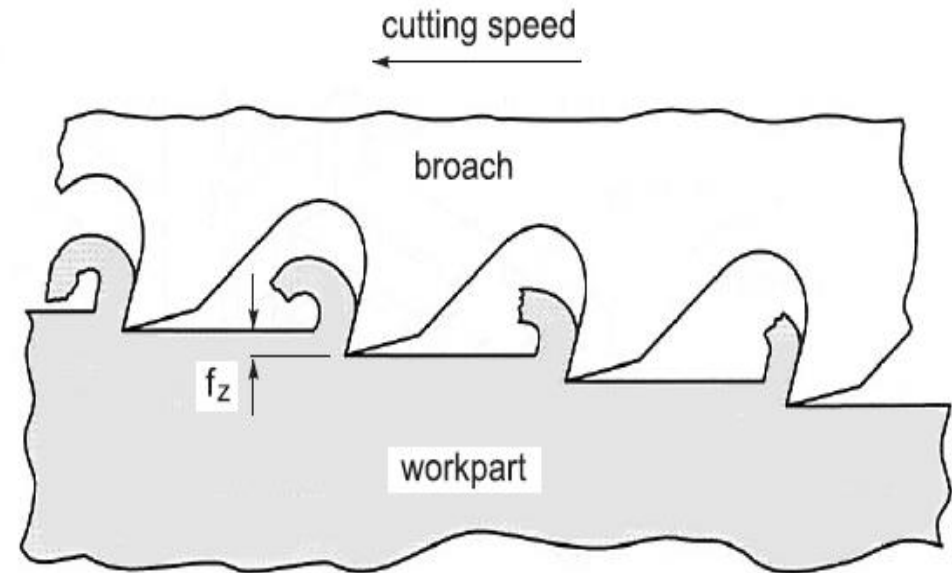
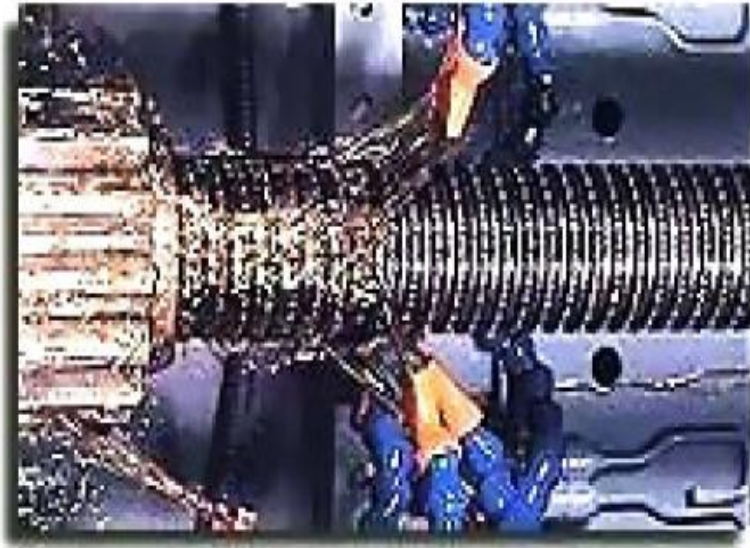


BROACHING MACHINE

BROACHING

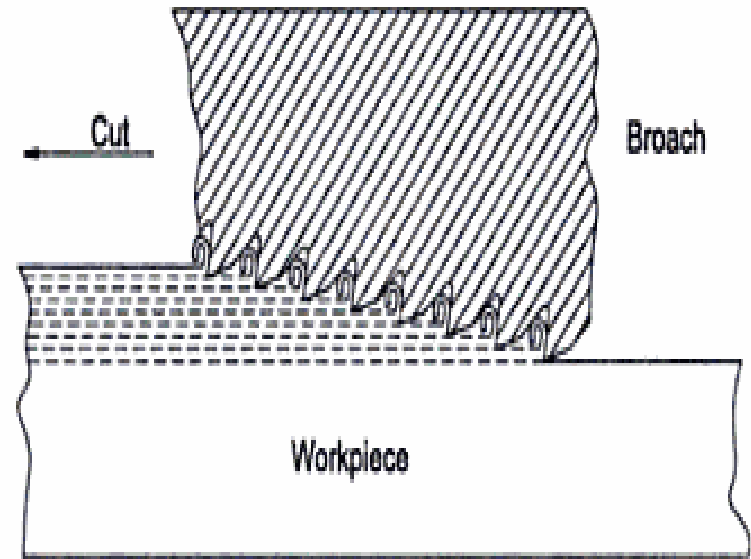
Broaching is a machining operation that involves the use of a multiple-tooth cutting tool moved linearly relative to the workpiece in the direction of the tool axis:

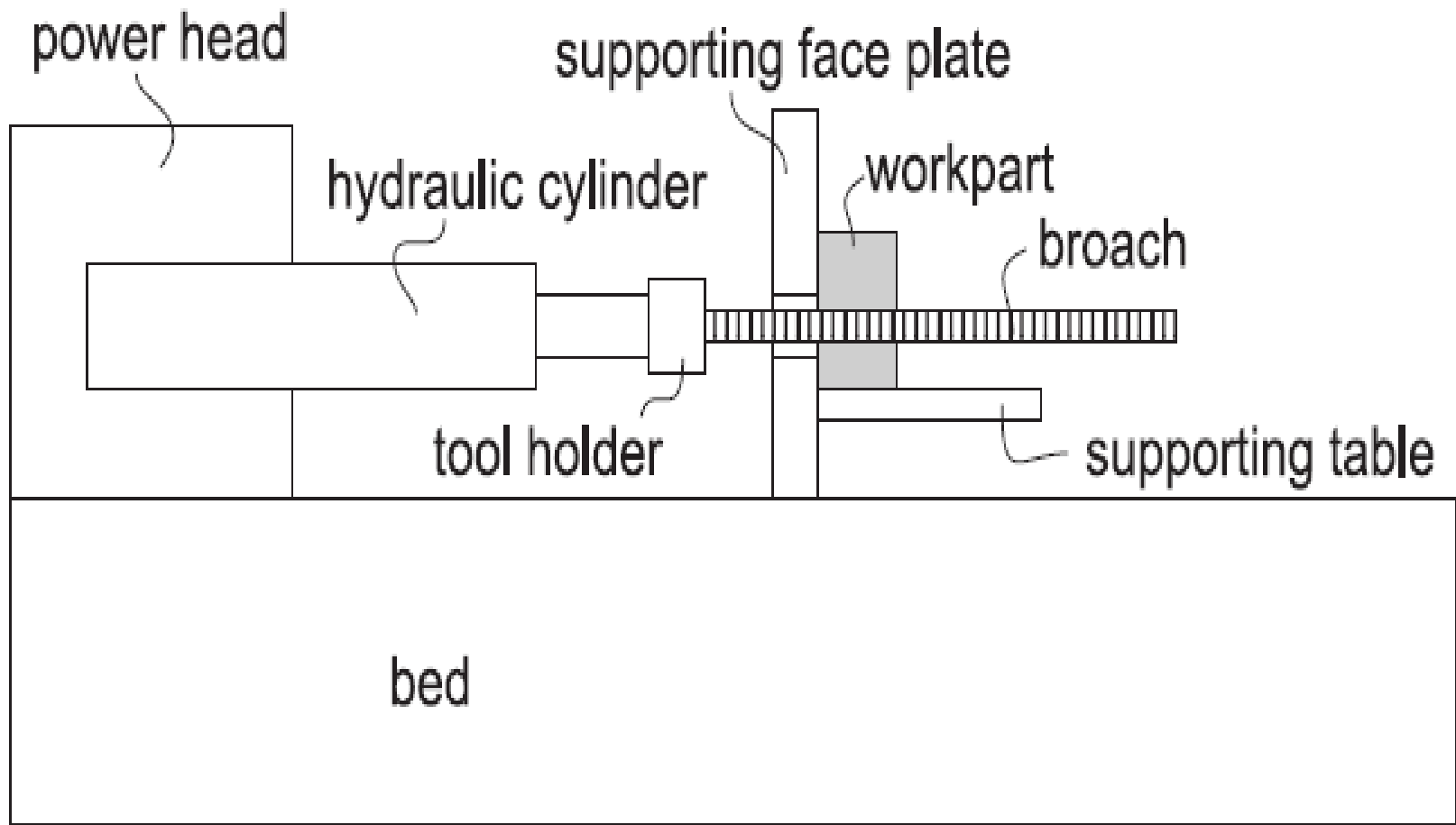


The broaching operation.

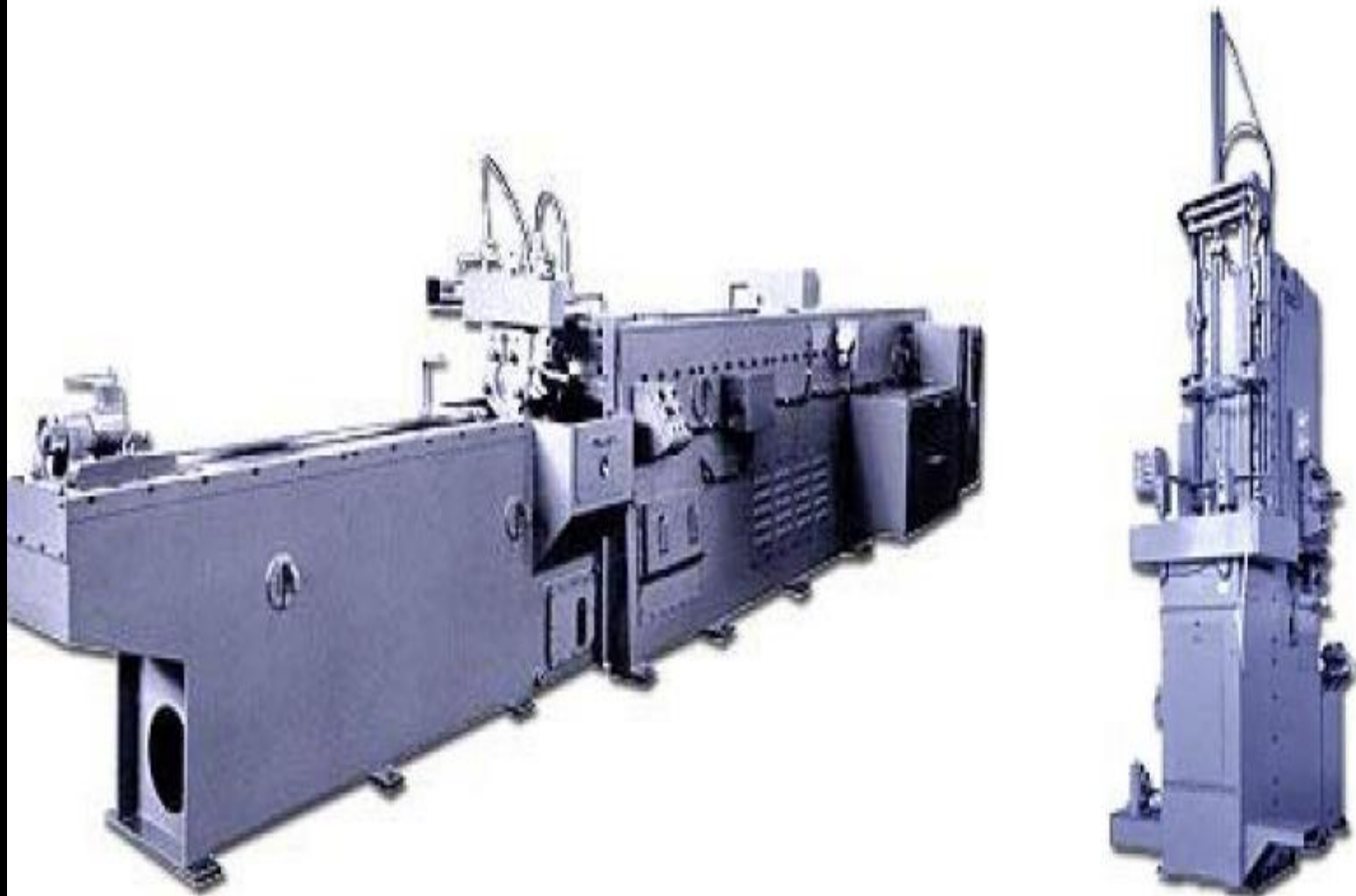
The cutting tool is called a *broach*, and the machine tool is called a *broaching machine*. The shape of the machined surface is determined by the contour of the cutting edges on the broach, particularly the shape of final cutting teeth. Broaching is a highly productive method of machining. Advantages include good surface finish, close tolerances, and the variety of possible machined surface shapes, some of them can be produced only by broaching. Owing to the complicated geometry of the broach, tooling is expensive. Broaching is a typical mass production operation.

- It is a multiple tooth cutting operation with the tool reciprocating as in sawing machine.
- Machining operation completed in a single stroke.
- Teeth are at a gradually increasing height.
- Broach are originally developed for machining internal keyways.
- It is extensively used in mass automobile component manufacture for various other surfaces.





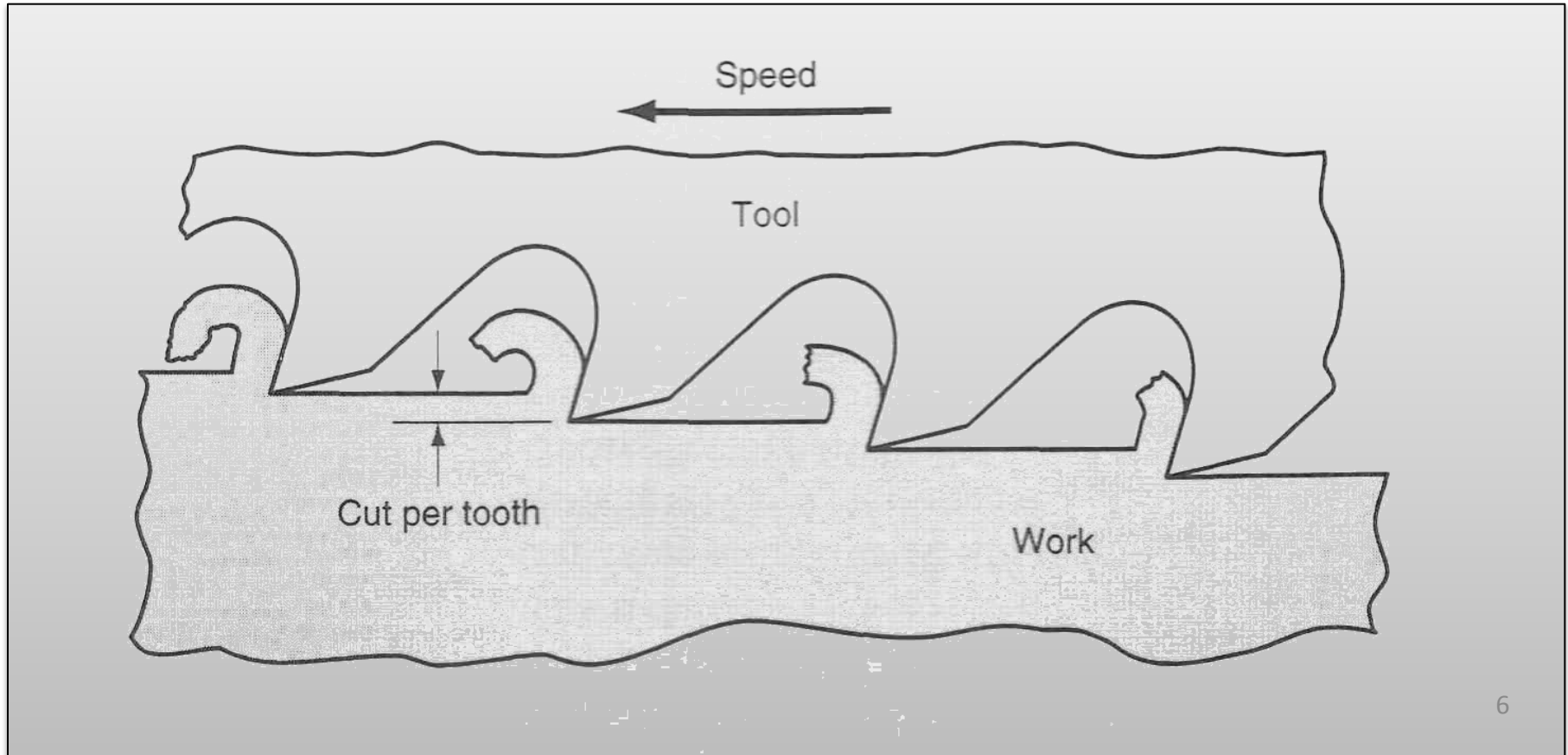
Major components of a broaching machine.



Horizontal (*Left*) and vertical (*Right*) broaching machine.

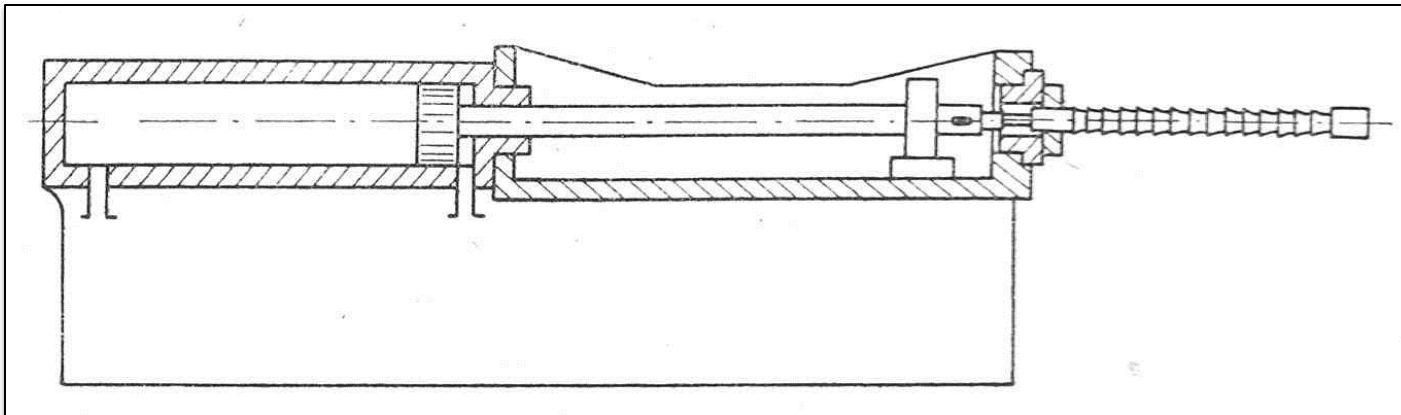
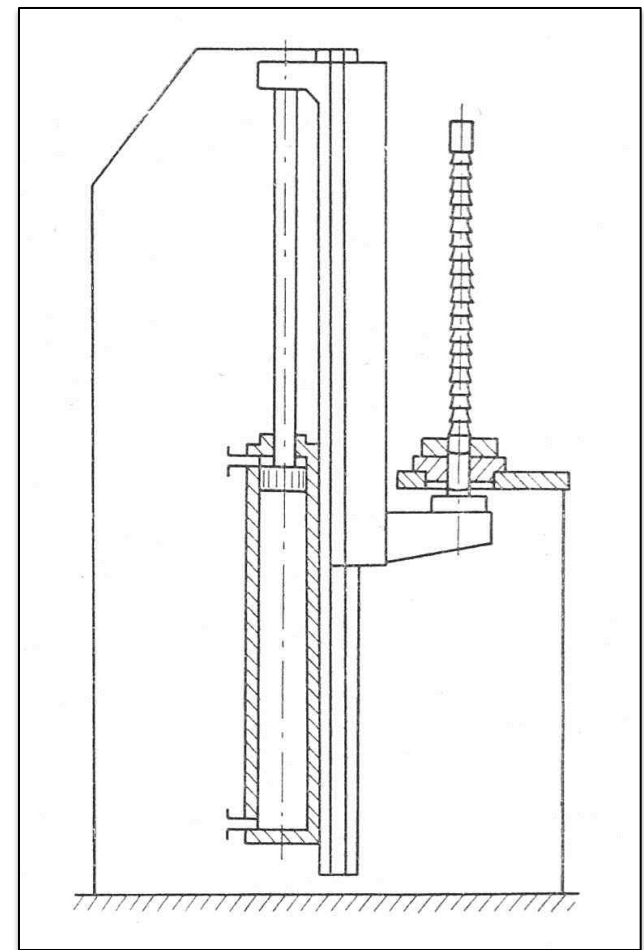
BROACHING

- a multiple tooth cutting tool
- the forming tool moves linearly relative to the workpiece in the direction of the tool axis
- Movement through or along the part



Broaching machines

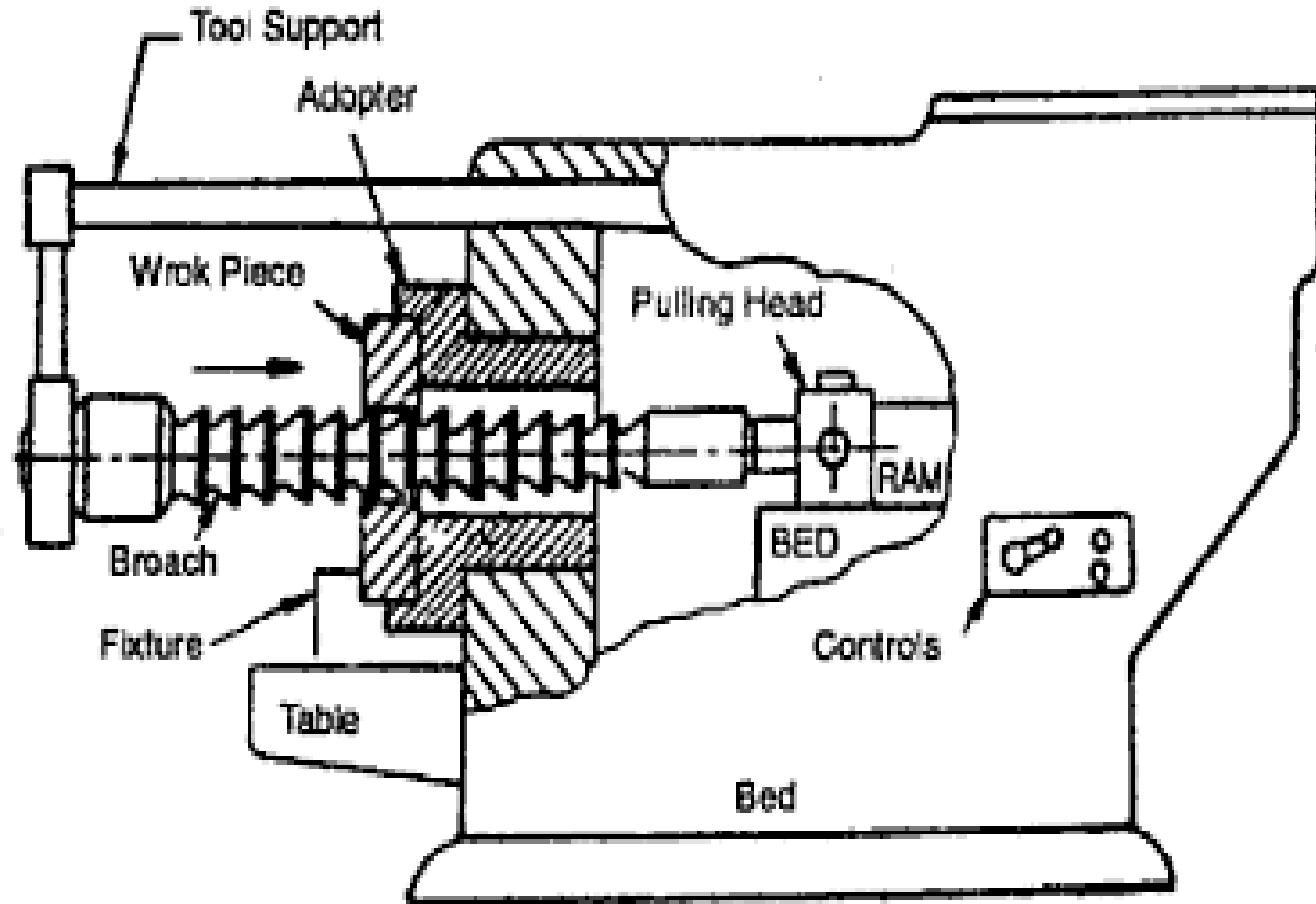
- vertical ▶
- horizontal ▼



HORIZONTAL BROACHING MACHINE

- Mostly all are pull type.
- Both internal and external broaching can be done.
- Consists of a box type bed having length is twice the length of stroke.
- All modern machines are provided with hydraulic drive housed in the bed.
- Job located in the adapter which is fitted on front vertical face.
- Small end is connected to hole of the job, then connected to pulling end which is mounted on front end of ram.
- Ram is connected to hydraulic drive.
- Rear end is supported by guide.

HORIZONTAL BROACHING MACHINE

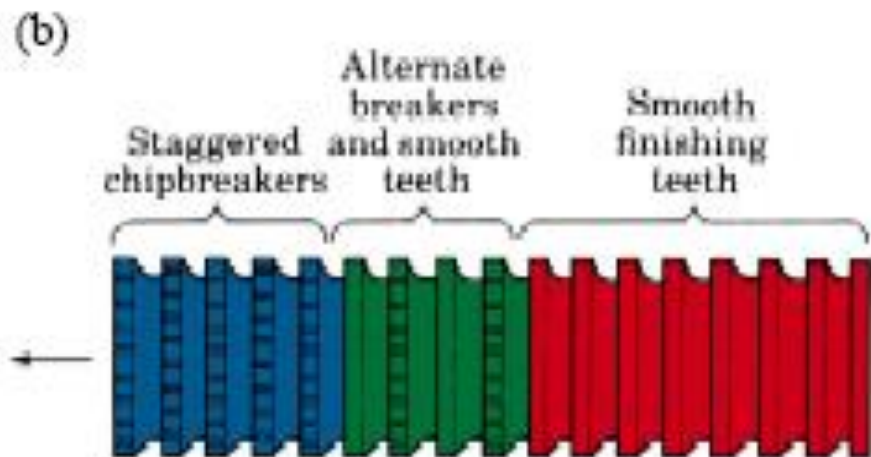
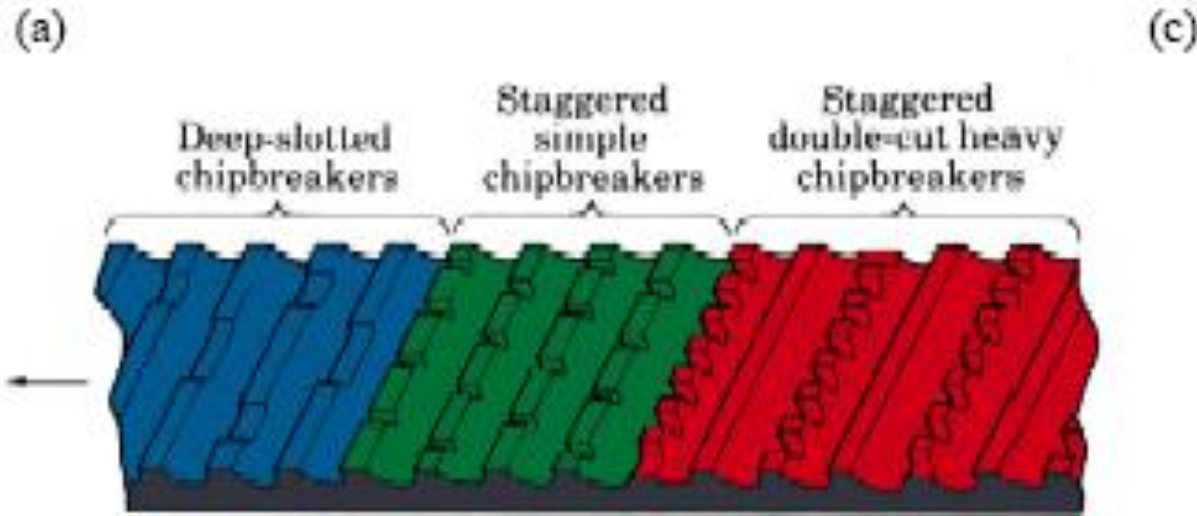


- Cutting speed- 4 to 15 mpm.
- Return speed- 35 mpm.
- Automatic stops are provided to control the stroke of ram.
- Used for small works like key ways splines, gun barrel
- refilling, cutting internal and external gears with helix angle less than 15°



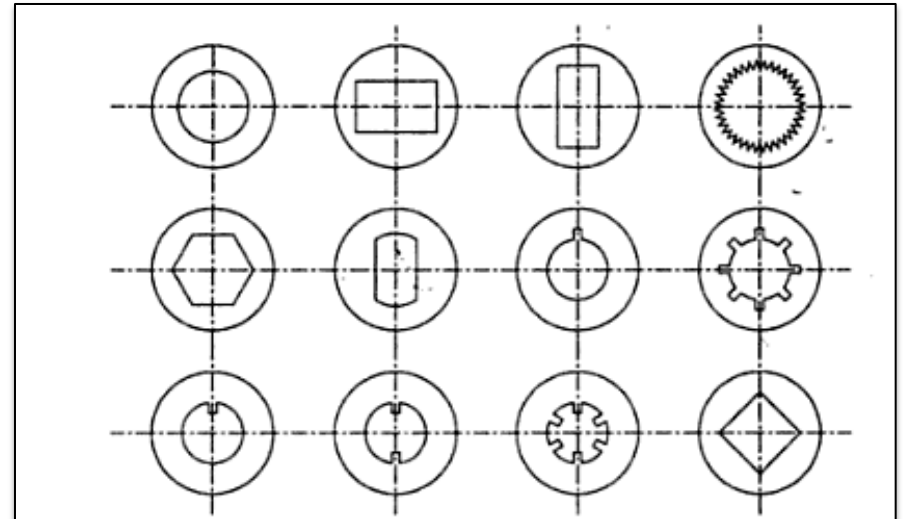
Various shapes produced by internal broaching operation.

VERTICAL BROACHING MACHINE



APPLICATIONS OF BROACHING

- Examples of internal shapes that can be done on broaching machine.

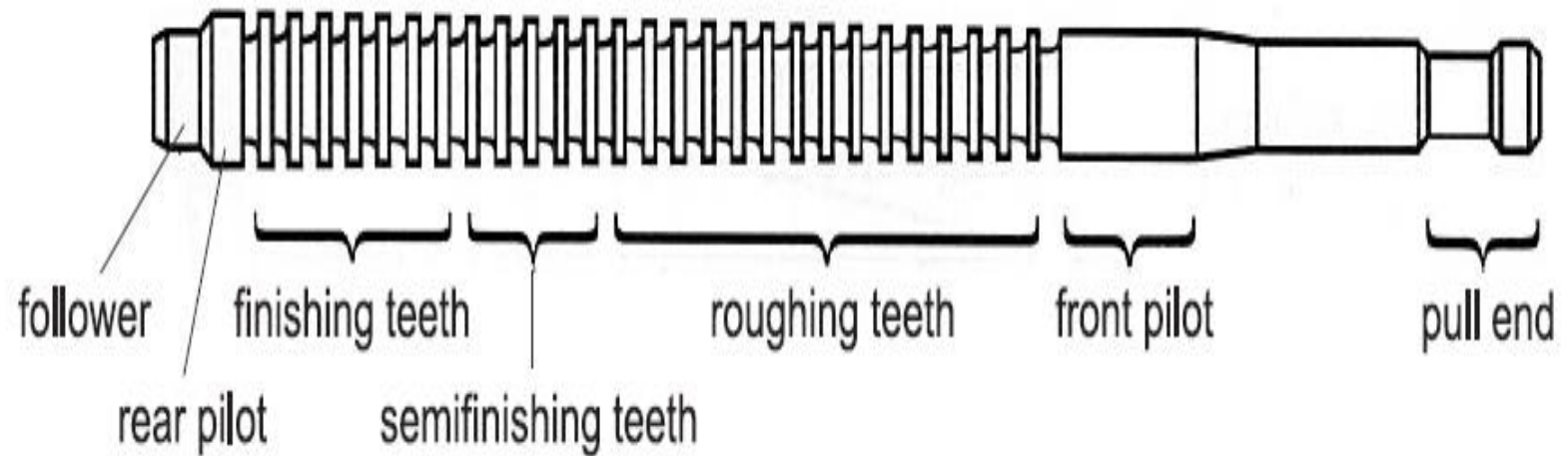


SPECIFICATION OF BROACHING MACHINE

- Power of the motor and its speed
- Length of bed
- Length of slide stroke
- Rated pulling force
- Cutting stroke speed
- Number of speeds
- Return stroke speed
- Maximum size of cut
- Weight of machine
- Size and floor area

Cutting tools for broaching

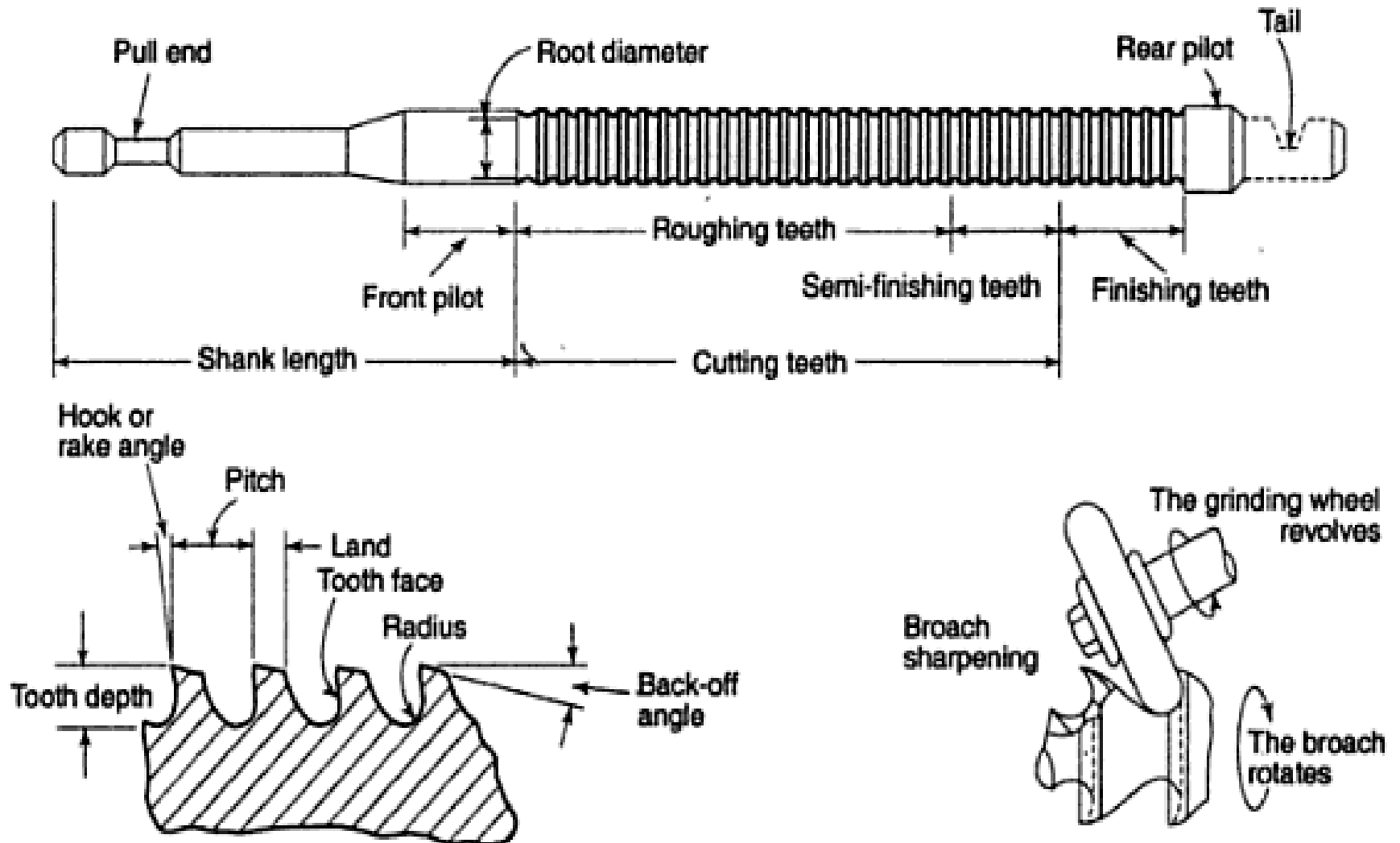
The terminology of the broach is shown in the figure:



Typical broach for internal broaching.

Most broaches are made of high-speed steel, although broaches with carbide inserts either brazed or mechanically attached are also available.

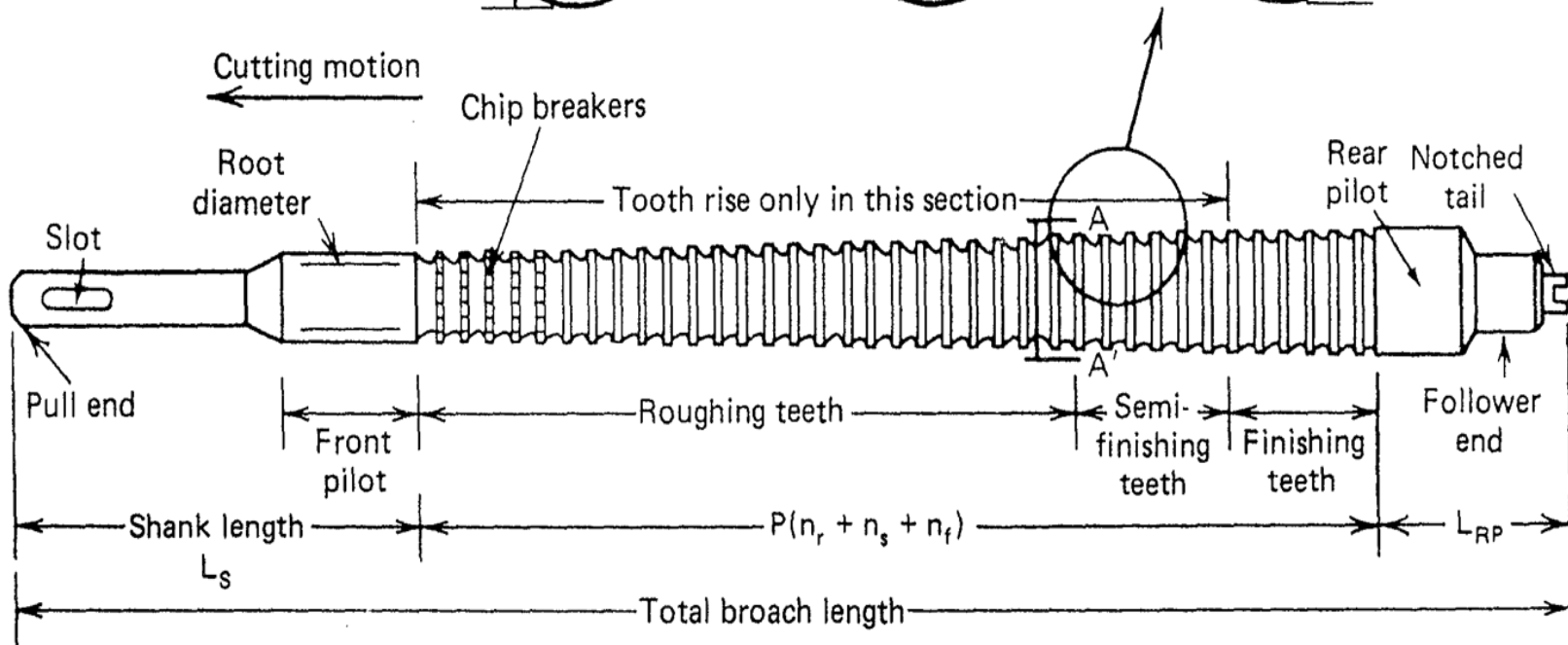
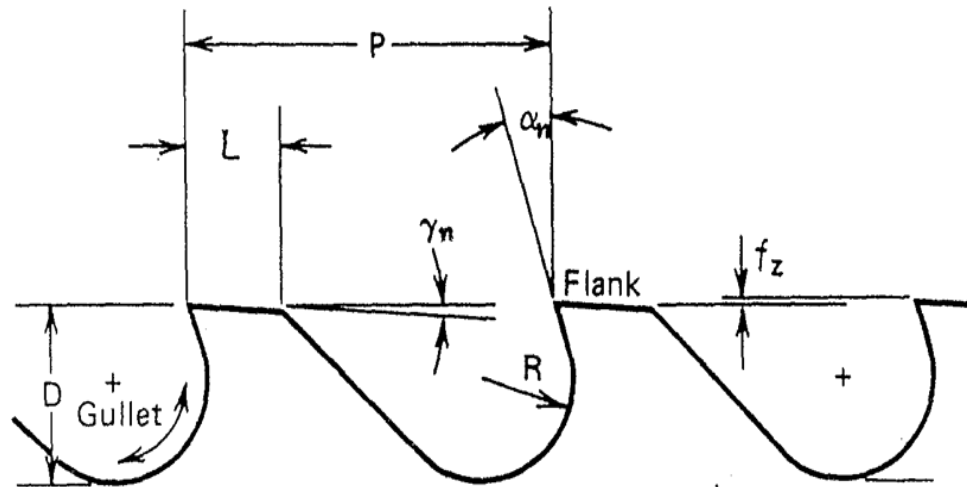
BROACH TOOL NOMENCLATURE

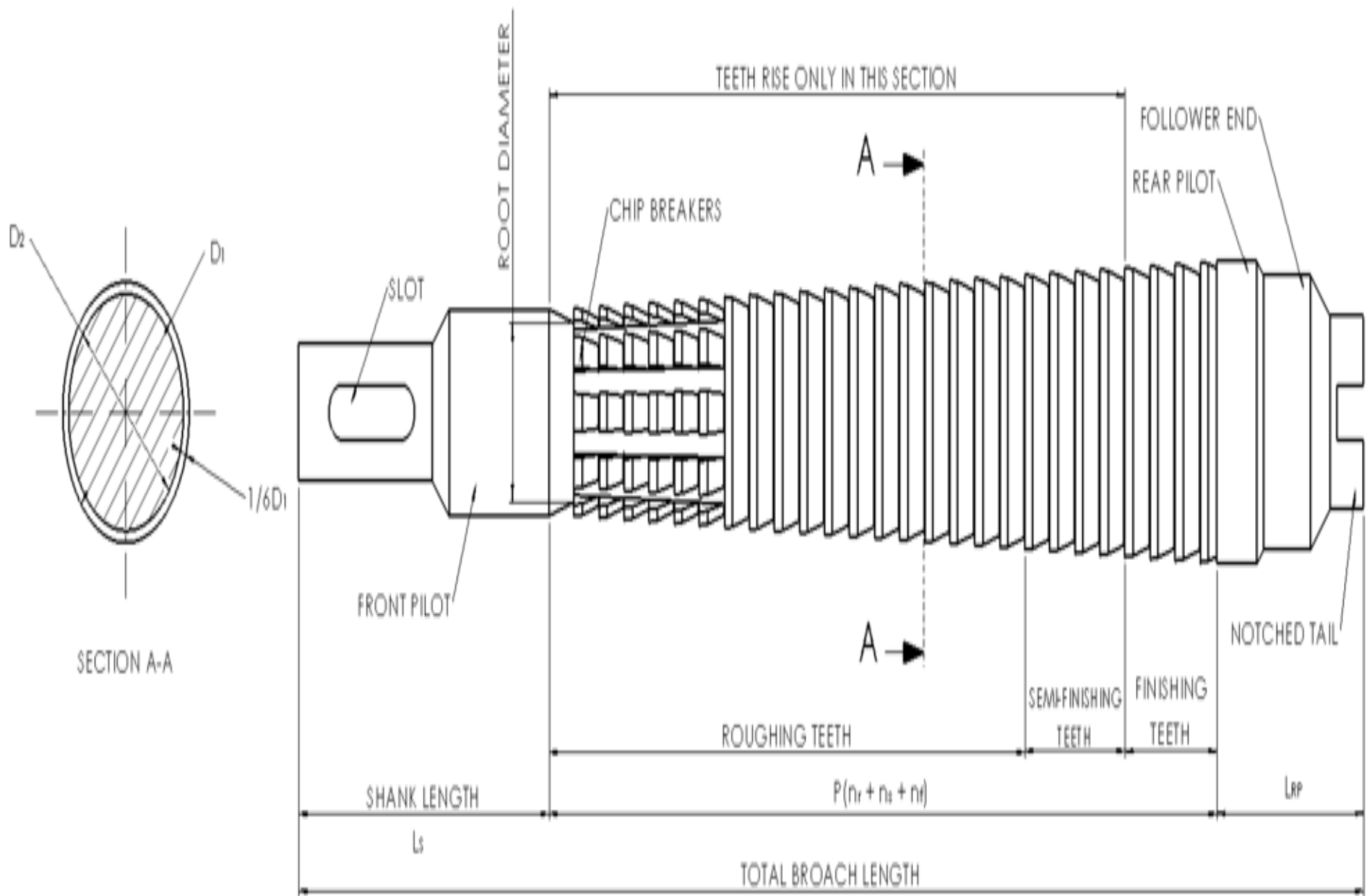


- Pull end- connected to pulling head of broaching machine.
- Front pilot- this locates the broach centrally with the hole to be broached.
- Roughing teeth and semi finished teeth- used for removing most of metal in broaching.
- Finishing teeth- meant for finishing the hole to the size and shape.
- Rear pilot- meant for giving support to the broach after the last tooth leaving the work piece.
- Land- top portion of teeth.
- Clearance or back off angle- back of the tooth sloped to give clearance angle.
- Rake or face angle- angle made by sloping the front face of tooth. Depends upon workpiece material.
- Pitch- linear distance between one tooth to the next tooth.
It is more in roughing teeth than finishing teeth.

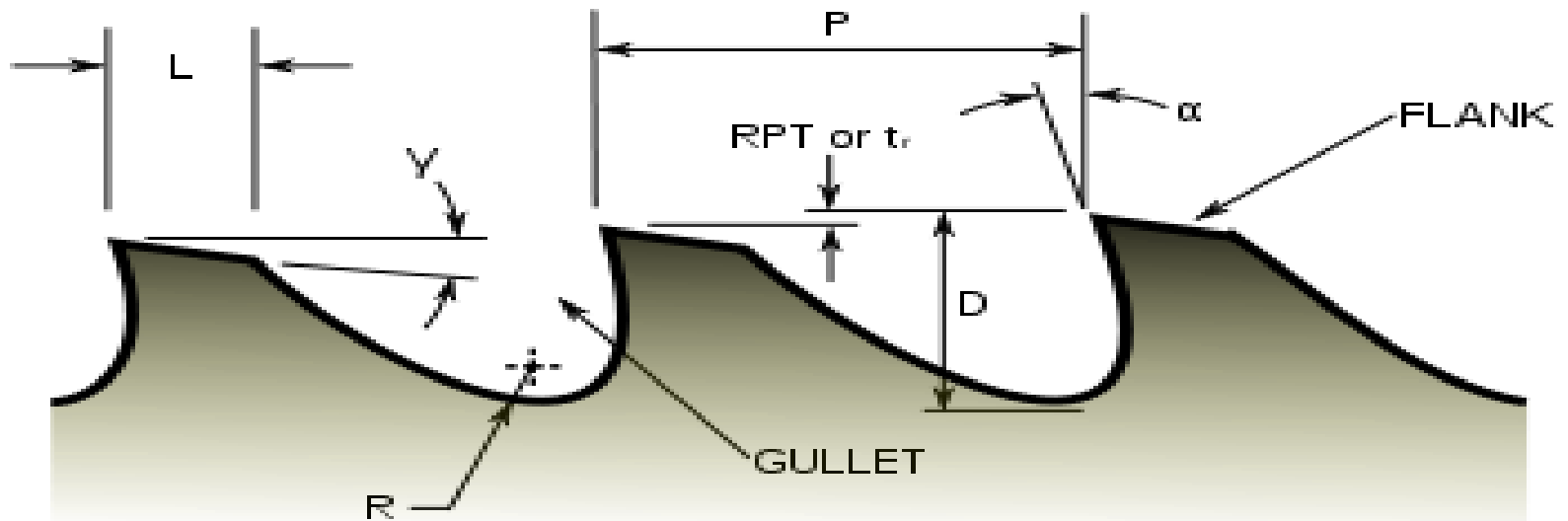
Broaching tool

- P – pitch of teeth
- D – depth of teeth ($0.4P$)
- L – land behind cutting edge ($0.25P$)
- R – radius of gullet ($.25P$)

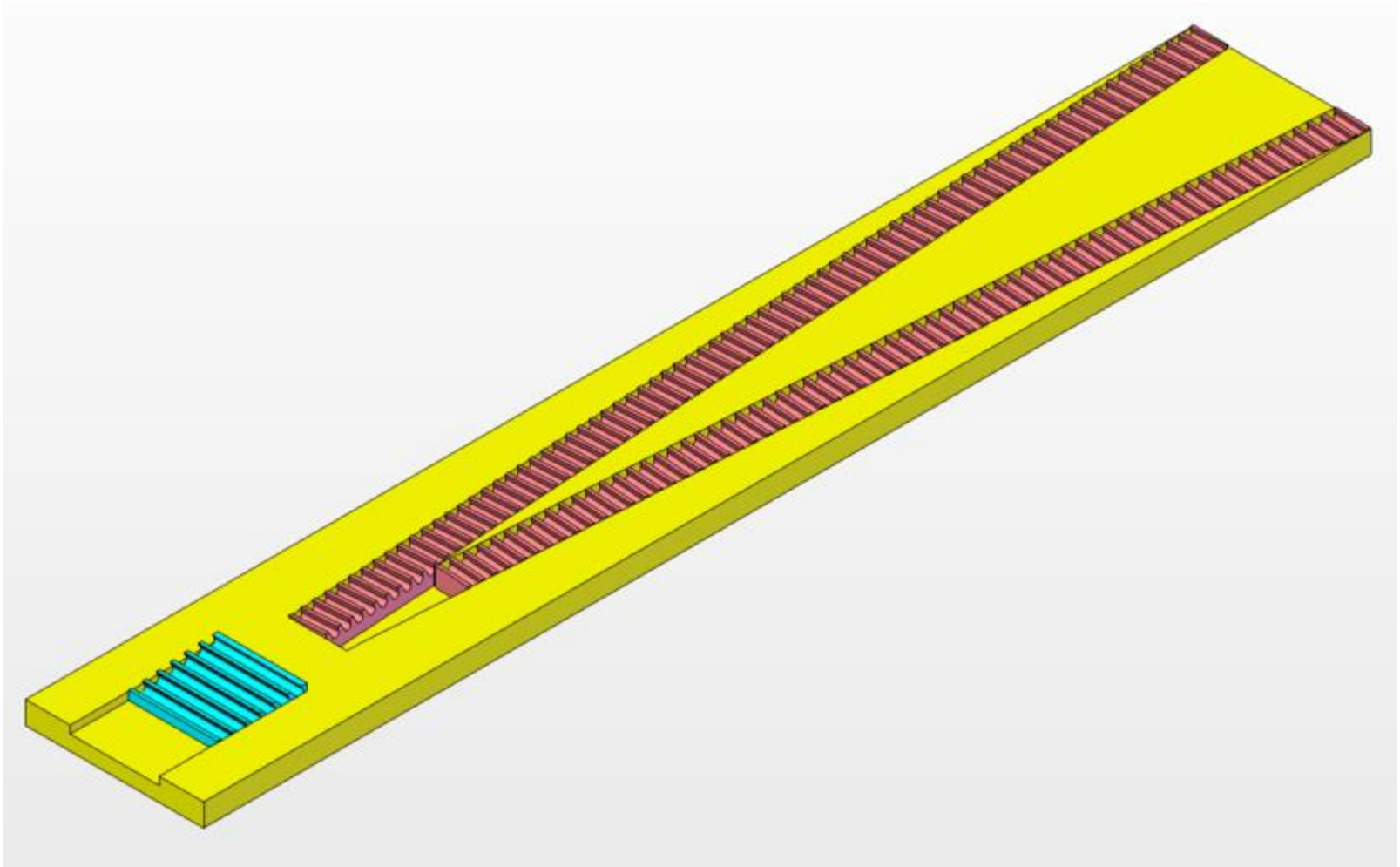




Broaching tool

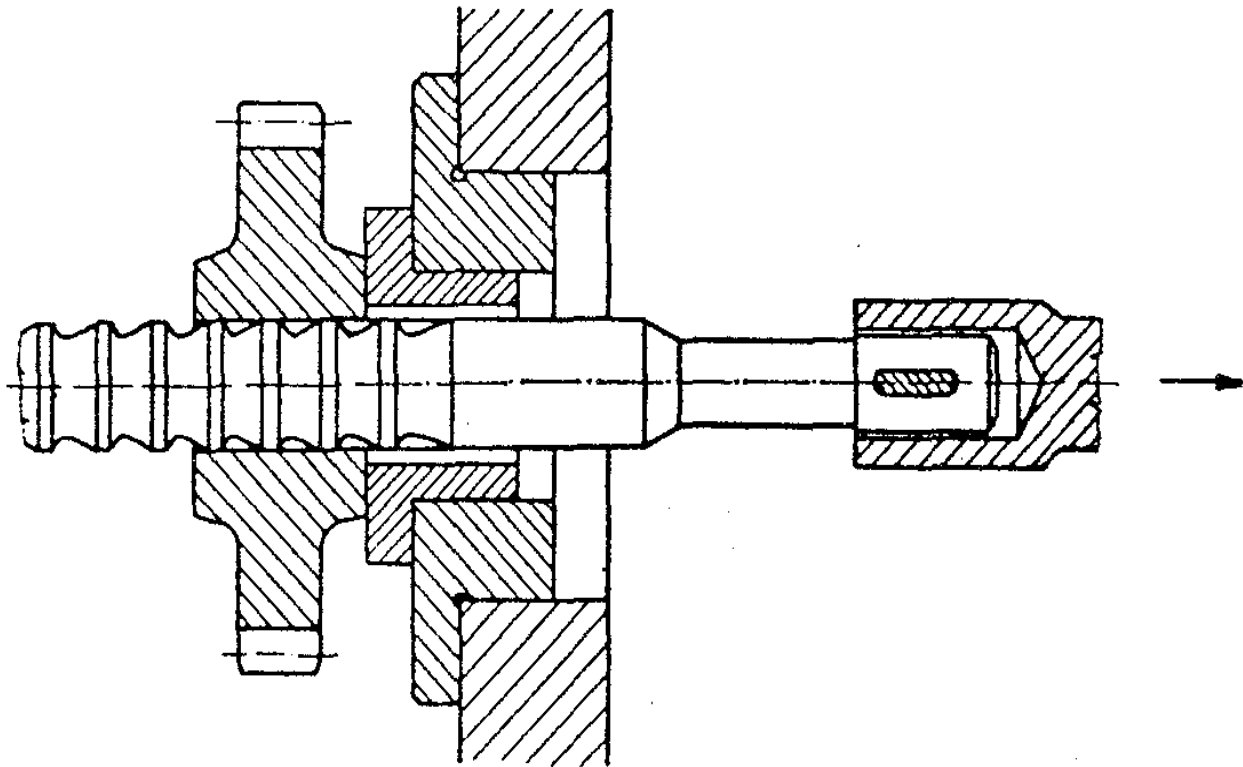


External broaching tool



Broaching process

- on a **press** – the tool is **pushed**
- on a **broaching machine** – the tool is **pulled**
- Using **special** machine – **stationary** broach



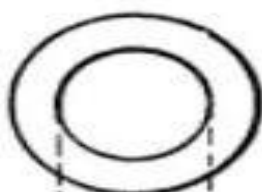
Broached shapes

- Internal – holes and other round shapes, keyways, profiles, gears
 - Need leading hole to place the pilot
- External – faces, T-shape, co-planar surfaces, gears
- Holes calibration – Broach diameter slightly bigger than the hole.



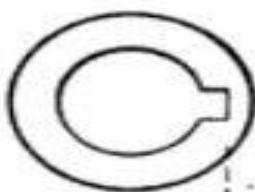
SQUARE

A



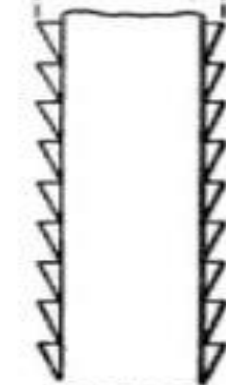
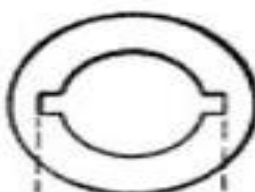
ROUND

B



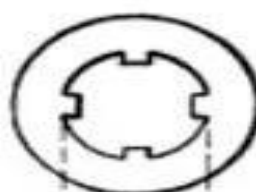
SINGLE
KEYWAY

C



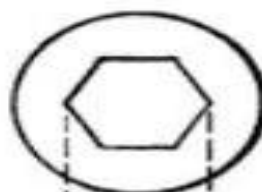
DOUBLE
KEYWAY

D



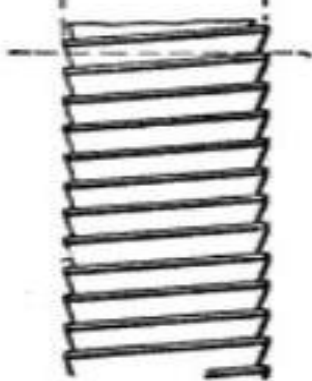
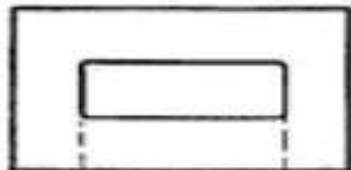
4-SPLINE

E



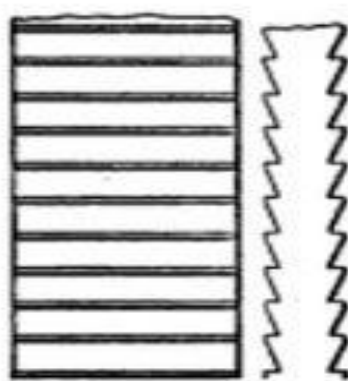
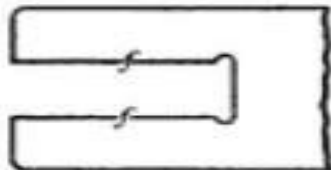
HEXAGON

F



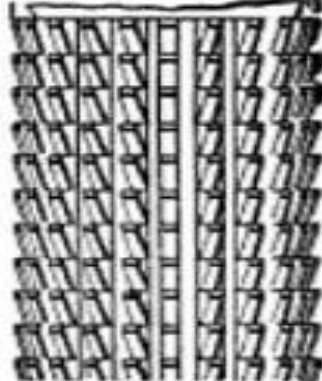
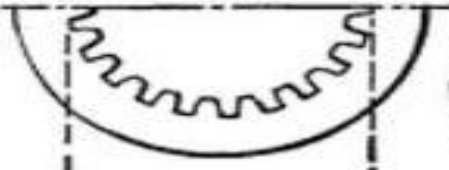
RECTANGULAR

G



DOUBLE-CUT

H



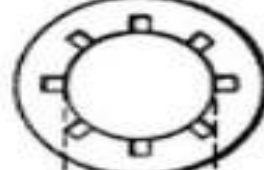
INTERNAL GEAR

I



ROUND

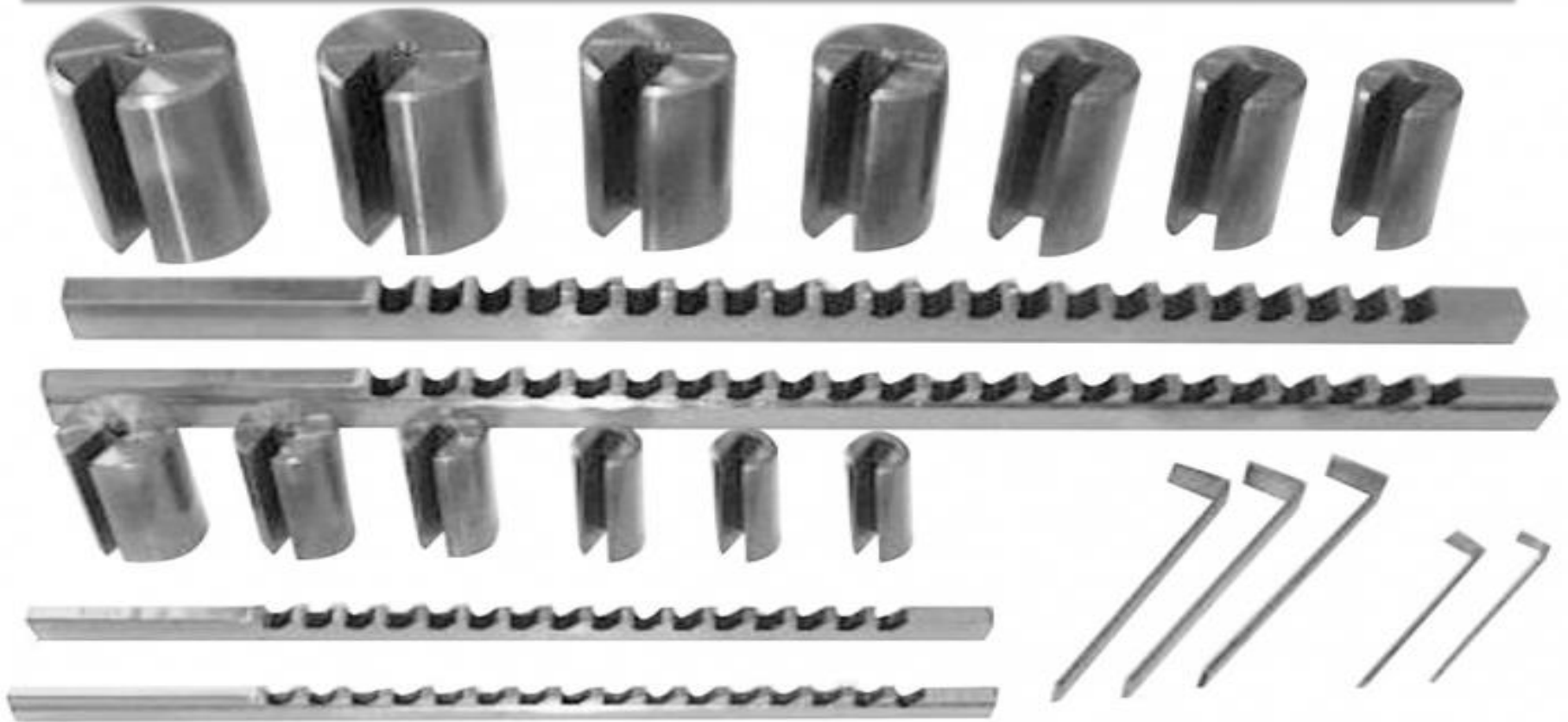
J



HELICAL GROOVE

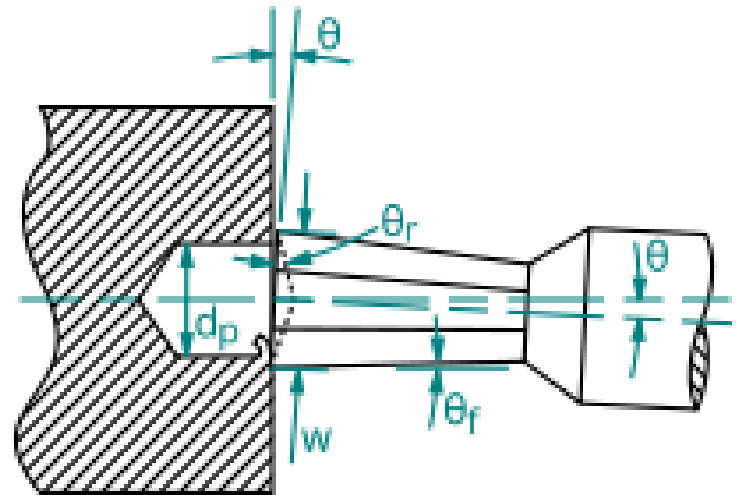
K

Keyway broaches



Rotary broaching

- internal



Schematic of a rotary broach starting a cut.

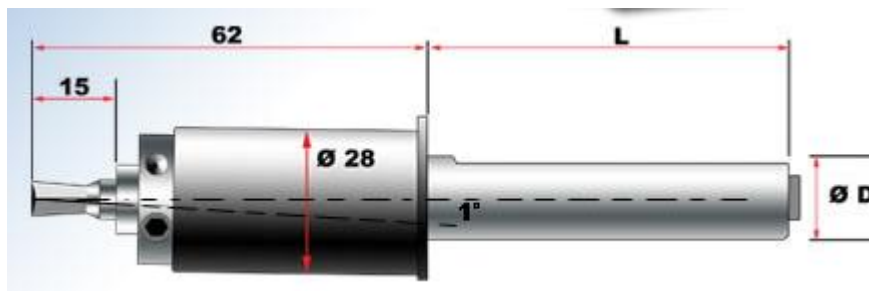
θ Off-axis (wobble) angle

θ_r Rake

θ_f Front relief

d_p Pilot diameter

w Width across corners (AC)



Cutting conditions in broaching

The *cutting speed* motion is accomplished by the linear travel of the broach past the work surface.

Feed in broaching is unique among machining operations, since is accomplished by the increased step between successive teeth on the broach. This step is actually the *feed per tooth*, f_z . The feed per tooth is not a constant for all the teeth. The total material removed in a single pass of the broach or the *total feed* f is the cumulative result of all the steps in the tool. Since not all of the broach teeth are engaged simultaneously in cutting but only a part of them, the term *active cumulative feed* can be introduced, defined as the sum of all the steps only of the active teeth.

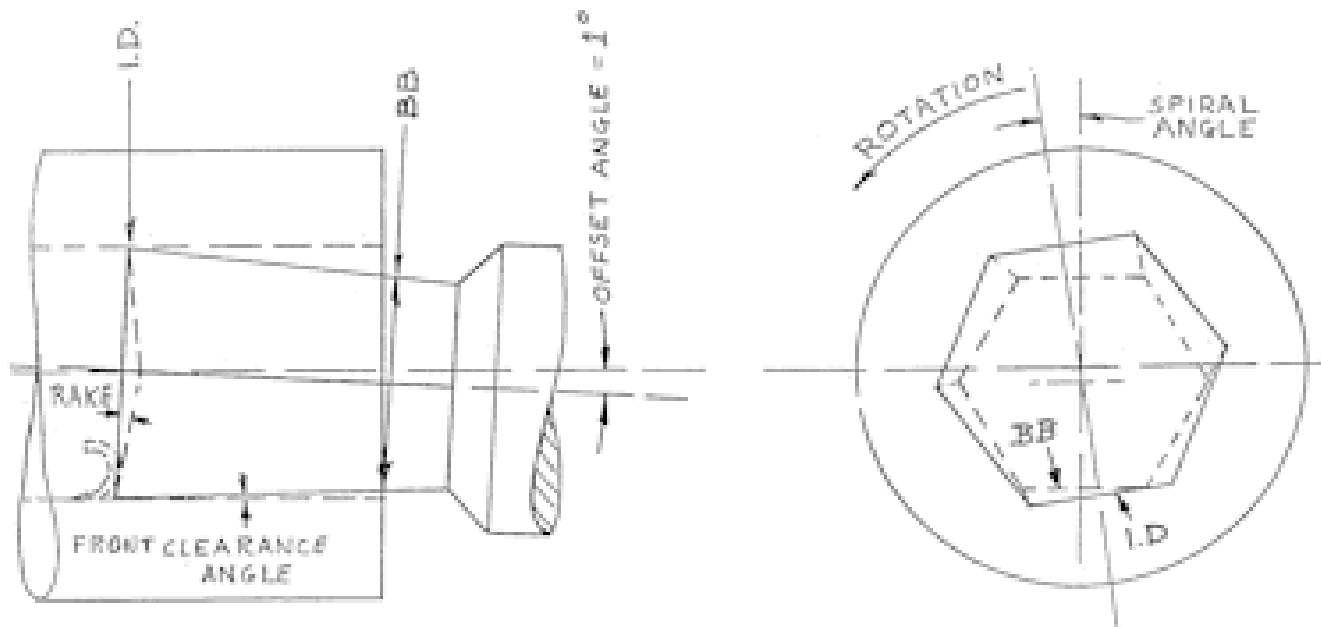
Depth of cut in broaching is defined as the length of the active cutting edge. In internal broaching, which is the most common type of broaching, the entire length of a single broach tooth is engaged in cutting and the depth of cut is actually the tooth circumference.

From the definitions of feed and depth of cut it follows that the total area of cut and respectively the cutting force in broaching will be substantial.

Rotary broaching - limitations

Broach length

Spiraling



Broaching limitations

- Machined volume
 - Limited by chip thickness → long broach
- Speed
 - No wear demands → low temperature, forces
- Tool costs
 - Expensive production → long tool life

BROACHING

ADVANTAGES OF BROACHING

1. **Broaching** is faster than other machining operations, resulting in higher rate of production with better finish and more accuracy.
2. As each tooth of the broach takes a small cut only once in one operation, the broach has a longer life.
3. The broach performs both roughing and finishing operation.
4. As the machining cycle is quite simple, the **broaching** operation does not need a highly skilled operator.
5. The cutting force of the broach serves to clamp the workpiece and hold it firmly in position.

LIMITATIONS OF BROACHING

1. Initial cost of a broach is very high.
2. The **broaching machine** is a very costly **machine** tool. Therefore the operation is justified only for mass production.

3. Broach sharpening is an expensive and difficult process and requires a separate sharpening procedure.
4. A surface having an obstruction in the way of broach travel cannot be machined.
5. Delicate and very light jobs are difficult to broach.
6. One broach is used to produce only one type of surface. Therefore for getting different shapes and sizes, different broaches are required.
7. Blind holes cannot be easily produced through broaching.



The end

Thank You !