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2. DRILLING MACHINE

2.1 Introduction

Drilling machine is one of the most important machine tools in a workshop. It was designed to produce a cylindrical hole of required diameter and depth on metal workpieces. Though holes can be made by different machine tools in a shop, drilling machine is designed specifically to perform the operation of drilling and similar operations. Drilling can be done easily at a low cost in a shorter period of time in a drilling machine.

Drilling can be called as the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edges of a drill. The cutting tool known as drill is fitted into the spindle of the drilling machine. A mark of indentation is made at the required location with a centre punch. The rotating drill is pressed at the location and is fed into the work. The hole can be made upto a required depth.

2.2 Construction of a drilling machine

The basic parts of a drilling machine are a base, column, drill head and spindle. The base made of cast iron may rest on a bench, pedestal or floor depending upon the design. Larger and heavy duty machines are grounded on the floor. The column is mounted vertically upon the base. It is accurately machined and the table can be moved up and down on it. The drill spindle, an electric motor and the mechanism meant for driving the spindle at different speeds are mounted on the top of the column. Power is transmitted from the electric motor to the spindle through a flat belt or a 'V' belt.

2.3 Types of drilling machines

Drilling machines are manufactured in different types and sizes according to the type of operation, amount of feed, depth of cut, spindle speeds, method of spindle movement and the required accuracy.

The different types of drilling machines are:

1. Portable drilling machine (or) Hand drilling machine
2. Sensitive drilling machine (or) Bench drilling machine
3. Upright drilling machine
4. Radial drilling machine
5. Gang drilling machine
6. Multiple spindle drilling machine
7. Deep hole drilling machine

2.3.1 Portable drilling machine

Portable drilling machine can be carried and used anywhere in the workshop. It is used for drilling holes on workpieces in any position, which is not possible in a standard drilling machine. The entire drilling mechanism is compact and small in size and so can be carried anywhere. This type of machine is widely adapted for automobile built-up work. The motor is generally universal type.

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These machines can accommodate drills from 12mm to 18 mm diameter. Portable drilling machines are operated at higher speeds.

2.3.2 Sensitive drilling machine

It is designed for drilling small holes at high speeds in light jobs. High speed and hand feed are necessary for drilling small holes. The base of the machine is mounted either on a bench or on the floor by means of bolts and nuts. It can handle drills upto 15.5mm of diameter. The drill is fed into the work purely by hand. The operator can sense the progress of the drill into the work because of hand feed. The machine is named so because of this reason. A sensitive drilling machine consists of a base, column, table, spindle, drill head and the driving mechanism.

A sensitive drilling machine is shown in Fig. 2.1.

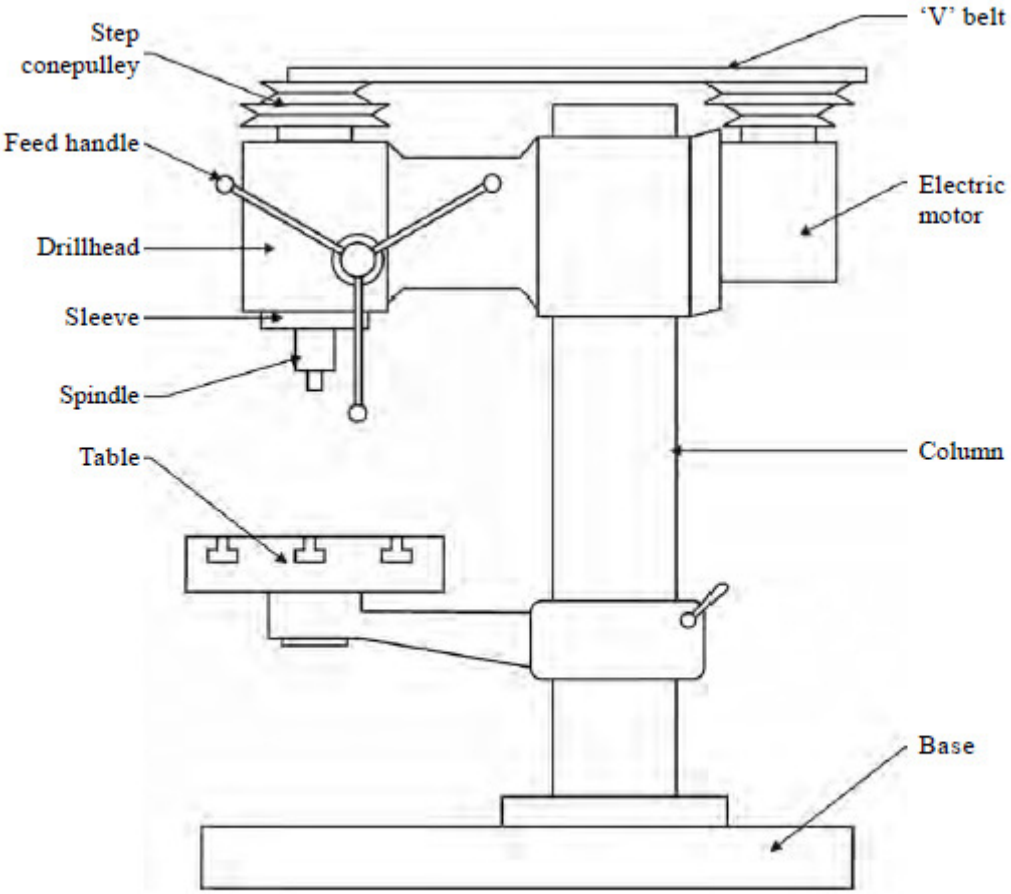

Fig 2.1 Sensitive drilling machine

Base

The base is made of cast iron and so can withstand vibrations. It may be mounted on a bench or on the floor. It supports all the other parts of the machine on it.

Column

The column stands vertically on the base at one end. It supports the work table and the drill head. The drill head has drill spindle and the driving motor on either side of the column.

Table

The table is mounted on the vertical column and can be adjusted up and down on it. The table has 'T'-slots on it for holding the workpieces or to hold any other work holding device. The table can

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be adjusted vertically to accommodate workpieces of different heights and can be clamped at the required position.

Drill head

Drill head is mounted on the top side of the column. The drill spindle and the driving motor are connected by means of a V-belt and cone pulleys. The motion is transmitted to the spindle from the motor by the belt. The pinion attached to the handle meshes with the rack on the sleeve of the spindle for providing the drill the required down feed. There is no power feed arrangement in this machine. The spindle rotates at a speed ranging from 50 to 2000 r.p.m.

2.3.3 Upright drilling machine

The upright drilling machine is designed for handling medium sized workpieces. Though it looks like a sensitive drilling machine, it is larger and heavier than a sensitive drilling machine. Holes of diameter upto 50mm can be made with this type of machine. Besides, it is supplied with power feed arrangement. For drilling different types of work, the machine is provided with a number of spindle speeds and feed.

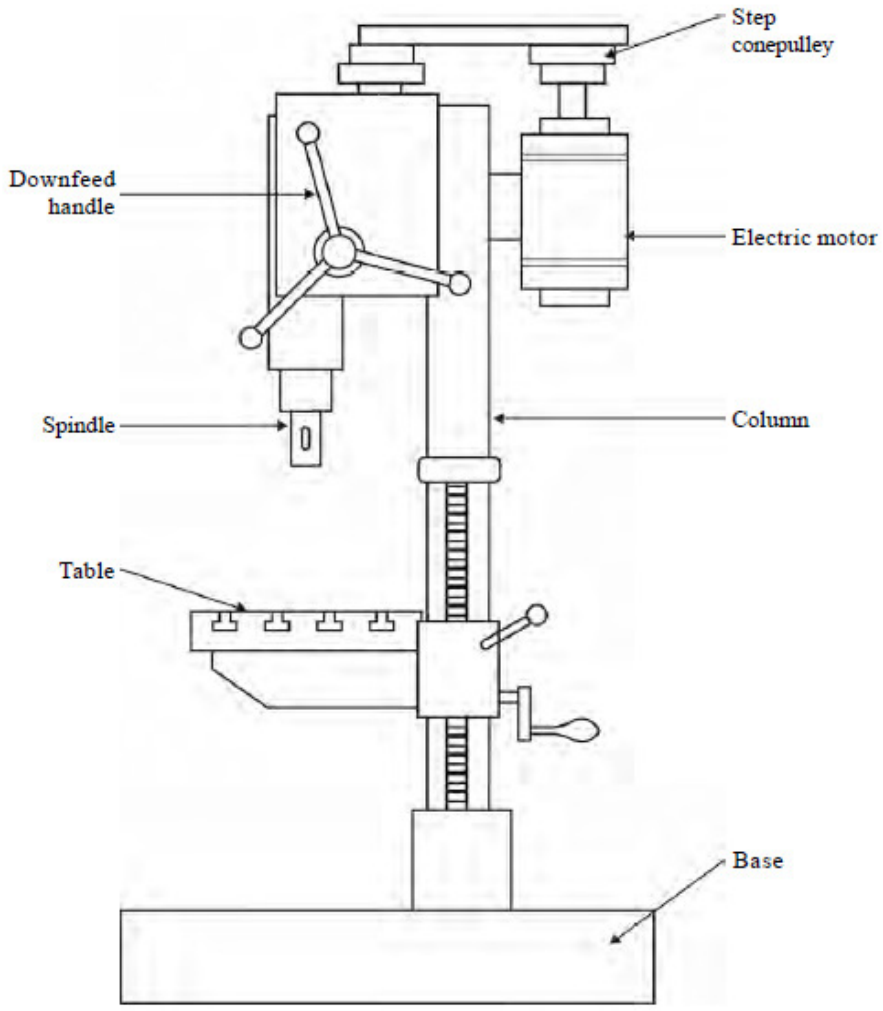

Fig 2.2 Upright drilling machine

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2.3.4 Radial drilling machine

The radial drilling machine is intended for drilling on medium to large and heavy workpieces. It has a heavy round column mounted on a large base. The column supports a radial arm, which can be raised or lowered to enable the table to accommodate workpieces of different heights. The arm, which has the drill head on it, can be swung around to any position. The drill head can be made to slide on the radial arm. The machine is named so because of this reason. It consists of parts like base, column, radial arm, drill head and driving mechanism. *A radial drilling machine is illustrated in Fig. 2.3*

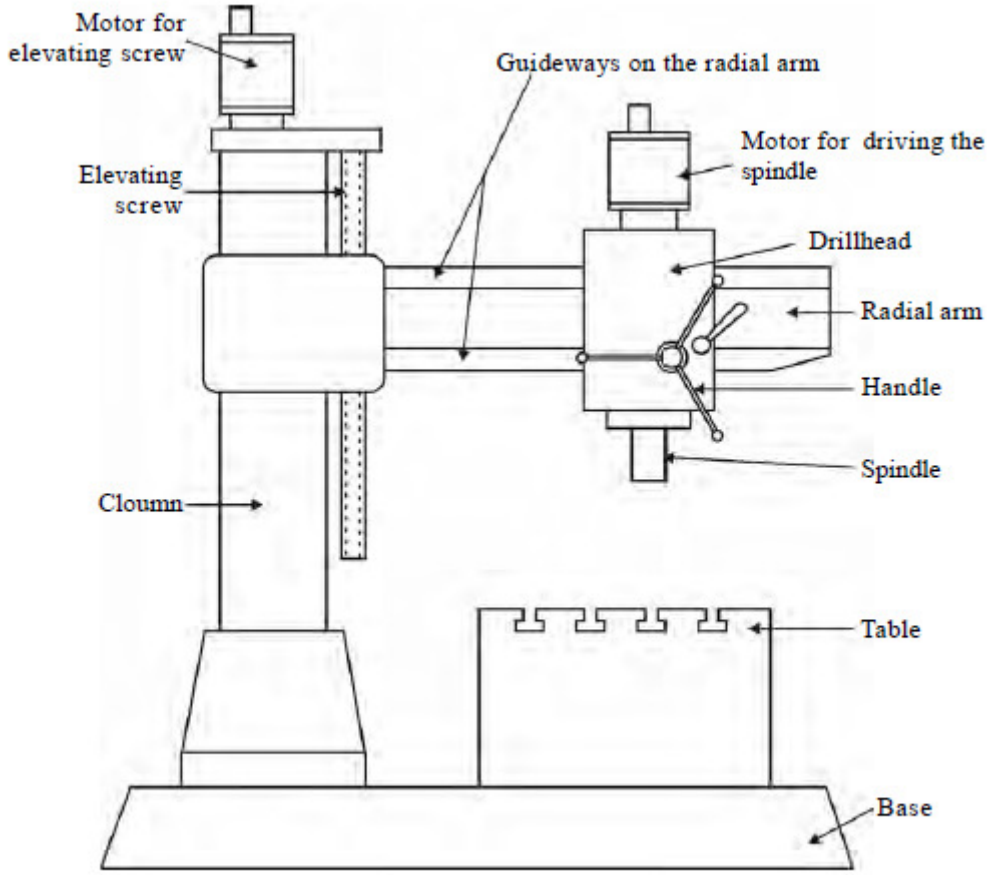

Fig 2.3 Radial drilling machine

2.3.5. Gang drilling machine

Gang drilling machine has a long common table and a base. Four to six drill heads are placed side by side. The drill heads have separate driving motors. This machine is used for production work.

A series of operations like drilling, reaming, counter boring and tapping may be performed on the work by simply shifting the work from one position to the other on the work table. Each spindle is set with different tools for different operations.

2.3.6 Multiple spindle drilling machine

This machine is used for drilling a number of holes in a workpiece simultaneously and for reproducing the same pattern of holes in a number of identical pieces. A multiple spindle drilling machine also has several spindles. A single motor using a set of gears drives all the spindles. All the spindles holding the drills are fed into the work at the same time. The distances between the

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spindles can be altered according to the locations where holes are to be drilled. Drill jigs are used to guide the drills.

2.3.7 Deep hole drilling machine

A special machine and drills are required to drill deeper holes in barrels of gun, spindles and connecting rods. The machine designed for this purpose is known as deep hole drilling machine. High cutting speeds and less feed are necessary to drill deep holes. A non rotating drill is fed slowly into the rotating work at high speeds. Coolant should be used while drilling in this machine. There are two different types of deep hole drilling machines

2.4 Size of a drilling machine (Specification)

Drilling machines are specified according to their type.

To specify the machine completely the following factors are considered:

1. the maximum diameter of the drill that it can handle
2. the size of the largest workpiece that can be centred under the spindle
3. distance between the face of the column and the axis of the spindle
4. diameter of the table
5. maximum travel of the spindle
6. numbers and range of spindle speeds and feeds available
7. Morse taper number of the drill spindle
8. floor space required
9. weight of the machine
10. Power input is also needed to specify the machine completely.

2.6 Work holding devices

The work should be held firmly on the machine table before performing any operation on it. As the drill exerts very high quantity of torque while rotating, the work should not be held by hand. If the workpiece is not held by a proper holding device, it will start rotating along with the tool causing injuries to the operator and damage to the machine.

The devices used for holding the work in a drilling machine are

1. Drill vise
2. 'T' - bolts and clamps
3. Step block
4. V - block
5. Angle plate
6. Drill jigs

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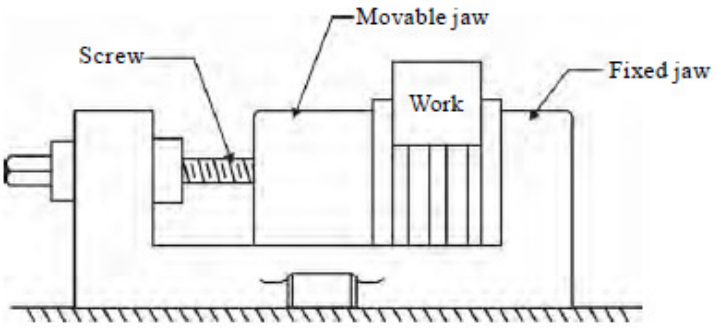

Fig 2.6 Drill vice

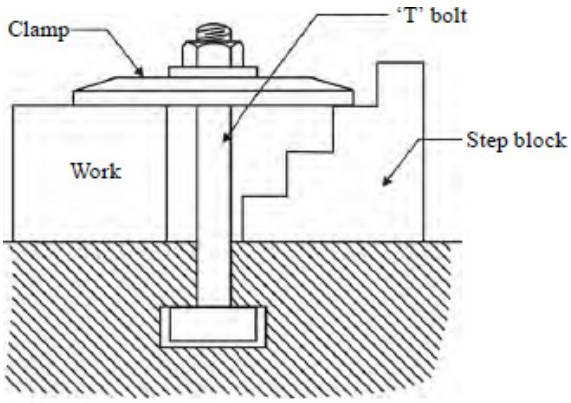

Fig 2.7 T-bolt & clamp

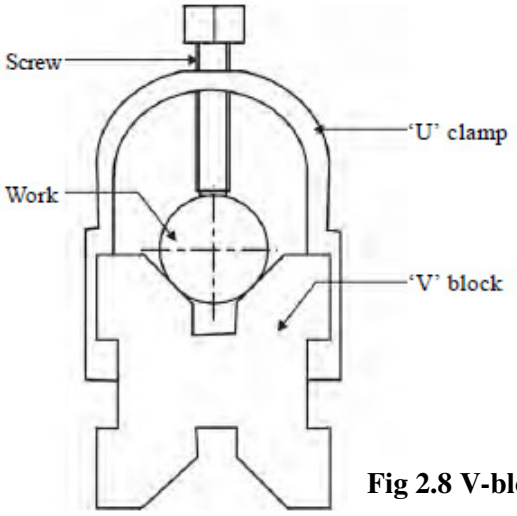

Fig 2.8 V-block

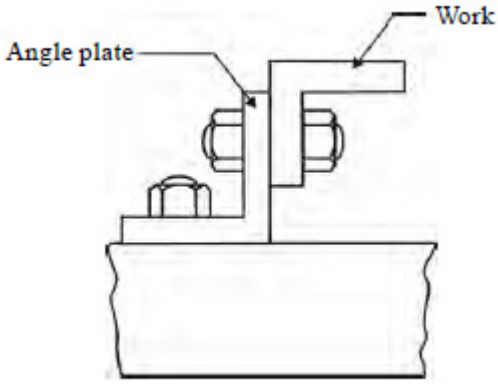

Fig 2.7 Angle plate

2.7 Tools used in a drilling machine

Different tools are used for performing different types of operations. The most commonly used tools in a drilling machine are

1. Drill
2. Reamer
3. Counter bore
4. Countersink
5. Tap

2.7.1 Drill

A drill is a tool used to originate a hole in a solid material. A helical groove known as 'flute' is cut along the length of the drill.

Different types of drills are

1. Flat Drill
2. Straight fluted drill
3. Twist drill
4. Centre drill

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Twist drills are the type generally used in shop work. They are made of High speed steel (HSS) or High carbon steel. There are two types of twist drills namely (i) Straight shank twist drill and (ii) Taper shank twist drill. The diameter of the straight shank drill ranges from 2 to 16mm. Taper shanks is provided on drills of larger diameter.

2.7.2 Reamer

The tool used for enlarging and finishing a previously drilled hole is known as a reamer. It is a multi tooth cutter and removes smaller amount of material. It gives a better finish and accurate dimension.

2.7.3 Counter bore

A Counter bore is a multi tooth cutting tool used for enlarging the top of the previously machined hole. It has three or four cutting teeth. The flutes on them may be straight or helical. Straight fluted tools are used for machining softer materials like brass and aluminium and for short depth of cut. Helical fluted counter bores are used for longer holes.

2.7.4 Countersink

A countersink has cutting edges on its conical surfaces. It has a similar construction of a counter bore except for the angle of the cutting edges. The angle of countersinks will generally be 60°, 82° or 90°. It is used for enlarging the top of the holes conically.

2.7.5 Tap

A tap has threads like a bolt. It has three to four flutes cut across the threads. It can cut threads on the inside of a hole. The flutes on the threads form the cutting edges. It is a multi point cutting tool. It will dig into the walls of the hole as the lower part of the tap is slightly tapered. The shank of the tap is square shaped to enable it to be held by a tap wrench.

2.7.6 Twist drill nomenclature

Axis

It is the longitudinal centre line of the drill running through the centres of the tang and the chisel edge.

Body

It is the part of the drill from its extreme point to the commencement of the neck, if present. Otherwise, it is the part extending upto the commencement of the shank. Helical grooves are cut on the body of the drill.

Shank

It is the part of the drill by which it is held and driven. It is found just above the body of the drill. The shank may be straight or taper. The shank of the drill can be fitted directly into the spindle or by a tool holding device.

Tang

The flattened end of the taper shank is known as tang. It is meant to fit into a slot in the spindle or socket. It ensures a positive drive of the drill.

Neck

It is the part of the drill, which is diametrically undercut between the body and the shank of the drill. The size of the drill is marked on the neck.

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Point

It is the sharpened end of the drill. It is shaped to produce lips, faces, flanks and chisel edge.

Lip

It is the edge formed by the intersection of flank and face. There are two lips and both of them should be of equal length. Both lips should be at the same angle of inclination with the axis (59°).

Land

It is the cylindrically ground surface on the leading edges of the drill flutes adjacent to the body clearance surface. The alignment of the drill is maintained by the land. The hole is maintained straight and to the right size.

Flutes

The grooves in the body of the drill are known as flutes. Flutes form the cutting edges on the point. It allows the chips to escape and make them curl. It permits the cutting fluid to reach the cutting edges.

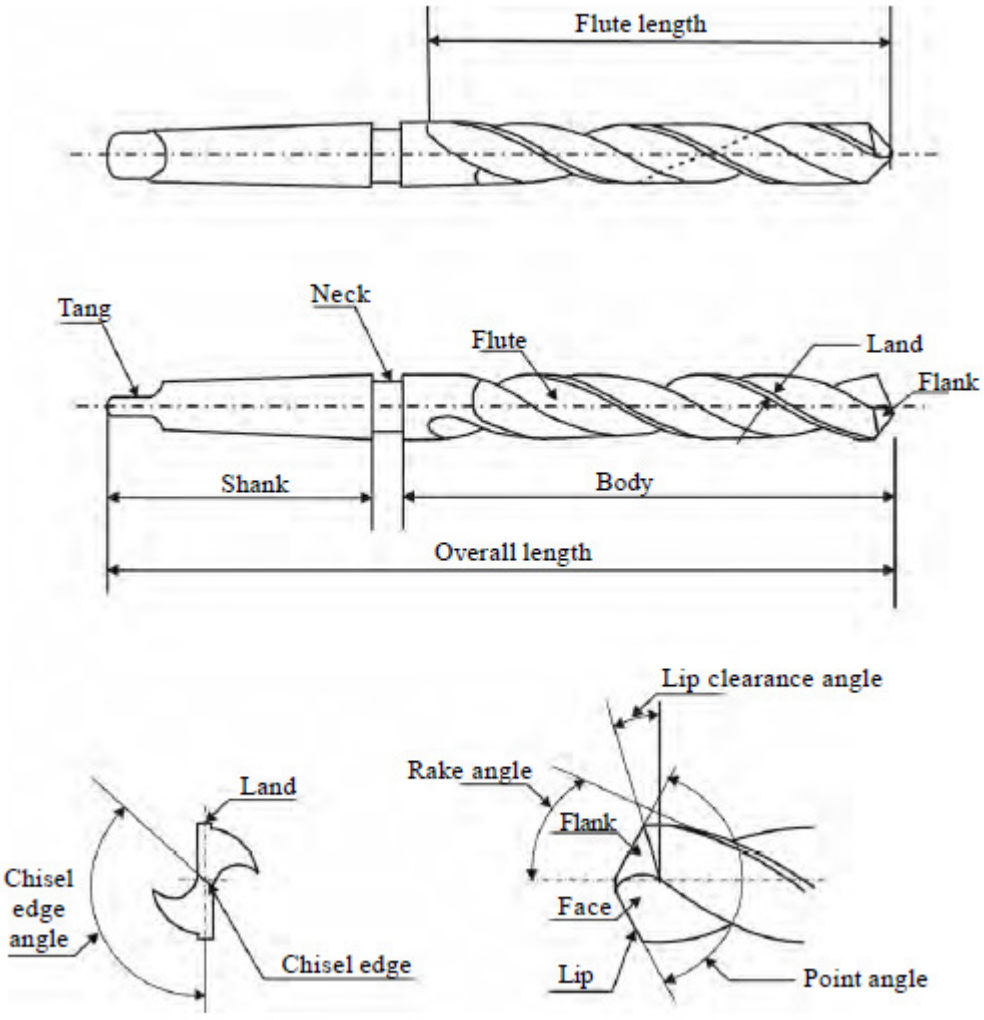

Fig 2.12 Twist drill nomenclature

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2.8 Tool holding devices

Different tools are used for performing different operations. They are fitted into the drill spindle by different methods. They are

1. By directly fitting in the spindle
2. By a sleeve
3. By a socket
4. By a chuck
5. Tapping attachment

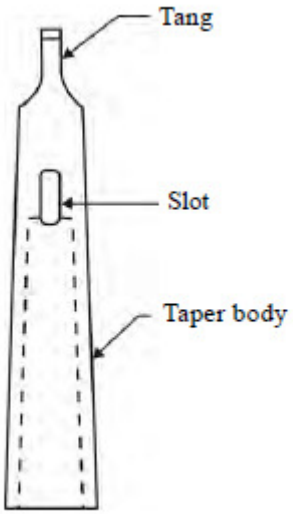

Fig 2.13 Drill sleeve

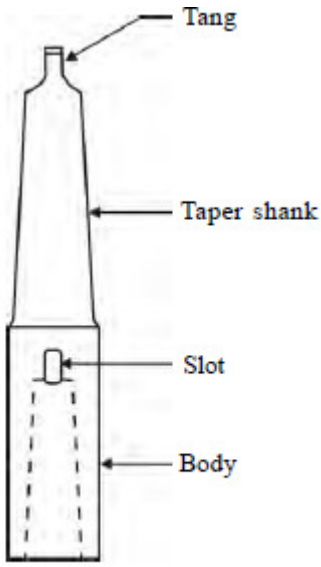

Fig 2.14 Drill socket

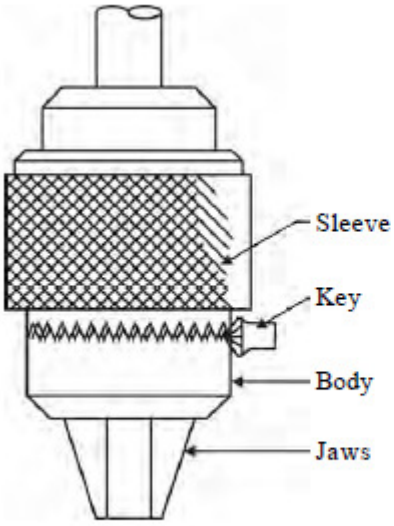

Fig 2.15 Drill chuck

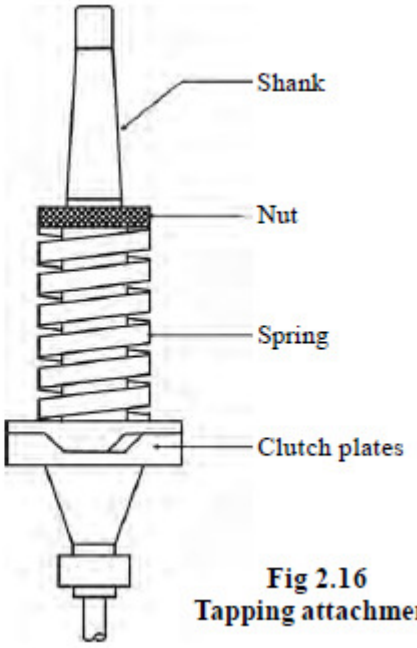

Fig 2.16
Tapping attachment

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2.9 Drilling machine operations

Though drilling is the primary operation performed in a drilling machine, a number of similar operations are also performed on holes using different tools. The different operations that can be performed in a drilling machine are:

1. Drilling
2. Reaming
3. Boring
4. Counter boring
5. Countersinking
6. Spot facing
7. Tapping
8. Trepanning

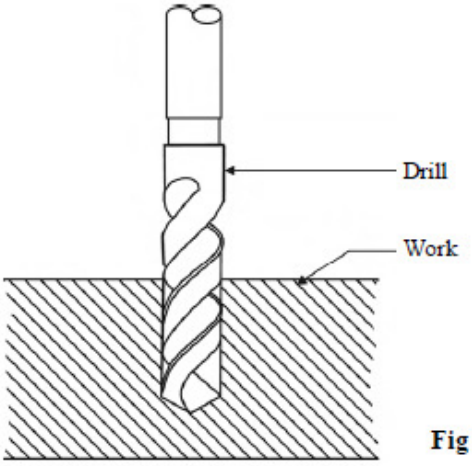

Fig 2.17 Drilling

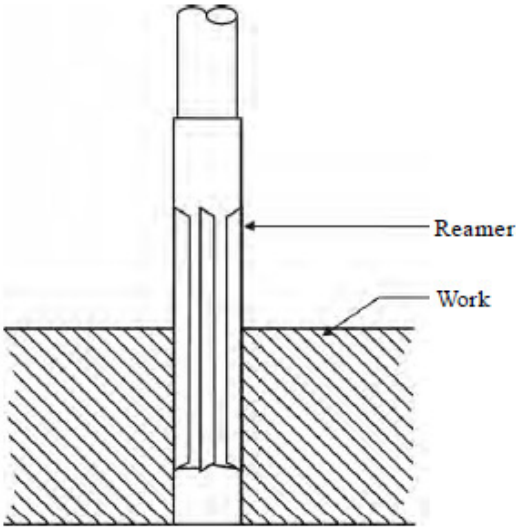

Fig 2.18 Reaming

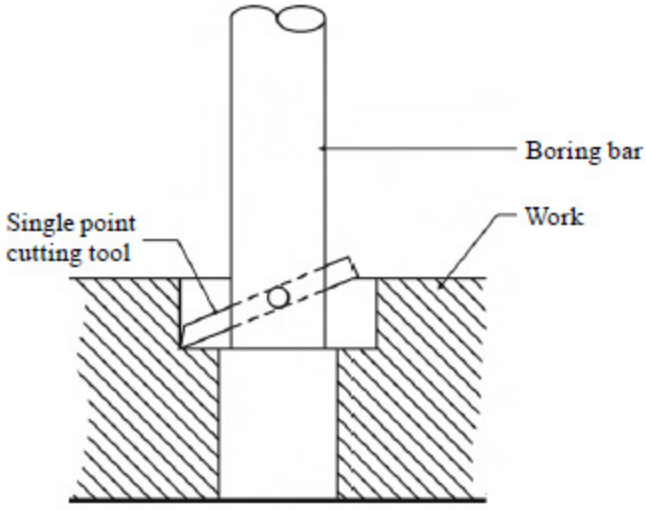

Fig 2.19 Boring

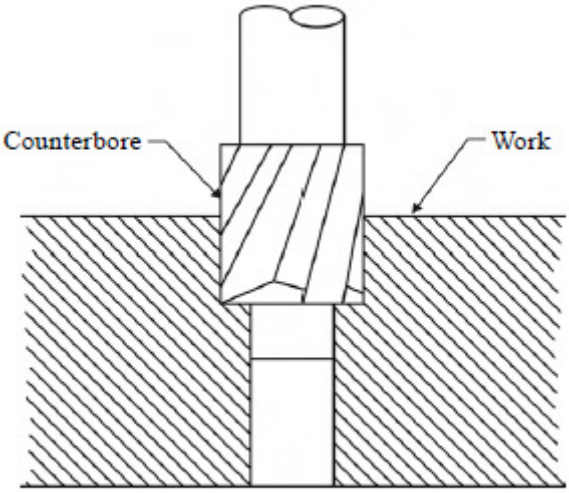

Fig 2.20 Counterboring

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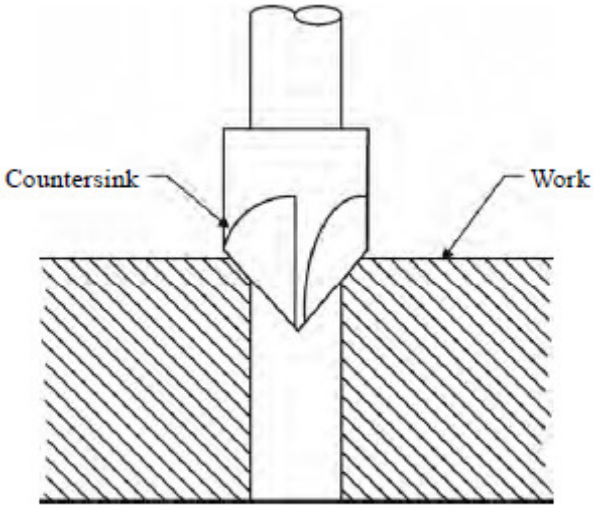

Fig 2.21 Countersinking

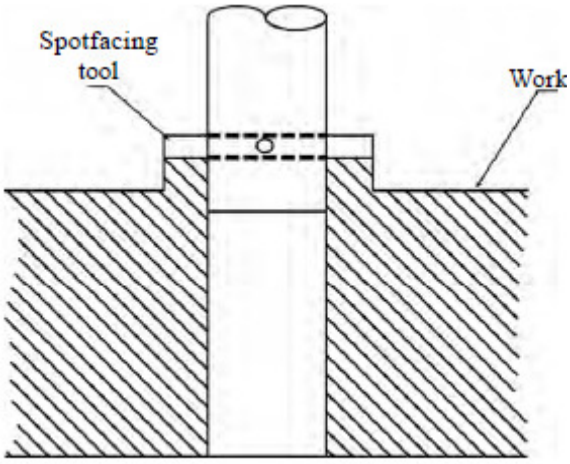

Fig 2.22 Spotfacing

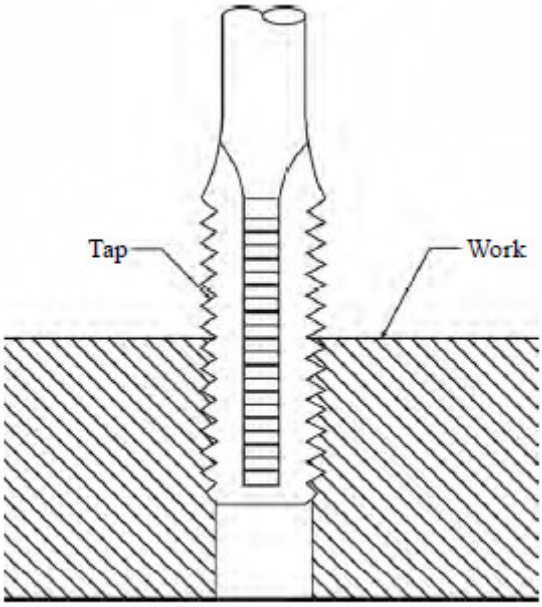

Fig 2.23 Tapping

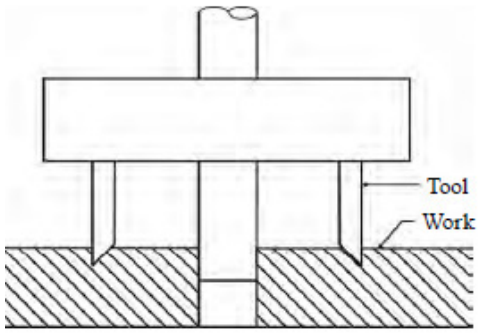

Fig 2.24 Trepanning