16 Honing

Honing is the finest grinding method with bound abrasive grain and longitudinally oriented bonded abrasive segments (honing stones).

Depending on the purpose and workpiece dimensions, the honing tool (Figure 16.1) is equipped with between 2 and 6 honing stones.

The honing tool simultaneously carries out a rotary motion and a stroke motion, which is generated by the honing machine (Figure 16.2).

Figure 16.1
Honing tool equipped with 6 honing stones
(*photo by Gehring*, *Ostfildern*)

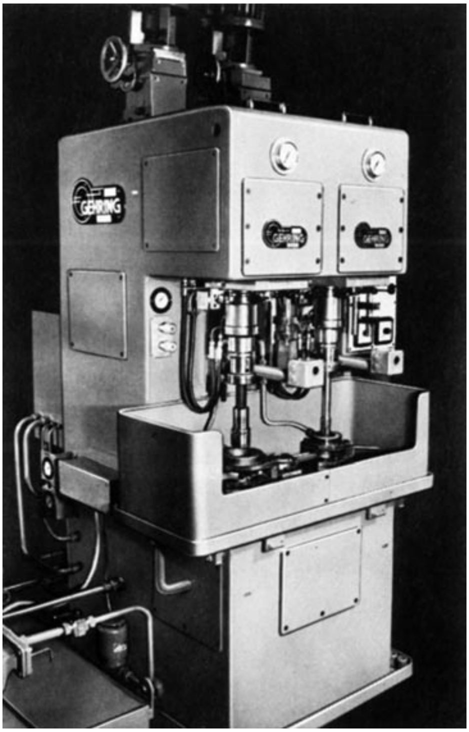

Figure 16.2
Honing machine with 2 spindles working autonomously
(*photo by Gehring*, *Ostfildern*)

During honing, the tool or the workpiece, each one element, should have more than one degree of freedom in order to machine a hole coaxially.

The portable element is aligned according to the clamped part. For this reason, we differentiate between two different methods of honing:

1. Workpiece is fixed.
   With a fixed workpiece, the honing tool is suspended on a pendulum bar and is movable (Figure 16.3a or b).
2. Workpiece is mounted so that it is floating or cardanic.
   If the workpiece is movable, the honing tool is fixed on a rigid driving rod (Figure 16.3c).

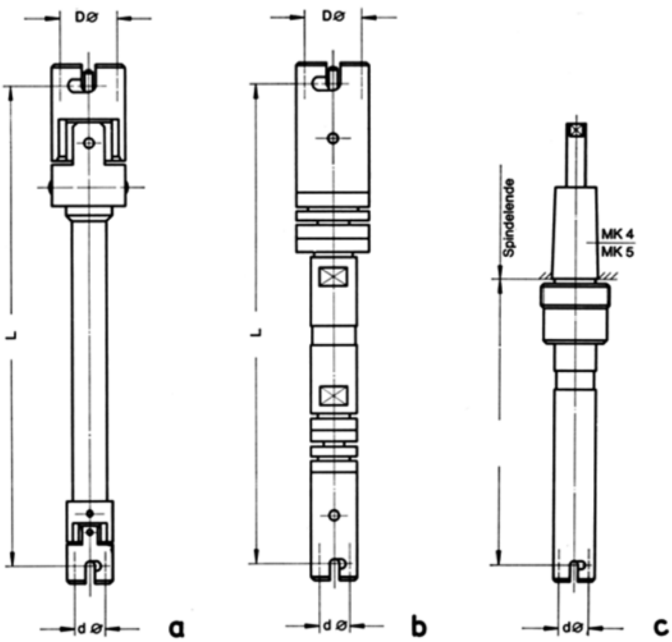

Figure 16.3
Driving rods for honing tools include a) double-joined joint rod with fixed stopper limit, b) double-joined pendulum rod with ball-and-socket joints and adjustable deflection limit, c) rigid driving rod, *D* connecting diameter for driving head, *d* connecting diameter for honing tool, *L* ordering length

During honing, material is removed by squeezing the honing stones into the hole that is being machined.

An expanding mechanism for the honing tool (Figure 16.4) allows the honing bars to be pressed hydraulically or mechanically to the surface to be machined through the honing motion.

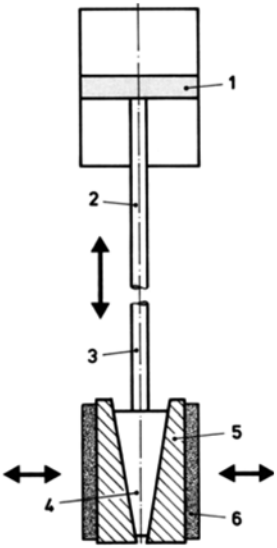

Figure 16.4
Design principle of a hydraulic feeding attachment
1 Feeding piston,
2 Piston rod,
3 Feeding bar,
4 Expansion cone,
5 Stone holder,
6 Honing stone

Operating mechanism of the expansion attachment:

At the beginning of the honing operation, the honing tool travels into the hole. After this occurs, oil flowing from the top affects feeding piston 1. The developing pressure causes piston rod 2 to move downward onto feeding bar 3. The expansion cones 4 and 5 transform the axial motion in a radial motion according to their angle of inclination. When they do this, they expand the honing stones against the hole wall. If the honing procedure has ended, the feeding piston returns over a limited path. The honing stones are pulled back by tension springs. The honing operation concludes with moving the spindle out of the workpiece.

The specific contact pressure of the honing stones depends on the selection of the honing stone. The order of magnitude of the contact pressure values is shown below.

Diamond honing bars	300–600 N/cm^2
Cubic crystalline boron nitride bars	200–350 N/cm^2
Ceramically bonded honing bars	30–200 N/cm^2

The small chips formed during honing are flushed away immediately with the coolant (honing oil) at once.

The honed surface has the highest possible accuracy to form and size. It has fine crossing traces (grooves).

Honing stone dimensions

For cylindrical through holes, the honing stone length should be 2/3 of the hole length (Figure 16.5).

$$L = \frac{3}{2} \cdot l$$

L in mm honing stone length
l in mm hole length

For overrun, select approx. 1/3 of the honing stone length L

$$U = \frac{1}{3} \cdot L$$

U in mm overrun
L in mm honing stone length

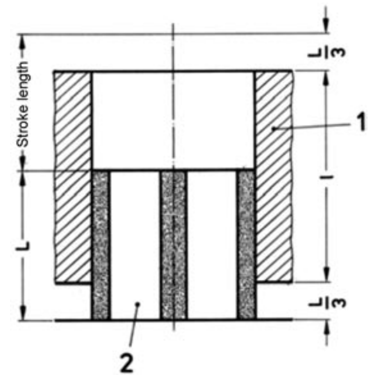

Figure 16.5
Principle of honing through holes
1 workpiece with through hole, 2 honing tool

Stroke length H results from tool length and overrun.

$$H \cong 0{,}8 \cdot L$$

H in mm stroke length
L in mm honing tool length

Due to the required overrun of the honing stone, blind holes (Figure 16.6) should be designed with an undercut.

Since even in honing of blind holes the overrun should amount to approx. 1/3 of the honing stone length, the honing stone length is consequently:

$$L = 3 \cdot U$$

L in mm honing stone length
U in mm overrun

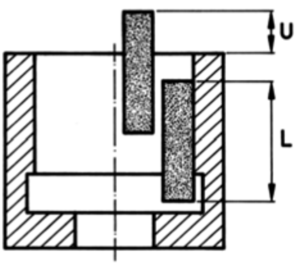

Figure 16.6
Principle of honing blind holes

A honing tool for blind holes, with parallel rod adjustment, for the workpiece shown in Figure 16.6, is demonstrated in Figure 16.7.

During honing, the cutting speed is composed of two components due to simultaneous rotary- and stroke motions.

$$v = \sqrt{v_u^2 + v_a^2}$$

v in m/min resultant cutting speed
v_u in m/min peripheral speed
v_a in m/min axial speed

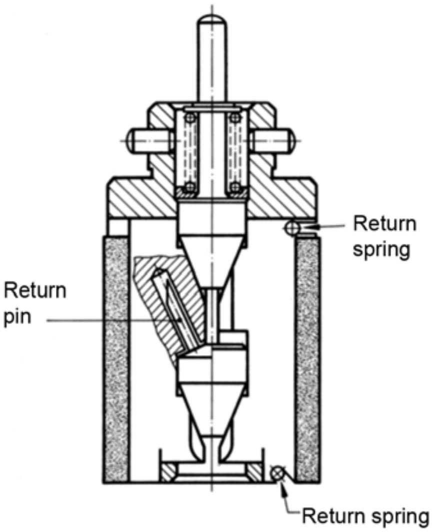

Figure 16.7
Honing tool for blind holes for the workpiece shown in Figure 16.6

Mean values for v_u and v_a are:

v_u = 10–15 m/min

v_a = 15–20 m/min

Additional reference values are collected in Table 16.1.

Table. 16.1 Reference values for honing

Material	Peripheral speed v_u in m/min	Axial speed v_a in m/min
Steel, unhardened	22	12
Steel, hardened	22	9
Alloyed steels	25	12
Grey cast iron	28	12
Brass and bronze	26	14
Aluminium	24	9

The values in the table are applicable for pre-honing. For finish-honing, these values may be increased by 10 %.

Honing tool denomination
The honing tool name is composed of several code numbers. This short identifier specifies workpiece size and -structure.

Denomination of a honing tool (standard series) for 14 mm diameter, four-part, with 3 cones, 60 mm honing stone length and 200 mm connecting length (bayonet middle to bottom edge of the honing tool) of 200 mm is given in Figure 16.8.

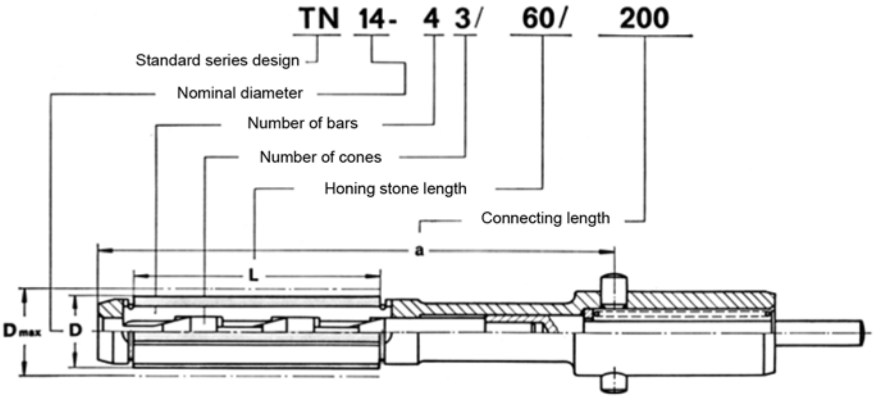

Figure 16.8
Names of honing tools

16.1 Application of the honing procedure

Honing as a finishing operation can be used for practically all materials, such as grey cast iron, hardened and unhardened steels, hard metal, non-ferrous metals and aluminium.

Honing is applied as a finishing operation after drilling or grinding of cylinder sliding surfaces, housing holes, holes in toothed gears and connecting rods, tubes and bushings (Figure 16.9).

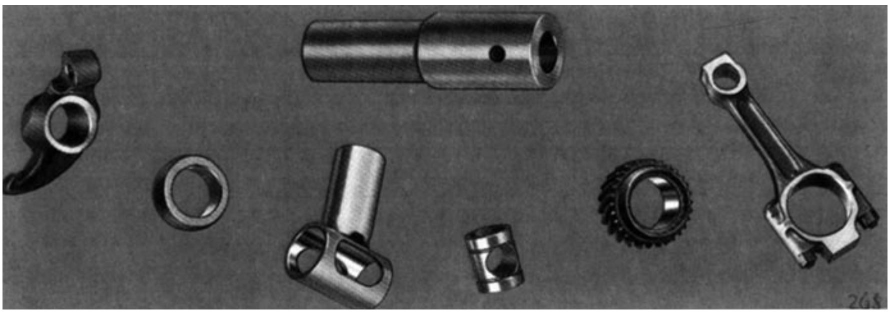

Figure 16.9
Honed holes on different workpieces

16.2 Achievable accuracies and allowances

Table. 16.2

Workpiece length in mm	at 25	At 300
Hole diameter in mm	at 20	80 to 100
Allowance, related to diameter, in mm	0,03–0,04	0,05–0,10
Accuracy to size	IT 4 to IT 5	IT 4 to IT 5
Roughness in µm	0,05–0,2	0,05–0,2