Introduction: Milling is a process of removing materials with a rotating multiple-tooth cutting tool called a milling cutter. **Milling machines** are tools designed to **machine** metal, wood, and other solid materials. Often automated, **milling machines** can be positioned in either vertical or horizontal orientation to carve out materials based on a pre-existing design.

Types of milling machines:

There are the following types of milling machines which are usually used in industry.

Knee type machines

I) Plain horizontal milling machines
II) Universal horizontal machines
III) Vertical milling machines
IV) Ram head (universal) milling machines etc.

Vertical bed types milling machines

I) Single column or open side and
II) Double column machines

Specialized milling machines

I) Thread cutting milling machines
II) Key-way milling machines
III) Spline-shaft milling machines

Main Components of a Universal Horizontal milling machine:

Universal horizontal milling machine comprise the following parts:

1. Column
2. Push button control panel
3. Speed change panel
4. Main motor
5. Spindle speed selection dial
6. Push-button control panel
7. Speed gear box
8. Over-arm
9. Spindle
10. Bearing bracket
11. Longitudinal feed control lever
12. Work table
13. Swivel plate
14. Cross slide
15. Knee
16. Base plate
17. Feed selection knob
18. feed dial
19. Feed change mechanism
20. Feed gearbox

The column, including the base, is the main casting, which support all the other parts of the machine. The front of the column, the column face is machined to provide an accurate guide for the vertical travel of the knee. The knee supports the saddle, The feed-changed gearing is enclosed within the knee. The knee can be raised or lowered on the column face. It is supported and can be adjusted by the elevating screw. The table holds the work piece. They are used to align the job or the fixture, which holds the job. The over-arm is mounted on the top of the column and is guided in perfect alignment by the machined dovetail surfaces. The shape and size of the work to be milled will determine what type of vise is used. The small vise is used for light milling operation. The vise is fastened to the table with T-bolts, which pass through slotted holes at the end of the vise.

Milling Operation:

Conventional milling, which is also called up milling and climb up milling, also called down milling refer to the direction in which work is fed against the cutter. In up milling operation, the direction of feed can force the work into the cutter, and the result could be a broken cutter and damaged work. In down milling operation, cutters retain sharpness longer because cutting is started at the full thickness of the clip and comes out at zero thickness.

Conclusion:

The milling machine is one of the most versatile and widely used machine tools for both tool room and production purposes. Learning and deep comprehension of various types of milling machines and is a must for learners who want to achieve deeper understandings of Industrial and Production Engineering. By learning about this machine, we deepened our overall understanding of machining tools, cutting tools, milling etc. To speak the truth, production in Industries would be completely hampered without the milling machine.

Assignment

01. What are the advantages of down milling over up milling?

Ans: The gradual decrease in cutting force and absence of sliding and crushing usually results in a much better finish than is normal in down cut milling; also tool life is improved. Power required for the table feed is reduced, and the cutter tends to push the workpiece more firmly to the table achieving better accuracy, however there must be no backlash in the table feed mechanism or the cutter will snatch the workpiece leaving at best an uneven surface; at worst a broken tool or arbor. A further disadvantage of down cut milling is that any scale or surface hardening of cast or forged blanks can rapidly dull or chip the cutting edge.

02. What is meant by the feed of a milling machine cutter?

Ans: *Feed rate* (also often styled as a solid compound, *feedrate*, or called simply *feed*) is the relative velocity at which the cutter is advanced along the workpiece; its vector is perpendicular to the vector of cutting speed. Feed rate units depend on the motion of the tool and workpiece; when the workpiece rotates (*e.g.*, in turning and boring), the units are almost always distance per spindle revolution (inches per revolution [in/rev or ipr] or millimeters per revolution [mm/rev]).

03. What factors we might consider in a selection of cutting speed in milling operation?

Ans: There are no hard and fast rules governing the speed of milling cutters; experience has shown that the following factors must be considered in regulating speed:

- A metal slitting saw milling cutter can be rotated faster than a plain milling cutter having a broad face
- Cutters having undercut teeth (positive rake) cut more freely than those having radial teeth (without rake).
- Angle cutters must be run at slower speeds than the plain or side
- Cutters with inserted teeth generally willl stand as much speed as a solid cutter.
- A sharp cutter may be operated at greater speeds than a dull one.
- A plentyful supply of cutting oil will permit the cutter to run at higher speeds than without cutting oil.

05. Find the machining time for milling operation.

Ans: Terms Used:

N: RPM of Cutter
n: Number of Teeth on Cutter
W: Width of cut (may be full cutter or partial cutter)
t: depth of cut
V: cutting speed -- a Handbook value
L: Length of pass or cut
f_m: Table (machine) Feed
f_t: feed/tooth of cutter -- a Handbook value
D: Cutter Diameter

A. Cutting Speed:

$$N = \frac{kV}{pD}$$

If Cutting Speed for a given RPM rate is desired, solve above equation for V: V = ND/k

B. Table Feed Rate:

$$f_m = f_t * N * n$$

C. Cutting Time:

$$CT = \frac{L + L_A}{f_m}$$

L_A

$$L_A = \sqrt{t(D - t)}$$

D. Material Removal Rate:

$$MRR = \frac{\text{Vol. Removed}}{CT} = \frac{L * W * t}{CT} = W * t * f_m$$