

# How is the P 1000 controlled?

Hobbing machines incorporate considerably more motions than other machine tools. Therefore CNC results in particularly large benefits to the user. Two types of controls are available for optimum adaptation to different gear cutting requirements. The table on page 9 is designed to assist in the selection of the optimal solution for each application.

Depending on the number of motions to be controlled, the P 1000 offers substantial reductions in:

- idle times – by minimizing the safety allowances for approach and overrun travel,
- process planning time,
- set-up times – about 15 minutes are saved by the elimination of trip dogs and end stops. The full NC-version of the P 1000 saves another 15 minutes. Change gears are replaced by digital input of the number of teeth, the helix angle and the number of hob starts.

These savings are particularly obvious in small and medium lot production where they result in an impressive reduction of unit costs.

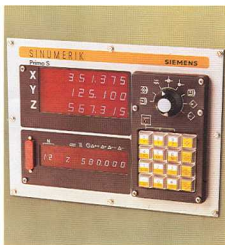
## CNC reduces set-up time by fast, easy and reliable setting

- Digital inputs replace limit switches and fixed stops.
- Digital readouts allow positions to be checked "at a glance" and eliminate the time consuming checks required in conventional set-ups.
- Idle times are reduced by more precise and therefore faster adjustment of slide travels.
- Digital input of the amount of crown or taper etc. eliminates templates.
- Digital input of the desired swivel angle permits fast and effortless swiveling of the hob head.

**Programming is easy** and can be performed on the machine.

- With or without a previously prepared data sheet, the required travels and machine functions are keyed in manually on the keyboard with the mode selector switch in the appropriate position. The work cycle of the machine is determined by the sequence of the data input.
- The information stored in the control system can be transferred to external data carriers, (cassette or tape) entered into the CNC by these carriers or retrieved when needed through a standard interface.
- The information stored in the memory can be changed or optimized at any time.
- In general the available storage capacity is sufficient to accommodate the programs for several work-pieces.
- Standard program sheets are available for many operational sequences. Computer programs are already available for processing the entire gear hobbing geometry, printing out the block sequence and determining the floor-to-floor time. The data sheets and the data carriers can be prepared in the programming department.

- J11. 9  
Point-to-point control (CNC)
- J11. 10  
Continuous path control (CNC)
- J11. 11  
Electronic handwheel



## The electronic handwheel

controls all linear motions and permits fine adjustments within .01 mm (.0004 in.).

In operation and effect it corresponds to a mechanical handwheel. The speed of the slide motions corresponds to the rotational speed of the handwheel. The positions determined by the handwheel can be read from and entered via the set-up mode of the digital display of the CNC.

## The P 1000 NC

without change gears for number of teeth and helix angle of the workpiece.

- Digital input of number of teeth and helix angle of workpiece and the number of hob starts.
- Especially advantageous for individual workpieces and small and medium lot sizes.
- Further reduction of set-up time by approximately 15 minutes.

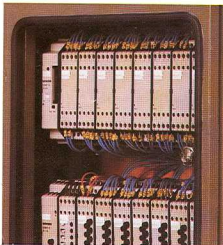
- Further reduction of process planning time due to elimination of change gear calculation and mounting.
- Problems of change gear accuracy are eliminated.
- Additional special programs are available, e.g. for hobbing cluster gears and similar workpieces (with several sets of teeth having different numbers of teeth and different helix angles but the same pitch) in one clamping.

Control system selection table		Point-to-point CNC	Continuous path CNC
Standard motions and functions	Axial motions	●	●
	Radial motions	●	●
	Tangential motions	●	●
	Hob head swivel within work cycles	—	●
	Number of teeth, helix angle of workpiece and number of hob starts	(P 1000 NC only)	
Additional functions	Axial hobbing	●	●
	Radial and radial-axial hobbing	●	●
	Tangential, radial-tangential and diagonal hobbing*	●	●
	Hob shifting and precision hob shifting	●	●
	Multi-cut work cycle	●	●
	Skip feed	●	●
	Dipping	●	●
	Stepped feeds	●	●
	Feeds in mm per workpiece revolution	—	●
	Preselection of two hob speeds	●	●
	Speeds programmable in 16 steps	●	—
	Speeds directly programmable	—	●
	Taper hobbing	—	●
	Crown hobbing	—	●
	Combined taper and crown hobbing	—	●
	Dwelling	●	●
Single indexing (form milling)	—	●	
Change-over to a different number of teeth during work cycle	—	●	
Electronic handwheel	●	●	
External data input/output	●	●	
	(P 1000 NC only)		

## Interface (PC)

In addition to the CNC system the P 1000 is equipped with an interface (PC) without contacts and thus wear-free. Trouble shooting in the event of a malfunction is greatly facilitated by luminous diodes.

J11. 12  
Interface (PC)



12

\* Diagonal hobbing on P 1000 NC requires continuous-path CNC

● available — not available

# Standard equipment

## Point-to-point CNC

for two linear motions (axial and radial) with incremental measuring systems and digital position read-outs for programming the following work cycles and functions:

- axial hobbing
- radial hobbing
- radial-axial hobbing
- two-cut work cycle
- skip feed
- relieving
- dwelling
- feed control
- shifting (automatic incremental hob shift)
- feeds in mm/min (in./min) including feed correction switch for feed control in 3 steps from 0 to 100% of the programmable value,
- auxiliary functions.

## Universal hob head

with tangential slide.

## Index drive

with two backlash-free worms.

## Differential

for hobbing helical gears.

## Hob speeds

Two hob speeds selected via potentiometers and retrieved from the CNC program as required.

## Axial feed

with DC-drive and ball screw with pre-loaded nut.

## Radial feed

with DC-drive and ball screw with pre-loaded nut.

## Rapid traverses

for all slides.

## Tailstock column

with swing-away tailstock arm and hydraulic vertical movement.

## Automatic lubrication

for all drives, bearings and slides. Includes filter.

## Safety interlock

of all electric drives with open change gear compartment doors.

## Electrics

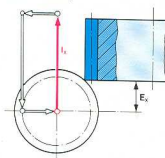
in conformance with all applicable German and European standards IEC 204/1 and 2, VDE 0113 (DIN 57 113) and VDI 3231. Machine equipped with programmable control (PC). Control cabinet machine mounted with integrated operator panel. All motors and controls included.

## Standard accessories

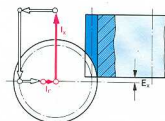
1 set of index and differential change gears for one workpiece - 6 reversing gears - 1 cylindrical work arbor guide bushing - 1 hob arbor 40 mm (1.6 in.) diameter with spacers and nut - 1 hob setting gauge - 1 machine lamp - 1 set of tools for operation and maintenance of machine - 1 operator's manual - 1 service manual.

13

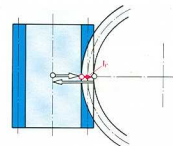
### 1. Axial hobbing



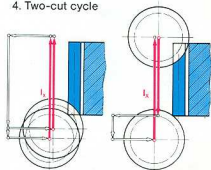
### 2. Radial-axial hobbing



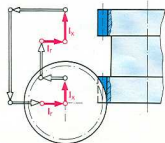
### 3. Radial hobbing



### 4. Two-cut cycle



### 5. Skip feed



JlIs. 13 and 14

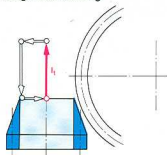
Schematic diagrams of selected work cycles

- Feed movements
- Rapid traverse movements
- Slide movements
- Switch points
- $E_x$  Axial hob approach
- $l_b$  Crown hobbing feed
- $l_k$  Taper hobbing feed
- $l_r$  Radial feed
- $l_t$  Tangential feed
- $l_x$  Axial feed

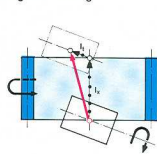
# Special equipment

14

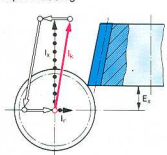
## 6. Tangential hobbing



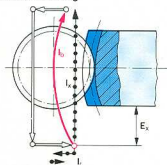
## 7. Diagonal hobbing



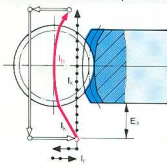
## 8. Taper hobbing



## 9. Crown hobbing



## 10. Combined crown and taper hobbing



## Continuous path CNC

for three linear motions with incremental measuring systems, digital position read-outs and integrated programmable control (PC). This control system incorporates all work cycles and functions of the standard point-to-point CNC and the following additional functions:

- crown hobbing
- taper hobbing
- combined crown and taper hobbing and hobbing of all other curves
- hob head swivel
- precision shifting.

The following data can be entered via CNC on the P 1000 NC:

- number of workpiece teeth
- number of hob starts
- workpiece helix angle.

## Feeds in mm/WU

in combination with continuous path CNC.

## Electronic handwheel

adjustable for all linear motions.

## Speeds programmable in 16 steps

in lieu of adjustment via potentiometers.

## Direct programming of speeds

in lieu of adjustment via potentiometers.

## Airconditioned control cabinet

## Two-start index drive

in lieu of standard single-start index drive.

## Tangential and diagonal hobbing

for tangential and radial-tangential hobbing of worm gears or skiving of worms and for diagonal hobbing and shifting.

## Automatic indexing

with automatic work cycle.

## Special accuracy

## Extended main column

with 700 mm (27.6 in.) axial slide travel.

## Extended tailstock

either with swing-away or clamshell-type tailstock arm.

## Automatic interlock of work arbor in tailstock

Live or dead center.

## Power clamping base

for high-volume production.

## Complete enclosure of work area and hob cooling

required with oil or water-soluble coolant. Two chip boxes are included.

## Oil mist separator

incorporated in complete enclosure of work area.

## Magnetic chip conveyor

for efficient separation of steel and cast iron chips from the coolant.

## Coolant cleaning centrifuge

for wet hobbing cast iron and for removing fine chips.

## Universal hob head with 300 mm

(11.8 in.) tangential slide travel for hobbing of worm gears.

## Backlash-free hob head drive

with friction gear system.

## Motorized hob head swivel

via pushbutton control.

## Mechanical clamping of hob head

via pushbutton control.

## Digital read-out of hob head swivel angle

## Automatic swiveling and clamping of hob head

within work cycle.

## Special accessories

Additional index and differential change gears for hobbing all numbers of teeth from 6 to 400 and prime numbers up to 97 - additional sets of prime number change gears for hobbing prime numbers from 101 to 211 - leveling wedges for installing and leveling the machine - additional hob arbors with spacers and nuts - hydraulic hob arbor nuts - table bushing and work arbors - accessory cabinet - locking control panel - work-holding fixtures and other workpiece related accessories.

# The P 1000

## The hobbing machine

2



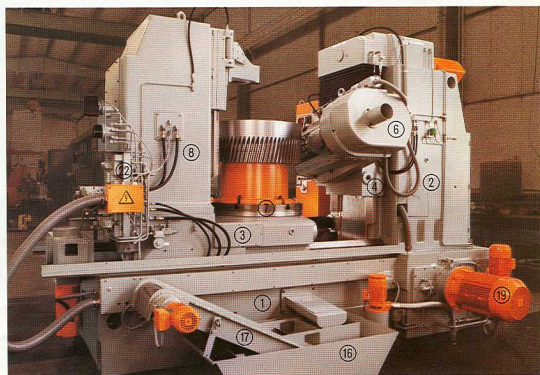
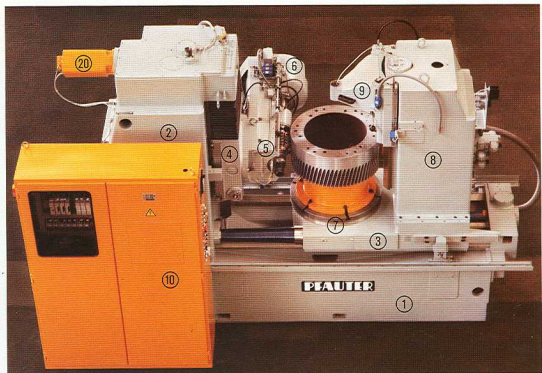
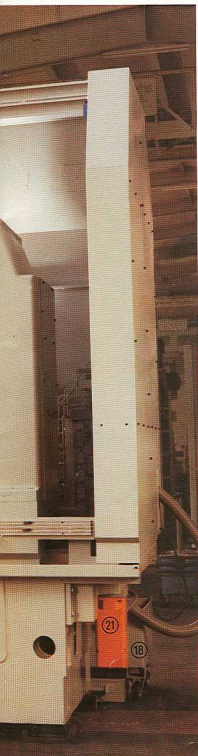
4

Jlts. 2 and 3  
Operator's view

Jlt. 4  
Rear view

- ① Machine bed
- ② Main column
- ③ Radial slide
- ④ Axial slide
- ⑤ Tangential slide
- ⑥ Hob head
- ⑦ Work table
- ⑧ Tailstock column
- ⑨ Tailstock (swing-away)
- ⑩ Control cabinet
- ⑪ Operator panel
- ⑫ Control system (CNC)
- ⑬ Control system (PC)

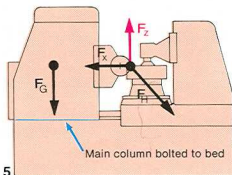
- ⑭ Sliding door
- ⑮ Complete enclosure of work area
- ⑯ Coolant reservoir
- ⑰ Chip conveyor
- ⑱ Chip box
- ⑲ Main motor
- ⑳ Axial feed motor
- ㉑ Radial feed motor
- ㉒ Hydraulic controls
- ㉓ Oil mist separator



3

4

# What are the design characteristics of the P 1000?



JII. 5

## Forces in gear hobbing

- $F_H$  Main cutting force
- $F_z$  Reaction force in the direction of the workpiece axis
- $F_x$  Reaction force perpendicular to the workpiece axis
- $F_G$  Weight of main column

JII. 6

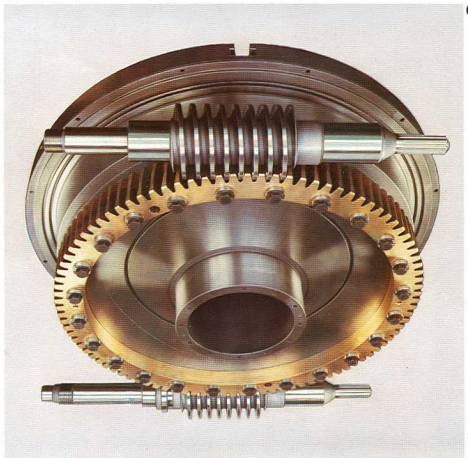
Double worm index drive

The P 1000 is a universal hobbing machine for spur and helical gears, worm gears and worms and any other profiles which can be generated.

## Design

The P 1000 was deliberately designed with a sliding work table. The metal removal rates this machine is capable of result in cutting forces whose vertical vector may well exceed the weight of the main column. Thus a sliding main column would have to be equipped with wrap-around guide ways and clamping elements to prevent it from being lifted off the machine bed. For radial hobbing this represents a distinct drawback. In this case a main column bolted to the bed and a sliding work table are the preferred design because the cutting forces are then directed towards the guide ways.

On universal hobbing machines this design combines compact machine dimensions, convenient operation, quick change-over and easy maintenance.



## High static and dynamic rigidity

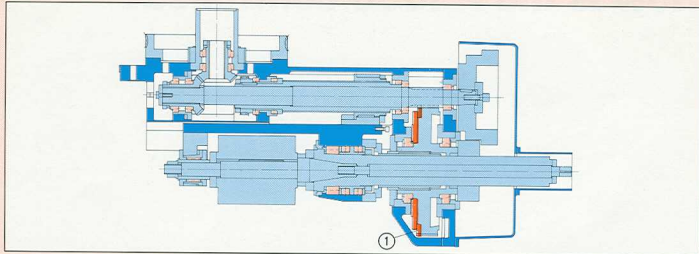
- High distortion-resistant bed and optimally closed frame components. Essential openings reduced to a minimum.
- Scientifically determined mass distribution to avoid vibrations that may influence the accuracy of the gears hobbed.
- Torsion-resistant gear train.

## High geometric and kinematic accuracy

- Hydraulically preloaded double worm index drive with zero backlash.
  - Recirculating ball screws for the main feed motions with zero backlash and virtually no wear.
  - Zero-backlash hob head drive incorporating a friction gear system with very little relative motion between driving and braking gear.
  - Highly accurate measuring and control systems for radial displacement.
- Smallest programmable increment  
 $5 \mu\text{m} - .0002 \text{ in.}$   
 $(1 \mu\text{m} - .00004 \text{ in. optional}).$
- Transmission design incorporating high final transmission ratios of all gear trains.

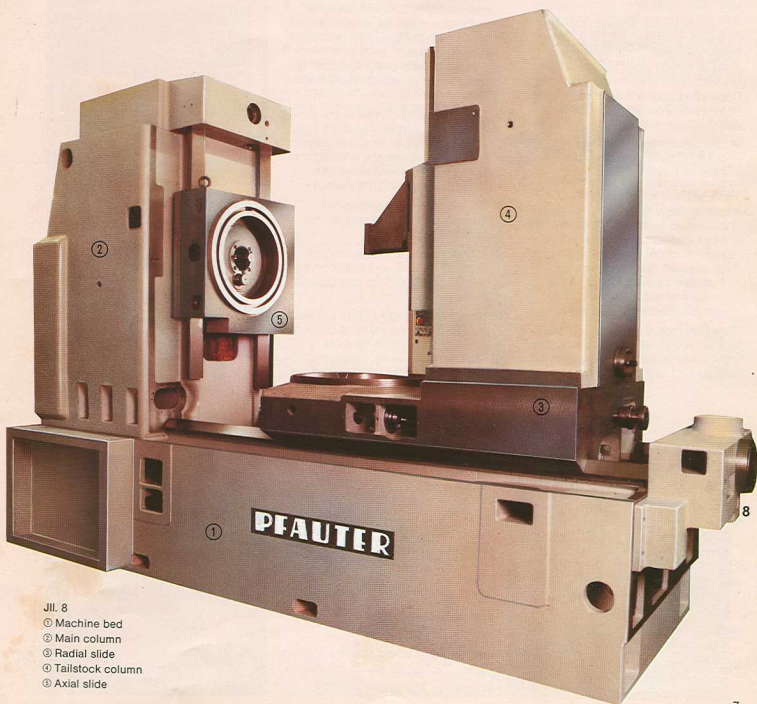
## High thermal stability

- The main sources of heat are located to minimize their influence on the accuracy of the machine.
- Temperature differences are reduced by carefully engineered distribution of lubricant and coolant with heat exchange between them.
- Where a larger amount of heat is generated, e.g. in the hob head, a circular lubrication system assists in dissipating the heat.



JII. 7

Universal hob head  
 ① Friction gear system

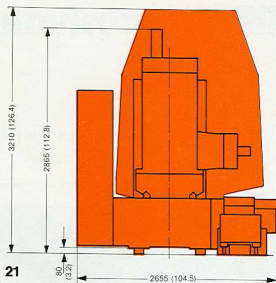


JII. 8

① Machine bed  
 ② Main column  
 ③ Radial slide  
 ④ Tailstock column  
 ⑤ Axial slide

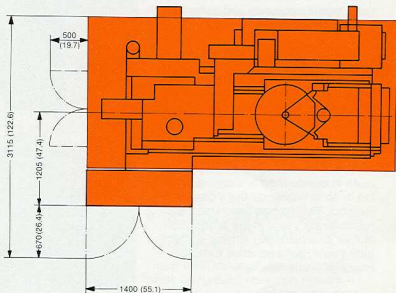
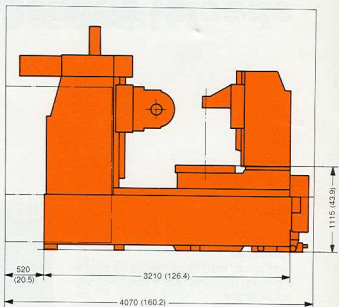


# Specifications



21

JLI 21  
P 1000 dimensions  
Inches in ( )  
Scale 1:50



## Capacities and dimensions

Maximum workpiece diameter	1,000 mm	39.4 in.
Maximum module (pitch) in steel with a tensile strength of approximately 600 N/mm <sup>2</sup> (38 tons/sq.in.)	14 (18) mm	D.P. 1.8 (1.4)
Maximum axial slide travel		
- Standard equipment	500 mm	19.7 in.
- Optional equipment	700 mm	27.6 in.
Minimum number of teeth		
- Standard single-start index drive	6	
- Optional two-start index drive	3	
Maximum table speed		
- Standard single-start index drive	16.5 min <sup>-1</sup> (rpm)	
- Optional two-start index drive	27 min <sup>-1</sup> (rpm)	
Maximum hob shift travel	200 mm	7.9 in.
Infinitely variable hob speed (other speed ranges on request)	30 to 180 min <sup>-1</sup> (rpm)	
Axial feed programmable in steps of .1 mm/min (.004 in./min)	.1 to 750 mm/min .004 to 29.5 in./min	
Radial feed programmable in steps of .1 mm/min (.004 in./min)	.1 to 500 mm/min .004 to 19.7 in./min	
Axial rapid traverse	750 mm/min	29.5 in./min
Radial rapid traverse	500 mm/min	19.7 in./min
Tangential rapid traverse	400 mm/min	15.7 in./min

## Center distance between workpiece and tool

- Minimum	50 mm	1.97 in.
- Maximum	625 mm	24.6 in.
Work table diameter	780 mm	30.7 in.
Table bore diameter	180 mm	7.1 in.
Hob spindle taper	Steep taper 50	
Maximum hob dimensions		
- Diameter	210 mm	8.3 in.
- Length	240 mm	9.4 in.

## Electrical data

Voltage	220/380 V
Frequency	50 Hz
(other voltages and frequencies on request)	
Main motor rating	15 kW
Total electric power rating approximately	31 kVA

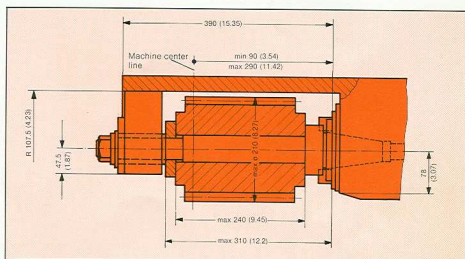
## Weight and space requirements

Weight of machine approximately	12,500 kg	27,600 lbs.
Floor space required with chip box and open doors		
- Length	4,570 mm	180 in.
- Width	3,325 mm	131 in.
- Height	3,200 mm	126 in.
Export packing dimensions:		
- Length	4,500 mm	177 in.
- Width	2,600 mm	102 in.
- Height	3,200 mm	126 in.
Additional weight of packing	2,700 kg	5,950 lbs.
Cargo space required	37 m <sup>3</sup>	1,316 cu.ft.

# Work area dimensions

Designs, dimensions and weights are subject to change without notice.

JIL 22  
Hob mounting



JIL 23  
Workholding fixture

