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Product note

Guidelines for profile broaching (wobbling)

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A word on copyright

General

Application guidelines

Special tool holders have been developed to enable automated profile broaching.

For non-live tool holders, the workpiece drives the rotation of the mounting including tool/broaching mandrel.

For stationary workpieces, the live tool holder must be rotating.

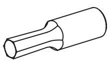
The direction of rotation can be either clockwise or counterclockwise in both cases. With these tool holders, it is economically and technically feasible to complete turning operations and add profiles to workpieces in a single setup.

Suitable external and internal geometries can be produced using the profile broaching manufacturing process.

Selection options

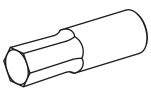
Broaching mandrels

Broaching mandrel with 8mm shank diameter

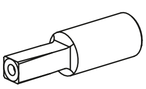


Hexagon AF3-6mm
for machining steel DIN1651 (9S20k)
and non-ferrous metals

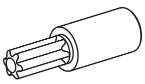
Broaching mandrel with 12mm shank diameter



Hexagon AF2-14mm
for machining steel DIN1651 (9S20k)
and AF2-17mm for non-ferrous metals



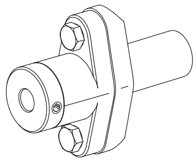
Square AF3-12mm
for machining steel DIN1651 (9S20k)
and non-ferrous metals

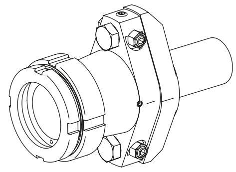


Torx 15-55
for machining steel DIN1651 (9S20k)
Torx 15-70
for non-ferrous metals

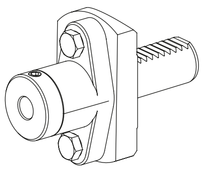
Tool holders

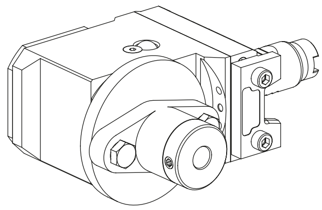
Use with 3/4“ and 1“ shanks



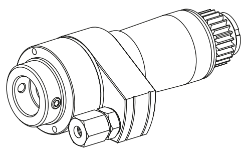


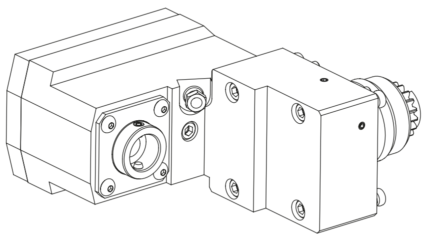
Use with VDI, with various fastenings





Use with 36mm shank and compact shank



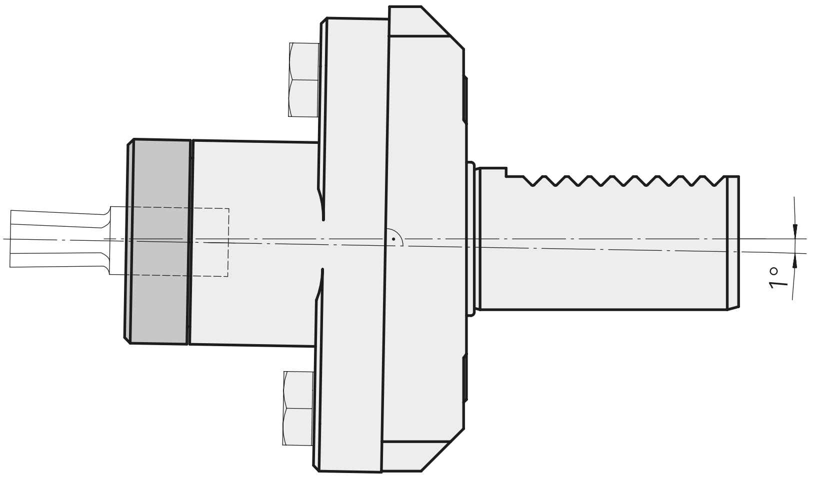


You can find additional broaching holders/broaching units on the Internet at ixshop.ixworld.com
Matching broaching mandrels can be found there in the Accessories for Tool Holders (Cutting Tools) section

General

Functional description

In profile broaching, both the workpiece and the tool rotate synchronously. The axis of rotation of the tool typically differs by 1° from the axis of rotation of the workpiece.



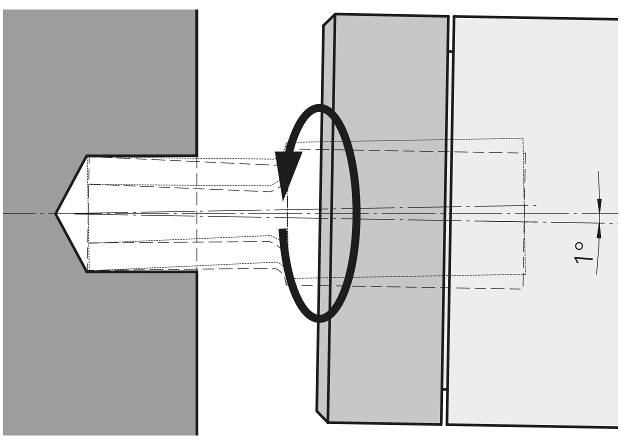
In non-driven profile broaching, the rotating workpiece spins the bearing-mounted tool as soon as the tool carrier's feed motion brings them into contact.

In driven profile broaching, the workpiece and tool rotate synchronously.

In eccentric profile broaching, the tool rotates while the workpiece remains stationary.

In profile broaching, the tool axis is tilted, causing the cutting edge to roll along or into the workpiece. The tilt angle, feed rate, and spindle speed determine how much of the cutting edge engages the workpiece. This allows for precise control over the cutting forces.

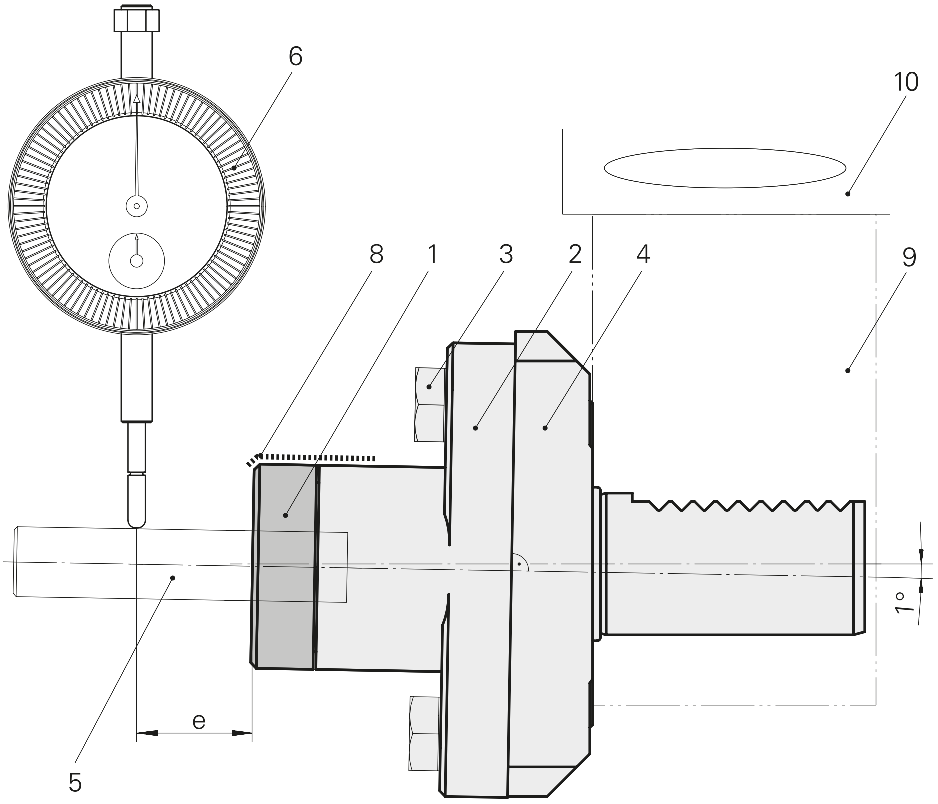
Due to the angular position of the tool axis, the cutting edge of the tool must be continuously aligned with the work spindle axis.



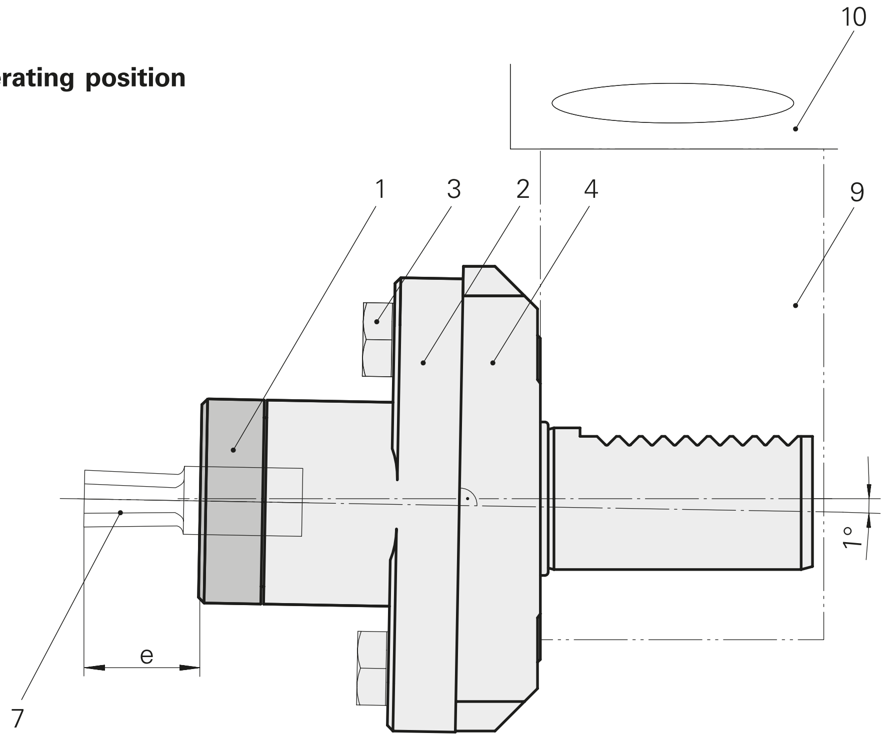
Guidelines for profile broaching of internal profiles

Setting guidelines

Test position



Operating position



1 Mounting
2 Head
3 Mounting screws
4 Shank
5 Test mandrel
6 Dial gauge
7 Tool
8 Adhesive tape
9 Compensation holder
10 Radial turret

Guidelines for profile broaching of internal profiles

Setting guidelines

1. Insert the tool holder into the compensation holder (9), but do not clamp it.
2. Insert the test mandrel (5) into the tool holder's mounting (1) and clamp it.
3. Attach the dial gauge (6).
4. Position the dial gauge (6) probe against the test mandrel (5) (see distance "e").

> Distance "e":
> The test position on the test mandrel (5) and the front edge of the tool must be at the same distance from the front edge of the broaching holder.
>
> The distance "e" depends on the profile broaching depth.
>
> The clamping point and measuring point must be in proper alignment.

5. Check the runout of the clamped test mandrel (5) by rotating the entire tool holder in the compensation holder (9). During this process, the mounting (1) with the clamped test mandrel (5) must not twist relative to the head (2). This can be prevented by applying adhesive tape (8) over the mounting (1) and head (2) during the adjustment process.
6. The adjustability of the head (2) relative to the shank (4) of the tool holder allows for precise alignment to the workpiece center and runout adjustment.
7. Replace the test mandrel (5) with the tool (7).
   The tool (7) must seat properly in the bore of the mounting (1).
8. Secure the head (2) using the mounting screws (3).
9. Finally, tighten the adjusted tool holder in place and remove the adhesive tape (8).

Technology guidelines

When profile broaching internal profiles, the bore should always be drilled slightly larger (1%) than the largest across-flats dimension of the hexagon. Consider the ISO 4759/1 dimensions when doing this.
Please apply the following guidelines for medium steel strength:

up to	**D 9mm**	**approx. 0.1mm,**
more than	**D 9mm**	**approx. 0.2mm.**

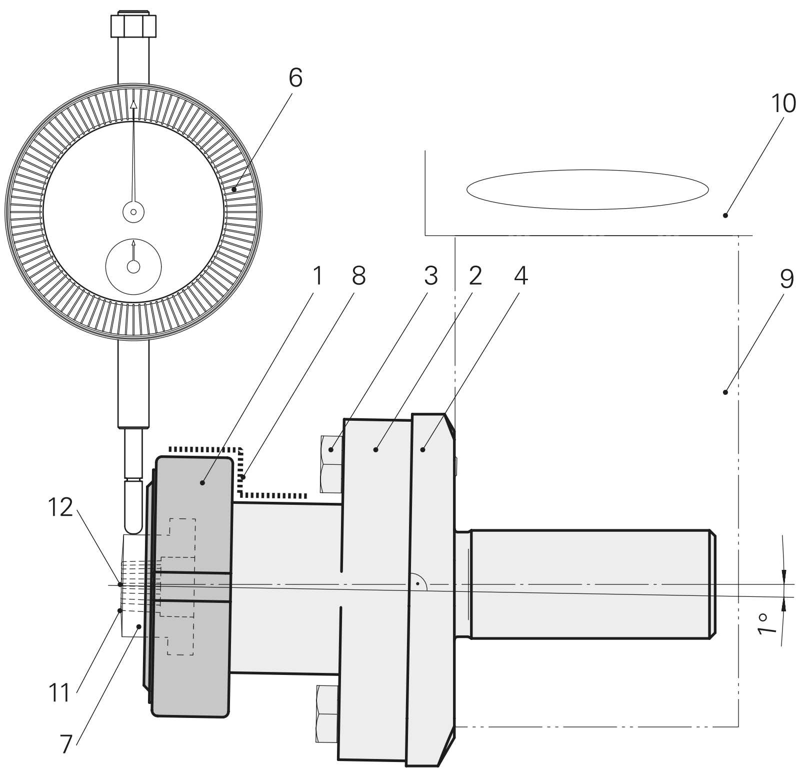
These values can be reduced for soft materials and increased for tough materials.

The drilling depth for a blind hexagonal hole should be 1.3 to 1.5 * broaching depth. The produced broaching chips must fit within the clearance space. If necessary, additional drilling may be required to remove the chips. Depending on the size of the broaching mandrel, the eccentricity of the pilot hole must not exceed the range of 0.02mm to 0.04mm.

In non-driven profile broaching, a burr may form at the moment the tool engages, which can be removed by subsequent countersinking if needed.

Guidelines for profile broaching of external profiles

Setting guidelines



1 Mounting
2 Head
3 Mounting screws
4 Shank
6 Dial gauge
7 Tool
8 Adhesive tape
9 Compensation holder
10 Radial turret
11 Cutting edge
12 Workpiece center

1. Insert the tool holder into the compensation holder (9), but do not clamp it.
2. Insert the tool (7) into the tool holder's mounting (1) and clamp it.
3. Attach the dial gauge (6).
4. Position the probe of the dial gauge (6) against the foremost outer edge.

> The outer edge of the tool (7) must be precisely aligned with the profile (see Guidelines for tool manufacturing).

5. Check the runout of the clamped tool (7) by rotating the entire tool holder in the compensation holder (9). During this process, the mounting (1) with the clamped tool (7) must not twist relative to the head (2). This can be prevented by applying adhesive tape (8) over the mounting (1) and head (2) during the adjustment process.
6. The adjustability of the head (2) relative to the shank (4) of the tool holder allows for precise alignment to the workpiece center (12) and runout adjustment.
7. Secure the head (2) using the mounting screws (3).
8. Finally, tighten the adjusted tool holder in place and remove the adhesive tape (8).

Guidelines for profile broaching of external profiles

Technology guidelines

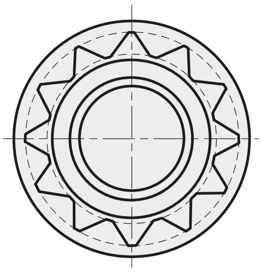
For profile broaching external profiles (A), the turning diameter must be slightly larger than the finished dimension of the respective profile. This needs to be determined on a case-by-case basis through trial and error. During the machining process, this ensures that the entire outer contour of the profile to be produced is machined.

To guide the tool (B), it is recommended to turn a cylindrical extension to the size of the core diameter of the tool, i.e., the respective profile, and chamfer the outer diameter.
After machining the external profile (C), this extension can be turned off again.

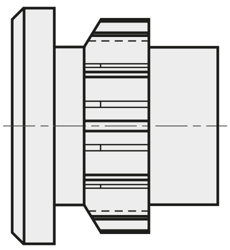
The material and profile size determine the feed rate per revolution when profile broaching. As a guideline for medium steel toughness: profile broaching diameter * 0.03mm to 0.06mm.
With sufficient pressing force, these values can be doubled or tripled, especially for aluminum or brass. Typically, one starts with a low feed rate, increasing it depending on the different material characteristics. When larger profiles need to be machined into tough materials and the machine's feed force capacity is insufficient, the feed rate must be reduced to as low as 0.01mm.

In general: the smaller the diameter, the smaller the feed rate.

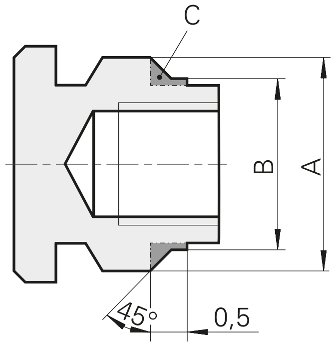
Tooth profile, enlarged view



After profile broaching



Before profile broaching



A Turning diameter before profile broaching 0.02mm to 0.04mm larger than the tool diameter

B Core diameter of the tooth profile as a guide for the tool

C Tool guide (removed after profile broaching)

General technology guidelines

Work spindle speed for profile broaching

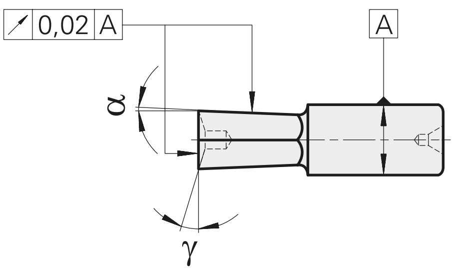
The profile broaching process with a rotating, wobbling tool allows for high speeds. Depending on the application, the speed ranges between 1500 rpm and 3000 rpm. In this context, cutting speed plays a secondary role. If the workpiece touches the broaching mandrel at a constant high speed, the tool must be carried along up to the maximum speed. Until reaching the maximum speed, this causes corresponding cutting edge wear, especially on small broaching tools.

This can be avoided as follows: If possible, start with a low speed for the first tenths of a millimeter of the broaching process and then increase continuously to the maximum speed.
The profile will always be more or less spiral-shaped. For longer profiles, this can be limited by programming multiple direction changes over the entire profile length.

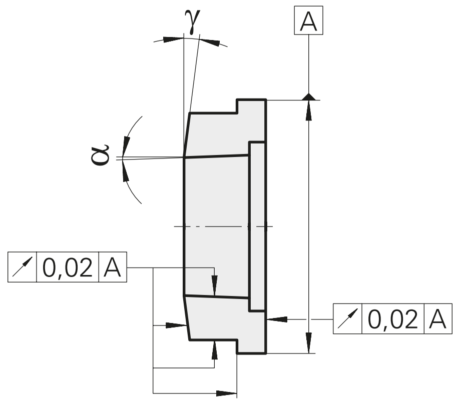
Guidelines for tool manufacturing

The clearance angle on the tool must be larger than the angle of inclination of the tool holder

Internal tool



External tool



α = Clearance angle 1°15´ to 2°
γ = Rake angle 6° to 8°

Technology guidelines for profile broaching on multi-spindle automatic lathes

The work spindles of multi-spindle automatic lathes are specifically designed for continuous operation and high speeds. Process forces above 1800N during profile broaching can damage the spindle bearings.

For non-driven profile broaching, the speed at the moment of contact between the rotating spindle and the "still stationary" tool should be as gentle as possible. Speeds below 1000 rpm have proven practical in this case.
The abrupt engagement of the tool in non-driven profile broaching can cause damage to the initial area of the broached profile.

To operate more gently or at higher speeds, it is advisable to use driven profile broaching, as there is no relative speed difference between the spindle and tool at the moment of contact.

Changing spindle speeds under load during profile broaching is not permitted.
Depending on the magnitude of the process forces during profile broaching, damage to the spindle bearings is possible.

For long profiles, a twist may occur with non-driven profile broaching.
In this case, it is advisable to perform profile broaching with a driven (live) tool, as the speeds of the spindle and tool are coupled.

High process forces during profile broaching can damage the spindle bearings.

Therefore, the ratio $\frac{f}{\sin(\alpha) * D_{tool}}$ should be significantly less than 1.

If this ratio reaches 1, the cutting edge of the broaching tool never lifts off, and the profile is "pressed" into the workpiece under high process forces.

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INDEX-Werke GmbH & Co. KG
Hahn & Tessky

Plochinger Strasse 92
D-73730 Esslingen

Phone +49 711 3191-0
Fax +49 711 3191-587

info@index-werke.de
www.index-werke.de