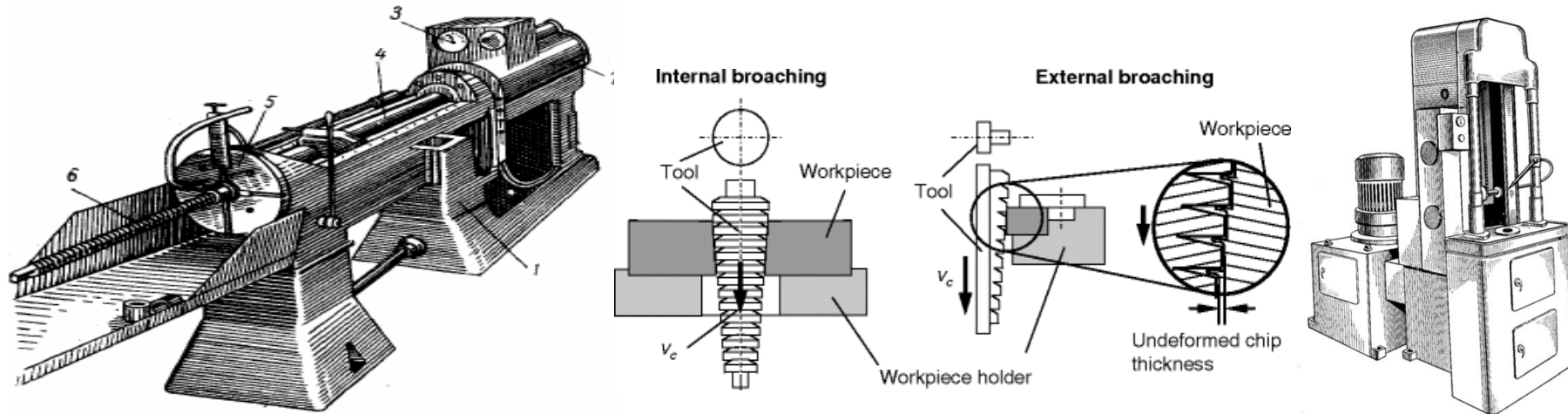
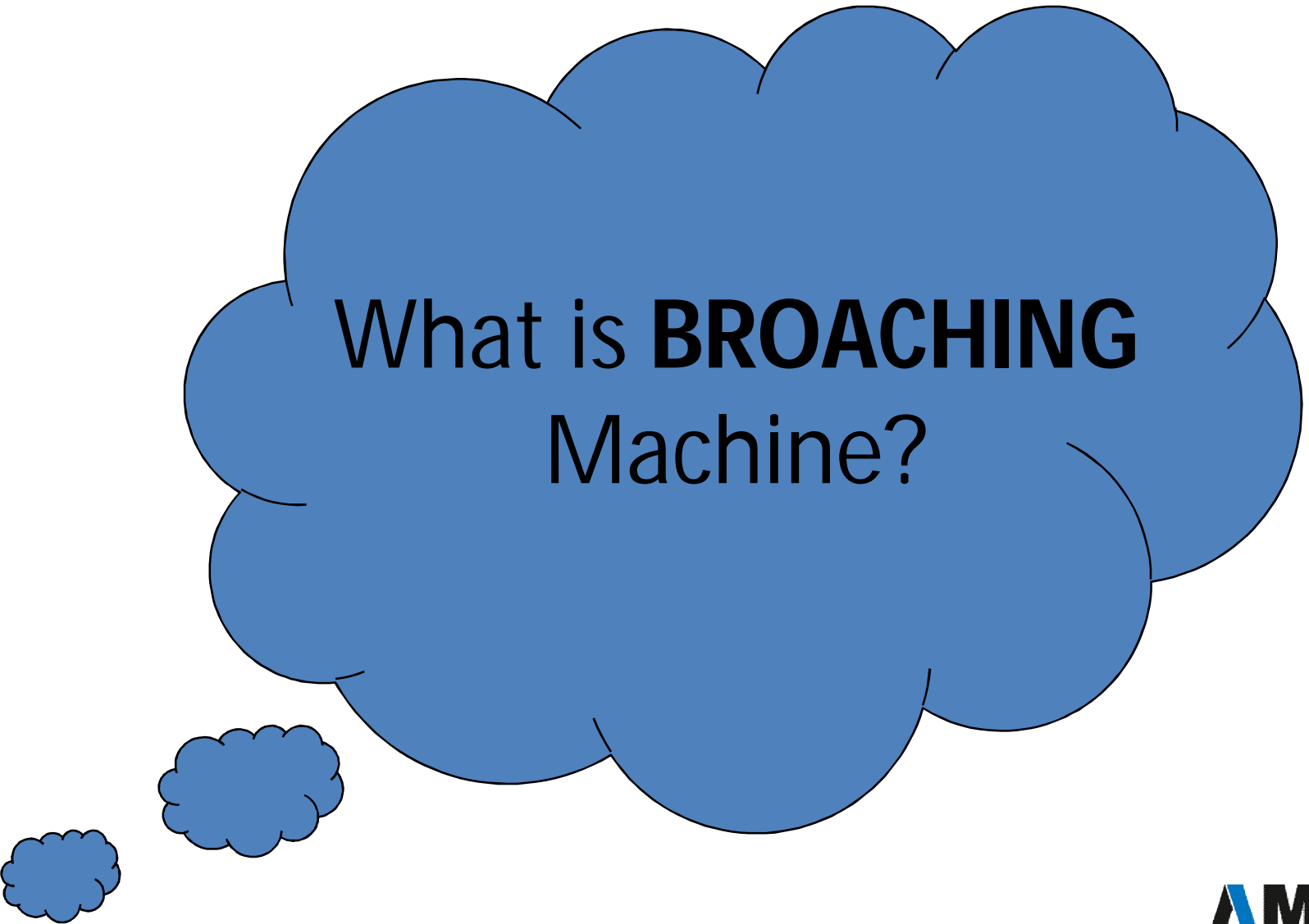


## Ch-7 Sawing & Broaching Machines



Subject:- MP  
Code:-3141908

Prepared by:  
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What is **BROACHING**  
Machine?

# What is Broaching?

Broaching is a machining operation in which a tool used is called as “*Broach*” having series of cutting teeth.

- In this operation broach is either *Pulled or Pushed* with the help of broaching machine on the workpiece surface.
- Parts that is produced by the broaching have *good surface finish and dimensional accuracy*.

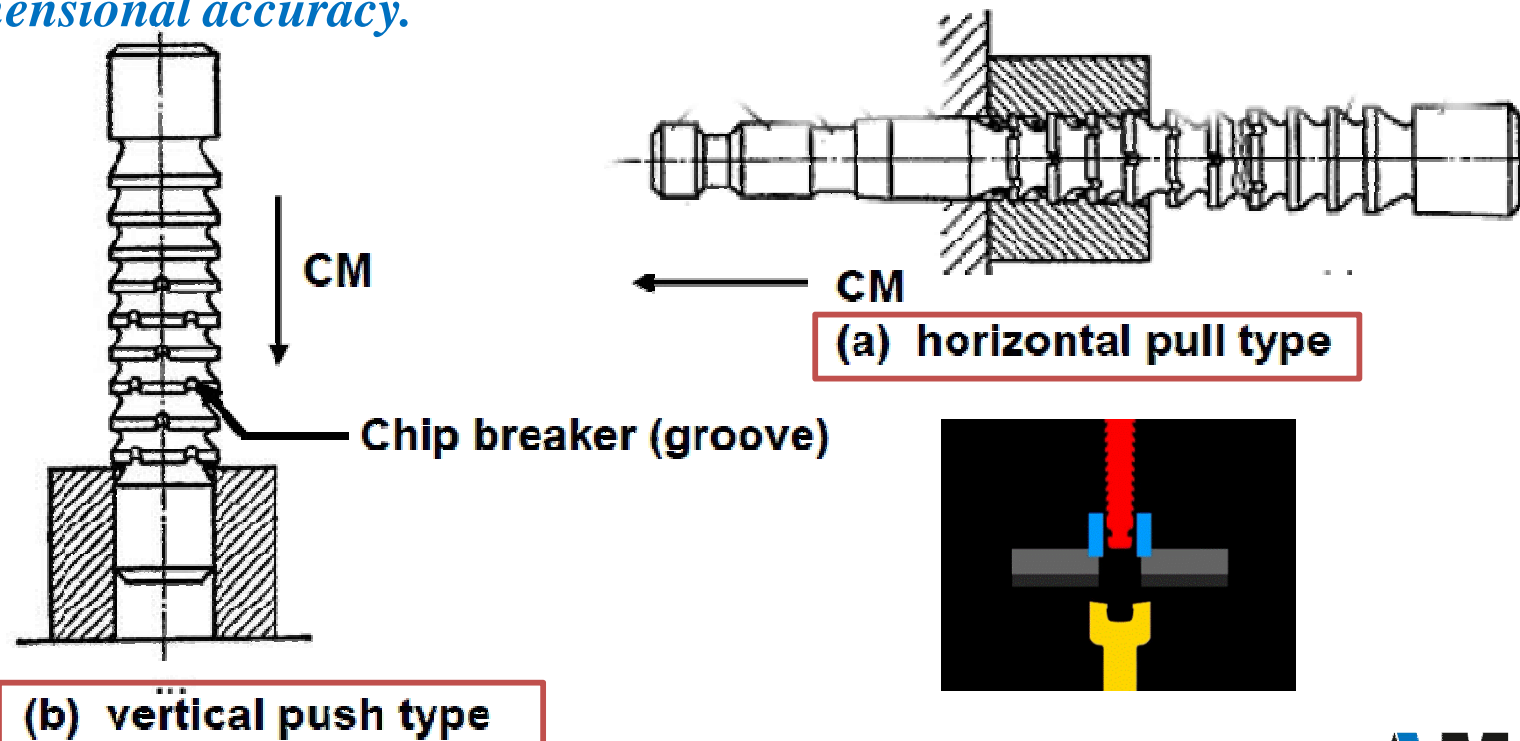
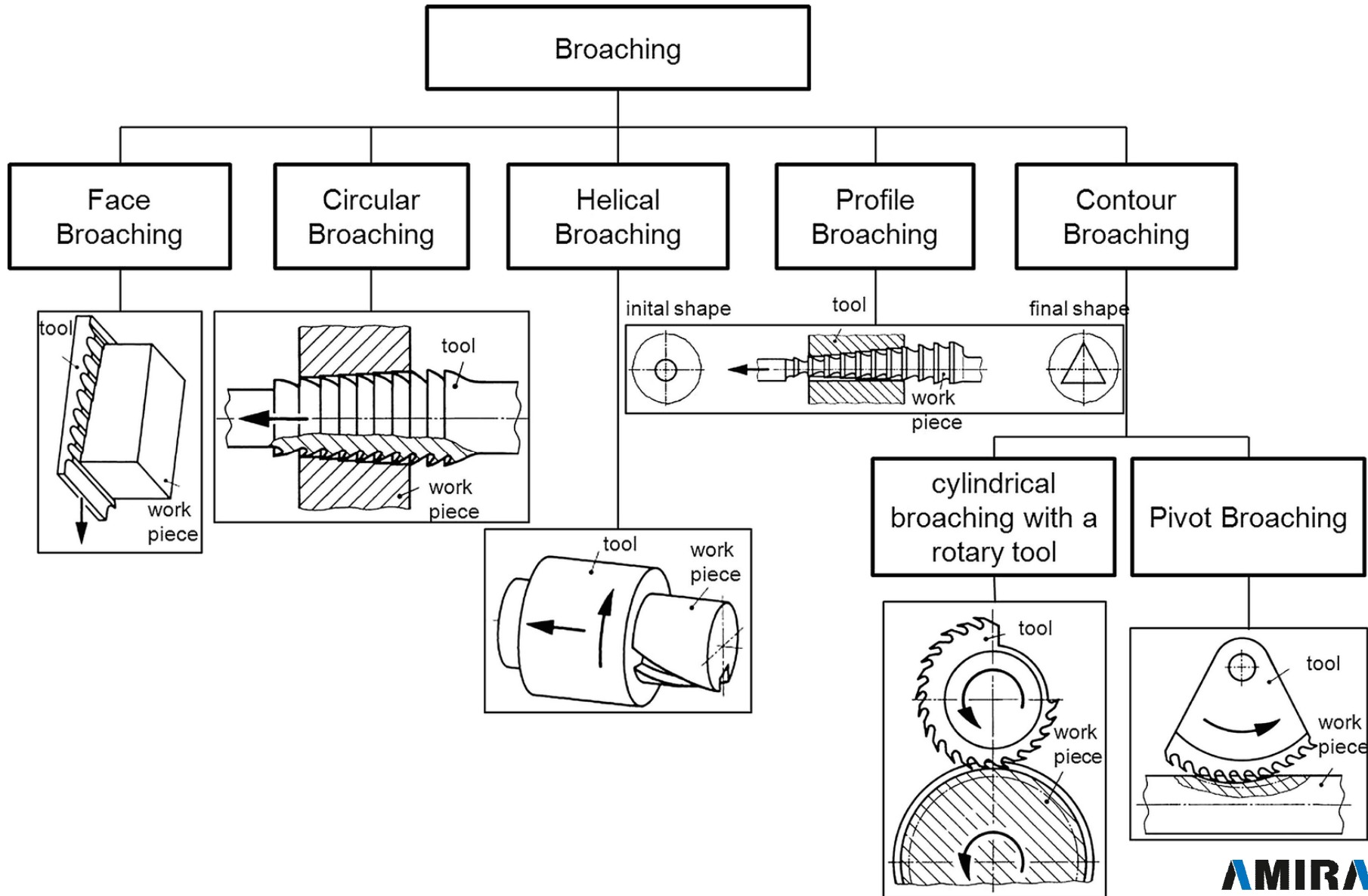
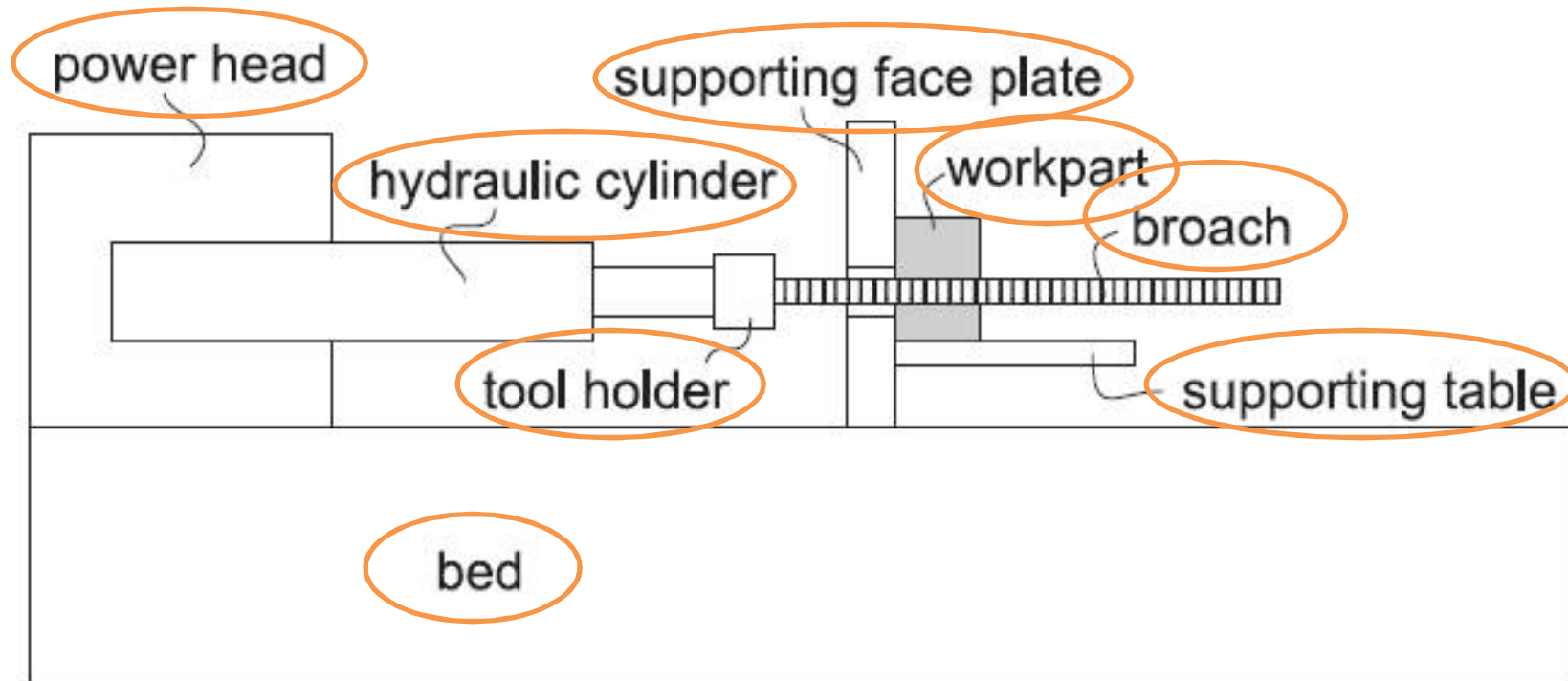


Fig. 4.10.2 Schematic views of finishing hole by broaching.

# Classification Broaching Machine



# Major Components of Broaching Machine



Major components of a broaching machine.

# Principle of Broaching

- When the broach is fed in a straight line, metal is cut in **several successive layer with the help of broach.**
- The thickness of each layer is same and called as **feed per tooth and sum of** the thickness of all the layers is called as **depth of cut.**

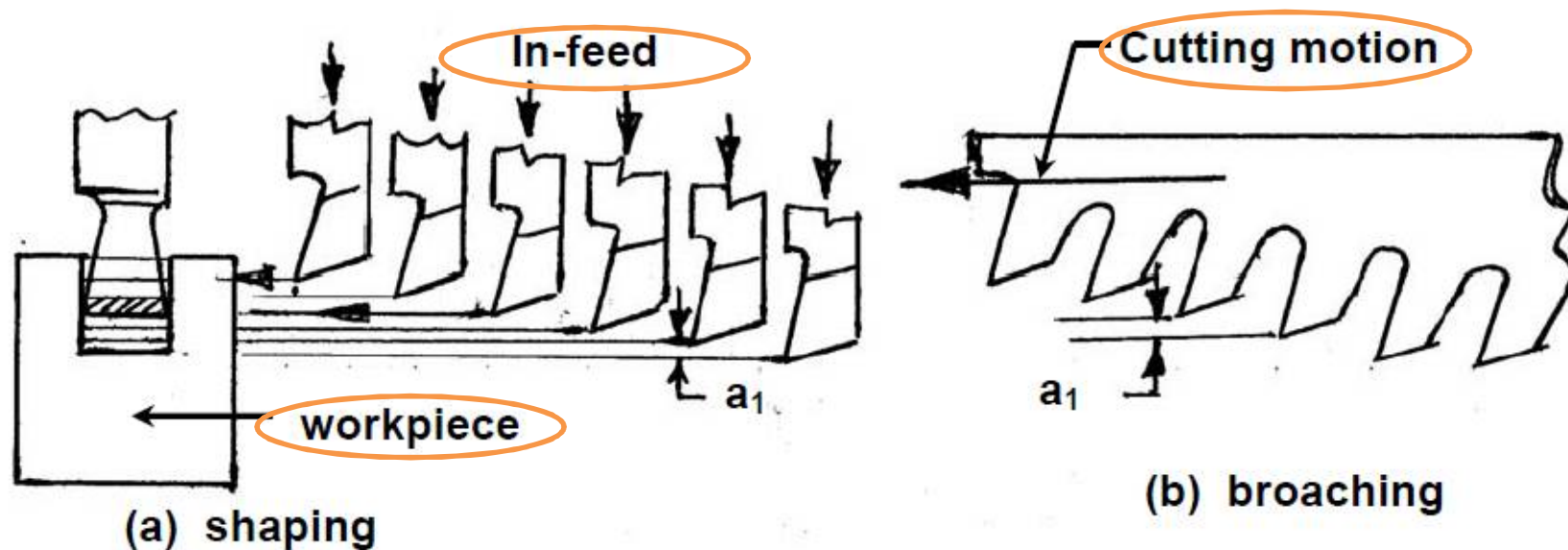


Fig. 4.10.1 Basic principle of broaching.

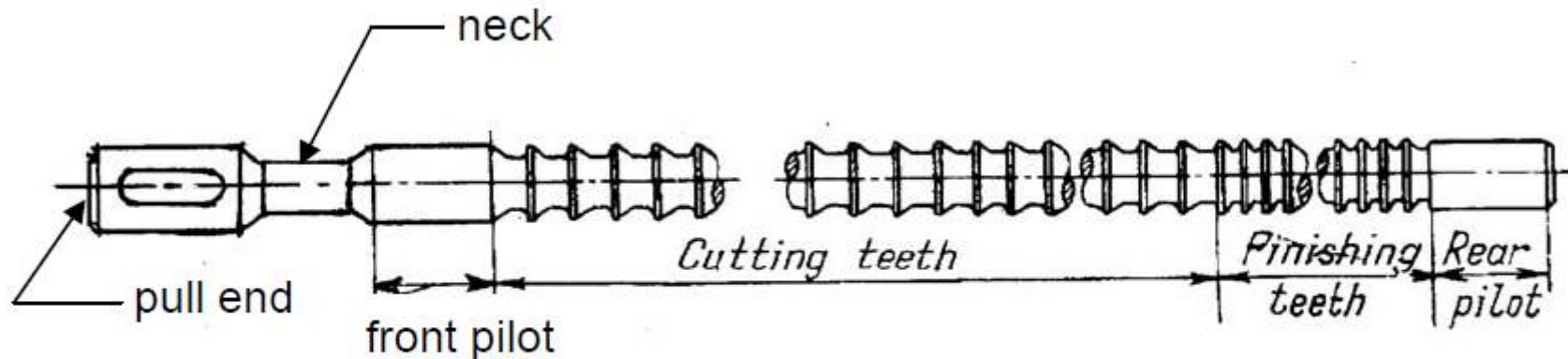
# *Construction of broaching tools*

❖ Construction of any cutting tool is characterised mainly by

1. Configuration
2. Material and
3. Cutting edge geometry

# 1. Configuration of broaching tool

- Both pull and push type broaches are made in the form of slender rods or bars of varying section having along its length one or more rows of cutting teeth with increasing height (and width occasionally).
- **Push** type broaches are subjected to compressive load and hence are made shorter in length to **avoid buckling**.
- The general configuration of **pull** type broaches, which are widely used for enlarging and finishing preformed holes, is schematically shown in Fig.



**Fig. 4.10.3** Configuration of a pull type broach used for finishing holes.



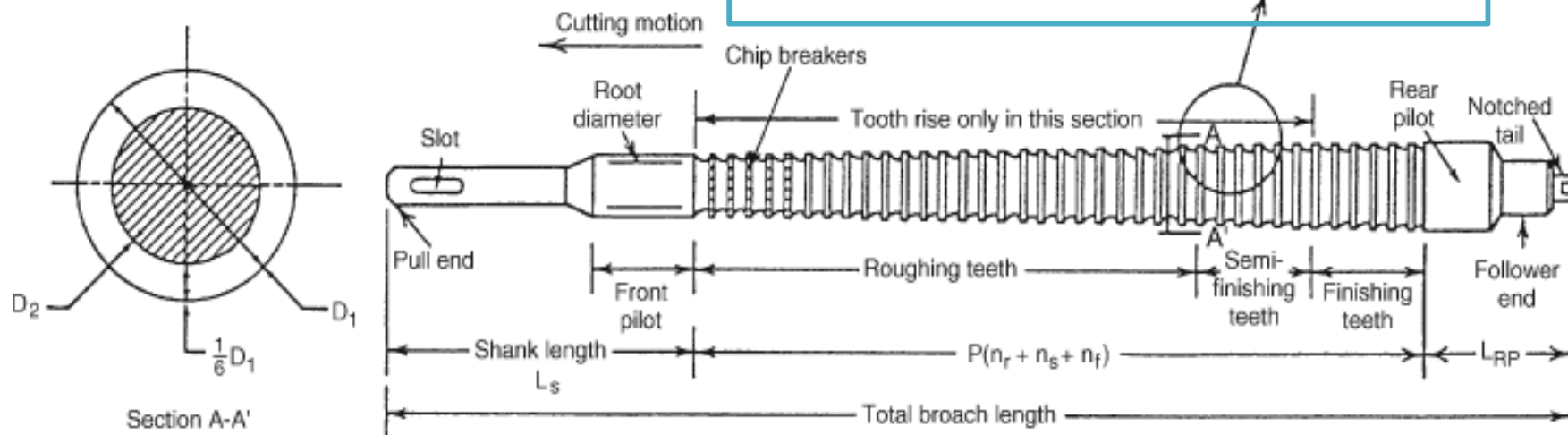
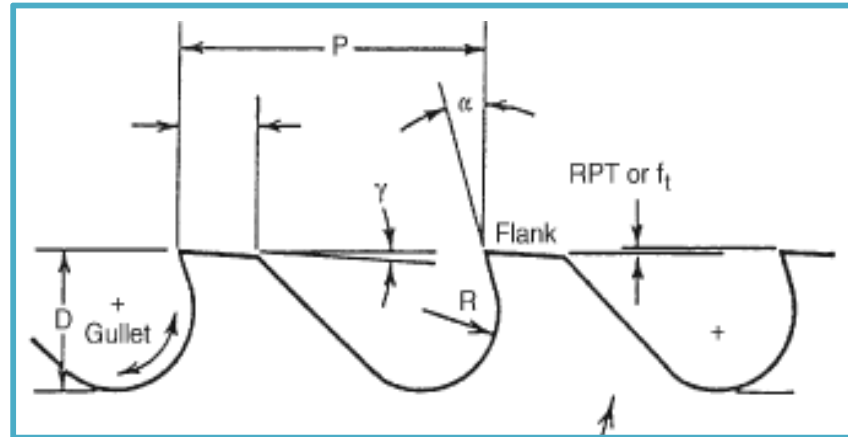
# 2. Material of Broach

- Being a cutting tool, broaches are also made of materials having the usual cutting tool material properties, i.e., **1.High strength, 2.Hardness, 3.Toughness and 4.Good heat and wear resistance.**
- For ease of manufacture and resharpener the complex shape and cutting edges, broaches are mostly made of **HSS** (high speed steel).
- To enhance cutting speed, productivity and product quality, now-a-days cemented carbide segments (assembled) or replaceable inserts are also used specially for stronger and harder work materials like **cast irons and steels.**
- **TiN coated carbides** provide much longer tool life in broaching. Since broaching speed (velocity) is usually quite low, **ceramic tools are not used.**

# 3. Geometry of Broaching Teeth and their Cutting Edges

- The cutting teeth of HSS broaches are provided with positive radial or orthogonal rake ( $5^\circ$  to  $15^\circ$ ) and sufficient primary and secondary clearance angles ( $2^\circ$  to  $5^\circ$  and  $5^\circ$  to  $20^\circ$  respectively) as indicated in Fig. 4.10.4.

- P — pitch of teeth
- D — depth of teeth ( $0.4P$ )
- L — land behind cutting edge ( $0.25P$ )
- R — radius of gullet ( $.25P$ )
- $\alpha$  — hook angle or rake angle
- $\gamma$  — backoff angle or clearance angle
- RPT — rise per tooth (chip load) =  $f_t$



# Selection of Broach and Broaching Machine

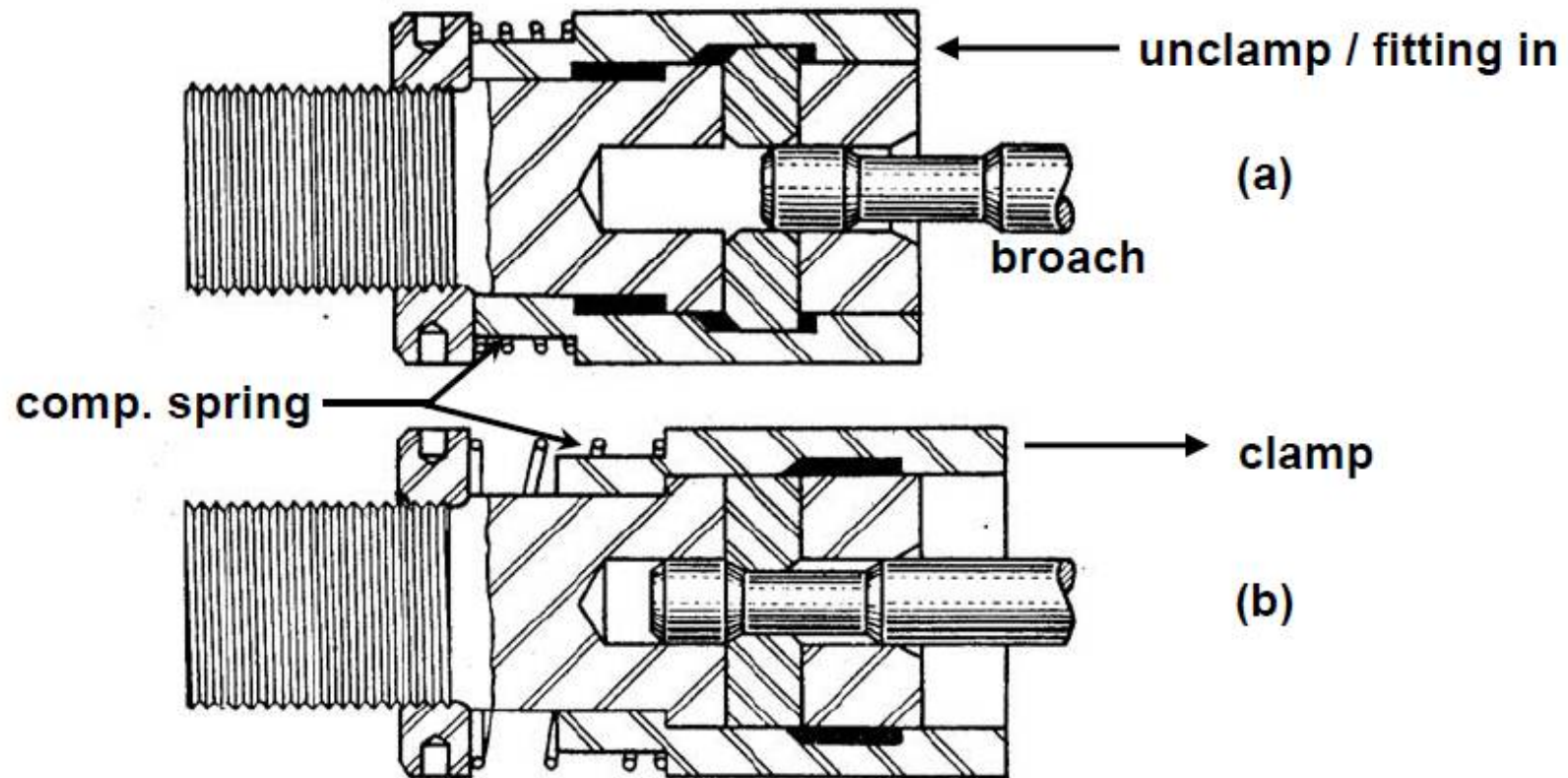
There are various types of broaches available. The appropriate one has to be selected based on

- o Type of the job ,size, shape and material
- o Geometry and Volume of work material to be removed from the job
- o Desired length of stroke and the broach
- o Type of the broaching machines available or to be used

Broaching machine has to be selected based on

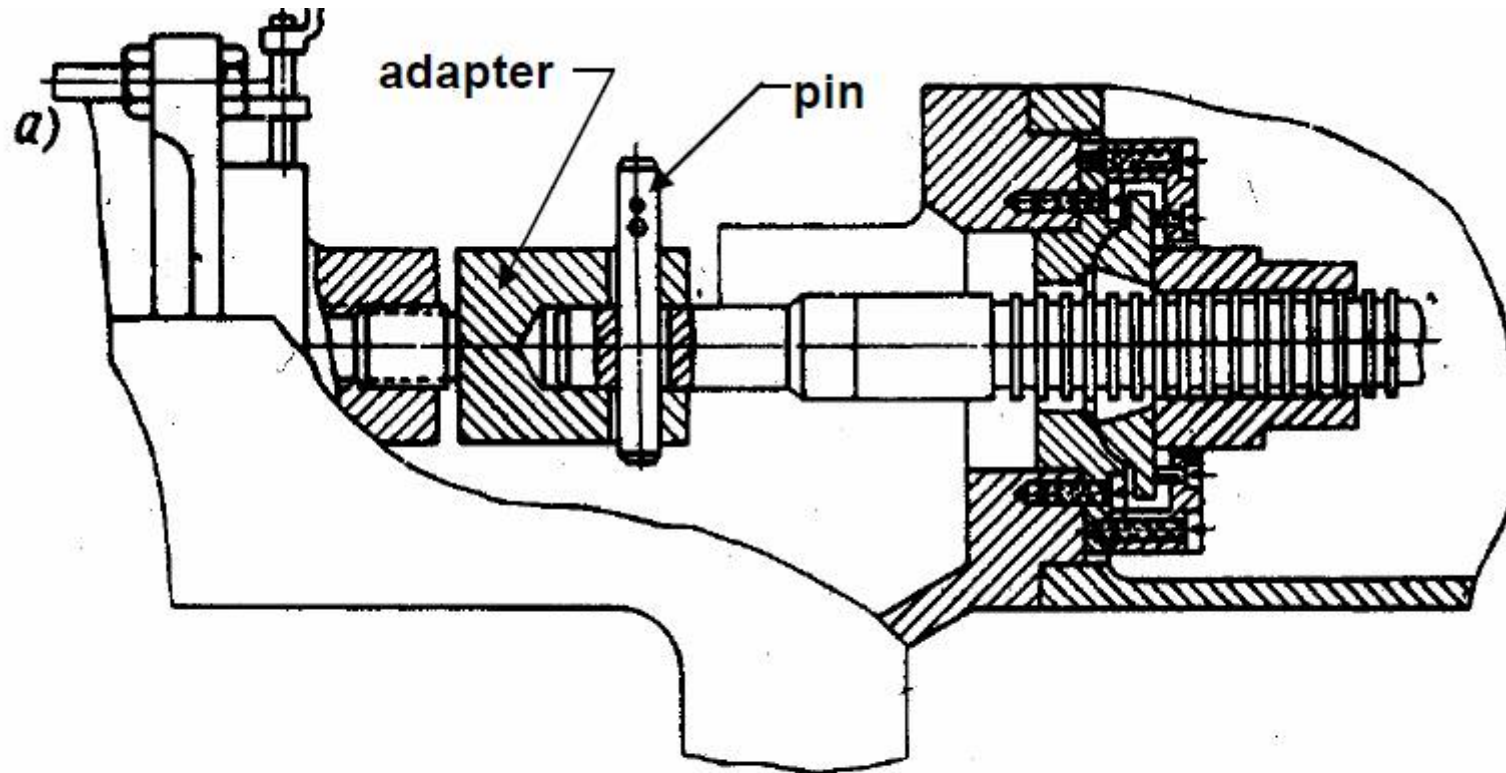
- o The type, size and method of clamping of the broach to be used
- o Size, shape and material of the workpiece
- o Strength, power and rigidity required for the broaching machine to provide the desired productivity and procecapability.

# Mounting and Clamping Broach in the machine



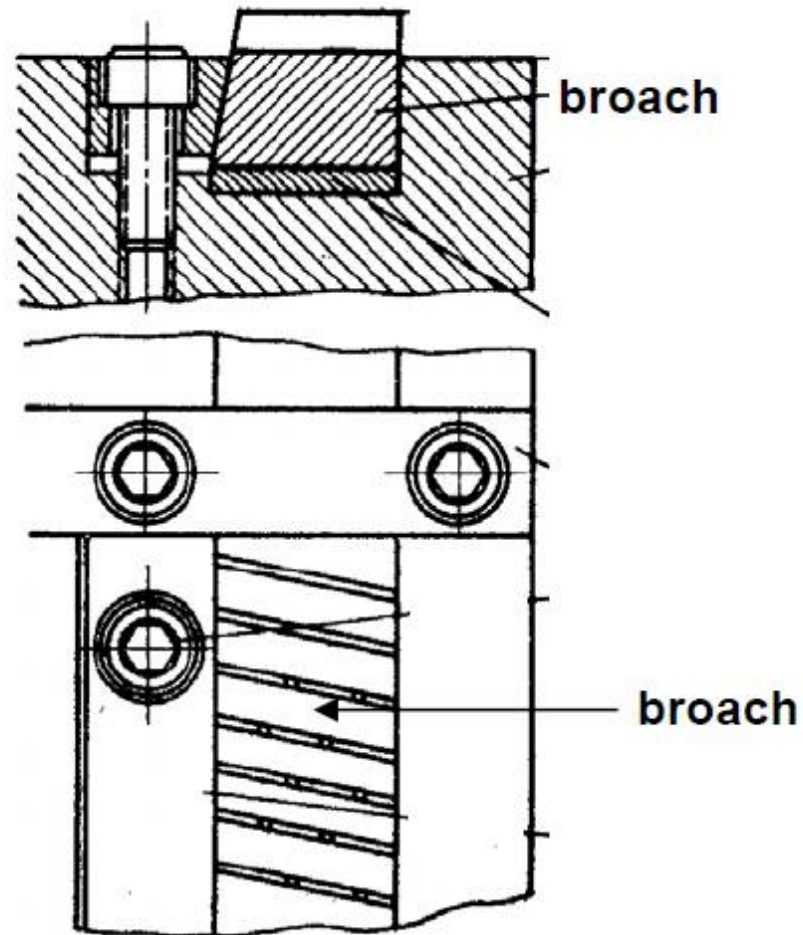
*Fig. 4.10.5 Mounting and clamping pull type broach.*

# Mounting and Clamping Broach in the machine



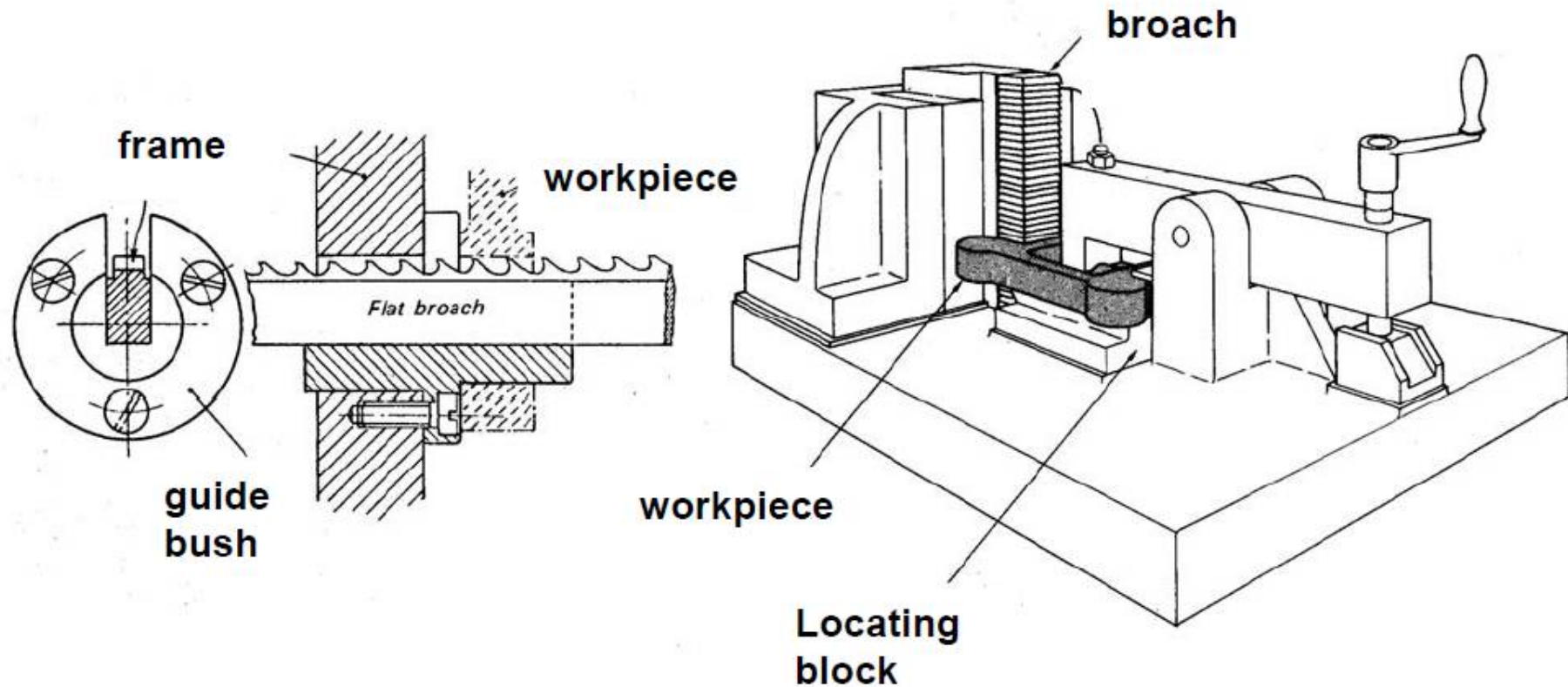
**Fig. 4.10.6** *Fitting pull type broach by an adapter and a pin.*

# Mounting and Clamping Broach in the machine



*Fig. 4.10.7 Mounting external broach for surfacing and slotting.*

# Mounting and Clamping Broach in the machine



**Fig. 4.10.8** *Mounting blank in broaching machine.*

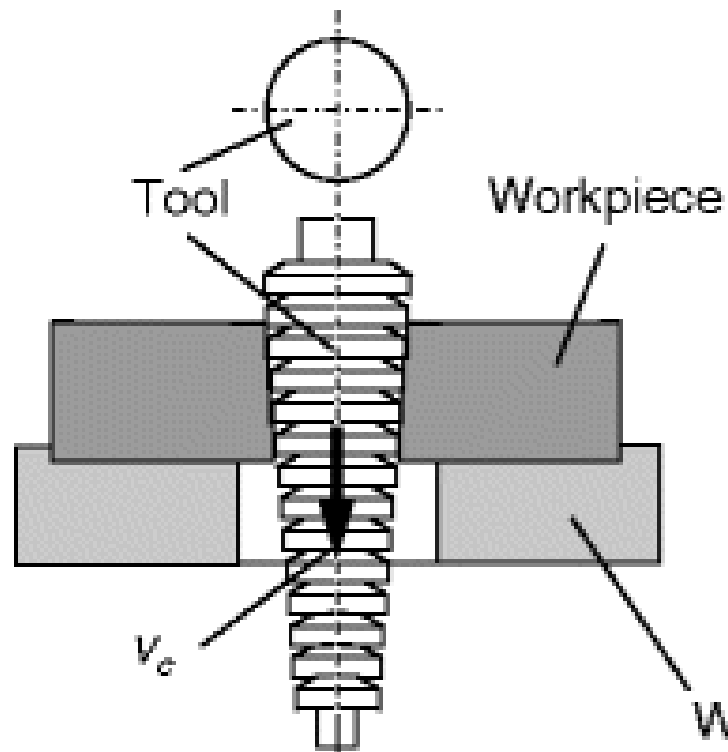
# Different Types Of Broaches And Their Applications

Broaches can be broadly classified in several aspects such as,

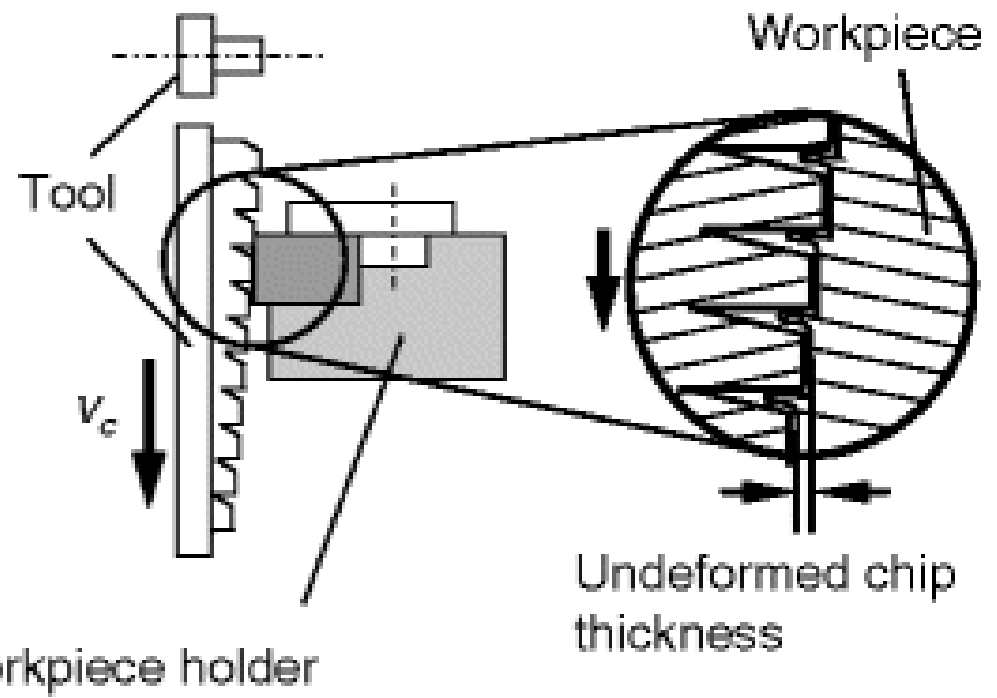
- 1 • Internal broaching or External broaching
- 2 • Pull type or Push type
- 3 • Ordinary cut or Progressive type
- 4 • Solid, Sectional or Modular type
- 5 • Profile sharpened or form relieved type



### Internal broaching



### External broaching



# Internal broaching

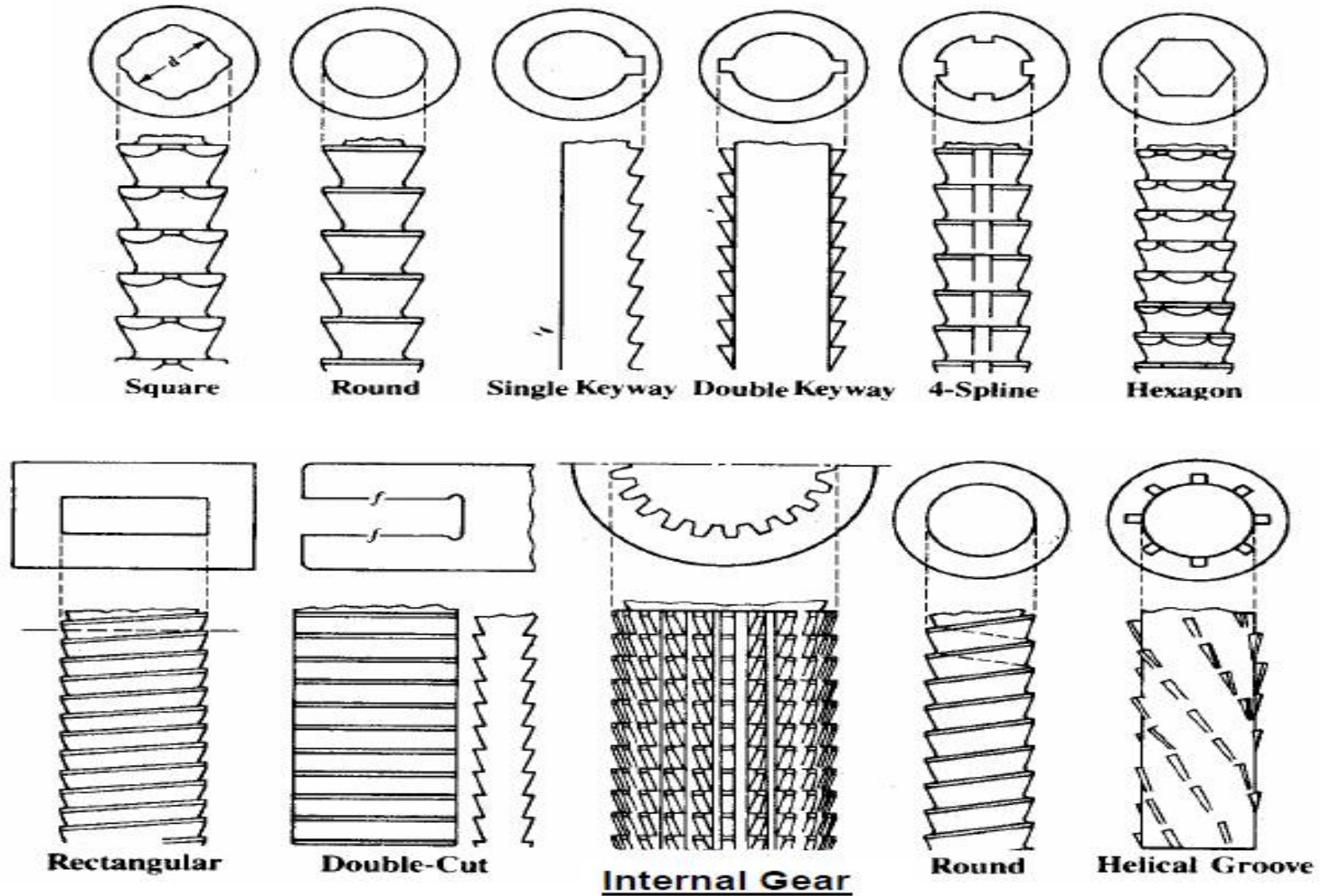
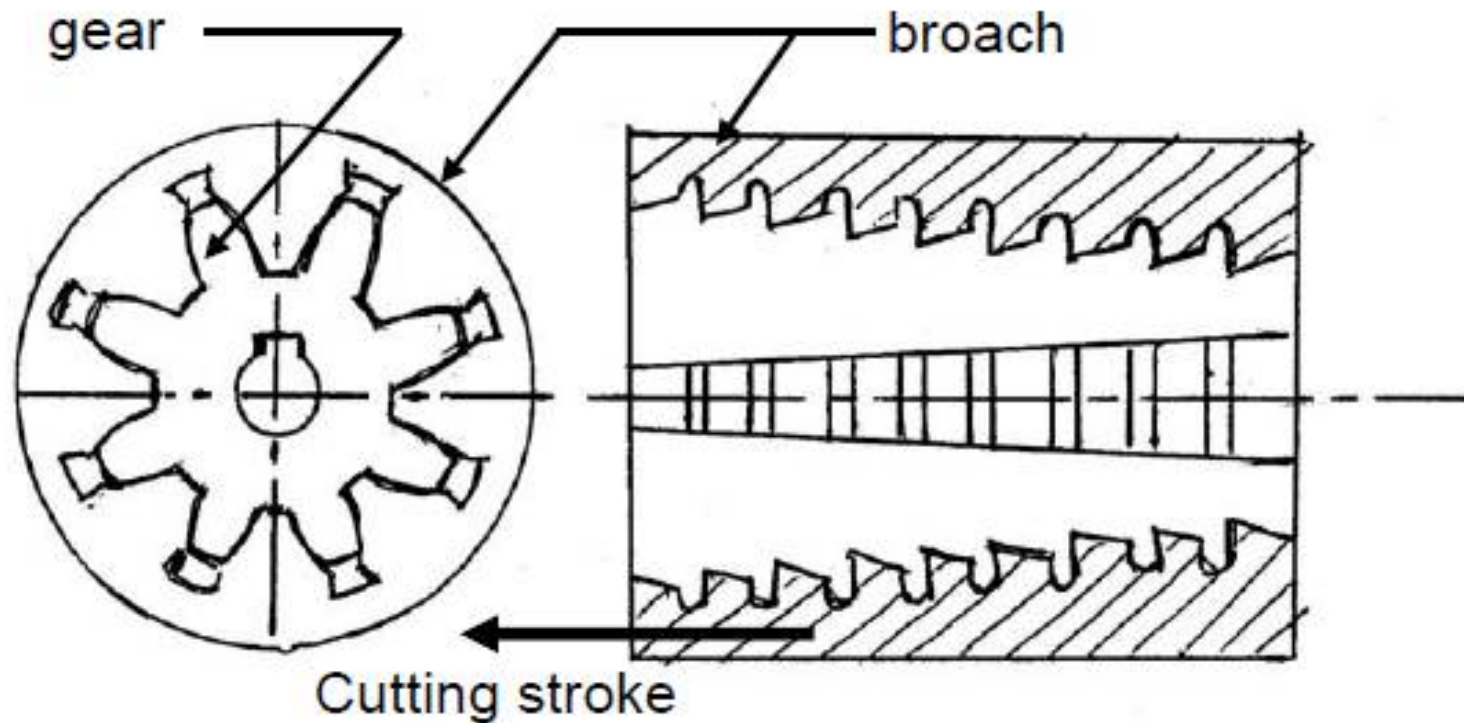


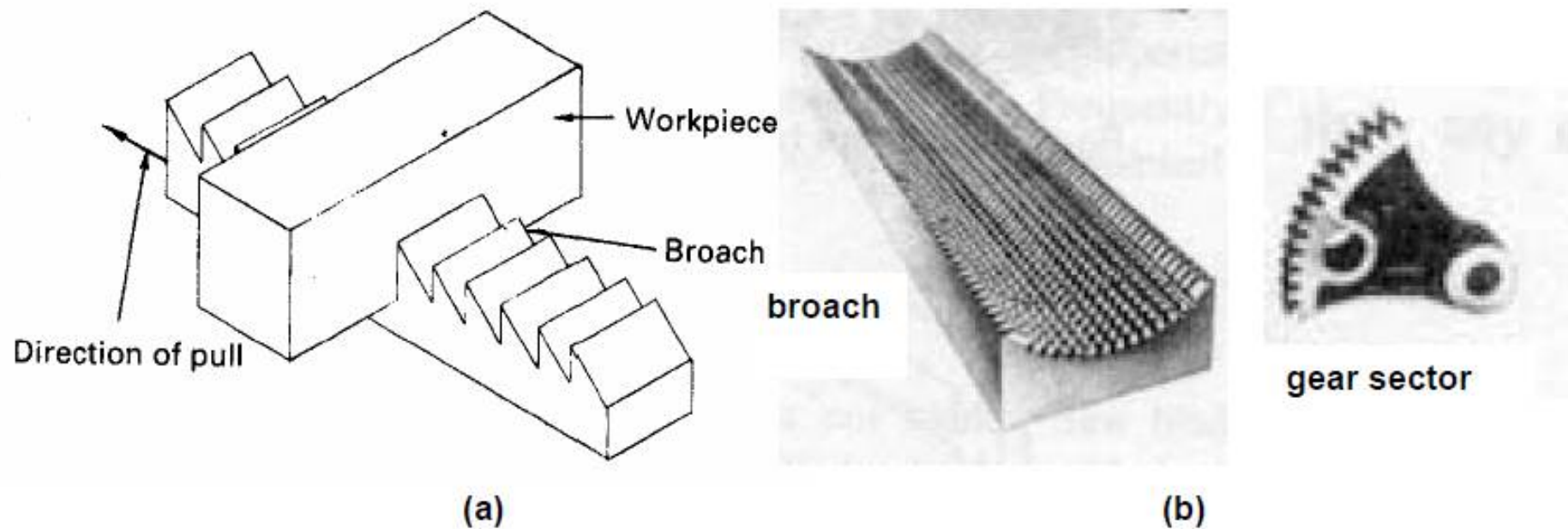
Fig. 4.10.9 Internal broaching – tools and applications.

# External Broaching



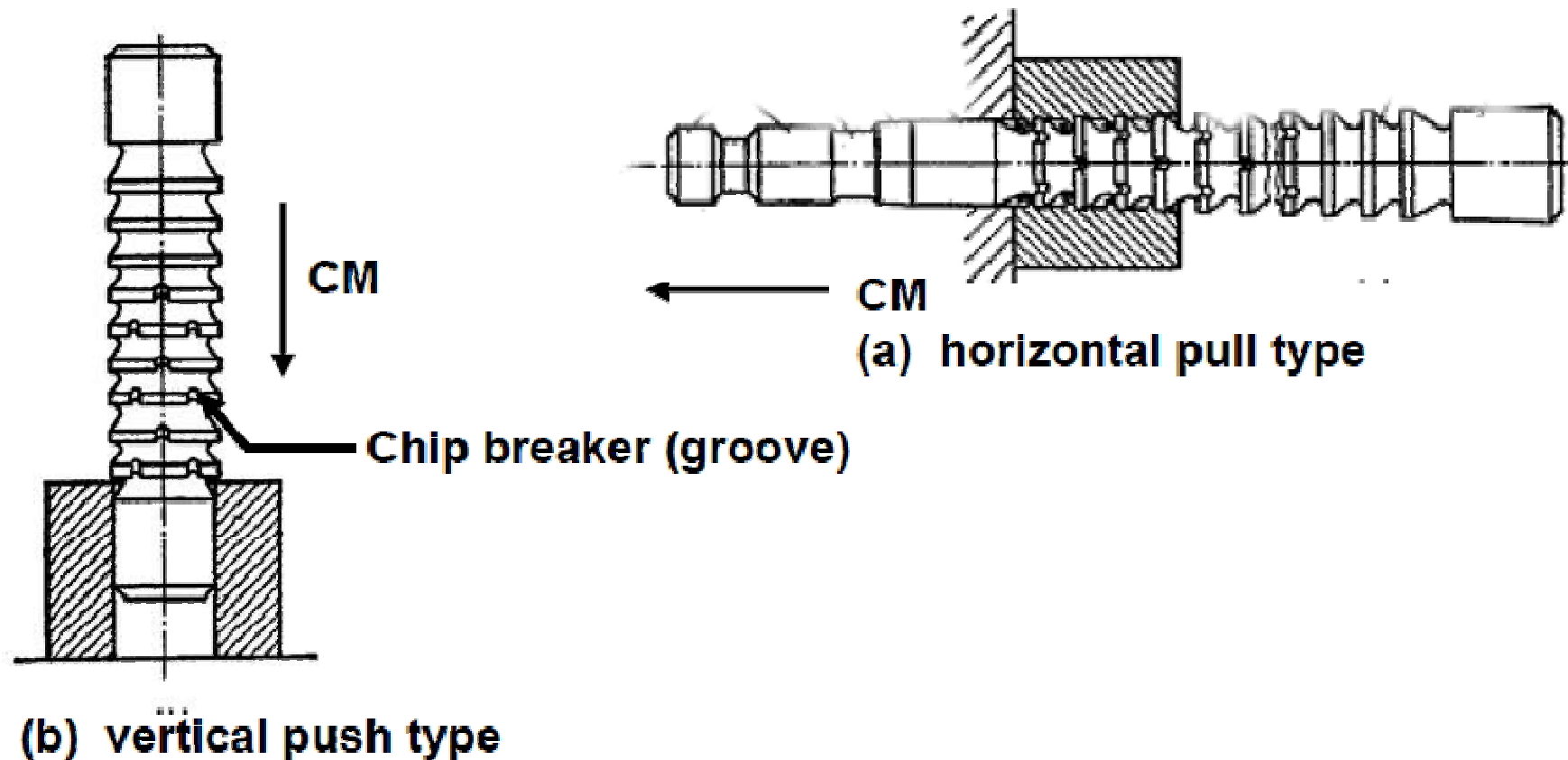
*Fig. 4.10.10 Machining external gear teeth by broaching.*

# External Broaching



**Fig. 4.10.11** Typical external broaching (a) making slot  
(b) teeth of gear sector

# Pull type and Push type broaches



**Fig. 4.10.2** Schematic views of finishing hole by broaching.

# Ordinary – cut and Progressive type broach

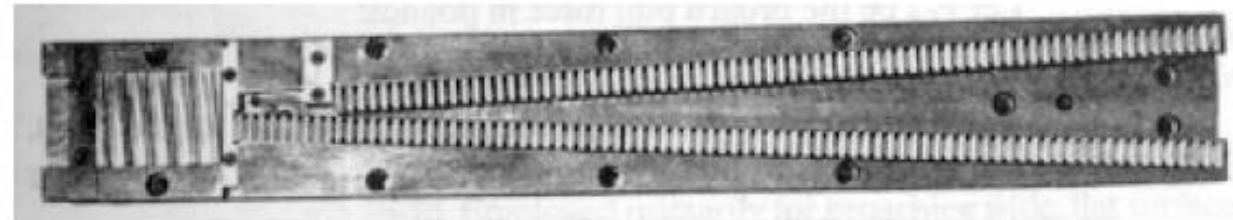
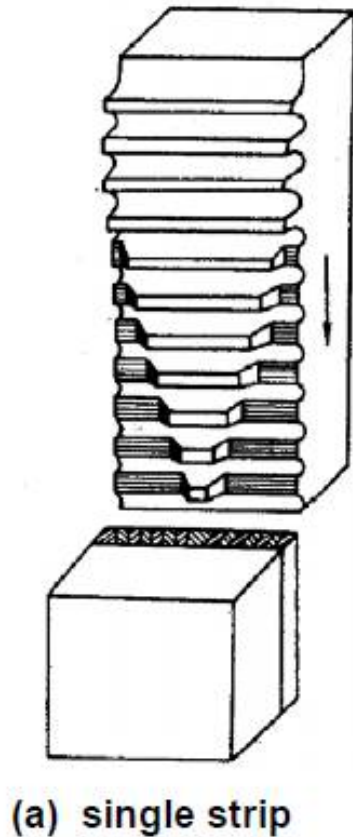
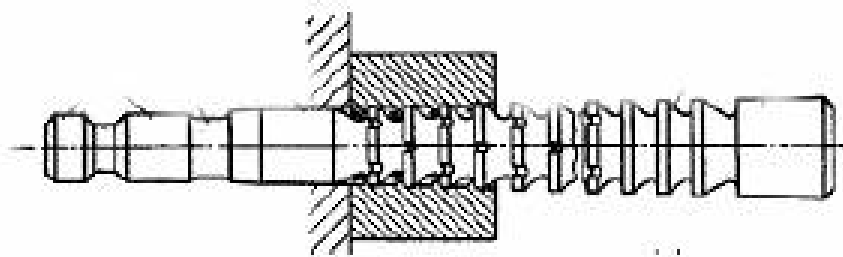
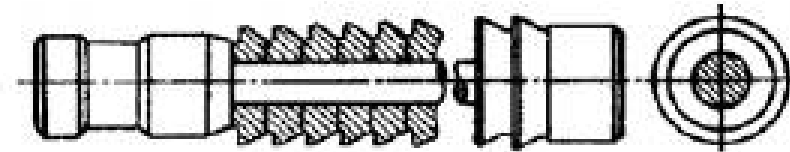


Fig. 4.10.12 Progressive – cut type broaches; (a) single bar and (b) double bar type

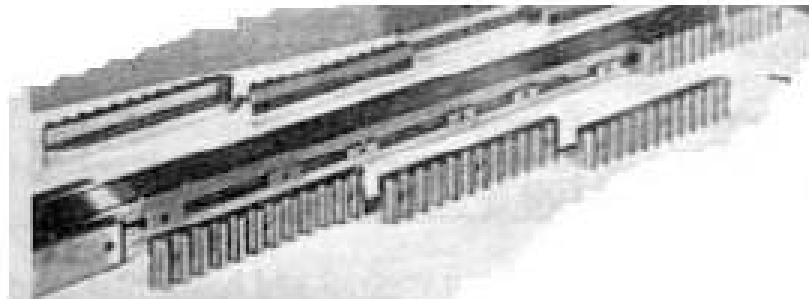
# Solid, Sectional and Module type Broaches



(a) solid



(b) sectional



(c) segmented

**Fig. 4.10.13** (a) Solid, (b) Sectional and (c) Segmented broaches.

# Classification Broaching Machine

There are different types of broaching machines which are broadly classified

## **1. According to purpose of use**

Δ general purpose

Δ single purpose

Δ special purpose

## **2. According to nature of work**

Δ internal broaching

Δ external (surface) broaching

## **3. According to configuration**

Δ horizontal

Δ vertical

## **4. According to number of slides or stations**

Δ single station type

Δ multiple station type

Δ indexing type

## **5. According to tool / work motion**

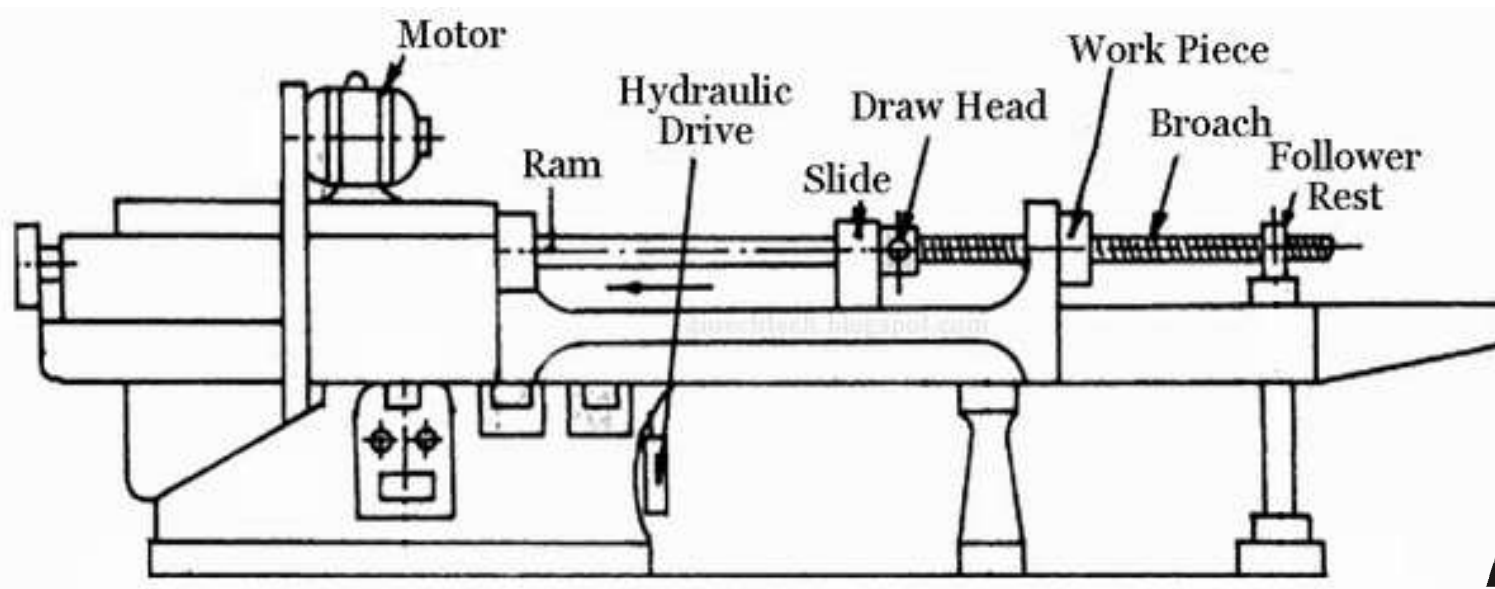
Δ intermittent (one job at a time) type

Δ continuous type

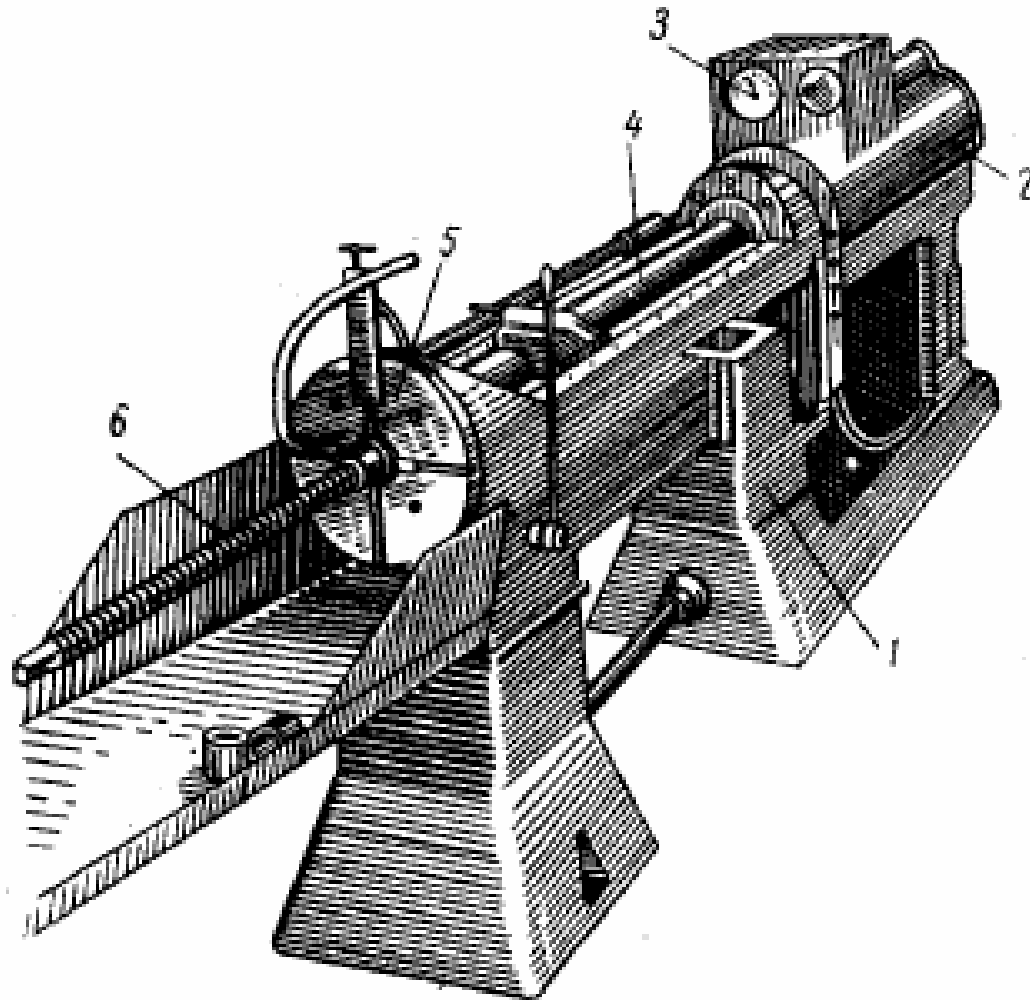


# Horizontal broaching machine

- Horizontal Broaching Machines are capable of **both internal and external surfaces**.
- In operation either workpiece is kept stationery and broach is fed past or broach is kept stationery and workpiece is fed past.
- This machine has **bed similar to the lathe machine**.
- This machine range from **2 to 60 tones and stroke of 3m for internal broaching machine** and for external broaching machine it ranges upto **100 tones and stroke of 9m**.



# Horizontal broaching machine

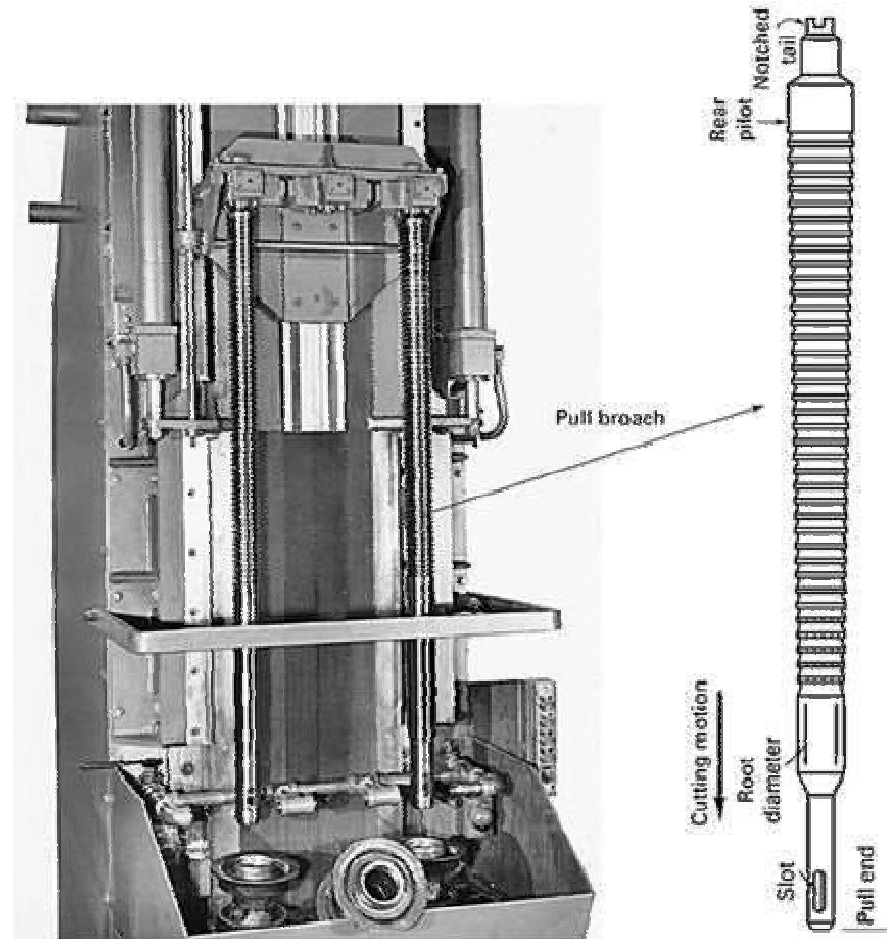


**Fig. 4.10.14** *Horizontal broaching machine.*

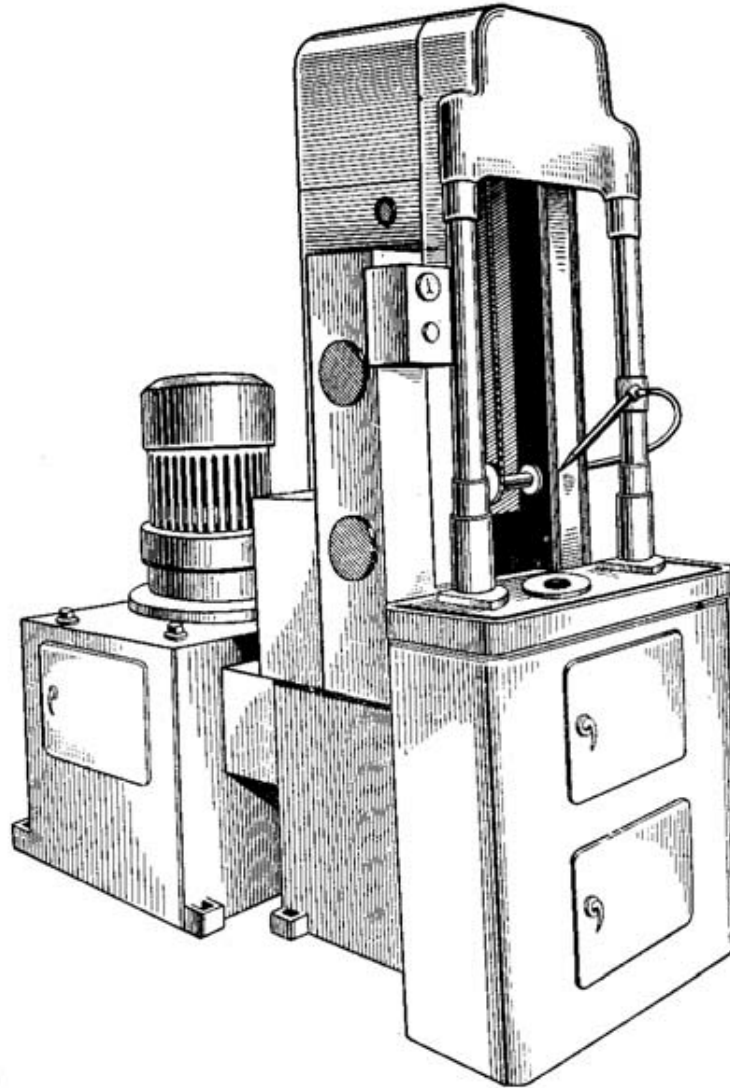
# Vertical broaching machine

This type of machine are available for **both pull up and pull down type of machine.**

- This machine is only used for **internal broaching or hole broaching.**
- In this machine we can mount **more than one broach.**
- In the pull down type the workpiece is mounted on table and the broach is lowered to pass its front pilot through the workpiece.
- In the pull up type, the only difference is that the ram is provided at the top which will carry the broach from bottom to top.



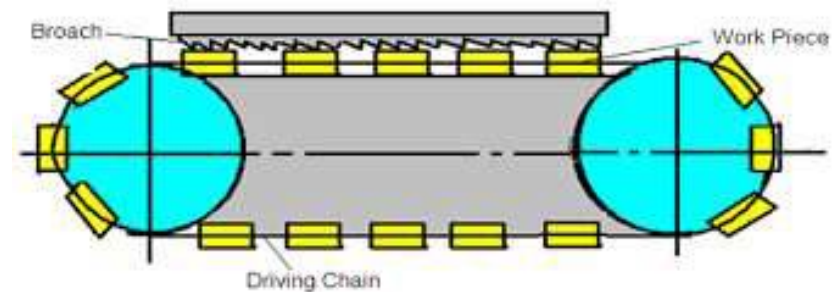
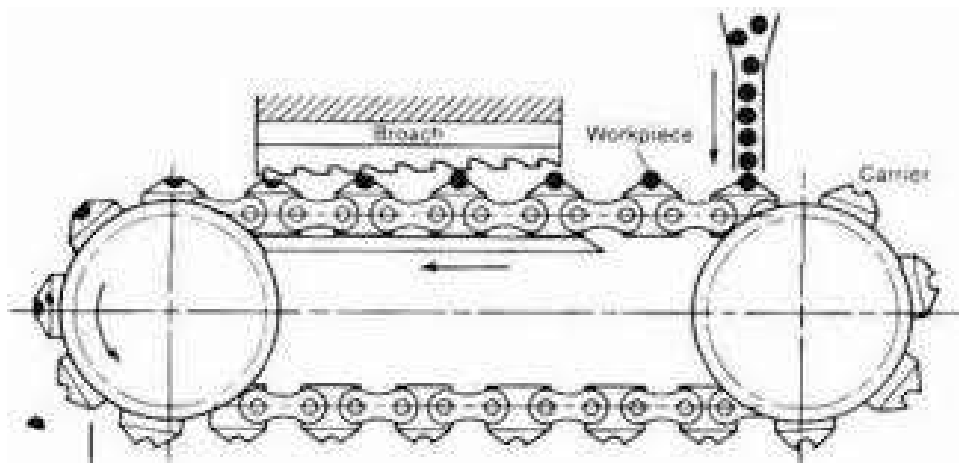
# Vertical broaching machine



# Continuous Broaching Machine

This machine are available both in **horizontal and vertical type**.

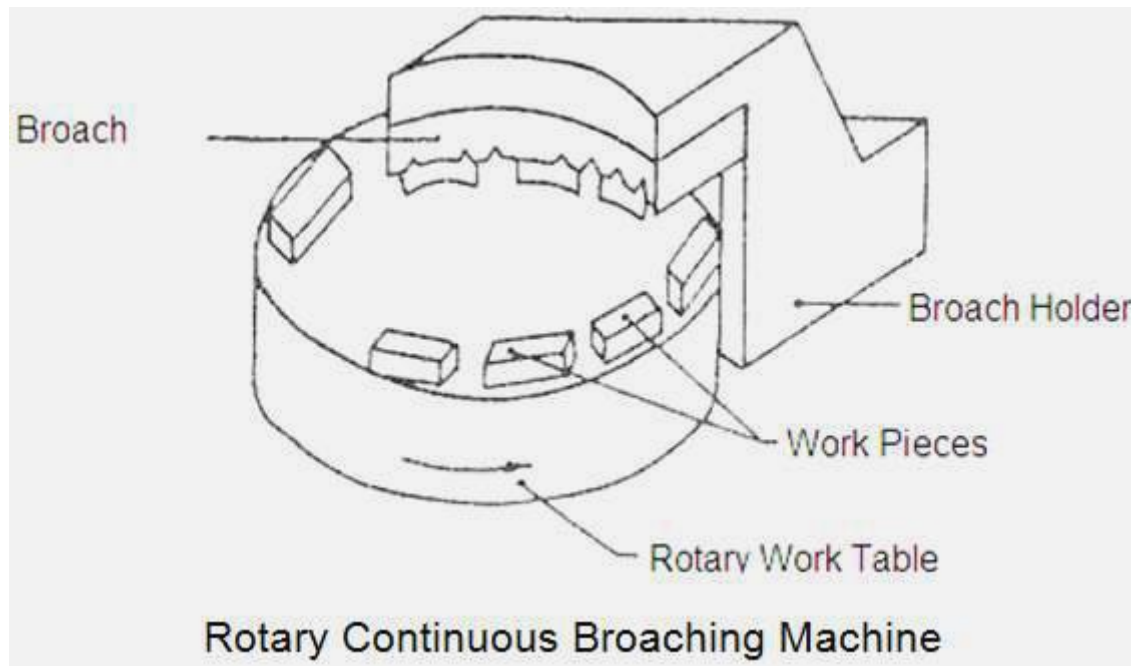
- In this machine the **broach remains stationery while the workpiece moves** continuously past.
- In this machine the workpiece are fed past on the chain which is traveling continuously with the help of **sprockets on both the end**.
- The chain has **a series of fixtures which will hold the workpiece**.
- In this machine the workpiece is loaded on a side and unloaded on the other side.



Horizontal Continuous Broaching Machine

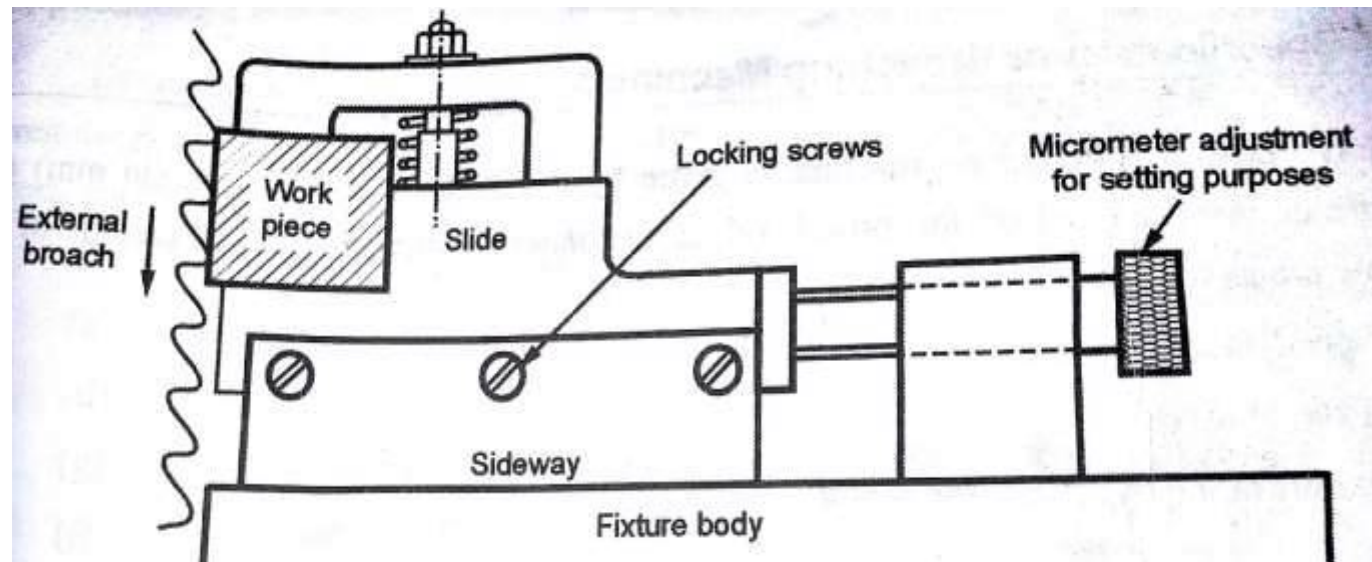
# Rotary Table Broaching Machine

- This machine is also used as a **Continuous Broaching Machine**.
- In this machine a table is provided which **continuously rotates about a vertical axis**.
- On this the fixtures are mounted and broach is held tightly on broach holder.
- The shape of the **broach is same as of the table**.
- As the table rotates the workpieces are **loaded, machined and unloaded**.



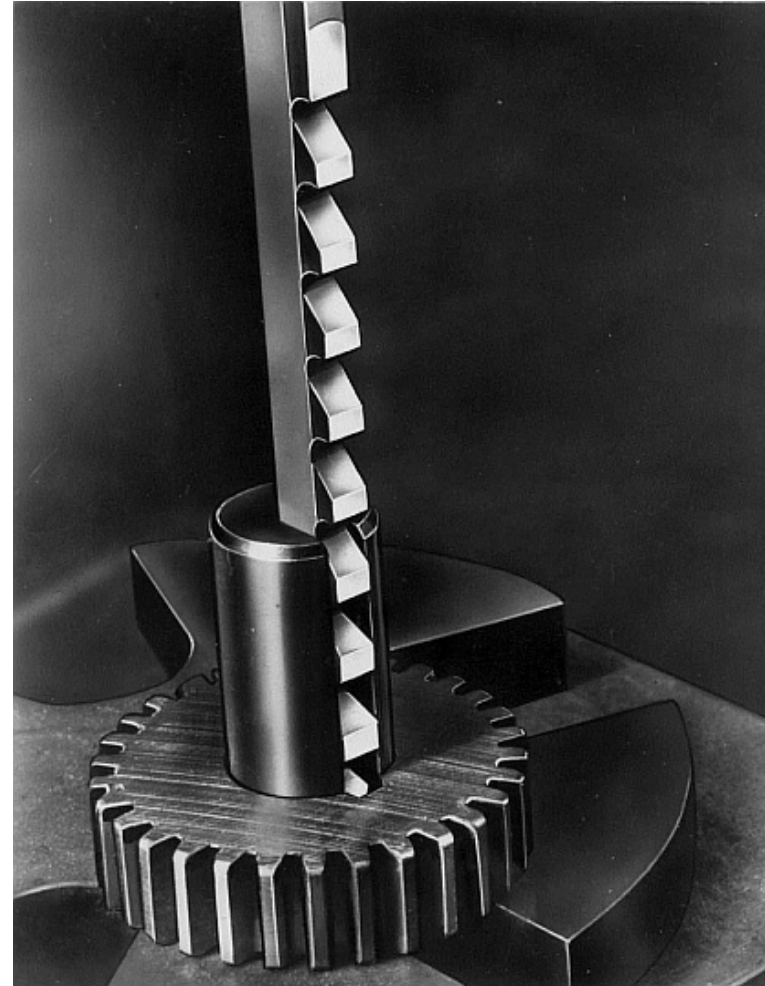
# Surface Broaching Machine

- In this machine either workpiece or broach moves across each other.
- These machines are generally **vertical and hydraulically operated**.
- This machine is an **alternative to milling machine** so machine fixtures are also used to hold the workpiece.
- These machines are used for **large quantities of workpiece having flat surfaces**.



# Keyway Broaching Machine

- This machine is the simplest type of machine and it can be used for general purpose also.
- If multiple keyways or splines are to be cut the single broach can be used with the workpiece and indexed after each other.
- This machines method is the oldest methods of all.





# Advantages of Broaching

- Broach has a **longer life than other tools.**
- Broach can perform **roughing and finishing operations.**
- High skilled operator is **not required.**
- **Interchangeable components can be produced at faster rate.**

# Disadvantages of Broaching

- In this process, all jobs **need a fixture.**
- Sharpening of broach is **difficult and expensive.**
- With the help of broaching, it is difficult to produce **blind holes.**
- Initial cost of broach and broaching machine is **very high.**

# Applications of Broaching

- The examples of components produced by broaching are as follows:
  1. Bearing caps
  2. Bearing bodies
  3. Cylinder blocks
  4. Connecting rods
  5. Gears and Turbine
  6. Keyways
  7. Splines



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