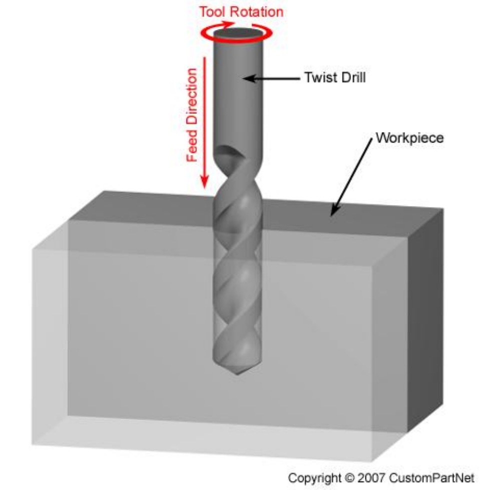
Drilling and Allied operations

Lect : 11

TA 102 Workshop Practice



By

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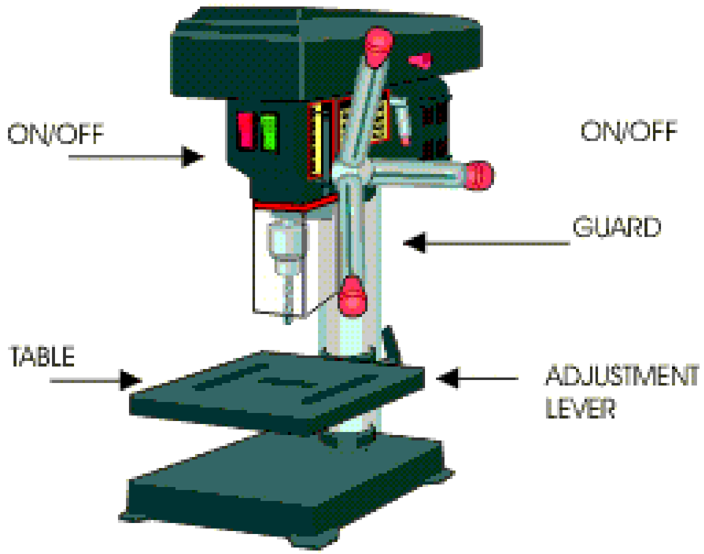
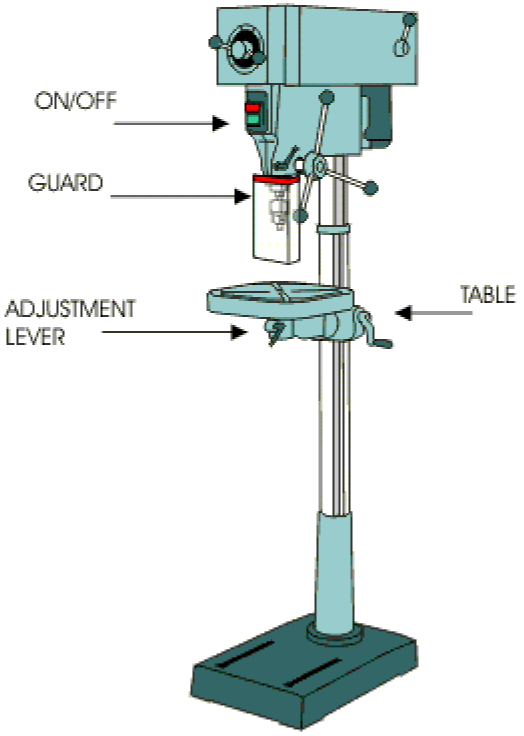
Drilling

- The process of making holes is known as drilling and generally drilling machines are used to produce the holes.
- Drilling is an extensively used process by which blind or though holes are originated or enlarged in a work piece.
- The tool used for making holes is called drill.





Drilling Machines

- The drilling machine is also called drill press.
- The two common types of drilling machines are

  i) drill press ii) radial drilling machine

- The drill press is relatively easy to set up and use.
- The radial drilling machine is more versatile and suitable to drill multiple holes in a heavy job.

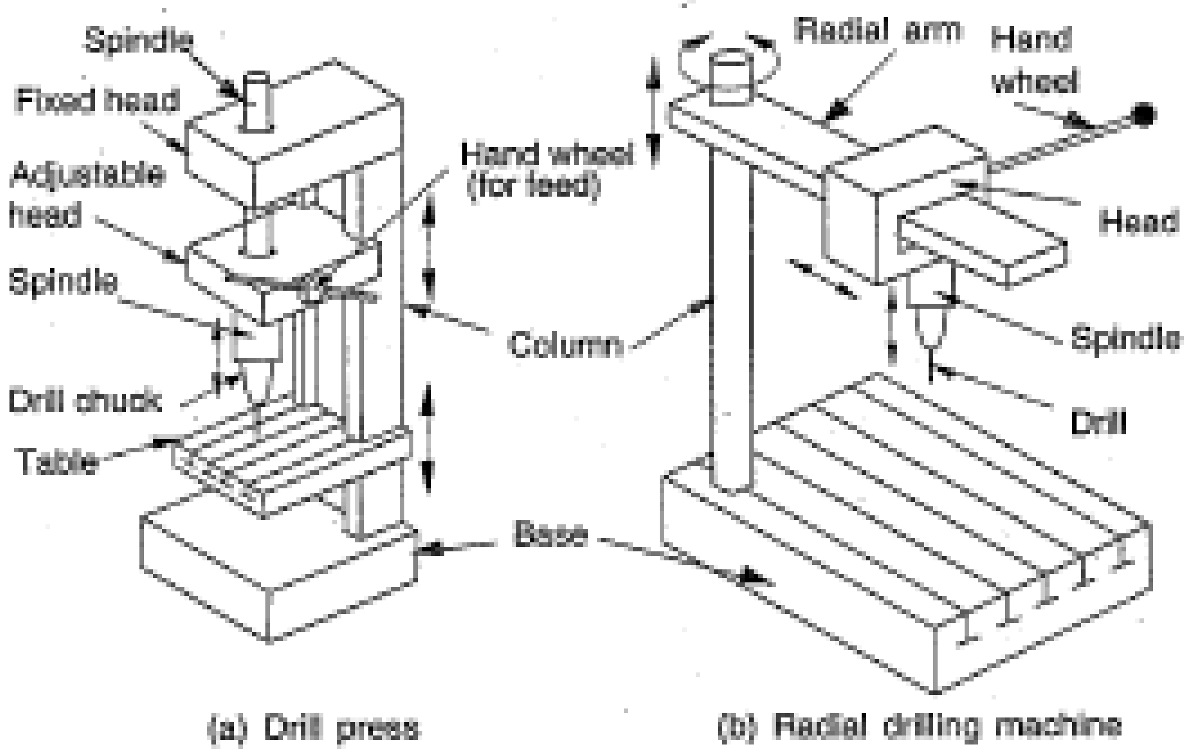


Figure 6.1 Two common types of drilling machines.

- **Various other types of drilling machines are available for specialized jobs.**

These may be portable, bench type, multiple – spindle, gang, multiple drills or automatic drilling machines.

- the size of the drilling machine is usually specified by the largest diameter of the hole that can be drilled on it.

The Drilling operation

- The work piece is placed on the adjustable table or base, and is clamped firmly both for safety and accuracy to over come high drilling torque.
- The cutting tool i.e., the drill, is fastened to the end of the vertical spindle, and is rotated at the desired speed.
- The rotating drill is fed against stationary work piece either by hand feed or by power feed.

The Drill

- The tool employed to drill holes is called drill.
- A drill is a multi point cutting tool.
- A drill consists of the body, point, neck and shank.
- The shank is for holding or fixing the drill in the drilling machine. It is either taper or straight.
- The chips that are produced with in the work piece have to move in the direction opposite to the axial movement of the drill and cutting fluid has to reach the cutting edges at the end of the drill. Hence, chip disposal and effectiveness of cutting fluids are significant problems in drilling.

The Drill

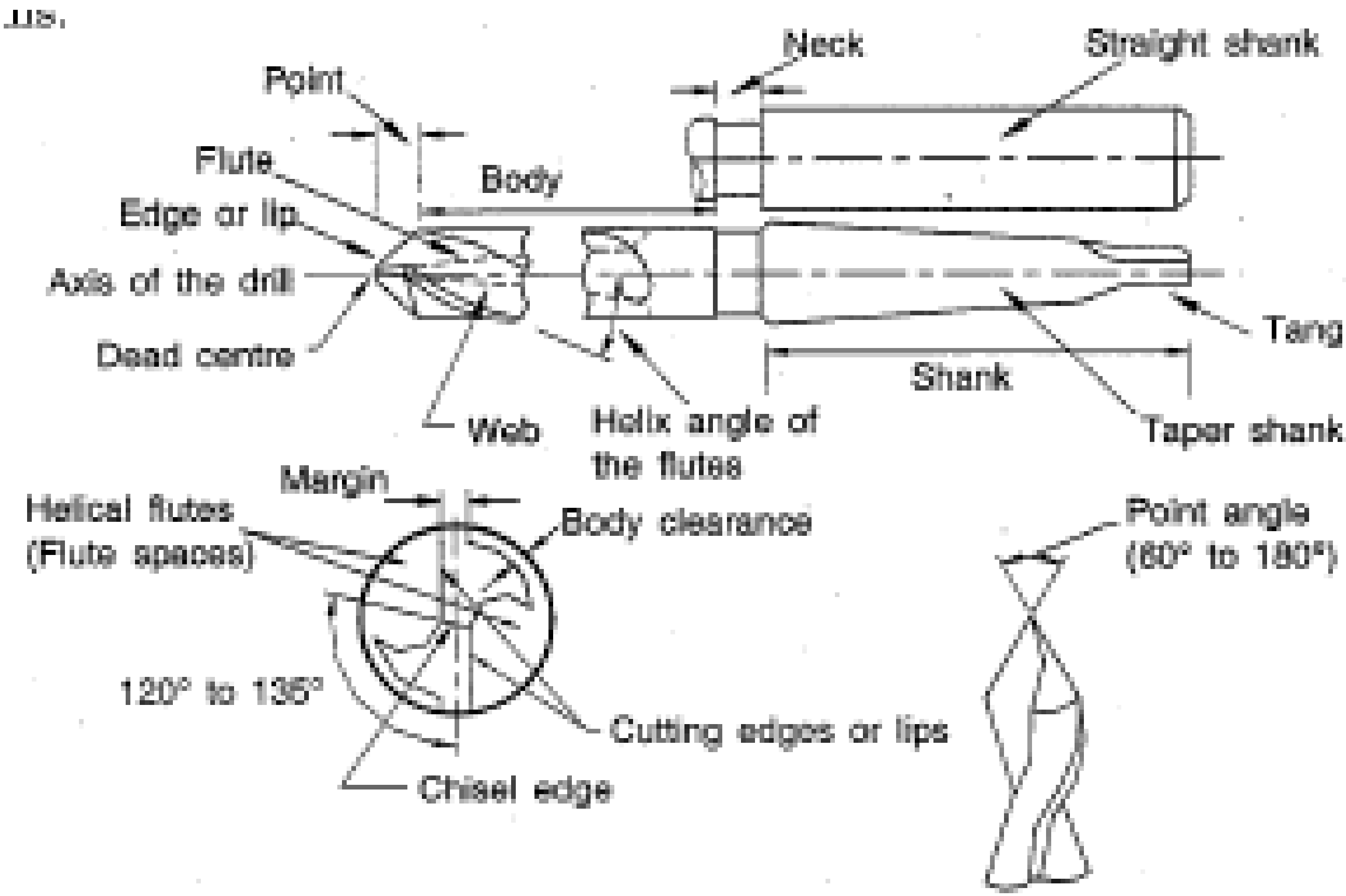
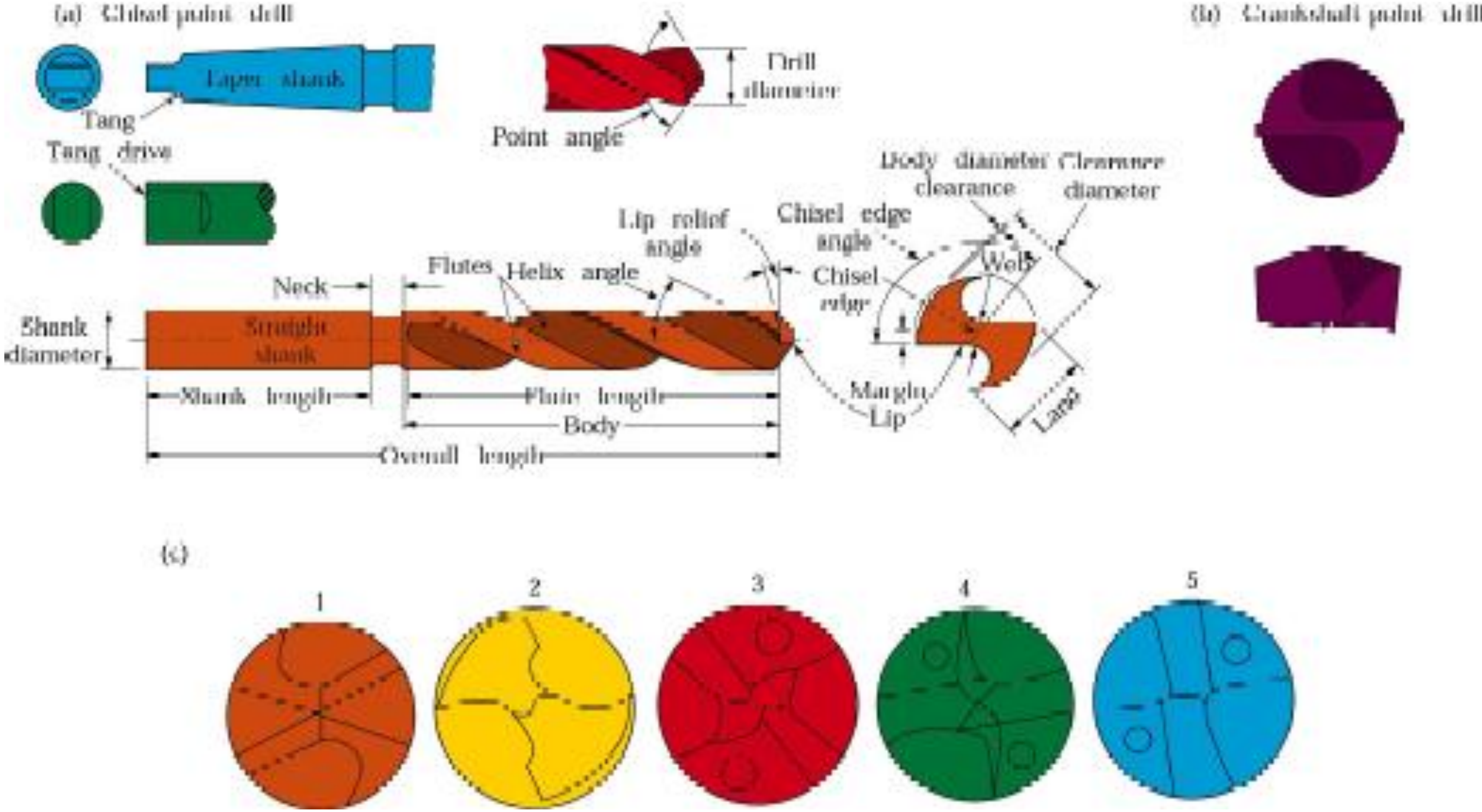
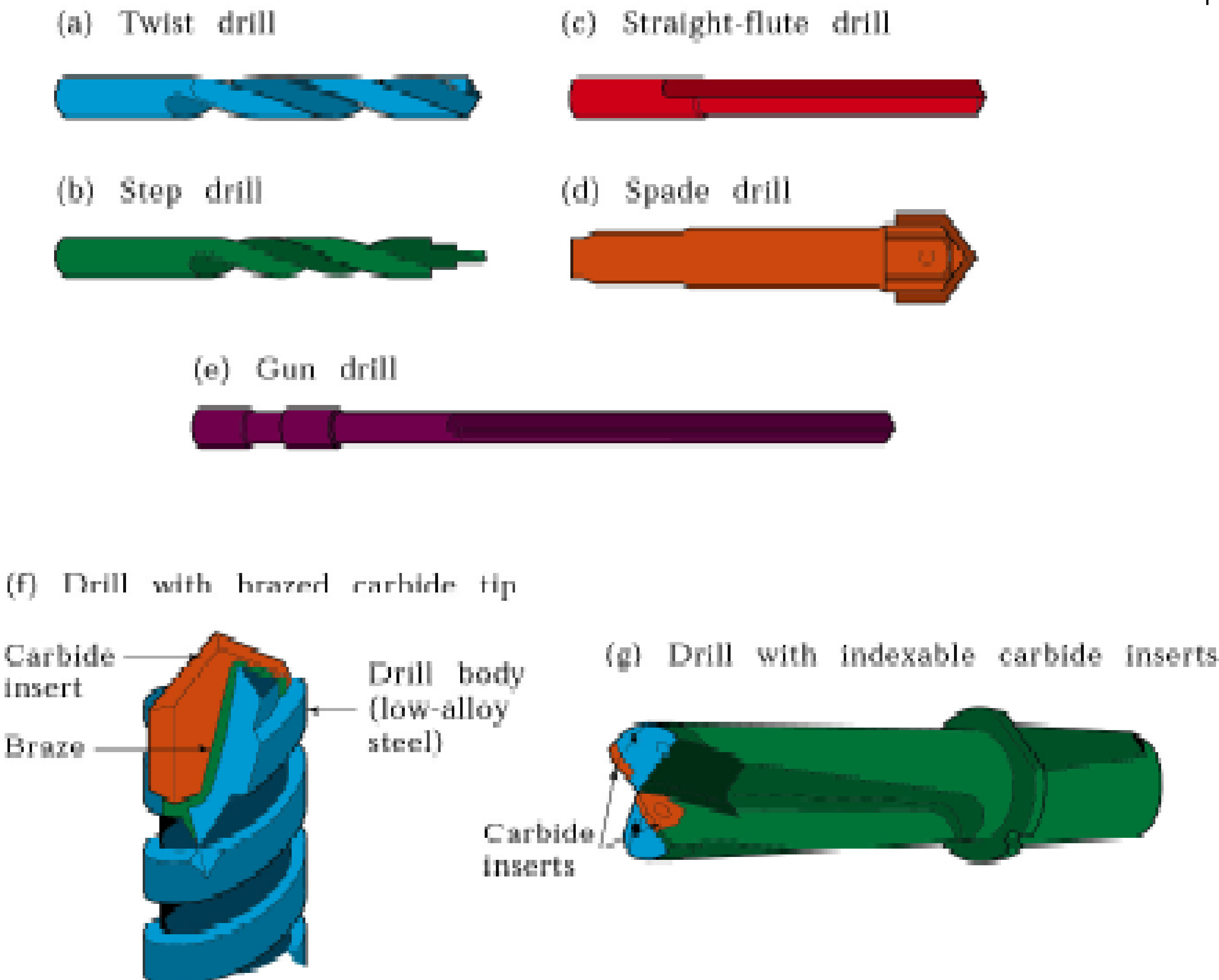


Figure 6.2 Geometry of the twist drills.



Tang
Tang drive
Point angle
Body diameter clearance
Clearance diameter
Lip relief angle
Chisel edge angle
Web
Chisel edge
Flutes
Helix angle
Neck
Shank diameter
Body
Lip
(c)
1
2
3
4
5



(a) Twist drill
(c) Straight-flute drill
(b) Step drill
(d) Spade drill
(e) Gun drill
(f) Drill with brazed carbide tip
Carbide insert
Braze
Drill body (low-alloy steel)
(g) Drill with indexable carbide inserts
Carbide inserts

Parts of a Twist Drill

- Three main components are the:
  - Shank
  - Body
  - Point

Parts of a Twist Drill

- Shank - This is the portion which is "clamped" to provide the drive. Straight shank for drill up to ½". Shank is equal to body diameter. Above ½", shank can be tapered or reduced.
- Body
  - Flutes - Helical grooves cut around the body which form the cutting edges
    - Allow coolant to flow to the cutting edge
    - Allow chips to be withdrawn

Parts of a Twist Drill

- **Margin-** Narrow raised section of the body. Provides full body to hole support to help keep it aligned as it drills.
- **Body clearance** - Reduced section of the drill between the flutes and margin. Used to reduce friction between drill and workpiece
- **Web-** Thin section in the center of the drill which forms a "core" for the drill. This feature increases as it extends to the shank. Forms the chisel edge of the drill.

Types of drills

- **Twist drill:** most common drill
- **Step drill:** produces holes of two or more different diameters
- **Core drill:** used to make an existing hole bigger

Operating conditions in Drilling

- The cutting speed in drilling is the peripheral speed of the drill.
- The cutting speed that should be used in drilling depends on number of factors:

  properties of material being drilled, drill material, drill diameter, rate of feed, coolant used etc.,

  Ex : for cemented carbide tipped drill can drill steel at the speed ranging from 45 to 80 m/min

- Depth of cut (d) is defined as the distance from the machined surface to the drill axis.

$$d = D/2$$

Where,

D is the diameter of the drill

- For machining holes of very large length, a special type of drilling process known as gun drilling is used.

Material Removal Rate

- The cutting speed is decides the speed of rotation of the drill N based on the diameter of the drill D

$$v = \frac{\pi D N}{1000} \text{ m/min}$$

where D is in mm and N is in rev/min or rpm.

Feed rate f (in mm/rev) and the rotational speed N of the drill

$$MRR = \left(\frac{\pi D^2}{4}\right) f N \text{ mm}^3/\text{min}$$

Machining time in Drilling

- The machining time for drilling a hole depends upon

- the length L of the hole to be drilled,
- Rpm of the drill i.e., N
- Feed f

$$t = \frac{L}{fN} \text{ min}$$

where L is in mm, f is in mm/rev and N is in rpm.

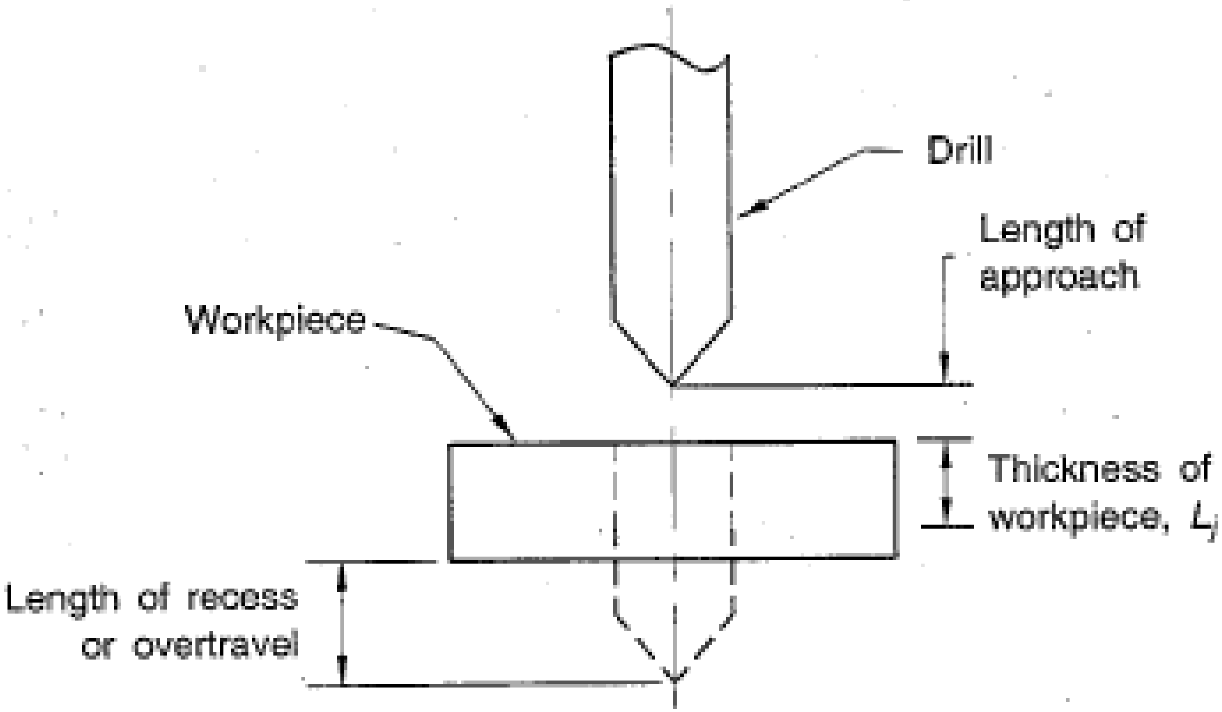


Figure 6.3 Length of approach and length of recess.

Boring

- Boring is done principally to ensure correct location of a hole by making it concentric with axis of rotation of the spindle.
- Boring is also used for increasing the diameter of the hole or machining larger-diameter of the holes.
- the operation of boring consists of producing circular internal profiles in work pieces where a hole has been made by drilling or any other process.
- Boring is done with a cutting tool known as boring bar, which holds in a single point tool made of HSS or Carbide.

The process of boring can be done on a lathe , on a drilling machine or on a special machine tools called boring machines.

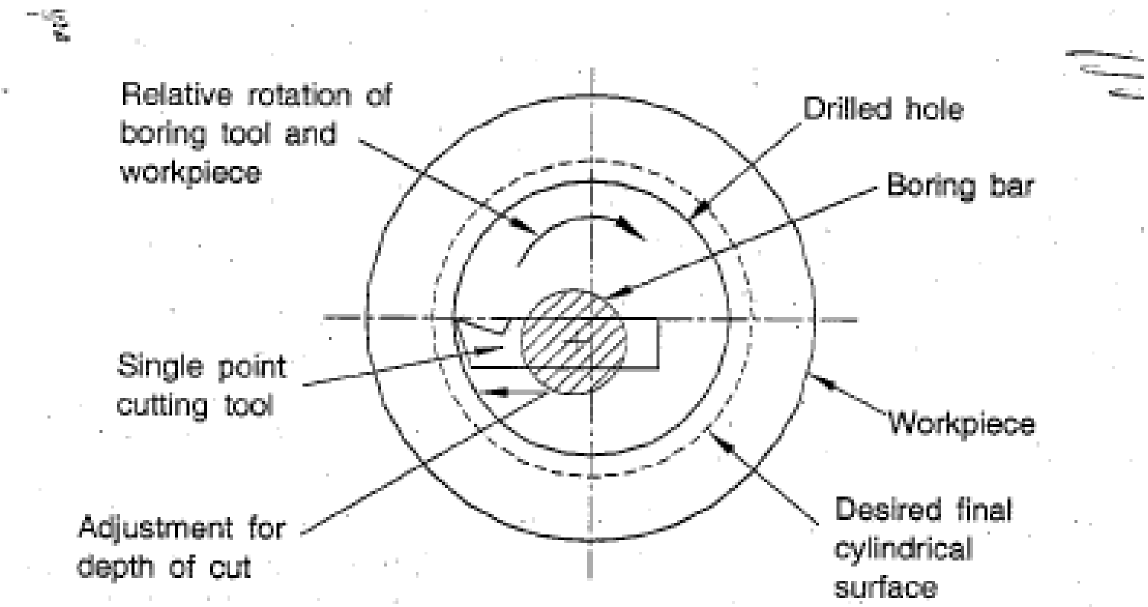


Figure 6.4 The boring operation.

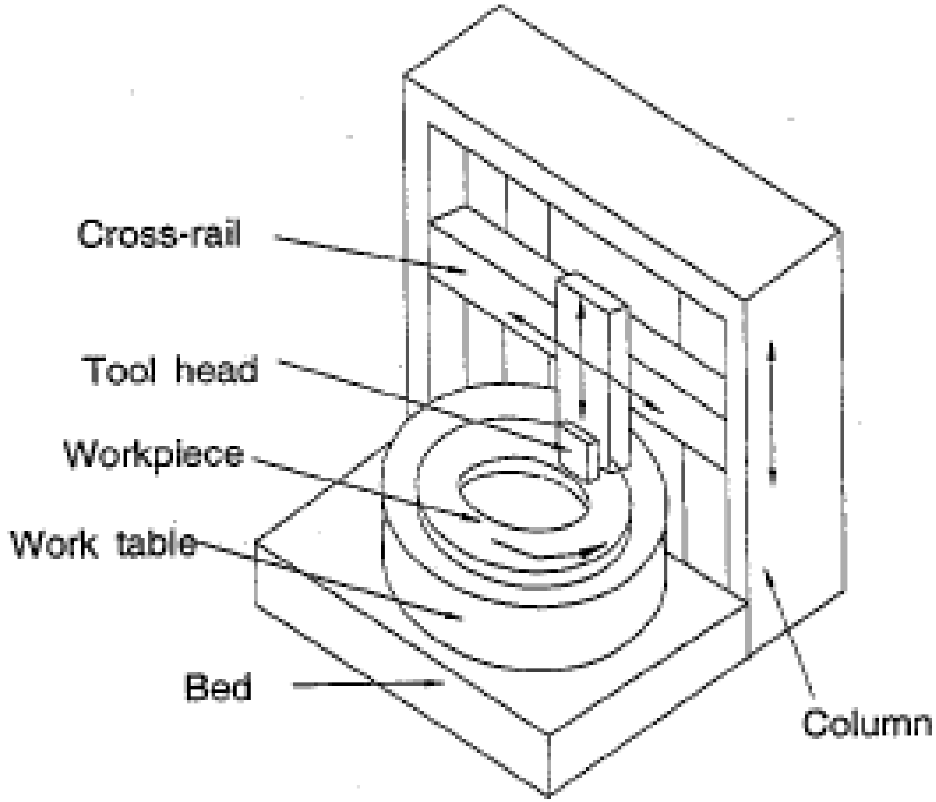


Figure 6.5 A vertical boring machine.

Reaming

- Reaming is an operation to make an existing hole, obtained by drilling, dimensionally more accurate and to improve its surface finish.
- The tool used for the process of reaming is called reamer
- A reamer is a multiple-edge-cutting tool with straight or helical flutes and cutting edges, which removes very little amount of material from the internal cylindrical surface of the hole.

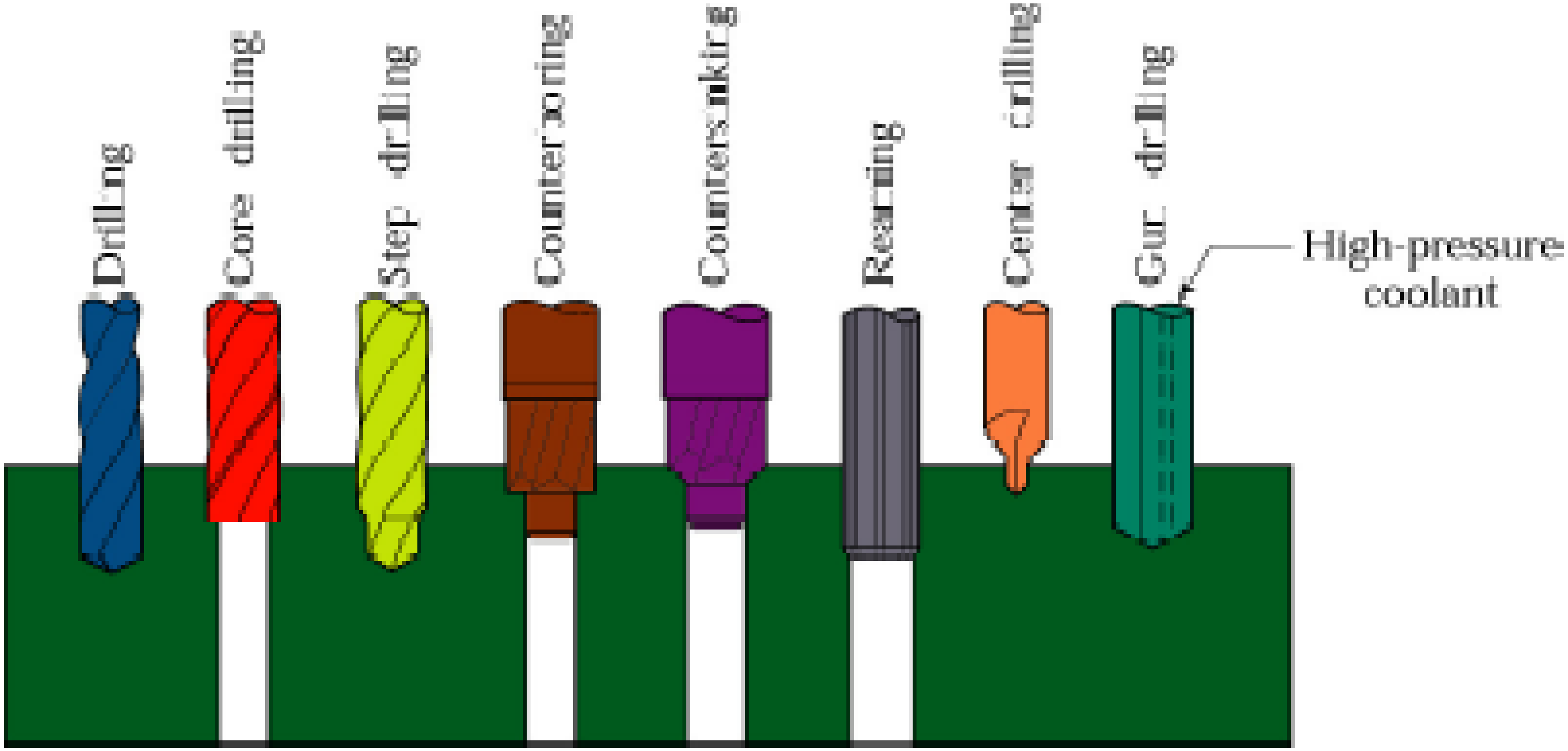


Fig : various types of drilling and reaming operations.

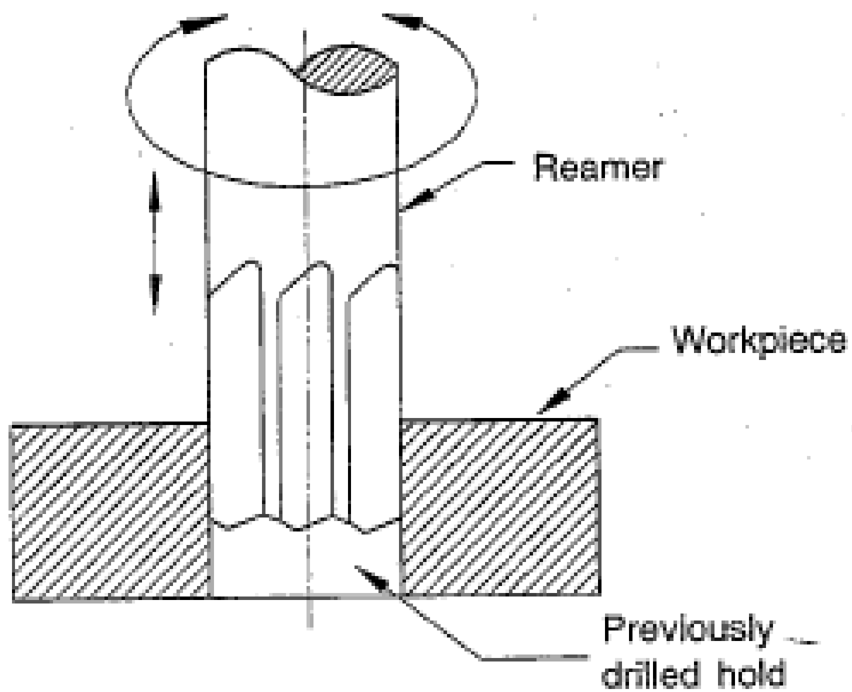


Figure 6.6 The reaming process.

- Drilling can originate a hole and boring can enlarge the hole, whereas, reaming simply follows the previously made hole and cannot correct a hole location , eccentricity etc.,
- Hence, to produce most accurate holes the following sequence of operations can be employed:

1. Centering
2. Drilling
3. Boring
4. Reaming

centering is done to ensure proper entry of drill tool to the work piece.

Tapping

- For making threads in a hole, tapping operation is used.
- The threads in a hole is called internal threads.
- The tool used for tapping is known as tap.
- The process of cutting internal thread using a tap is called tapping.

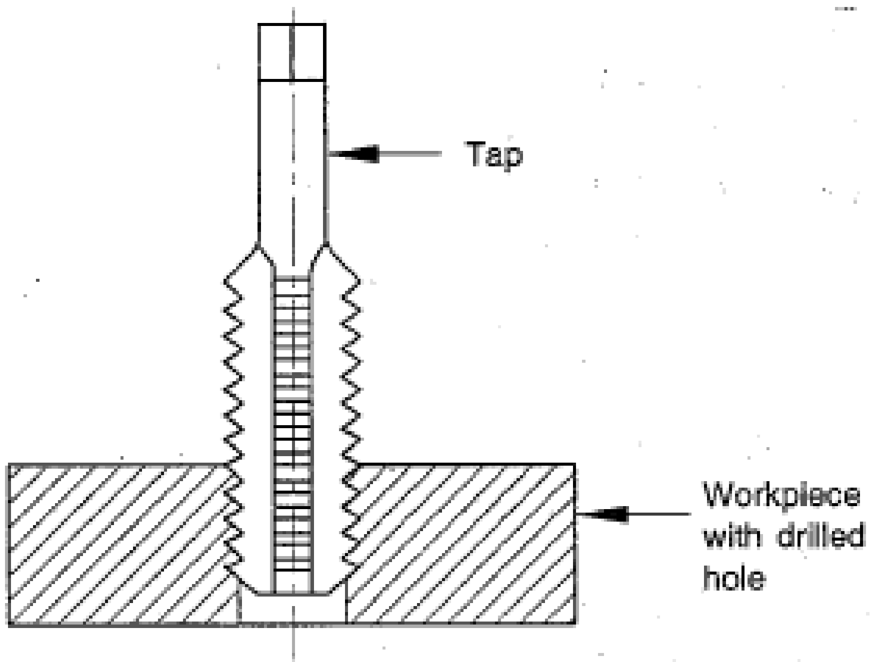


Figure 6.7 Tapping operation and a tap.

Counter boring and spot facing

- Counter boring enlarges a portion of an existing hole to larger diameter and makes the surface at the bottom of the larger diameter flat and square. this enlarged hole forms a square shoulder with original hole.
- The process of counter boring is essential to provide a recess for bolt heads or nuts.
- The cutting speed of counter boring is less than that of drilling operation.

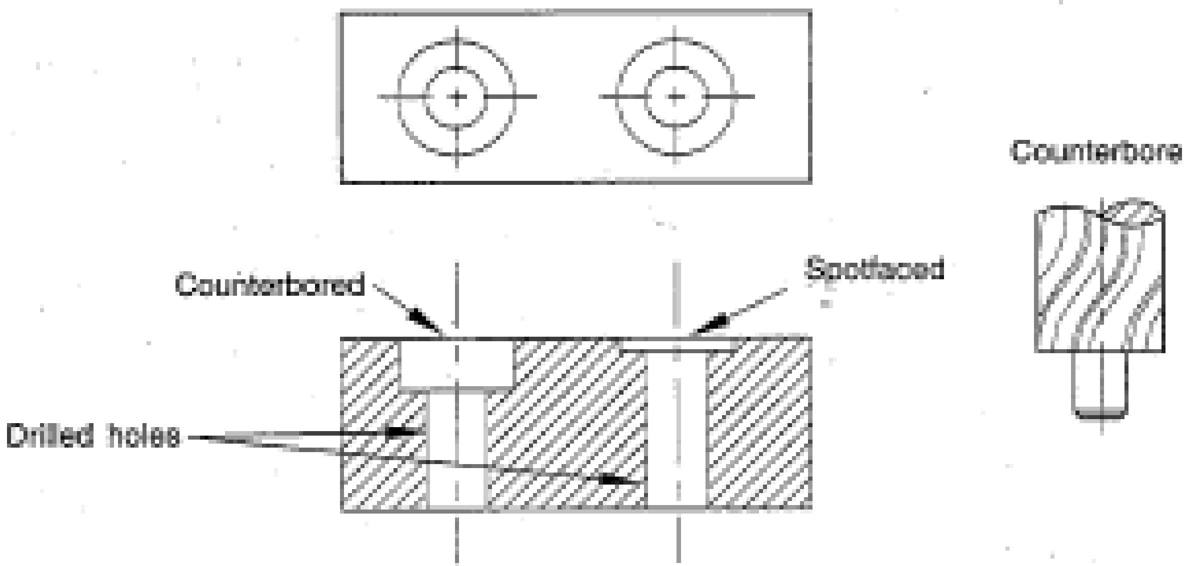


Figure 6.8 Counterboring, spotfacing and a counterboring tool.

Spot facing

- It is similar to counter boring except for the difference that it removes only enough material around a hole to produce a machined flat surface normal to the hole axis to provide a seat for the washer.

Countersinking

- It is the tapering of the entrance to the hole.
- It is carried out to provide a recess for a countersunk flat head screw or counter sunk rivet to be fitted in to the hole.
- The tool used for this operation is called counter sink.
- The included angle of the counter sink is usually varies from 60^0 to 90^0.

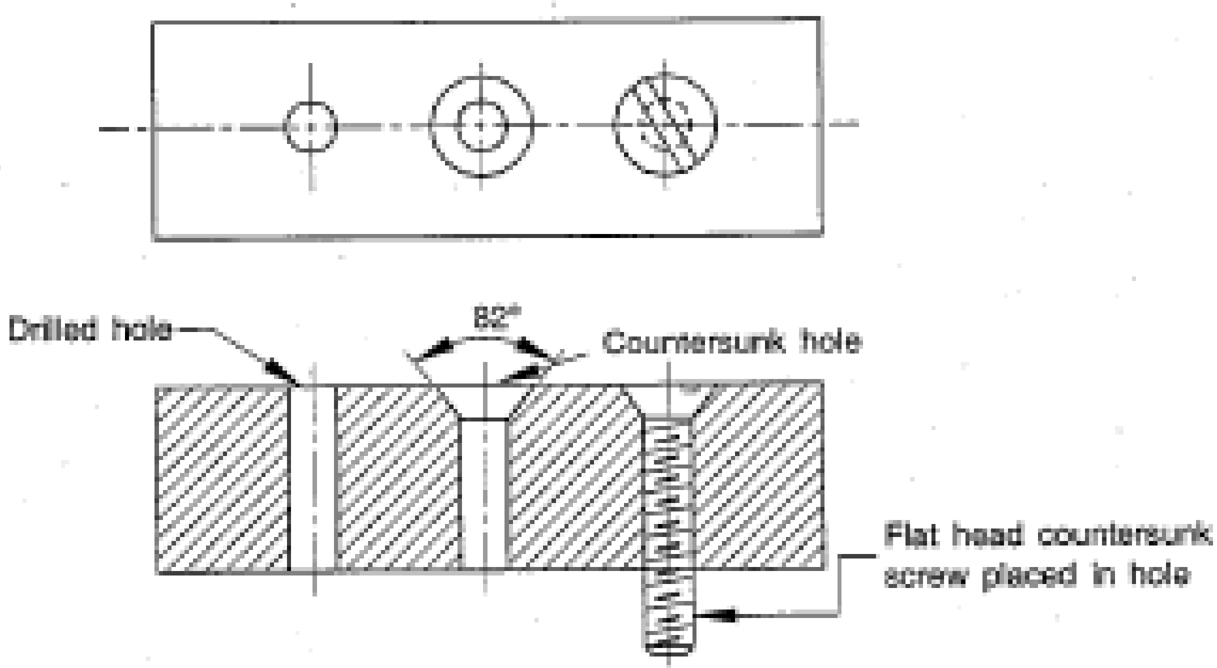


Figure 6.9 Countersinking.

Drilling and Allied operations

Problems

Problem - I

- A HOLE IS BEING DRILLED IN BLOCK OF MAGNESIUM ALLOY WITH A 10 MM DRILL AT A FEED OF 0.2MM/REV. THE SPINDLE IS RUNNING AT 800 RPM. CALCULATE THE MRR.

D = 10mm, f = 0.2mm/rev

N = 800 rpm

MRR = $\pi 10^2/4 \times 0.2 \times 800$

= 12,566mm^3/min

Example 6.2 Calculate the time required to drill a 25 mm diameter hole in a workpiece having thickness of 60 mm to the complete depth. The cutting speed is 14 m/min and feed is 0.3 mm/rev. Assume length of approach and overtravel as 5 mm.

Solution: Given

$$D = 25 \text{ mm}, \quad L_j = 60 \text{ mm}, \quad v = 14 \text{ m/min},$$

$$f = 0.3 \text{ mm/rev. (with usual notations.)}$$

$$v = \frac{\pi \times 25 \times N}{1000}$$

or $$N = 178 \text{ rpm}$$

$$\begin{aligned}\text{Length of tool travel} &= L_j + \text{Length of approach and overtravel.} \\ &= 60 + 5 \\ &= 65 \text{ mm}\end{aligned}$$

$$t = \frac{65}{0.3 \times 178} = 1.22 \text{ min}$$

Example 6.3 A job shown in Fig. 6.10 (all dimension in mm) is to be produced from a raw material having 110 mm length and 60 mm diameter.

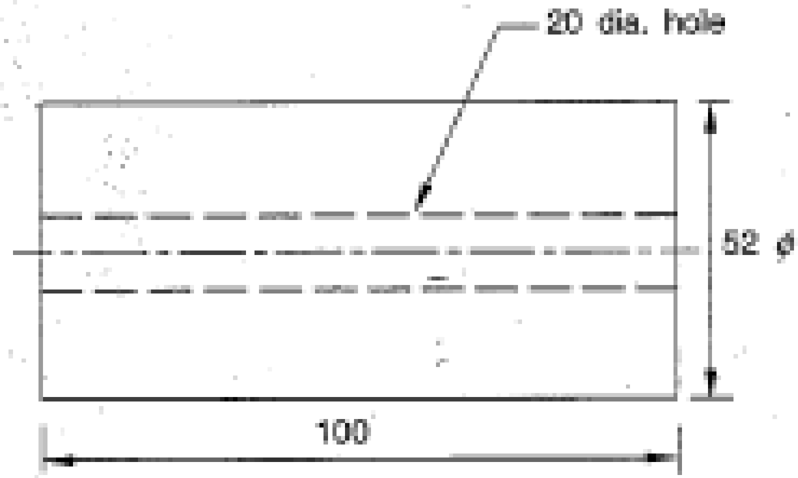


Figure 6.10 Drawing of the job to be produced.

For turning and facing operations, rpm is 250 and for drilling, rpm of the drill is 200. Drilling operation is carried out on a drilling machine. Assume 2 passes for the turning operation and 5 passes for the facing operation, and a feed of 0.5 mm/rev for all operations. For drilling, assume approach and overtravel distance as 20 mm. Calculate (a) total time required to manufacture 1000 components, (b) if the firm operates 8 hours a day and 300 days in a year, how many components can be produced in one year? Assume set-up time per component as 25% of the processing time.

1. (a) Facing (b) Turning (c) Drilling
2. (a) Turning (b) Facing (c) Drilling
3. (a) Drilling (b) Turning (c) Facing
4. (a) Drilling (b) Facing (c) Turning

The total time required to manufacture the component would be the sum of all individual operations.

Now, let us consider the first sequence, i.e. facing, turning, and drilling then compute the time required to complete the job.

Time for Facing:

Length of tool travel = $\frac{60}{2}$ = 30 mm (as diameter = 60 mm)

$$t_{facing} = \frac{L}{fN} \times (\text{Number of passes})$$

$$= \frac{30}{0.5 \times 250} \times 5$$

$$= 1.2 \text{ min}$$

Time for Turning:

After facing, the length of the job = 100 mm. Then

$$t_{turning} = \frac{L}{fN} \times (\text{Number of passes})$$

$$= \frac{100}{0.5 \times 250} \times 2$$

$$= 1.6 \text{ min}$$

Time for Drilling:

Length of tool travel = Length of hole + Length of clearance

= 100 + 20

= 120 mm

Then

$$t_{\text{drilling}} = \frac{L}{fN} = \frac{120}{0.5 \times 200} = 1.2 \text{ min}$$

Therefore,

Total processing time/component $= t_{\text{facing}} + t_{\text{turning}} + t_{\text{drilling}}$

= 1.2 + 1.6 + 1.2

= 4 min

Now,

Manufacturing time/component = Processing time + Set-up time

= 4 + (0.25 × 4)

= 5 min

(a) Total time for producing 1000 components

$$t = 5 \times 1000 = 5000 \text{ min}$$

(b) Number of components that can be produced in one year

The company works 8 hr/day and 300 days in a year.

Total working time = 8 × 300 = 2400 hrs.

Number of components produced in this period

$$= \frac{\text{Total working time (min.)}}{\text{Total mfg. time (min.)}}$$

$$= \frac{2400 \times 60}{5}$$

= 28,800 pieces

12. List the various operations involved to make the job shown in Fig. 6.11 from a raw workpiece of size 500 mm length and 50 mm diameter.

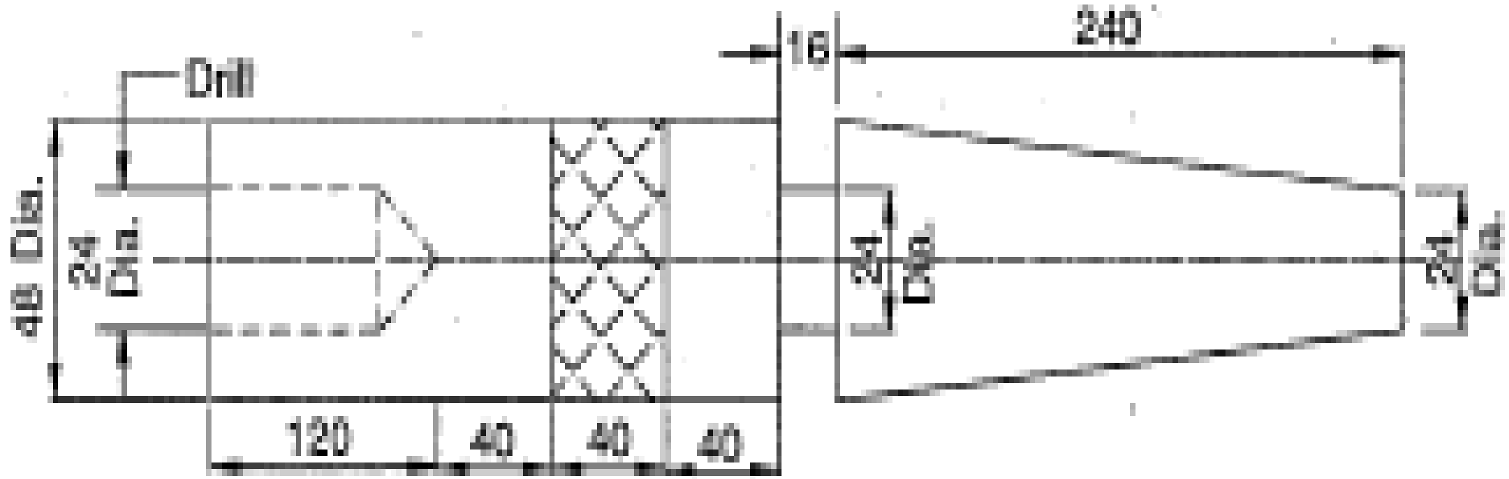


Figure 6.11 Figure for question 12.

13. Component shown in Fig. 6.12 is to be manufactured from workpiece of size 45 mm diameter and 150 mm length. List the operations involved and what will be the best sequence of operations in your opinion.

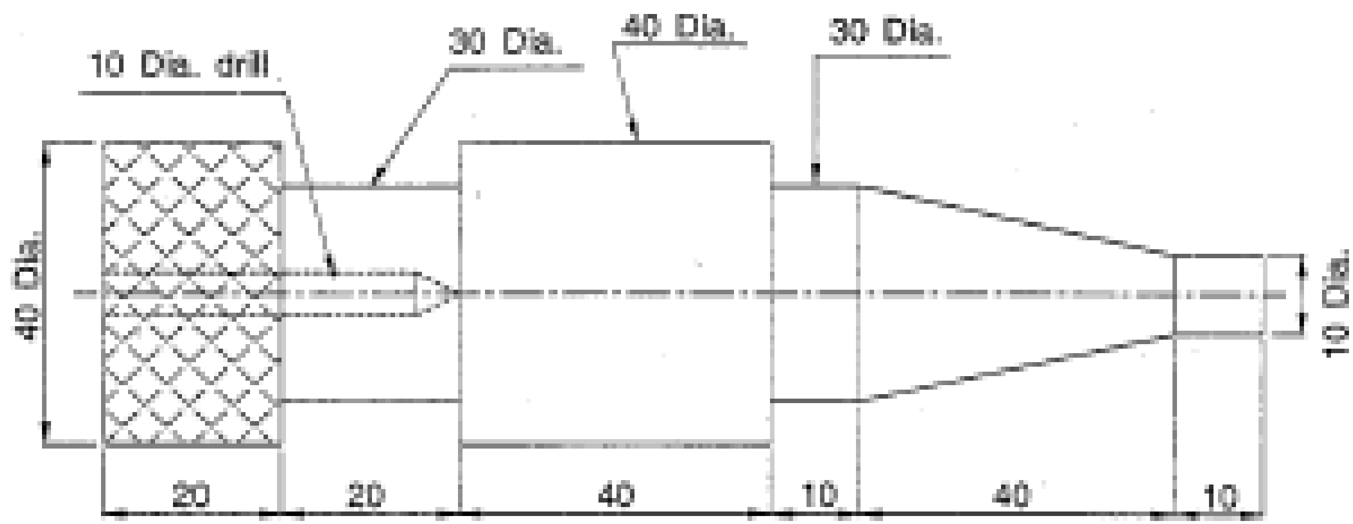


Figure 6.12 Part to be machined for question 13.