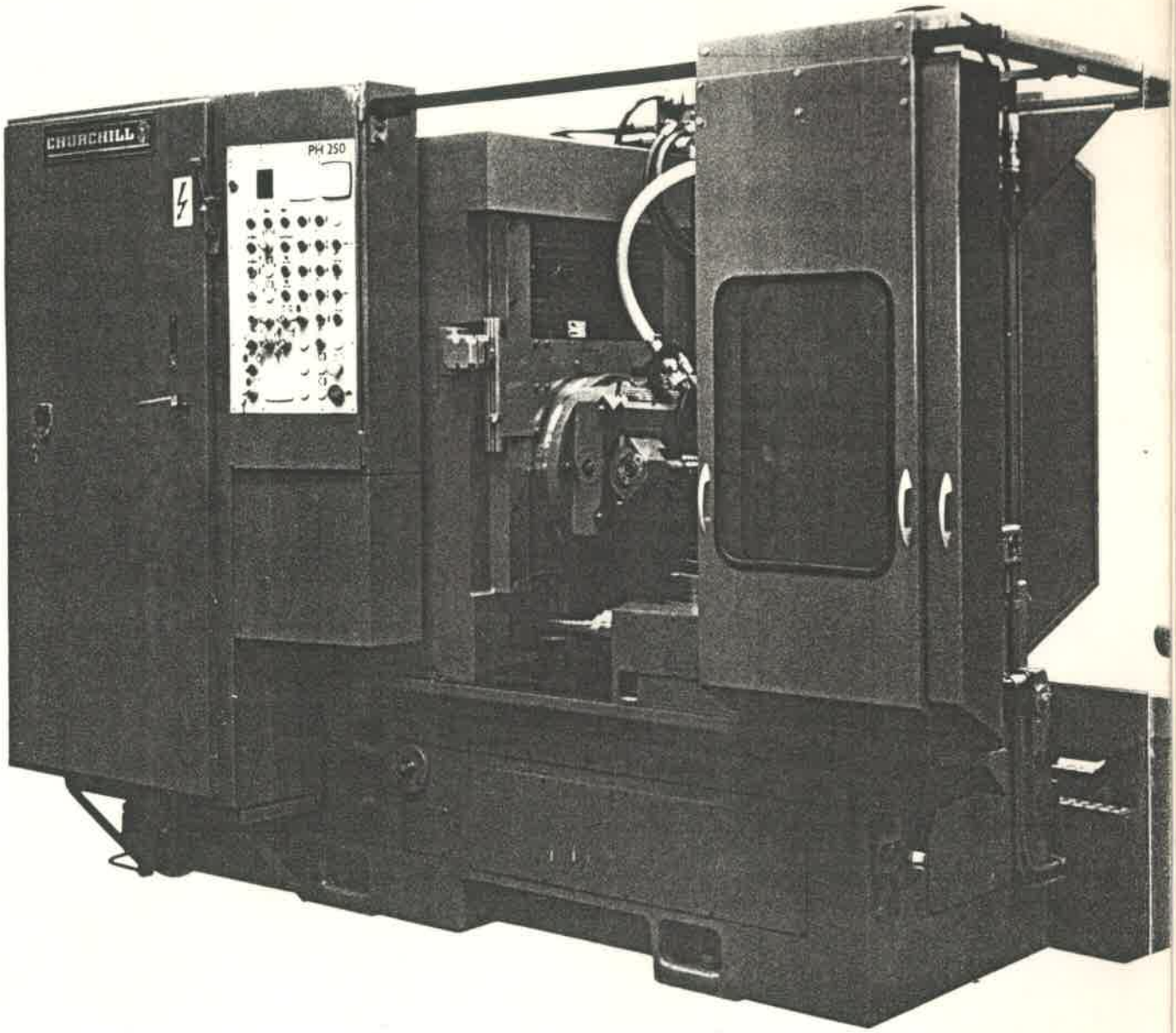
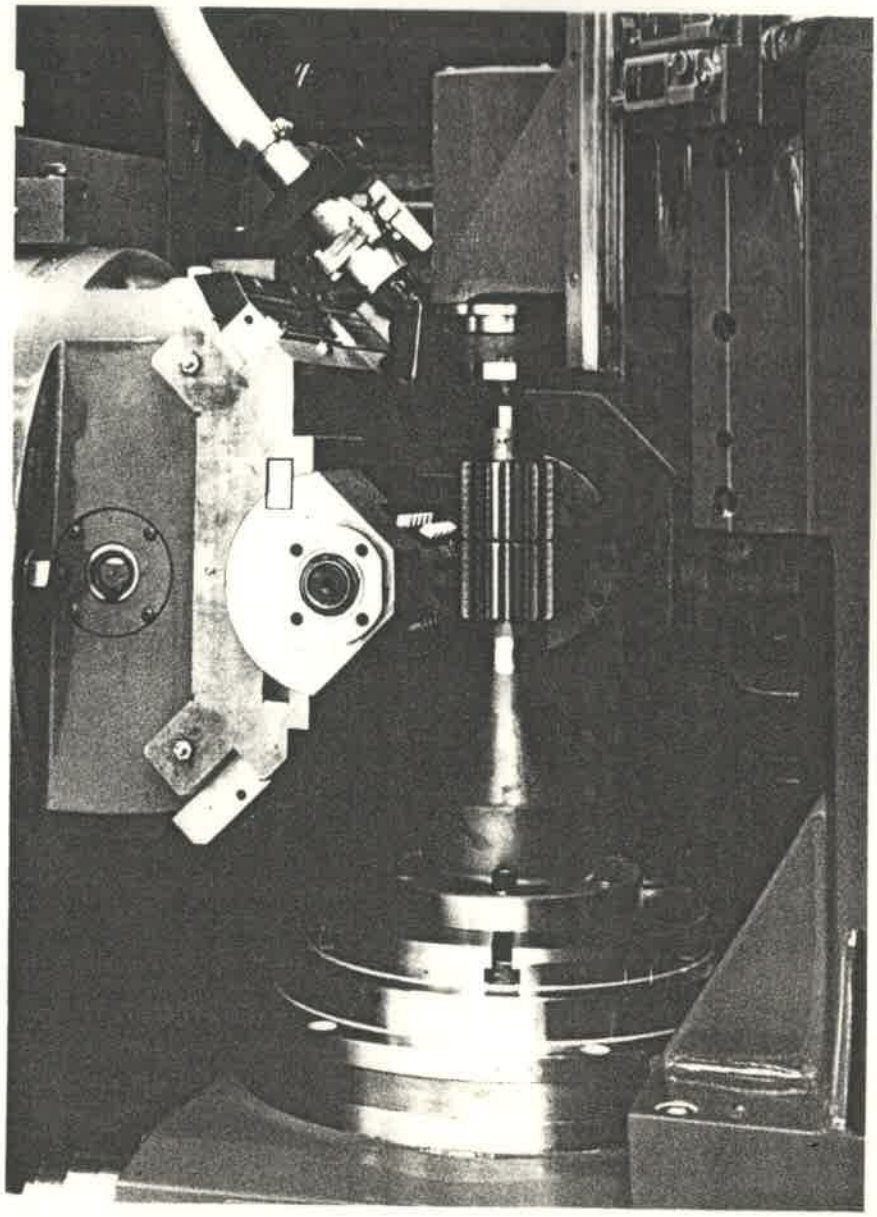


PH250
high production gear hobbing machine



To meet requirements of the high production, medium range transmission gear market, T I Churchill have developed the PH250 heavy duty gear hobbing machine. Close examination of today's problems and the requirements of the future revealed a greater demand for higher production with improved accuracy.
The PH250 meets these requirements exactly.

Benefits from the PH250 are as follows :—

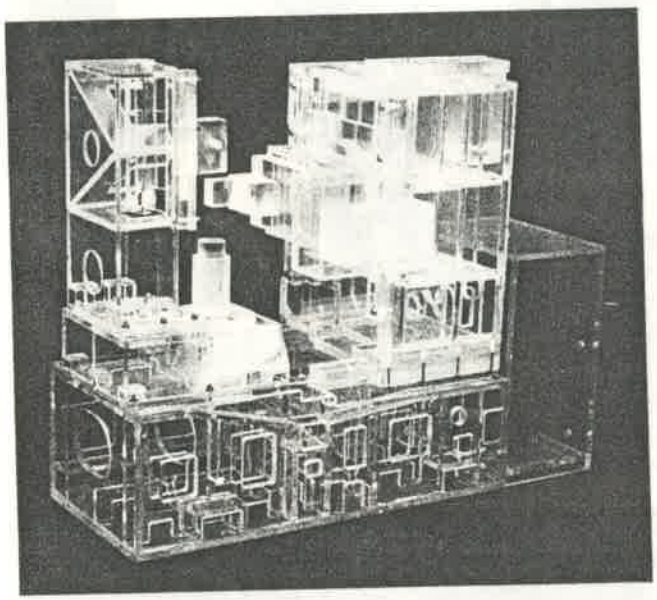
- High rates of metal removal with improved accuracy
- Exceptional structural stiffness to minimise vibration and ensure accuracy of finish
- Easy adjustment and maintenance
- Automatic loading facility to enable the machine to be incorporated into a fully automated 'link-line' production system
- Wide range of optional features enabling the customer to specify a machine which will meet his exact production requirements
- Compliance with British Health and Safety At Work regulations

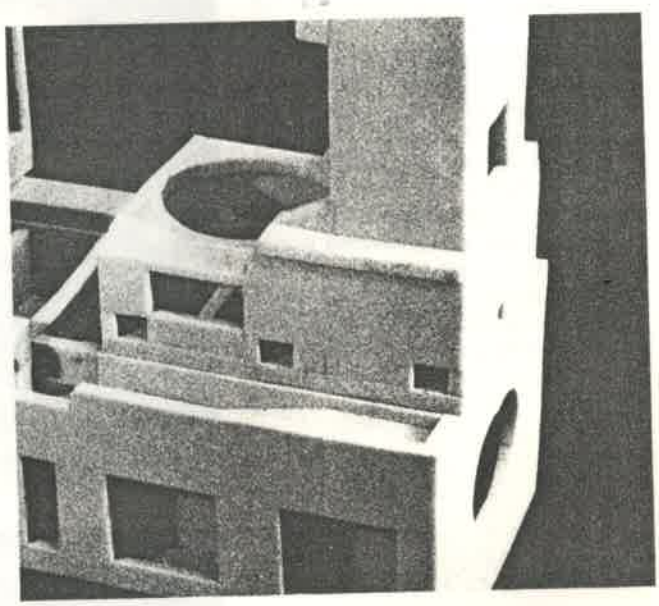
PH250 rigid machine structure

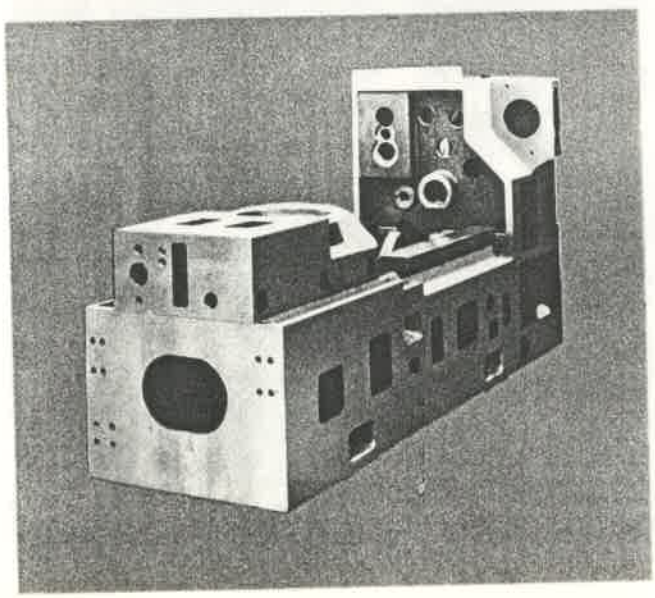
In the development stage of the PH250 the most advanced plastic and foam model techniques and computer design facilities were used to determine optimum structural stiffness. Computer techniques were also used to determine optimum bearing configurations.

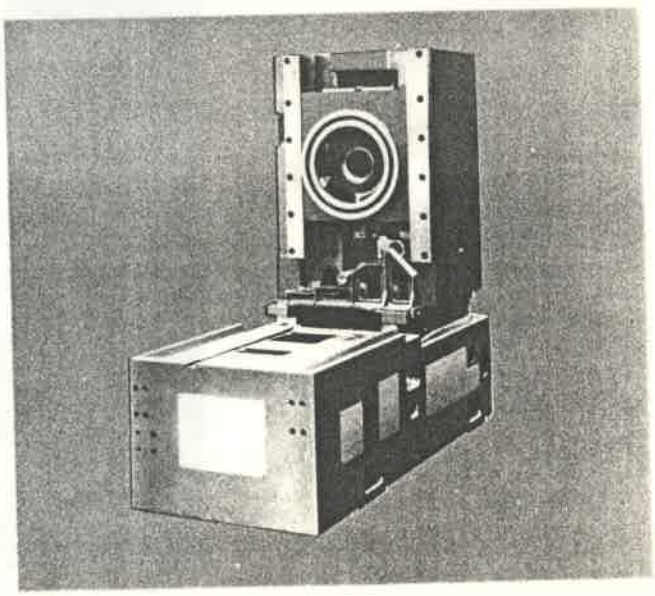
The main structural members which include castings for the machine base, column and worktable and the fabricated tailstock column have heavy internal ribbing, with minimum side openings. This gives maximum rigidity and allows high metal removal rates to be achieved. To add further to the overall structural rigidity, the fixed position worktable with moving column configuration has been adopted, with transmission elements and change gears isolated in a fixed gearbox at the end of the machine base.

The moving machine column is therefore an extremely rigid casting, isolated from potential heat sources, thus minimising thermal distortion and therefore improving accuracy. The fixed worktable has the added advantage of making the machine particularly suitable for the fitting of automatic loading systems.

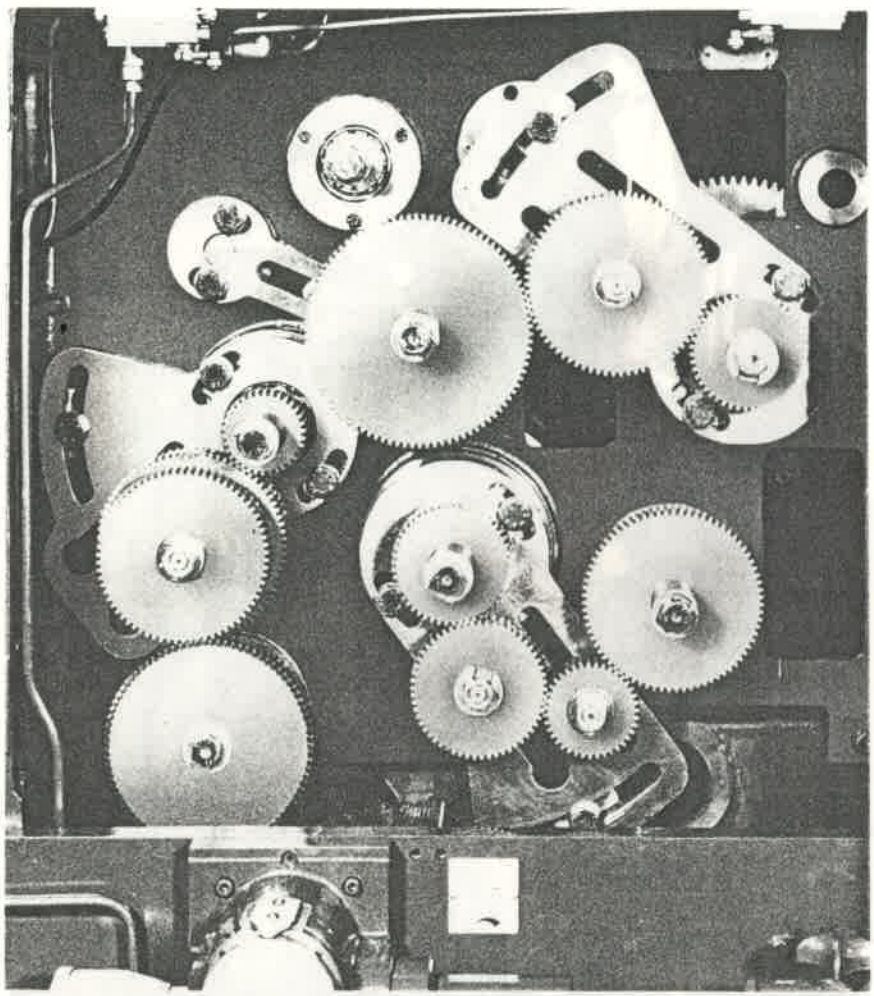








PH250 gearbox

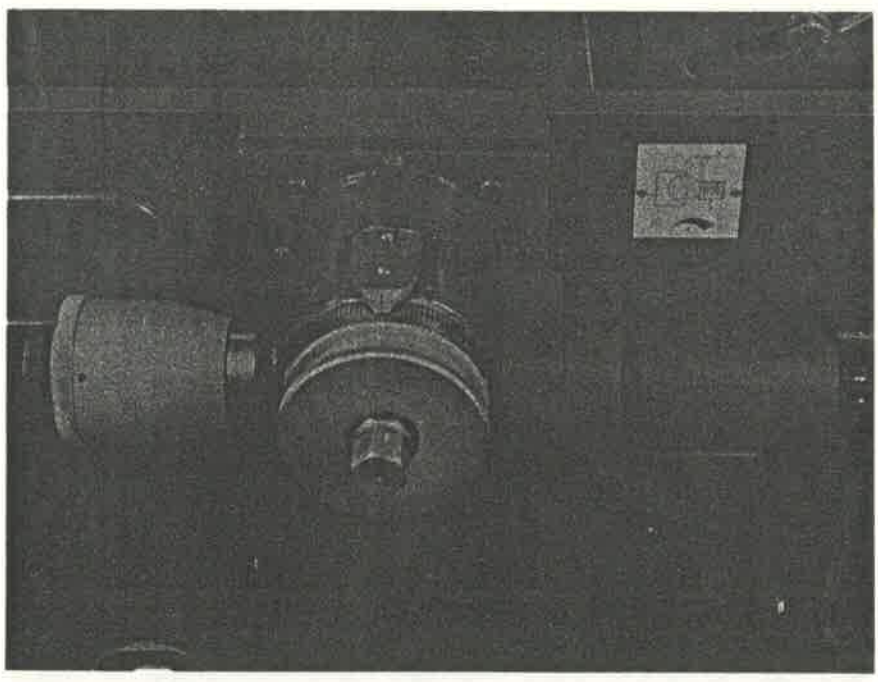


The main transmission gearbox is isolated from the column and positioned at the end of the machine base. It houses the index, feed and differential change gears and also the differential mechanism and clutches for the feed system, which are the hydraulically operated disc type.

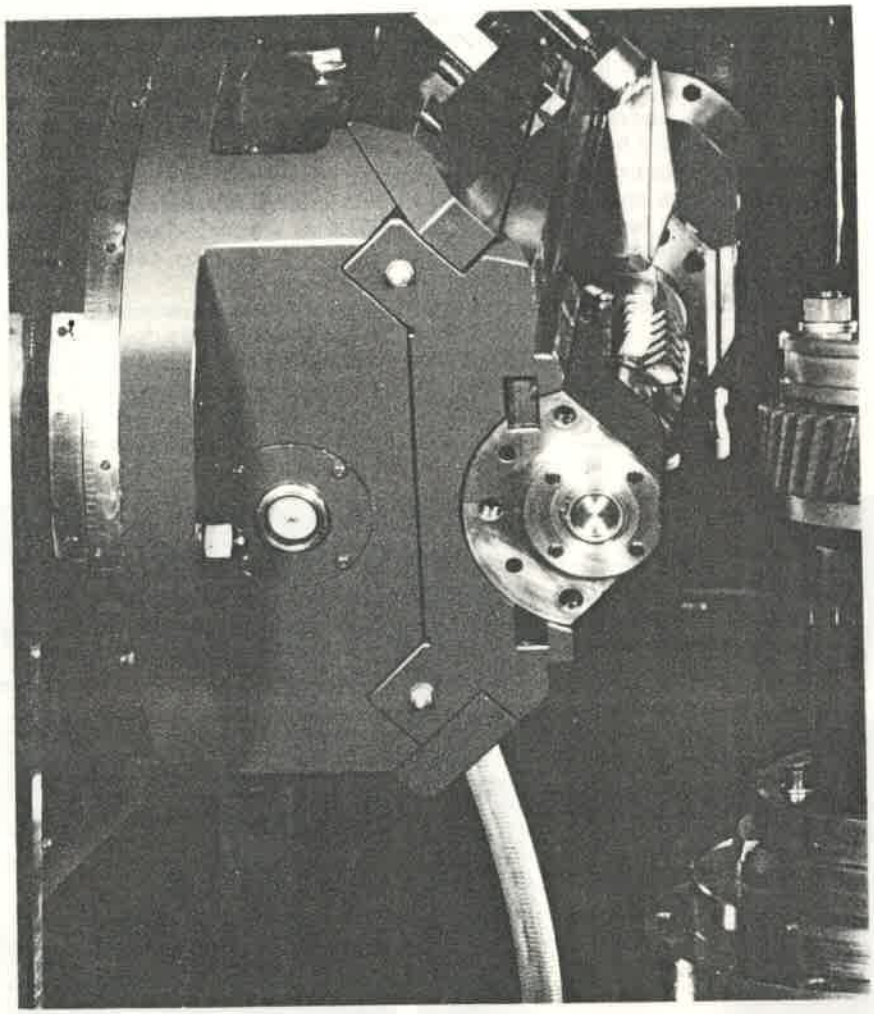
All transmission shafts are of maximum diameter for greater stiffness and the gearbox is provided with an independent pressure lubrication system.

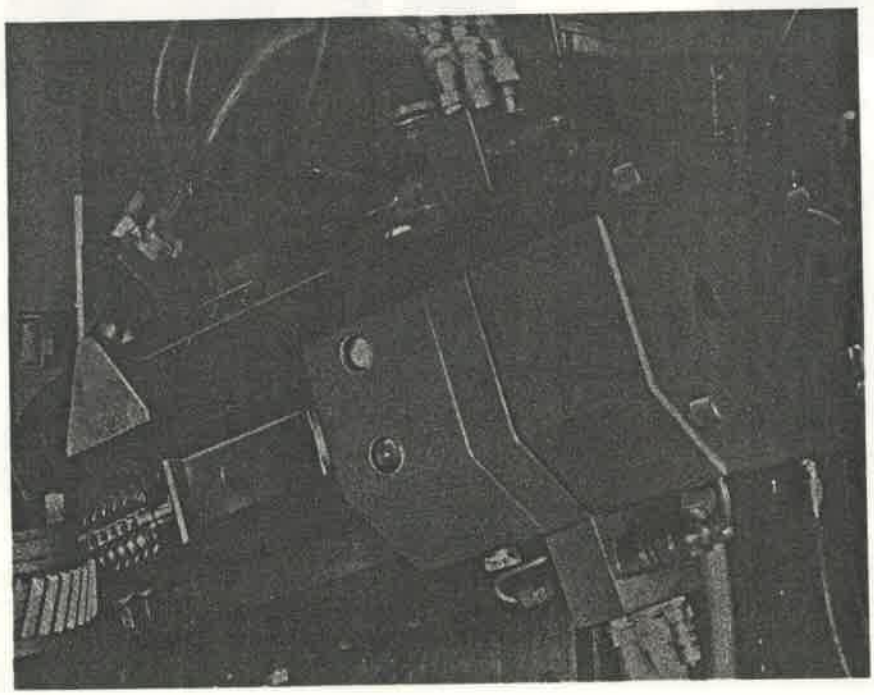
The isolation of the transmission elements not only reduces thermal distortion but provides easy access for maintenance purposes.

The main machine deadstop and, when fitted, the double cut dead-stop system is also fitted at the rear of the machine, immediately below the gearbox access doors. The deadstop extends through the gearbox and along between the machine base guideways. For convenience in machine setting an auxiliary deadstop adjustment is provided at the operating position of the machine.



PH250 hobhead





In designing the hob head, particular attention was paid to the overall rigidity of the assembly. The tangential slide carrying the hob is mounted in angled slideways, so that the cutting forces generated during hobbing hold the slide back in the guideways. This configuration eases maintenance by eliminating the need for adjustable gib strips. The angled guideways also improve the clearance between the hob head and worktable, allowing shorter, more rigid work fixtures to be used. Hydraulic clamps have also been introduced in the tangential slide keep strips, providing maximum rigidity during cutting. The hob arbor bearings at the inboard end are double row roller bearings, adjustable for radial clearance, with the end thrust being taken by a pre-loaded angular contact bearing. The hob arbor nut clamps directly against the hob and the free end of the arbor is carried in a controlled clearance needle race.

In the transmission to the hob arbor, backlash elimination is provided in the final drive gear pair, which are hardened and ground with the hob arbor gear being split. Backlash is also eliminated on the final drive spline on the hob arbor drive socket, where a similar split adjuster is fitted. The drive pinion shaft carries a large diameter high inertia flywheel to damp vibration caused by the inherent intermittent cutting action of the hobbing process.

Hob shifting is fully automatic at the end of each cutting cycle and is actuated by a hydraulic motor drive. The amount of hob shift is readily set on a digital counter on the control station. At completion of hob shift the hob slide may be hydraulically powered back to its 'start' position.

The hob head is carried on a vertically moving hob slide mounted on square ways on the machine column. The precision ground, large diameter feed screw is provided with means of backlash elimination through a split nut anchored in the vertical slide casting.

PH250 worktable

The worktable spindle is carried in a large diameter tapered bronze bearing mounted immediately below the worktable face. The spindle is prevented from tilting by a flange retained between two bronze bearing faces and to provide additional stability, the lower end of the spindle is located in a parallel cast iron bearing.

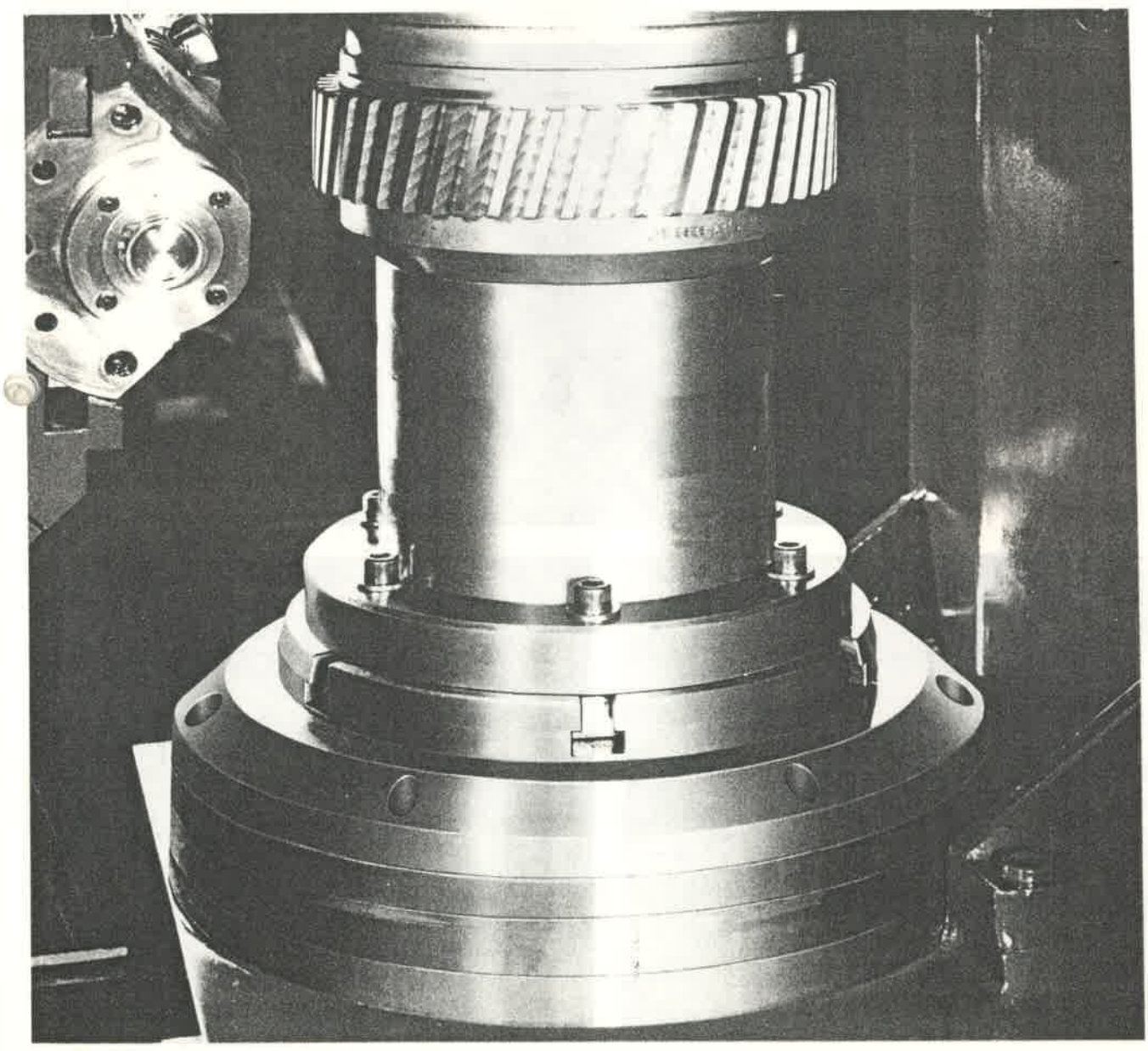
The pitch diameter of the index wormwheel, which is mounted directly onto the work spindle, is greater than the maximum rated diameter of the machine ensuring high tooth spacing accuracy.

Backlash between the index worm and wormwheel is controlled by the use of a dual lead worm system which allows adjustment to retain correct backlash throughout the working life of the machine. The worm is mounted in precision taper roller bearings and these along with the main workspindle bearings are lubricated by an independent pump unit whose operation is interlocked with the machine cycle.

The machine drives through pulleys and drive belts so that the required range of hob speeds is obtained through easily changed pulleys. An infinitely variable hob speed drive unit is available as an optional alternative, where frequent hob speed changes are required.

The feed drive is through change gears and again, changes of feed are easily made.

All machine controls are positioned for ease of operation, with all electrical controls grouped in one control station.



PH250 change gears

Index Gearing

Index change gears are located in the main gearbox compartment at the rear of the machine providing easy access and ample working space. The standard indexing ratio is 18, using a single start table drive wormwheel but special ratios can be supplied for specific applications.

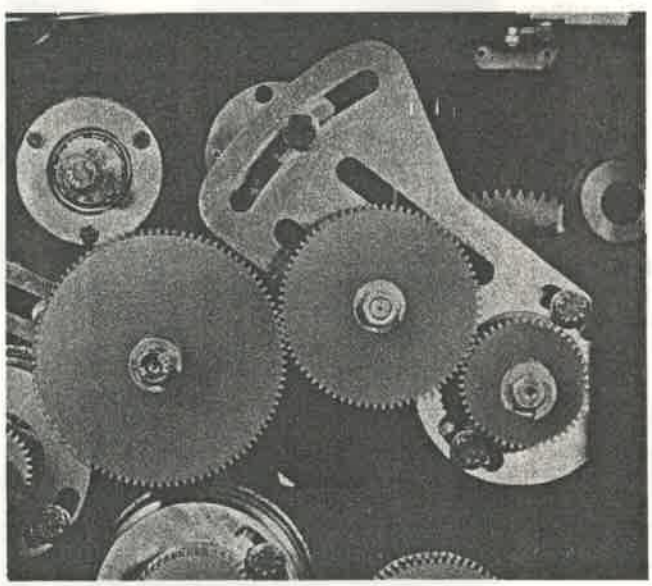
Table reversal to suit right hand or left hand gears is achieved by the addition of an extra stud in the indexing swing frame. The swing frame has been carefully designed to ensure rigidity whilst giving maximum coverage for any number of teeth.

Feed Gearing

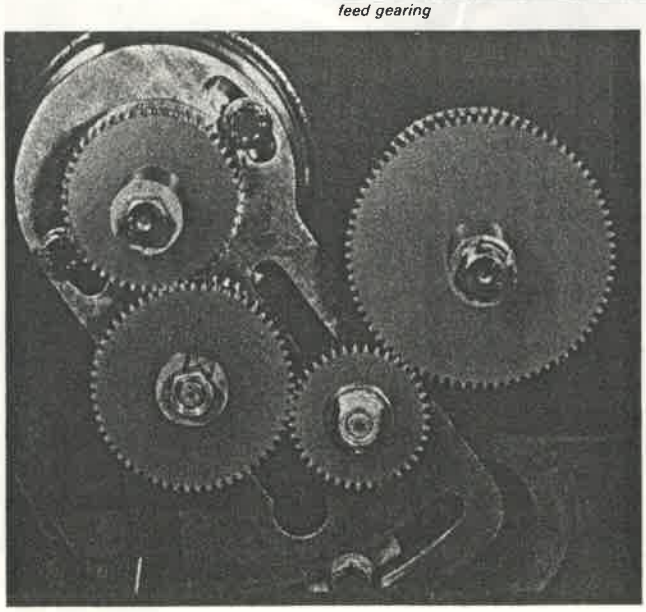
Feed increment per revolution of the worktable is selected by change gearing also mounted in the main gearbox compartment. Feed reversal to suit climb or conventional hobbing can be achieved by an additional idler stud on the swing frame. Quick power feed is by a separate motor running at 1500 rpm giving a traverse rate of 450 mm/min. During rapid traverse normal drive is disconnected automatically by a hydraulically operated clutch mechanism.

Differential Gearing

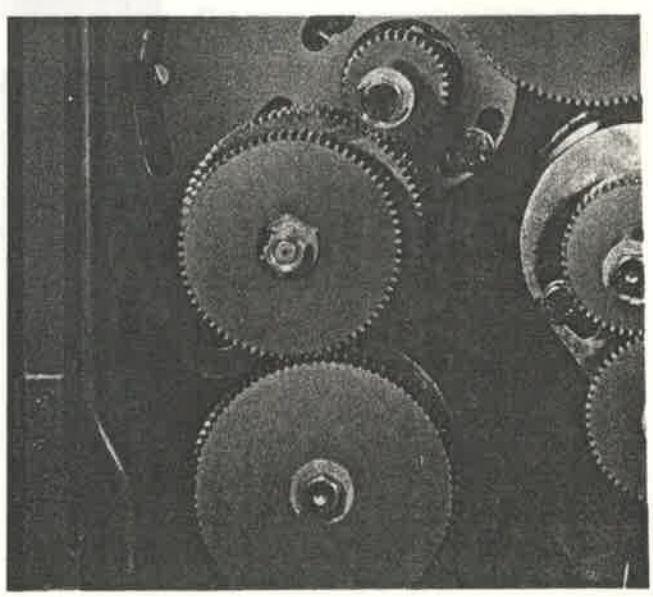
The differential ratio enables a wide range of leads to be attained. High speed input to the differential wormwheel has been avoided by the selection of this gear ratio, thus avoiding overloading the differential gearing when rapid traversing the hob slide. The differential change gears are mounted in the main gearbox compartment. Change gears used for indexing, feed and differential drives are fully interchangeable. The change gear compartment doors are fitted with safety isolating switches.



feed gearing



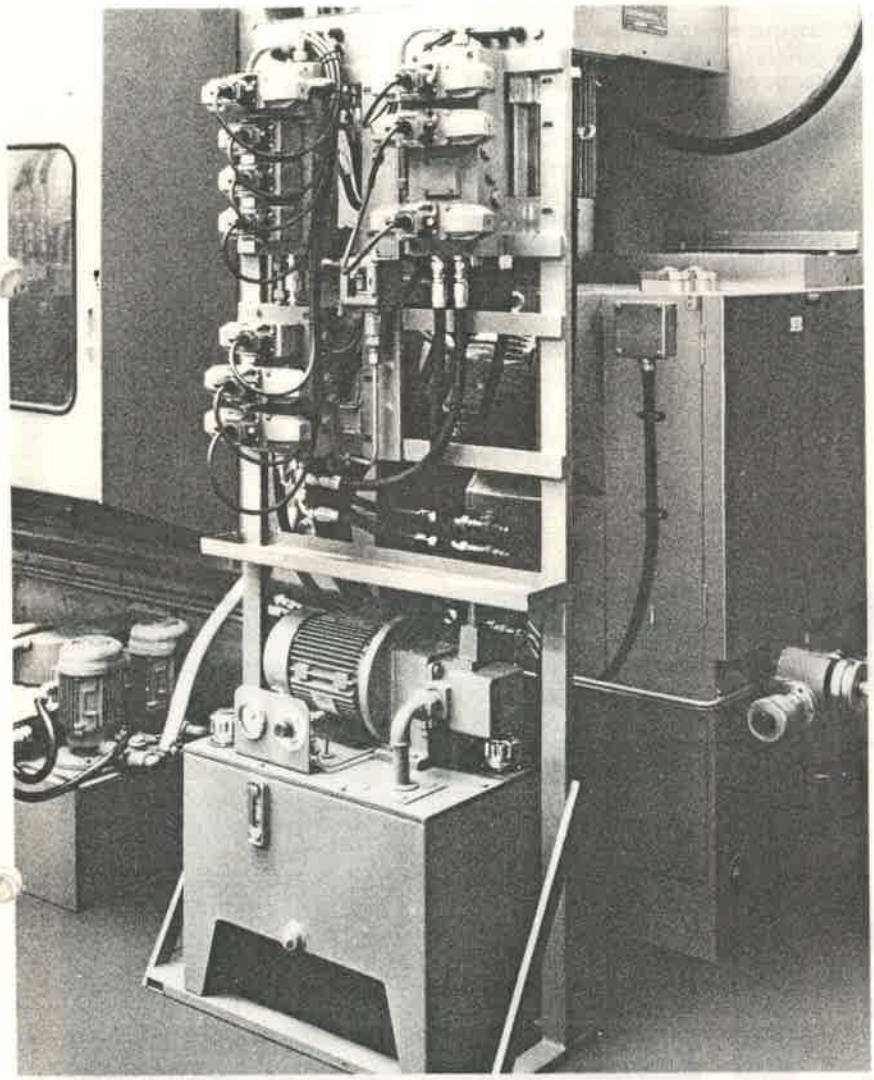
index gearing



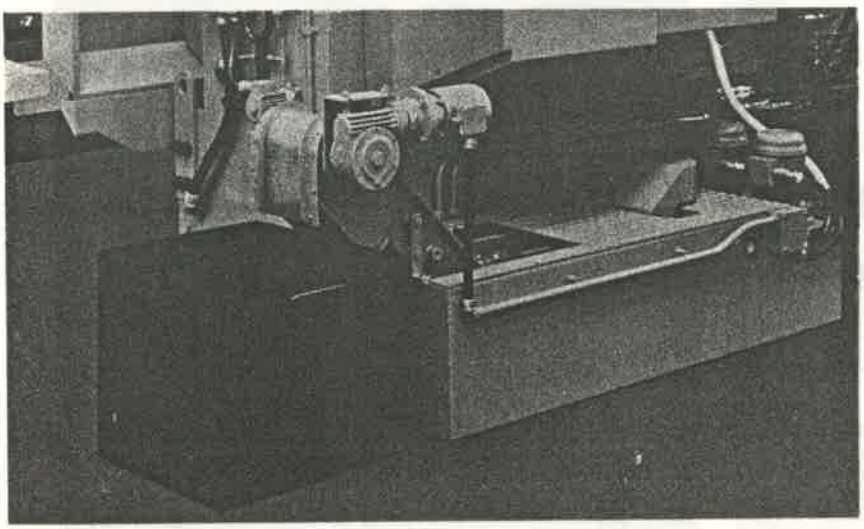
differential gearing

PH250

hydraulics lubrication chip clearance



hydraulic panel, tank and pump unit



magnetic chip conveyor

Hydraulics

All hydraulic movements are automatic in the machine cycle, i.e. column rapid traverse, tailstock vertical motion, hob shift, slide and work clamping mechanisms, feed engage and 'one shot' lubrication system actuator.

Controlled infeed can be supplied as an optional extra using a flow control valve in conjunction with the infeed cylinder.

Deadstop

A graduated dial is provided for accurate and precise adjustment of cutting depth. Forward motion is arrested by an adjustable dead-stop nut which determines cutting depth. The table infeed dead-stop is adjusted to suit various gear diameters by rotating the dead stop screw.

Backward motion can be stopped at any point within the traverse range by a limit switch. Motion both in and out is rapid.

Lubrication

The main drive gearbox and all change gears are lubricated by an automatic force-feed system supplied by an independent motor driven pump unit located on the side of the gearbox. Oil flow commences immediately the 'prepare start' button is pressed, ensuring all moving parts and bearings in the transmission are fully lubricated before movement.

The force feed system is monitored through visual indicators situated on the top of the gearbox. Hob arbor drive gears are oil bath lubricated. The worktable bearings are lubricated by an independent interlocked pressure system. Machine slideways are lubricated by a centralised 'one shot' system, actuated hydraulically at the start of each machine cycle.

Chip Clearance

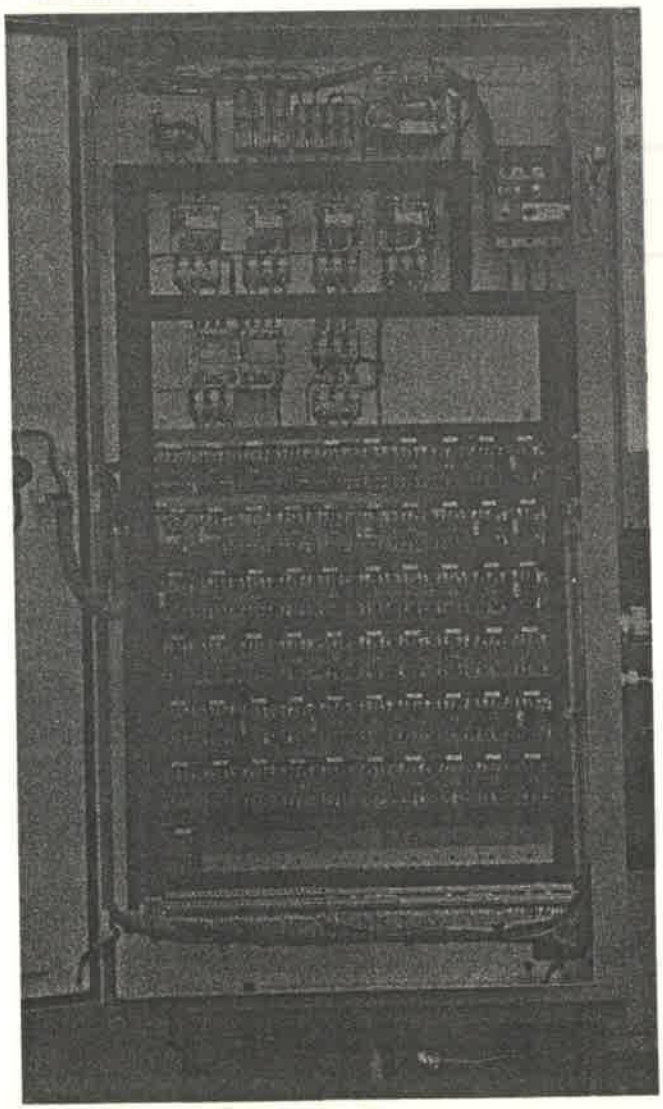
The machine base structure facilitates easy chip clearance. Chips and coolant run to the back of the machine base top plate and are discharged into a collection bin. A magnetic chip conveyor can be supplied as an optional feature and is recommended for all high production of ferrous parts.

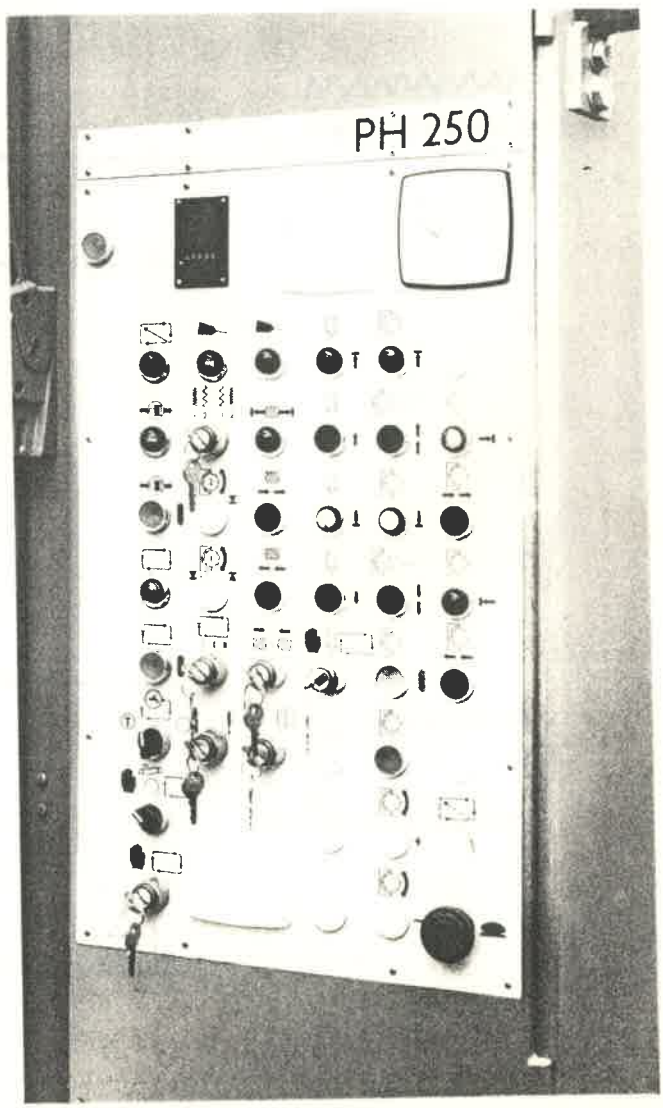
PH250 electrical control equipment

Simple reliable circuitry with full interlocks ensure complete operator and machine protection. The electrical control cabinet is fixed at the front of the machine and houses all contactor switchgear and machine control relays.

Maximum reliability is ensured by using a minimum number of relays and moving contacts.

Circuitry conforms to J.I.C. standards and control is from a push button station conveniently located on the front of the machine. The control panel is hinged to permit easy access and heavy duty limit switches are used throughout. The push button station incorporates international standard symbols for easy recognition.



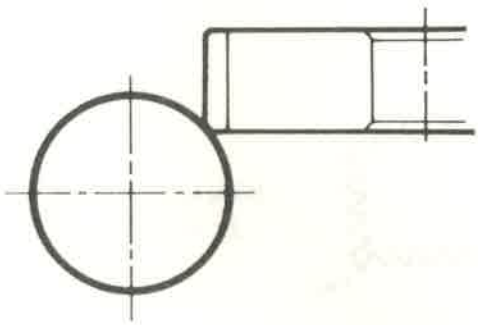


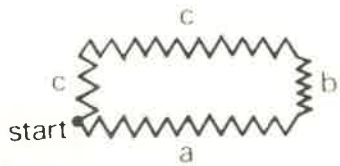
PH250 hobbing modes

Axial Hobbing

(a) Hob rapid feeds to dead stop just clear of workpiece.
(b) Hob feeds vertically through workpiece.
(c) Hob rapid traverses back to start position.

Application—spur gears, helical gears and splines.

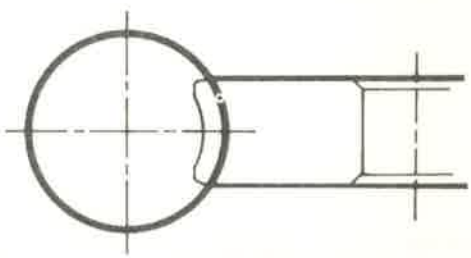


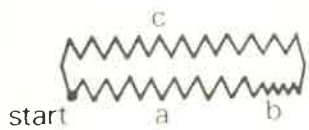


Radial Hobbing

(a) Hob rapid feeds to just clear of workpiece.
(b) Hob fine feeds into full tooth depth and work completes one revolution at full depth.
(c) Hob rapid traverses back to start position.

Application—wormwheel generation. Single start on worm angles less than 12°.

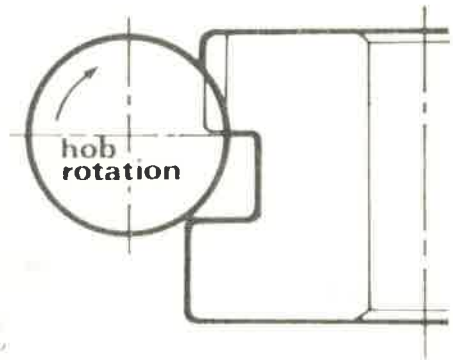


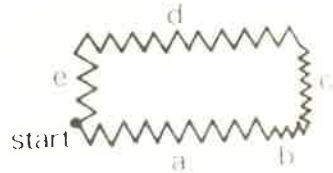


Radial and Axial Climb Hobbing (with controlled infeed)

(a) Hob rapid feeds to feed changeover trip.
(b) Hob fine feeds into full tooth depth.
(c) Hob feeds vertically through workpiece.
(d) Hob rapid traverses out.
(e) Hob rapid traverses back to start position.

Application—spur and helical gears, particularly shoulder gears.

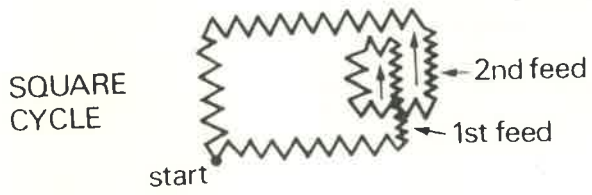




PH250 double cut cycle

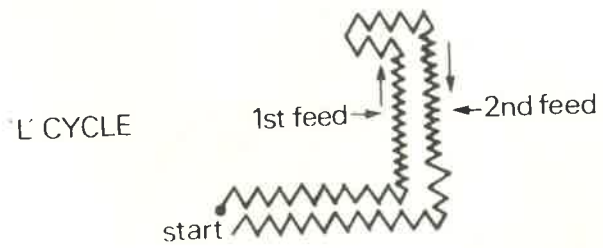
Square Cycle

(a) Hob rapid feeds to full depth.
(b) Hob feeds through work at feed 1.
(c) Hob retracts clear and dead-stop resets.
(d) Hob rapid returns to new start position to give reduced traverse on 2nd cut.
(e) Hob rapid feeds to full second depth.
(f) Hob feeds through at feed 2.
(g) Hob retracts and traverses back.



L Cycle

(a) Hob rapid feeds to full 1st cut depth.
(b) Hob feeds through at feed 1.
(c) Hob retracts clear and deadstop resets.
(d) Hob rapid feeds to full 2nd cut depth.
(e) Hob feeds through at feed 2, in opposite direction to feed 1.
(f) When clear of work, hob rapid traverses to start position.
(g) Hob retracts.



On either square or L cycle the hob speed may be changed automatically either by a 2 speed motor or by a servo operated variable speed unit.

Application—This method is beneficial if high quality coarse pitch gears are to be produced, especially when tooth alignment is critical, as it enables high feeds to be used for both roughing and finishing cuts and in addition to giving improved tooth accuracy and form, times often compare favourably with single cut hobbing using lower feeds.

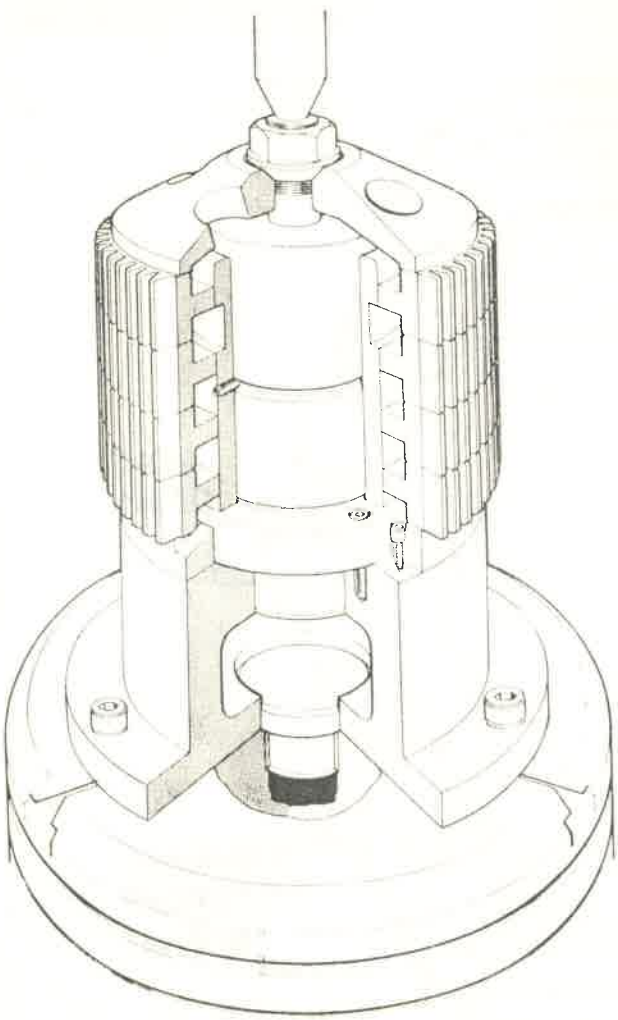
PH250 work holding fixtures

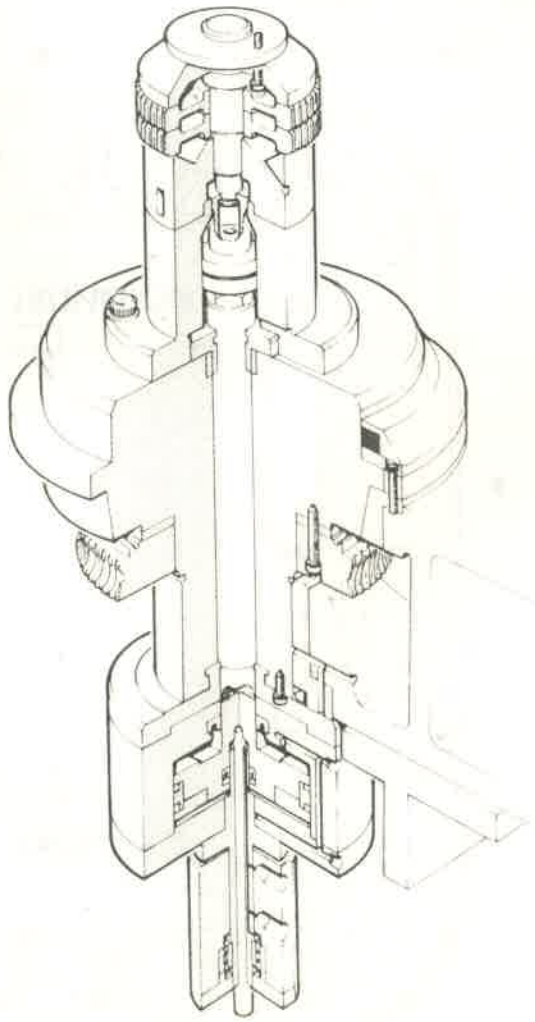
Manual

These can be supplied to suit individual components or as basic units with interchangeable adaptors. These fixtures are designed and manufactured to ensure absolute rigidity, conforming with the high standards set in the design of the machine.

Hydraulic

A hydraulic pull down clamping unit can be fitted with the clamping cylinder positioned below the workspindle. This can be either supplied complete with an upper fixture or designed to accept a range of interchangeable fixtures. Clamping may be manually or automatically actuated as required. Fixture designs to suit starter ring gears and other special applications are available.





PH250 automatic loading

The PH250 readily lends itself to the fitting of automatic loading equipment. The system uses an automatic indexing turret mounted around the machine tailstock column. This is of a standard design and is easily arranged to accommodate a range of workpieces, with convenient changeover.

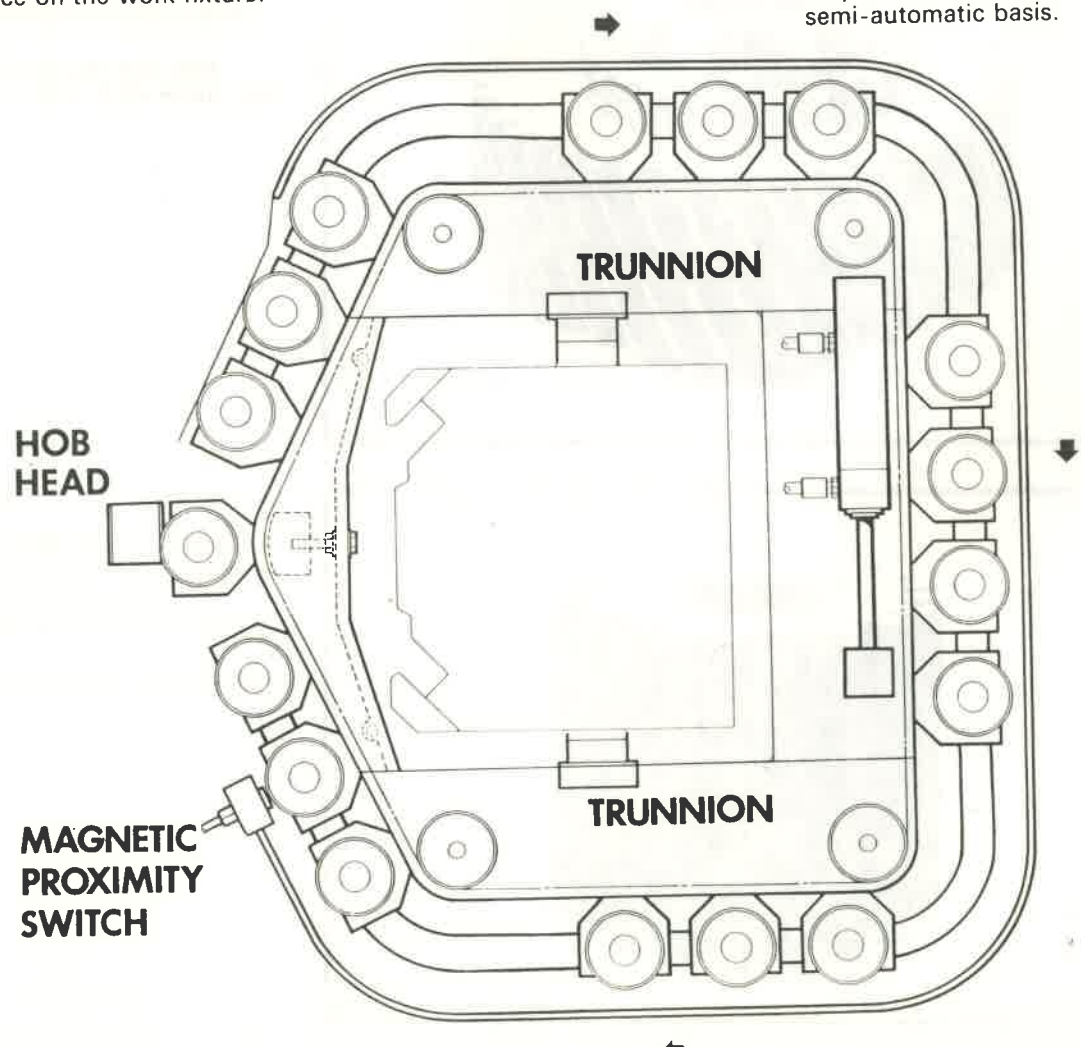
The large capacity magazine type turret accommodates a full load of components enabling the machine to run for long periods without operator attention. Components are located in carriers which are attached to an indexing chain mechanism. At the beginning of each machine cycle the turret tilts to allow the component, or stack of components in the first station to be indexed into the cutting position and then lowers to position the workpiece on the work fixture.

The workpiece is then automatically clamped in position either by flanges operated from a collet or by the tailstock centre depending on component configuration. The machine then runs through the cutting cycle and on completion the workpiece is released. The loader then lifts the work clear of the fixture, the indexing motion removes the finished part from the cutting position while simultaneously moving the next blank into the station. The machine operation then proceeds through successive cycles as long as blanks are available.

Link-Lines

The design of the PH250 is such that it lends itself readily to inclusion in fully automatic transfer 'Link-Line' production systems. These fully automatic lines usually operate on the Churchill 'free-flow' conveyor system. This consists of four tracks of continuously moving heavy duty slat-band chain, three tracks carrying components to and through the machine stations, the fourth being used to re-circulate uncut components back to the start of the 'Link-Line' ensuring equal distribution between hobbing machines. At the end of the line the fourth track can also be used for the storage of finished components.

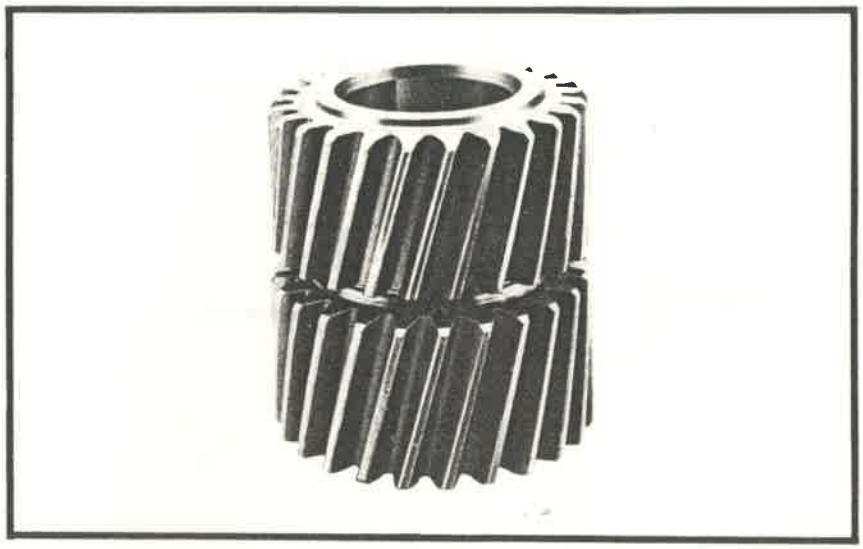
The PH250 is versatile to the extent that the machine which is incorporated into the 'Link-Line' may also be used on a separate semi-automatic basis.



PH250 production examples

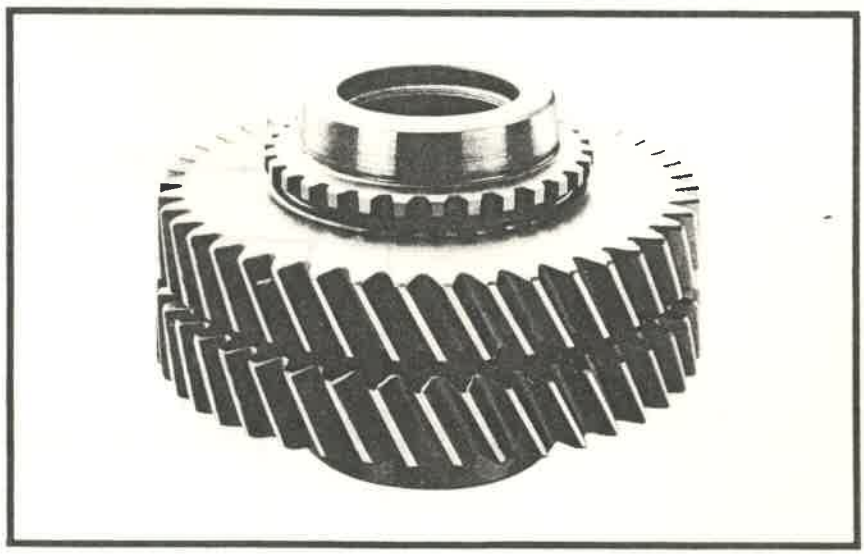
Timing Gear

25 teeth x 2·5 MOD. Cut with 125mm diameter, 3-start inserted blade hob.
160 rpm x 4mm per rev. feed.
Floor to floor time **1·5 mins per pair.**



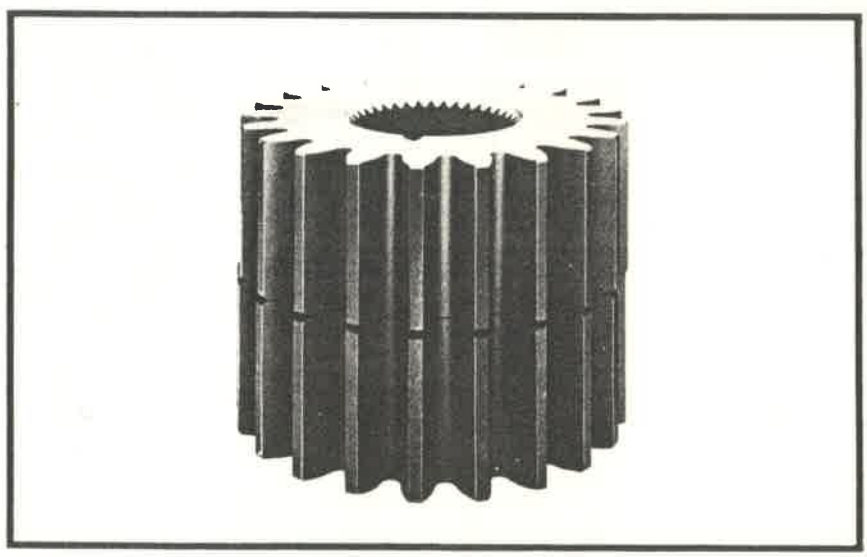
Automotive Transmission Gear

43 teeth x 2·25 MOD. Cut with 100mm diameter, 3-start inserted blade hob.
240 rpm x 2mm per rev. feed.
Floor to floor time **2·25 mins. per pair.**



Sun Gear

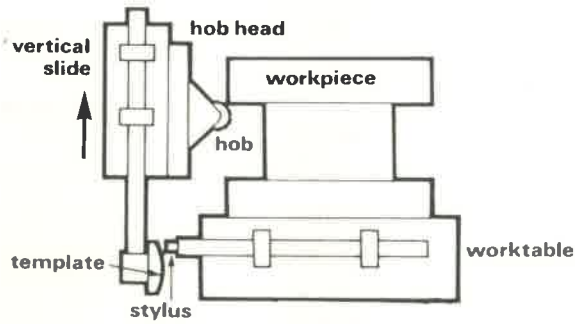
21 teeth x 5·08 MOD. Cut with 140mm diameter, 2-start inserted blade hob in 2-cut cycle.
160/210 rpm x 4·5/6·5mm per rev. feed.
Floor to floor time **3·7 mins per pair.**



PH250 copy hobbing capacities

Copy Hobbing

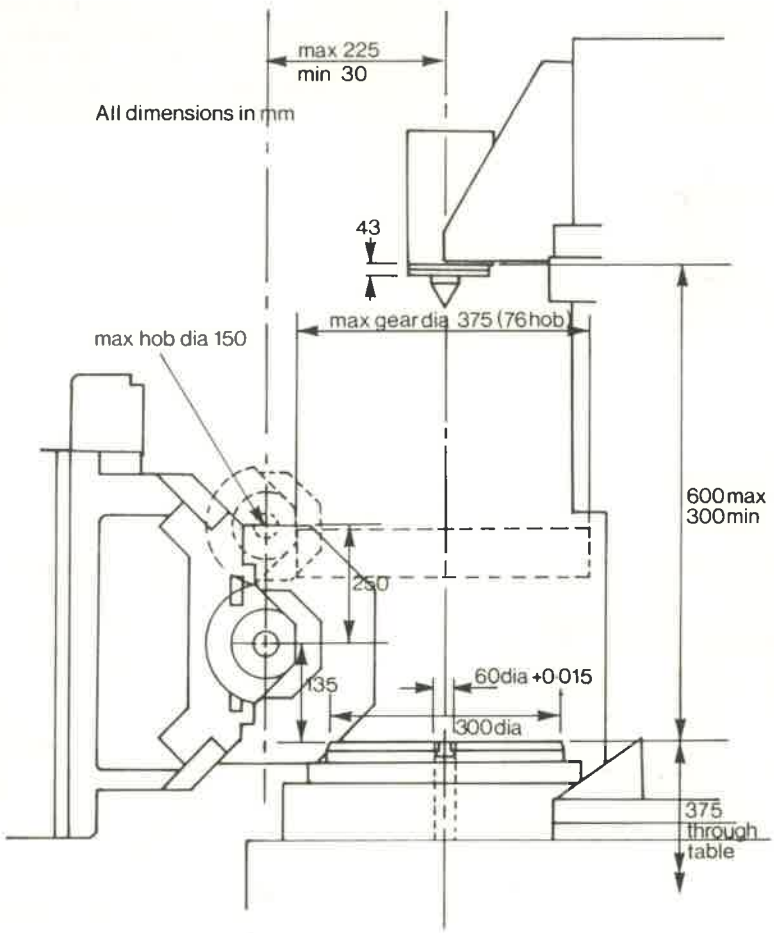
The diagram shows the general arrangement of the copying device used for crown, taper and barrel hobbing. This is an extremely accurate device which once set up, operates entirely automatically and does not interfere with the normal operation of the machine.



Commercial Standard

A machine intended for general purpose work to DIN 3962 quality 7 limits.

CAPACITIES



PH250 specification dimensions

Specification

Maximum workpiece diameter (at rated pitch)	250mm
Maximum pitch (depending on material and gear diameter)	6 mod

Machine Capacity

Horizontal distance (hob arbor centre line to tailstock centre line)	
Minimum	30mm
Maximum	225mm
Height (hob centre to worktable)	
Minimum	135mm
Maximum	385mm
Max height worktable to tailstock centre locating face	557mm
Max hob diameter	150mm
Max hob length	160mm
Max hob shifting distance	120mm
Hob arbor diameter standard (other sizes available on request)	32mm
Hob arbor drive taper	No 40 international

Machine Dimensions

Worktable face diameter	300mm
Worktable bore diameter	60mm
Worktable bore depth	375mm
Approximate weight	15000lbs (6800 Kg)

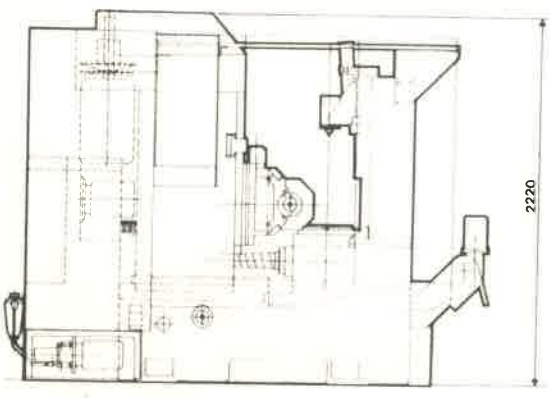
Speeds and Feeds

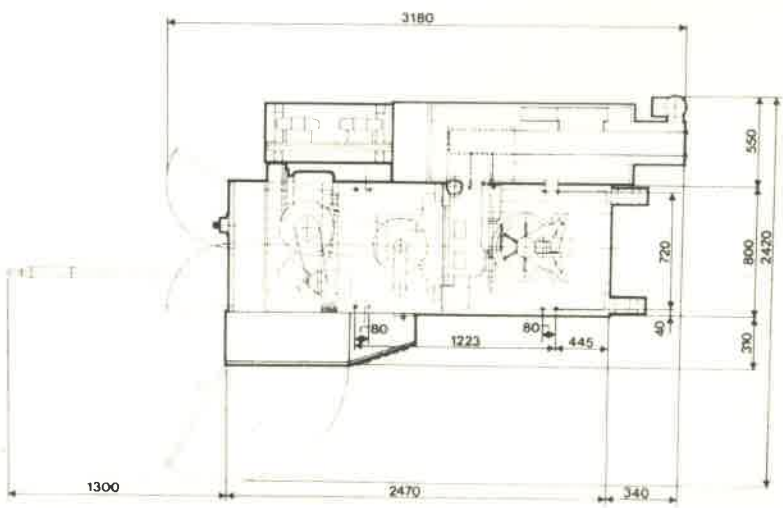
Hob spindle speeds (standard belt drive)	90-500rpm
Hob spindle speeds (optional variable speed unit)	100-500rpm
Vertical feed rate (standard with change gears)	0·5-10mm per work rev.
Vertical feed rate (optional with variable feed unit)	0·85-7·5mm per work rev.
Controlled radial infeed (option)	0·166-1·5mm per work rev.

Electrical Data

Main drive motor (belt drive)	1000rpm (15 hp) 11·2Kw
Main drive motor (variable speed unit)	1000rpm (15 hp) 11·2Kw
Rapid traverse motor	1500rpm (5·5 hp) 4Kw
Hydraulic pump motor	1500rpm (2 hp) 1·5Kw
Coolant pump motor	3000rpm (0·5 hp) 0·37Kw
Lubrication pump motor	1500rpm (0·75 hp) 0·56Kw

Dimensions





PH250 standard & optional equipment

Standard Equipment

- Differential mechanism
- Single start index worm and wheel
- Automatic intermittent hob shift
- One hob arbor complete with spacers
- Automatic machine cycles
- Automatic machine lubrication
- Belts and pulleys for one fixed hob speed
- Rake out swarf chute
- Live tailstock centre

Optional Equipment

- Infinitely variable hob speeds
- Infinitely variable feeds
  (Both of the above options can be servo-controlled when used in conjunction with automatic double-cut cycle or manually operated)
- Automatic double cut cycles
  (a) with change of depth, feed and reduced length of stroke on second cut
  (b) with change of depth, feed, feed direction and reduced length of stroke on second cut
  (c) either of the above cycles with speed change between cuts
- Controlled radial infeed
- Magnetic swarf conveyor
- Crown and taper hobbing attachment
- Full set of index, feed and differential gears in cabinet
- Multi-start index worm and wheel
- Hydraulic work holding fixture
- Automatic loading

With continued research and development, the company retains the right to change, without notice any detail appearing in this publication.

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CHURCHILL

work holding fixtures

Manual

These can be supplied to suit individual components or as basic units with interchangeable adaptors. These fixtures are designed and manufactured to ensure absolute rigidity, conforming with the high standards set in the design of the machine.

Hydraulic

A hydraulic pull-down clamping unit can be fitted on the worktable either supplied complete with an upper fixture or designed to accept a range of interchangeable fixtures. Clamping may be manually or automatically actuated as required. Fixture designs to suit starter-ring gears and other special applications are available.