



Milling Machine: Definition, Parts, Types, Operations (With PDF)

In Manufacturing Technology by Amrit Kumar September 19, 2018 12 Comments

Milling machine another most important machine tool after Lathe machine tool and drilling machine.

In a **milling machine**, a multipoint cutter is rotating against the workpiece and material removed from the workpiece accordingly.

In today's article, you will learn about the **definition, parts, types, and operation of a milling machine**, also at the end of the article, I will add the downloadable link of the PDF.

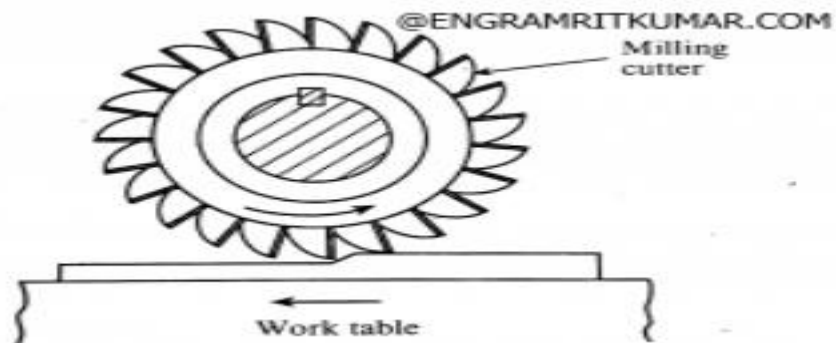
Milling Machine Definition

The **milling machine** is defined as **perhaps most widely used in manufacturing industries after the lathe machine**.

However, In the case of **lathe machine tool**, the tools used there **single point cutting tool** but In the case of this machine, the tool used is **multi-point cutting tools**.

The milling is a process of metal-removing by feeding the workpiece passes through the **rotating multipoint cutter**.

The diagram of cutting operation is shown below:



Milling machine cutter and workpiece position

This machine can hold one or more number of cutters at a time and rotates at high speed to remove the metal at a faster rate.

The metal removal rate is faster as compared to a [lathe machine](#).

This machine is used to make gears like Spur gears, and also drill the workpiece bore, and produce slots.

Milling Machine Parts

A milling machine consists of the following parts:

- Base
- Column
- Knee
- Saddle
- Table
- Overhanging Arm
- Spindle



- Arbor
- Arbor Supports
- Milling Head
- Ram

So let discuss all of these parts in details.

Base:

It is the foundation part of a machine and all other parts are joined on it.

It carries the entire load so it should have high compressive strength and it is made up of cast iron.

Column:

It is mounted vertically on the base.

It supports the knee, table, etc. and work as housing for all the other driving member.

The column is a hollow member which contains driving gears and sometimes motor for the spindle and the table.

Knee:

It is a casting that supports the saddle and table.



All **gearing mechanism** is enclosed within the knee.

It is fastened to the column by dovetail ways.

The knee is supported and adjusted by a vertical positioning screw (elevating screw).

The elevating screw is used to adjust the knee up and down by raising or lowering the lever either with the help of hand or power feed.

Saddle:

This is placed between the table and the knee, and work as an intermediate part between them.

This can moves transversally to the column face.

This slides over the guideways provided situated on the knee which is perpendicular to the column face.

The main function is to provide motion in a horizontal direction to the workpiece.

This is also made by cast iron.

Table:

This is a rectangular casting which is present on the top of the saddle.

The table is situated over the knee.

It is the part of a machine which holds the workpiece while machining.



This is made by cast iron and has T-slot cut over it.

This provides vertical motion by moving the knee up and down.

It provides horizontal motion by the feed screw.

This provides a horizontal (transverse) motion by moving the saddle.

Overhanging arm:

The overarm is used to fastened arbor support.

It may consist of one or two cylindrical bars which slide through the holes in the column.

It is made by cast iron.

Spindle:

The spindle is the main part of the machine which holds the tool in the right place.

This spindle provides the drive for arbors, cutters, and attachments used on a milling machine.

Arbor:

This is a mechanical part, on which is used as an extension part of the spindle in a horizontal milling machine.



It is fitted on the spindle whenever it's required.

This holds the tool and moves it in the correct direction.

Arbor Supports:

There are generally two types of arbor supports used in the milling machine.

The first one has a small diameter bearing hole, 1-inch in maximum diameter, and the other one has a large diameter bearing hole, usually up to $2\frac{3}{4}$ inches.

The arbor support has an oil reservoir that lubricates the bearing surfaces.

It can be clamped anywhere on the overarm.

The arbor support is used only in the horizontal types of milling machine.

Milling head:

It is the upper section of a vertical milling machine.

It consists of a spindle, driving motor and other controlling mechanisms.

Ram:

One end of the arm is attached to the column and other ends to the milling head.

The ram can be moved transversally (in and out) on the column by a hand lever.



Milling Machine Types

The **types of milling machines** are the following:

- Column and Knee Type Milling
- Vertical Milling
- Horizontal Milling
- Universal milling
- Fixed Bed Milling
- Simplex Milling
- Duplex Milling
- Triple Milling
- Planer Milling
- CNC Milling
- Tracer Milling

Column and knee type milling machine:

It is a very common machine type.

In this machine, a vertical column is attached to the bed which consists of all gear drives which rotate the knee and saddle.

A knee is situated on the base which provides vertical motion to the workpiece or which moves up and down.

A saddle is attached to the upper section of the knee which can move in the transverse direction.

The table is placed over the which can hold the workpiece by use of climbing bolts.

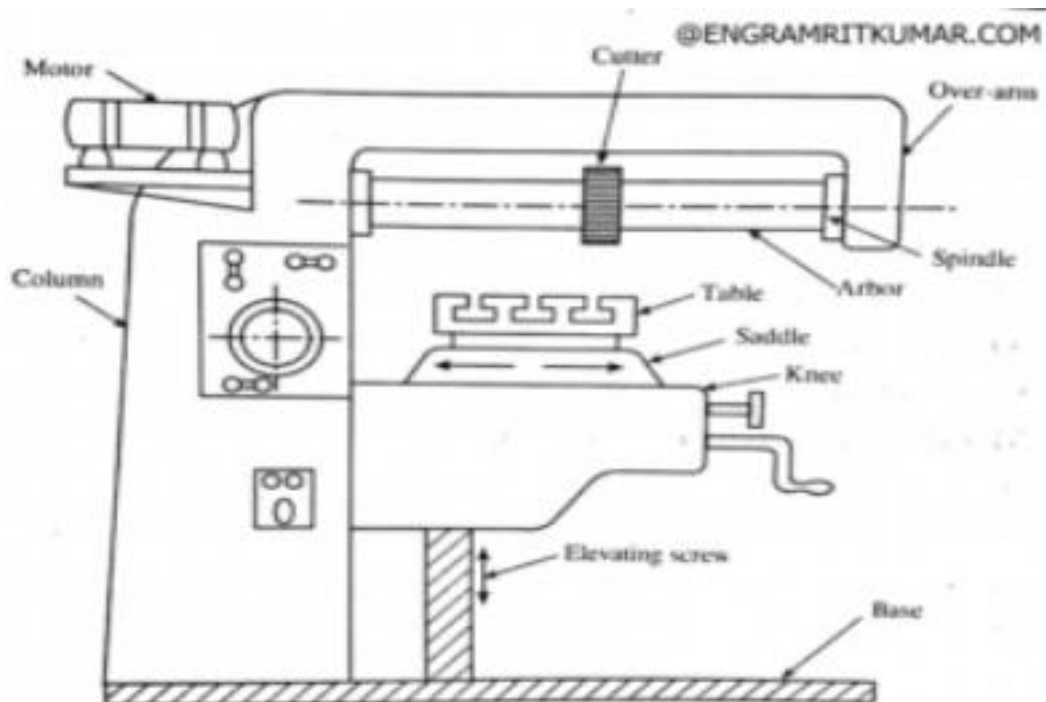


Fig. 3.2 : Column and knee type milling machine.

Column and knee type milling machine: diagram

Vertical milling machine:

The spindle of this machine is in a vertical position.

No arbor is required in this machine.

The cutter tool has the cylindrical shape and the cutting edges are situated at the circumference of the cylindrical face.



Verticle milling machine (Source: IndiaMart)

Horizontal milling machine:

As the name implies, the spindle is situated horizontally.

The spindle rotates horizontally.

An arbor is attached to the machine which holds the cylindrical disk shape cutter which cuts the metal workpiece.



machine (Source: IndiaMart)

Horizontal milling

Universal milling machine:

The **universal milling machine** is the same as the horizontal milling machine, except there is an arrangement of swing up the table to 45 degrees in either direction.



Universal milling machine (Source: IndiaMart)

Fixed bed milling machine:

In this type of machine, the bed of the machine is fixed to the machine.

There is no arrangement of the knee and saddle which can move vertically and transversally.

The worktable is directly situated at the fixed bed.

The spindle of this machine is mounted on a movable spindle head.

It can move in the vertical and horizontal direction and to perform the cutting operation.

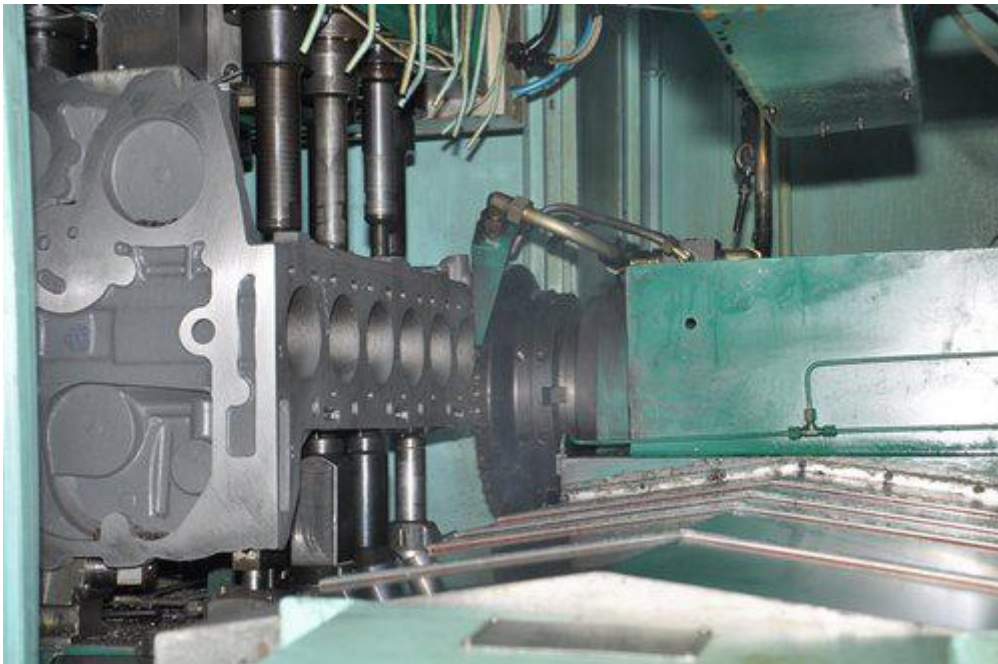


Fixed bed milling machine (Source: IndiaMart)

Simplex milling machine:

In the simplex machine, spindle head or the spindle travel only in one direction.

Mostly it travels in the vertical direction.



Simplex milling machine (Source: IndiaMart)

Duplex milling machine:

In this machine, the spindle travels both vertical and horizontal direction.



Duplex milling machine (Source: IndiaMart)

Triplex milling machine:

In the triplex machine, the spindle can move in all three directions along X, Y, and Z-axis.



Triplex milling machine (Source: IndiaMart)

Planner milling machine:

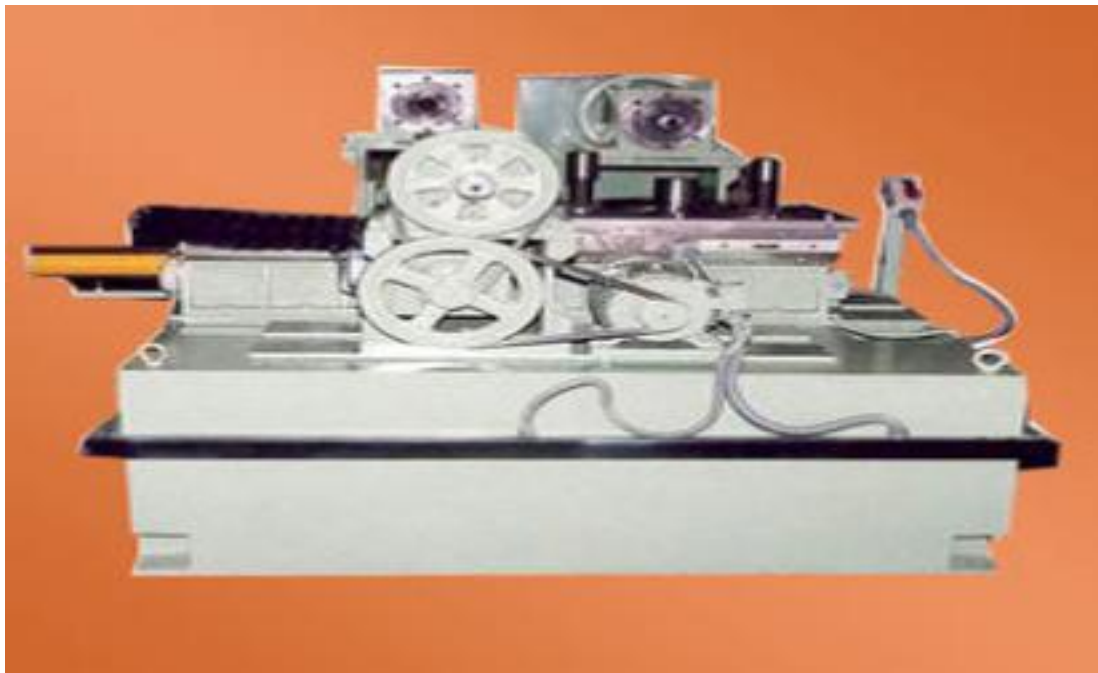
The planner milling machine is mostly used for facing operation in mass production.

These machines are similar to the bed type milling machine, except it can be mounted with various cutters and spindle heads to the machine.

These cutters in the machines can perform the facing operations simultaneously which is a great function.

Special milling machine:

These machines are the modern milling machines which are developed to easy the milling operations according to the jobs.



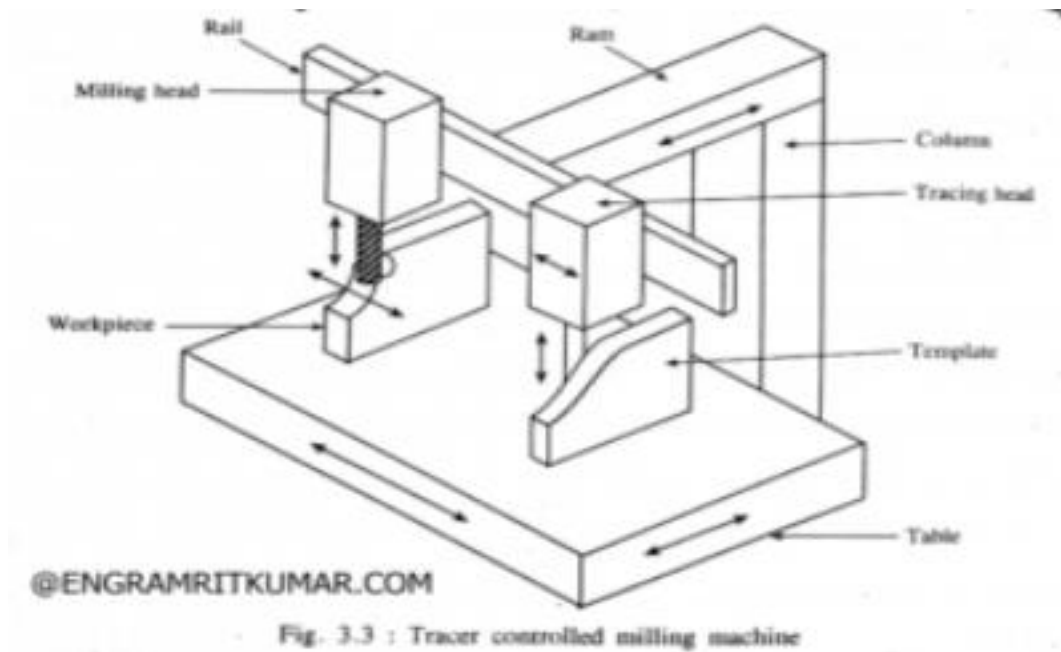
Special milling machine

Tracer milling machine:

This machine performs all difficult operation like, die making the job by synchronizing the tracing unit.

This can develop any difficult shape.

This is mostly used in the automobile and aerospace industries.



Tracer milling machine

CNC milling machine:

CNC is the most versatile milling machine which is control by a computer.

It is an upgraded version of the bed type milling machine, in which the spindle can move in all three directions and the table can rotate 360 degrees.

These all movement is hydraulically controlled which is commanded by a computer.

In this, any difficult geometry can make on it.

A sketch of the workpiece is loaded to the computer which is cut on the workpiece by the cutters automatically.



CNC milling machine (Source: IndiaMart)



Operations that can be performed in a Milling Machine:

There are several **types of operation** that can be performed in a milling machine, and those are:

- Plain Milling Operation
- Face Milling Operation
- End Milling Operation
- Form Milling Operation
- T-slot Milling Operation
- Side Milling Operation
- Gear Milling Operation
- Straddle Milling Operation
- Grooves Milling Operation
- Gang Milling Operation

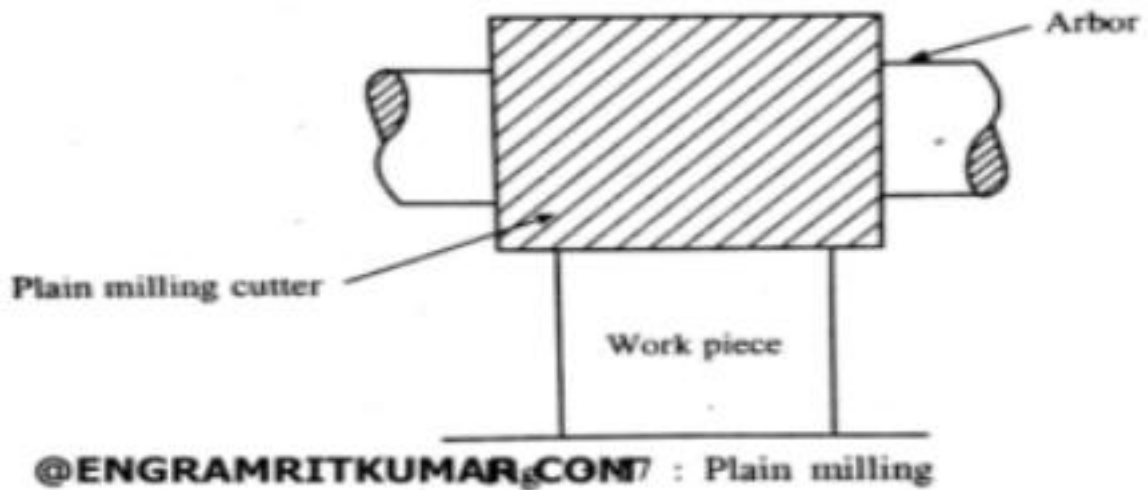
Plain Milling Operation:

It is the operation on producing plain, flat, horizontal surface, parallel to the axis of rotation.

This operation is also known as **slab milling**.

This operation is very common and done in almost all jobs.

This can be carried out on every milling machine.

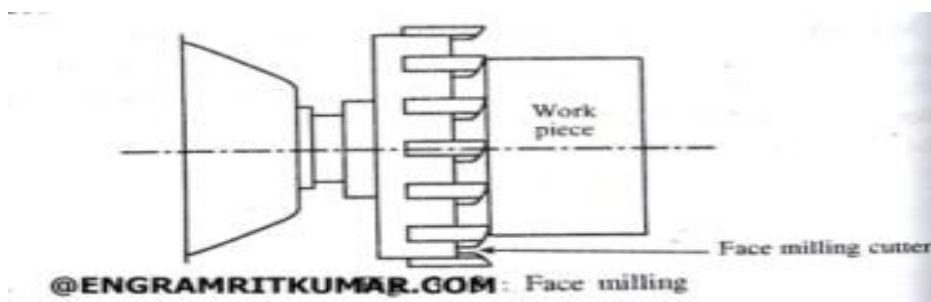


Plain milling operation diagram

Face milling Operation:

This machining operation is done on the surfaces which are perpendicular to the axis of the cutter.

The operation is performed by the face milling cutter mounted on stub arbor of the machine.



End milling operation:

It is the process of producing flat surfaces which may be horizontal, vertical and at an angle taking worktable as a reference.

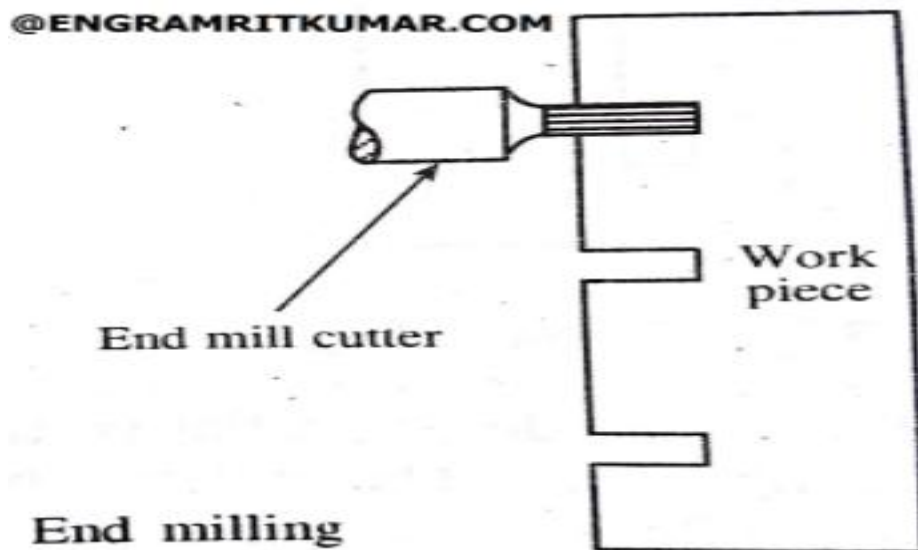
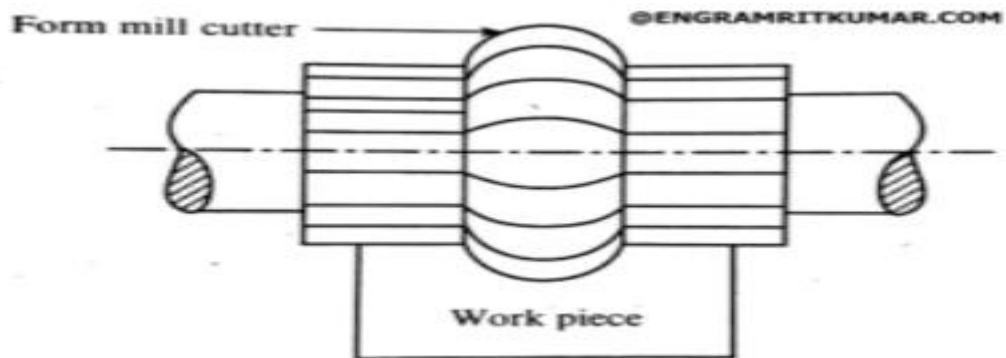


Diagram of End milling operation

Form milling Operation:

It is the process of machining special contour (outline) composed of curves, straight lines, or entirely of curves, at a single cut.

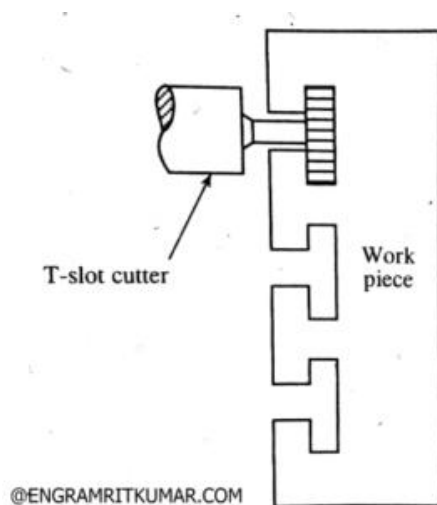
This operation is accomplished by using convex, concave and corner rounding milling cutters.



Form milling operation diagram

T-slot milling Operation:

It is the operation on producing the T-slots on the workpiece by using the **T-slots milling cutter**.



T-slot milling operation diagram



Side milling Operation:

It is the operation on producing the flat vertical surface on the sides of the workpiece by using a side milling cutter.

The cutter is having teeth on its face as well as it's side.

Gear cutting Operation:

It is the operation on producing gear tooth on the gear blank by using a form-relieved cutter in a milling machine.

The cutter profile is exactly matched with the tooth space of the gear.

Straddle milling Operation:

It is the operation on producing the flat vertical surface on both sides of the workpiece by using two side milling cutter mounted on the same arbor.

The distance between the two cutters is adjusted by using a spacing collar.

This is commonly used to produce a hexagonal or square surface.

Grooves milling Operation:

It is the operation on producing the groove on the surface of the workpiece by using a saw-milling cutter or end milling cutter.



The workpiece is fixed firmly on a milling machine and fixing the end milling cutter on an arbor, by adjusting the depth of cut, the work is fed against the cutter to cut the groove on the work surface.

Gang milling Operation:

It is the machining process in which two or more milling cutters are used together to perform different milling operation simultaneously.

In gang milling, the cutters are mounted on the arbor.

The advantages of the Milling machine:

In the **milling machine there are following advantages**, those are:

- Ideal for the production of individual pieces and small batches.
- Capable of producing complex shapes with the use of multitooth, as well as a single point, cutting tools.
- Operation cost can be very modest given general-purpose equipment and cutters are used.

Milling Machine Disadvantages:

These are the following **disadvantages of a milling machine**:



- It is more costly than casting, cold forming, extrusion, etc. If these process can provide the flatness, surface finish and dimensional accuracy required for the part.
- For mass production, it becomes economically necessary to use special-purpose machines.
- They may cost millions of dollars but the cost is justifiable when handling labor which is virtually eliminated and machining accuracy and repeatability is ensured.

The applications of Milling Machine:

These are the following **applications of the milling machine**:

- The milling machine is used to making gears.
- Usually used to a machined flat surface but can also produce irregular surfaces.
- Used to produce the groove or slot.
- Modern milling machine cut superalloys, titanium, tensile steel to closer tolerance, a greater accuracy, and faster rate.
- The milling machine is used to design of metal and other materials.

I also wrote an article on Indexing [What is indexing head in a milling machine?](#) and [up milling and down milling](#), you may check that too.