Machine tool spindles

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Machine tool spindles

- **requirements,**
- **rigidity,**
- **examples of mounting.**

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Machine tool spindles

- The spindle must guarantee a workpiece (lathes) or tools (milling machines, drills, grinders) precise rotary motion.
- The spindle is located in headstock.
- The spindle is usually mounted in two radial and one axial bearing.
- The end for clamping a tool or workpiece is called a front end. Its end is normalized and is usually provided with a tapered bore (1:20 small, 1:10 big).
- Bearing closer to the front end has a decisive impact on the accuracy of rotation.

Machine tool spindles - requirements

- Running accuracy - axial and radial runout.
- Perfect guidance - spindle must not change the position if the load changes.
- Option to minimize backlash.
- Heat losses in mounting must be minimized.
- Minimum passive resistances.
- Maximum rigidity.

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Machine tool spindles – What affects the stiffness

- Distance of bearings - has to be found the optimal.

- Selection of structural material. The main characteristic of the material is modulus of elasticity E. Spindles made from steel satisfy the requirements of high static stiffness. High-speed spindles are made from composite materials (graphite-epoxy). These spindles are lighter and does not need such a large cross-section.

Machine tool spindles – What affects the stiffness

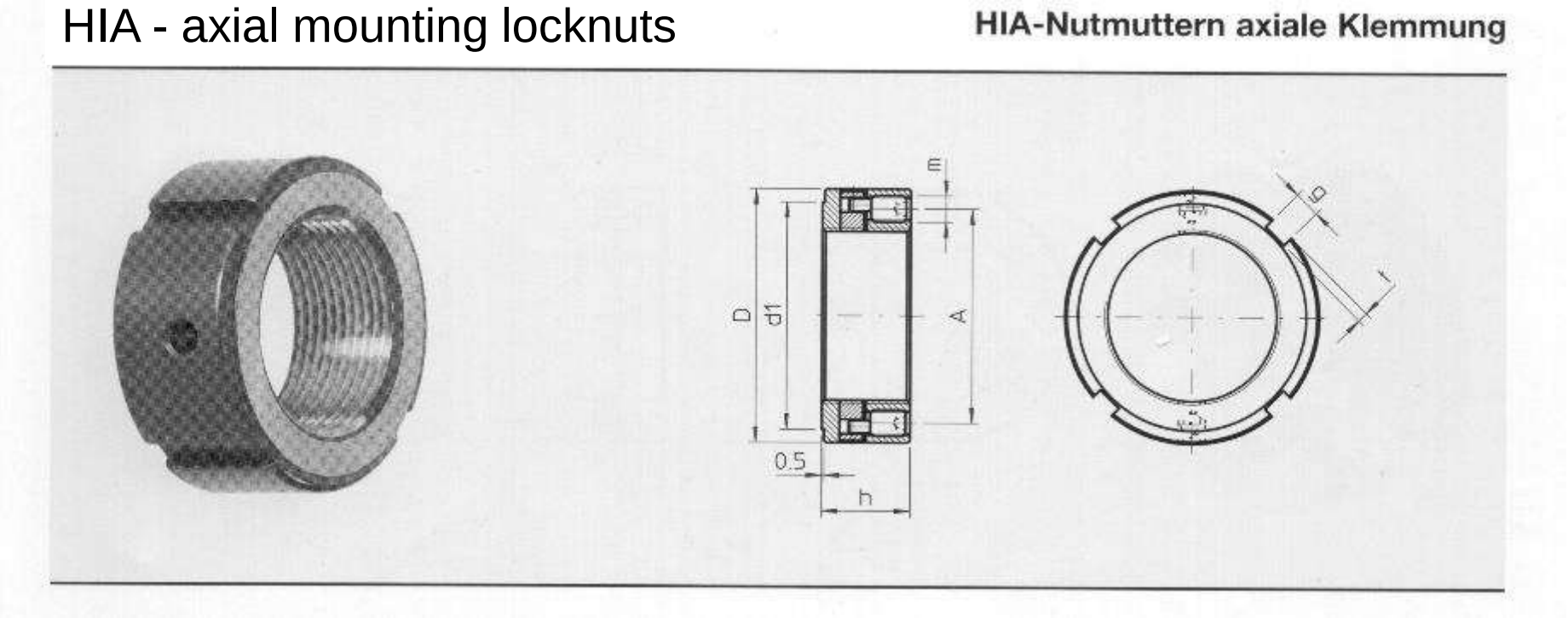
- Shape of the diameters of spindle. The shape of the spindle should be as simple as possible. The number of graduated diameters, both external and internal, shall be minimum. Determined only by diameters of bearings.

- Support rigidity, i.e. the smallest flexibility, especially the front bearing. We will achieve this by increase geometric precision.

- The smallest overhang the front end of the spindle.

Machine tool spindles – examples of mounting

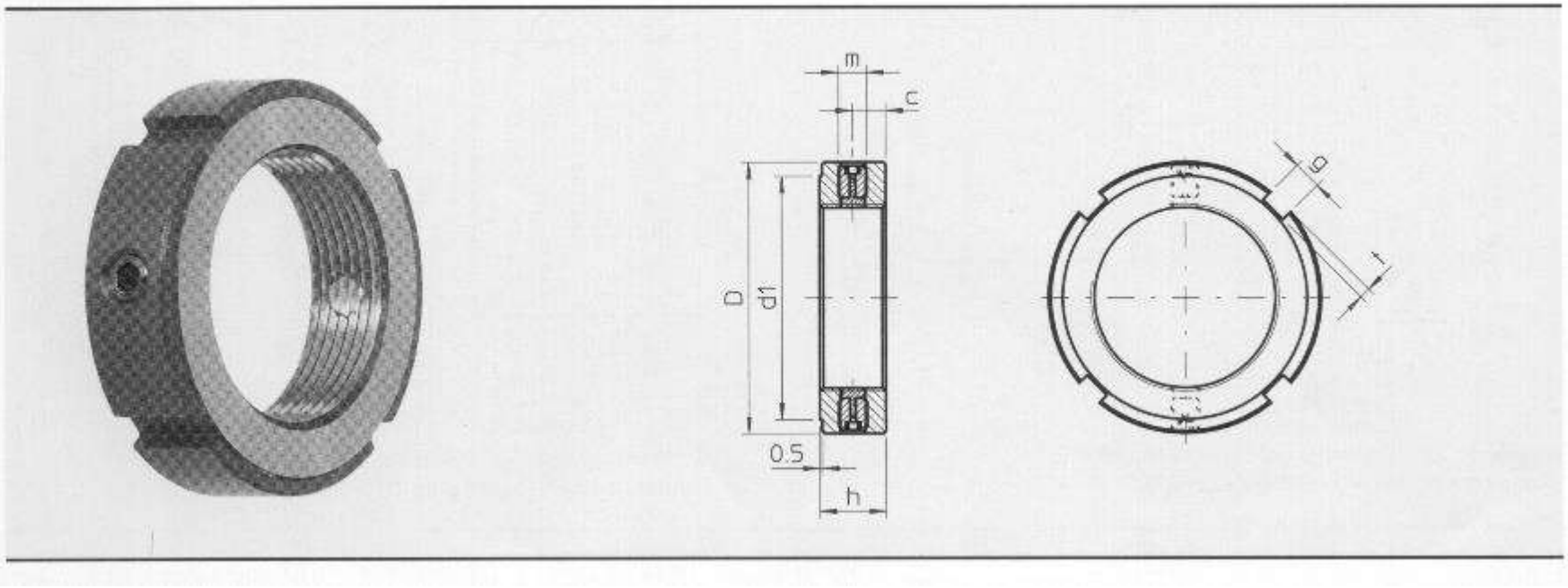
HIA - axial mounting locknuts



Machine tool spindles – examples of mounting

HIR-Nutmuttern radiale Klemmung

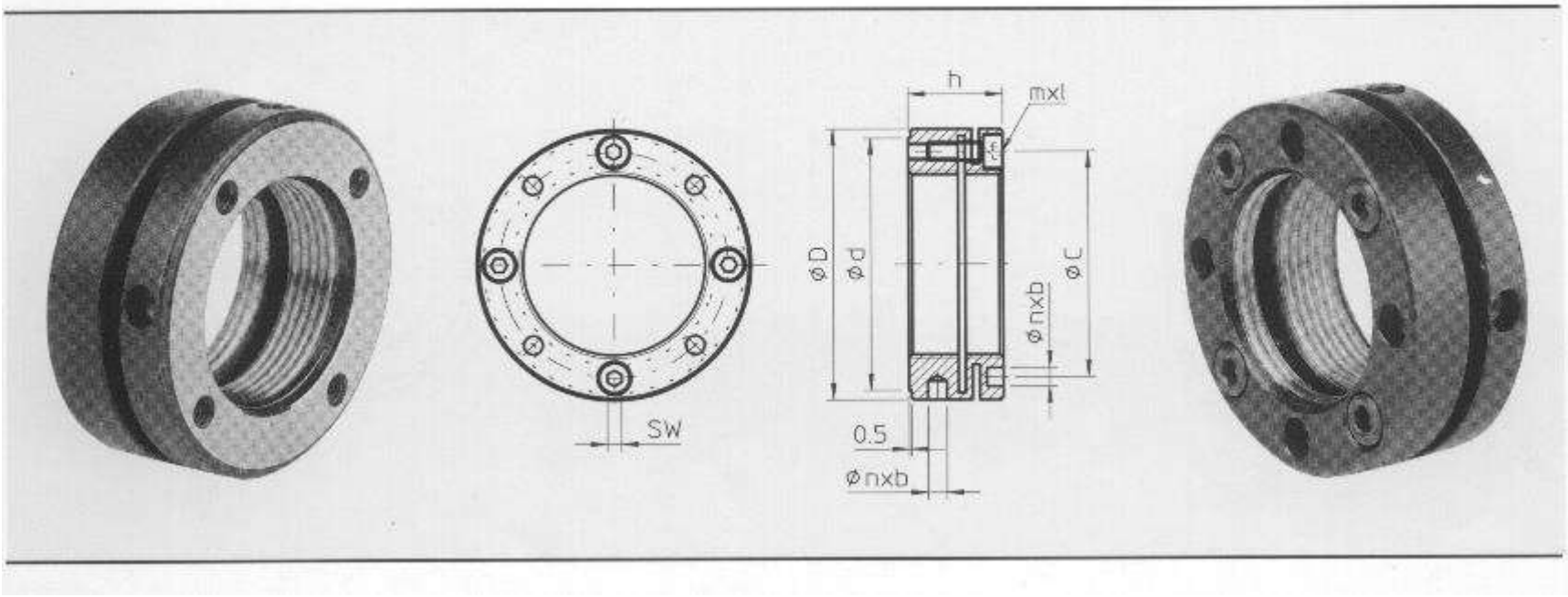
HIR - radial mounting locknuts



Machine tool spindles – examples of mounting

Nutmuttern mit Gewindeklemmung

Locknuts with clamp mounting



Machine tool spindles – examples of mounting

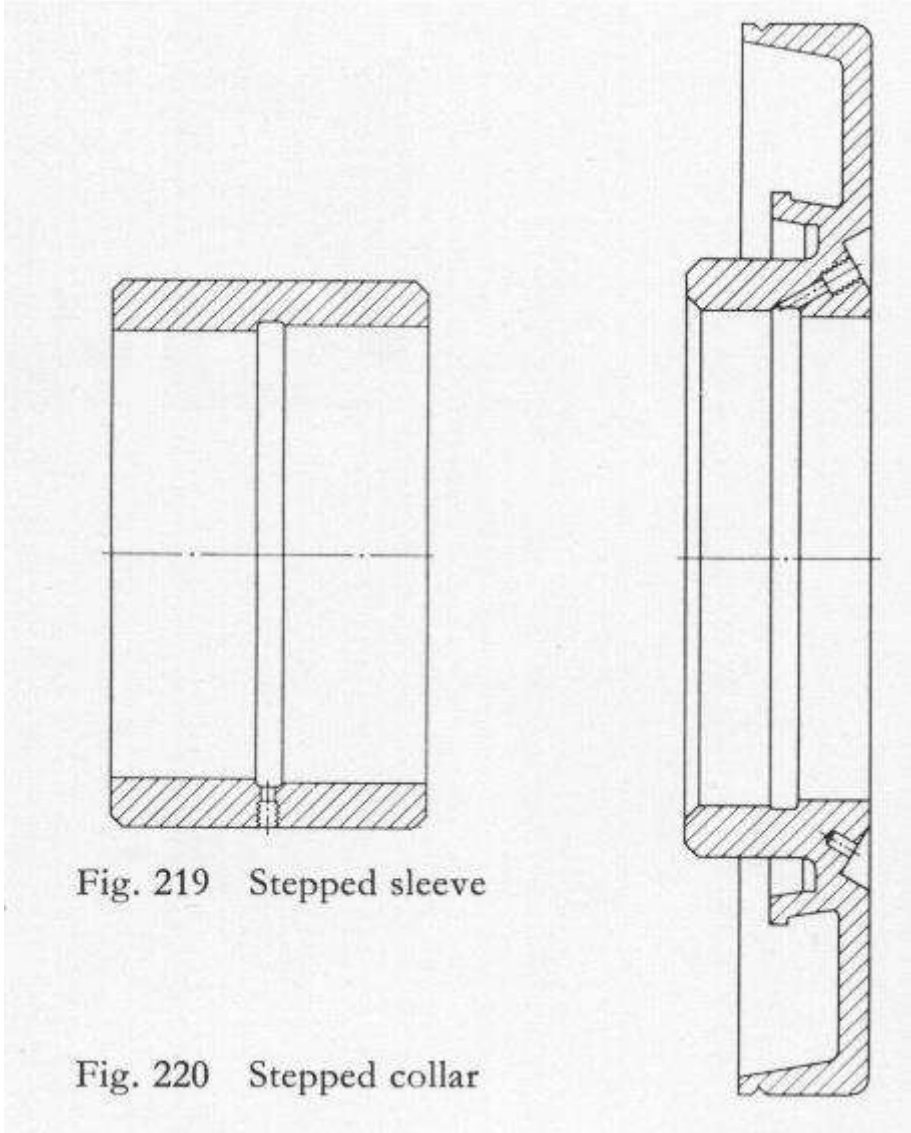
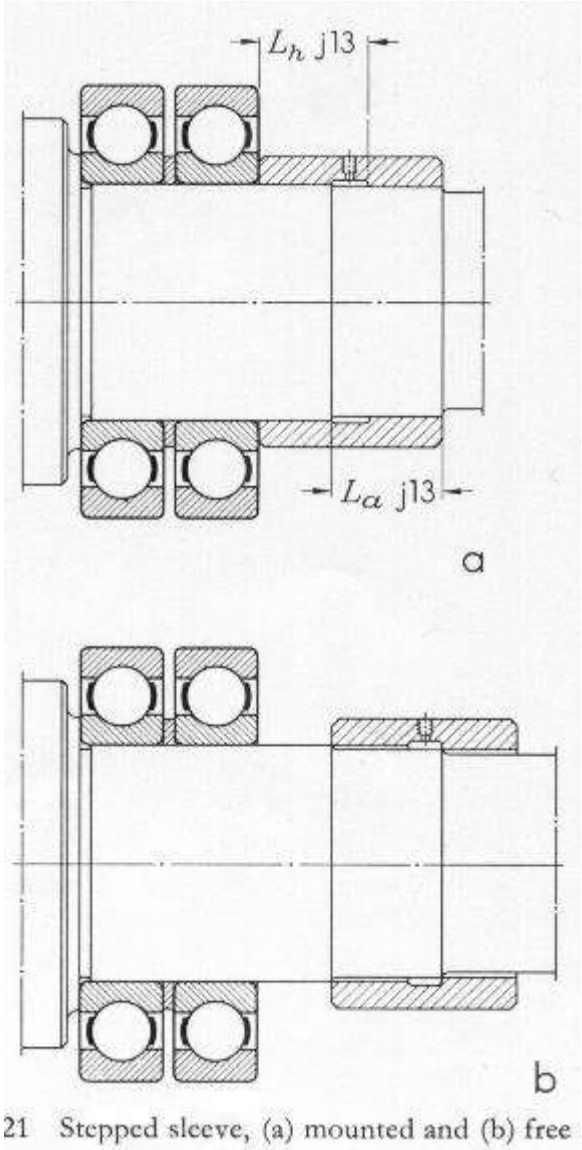


Fig. 219 Stepped sleeve

Fig. 220 Stepped collar



21 Stepped sleeve, (a) mounted and (b) free

Machine tool spindles – examples of mounting

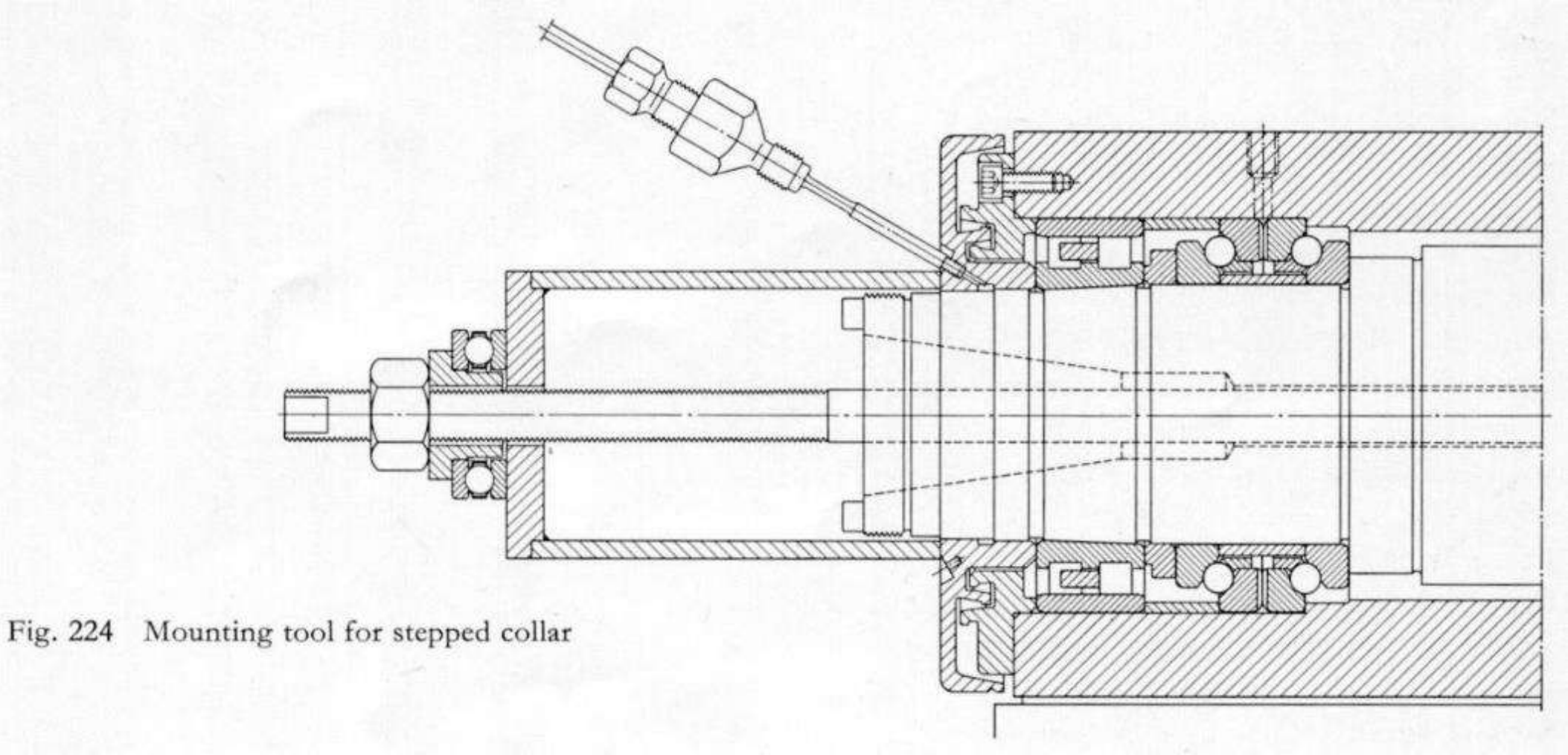


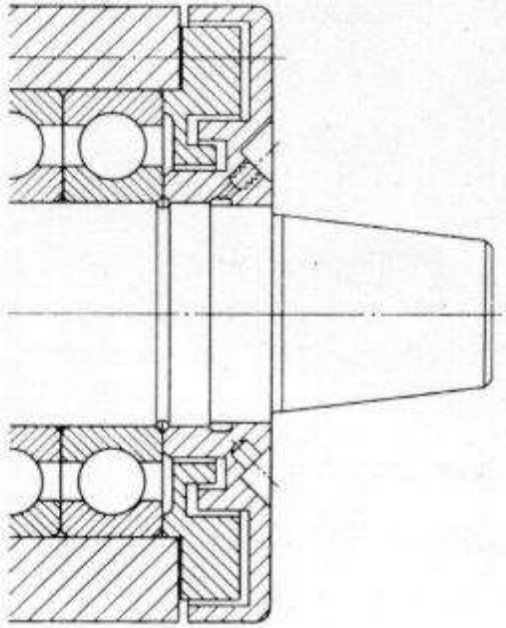
Fig. 224 Mounting tool for stepped collar

Machine tool spindles – examples of mounting

Grease
Oil mist

Labyrinth seals

This type of seal is frictionless and suitable for high speed spindles. The sealing collar should be located on the shaft and dynamically balanced.

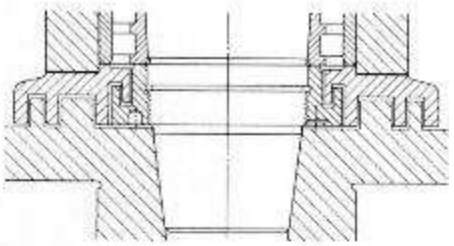


Machine tool spindles – examples of mounting

Grease

Labyrinth seals

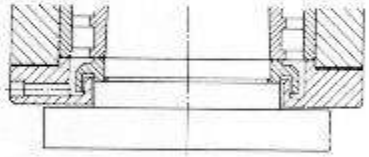
This type of seal is used where conditions are onerous and where it is essential to prevent the ingress of foreign matter as with vertical spindles on face grinding machines, for example. The main task of the inner labyrinths of the seal is to retain grease in the bearing housing. The external labyrinths can be incorporated in the grinding wheel flange or in the chuck to save space.



Oil

Labyrinths with oil flingers

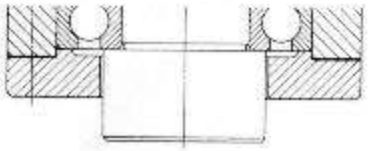
This type of seal incorporates an oil flinger to throw off the oil which has passed through the bearing. The oil is collected in the housing and led away.



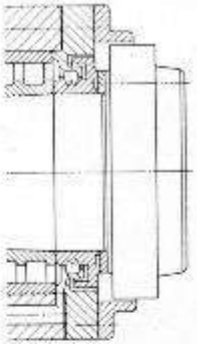
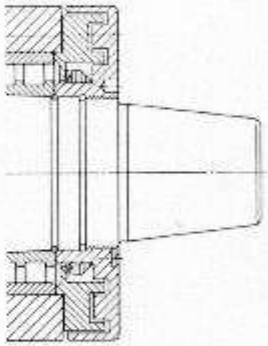
Grease

Gap seals

This type of seal is generally used on smaller sizes of drilling spindle.



Machine tool spindles – examples of mounting

Oil, small quantities	*Labyrinth seals incorporating oil drainage grooves* This type of seal is suitable for most types of spindle. It can be reinforced with an external flinger ring or collar if the spindle is exposed to swarf or coolant.	
Grease	*Reinforced labyrinth seals* Under difficult working conditions the labyrinth seal should be reinforced with a rubbing sealing collar of oil resistant material. The collar must only be in light contact with the spindle so that friction is small. This seal is suitable for slow and medium speed spindles where coolant or cutting fluid may spill over the housings.	
Grease Oil mist	*Gap seals* This type of seal is used for simple spindle arrangements where conditions are favourable, there being no hazard from swarf or coolant. Sealing against the ingress of foreign matter can be improved by using an external flinger.	

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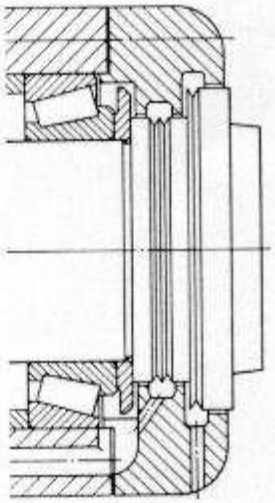
Machine tool spindles – examples of mounting

Liberal
oil circulation

Gap seals with oil flinger

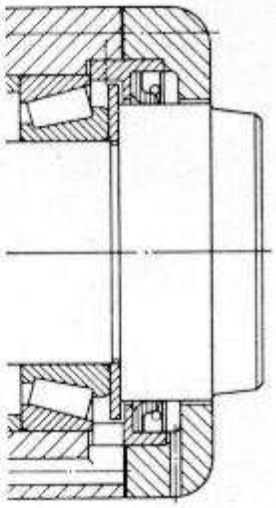
This type of seal is suitable when, because of the high speeds involved, the bearings have to be cooled by a liberal flow of oil. It has good sealing against the ingress of foreign matter and is used with an internal oil flinger; a drainage groove returns escaped oil. When coolant is used during machining the seal should be supplemented with an exterior flinger ring or collar.



Oil
Grease

Rubbing seals

This type of seal is used where cutting fluid spills over the spindle nose as with automatic lathes, for example. The sealing collar, which is shielded by a swarf guard, is mounted so that it gives maximum protection to the bearing. The spindle speed must not exceed the permissible peripheral speed for this type of seal.



Machine tool spindles – examples of mounting

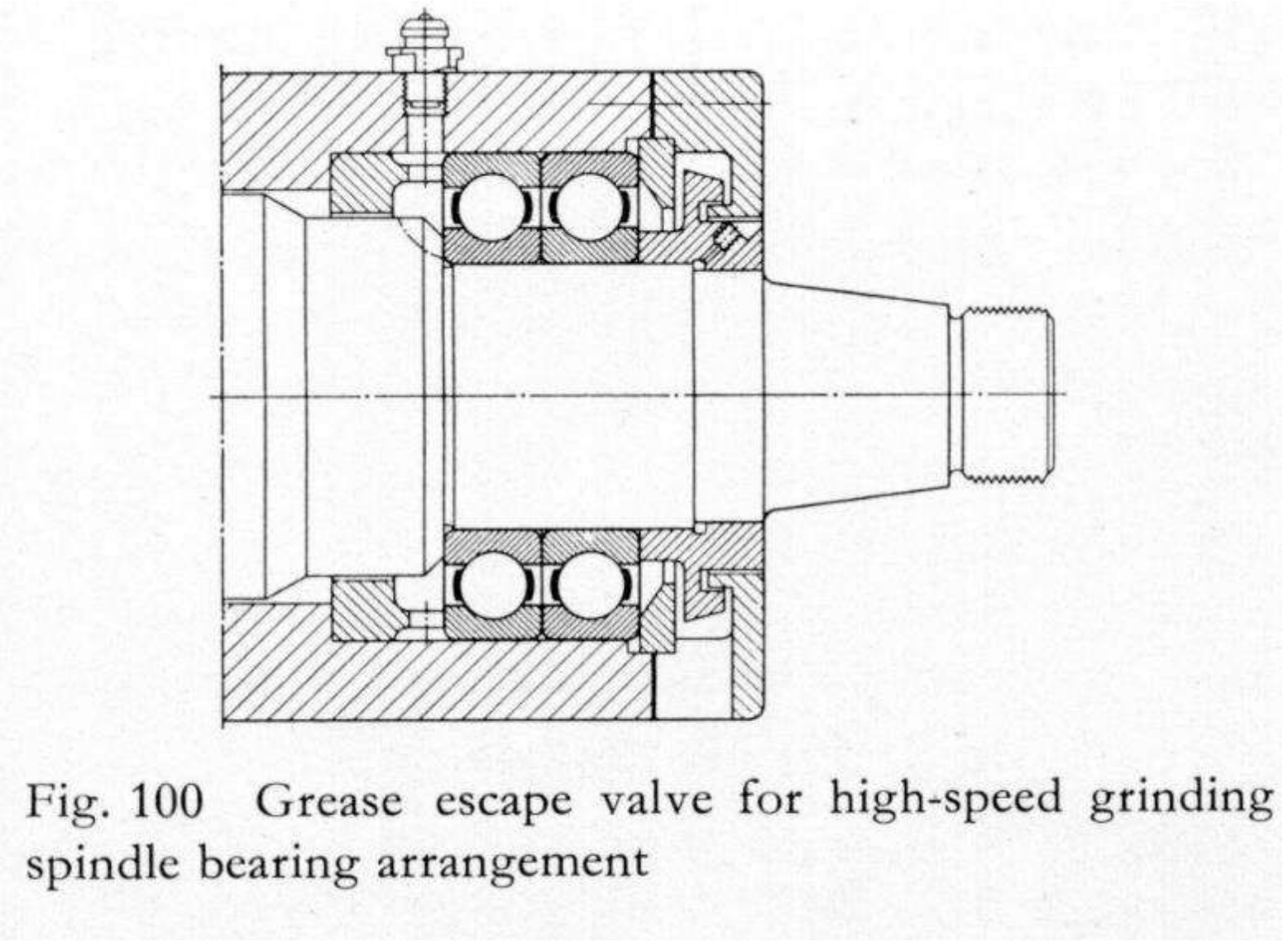


Fig. 100 Grease escape valve for high-speed grinding spindle bearing arrangement

Machine tool spindles – examples of mounting

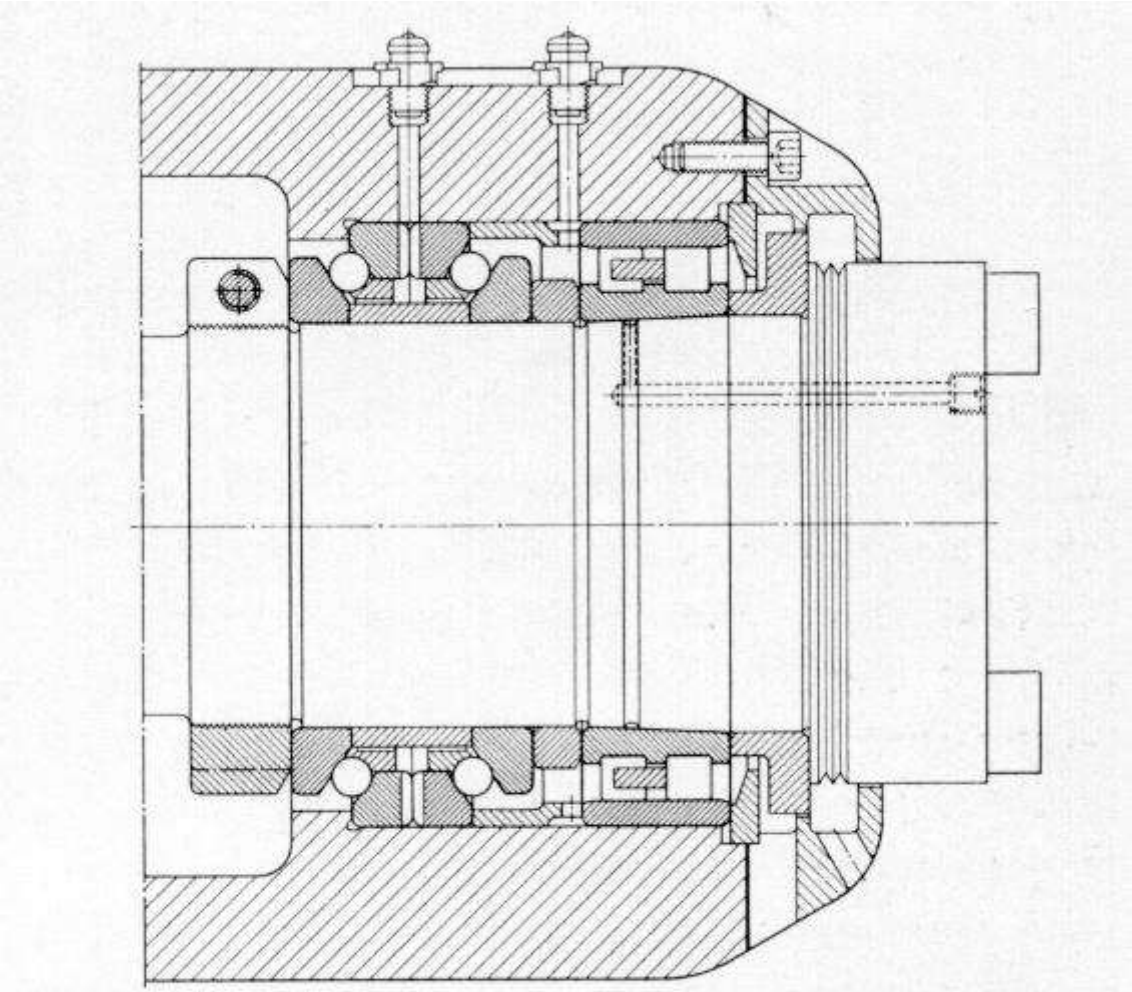


Fig. 101 Grease escape valve for lathe or milling machine spindle

Machine tool spindles – examples of mounting

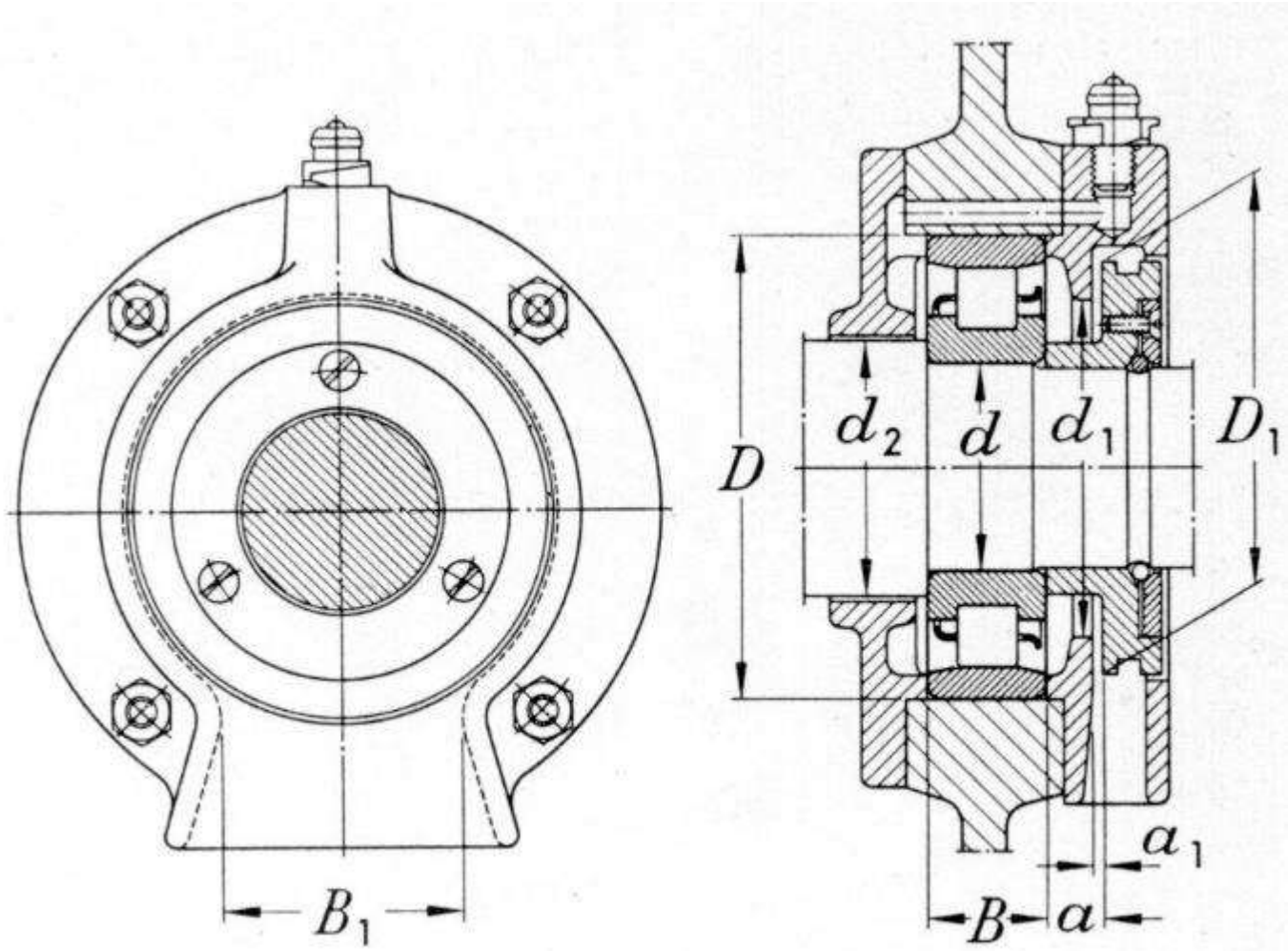


Fig. 102 Principal dimensions of grease escape valve

Machine tool spindles – examples of mounting

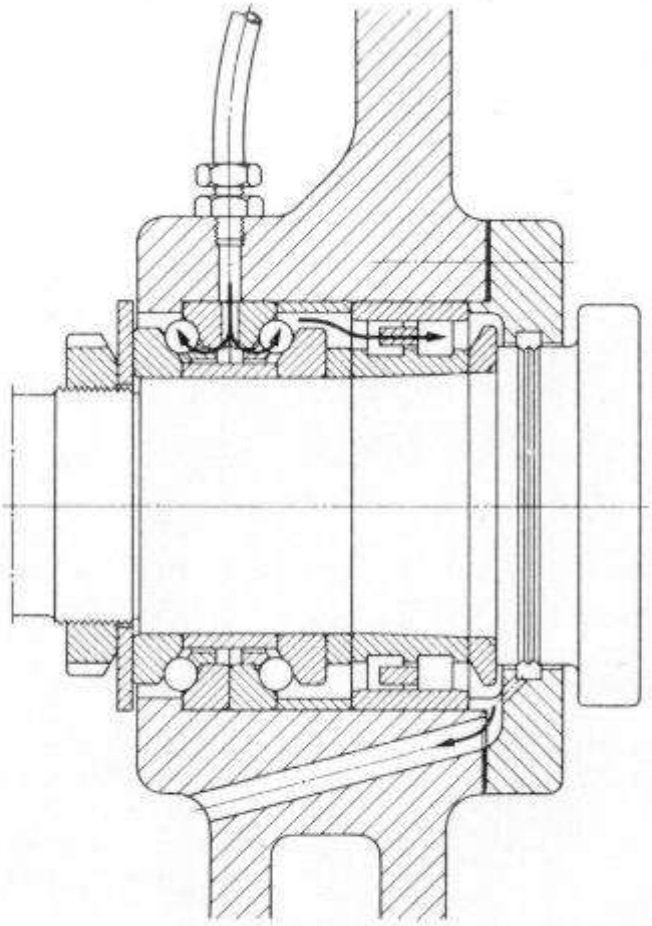


Fig. 82 Circulating oil system for a spindle bearing arrangement incorporating one angular contact thrust ball bearing and one double row cylindrical roller bearing

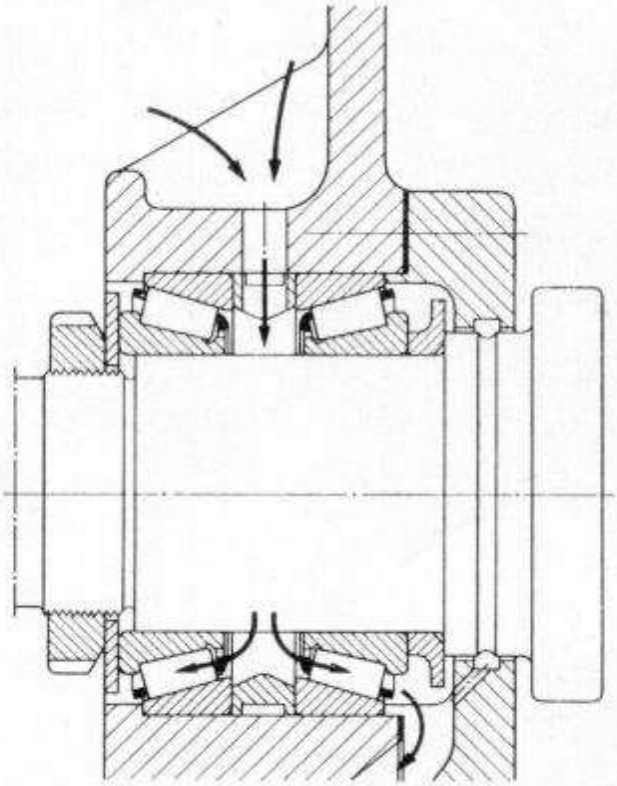


Fig. 83 Circulating oil system for a spindle bearing arrangement incorporating two taper roller bearings

Machine tool spindles – examples of mounting

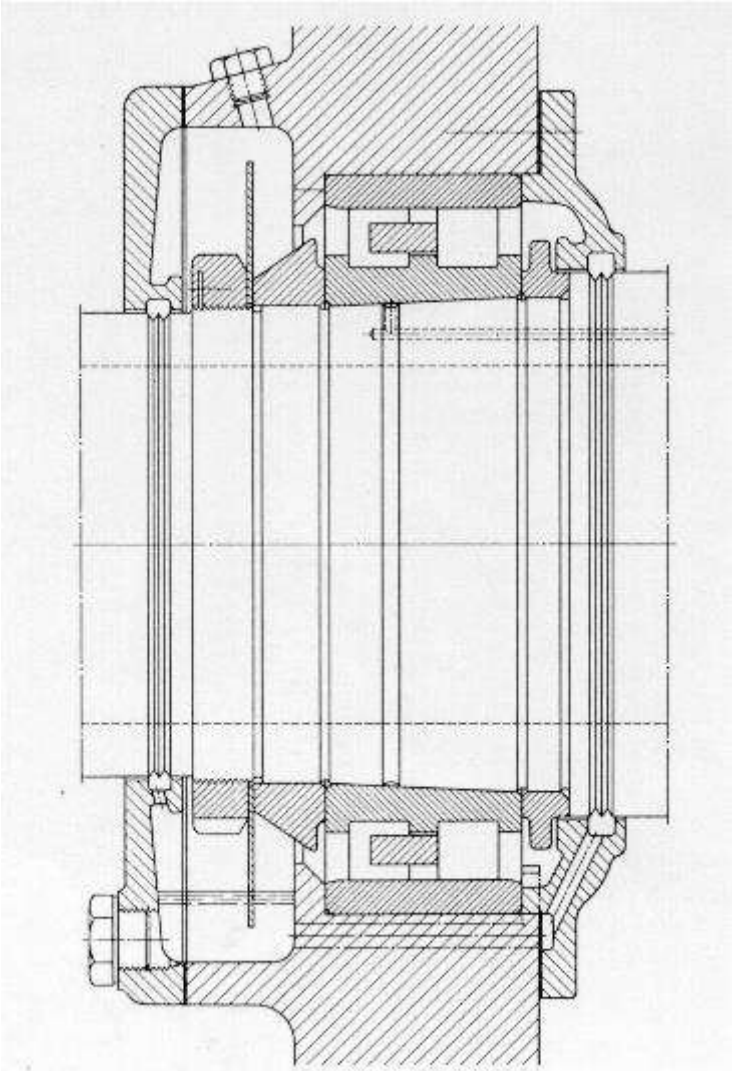


Fig. 81 Spindle bearing arrangement having oil bath lubrication