	Bed	- clean and light film of oil
9.	Topslide	- light film of oil on slides
10.	Topslide screw	- one oiler behind dials
11.	Cross slide	- light film of oil on slides
12.	Cross slide screw	- 2 oilers, one through slide, one behind dials
13.	Tailstock barrel & screw	- 3 oilers on top of tailstock body
14.	Headstock bearing	- grease nipple through headstock behind chuck (N.B. sparingly)
15.	Camlock	- light film of oil on cams

LUBRICATION CHECKS

All oiling and greasing points have been filled prior to despatch. Before operation of the machine, check the oilsite levels in the headstock gearbox and single shot reservoir and fill to correct levels. All slideways should be lightly oiled before movement of the saddle and tailstock. Ensure end drive is lubricated and free to move. For

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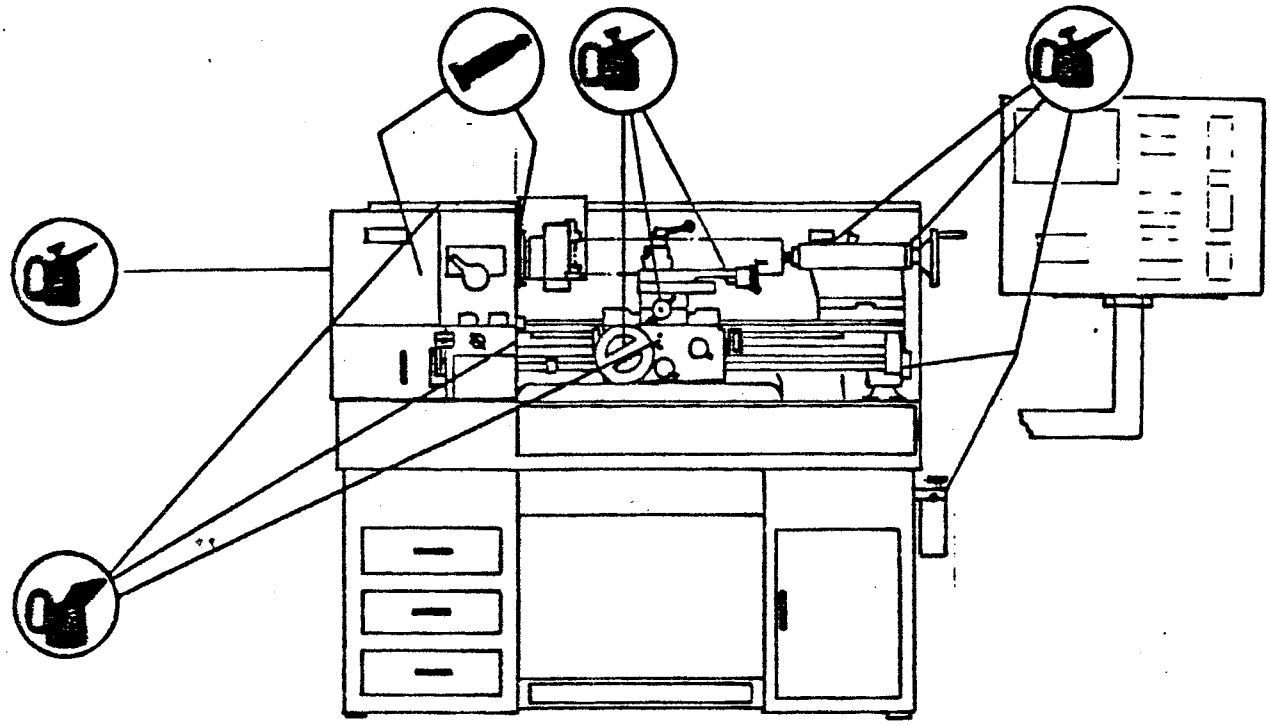
frequency of lubrication and correct grade oils refer to the chart (Fig. 4).



LUBRICATION.

	ESSO.	CASTROL.
	BEACON 3.	CASTROLITE.
	BEACON 3.	CASTROLITE.
	NURAY 32.	SPHEEROL-AP3.

FIG. 4

EQUIVALENTS OF ALL LUBRICANTS ARE AVAILABLE FROM OTHER MANUFACTURERS

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Having carried out the necessary procedure for the installation of the machine it is now ready for operation.

Switch on the isolator switch, then the switch on the pendant panel to forward or reverse for spindle travel. First run should be at a slow speed to ensure lubrication and freedom of all running parts.

SPEED SELECTION - OPERATION OF SPINDLE

The spindle speeds are divided into high and low range, selection is made by moving the lever on the headstock face (B) (Fig. 5) to HIGH or LOW range. Speeds within the selected range are obtained by moving the vari-speed switches on the control panel. Press the switch marked + to increase speed or - to decrease the speed. Speeds can be changed whilst the spindle is in motion within the selected range. STOP THE SPINDLE to change to HIGH or LOW range moving the spindle by hand until engagement is made. To stop the spindle press the spindle stop button on the pendant panel. To rotate the spindle by hand move the lever on the headstock face to the intermediate vertical position.

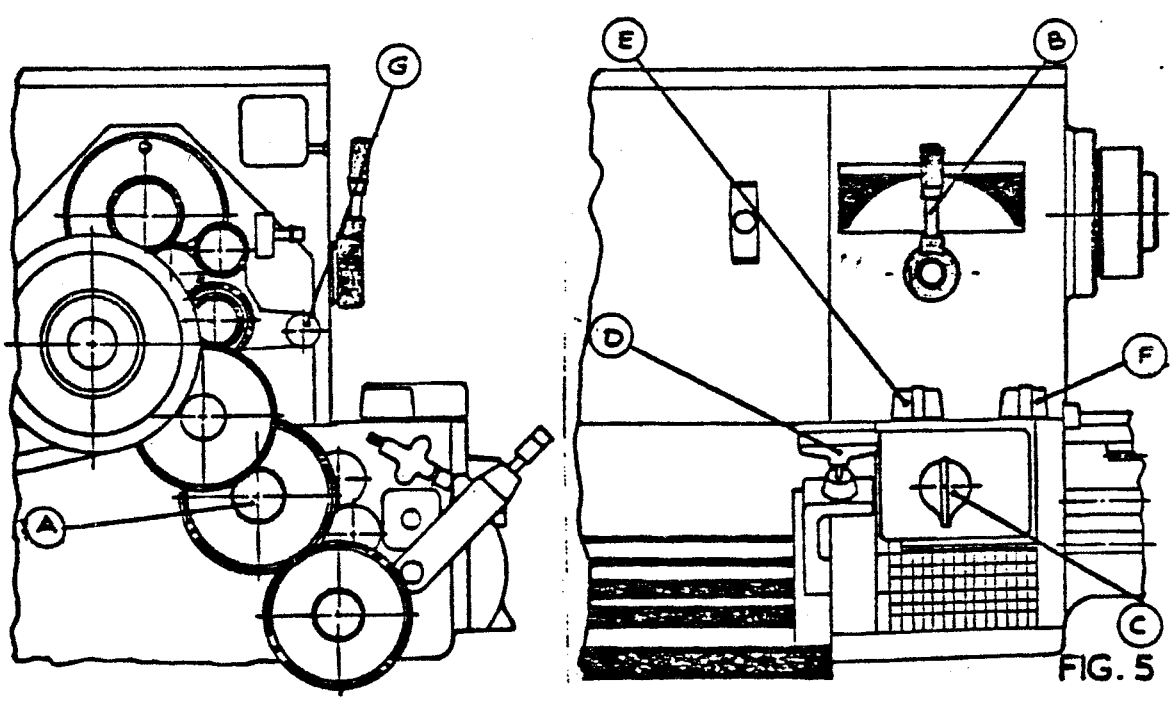

FIG. 5

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SADDLE MOVEMENT - MANUAL

The machine is fitted with two leadscrews - one for manual control and one for operating the machine with the CNC mode.

Attached to the back of the saddle is a camlock unit for selecting which screw to use for each mode, manual or CNC (See Fig. 6).

To use the saddle in the manual mode press the N.C. mode button. The "jog" buttons on the CNC panel can now be used to move the saddle to the machine DATUM at the tailstock end of the bed, ensuring that the location pin in the park bracket is located in the hole in the saddle camlock. Using the key, switch the camlock to manual. This will disengage the ball screw used in the CNC mode and allow the use of the manual leadscrew and feedshaft located at the front of the machine.
Reverse the operation when returning to CNC mode.

IMPORTANT

Ensure before operation in CNC mode from manual that back gear drive is disengaged, traverse handle is in neutral and screw cutting dial is disengaged and cross travel handwheel is in free position.

THREAD AND FEED SELECTION

The 280VS machine is fitted with a universal gearbox. All threads and feeds directly available are displayed on the front of the gearbox together with instructions for lever settings to obtain them. (See Figs. 7 and 8).

e.g. To select 20 T.P.I.

1. Select low range spindle speed required (B) (Fig 5)
2. With LATHE SWITCHED OFF, move quadrant sliding gear (A) (Fig 5) to IN position and close guard
3. Start machine

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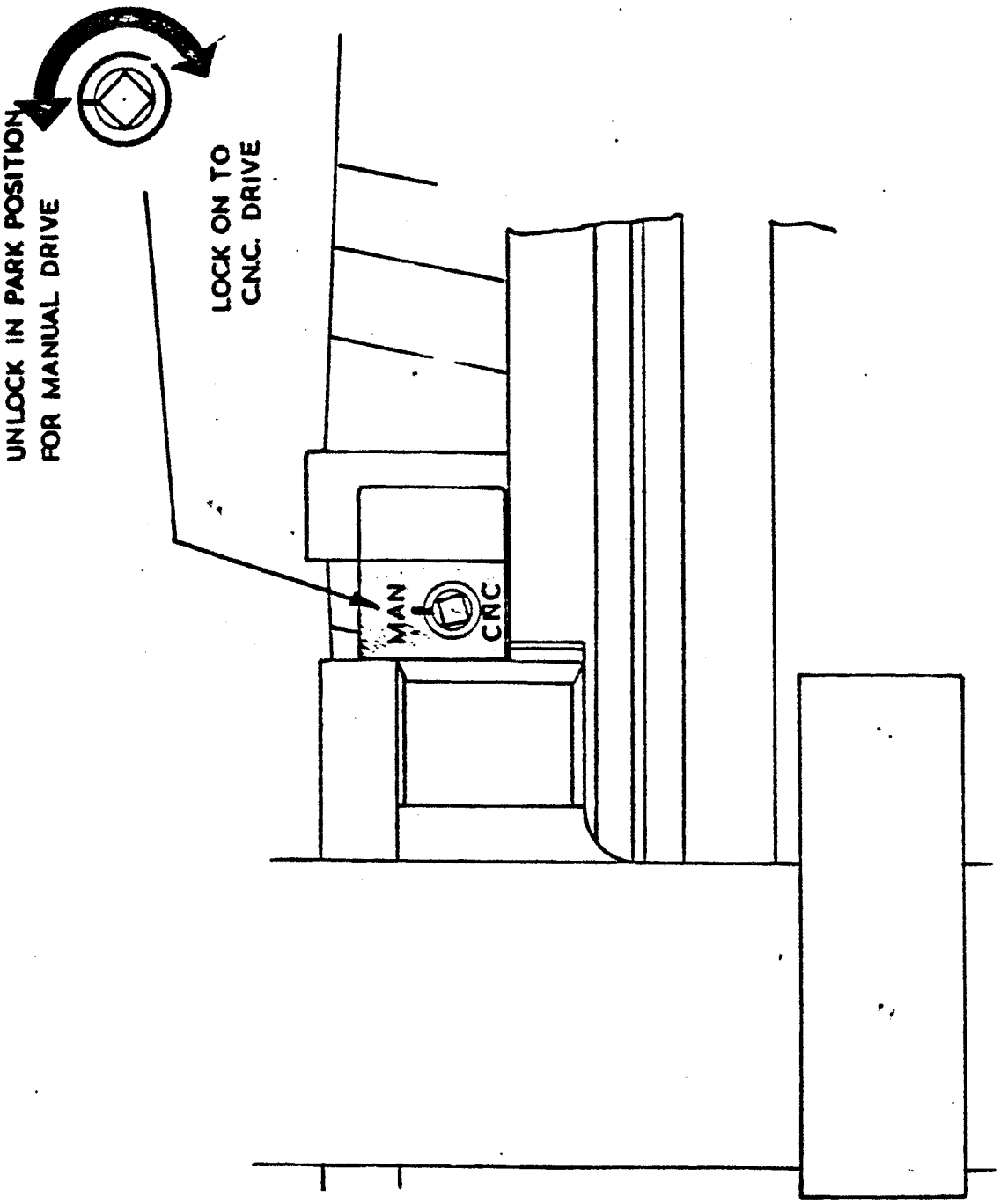
FIG. 6



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IMPERIAL THREADS & FEEDS

QUAD SLIDING GEAR	TOP LEVER	THREADS PER INCH — FEEDS IN THOUSANDTHS								DIAL
		1	2	3	4	5	6	7	8	
IN	LEFT	4 ·0764 ·0300	45 ·0680 ·0267	5 ·0611 ·0240	55 ·0555 ·0218	5·75 ·0531 ·0209	6 ·0509 ·0200	65 ·0470 ·0184	7 ·0437 ·0171	
	CENTRE	8 ·0382 ·0150	9 ·0340 ·0134	10 ·0306 ·0120	11 ·0279 ·0109	11·5 ·0266 ·0104	12 ·0254 ·0100	13 ·0235 ·0092	14 ·0218 ·0086	
	RIGHT	16 ·0191 ·0075	18 ·0170 ·0067	20 ·0153 ·0060	22 ·0139 ·0055	23 ·0133 ·0052	24 ·0127 ·0050	26 ·0118 ·0046	28 ·0109 ·0043	
OUT	LEFT	32 ·0096 ·0038	36 ·0085 ·0034	40 ·0076 ·0030	44 ·0070 ·0027	46 ·0066 ·0026	48 ·0064 ·0025	52 ·0059 ·0023	56 ·0054 ·0021	
	CENTRE	64 ·0048 ·0019	72 ·0042 ·0017	80 ·0038 ·0015	88 ·0035 ·0014	92 ·0033 ·0013	96 ·0032 ·0012	104 ·0029 ·0011	112 ·0027 ·0010	FINE PITCHES
O	RIGHT	128 ·0024 ·0009	144 ·0021 ·0008	160 ·0019 ·0008	176 ·0018 ·0007	184 ·0017 ·0007	192 ·0016 ·0006	208 ·0015 ·0006	224 ·0014 ·0005	FINE FEEDS

FIG. 7

I.S.O. THREADS & FEEDS.

QUAD SLIDING GEAR	TOP LEVER	3M/M L'SCREW PITCHES AND FEEDS IN M/M												STUD GEAR
		G	D	G	C	E	G	D	F	C	D	B	A	DIAL
		2	1	4	1	2	5	2	3	2	3	2	2	
IN	LEFT	7·0 2·14 ·84	6·0 1·83 ·72	1·71 ·67	5·5 1·68 ·66	1·59 ·62	5·0 1·53 ·60	1·47 ·58	4·5 1·375 ·54	1·34 ·53	4·0 1·22 ·48	1·10 ·43	·98 ·38	
	CENTRE	3·5 1·07 ·42	3·0 ·92 ·36	·85 ·34	·84 ·33	·79 ·31	2·5 ·76 ·30	·73 ·29	·68 ·27	·67 ·26	2·0 ·61 ·24	·55 ·22	·49 ·19	
	RIGHT	1·75 ·54 ·21	1·5 ·47 ·18	1·4 ·43 ·17	·42 ·16	1·3 ·40 ·156	1·25 ·38 ·15	1·2 ·36 ·144	·34 ·135	1·1 ·33 ·132	1·0 ·30 ·120	·90 ·28 ·108	·80 ·24 ·096	
OUT	LEFT	·26 ·105	·75 ·23 ·09	·70 ·22 ·084	·21 ·082	·20 ·078	·19 ·075	·60 ·18 ·072	·17 ·068	·16 ·066	·50 ·15 ·06	·45 ·14 ·054	·40 ·12 ·048	
	CENTRE	·134 ·052	·375 ·114 ·045	·35 ·107 ·042	·105 ·041	·325 ·099 ·039	·095 ·038	·30 ·091 ·036	·085 ·034	·275 ·084 ·033	·25 ·076 ·03	·225 ·069 ·027	·20 ·061 ·024	FINE PITCHES
O	RIGHT	·067 ·026	·057 ·022	·175 ·054 ·021	·052 ·02	·049 ·019	·048 ·019	·15 ·045 ·018	·042 ·017	·04 ·016	·125 ·038 ·015	·034 ·014	·10 ·03 ·012	FINE FEEDS

FIG. 8

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4. Move gear engagement lever to NEUTRAL position marked 'N' on gear engagement chart (D) (Fig. 5)

   Select No. 3 on selector dial (C) (Fig. 5) DO NOT TRY TO MOVE selector dial (C) unless gear engagement lever (D) is in NEUTRAL position

6. Move gear engagement lever (D) to No. 3 to correspond to the number of selector dial (C) (Fig. 5)

   Move lever on top left of gearbox (E) to the right to select 20 T.P.I. as indicated on chart when MACHINE IS RUNNING.

8. Move feedshaft/leadscrew selector lever (F) on top of gearbox tO leadscrew position WHEN MACHINE IS RUNNING

The lathe is now ready to cut 20 T.P.I.

N.B. DO NOT FORCE LEVERS INTO ENGAGEMENT. ENSURE CORRECT SEQUENCE FOR SELECTION IS OBSERVED

CROSS AND TOP SLIDES

The tapped holes in the saddle wings of the 280VS lathe facilitate the clamping of ancillary equipment e.g. travelling steady, coolant equipment, etc. By removing the top slide a boring table may be fitted for boring and milling operations.

OPERATION OF APRON FOR SLIDING AND SURFACING

Select feed from the chart on the gearbox and set the levers to the appropriate positions. The apron is then ready for engagement on the feedshaft. Clear the workpiece with the cutting tool and slide on the chip guard. Engage the feed by moving the lever (A) (Fig. 9) in the centre of the apron. Move the lever up to traverse towards the chuck. To reverse the travel engage reversing bracket (G) (Fig. 5). To stop the apron traversing move the lever to a horizontal position.

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FIG. 9

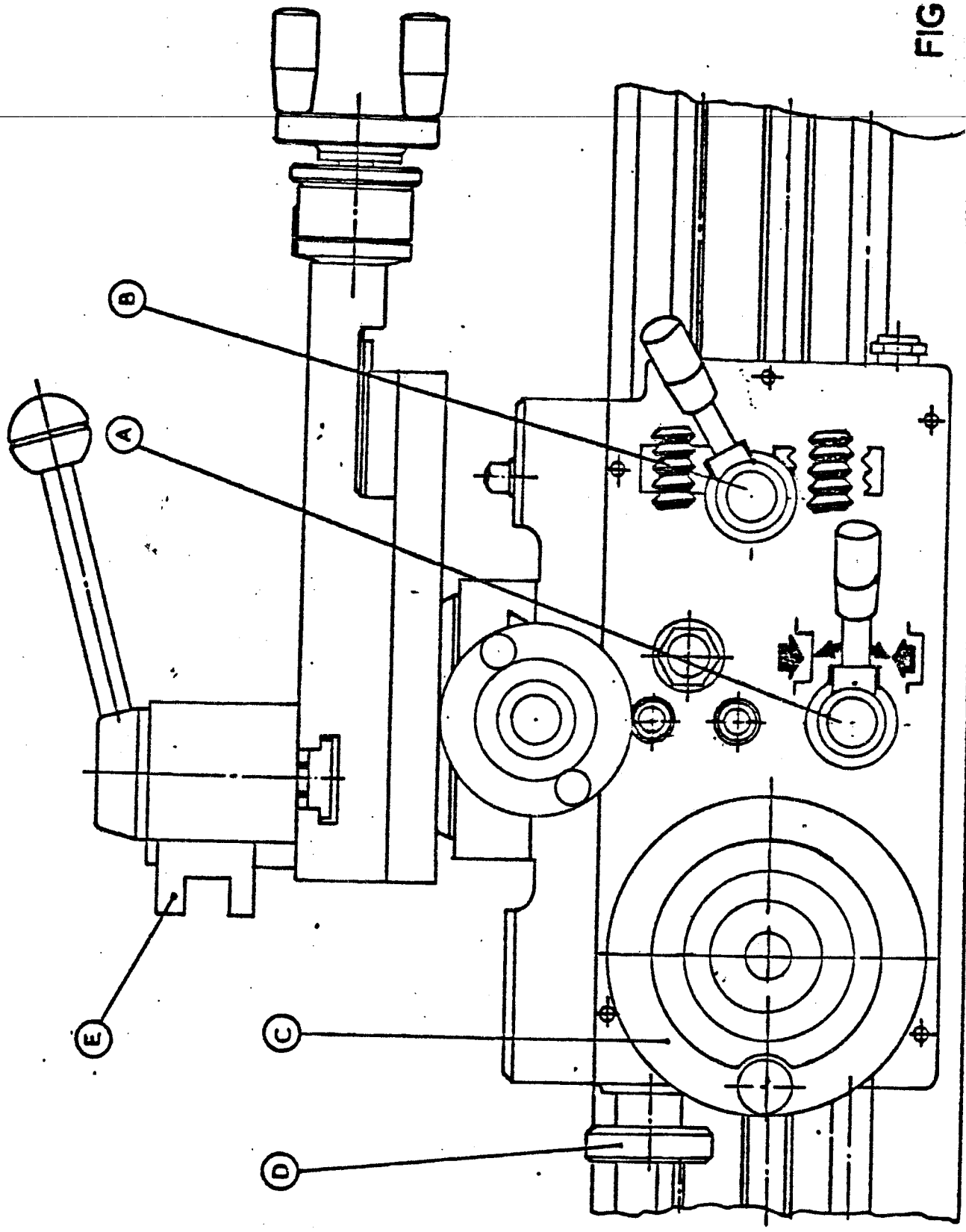

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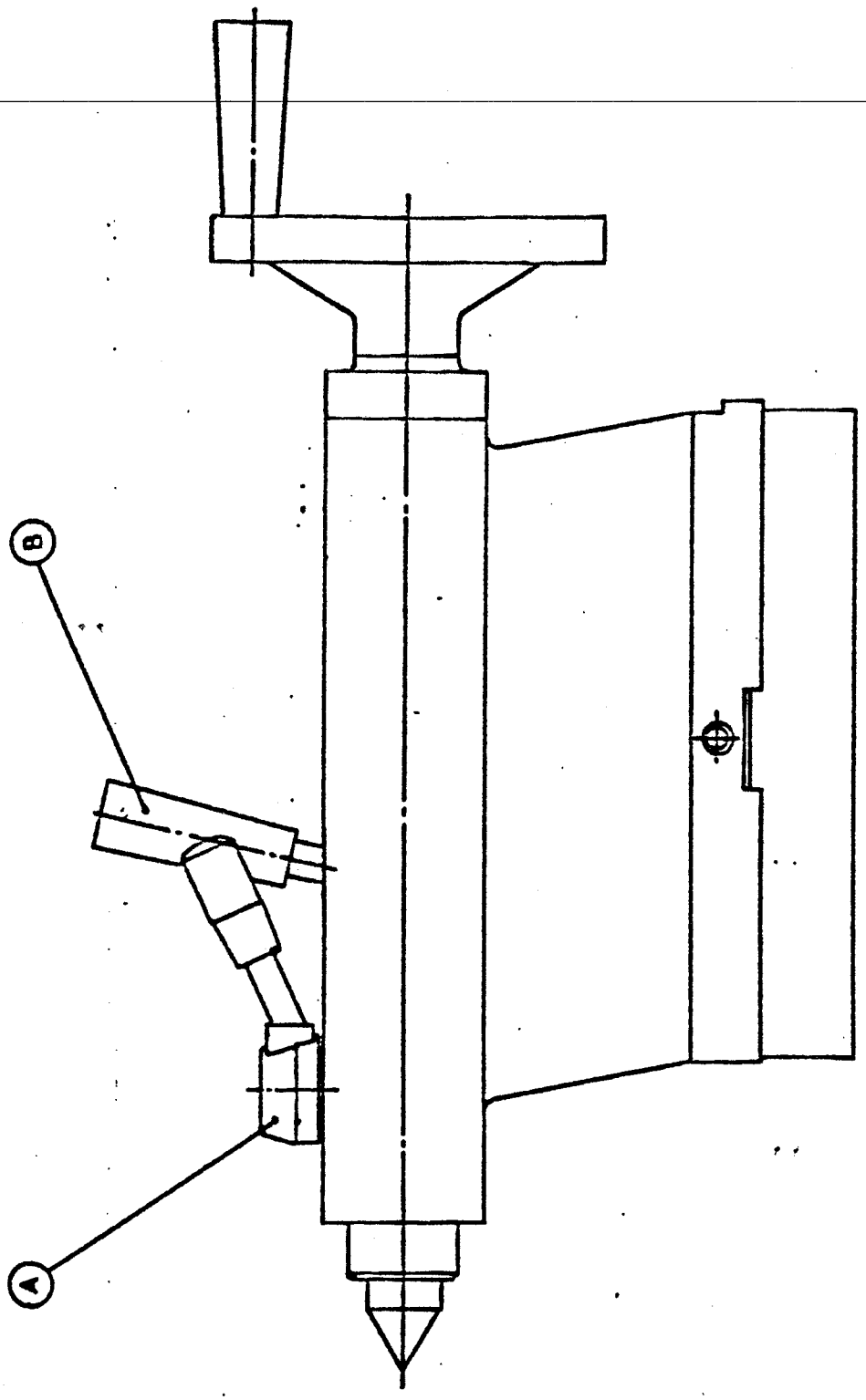
FIG.10



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SURFACING

To engage the cross slide traverse turn the knob on the chuck side of the apron (D) anti-clockwise to engage the traverse towards the centre of the chuck.

SCREWCUTTING

All screwcutting feeds are obtainable through the 3mm pitch (metric) or 8 T.P.I. (imperial) leadscrew. The pitches available are displayed on the front of the gearbox (Figs. 7 and 8).

TAILSTOCK

The tailstock is of 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. 10) (Lever A).

LOCKING

The tailstock is locked to the bed by means of a bed clamp operated by lever (B) (Fig. 10). 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. 11).

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N.B. 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:

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

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

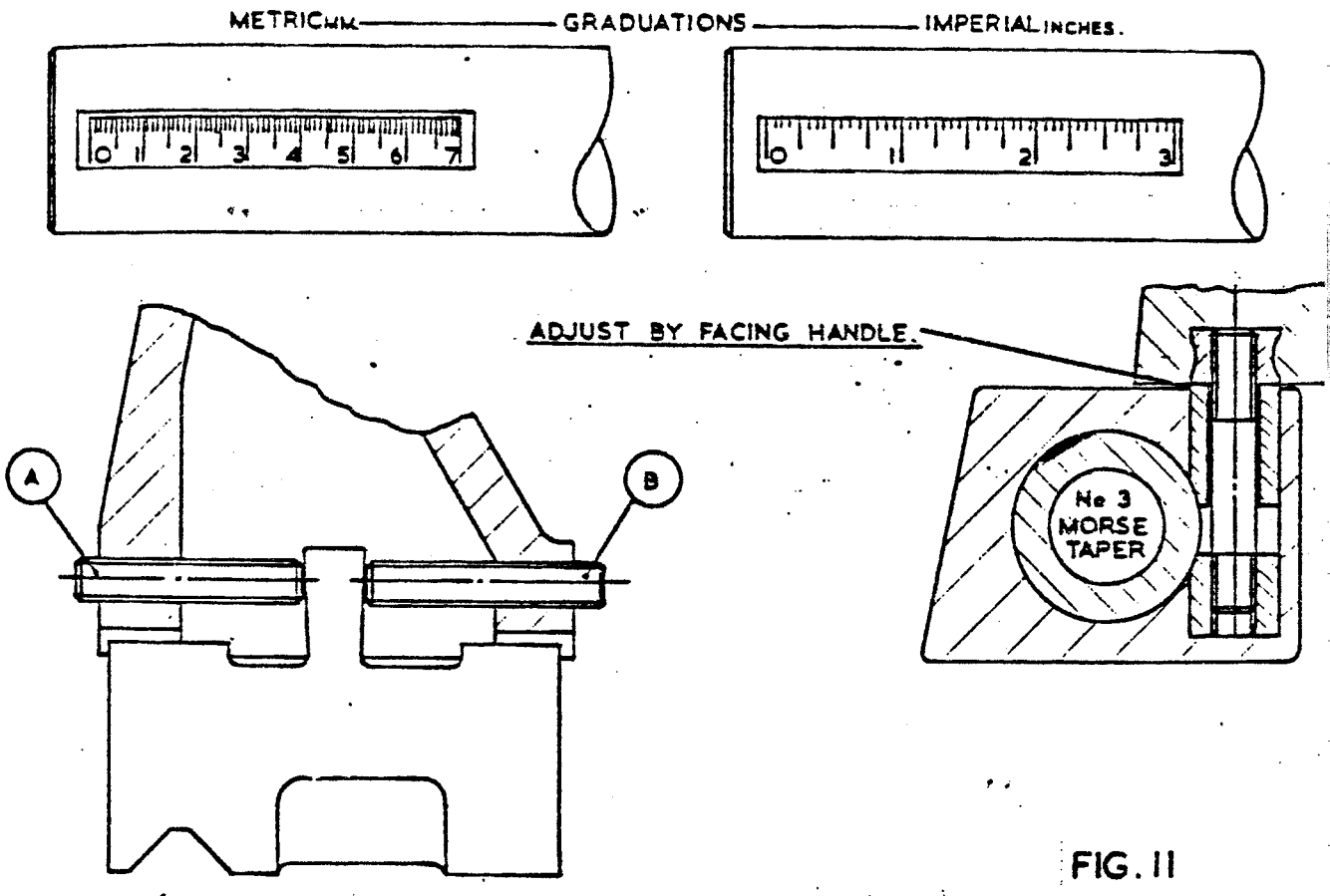

FIG. 11

TAILSTOCK ADJUSTMENT.

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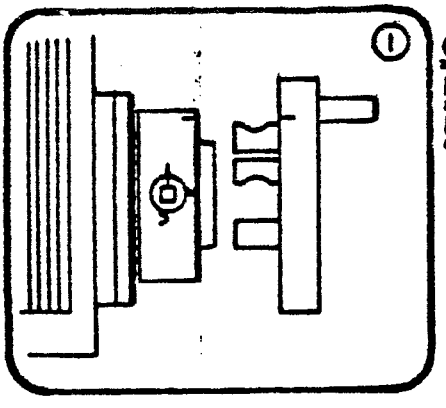
CHUCK AND FACEPLATE MOUNTING

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 dust or protective covering.

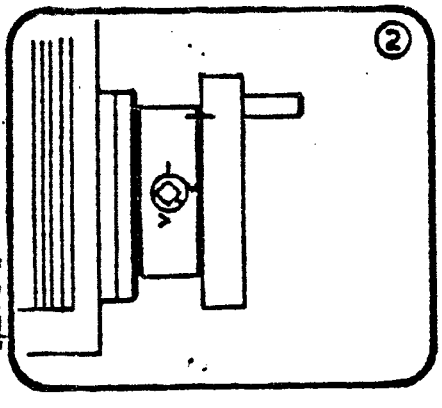
The line on the camlock cams in the spindle should be in line with the mark on the spindle o/d when the chuck is loaded to the spindle. Load the chuck and turn the cams with the key provided in a clockwise direction to tighten and lock the chuck to the spindle nose. The correct position of the cams in the lock position is shown in diagram 2 (Fig. 12).

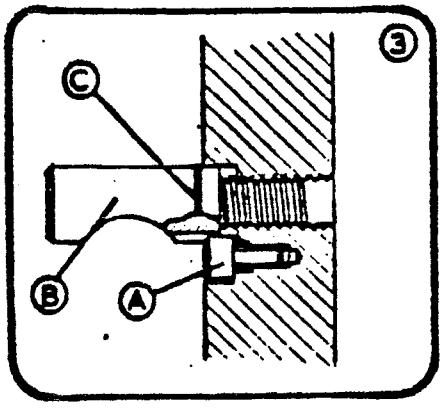
It may be necessary on chucks supplied without the camlock studs fitted, to adjust the studs so that the required cam action is obtained. This can best be set by screwing the studs to the bottom thread and then removing one complete turn. Adjustment for locking should then be carried out.



CAMS IN RELEASE POSITION.

CAMS IN LOCKING POSITION





TO ADJUST 'CAMLOCK STUDS'

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

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

FIG. 12

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MAINTENANCE

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

PERIOD	MAINTENANCE REQUIRED
Daily	Check level of oil in sight glasses
	Lubricate oil nipples
	Clean dials and graduations
	Wipe slides and ways leaving a thin film of oil
	Check quantity of cutting fluid in reservoir
	Clean out swarf
	Lubricate end drive
	Operate single shot lubrication
Weekly	Clean machine thoroughly
	Check nuts and bolts for slackness
Six monthly	Drain apron, gearbox, headstock, oil sumps and replenish with clean oil
	Check adjustment of saddle and side strips
	Clean out coolant reservoir, pipes and pump
	Grease headstock bearings
Annually	Check machine alignments and accuracy
	Check headstock bearings adjustment
	Regrease motor bearings and inspect electrical equipment

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MAINTENANCE

Changewheel Shear Key

As a protection against accidental overload of the end train a shear key is fitted in the sleeve at the bottom of the quadrant train. In the event of a replacement being necessary a 3/16" sq. x 13/16" long GRl aluminium key should be fitted. Remove the end plate by removing centre screw using 6mm allen key, pull off the gears and sleeve and remove the sheared key. Replace the key and re-assemble - see (END DRIVE ARRANGEMENT) (Fig. 5).

TOP SLIDE - STRIP ADJUSTMENT

Take up for wear on the top slide jib strip is by means of 3 socket lead screws and lock nuts. To adjust loosen the 3 lock nuts, adjust screws to give slight drag, then tighten lock nuts - (See Fig. 13).

CROSS SLIDE - STRIP ADJUSTMENT

As for top slide - (See Fig. 13).

SPINDLE END PLAY ADJUSTMENT

The taper roller main bearings have been correctly adjusted and pre-loaded on assembly and should not require any attention provided the initial setting is not disturbed. To adjust the pre-load, slacken off the lock nut on the spindle (A) (Fig. 14) and adjust the pre-load by turning the transducer gear (B) in small increments. NOTE THE THREAD IS LEFT HAND. After each tightening of the transducer gear (B) check that the pre-load is not excessive. The machine should run at top speed and the bearings should not exceed 65°C (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 hours running without discomfort. Check that the lock nut (A) is tight up against the transducer gear (B)

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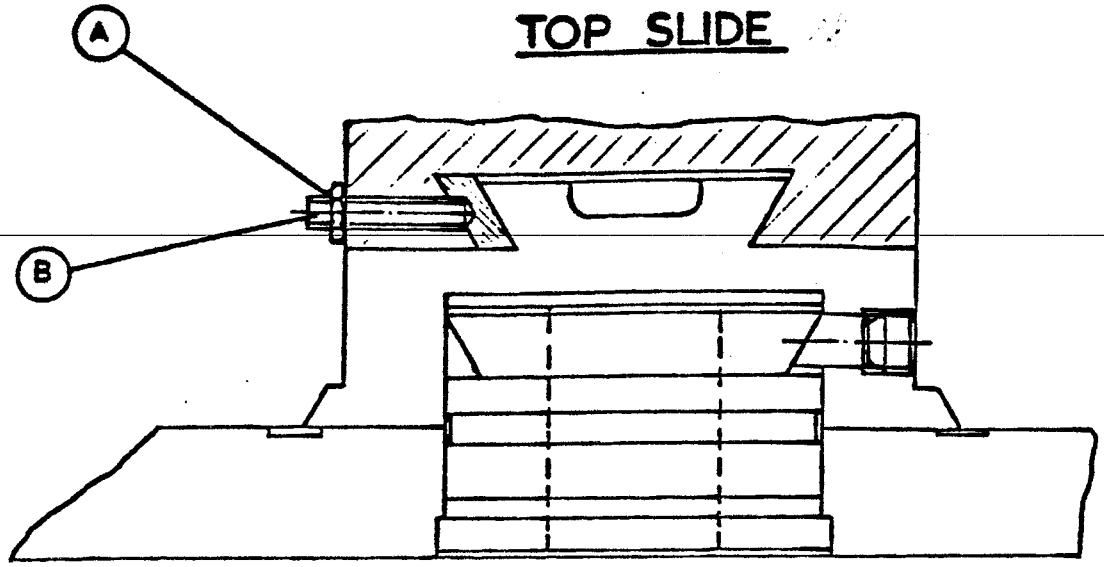
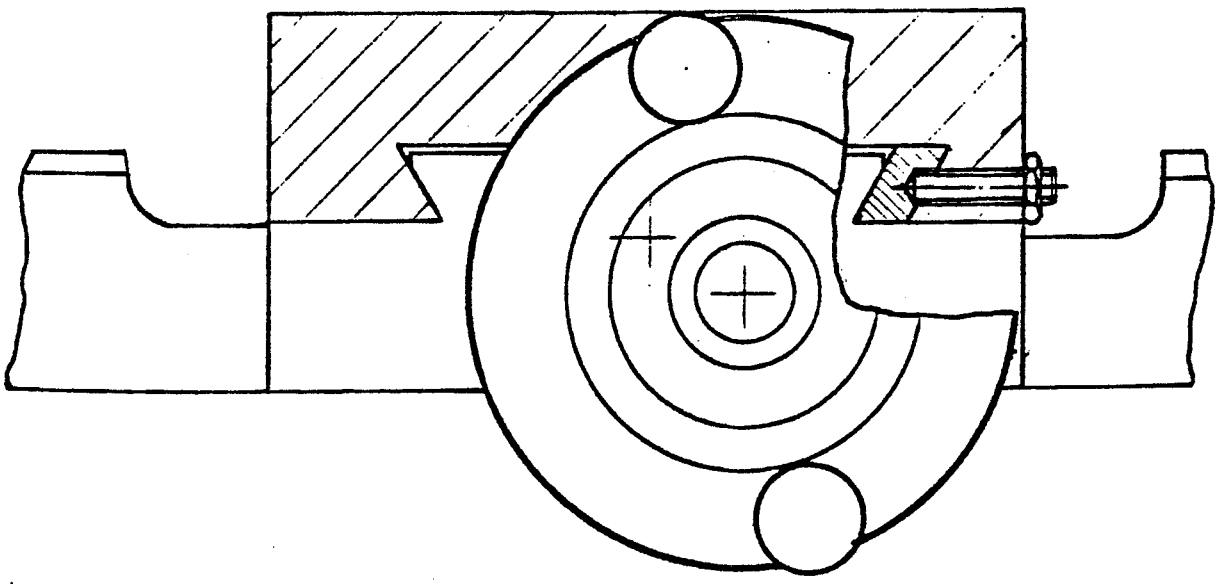
TOP SLIDE



TO ADJUST STRIP FOR WEAR LOOSEN NUTS, ADJUST SCREW (B) & TIGHTEN LOCKNUTS (A)

CROSS SLIDE



ADJUST AS FOR TOP SLIDE

FIG.13

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after adjustment. The transducer re-set gap is .040".

LEADSCREW ADJUSTMENT

The end thrust of the leadscrew acts upon a pair of needle roller thrust washers at the tailstock end of the bed. To eliminate any end play, adjust the lock nuts at the end of the leadscrew.

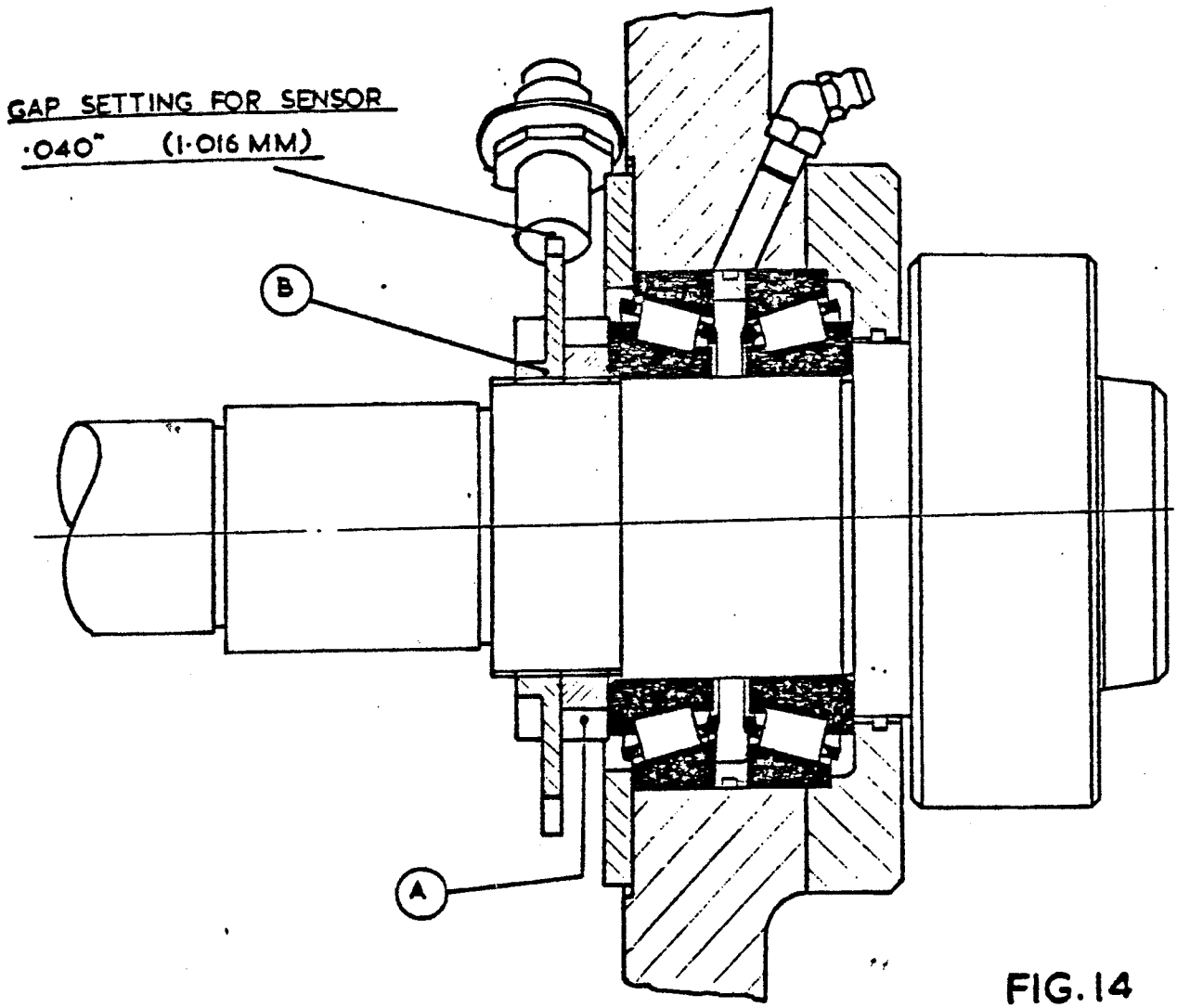

FIG.14

The Micromaster combines the accuracy and versatility of the 280VS Lathe with the latest microprocessor technology to give a complete training package. The Micromaster is ideal for training or retraining operators and with its "can't go wrong - learn as you go" method of programming, makes it the complete lathe for training in technical education and industry.

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OPERATION OF CNC MODE

LC 80 CONTROL

All movements of the carriage in the NC mode are made through the recirculating ball screws located at the rear of the machine. To bring the ball screw into operation, locate the camlock on the machine saddle and change the mode to NC (as previously detailed on page 12).

All tools for use in the NC mode are used in conjunction with the 'Multifix' quick change toolpost.

The tools can be pre-set on a setting fixture to ensure that tools are set uniformly and also to the same position after tip changes.

FROM MANUAL TO CNC MODE

Disengage cross slide drive by pulling out cross slide handle. This will disengage the cross slide handwheel. Reverse procedure when returning to manual control.

The long traverse handwheel is fitted with a spring lever handle and when in use on CNC mode it is advisable to ensure that handle is re-located inside handwheel.

Ensure after manual use that the leadscrew engagement cover is in the down position.

Disengage the reversing bracket inside the end drive guard and the interlock light on the control panel will go out.

OPERATION OF NC MODE

(a) Switch on mains supply

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(b) Press NC mode button. This switches on the computer control and displays on the VDU. The axis jog buttons can now be used to move the cross slide and the saddle. Press stop cycle for the Micromaster CNC.

Use the axis jog buttons if required to check the slides for freedom of movement and lubrication. Exit from this facility by pressing the stop cycle button.

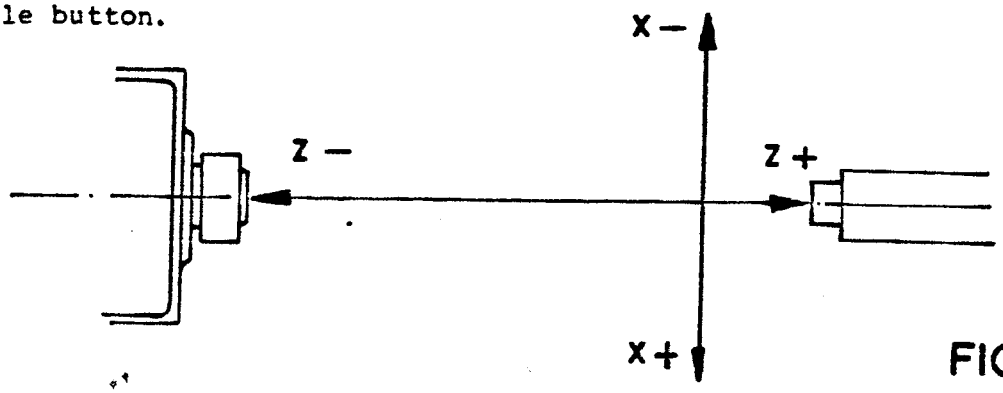

FIG. 15

For all points of reference in the CNC mode two axis are used. "Z" axis along the centre line of the machine from chuck to tailstock and "X" axis 90° to "Z" axis.

"X" AXIS

The "X" axis can be programmed at any required position within the range of the cross slide. However the "X" axis datum is set at a nominal value of 2.500".

"Z" AXIS

This can be programmed in at any required dimension within the range of the machine.

*Movements towards the chuck on both axes are a negative (-) value, away from the chuck a positive (+) value.

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Press ENTER key to proceed - the VDU displays -

"CHECK LIST".

Each item in turn should be checked and confirmed by pressing the ENTER key.

After confirming the last item the VDU displays -

"*CHOOSE PROGRAM MODE"

1. Cassette
2. Total program MDI (Manual Data Input)
3. Single step MDI

Program selection can now be made by selecting either code 1 - 2 or 3 and entering by the ENTER key. The asterisk will move to show the choice of mode selected.

CHOICE 1 - CASSETTE

See page 28.

CHOICE 2 - TOTAL PROGRAM MDI

On total program the whole of the program is fed into the machine memory before any execution can take place.

After selecting code 2 TP MDI, the VDU displays -

"*CHOOSE UNITS"

1. Inches
2. Metric mm

Choice is made by selecting the required code within 1 or 2 and entering by the ENTER key.

"*CHOOSE DATA FORMAT"

1. Absolute
2. Incremental

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(a) Absolute

All data entered is taken from the ZØ and XØ positions.

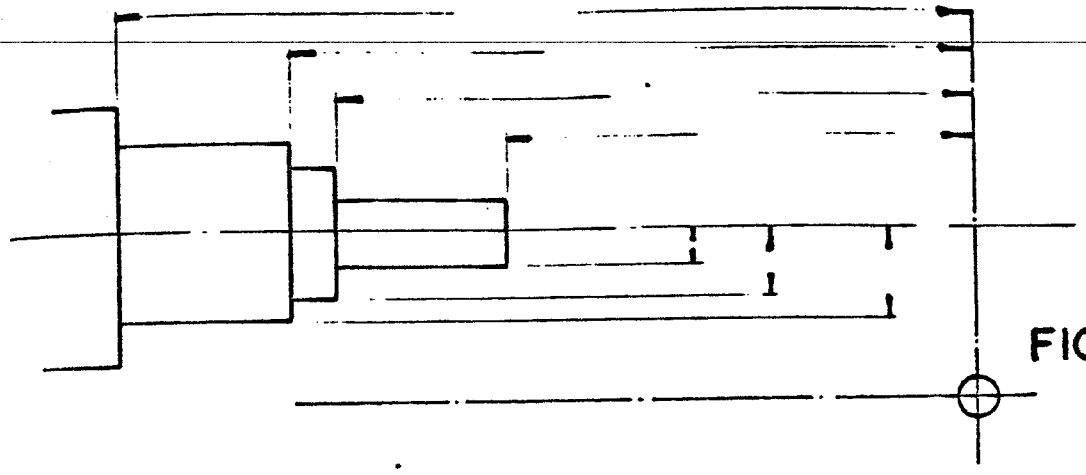

FIG. 16

(b) Incremental

All data entered is taken from the previous position.

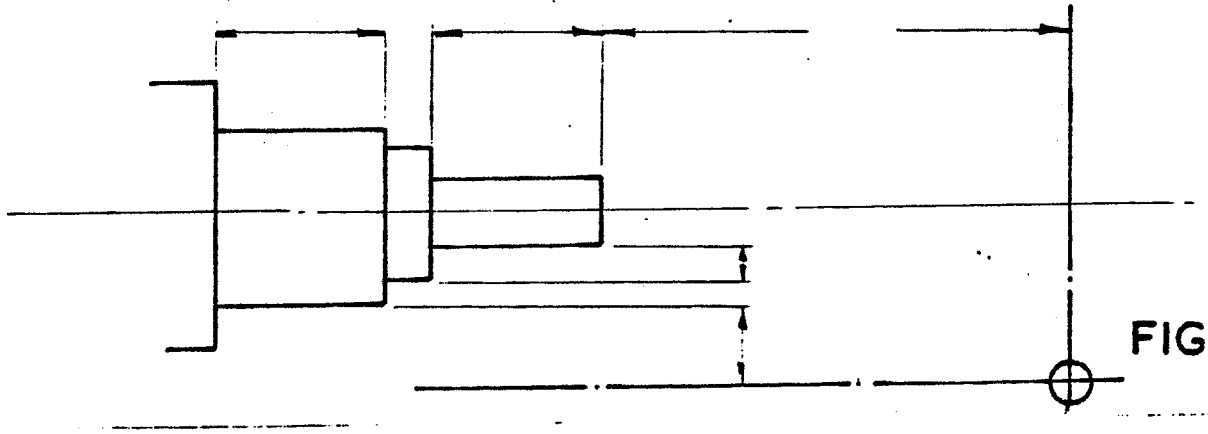

FIG. 17

"ENTER PROGRAM DATUMS"

X?

Z?

Key in appropriate dimensions for "X" and "Z". Program datums and press ENTER key. The VDU will only ask for "Z" datum when "X" has been entered. The X value should always be keyed in at 2.5 inches or 63.5 mm. After datum dimensions have been entered a final check will be prompted by the VDU - is all

"OK?"

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If incorrect information has been entered press the skip back keys marked . This will clear entered data and request new dimensions.

When the operator is satisfied that the correct data has been entered, confirm by pressing ENTER key.

BLOCK NO. 01

The following reminder information will now be displayed on the VDU and in each subequent block number -

(a) Program mode

(b) Units chosen

(c) Format

(d) Start of block position (This shows tool position at the start of the block number.

The VDU will also display the choice of operating modes -

(1) Point to point

(2) Facing CC

(3) Turning CC

(4) Taper

(5) Last block

The appropriate code is selected and entered by pressing the ENTER key.

After pressing the ENTER key all reminder information is maintained and the VDU will request in sequence all the information required in that block number, relevant to the OP mode chosen. Each item of information must be keyed in and entered before the next item of information is requested by the VDU.

Examples of VDU screen displays for T.P. OP mode, when all block information has been entered, are shown overleaf: (Fig. 18).

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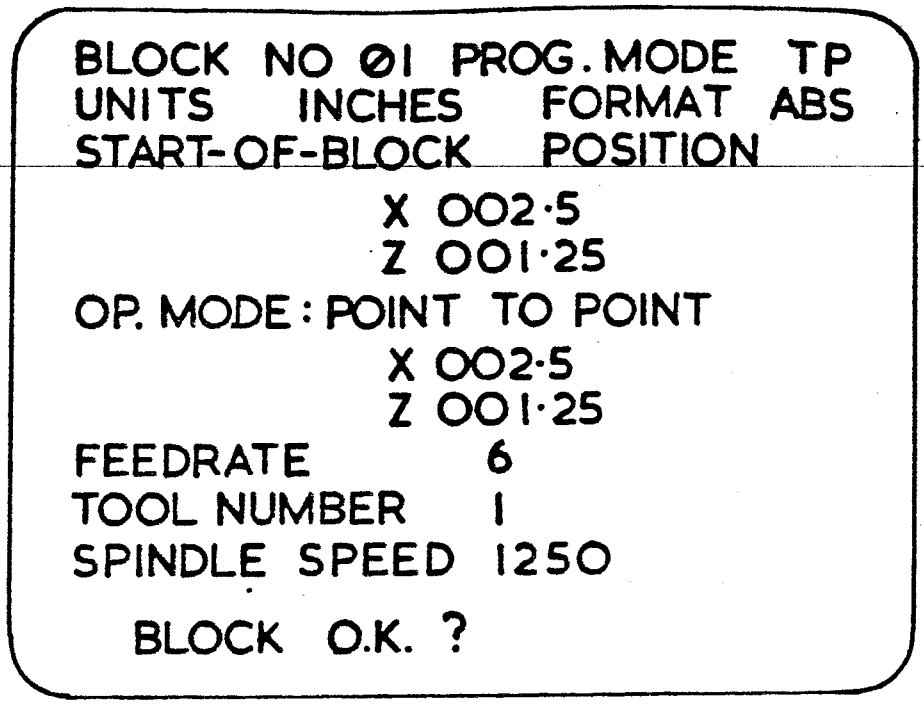

FIG.18

1. POINT TO POINT

Only "X" or "Z" co-ordinates can be entered. The VDU will first ask for "X" dimension. Key in dimension and ENTER. If there is no movement of "X" required press ENTER key. The current "X" position will be displayed and the VDU will ask for "Z". Key in value for "Z" and ENTER.

ENTER in sequence feedrate, tool number and spindle speed. A final prompt reminder will appear -

"BLOCK OK?"

Press ENTER key when satsified block is correct.

At any time during the progamming of a block incorrect information can be cleared and new data re-entered by using the skip back key marked . A single press of the button clears the preceding line. Once the complete block has been entered, one press of the skip back key clears all entries.

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2. FACING CANNED CYCLE

BLOCK NO 05 PROG. MODE: TP
UNITS INCHES FORMAT 2OC

START-OF-BLOCK POSITION
X -001.200
Z -005.512

OP. MODE FACING

LENGTH OF CUT X ?
DEPTH OF CUT Z ?
CUT-STEP (INCR) Z ?

FEEDRATE ?
TOOL NO ?
SPINDLE SPEED ?

BLOCK OK?

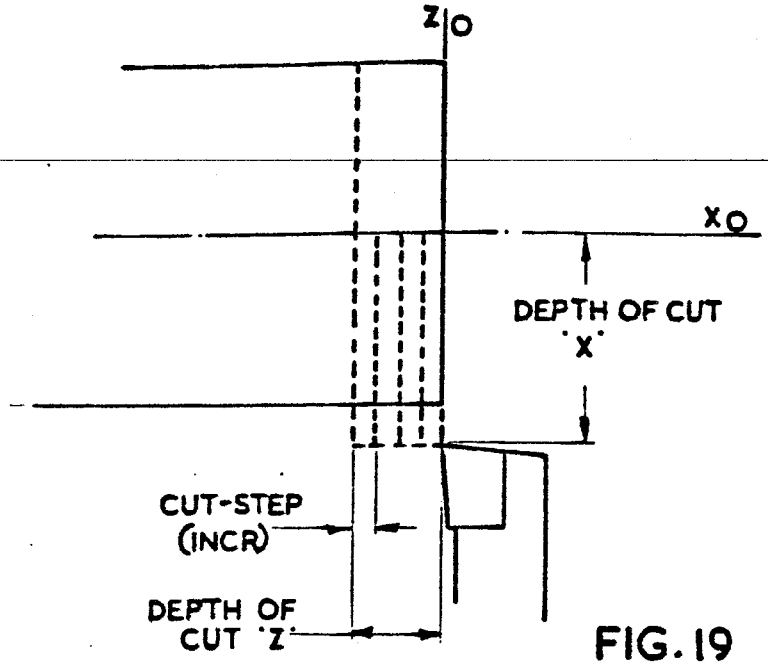

FIG. 19

Enter all data as requested, not forgetting that LENGTH OF CUT and DEPTH OF CUT can be INCREMENTAL or ABSOLUTE dependant upon format previously selected.

The CUT STEP is always an incremental value and does not require a MINUS sign when moving towards the centre line of the spindle. The machine automatically calculates the number of cuts to make to give the correct depth of cut.

Even if the CUT STEPS do not divide equally into the required DEPTH OF CUT the machine will calculate and make the last cut at the correct depth. This is a useful feature when it is required to remove a large amount of metal in a number of cuts when the last cut is required to be a finishing cut.

e.g. Depth of cut 10 mm

Cut step (Incr) 3.25 mm

The machine will make three cuts at 3.25mm depth and a finishing cut of 0.25mm.

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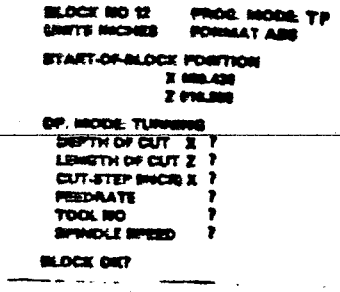
3. TURNING CANNED CYCLE



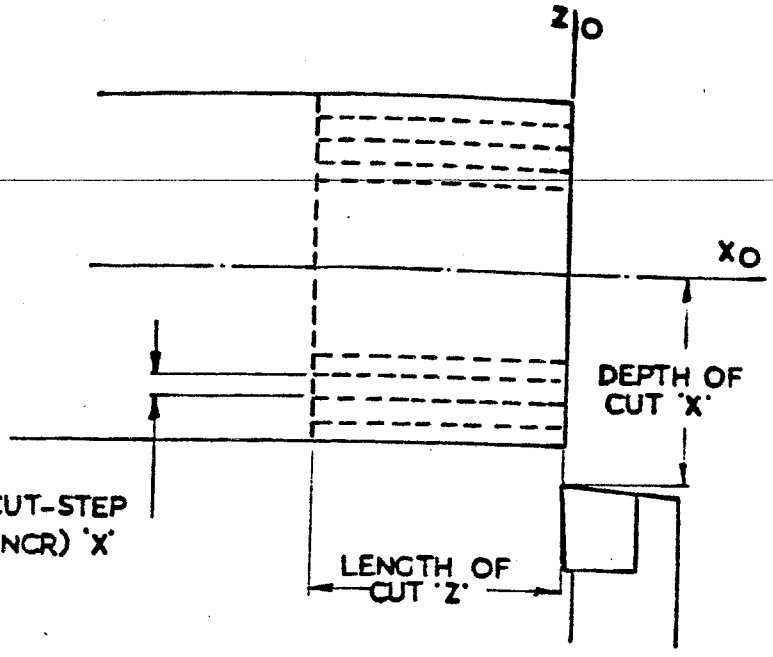


FIG.20

Procedure and function as FACING CANNED CYCLE. When taking cuts towards the chuck the cut step does not require a minus sign, only when cutting away from the chuck should a minus sign be entered.

4. TAPER

In the taper mode both "X" and "Z" axes are changed simultaneously, new "X" and "Z" co-ordinates are entered. The machine will accept feedrates 1 to 4 and calculate the correct ratio between "X" and "Z" drives such that both drives start and finish at exactly the same time, thus creating a taper for the full length of the cut. The tool starts at the START OF BLOCK POSITION and stops at the new "X" and "Z" positions.

In all the above four operation modes the final request on the VDU is the -

"BLOCK OK?"

prompt to remind the operator to re-check the entered data. A further press of the ENTER key confirms the data is correct and automatically increments on to the next block number and again offers the choice of OP

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MODES. The whole program can now be built up block-by-block. To end the program return to the original datum positions and enter tool 0 in the LAST BLOCK. This will eliminate any offsets and return the tool to the start of program position. To end the program choose LAST BLOCK.

After choosing "LAST BLOCK" the VDU will display for two seconds -

"LAST BLOCK"

"PROGRAM ENTRY COMPLETE"

Followed by -

"*CHOOSE:

1. EDIT
2. EXECUTE
3. SAVE

To proceed choose 1, 2 or 3 and ENTER. Refer to:-

Page 34 for EDIT

" 32 for EXECUTE

" 36 for SAVE

PROGRAM MODE CHOICE 1 - CASSETTE

If program mode choice 1 is made then the machine is ready for programming from a pre-recorded tape cassette. The VDU will ask -

"CASSETTE LOADED?"

Release cassette carrier by means of thumb button on face of recorder, load cassette into carrier and close carrier. Confirm this has been done by pressing ENTER key. The VDU will respond by displaying -

"CASSETTE LOADED OK"

the cassette will now automatically re-wind and load its contents into the machine memory.

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If the machine has done this correctly the CHECKSUM number will appear on the VDU. This number is a measure of the amount of information on the cassette which the machine compares with the amount loaded into its memory. This is then followed by the ID number. Press ENTER to proceed.

"PROGRAM TRANSFER COMPLETE"

followed by -

"CHOOSE TO....."

1. EDIT PROGRAM
2. EXECUTE PROGRAM
3. SAVE PROGRAM ON CASSETTE

To proceed choose 1, 2 or 3 and ENTER. Refer to:

Page 34 for EDIT

" 32 for EXECUTE

" 36 for SAVE

If the loading is incorrect the VDU displays -

ABORTED

Repeat the procedure. To stop a program once the cassette has commenced loading, press the ABORT button.

PROGRAM MODE CHOICE 3 - SINGLE STEP MDI

If program mode choice 3, i.e. SINGLE STEP MDI is chosen the machine must be set up to turn the actual piece of work step by step. Instructions for this are given via the VDU. Ater having chosen the units, format and program datum the VDU will display -

"CHOOSE YOUR ZØ PLANE"

Using the axis jog buttons touch the tool tip onto the turned face of the work piece. If no turned face exists one can be turned using the axis jog button after starting the spindle motor.

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With tool tip touching face press STOP CYCLE button.

For information only on TOOL OFFSET is defined on the VDU. Press ENTER to proceed. The program datum is now set at the values keyed in via the machine datum. The VDU now displays the title -

"TOOL OFFSETS"

and is ready to accept "X" and "Z" tool offset for all the tools to be used in this particular program and will take up to nine pairs of offsets.

Key in the TOOL NUMBER (1 to 9) and START SPINDLE motor.

Using the axis jog buttons turn any diameter and leave tool at that diameter. (This can be carried out either on the workpiece or a piece of scrap material) or "Toysteel". (RIGID FOAM - available from Denford).

Press STOP CYCLE button - Spindle stops. Measure the turned diameter and ENTER.

Start the spindle and using the axis jog buttons touch tool tip on to the previously turned face at ZØ.

Press STOP CYCLE button.

The machine now asks for further tools to be fitted and their numbers to be entered such that offsets can be taken. All the tool tips will vary slightly in position relative to the first tool. (This difference is automatically calculated in the machine after the above "touching-on" procedure.

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When all tool offsets have been taken proceed by pressing the ENTER key. This will exit the OFFSET routine.
The VDU will now request information for block number 1 and all data can be entered as described on pages 22 and 23.

The whole program can now be built up block-by-block and each block number is executed before requesting information for the next block.

PLEASE NOTE:

a) The spindle must be running before an EXECUTE can operate

If a tool change has been entered into a block then an asterisk will flash on the VDU reminding the operator to change to the appropriate tool in the toolpost

If a spindle speed has been entered that requires a change from high to low gear or vice versa then an asterisk will flash on the VDU reminding the operator to change gear. The block will not be executed until the operator has changed gear.

All speed changes not requiring a change of gear are done automatically by the machine. The machine will not execute a block until the spindle has reached the required speed.

To EXECUTE 1ST BLOCK press START CYCLE button. All subsequent blocks will be executed once the BLOCK OK? is ENTERED.

To end program choose LAST BLOCK after ensuring tool has returned to PROGRAM DATUMS "X" and "Z" as previously described.

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IMPORTANT

Ensure that when programming last block, machine is returned to datums and incorporates tool No. 0 as last tool number. All tool numbers from 1 - 9 may be used to incorporate tooling changes and as each tool offset is programmed the memory will set to zero. Tool No. 0 should then be utilised on the return to datum block prior to RE-EXECUTE.

After choosing last block VDU displays -

"END OF PROGRAM"

"*CHOOSE"

1. EDIT
2. EXECUTE
3. SAVE

END OF PROGRAM - CHOICE 2 - EXECUTE

On choosing EXECUTE VDU displays -

"EXECUTE"

"*CHOOSE"

1. DIRECT
2. VIA MACHINE DATUM

If the machine has just completed an EXECUTE cycle or has just been programmed using the SINGLE STEP program mode, all TOOL OFFSETS and DATUM POSITIONS will be in the machine memory. To ENTER into the EXECUTE CYCLE choose "DIRECT" and ENTER.

Block number 01 will now be displayed awaiting start by pressing the START CYCLE button.

If the total program has been selected and the last block completed, on selection of the execute program the total offset and datum procedure

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will be asked for. Carry out as described on page 29 as for single step mode.

If a program has been transferred into the memory from a cassette, the tool offset and datum procedure must be carried out.

TOOL OFFSETS

If whilst executing a program, tool damage occurs press tool offset key. This will stop the program and spindle.

The VDU now displays -

"CHOOSE"

1. ABORT

2. TOOL OFFSET

1. ABORT

If abort is selected, this will end the execution at that point and the choice can be made of whether to edit, execute or save. Edit if adjustment is required and re-execute by selecting 2.

The VDU now displays -

DATUM PROCEDURE

"CHOOSE"

1. SAME

2. NEW

CHOICE 1. Same datum positions are retained.

CHOICE 2. New datum positions and offsets must be entered.

2. TOOL OFFSET

After selection tool offset remove the tool as instructed. By pressing ENTER the program datum is found. The tool number is

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automatically called up for the new offsets to be taken. Complete the procedure as before. Remove the tool and press enter.

The machine is now ready to re-commence from start of block position.

EDIT

On entering the edit mode press ENTER. Now check the program datum. Press the C. Button to clear and insert the new values. On pressing ENTER a split screen will appear on the VDU.

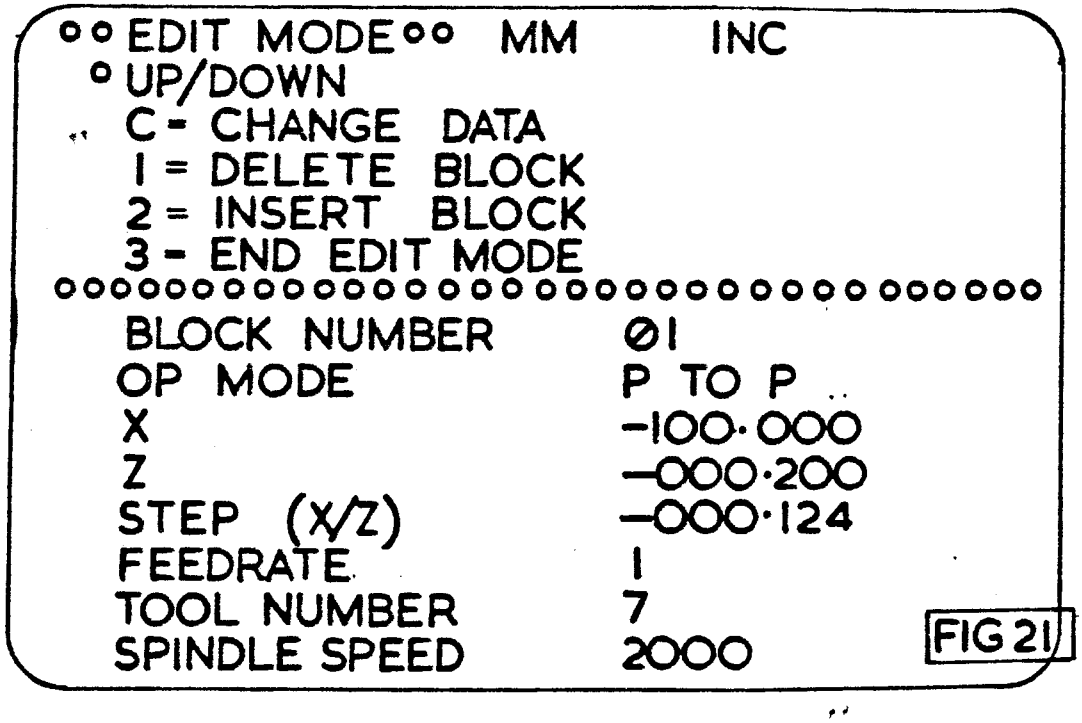

FIG 21

When data is required to be changed use the up-down arrows on the keyboard to move the bottom asterisk against the line that requires to be deleted. Press the "C" key which will move the top asterisk opposite the change data line. By pressing the ENTER key, the line information will be erased. Key in the new information and ENTER. Exit from edit facility by using Code 3 and ENTER. The VDU will then return to Edit-Execute-Save block.

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To delete a complete block ensure bottom asterisk is lined against block number. Key in Code 1 and ENTER. The existing block will then be deleted and all subsequent blocks renumbered.

To insert a new block, line up with arrowed keys, bottom asterisk opposite block number. Press "C" code and ENTER. Key in block number after the new block to be inserted. (E.g. If a new block is to be inserted between blocks 5 and 6 call up block 6). Select Key no. 2 and ENTER. This will erase the existing block and allow new data to be entered.

All following block numbers will automatically be re-numbered in sequence.

Always ensure that each new entry of data is keyed into the memory by the ENTER key.

After completion of block select and ENTER code 3 to return to Edit-Execute-Save selection.

If selection of consecutive blocks is required during edit using the step down key , line asterisk opposite spindle speed, a further press of the key will bring forward the next consecutive block. Exit by using Code 3.

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SAVE

To load data information from memory to cassette tape select code 3 (Save) and ENTER.

The VDU will ask

"CASSETTE LOADED?"

Load cassette and press ENTER key.

Key in ID number (this must be a 4 digit number) and should be used as a recording system for job identification. The checksum number will appear as a check against the memory value. Key in by pressing ENTER key.

The tape will fast rewind and load the data from the memory onto tape. Press the ABORT button to stop transfer. The VDU will display -

ABORTED

for 6 seconds and will return to edit, execute or save. On completion of program transfer the VDU will show

"PROGRAM TRANSFER COMPLETE"

and return to Edit-Execute-Save.

ABORT

The abort signal will be displayed on the VDU if the transfer of information on to tape is incorrect. Reload tape and execute program from start.

A video film of the programming sequences is supplied as standard equipment for the Micromaster tutor.

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This is in cassette form in any of the popular machine formats including those in the United States and Europe.

Running time is 15 minutes and is in sound and colour

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A

ABSOLUTE DIMENSION - A dimension expressed with respect to the origin of a coordinate system. The original of a coordinate system is arbitrary.

ABSOLUTE SYSTEM - N/C system in which all positional dimensions, both input and feedback, are measured from a fixed point of origin.

AXIS - 1) A principal direction movement of the tool or workpiece. 2) One of the reference lines of a coordinate system.

B

BACKLASH - A relative movement between interacting mechanical parts, resulting from looseness.

BLOCK - A set of words, characters, digits or other elements handled as a unit. A "word" or group of words considered as a unit separated from other such units by an "end of block" character (EOB). On a punched tape, a block consists of one or more characters or rows across the tape that collectively provide enough information for an operation.

BYTE - A set of contiguous binary bits, usually eight, which are operated on as a unit. A byte can also be a subset of a computer word.

C

CANNED CYCLE - A preset sequence of events (hardware or software) initiated by a single command, e.g. G84 or Cycle/Tap for an N/C tap cycle.

CIRCULAR INTERPOLATION - A mode of contouring control which uses the information contained in a single block to produce an arc of a circle. Shorter tape lengths are possible when circular interpolation is used instead of linear interpolation.

CLOSED LOOP SYSTEM - A control system in which the output, or some result of the output, is fed back for comparison with the input for the purpose of reducing the difference. See also OPEN LOOP SYSTEM.

COMPUTER-AIDED PROGRAMMING SYSTEM - A part programming language, a language processor (computer program), a post-processor (computer program), and a computer.

COMPUTER (COMPUTERIZED) NUMERICAL CONTROL (CNC) - A numerical control system wherein a dedicated, stored program computer is used to perform some or all of the basic numerical control functions.

CONTROL UNIT - 1) That portion of a CPU which directs the operation of the computer, interprets computer instructions and initiates the proper signals to the other computer circuits to execute instructions. 2) A numerical controller.

CRT(Cathode Ray Tube) - An electronic vacuum tube containing a screen on which alphanumeric or graphic information may be displayed.

CYCLE - 1) An interval of space or time in which one set of events of phenomena is completed. 2) A sequence of operations that is repeated regularly.

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CYCLE TIME - The period required for a complete action. In particular, the interval required for a read and a write operation in working memory, usually taken as a measure of computer speed.

D

DAMPING - A characteristic built into electrical circuits and mechanical systems to prevent rapid or excessive corrections which might lead to instability or oscillatory conditions.

DIGIT - A symbol that is used to represent one of the integers of a numbering system. For example, in the decimal system the integers 0 to 9 are digits and in the binary system 0 and 1 are digits.

DISPLAY - A visual presentation of data.

E

EDIT - To modify the form or format of data.

END OF PROGRAM - A miscellaneous function (m02) indicating completion of a workpiece. Stops spindle, coolant and feed after completion of all commands in the block. Used to reset control and/or machine.

F

FEED FUNCTION - The relative motion between the tool or instrument and the work due to the motion of the programmed axis or axes.

FEEDRATE NUMBER - A coded number read from the tape which describes the feedrate function. Usually denoted as the "F" word.

FEEDRATE OVERRIDE - A variable manual control function used to reduce or increase the programmed feedrate.

FLOW CHART - A graphical representation of the processing steps performed by a computer program or of the sequence of logic operations implemented in hardware.

FULL RANGE FLOATING ZERO - A characteristic of numerical machine tool control permitting the zero point on an axis to be shifted readily over a specified range. The control retains information on the location of "permanent" zero.

H

HARDWARE - Physical equipment, e.g. mechanical, electrical, hydraulic, magnetic devices.

I

INCREMENTAL DIMENSION - A dimension expressed with respect to the preceding point in a sequence of points.

INCREMENTAL SYSTEM - Control system in which each coordinate or positional dimension is taken from the last position.

INTERFACE - 1) A hardware component or circuit for linking two pieces of electrical equipment having separate functions, e.g. tape reader to data processor, or control system to machine. 2) A hardware component or circuit for linking the computer to an external I/O device.

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INTERLOCK - To arrange the control of machines or devices so that their operation is interdependent in order to assure their proper coordination

J

JOG - A control function which provides for the momentary operation of a drive for the purpose of accomplishing a small movement of the driven machine.

M

MACRO - A source language instruction from which many machine language instructions can be generated. See also COMPILER LANGUAGE.

MANUAL DATA INPUT (MDA) - A means of inserting data manually into the control system.

MANUAL FEEDRATE OVERRIDE - Device enabling operator to reduce or increase the feedrate.

MEMORY - A general term which refers to any storage media for binary data. Basic memory functional types include read/write and read-only.

MICROCOMPUTER - A class of computer having all major central processor functions contained on a single printed circuit board constituting a stand-alone module. Microcomputers are typically implemented by a small number of LSI circuits and are characterized by a word size not exceeding 16 bits, and very low cost.

MICROPROCESSOR - A single LSI circuit which performs the functions of a CPU. Some characterstics of a microprocessor include small size, inclusion in a single integrated circuit or set of integrated circuits, and low cost.

N

NUMERICAL CONTROL SYSTEM- A system in which the direct insertion of programmed numerical values, stored on some form of input medium, is automatically read and decoded to cause a corresponding action in machine or process.

O

OFFSET - The steady state deviation of the controlled variable from a fixed setpoint.

OPEN LOOP SYSTEM - A control system that has no means of comparing the output with the input for control purposes.

OUTPUT - 1) Information transferred from a computer's internal storage to output devices or external storage. 2) Printed or recorded data resulting from the computed source program.

OVERSHOOT - Occurs when a travelling member of the machine tool moves past a predetermined point, due to the inertia of the mechanical drive system.

P

POINT-TO-POINT CONTROL SYSTEM - An N/C system which controls motion only to reach a given end point but exercises no path control during the transition from one end point to the next.

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POSITION SENSOR - A device for measuring a position and converting this measurement into a form convenient for transmission.

PRINTED CIRCUIT - A circuit for electronic components made by depositing conductive material in continuous paths from terminal to terminal on an insulating surface.

PROGRAM - A plan for the solution of a problem. A complete program includes plans for the transcription of data, coding for the computer, and plans for the absorption of the results into the system. The list of coded instructions is called a routine. To plan a computation or process from the asking of a question to the delivery of the results, including the integration of the operation into an existing system. Thus, programming consists of planning and coding, including numerical analysis, systems analysis, specification of printing formats, and any other functions necessary to the integration of a computer in a system.

R

RESOLUTION - 1) The smallest distinguishable increment into which a signal or picture, etc., is divided in a device or system. 2) The minimum positioning motion which can be specified.

RETROFIT - Work done to an existing machine tool from simply adding special jigs or fixtures to the complete re-engineering and manufacturing, and often involving the addition of a numerical control system.

S

SEQUENCE NUMBER - A number identifying the relative location of blocks or groups or blocks on a tape.

SOFTWARE - The collection of programs, routines, and documents associated with a computer.

STEPPING MOTOR - A bi-directional permanent magnet motor which turns in finite steps.

STORAGE - A memory device in which data can be entered and held, and from which it can be retrieved.

T

TACHOMETER - A speed measuring instrument generally used to determine revolutions per minute. In N/C it is used as a velocity feed-back device.

TOOL OFFSET - 1) A correction for tool position parallel to a controlled axis. 2) The ability to reset tool position manually to compensate for tool wear, finish cuts and tool usage.

X

X AXIS - The X axis of motion is horizontal and parallel to the work holding surface. If Z is horizontal, positive X is to the right looking from the spindle toward the workpiece. If the Z axis is vertical, when looking from the spindle toward its supporting column(s) the positive X axis is to the right on single column machines or forward on dual column or gantry machines. On machines generating a surface of revolution, such as lathes, X motions shall be radial, and normally the positive direction of motion shall be away from the center of revolution. Where the linear motion can cross the centerline of rotation, positive motion

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shall be in the direction of maximum displacement from the center of rotation.

Z

Z AXIS - The Z axis of motion is parallel to the principal spindle of the machine. If there are several spindles, one shall be selected as the principal one. If there is no spindle the Z axis is perpendicular to the work holding surface. If the principal spindle can be swivelled or gimballed, the Z axis is parallel to the spindle axis when the spindle is in its zero position. The preferred zero position is with the spindle perpendicular to the work holding surface. (On such equipment as milling, boring, drilling, and tapping machines, the spindle is the tool rotating means. On such equipment as lathes, grinders and other machines which generate a surface of revolution, the spindle is the work rotating means.) Positive Z is in the direction from the work holding means toward the tool holding means. Positive Z motion increases the distance between the work and the tool.

ZERO OFFSET - A characteristic of a numerical machine tool control permitting the zero point on an axis to be shifted readily over a specified range. (The control retains information on the location of the "permanent" zero.)

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