MILLING MACHINE

The process of removing material from a workpiece by advancing rotary cutters fed into it is called milling.

Introduction

- Milling machine is a machine tool in which metal is removed by means of a revolving cutter with many teeth, each tooth having a cutting edge which removes metal from a workpiece.
- In the milling process, the workpiece is normally fed into a rotating cutting tool known as milling cutter. Equally spaced peripheral teeth on the cutter come in contact with the workpiece intermittently and machine the workpiece. This is called intermittent cutting.

Introduction

– Milling machines are used to produce parts having flat as well as curved shapes. Intricate shapes, which cannot be produced on the other machine tools, can be made on the milling machines.

Milling Processes

1. Up milling (or conventional milling) process
2. Down milling (or climb milling) process

Up milling
(or conventional milling) process

– In ‘‘up-milling process’’, the workpiece is fed opposite to the cutter’s tangential velocity

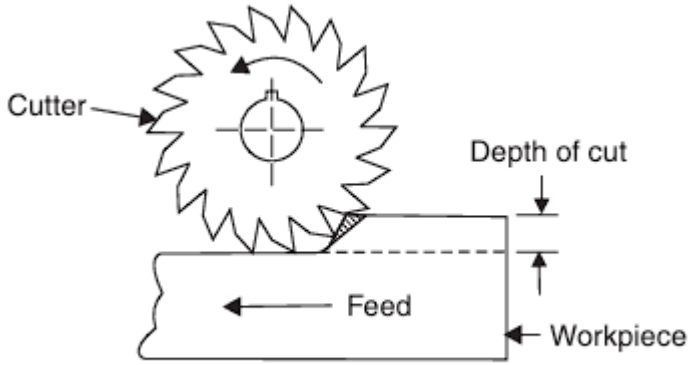


Fig. 9.92. Up milling process.

Down milling (or climb milling) process

– In ‘‘down milling process’’ the workpiece is fed in the same direction as that of the cutter’s tangential velocity.

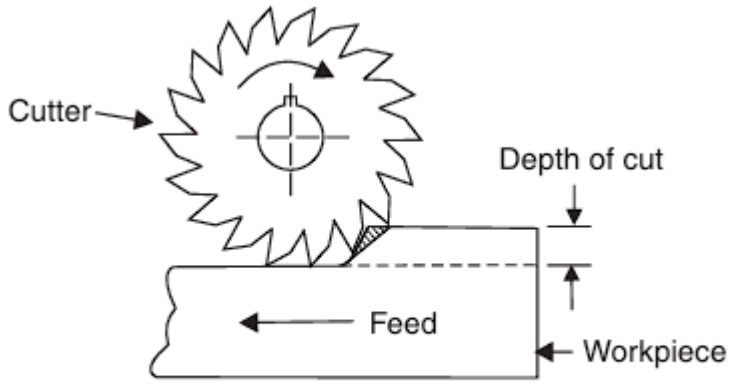


Fig. 9.93. Down milling process.

Advantage of Down milling over Up milling

- The cutting force tends to hold the work against the machine table, permitting lower clamping forces.
- This process produces better finish and dimensional accuracy.
- The coolant can be fed easily. The chips are also disposed off conveniently and they do not interfere with the cutting. Thus the machined surface of the workpiece is not spoiled.

Classification of Milling Machines

1. Column and knee type :
    1. Horizontal milling machine.
    2. Vertical milling machine.
    3. Universal milling machine.
2. Manufacturing or fixed bed type
3. Planer type
4. Special type

Work Holding Devices Used on Milling Machine

– It is necessary that the work should be properly and securely held on the milling machine table for effective machining operations. The cutting pressure exhorted by milling cutter is quite high comparing the single point tool of a lathe machine. Therefore the workpiece has to be secured rigidly to avoid any vibration.

– Various types of work holding devices are used for milling machine operations they are explained as follows :

T-bolts and clamps,

V – Block,

Dividing Head,

Angle Plates,

Machine Vices,

Circular Table or Indexing Table,

Work Holding Devices Used on Milling Machine

T- Bolts and clamps –

– Bulky workpieces of irregular shapes are clamped directly on the milling machine table by using T- bolts and clamps. Different types of clamps are used for different patterns of work.

– All these clamps carry a long hole, through which clamping bolt passes. This hole permits the bolts for adjustment according to the size and shape of the job.

Angle plates –

- When work surfaces are to be milled at right angles to another face, **angle plates** are used for supporting the work.
- The angle plate is made from high-quality material (generally spheroidal cast iron) that has been stabilized to prevent further movement or distortion.
- Slotted holes or “T” bolt slots are machined into the surfaces to enable the secure attachment or clamping of workpieces to the plate, and also of the plate to the worktable.
- Angle plates also may be used to hold the workpiece square to the table during marking-out operations.
- Adjustable angle plates are also available for workpieces that need to be inclined, usually towards a milling cutter.

V block –

– The V blocks are used for holding shafts on a milling machine table in which keyways and slots are to be milled.

Vices –

– Vices are the most common appliance for holding work on milling machine tables. According to its quick loading and unloading arrangement. Vices are of three types,

a) Plain Vice –

– The plain vice is directly bolted on the milling machine table.

– Work is clamped between the fixed and movable jaw and for holding workpieces.

– The base carries slots to accommodate ‘T’ bolts to fix the vice on the table.

Vices –

b) Swivel Vices –

– The swivel vice is used to mill an angular surface in relation to a straight surface without removing the work from the vice.

– It has got a circular base graduated in degrees. The base is clamped on the table by means of T-bolts.

c) Universal Vices –

– It can be swiveled in a horizontal plane similar to a swivel vice and can also be tilted in any vertical position for an angular cut.

– The vice is not rigid in construction and is used mainly in tool room work.

– It enables the milling of various surfaces, at an inclination to one another, without removing the workpiece.

Dividing Head –

– Dividing head or indexing head used to hold the workpiece and divide the periphery into the number of divisions required. These are of three types:

(a) Plain dividing head

(b) Universal dividing head

(c) Optical dividing head

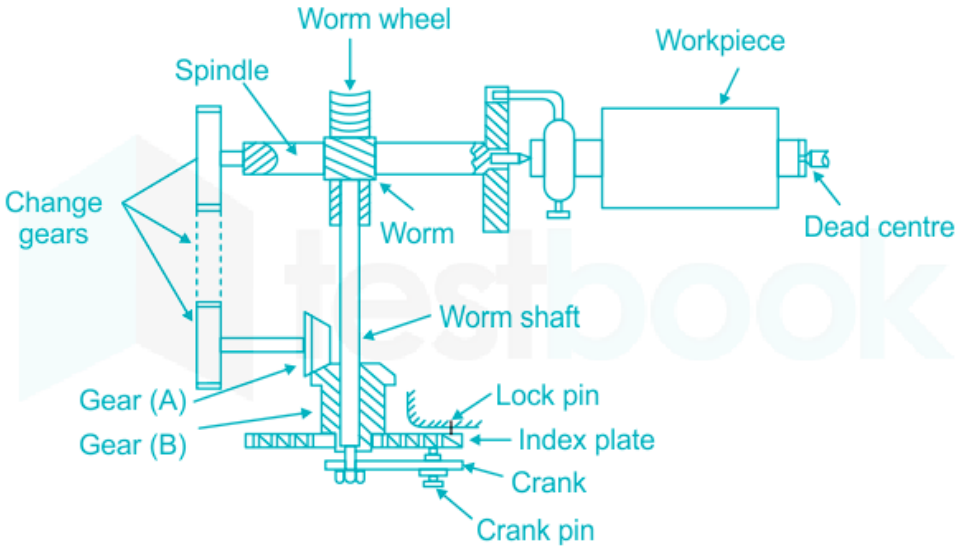
Universal dividing head

- It is the most commonly used type of attachment on a milling machine.
- It is used for setting the work in horizontal, vertical or inclined positions relative to the milling machine table , turning the work periodically through a given angle for performing indexing of the work and creating a continuous rotary motion to the workpiece for milling helical grooves.
- The dividing head spindle can be connected with the table feed screw through a gear train to create a continuous rotary motion to the workpiece for helical milling.

Universal dividing head

– Working mechanism of an universal dividing head is the crank which is rigidly fixed at one end of the work shaft, while the bevel gear runs free on the worm shaft.

– The index plate is bolted with gear & can be locked against the rotation of lock pin.



Compound indexing :

– The compound indexing method is employed when the number of divisions required is outside the range that can be obtained by simple indexing.

– The compound indexing is achieved in two stages by using two different hole circles of one index plate :

1. By a movement of the crank in the usual way as in simple indexing.
2. By adding or subtracting a further movement by rotating the crank and index plate together forward or backward.

Compound indexing :

Method 1

$$\frac{40}{N} = \frac{n_1}{N_1} \pm \frac{n_2}{N_2}$$

N = Number of divisions required.

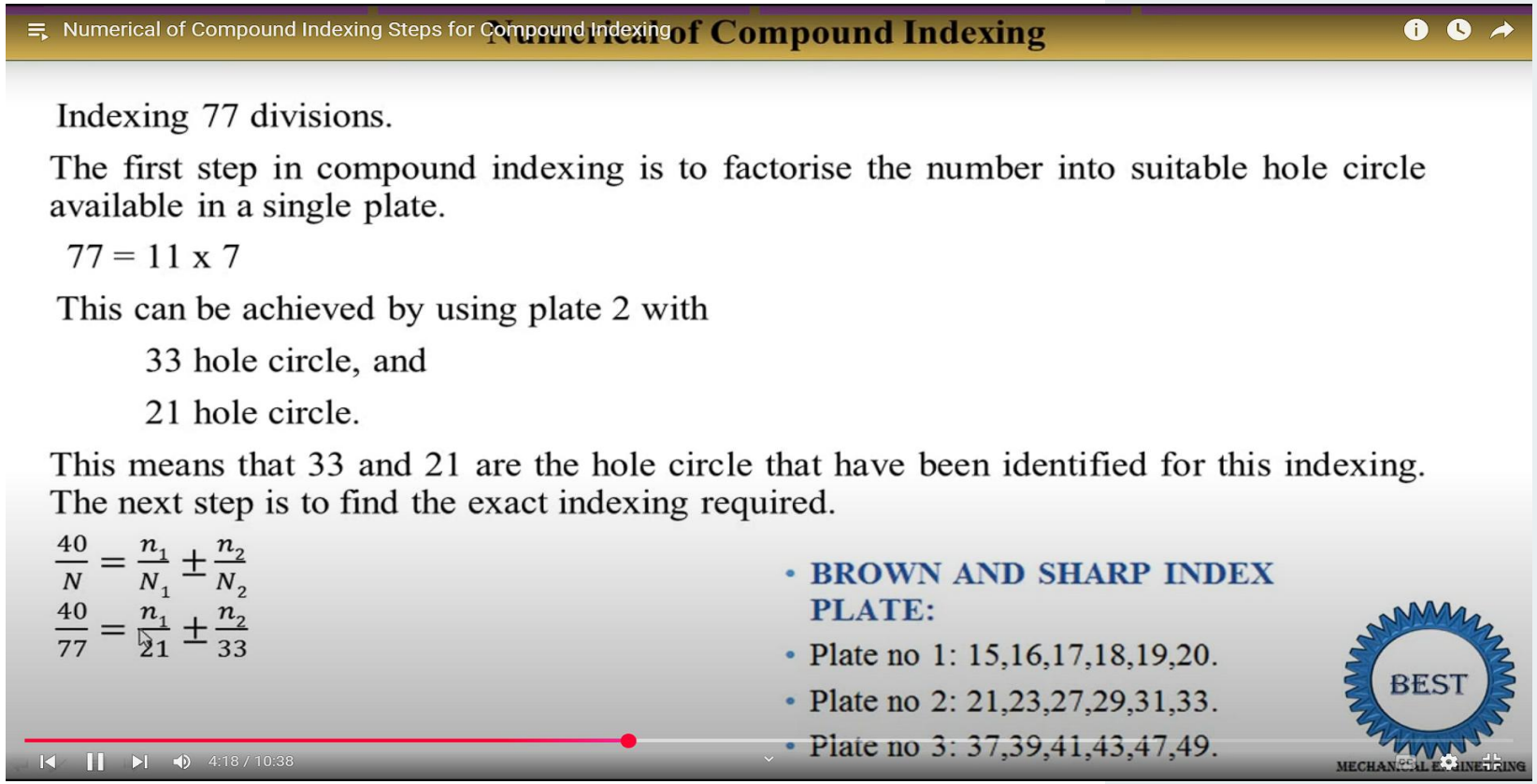
N_1= Hole circle used by crank pin.

N_2= Hole circle used by lock pin.

n_1= Hole moved by crank pin in N_1 hole circle.

n_2= Hole moved by plate and crank pin in N_2 hole circle.

Example of compound indexing



Example of compound indexing

$$\frac{n_1}{21} \pm \frac{n_2}{33} = \frac{40}{77}$$

$$33\ n_1 \pm 21\ n_2 = \frac{693\ X\ 40}{77}$$

$$33\ n_1 \pm 21\ n_2 = 360$$

By trail and error method ,we get n_1 and n_2

$n_1 = 9$ and $n_2 = 3$

$$33 \times 9 + 21 \times 3 = 360$$

$$\frac{9}{21} + \frac{3}{33} = \frac{40}{77}$$

Hence, the indexing required is 9 holes in the 21-hole circle **added** to 3 holes in the 31 hole circle to get 77 divisions.