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INFORMATION ON RAY

Interesting information on RAY Grinding Instruments

Conventional machine tools, such as boring machines, milling machines, etc. have recently become so precise and sturdy that it is easily possible to use some of them as coordinate grinding hines, cam grinding machines, etc., if equipped with the proper accessories.

To reach this goal, RAY Ltd. have developed various coordinate grinding heads, which, as machine tool accessories can easily and directly be mounted onto any machine tool by means of a fixing cone.

The coordinate grinding head KSK is being built in various versions. Depending on size, bores with diameters of 0,8 mm up to 320 mm can be machined.

For the repair shops of the airline industry RAY developed an especially large instrument. This coordinate grinding head AF is being built upon special request and according to the specific needs of the customer. For details, please refer to the corresponding leaflet.

To meet the various requirements of our customers,RAY Ltd developed apart from the KSK also a cam grinding head KUS. This instrument is equipped with an oscillatory movement, but planetaryadjustments are no longer possible here.

The KSK itself does not have any oscillating movement. Such a movement would have to be provided by the machine tool. Should this not be desirable, we should like to refer you to the RAY oscillating apparatus HUB.

The HUB is built in such a way that with the oscillating movements, which are adjustable both in stroke height and stroke speed, one can work in 3 shifts without problems. Our detailed leaflet will give you additional information. We should furthermore like to refer you to the work studies which you will find under chapter No. 5 of this folder.

In order not to reduce the spindle clearance of a machine tool when working with the HUB, RAY Ltd. have developed a special negative angle table.

By using RAY high frequency spindles, optimal working performance is obtained. This kind of drive may well be somewhat more expensive than collector motors or air driven units, since you will need an additional frequency convertor. The advantages of high rpm's and almost no decrease in rpm's, justify, however, the additional cost.

The rpm range lies between 6'000 and 175'000 rpm's, whereby for the range from 110'000 up to 175'000 rpm's an air spindle is used.

Almost all of the RAY high frequency spindles can be equipped with spindle prolonging devices (grinding arbors) so as to be able to also machine deeper bores. Please refer to the corresponding leaflets.

RAY LTD also manufacture high speed heads, which make it possible for the user to obtain high rpm's at standstill of the spindle of the machine. These spindles, which are used on the KSK, can without problems be mounted on any kind of machine tool by means of a fixing cone.

The working studies enclosed in this folder show you some working examples of the KSK and the KUS. We purposely did not give any type indication of these instruments, since it was our intention to make this operation manual as general as possible.

The examples show the smallest as well as the largest and deepest bores that can be machined with our instruments. These sizes mainly depend on the rpm's of the high frequency spindles and the rpm's of the KSK.

The lists following hereafter will show you which spindle rpm's you require for the various bores. These rpm's depend on the cutting speeds required by the individual tools.

Three cutting speed graphs of 10 / 20 as well as 30 m/sec should make it easier for you to select the proper spindle.

Based on the indications given by the tool supplier, you will have to judge yourself which speed would be best in your case. In this connection please consult our working study 0.7.

When making the selection of the KSK best suited for your pur- poses, you will also have to decide whether you want to have a manual or a CNC controlled instrument. We have recently put on the market a KSK which can be integrated into the control unit of a CNC machine tool by means of the interface RS 232.

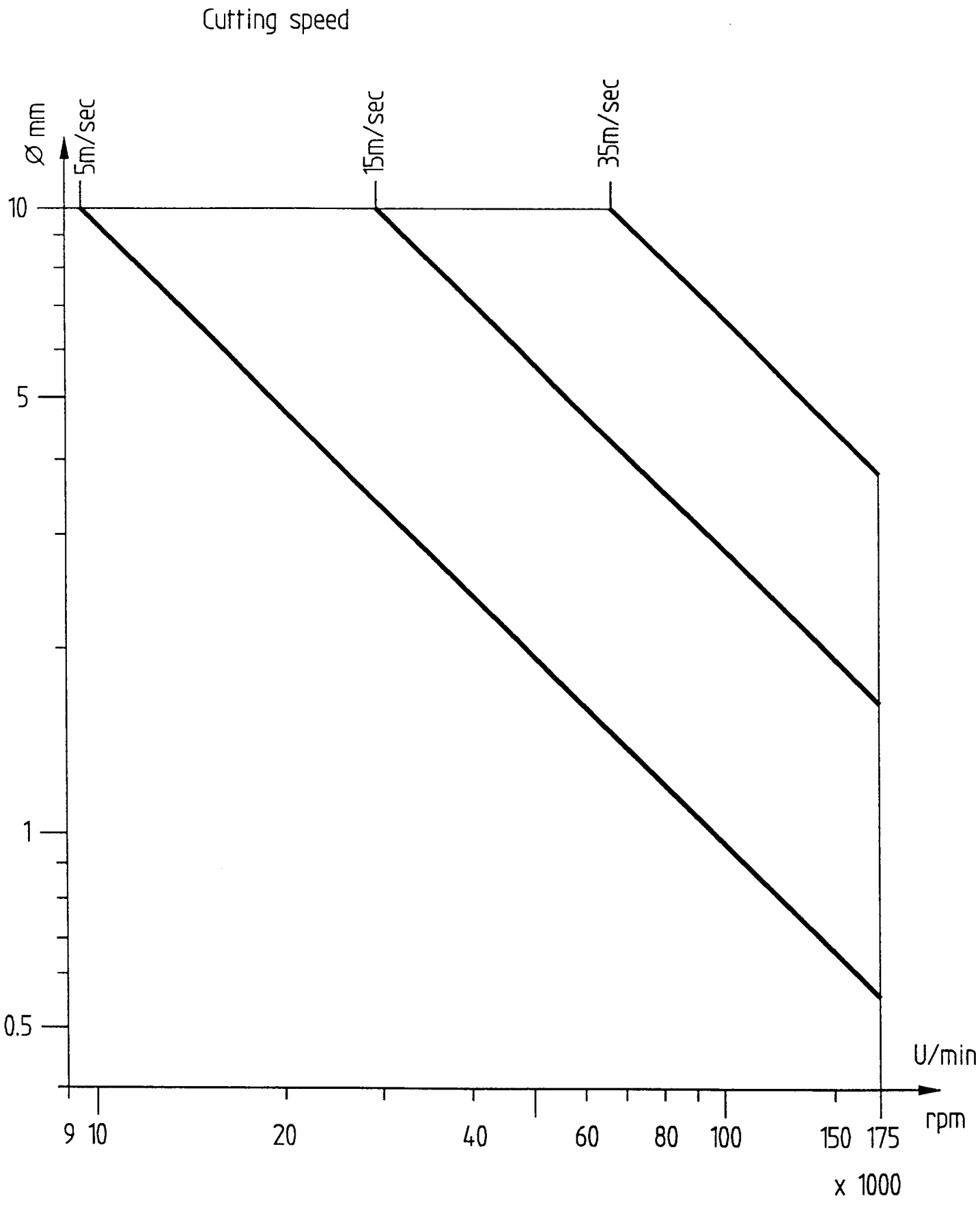
To facilitate you the selection, you will find hereafter a graph which indicates at which speed the KSK should turn for each particular bore. This graph also shows you up to which rpm you may let the various instruments work. For the instruments not included in this graph, please refer to the individual leaflets.

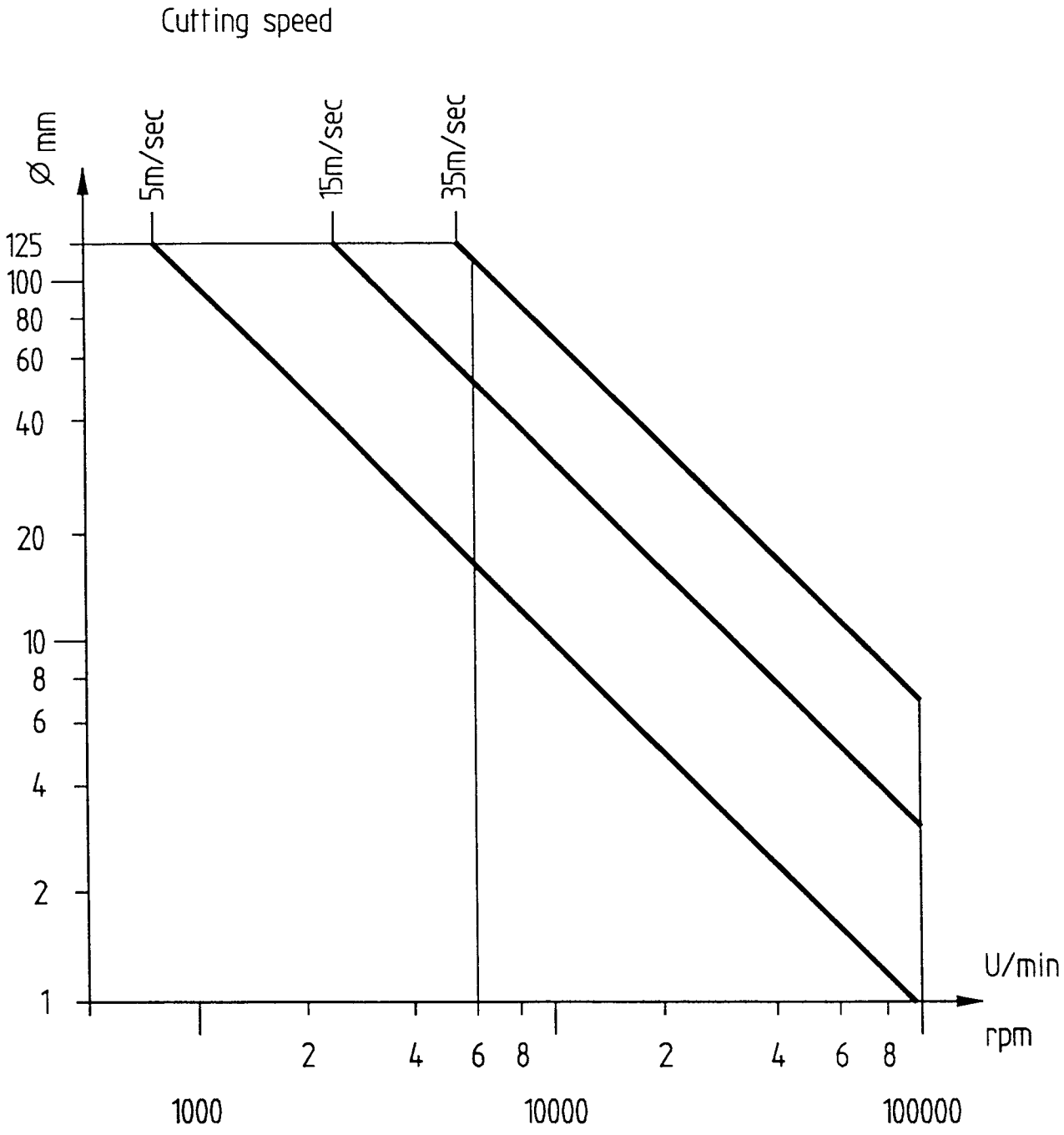
The working studies 1 - 6 also indicate infeeds, rpm's of the spindle, rpm's of the KSK, chip removal, etc.

We have ourselves done the actual machining, but are convinced that after gaining some experience, you will be able to improve on these values.

We hope that this paper will be of help to you. It goes without saying that our representatives, who are regularly undergoing training at our works in Nänikon, will be glad to answer any further questions you may have.

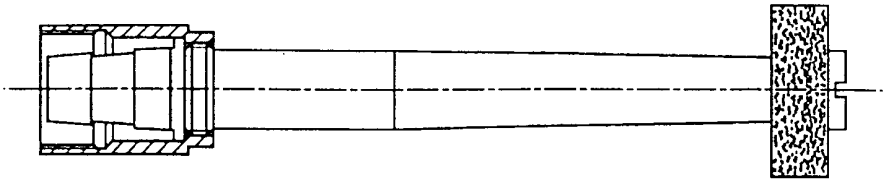
Nänikon, September 2, 1988
RS/MS


Cutting speed
Ø mm
5m/sec
15m/sec
35m/sec
10
5
1
0.5
U/min
9
10
20
40
60
80
100
150
175
rpm
x 1000

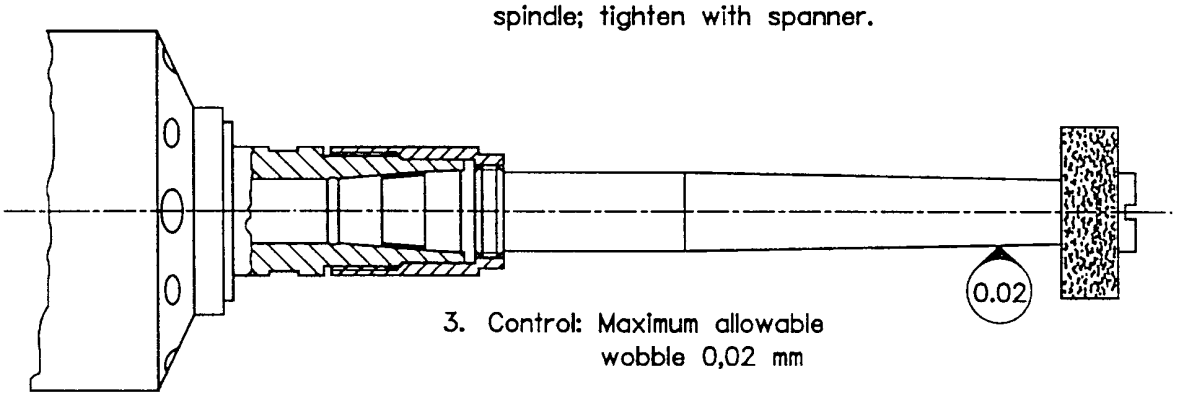

Cutting speed
Ø mm
5m/sec
15m/sec
35m/sec
125
100
80
60
40
20
10
8
6
4
2
1
U/min
rpm
2
4
6
8
2
4
6
8
1000
10000
100000

GRINDING ARBORS FOR KSK

1. To thread the nut flash onto the bolt thread.



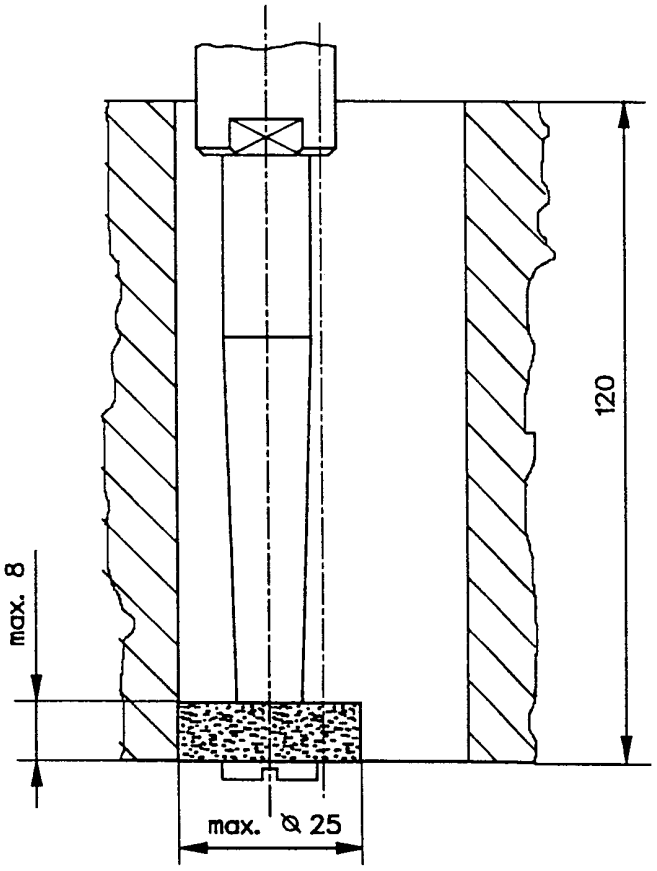
2. To thread the nut with bolt onto the spindle; tighten with spanner.



3. Control: Maximum allowable wobble 0,02 mm

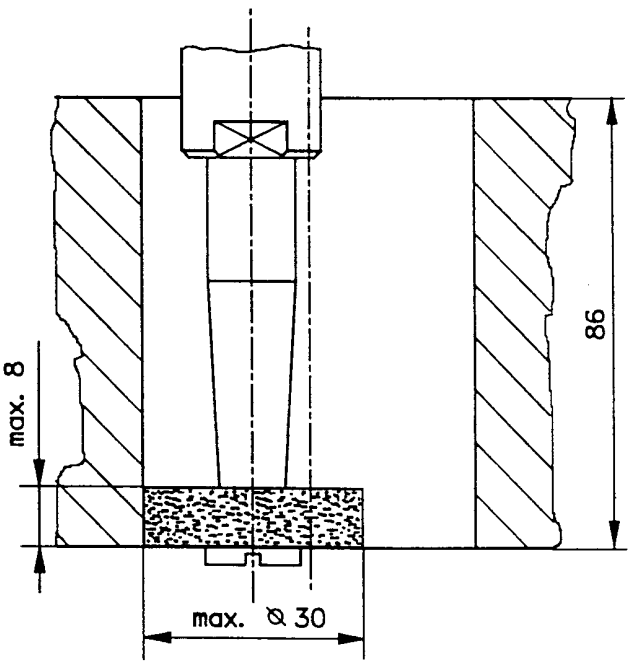
Grinding Arbor T120

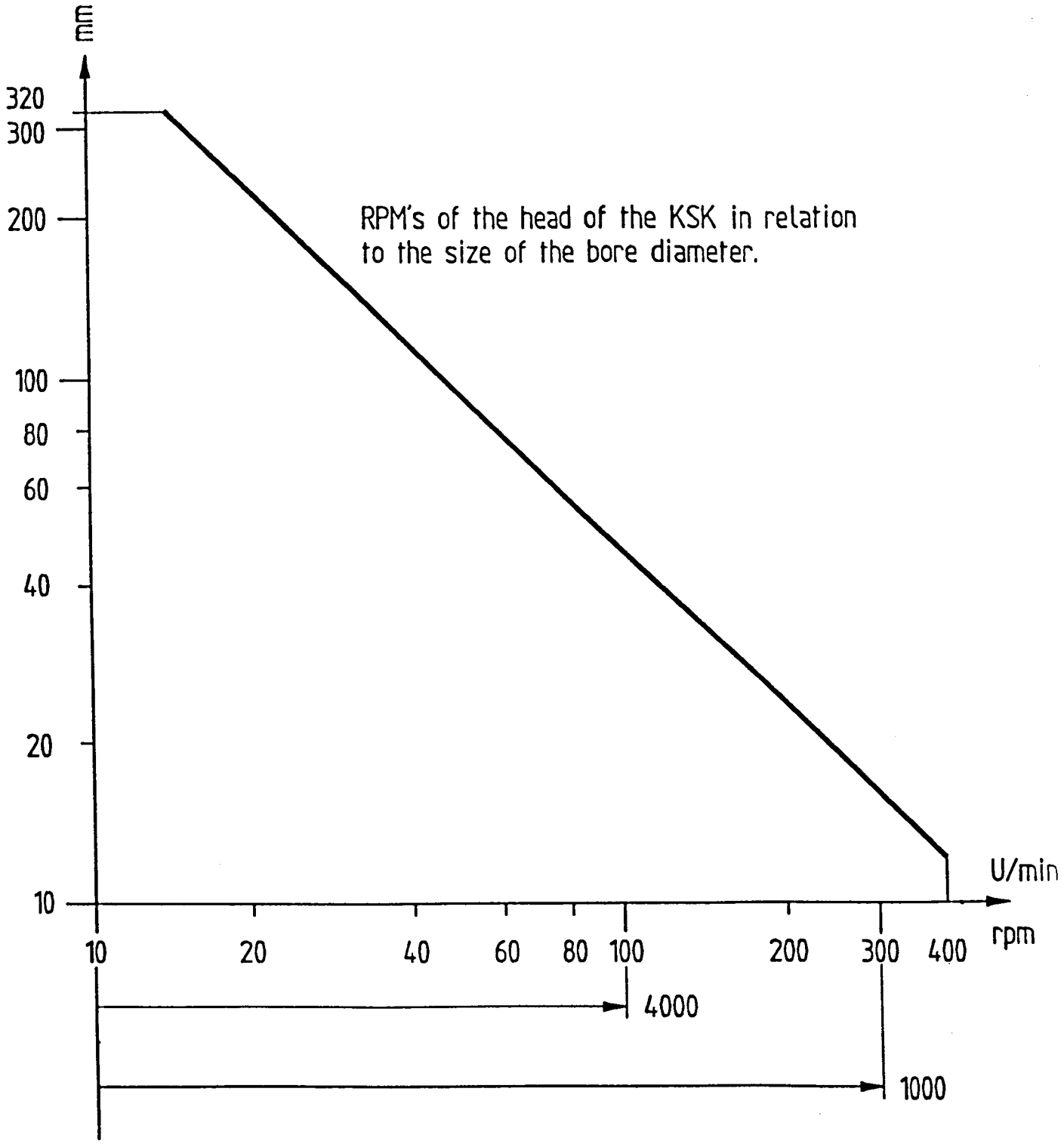
Maximum speed 20000 rpm
Grinding depth max. 120 mm



Grinding Arbor T86

Maximum speed 30000 rpm
Grinding depth max. 86 mm




mm
320
300
200
100
80
60
40
20
10
RPM's of the head of the KSK in relation
to the size of the bore diameter.
U/min
rpm
10
20
40
60
80
100
200
300
400
4000
1000

0) Working Studies INTERNAL GRINDING

The RAY coordinate grinding head (KSK) has been especially developed so as to have the possibility to machine on conventional machine tools such as boring machines, milling machines ,etc. bores in hardened materials.

With the KSK bores of 0,8 mm up to max. 320 mm can be machined.

Here one is working with grinding pins, grinding wheels, milling cutters, etc.; please refer to the working studies following hereafter. With grinding pins one can obtain a maximum bore depth.
We refer you here to our study 0.3, the corresponding leaflets as well as the operating instructions of the various KSK.

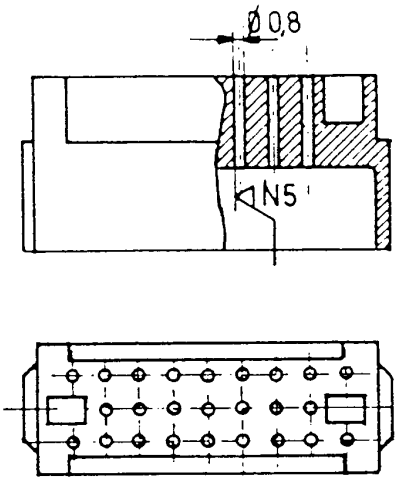
For Borazon grinding we offer our customers a collection of Borazon grinding pins: please see leaflet No. 213. Available is also a collection of grinding wheels; please see leaflet No. 217. Both of these collections allow you the machining of any material.

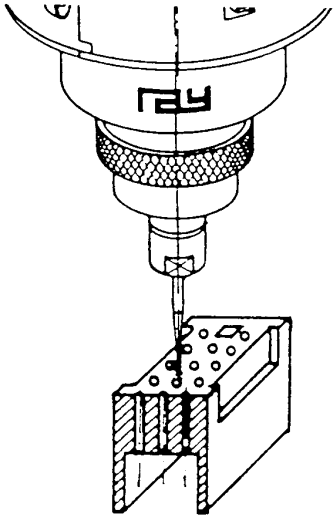
When grinding bores, attention should be paid to the fact that the size of the grinding wheel selected is the most adequate one in respect to the size of the bore. Optimum condition: Diameter of the grinding wheel approx. 80% of the diameter of the bore.

That this condition cannot always be met, is of course self-under-stood.

In addition one should pay attention to the selection of the required cutting speed. Thanks to the continuously adjustable rpm control of the high frequency spindle, this can easily be done.

Unfortunately also in this case is it for security reasons not always possible to set the ideal cutting speed. We emphatically recommend you the study of our
EXAMPLE (0.7).





Cutting speed:	4,5 m/sec	
RPM's of the head:	300	
RPM's of the spindle:	170'000	
Type of spindle:	Air spindle	
Work piece: Punch guide	Material: Hardness:	Tool steel Rc 62
Tool:	Borazon grinding pin	Ø 0.5mm B75
Machining data:	Feed: Cutting depth:	40 mm/min 0,002 mm

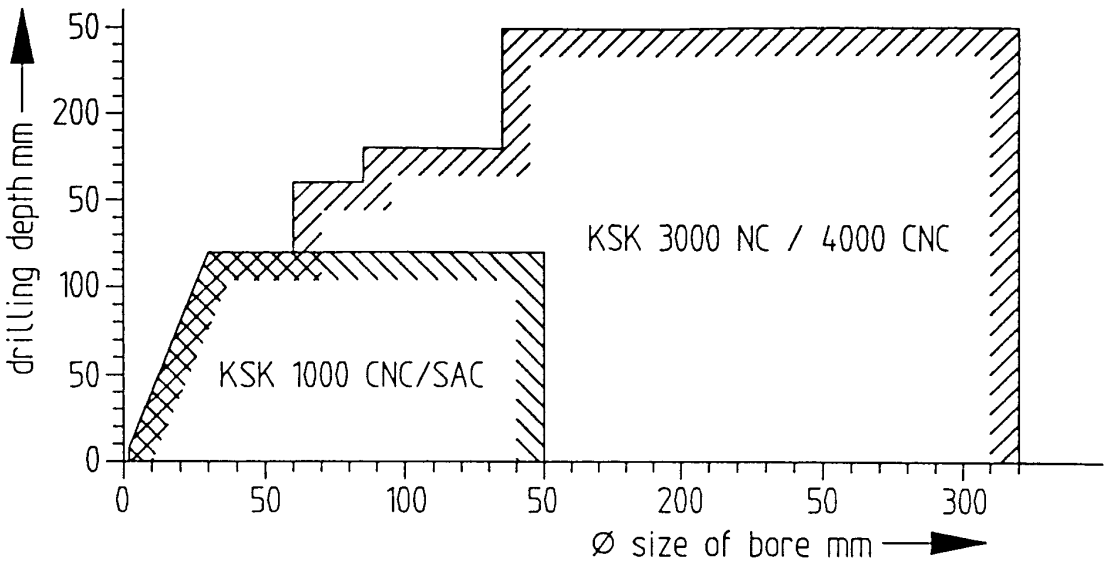
REMARKS:

Please bear in mind that there are no grinding pins available on the market with a diameter of less than 0,5 mm.

With such a grinding pin one could at best machine a bore diameter of 0,8 mm.

With a grinding pin of 0,5 mm one can obtain a cutting speed of 4,5 m/sec., which would have to be judged as barely sufficient. We may therefore state that with the RAY KSK the diameter of the

SMALLEST BORE IS 0,8mm.



Cutting speed:	----		
RPM's of the head:	----		
RPM's of the spindle:	----		
Type of spindle:	----		
Work piece: ----	Material:	----	
	Hardness:	----	
Tool:	----		
Machining data:	Feed:	----	
	Cutting depth:	----	

REMARKS:

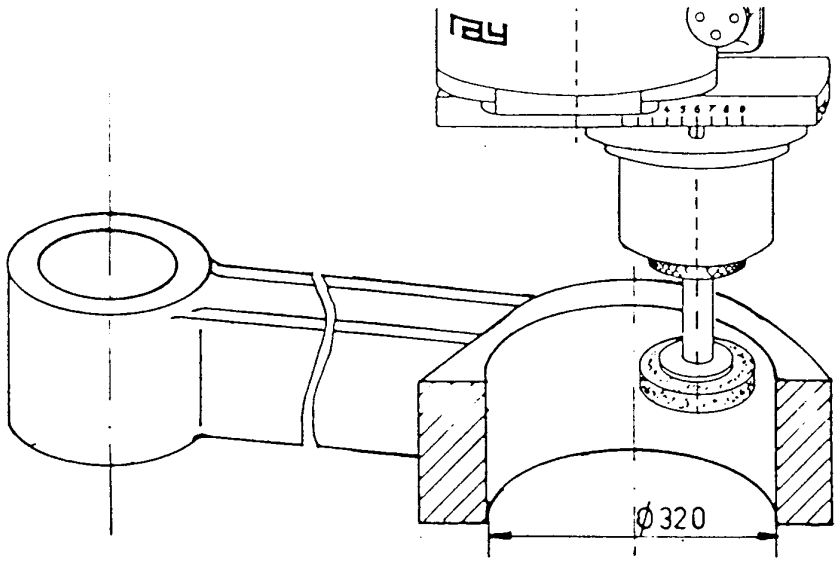
Since almost all of the RAY high frequency spindles can be equipped with grinding pins, the maximum machining depth depends on the spindle and the corresponding grinding pin being used.

As far as the exact dimensions are concerned, please refer to the data sheets of the corresponding spindle leaflets.

The sketch given above should give you an indication about the depths of bore which can possibly be machined.

It shows you that with the largest KSK and the available grinding pins or spindle prolonging devices,

THE DEEPEST BORE ATTAINABLE IS 250 mm



Cutting speed:	35 m/sec	
RPM's of the head:	12	
RPM's of the spindle:	6'000	
Type of spindle:	High frequency spindle	
Work piece: Connecting rod	Material: Hardness:	Tempering steel HB 150
Tool:	Grinding wheel	
Machining data:	Feed: Cutting depth:	10mm/min 0,002 mm

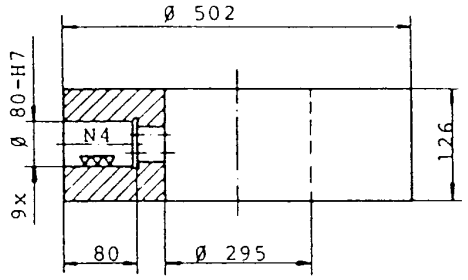
REMARKS:

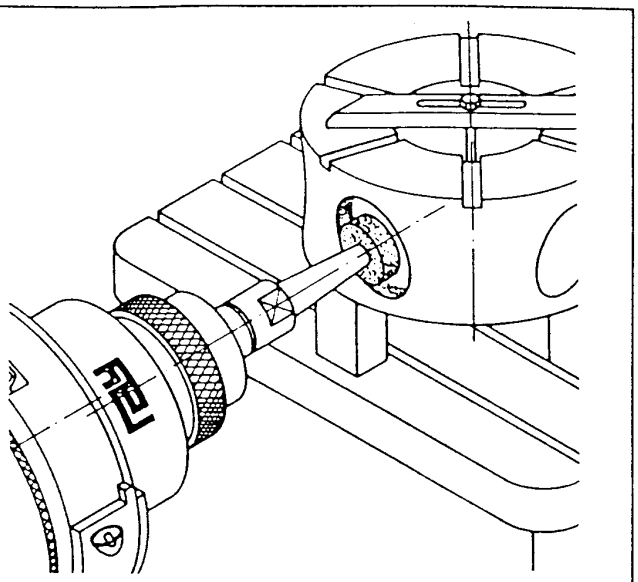
For large bores the rpm of the spindle is the most essential factor. We are working here with grinding wheels.

Normally one is working with a maximum cutting speed of 35 m/sec. Please observe, however, that nowadays grinding wheels with cutting speeds of 50 m/sec. and more are available on the market.

Each grinding wheel is marked with the maximum rpm and you will have to adhere to these indications. With 6000 rpm's, resp. 35m/sec., you may therefore select a wheel of 125 mm. Together with the maximum planetary travel of the KSK this means that the diameter

OF THE LARGEST BORE IS 320 mm.



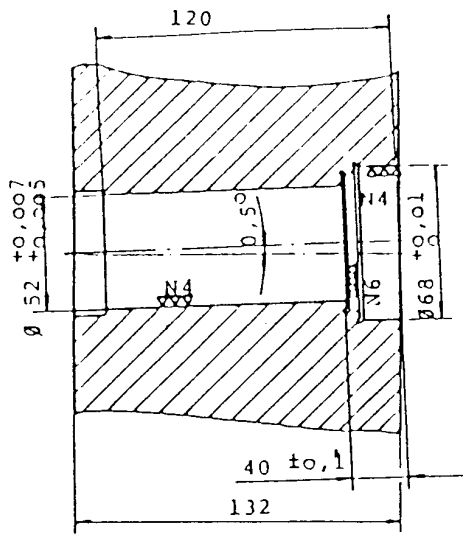


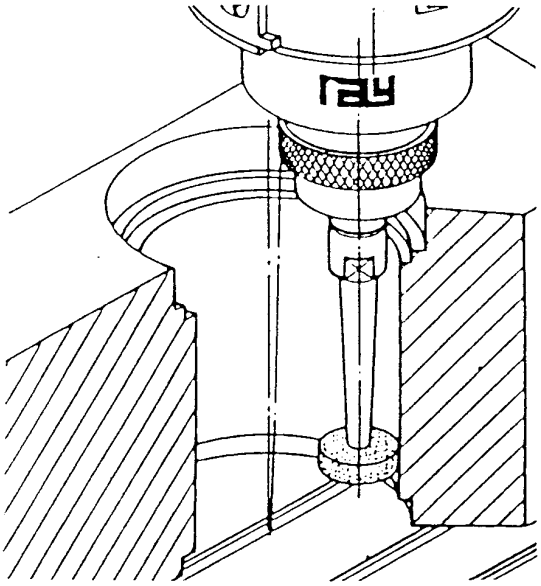
Cutting speed:	30 m/sec	
RPM's of the head:	60	
RPM's of the spindle:	15'000	
Type of spindle:	High frequensy spindle	
Work piece: Rotor for oil motor	Material: Hardness:	Case hardening steel Rc 56 - 58
Tool:	Grinding pin + Grinding wheel	
Machining data:	Feed: Cutting depth:	30 mm/min 0,03 mm

REMARKS:

In this case we are working horizontally with a grinding pin and a grinding wheel. This makes the machining of deeper bores possible.

When working with grinding pins, please carefully study the indications given on the corresponding instruction sheet.





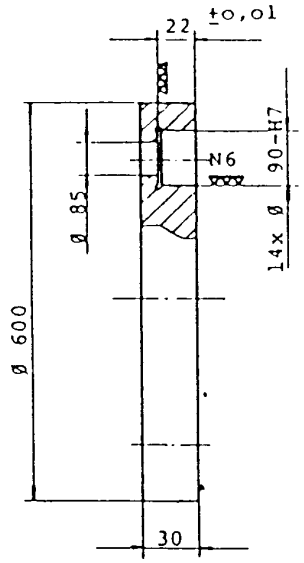
Cutting speed:		26 m/sec	
RPM's of the head:		80	
RPM's of the spindle:		20'000	
Type of spindle:		High frequency spindle	
Work piece:	Motor block	Material: Hardness:	Case hardening steel Rc 58 - 60
Tool:		Grinding pin + Grinding wheel	
Machining data:		Feed: Cutting depth:	30 mm/min 0,02 mm

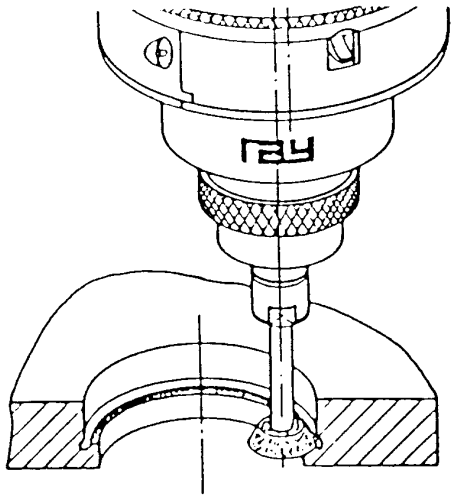
REMARKS:

Here we are working vertically with a grinding pin and a grinding wheel.

This makes the machining of an oblique bore in a motor block: (angle of inclination 0,5 mm, bore diameter 52 mm, bore depth 120 mm) possible.

When working with grinding pins, please study carefully the indications given on the corresponding instruction sheet.

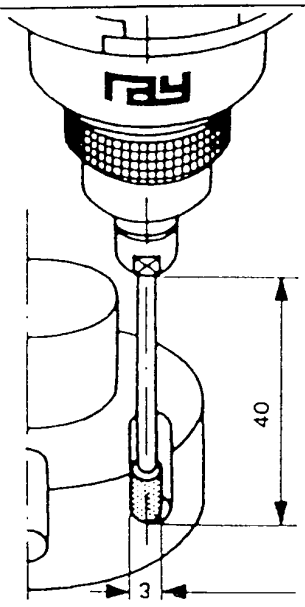


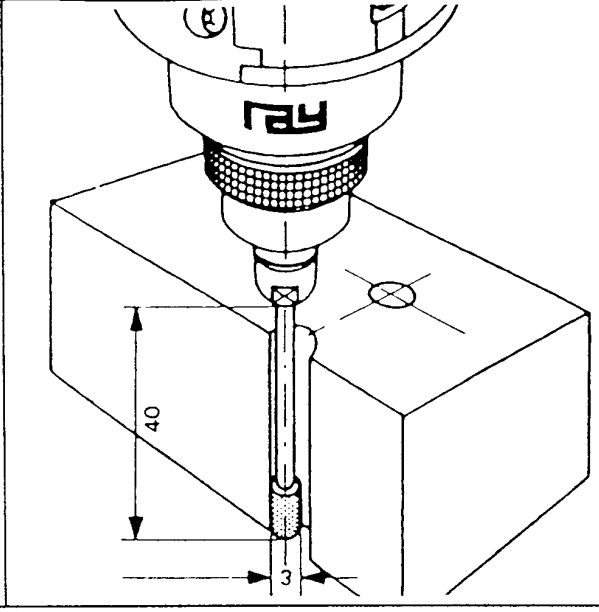


Cutting speed:	26 m/sec	
RPM's of the head:	40	
RPM's of the spindle:	20'000	
Type of spindle:	High frequency spindle	
Work piece: Feed plate	Material: Hardness:	Case hardening steel Rc 60 - 62
Tool:		
Machining data:	Feed: Cutting depth:	 0,01 mm

REMARKS:

Face grinding of a collar with a cup wheel:
Diameter: 25 mm x 8 mm.





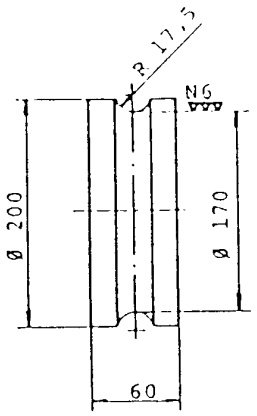
Cutting speed:	2,5 m/sec	
RPM's of the head:	300	
RPM's of the spindle:	15'000	
Type of spindle:	High frequency spindle	
Work piece: Parts of a gauge	Material: Hardness:	Alloy tool steel Rc 62 - 64
Tool:	Borazon grinding pin	
Machining data:	Feed: Cutting depth:	40 mm/min 0,01 mm

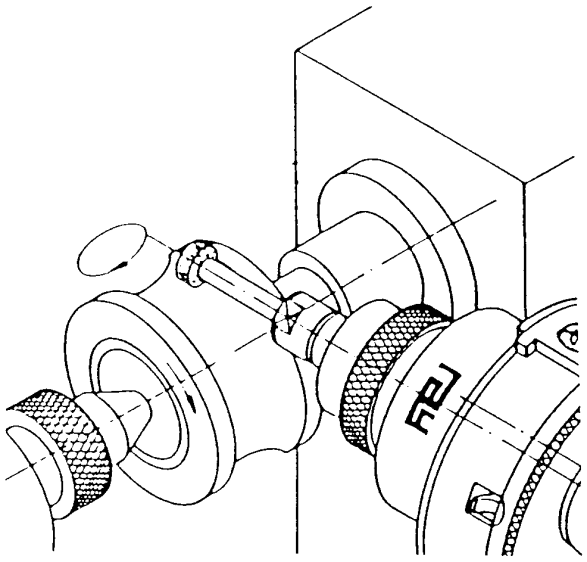
REMARKS:

According to the optimum circumferential speed for Borazon, this grinding pin could turn at approx. 60'000 rpm or more. It is evident that this is not possible for safety reasons.
Here the following rule applies:

Should the length L of the grinding pin exceed by 6 times the diameter of the pin, it will be necessary to work at lower speeds. Safety devices are absolutely necessary.

We would furthermore recommend to have the grinding pin start running in the bore it self.



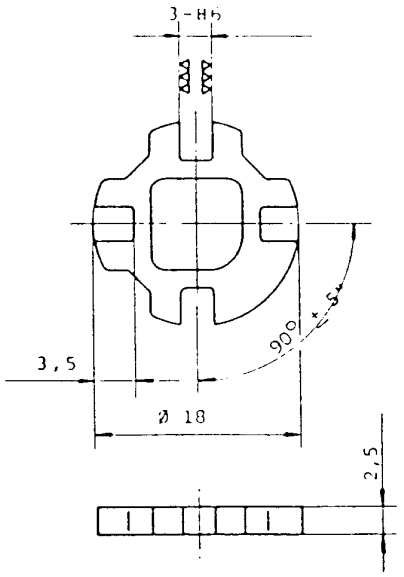


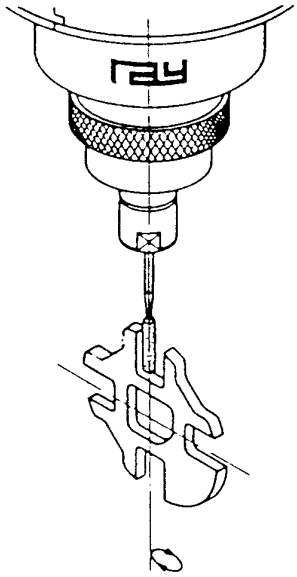
Cutting speed:	28 m/sec	
RPM's of the head:	85	
RPM's of the spindle:	18'000	
Type of spindle:	High frequency spindle	
Work piece: Profile roll	Material: Hardness:	Alloy tool steel Rc 60 - 62
Tool:		
Machining data:	Feed: Cutting depth:	ca. 5 mm/min 0,02-0,03 mm

REMARKS:

With this single purpose machine, equipped with a KSK, diameters of up to 180 mm can be machined.

Radius grinding of profile rolls.

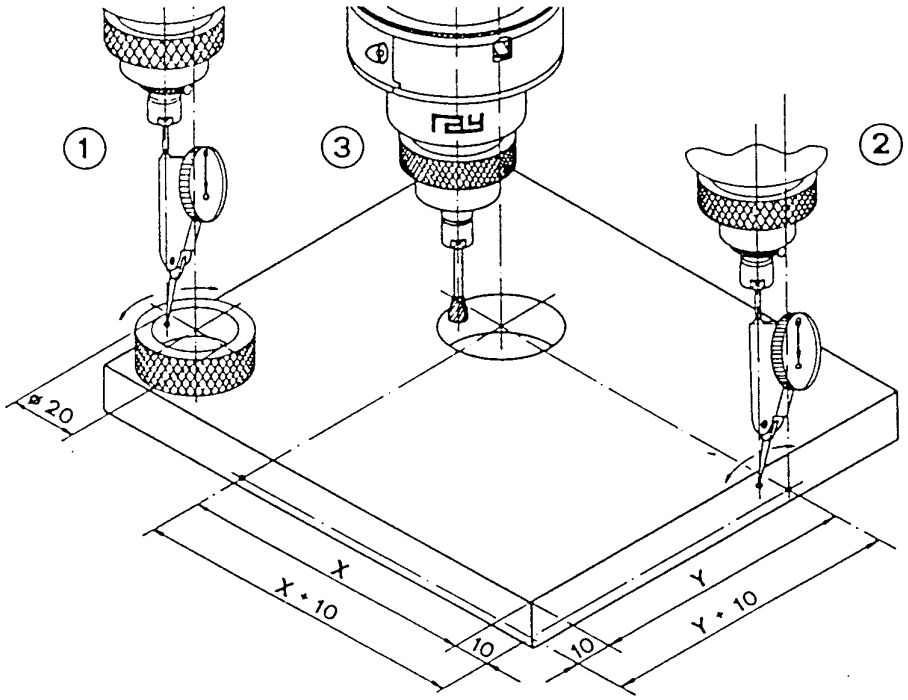




Cutting speed:		10,5 m/sec	
RPM's of the head:		300	
RPM's of the spindle:		99'000	
Type of spindle:		High frequency spindle	
Work piece:	Maltese cross for electronic calculator	Material: Hardness:	Nitride steel Rc 64
Tool:		Diamond pin	
Machining data:		Feed: Cutting depth:	5 mm/min 0.005 mm

REMARKS:

Machining of punched Maltese crosses
Time required per unit with 4 slots: approx. one minute.
The tolerance of **H6**, as well as the surface quality of **N6** are easily attainable.



Exact positioning starting from a base line

If the problem poses itself to have to find the exact coordinates of a bore from the edge of a plate, as shown in the above sketch, you will have to proceed as follows:

1. Pick-up of the diameter

With an indicator, put into the coordinate grinding head, and a calibrating ring of for instance 20 mm diameter, one can pick up this value 20 exactly.

2. Approaching of the base

Touch the base line of the plate with the indicator and feed with the spindle of the machine until the indicator reading is identical with the pick-up of the diameter as per point 1. Now we know that the axial center line of the KSK is exactly at 10 mm's distance from the base line (i.e. half of the value picked up.).

3. Positioning

In order to obtain the exact coordinate X of our bore, we will have to move the dimension X, determined as per point 2, whereby the 10 mm will have to be taken into acount.

The same procedure will have to be followed for the determination of the Y value, starting from the second base.

1) Working Studies SLOT GRINDING

With the coordinate grinding head KSK you can also grind slots. Theoretically the width of the slot may be 100 mm or more, the height up to max. 50 mm.

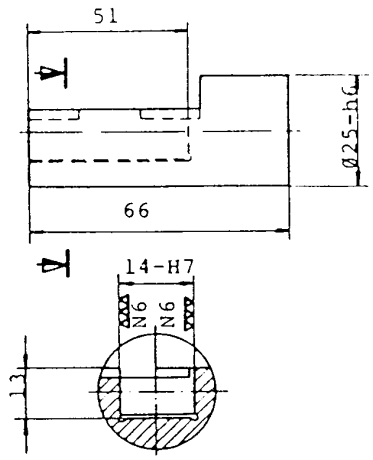
The slot can be machined in two different ways:

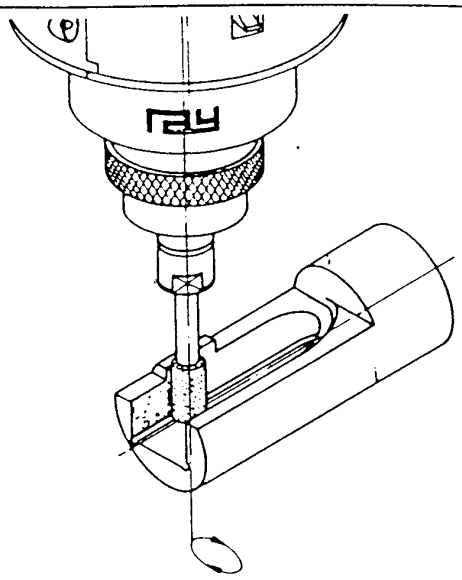
A)

The KSK is moved into the center of the slot. With the planetary movement the left and the right side can be ground simultaneously. For this, however, the end of the slot has to have the corresponding radius.

B)

The KSK first grinds one side and then the other side is being ground. This is, however, only being done if the end of the slot is such that it does not allow us to work with the planetary movement. With the KUS it is also possible to grind slots according to the second working technique, whereby in this case a much better surface can be obtained thanks to the oscillating movement.



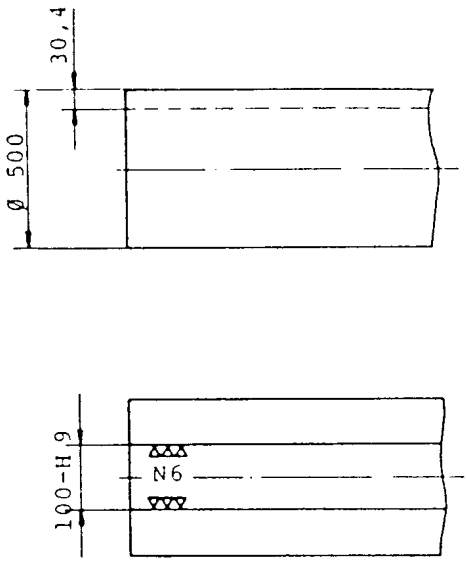


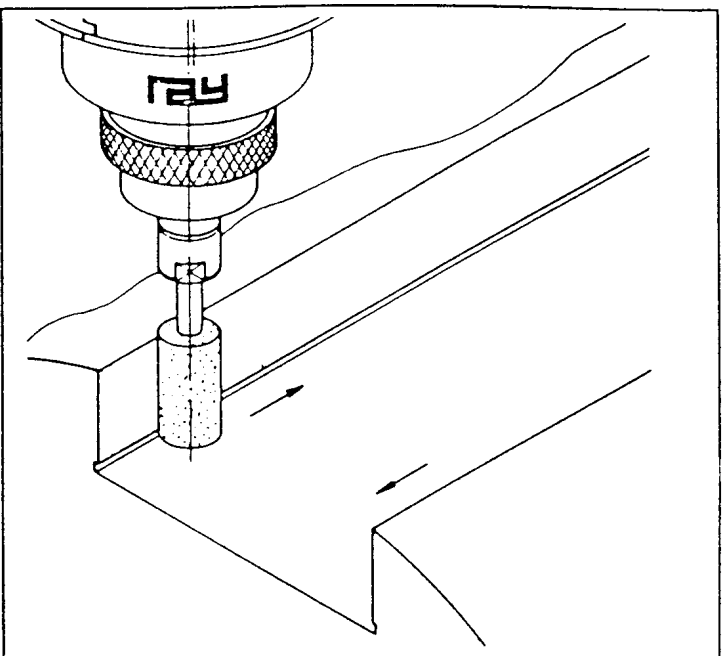
Cutting speed:	25 m/sec	
RPM's of the head:	180	
RPM's of the spindle:	40'000	
Type of spindle:	High frequency spindle + KSK	
Work piece: Pivoting lever	Material: Hardness:	Case hardening steel Rc 60 - 62
Tool:	Borazon pin	
Machining data:	Feed: Cutting depth:	10 mm/min 0.15 mm

REMARKS:

Here a slot **14H7**, with a depth of 13 mm is being ground with the KSK.

For the grinding of the slot the planetary movement is being used. Both sides are being ground simultaneously.



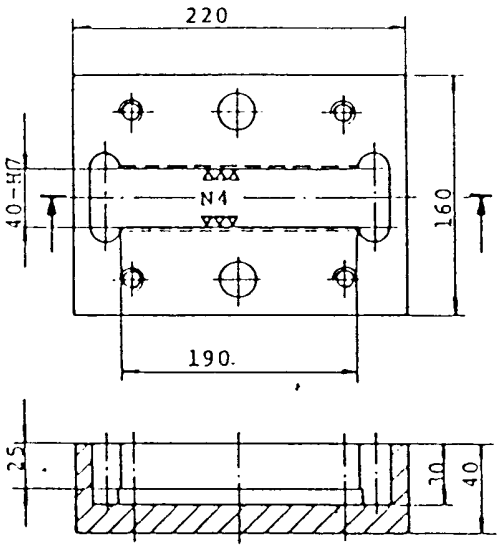


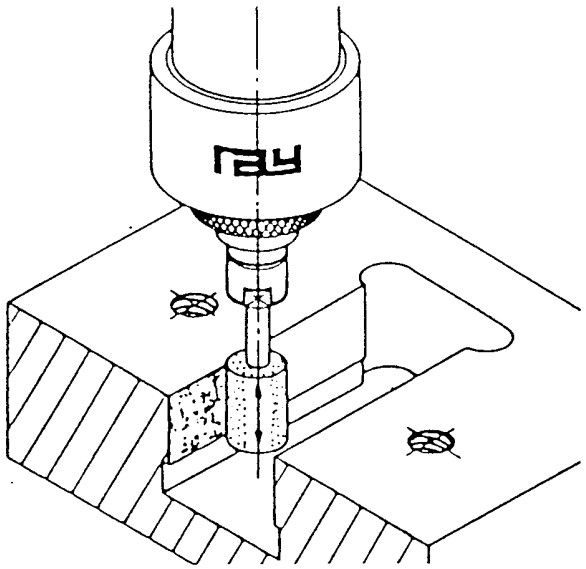
Cutting speed:	26 m/sec	
RPM's of the head:	180	
RPM's of the spindle:	25'000	
Type of spindle:	High frequency spindle + KSK	
Work piece: Rotor shaft	Material: Hardness:	Case hardening steel Rc 60 - 62
Tool:	Borazon pin	
Machining data:	Feed: Cutting depth:	10 mm/min 0,2 mm

REMARKS:

In this example a larger slot is being ground with the KSK, whereby first one side and then the other side is being machined.

The KSK is set at approx. **0,05 mm planetary movement.**





Cutting speed:		26 m/sec	
RPM's of the head:		Number of strockes ca. 10 Hz	
RPM's of the spindle:		25'000	
Type of spindle:		High frequency spindle + KUS	
Work piece:	Base plate of master gauge	Material: Hardness:	Tool steel Rc 60 - 62
Tool:		Borazon pin	
Machining data:		Feed: Cutting depth:	40 mm/min 0.2 mm

REMARKS:

A slot 40H7 is being machined with the KUS. Each side is machined individually.

This working procedure guarantees an optimum **surface** quality.

2) Working Studies SURFACES GRINDING

Each KSK can be equipped for surface grinding, be it by the use of a correspondingf ace grinding spindle, be it by mounting an additional face grinding plate. May we refer you to the corresponding operating instructions.

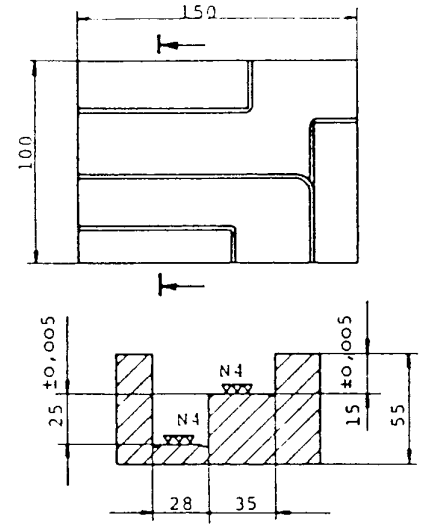
With surface grinding we can face a surface which is recessed and can therefore not be machined by a surface grinder.

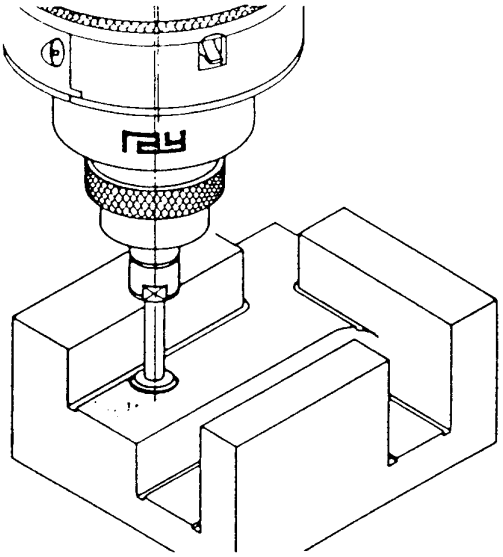
We do not require any deepening adjustment, i.e. we can start working on the surface directly. Since the feed is very small in this case, we need machine tools on which the Z-feed can be set very precisely.

For the surface grinding RAY Ltd. have developed special surface grinding wheels, coated with Borazon. The maximum infeed of these special surface grinding wheels is 0,04 mm.

Surfacing is a valuable complement for tool construction and will be a great asset for die makers. Please refer to the instructions concerning surfacing given in chapter 6.

With the use of grinding arbors it is possible to reach a depth of 120 mm, whereby the size of the surface to be surface ground is of no importance to the KSK.



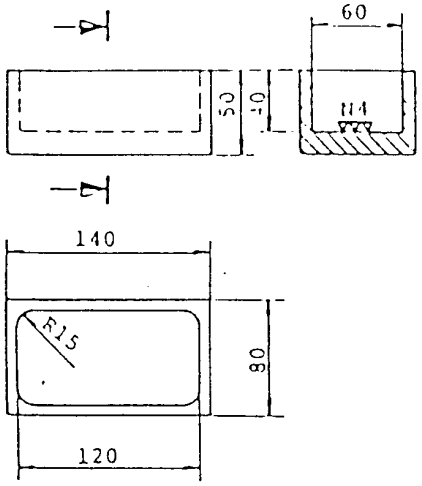


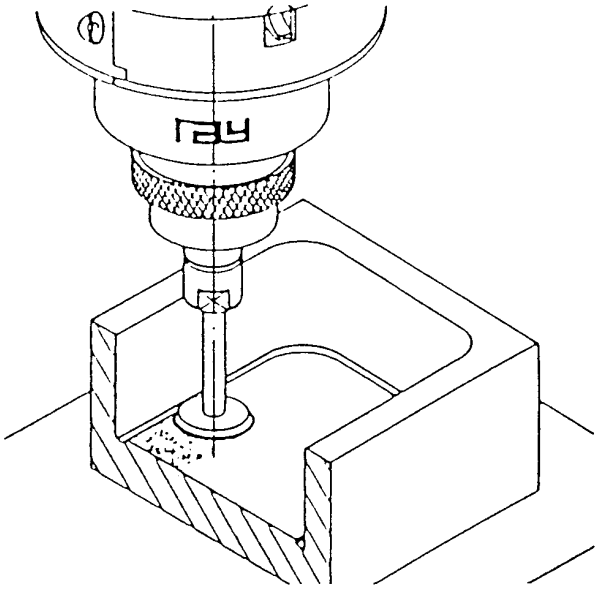
Cutting speed:	26 m/sec	
RPM's of the head:	150	
RPM's of the spindle:	20'000	
Type of spindle:	Spindle for surfacing	
Work piece: Master gauge	Material: Hardness:	Alloy tool steel Rc 60 - 62
Tool:	Surface grinding wheel RAY	
Machining data:	Advance feed: Feed depth:	20 mm/min 0.02 mm

REMARKS:

Surfacing of a master gauge with the KSK to ensure the exact adjustment of the height of

25 mm + 0,005 mm.

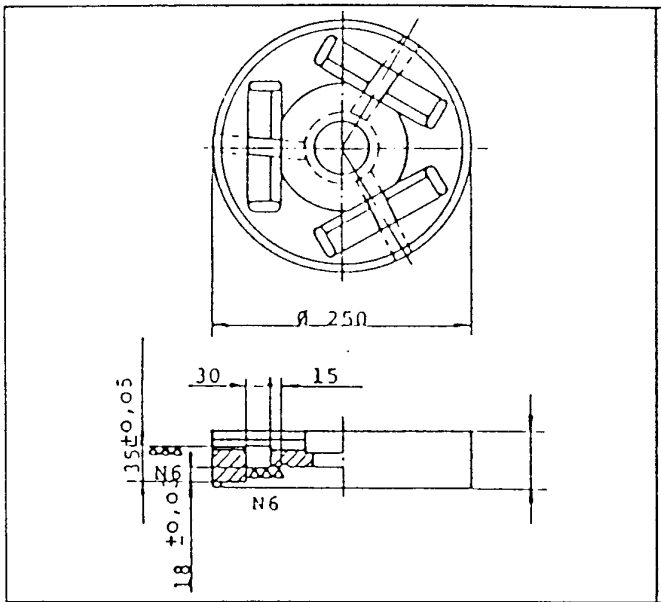


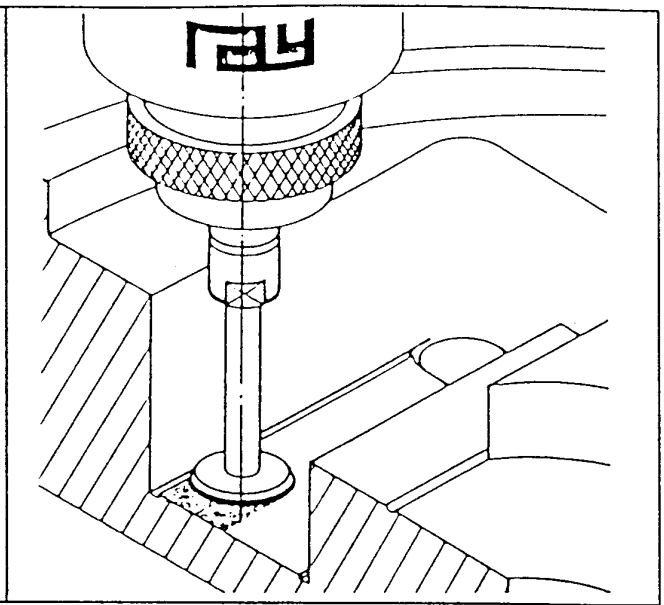


Cutting speed:	26 m/min	
RPM's of the head:	150	
RPM's of the spindle:	20'000	
Type of spindle:	Spindle for surfacing + KSK	
Work piece: Die holder	Material: Hardness:	Alloy tool steel Rc 60 - 62
Tool:	Surface grinding wheel RAY	
Machining data:	Advance feed: Feed depth:	20 mm/min 0.02 mm

REMARKS:

Surfacing of a die holder, which will lateron have to hold the respective tools. The surface will therefore have **to be absolutely flat.**





Cutting speed:		26 m/sec	
RPM's of the head:		150 U/min	
RPM's of the spindle:		20'000 U/min	
Type of spindle:		Spindle for surfacing	
Work piece:	Body for 3-jaw lever scroll chuck	Material: Hardness:	Case hardening steel Rc 58 - 60
Tool:		Surface grinding wheel RAY	
Machining data:		Advance feed: Feed depth:	20 mm/min 0,002 mm

REMARKS:

Surface grinding of the base plates of a 3-jaw lever scroll chuck.

This work was done with special surface grinding wheels. These surface grinding wheels are only available at RAY Ltd. and their representatives.

3) Working Studies CAM GRINDING

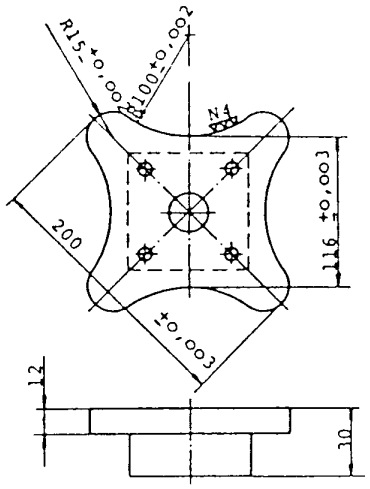
RAY Ltd. have developed a special cam grinding head KUS for the grinding of cams. With this KUS you are able to grind any profile. The cam is being determined by the machine, be it by CNC control or a copying procedure.

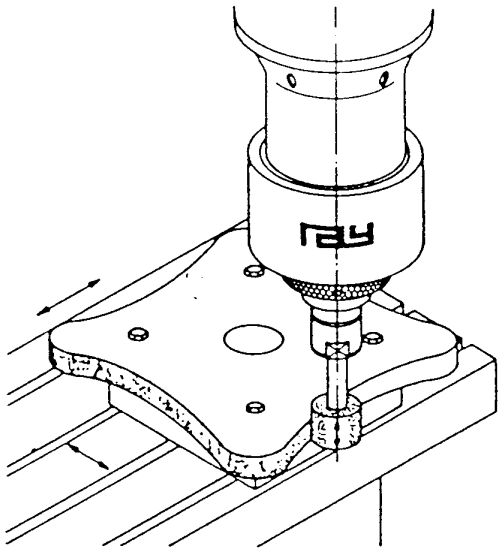
The maximum height of the cam is 50 mm. The KUS is equipped with an oscillating movement and consequently produces a very good surface finish.

Since the Borazon pins are constantly engaged, the cylindricity of the grinding pins is being transferred. Therefore the geometrical form as regards cylindricity of the work piece is somewhat limited. Depending on the grinding pin, the obtainable accuracy lies between 0,005 - 0,01 mm.

Should higher accuracies be requested, as for instance in the case of manufacturing a punch or a die, we would like to refer you to chapter 4, working studies with the oscillating apparatus.

The vertical head of the machine tool used has to be exactly at a right angle to the table. A badly set vertical head influences the cylindricity of the cam.

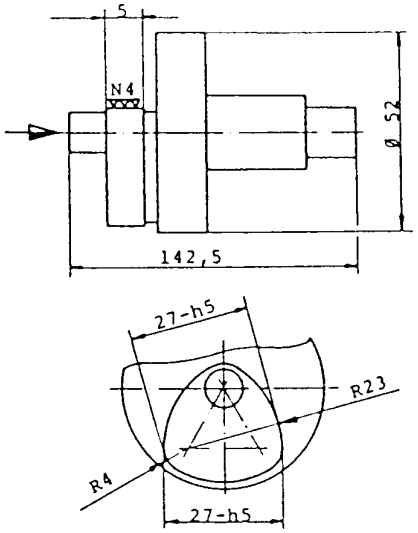


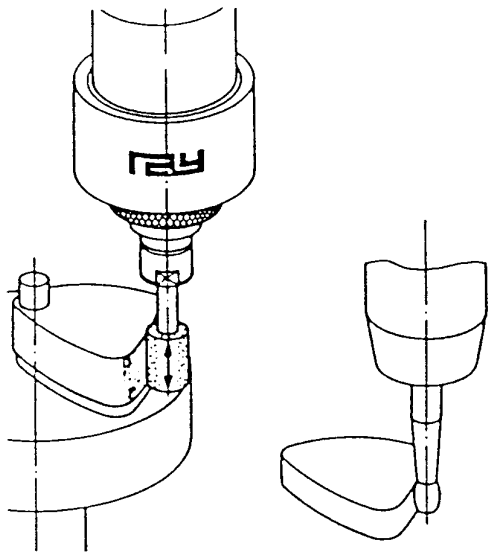


Cutting speed:	26 m/sec	
RPM's of the head:	Number of strokes 12Hz	
RPM's of the spindle:	20'000	
Type of spindle:	High frequency spindle + KUS	
Work piece: Cam	Material: Hardness:	Alloy tool steel Rc 60 - 62
Tool:	Borazon grinding pin B 76	
Machining data:	Feed: Cutting depth:	60 mm/min 0,15 mm

REMARKS:

Grinding of a cam on a CNC controlled milling machine with the KUS.

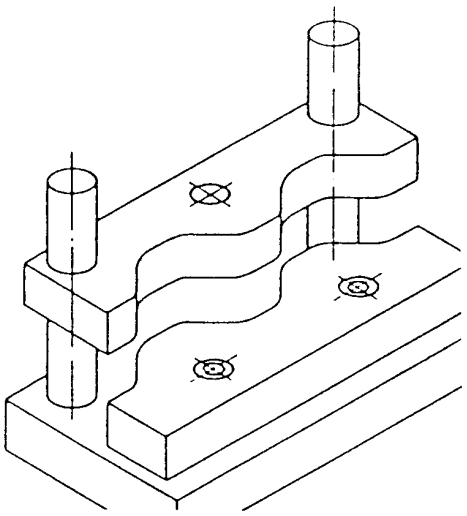


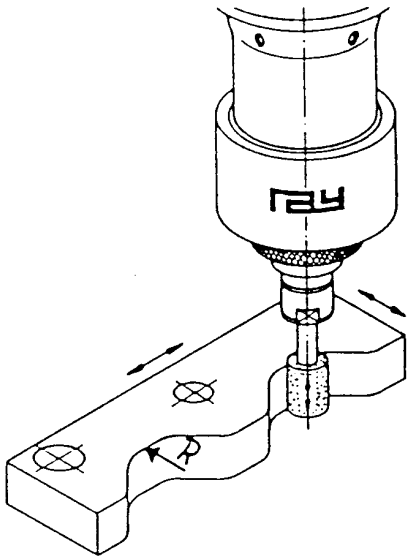


Cutting speed:	27 m/sec	
RPM's of the head:	Number of strokes ca. 12Hz	
RPM's of the spindle:	35'000	
Type of spindle:	High frequency spindle + KUS	
Work piece: Cam shaft	Material: Hardness:	Case hardening steel Rc 58 - 60
Tool:	Borazon grinding pin B 76	
Machining data:	Feed: Cutting depth:	40 mm/min 0,1 mm

REMARKS:

Grinding of the cam of a cam shaft with the KUS on a copy milling machine.



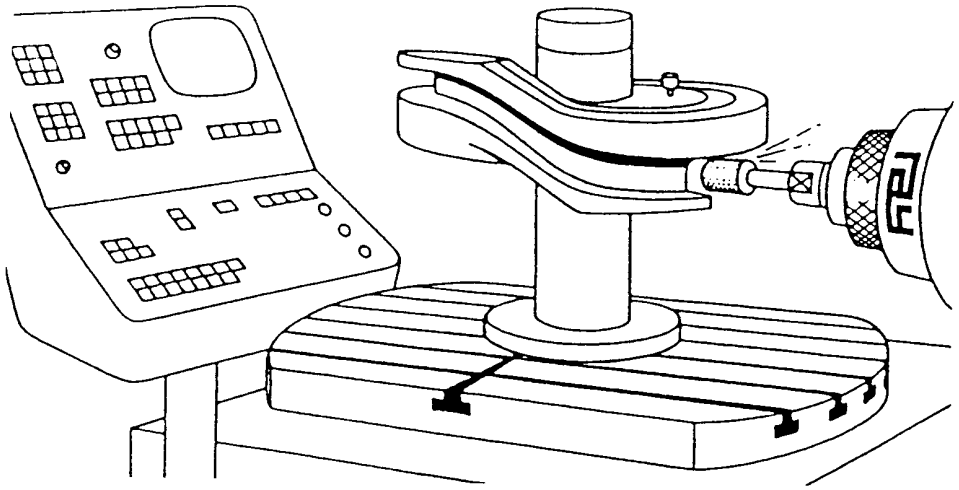


Cutting speed:	27 m/sec	
RPM's of the head:	Number of strokes 12Hz	
RPM's of the spindle:	35'000	
Type of spindle:	High frequency spindle + KUS	
Work piece: Punching die	Material: Hardness:	Alloy tool steel Rc 60 - 62
Tool:	Borazon grinding pin B 76	
Machining data:	Feed: Cutting depth:	60 mm/min 0,15 mm

REMARKS:

Grinding of a punching die on a CNC controlled milling machine with the KUS.

Please bear in mind that the radius of the grinding wheel has to be smaller than the **smallest concave radius R.**



Cutting speed:	26 m/sec	
RPM's of the head:	250	
RPM's of the spindle:	15'000	
Type of spindle:	High frequency spindle + KSK	
Work piece: Radial cam	Material: Hardness:	Alloy tool steel Rc 62 - 64
Tool:	Borazon grinding pin B 151 + B 76	
Machining data:	Feed: Cutting depth:	30 mm/min 0,01 mm

REMARKS:

In this case the planetary feed of the KSK is an absolute must.

Even nowadays no computer is able to control the exact curve of the theoretical trajectory with regard to the tracer roller besides the movements in the Z-axis, the X-axis and the circular table.

4) Working Studies APPLICATION FIELDS OF THE SPINDLES

The RAY frequency spindles were designed for use in the KSK and the KUS. They are therefore less suited for use as stationary spindles.

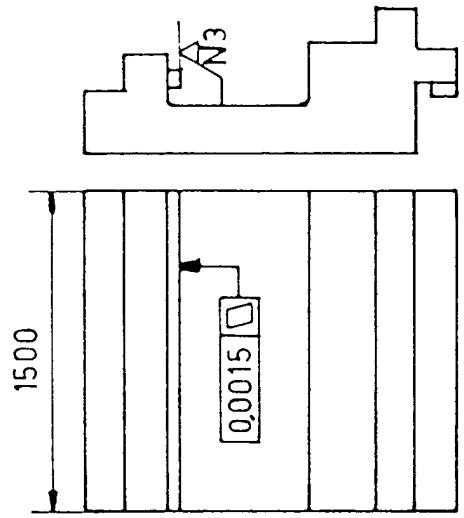
For these applications RAY Ltd. have especially built 2 spindles which work at 6'000 - 40'000 RPM; please refer to our leaflets 111 + 210.

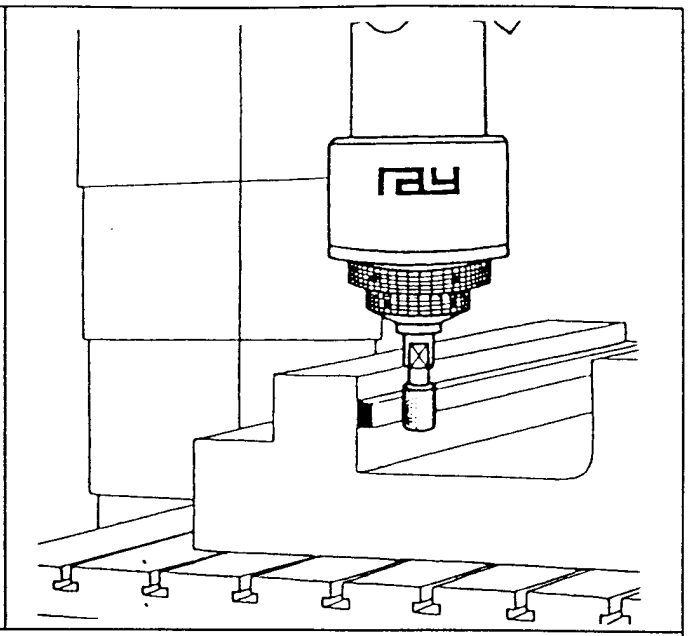
These spindles, which, should the customer so desire, can be provided with water cooling. They can be mounted into the cone of the spindle of the machine tool by means of a fixing cone. You thereby obtain high rpm's at standstill of your spindle.

It is often necessary to machine materials which are either very small in size or which, for some other reason necessitate high rpm's of the spindle.

For this kind of work RAY high frequency spindles could be utilized, be it on a lathe, a grinding machine or some other machine tool.

This way you can save the life of the spindle of your machine and apart from it do the work much faster.



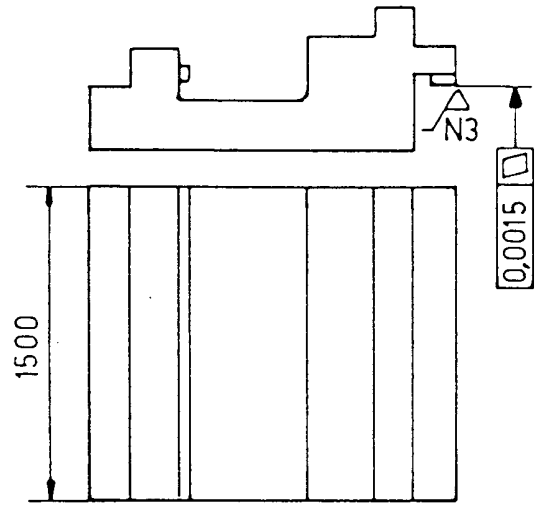


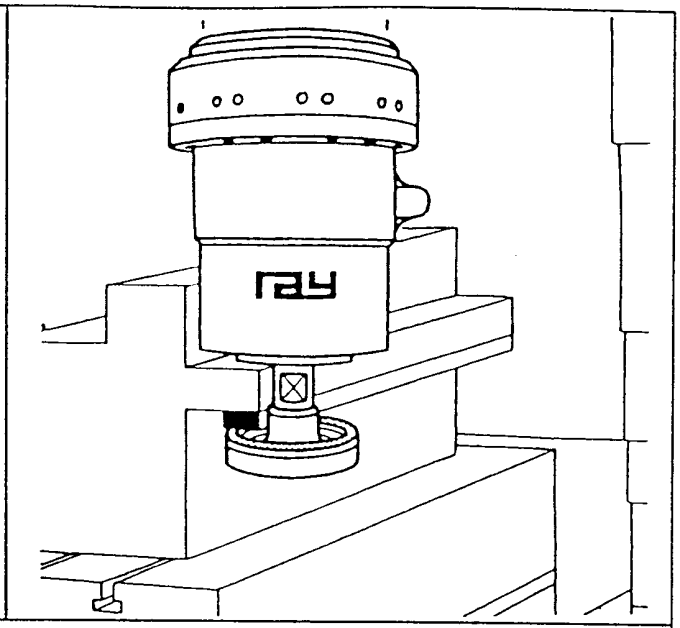
Cutting speed:	26 m/sec	
RPM's of the head:	Number of strokes 12Hz	
RPM's of the spindle:	20'000	
Type of spindle:	High frequency spindle + KUS	
Work piece: Machine Table	Material: Hardness:	Steel casting, hardened Rc 60 - 62
Tool:	Borazon grinding pin B 151	
Machining data:	Feed: Cutting depth:	200 mm/min 0,05 mm

REMARKS:

With the cam grinding head KUS a hardened guide rail, which is mounted onto a machine table, is being finish round.

Surface accuracy: **N3.**
Required evenness over a distance of 1'500 mm: **0,001 mm - 0,0015 mm.**
Requested cylindricity: **0,005 mm.**



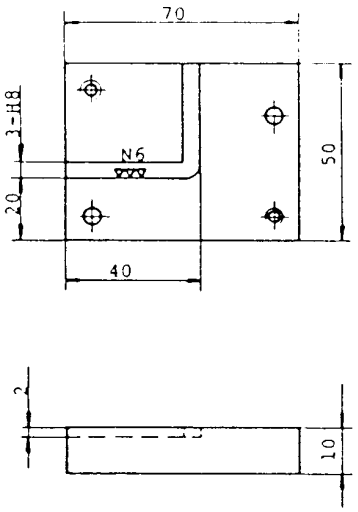


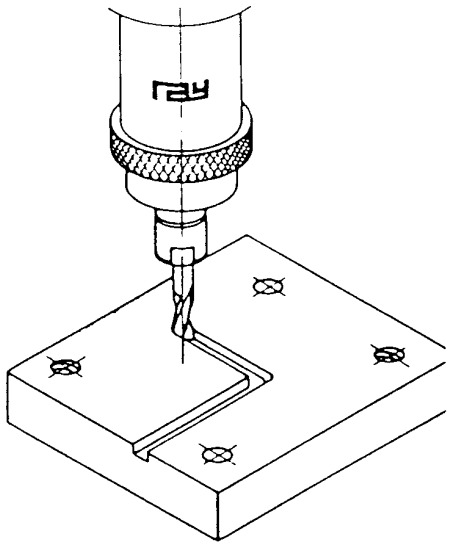
Cutting speed:	31 m/sec	
RPM's of the head:	stationary	
RPM's of the spindle:	6'000	
Type of spindle:	Water-cooled frequency spindle + adapter	
Work piece: Machine Table	Material: Hardness:	Steel casting, hardened Rc 60 - 62
Tool:	Borazon grinding pin B 91	
Machining data:	Feed: Cutting depth:	6 m/min 0,003 mm

REMARKS:

By means of a stationary, water-cooled RAY spindle, which was mounted onto a machine table, a hardened guide rail had to be finish ground.

Surface accuracy: **N3.**
Requested evenness over a distance of 1'500 mm: **0,001 mm - 0,0015 mm.**
Requested cylindricity: **0,005 mm.**



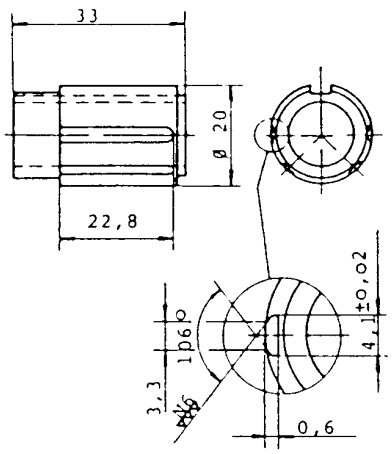


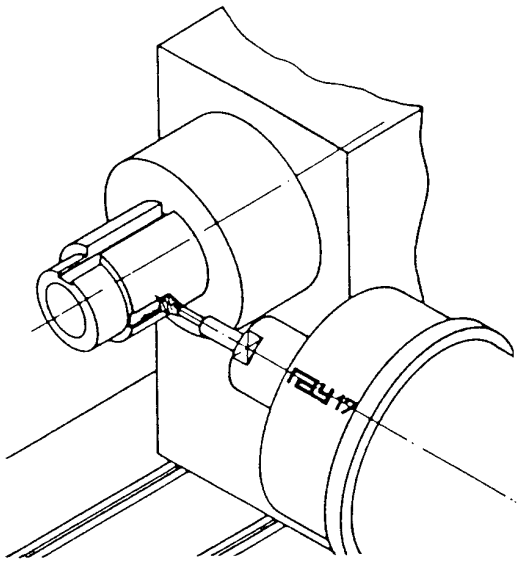
Cutting speed:	390 m/min	
RPM's of the head:	stationary	
RPM's of the spindle:	40'000	
Type of spindle:	Water-cooled frequency spindle + adapter	
Work piece: Slot plate	Material: Hardness:	PERUNAL 80 HB
Tool:	HM Carbide cutter	
Machining data:	Feed: Cutting depth:	3 m/min 2 mm

REMARKS:

Water-cooled RAY high frequency spindles, used on a milling machine for machining slots in aluminum.

Here your machine can mill these slots at a speed of 40'000 rpm for days, while the spindle of the machine is at standstill.





Cutting speed:	390 m/min	
RPM's of the head:	stationary	
RPM's of the spindle:	30'000	
Type of spindle:	Water-cooled frequency spindle	
Work piece: Lock cylinder	Material: Hardness:	Brass
Tool:	HM Carbide milling cutter	
Machining data:	Feed: Cutting depth:	770 mm/min 0,6 mm

REMARKS:

With a stationary, water-cooled RAY spindle and a single purpose machine, dovetail slots are being milled into a lock cylinder.

Machining time for 4 slots: **11 seconds**

5) Working studies HUB OSCILLATING APPARATUS

The RAY oscillating apparatus HUB has been developed for processes that require a continuous oscillating movement, which is not included in the machine tool or which cannot be made use of.

There is certainly little sense to carry out a stroke of 10 mm height at a stroke speed of 30 mm/sec. over a heavy machine tool table.

As the HUB is driven by a DC-motor and is controlled electronically, it is possible to program the stroke height, the stroke speed, the waiting time at reversing as well as the number of strokes.
The following working studies are to give you an idea of the possibilities of applications of the HUB.

We distinguish between:

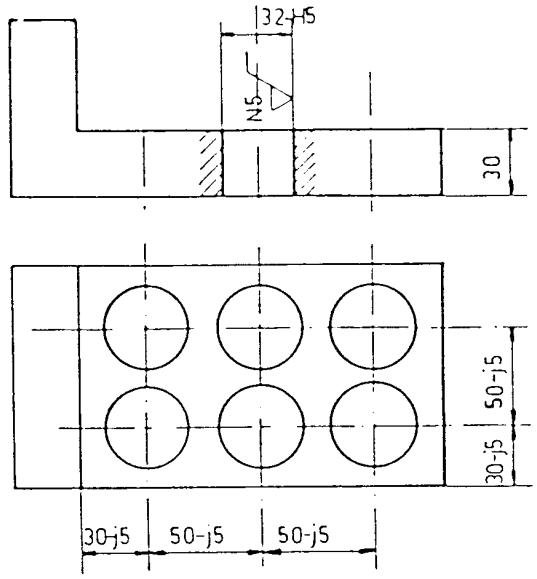
A. Internal Grinding

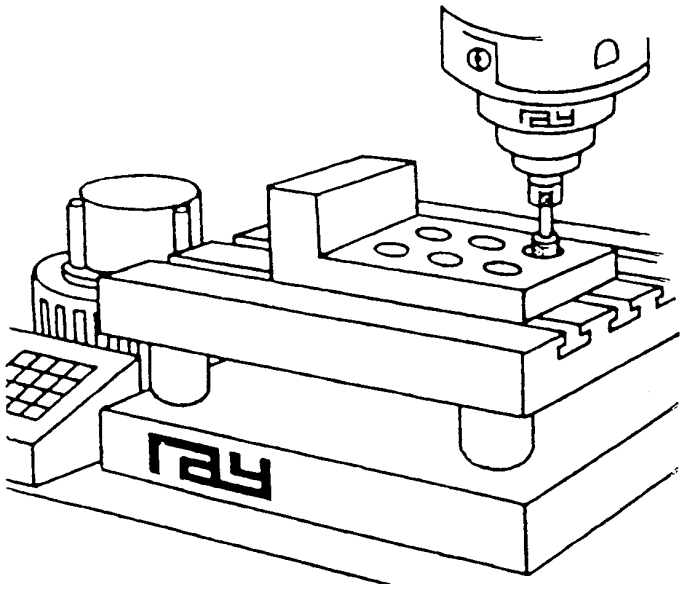
B. Cam Grinding + Profile Grinding

C. Slot Grinding

D. Slotting work for keyways

The height of the HUB is max. 200 mm. On smaller machines the spindle clearance of the milling machine is used to its limits. So as not to reduce the spindle clearance of the machine tool when using the HUB, RAY Ltd. have designed for their customers a special, **negative-angle-workingtable.**





REMARKS:

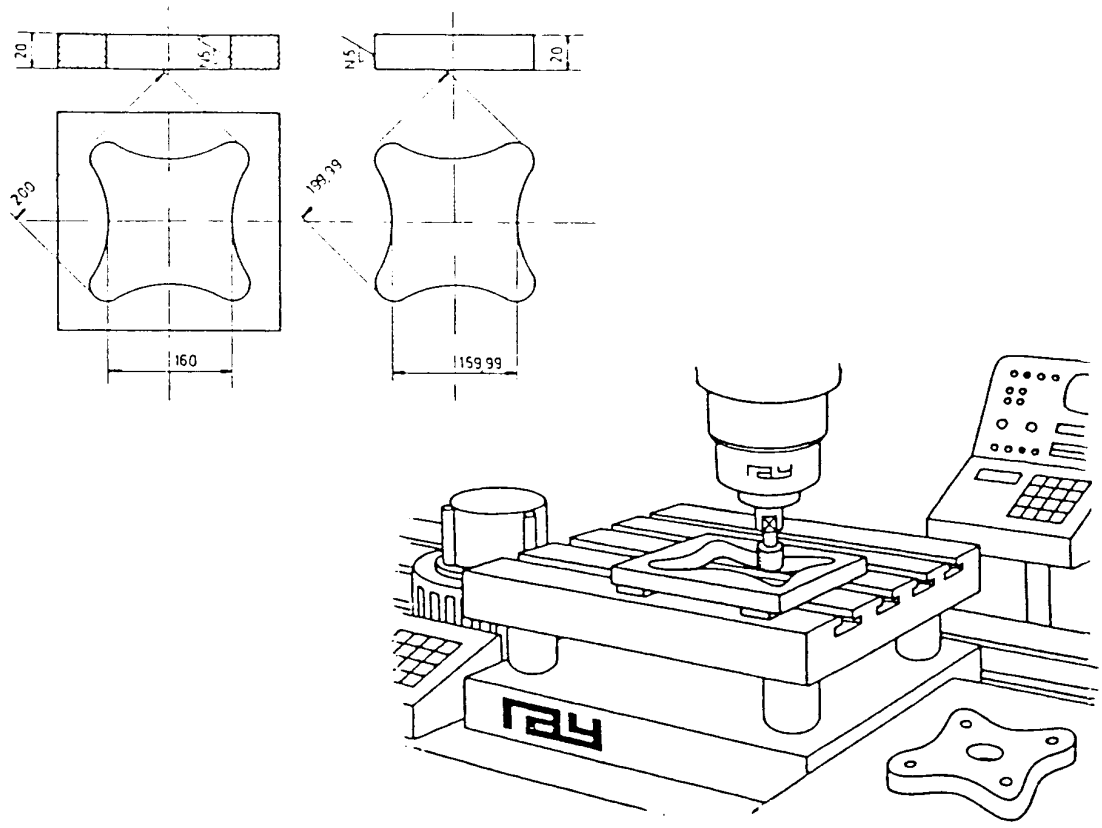
With the HUB the internal grinding with the KSK has been tremendously simplified, since the oscillating movement has been taken over by the HUB.

This is a great work saving element for the operator, who had to do it up to now manually. This apparatus is especially of great help for serial production, where the number of strokes can additionally be programmed. In our example it is not that easy to carry out this work on a cylindrical grinding machine, as the axis distance of the 6 bores to be ground, has to be taken into account.

With the HUB and the KSK these bores can be finish ground simultaneously, which would otherwise only be possible with a K-machine.

Working data:

Height of stroke = 30 mm	Speed of stroke	vv 80 mm/sec vvv 50 mm/sec
Number of strokes = 30	Grinding pin 25	vv 252 vvv B 76



REMARKS:

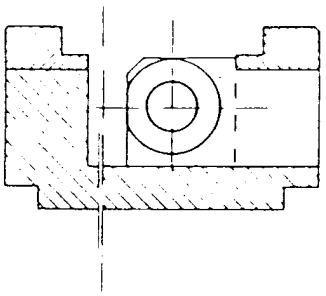
For the grinding of this stamping die the HUB is a MUST. In order to obtain a die clearance of 0,01 mm, a cylindricity of minimum 0,004 of the die, respectively of the die plate, is required. This, however, necessitates on the other hand that when finishing, the grinding wheel protrudes from the work piece, i.e. it will have to move over the entire grinding surface.

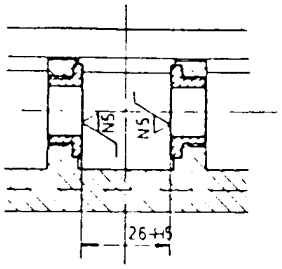
In our example a stroke of minimum 22 mm is necessary. Thereby we eliminate mistakes which may occur when the grinding wheel is not cylindrical. Furthermore the grinding wheel wears off evenly over the entire surface and we are also in a position to use a grinding pin which is smaller than the height of the work piece to be machined.

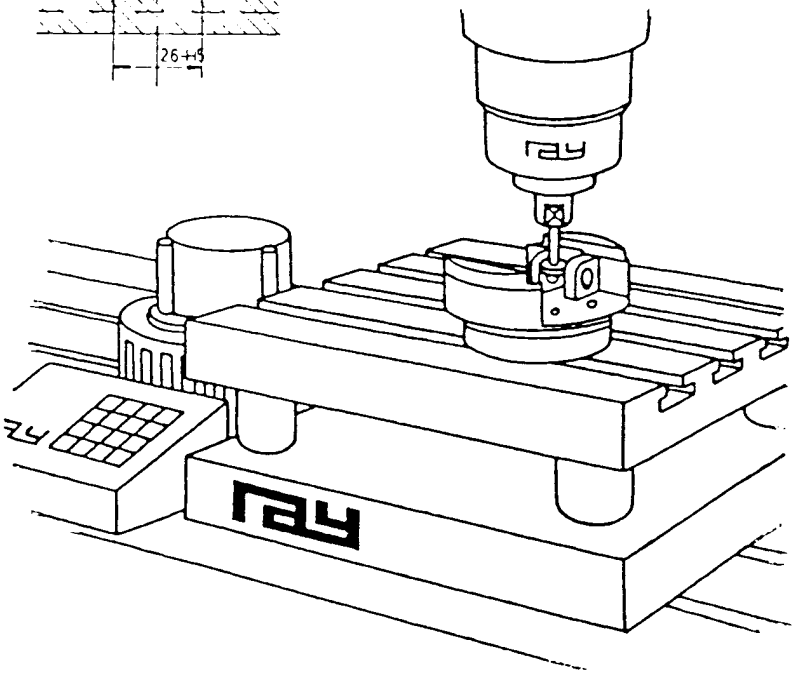
Such a small die clearance can only be obtained by the use of the HUB and a RAY grinding wheel.

Working data:

Stroke height =	22 mm+ the width of the layer of the grinding wheel.
Speed of stroke =	vv 80 mm/sec. vvv 50 mm/sec.







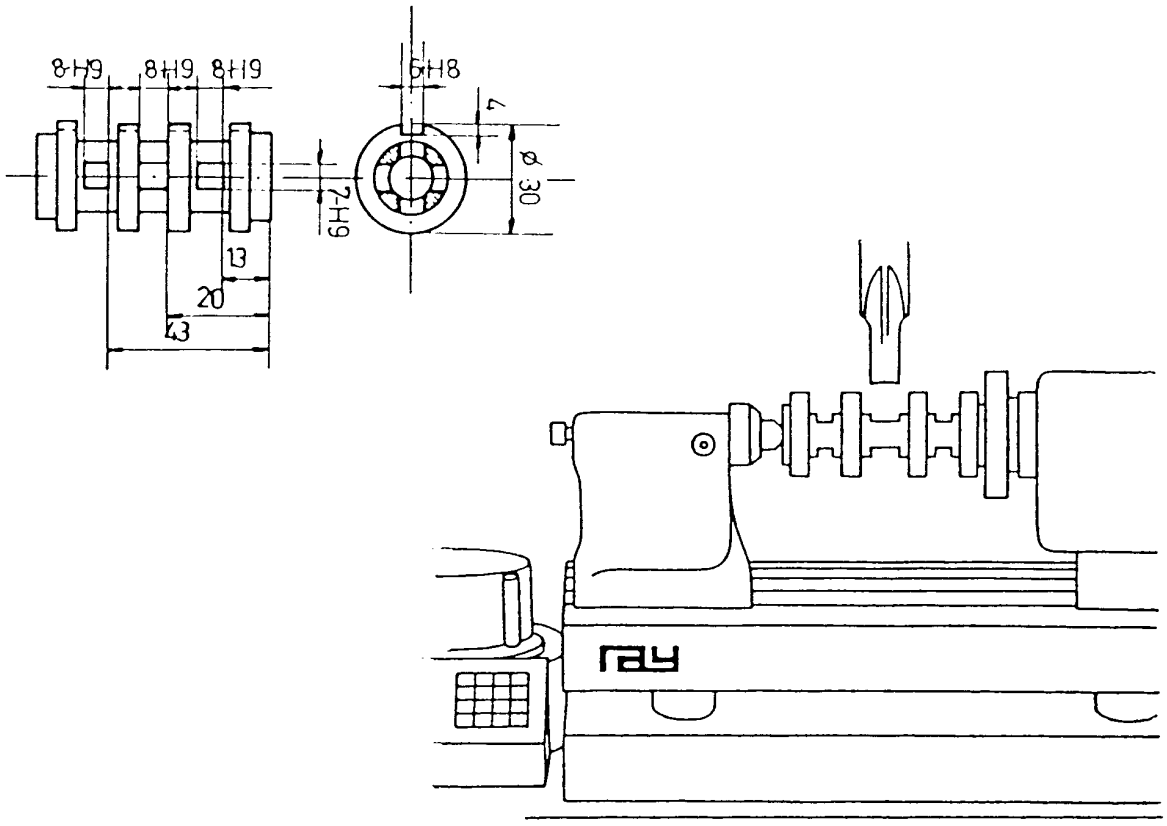
REMARKS:

In this working study we have to grind a slot 26H5. For technical reasons it is not possible to use a surface grinding machine or the KSK.

With the HUB, together with a RAY spindle and a grinding pin of approx. 15 or 22 mm diameter, this work can be carried out. Thanks to the adjustable stroke height on the HUB, the grinding pin touches the surface of the hardened steel bushing first on one width of the slot and with the X-axis of the milling machine the width of the slot 26H5 is exactly set. Thereafter the other side is ground.

Working data:

Stroke height =	30 mm
Stroke speed =	vv 80 mm/sec. vvv 40 mm/sec.



REMARKS :

In this study the oscillating apparatus is used for the slotting work of keyways.

The installation of a slotting attachment on the tool milling machine is very involved and blocks the milling machine. It is not possible to erode the slots, since a very high surface quality is required, all the more so as the eroding process would take up too much time.

Thanks to the possibility to adjust the stroke speed and stroke height on the HUB exactly to the work to be done, machining conditions can be obtained which are optimum as far as tolerance and surface quality are concerned.

Apart from the slotting work, it is also possible with the HUB to do milling on the same work piece and with the same chucking.

Working data:

Stroke height =	40 mm
Stroke speed =	40 mm/sec.

6) INSTRUCTIONS FOR SURFACE GRINDING

For surface grinding an adequate spindle or a surface grinding plate, fitting the instrument, is mounted.

For this operation you will have to consult the corresponding operating instructions. Only by following these instructions will it be possible for you to mount the spindle, resp. the plate properly and exactly. All surface grinding spindles are marked with a red circle on the clearly visible front collar, even when already mounted.

With the coordinate grinding heads which have been fitted for surface grinding work, only surface grinding operations may be executed.

For surface grinding RAY Ltd. have developed special grinding pins which correspond to the normal prolonging devices. Also here one clamps the cone directly into the spindle. These surface grinding pins are Borazon coated. The largest wheel diameter of approx. 25 mm should not be exceeded, as otherwise the bearings of the frequency spindle would be overstressed.

The grain of the surface grinding pins is 100 - 120 Mesh (B 151). Upon special request we can also supply finer or coarser coatings.

In order to obtain good results in surface grinding, please follow the instructions given below carefully.

1) Vertical head

The vertical head of the machine tool used has to b exactly at a right angle to the table. If the vertical head is not exactly aligned, you will have a difference in height in the various passes.

2) Setting

Before starting to work, you will have to find the highest point of the surface to be ground. From this point on you may start with the infeed.

3) Setting of the radius when machining bottoms of moulding plates

To obtain for instance a radius of 10 mm, you should select a grinding wheel not larger than 10 mm in Ø. With smaller grinding wheels you may vary the planetary movement of the coordinate grinding head in relation to the axis of the spindle (planetary infeed).

4) Recommended head speed for surfacing

The circle obtained by the surfacing wheel, together withthe planetary movement of the coordinate grindig head at standstill of the machine, corresponds to a bore in internal grinding. For this reason, the head speed may be taken from the corresponding table in chapter 0.

5) Selection of the advance feed

The advance feed depends on the slide feed, respectivelyon the planetary movement of the grinding wheel in relation to the axis of the spindle. The larger the planetary movement, the smaller the advance feed will have to be. In the case of a small planetary movement, you may work with an advance feed of 30 - 40 mm/min.

6) In-feed

When surfacing with a Borazon wheel of granulation B 151, you may feed up to maximum 0,04 mm.
With finer Borazon wheels the infeed should not exceed 0,01 to max. 0, 02 mm.

7) Cooling

Attention! Without cooling you cannot obtain optimum results in surfacing. The heat expansion of the grinding tools or the work piece must be eliminated by sufficient cooling. If the cooling is insufficient, the result will be defects in the evenness of the surface ground.

Here the use of an oil mist lubrication system would be very suitable.

You may, however, use any other kind of coolant.

8) Circumferential speed of the surface grinding wheels

The circumferential speeds of the Borazon coated surfacing wheels are identical with those for internal grinding. May we refer you to our leaflet.

LIST OF RAY BORAZON GRINDING PINS FOR SURFACING AVAILABLE EX STOCK

Order No.	Shaft	Grinding	Total length
1470	8,0 mm	14 mm	70 mm
1070	8,0 mm	10 mm	70 mm
670	6,0 mm	6 mm	70 mm

7) Instructions for cam grinding

In order to work correctly with the cam grinding head KUS, the following instructions must checked and followed:

a) Cam height

At present the maximum height is 25 mm to 30 mm. So far larger cams can at present not be machined with normal wheels.

b) Machine

The cam grinding head can only be used on a CNC-controlled machine, which can carry out radius corrections.

C) Material

Since with the cam grinding head it is only possible to work with Borazon or diamond wheels, work with this instrument is only feasible if the material has a hardness of 55 Rc.

d) Quality of the surface finish

Attaining good surface accuracy depends on the advance feed. Nevertheless this point will have to be discussed with the customer, since, as mentioned above, it is only possible to work with Borazon, respectively diamond pins.

e) Drawings

Should the representative not be in a position to decide himself whether a certain cam can be machined on the cam grinding head, he will have to submit a customer drawing to RAY Ltd. for final judgement.
In addition to their answer RAY Ltd. will also indicate the approximate working time for the machining of the cam in question.

f) Mounting

The cam grinding head KUS is mounted onto the machine by means of an intermediary flange. This intermediary flange is fastened tightly on one side of the vertical head of the machine and on the other side the cam grinding head is being screwed on.

The height of the intermediary flange has to be such that the spring for the reverse of the strokes for the oscillating movement has the proper preset tension. Each representative owns a drawing of this intermediary flange, please see addendum. On this sketch the customer will have to enter the measurements of his machine. On basis of these data the intermediary flange can be manufactured.
Please see to it that, if at all possible, the customer manufactures this flange himself. Should the customer be willing to make this intermediary flange himself, we are quite prepared to check his drawing, at no cost to the customer. The taper for the stroke drive is being made by RAY Ltd. and is included in the price. When placing your oder, please indicate the corresponding taper of the spindle of the machine tool.

g) Working with the cam grinding head

In the case of the cam grinding head we are working only with Borazon or diamond grinding wheels. If at all possible, these grinding wheels should be cylindrical. It is possible to order such wheels from the producer, already properly adjusted.

The adequate dimensions of the Borazon wheels are selected according to the following criteria:

1)
Height of the cam and height of the stroke give the optimum height of the Borazon wheel.

2)
The smallest radius of the cam determines the diameter of the wheel, whereby the largest diameter of 25 mm should not be substantially exceeded.

3)
The circumferential speeds of the wheels are the same as those which apply for internal grinding. May we refer you to the indications given in our leaflet No. 215.

4)
Grain size of the grinding wheels

for roughing B 151
for finishing B 64

5)
In-feed, depending on material and wheel, however

for roughing max. 0,15 mm
for finishing max.0,015 mm

6)
The advance feeds of the machines have to be selected according to wheel, material, etc., maximum, however, for roughing 40 mm/min. and 15 mm/min. for finishing.

7)

Before starting to work, the highest point of the cam has to be found. Based on this point, the work may be started.

h) Cooling

For cam grinding cooling is absolutely essential. An oil mist lubrication device is preferable to any other cooling system. Each cam grinding head is equipped with a fxing ring for mounting the oil mist lubrication system. This fixing ring serves to attach the spraying nozzles. It would be of advantage to work with two, or better even with three spraying nozzles.

i) Number of strokes

The number of strokes of the cam grinding head is controlled via the rotation of the spindle of the machine. If the spindle of the machine turns at 100 rpm's, this results in a stroke speed of 200 strokes / min.. The maximum stroke speed is
800 strokes / min. , since at higher speeds, the spring for the reverse of the stroke no longer works perfectly.

k) Filter

The cam grinding head is equipped with an air filter. This filter prevents grinding dust from entering through the cooling of the frequency spindle into the bearings. These filters have to be replaced periodically. It might be possible that soiled filters could be the reason for abnormal heating up of the spindle.