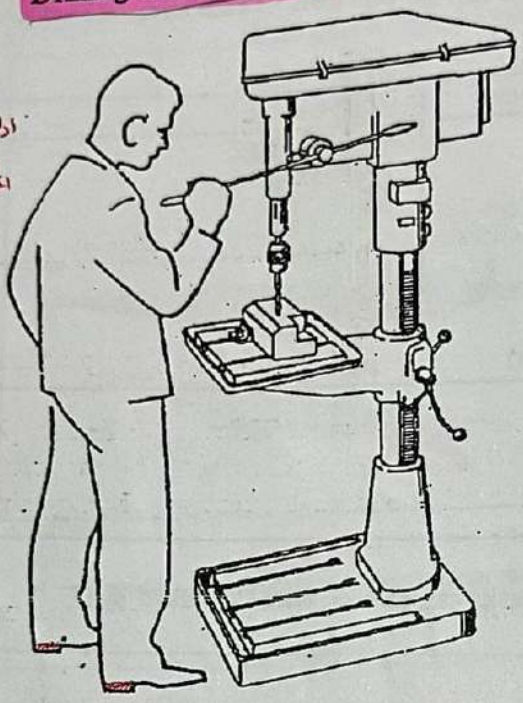
Drilling

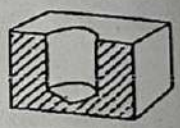
Definition:

Drilling is the process of originating a circular hole by removing chips.



Drilling on the drill press

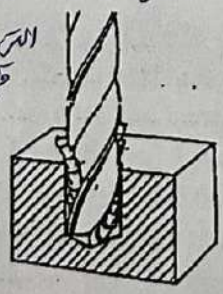
Through hole

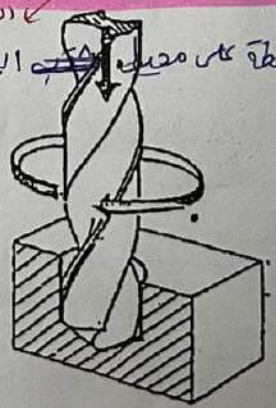


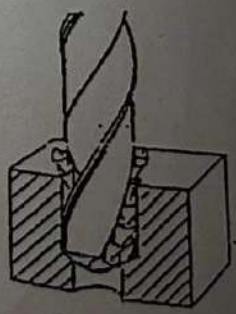
Blind hole

Principles of Drilling:

Drilling is the result of two motions, the rotary cutting motion and the axial feed motion of the drill. The cutting speed is the speed of a point on the drill's circumference and is measured in m/min. The feed is the distance that the drill enters the work at each revolution of the drill, measured in mm/rev.







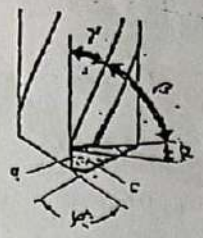
Drilling into full material

a = cutting motion
b = feed motion

Enlarging a predrilled hole

The drills most commonly used are twist drills. The two main cutting edges of a twist drill remove the chips, which are carried out of the hole by two flutes.

As on other cutting tools, there are clearance, rake and lip angles on twist drills.



α = Clearance angle
β = Lip angle
γ = Rake angle
ξ = Point angle
a = Cutting lip
c = Clearance surface

Drill holes are usually oversized. The enlargement depends on the drill diameter and is between 0.1 and 0.3 mm.

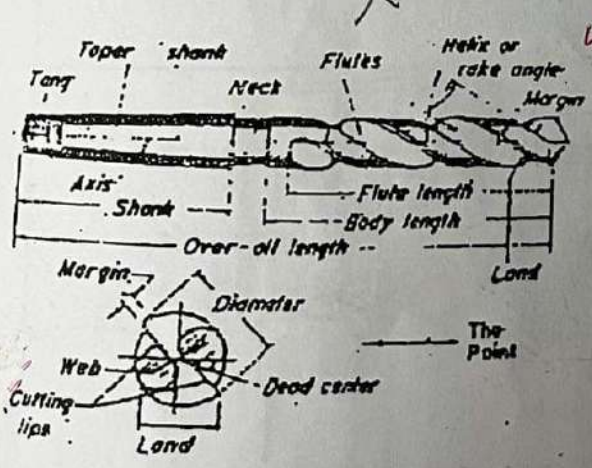
The surface quality of a drill hole is not very high. Drilling is a roughing process.

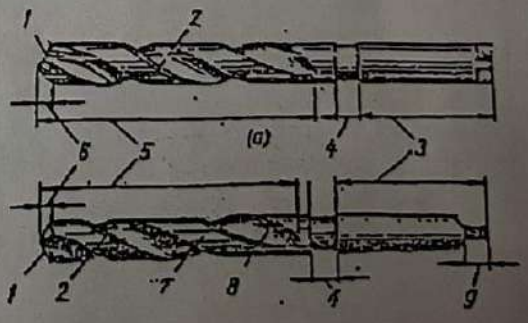
Drilling is used for originating holes in all types of work. Holes are drilled for joining parts by means of bolts, screws, rivets or other fasteners; for making holes which have to be threaded; for removing excess material in a more efficient way than by chipping or filing; for performing repair and assembly work.

Drilling may be classified as drilling with hand tools and drilling with power tools (machine tools, drilling machines).

Drilling Tools:

Drilling tools are the drill and the drilling machine. The drills most commonly used are twist drills. Twist drills are made of plain carbon tool steel or alloy tool steel. (HSS = High Speed Steel). For drilling of very hard materials drills with cemented carbide tips are used. The shank of a drill may be either straight or tapered.

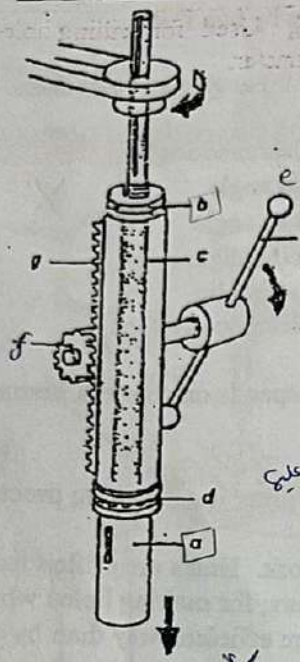




Straight shank and taper shank

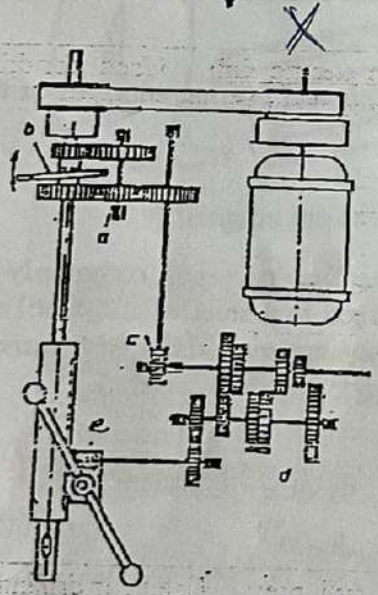
Parts of a twist drill

Drilling Machines:



The common mechanical feature of all drilling machines consists of revolving spindle, which holds the drills and a non-revolving sleeve, which carries the spindle. The sleeve slides in its bearing in a direction parallel to its axis.

a = revolving spindle
b = ring nut
c = non-revolving sleeve
d = ball bearing
e = feed lever
f = gear
g = tooth rack



Drilling machines are usually driven by an electric motor. The various cutting speeds (or numbers of revolutions) and feeds may be obtained through cone pulleys or gears.

a = gears for main drive
b = control lever for main drive
c = main drive and feed drive connected by a worm and a worm gear
d = gear drive for various feeds
e = worm and worm gear for power feed

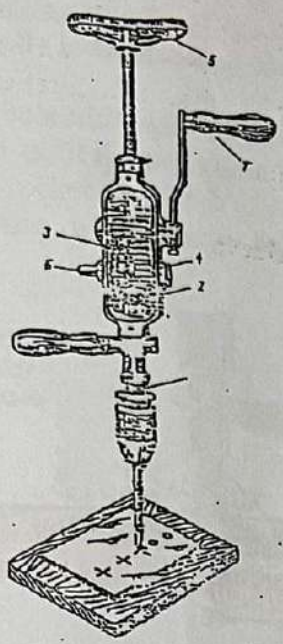
A counterbore.

Hole

counter sink.

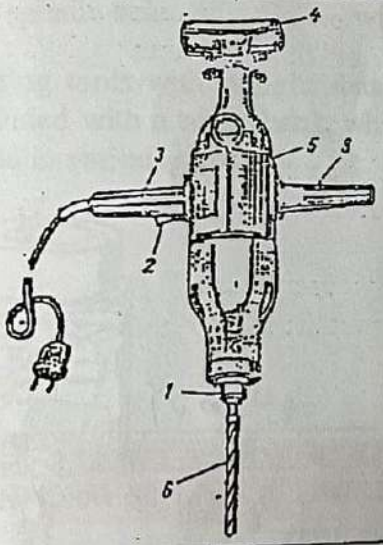
Hole

Symplay



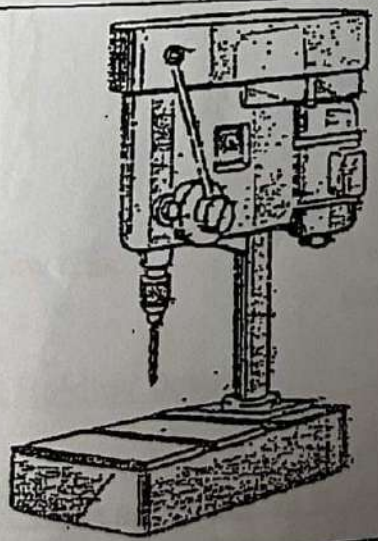
Hand drill. Used for drilling holes up to 10 mm diameter.

1 = spindle
2 = bevel gear
3 = bevel gear
4 = gear
5 = breast plate
6 = shaft
7 = handle

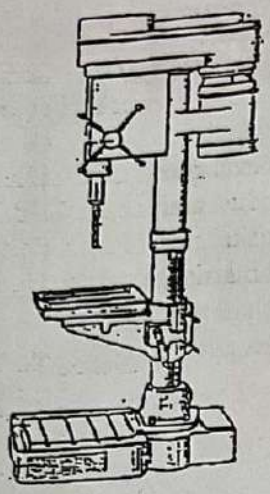


Portable electric drill. Used for drilling holes up to about 15 mm diameter.

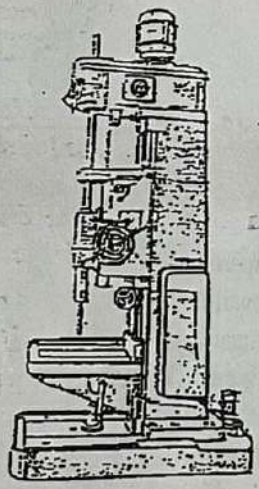
1 = spindle
2 = switch
3 = handle
4 = breast plate
5 = aluminum housing
6 = drill



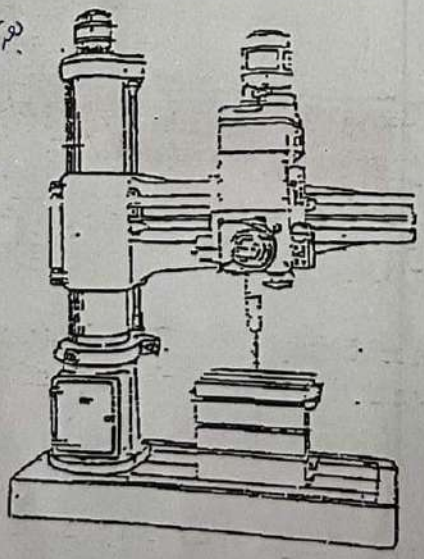
Bench drill press. Used for drilling holes up to 10 mm diameter.



Sensitive drill press. Used for drilling holes up to 25 mm diameter.



Heavy-duty drilling machine. Used for drilling holes up to 40 mm diameter.

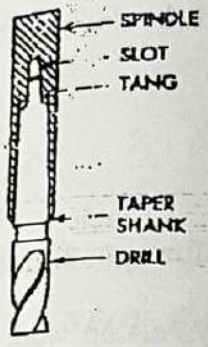


Radial drilling machine. Used for drilling several holes in the work which is fastened securely.

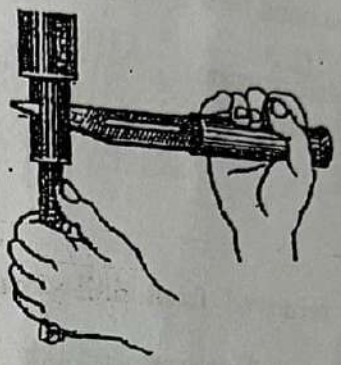
Tool Holding Devices:

The revolving spindle of the drill press carries the cutting tool. Some tools may be held directly in the spindle hole; others may be held in a taper socket, or a drill chuck.

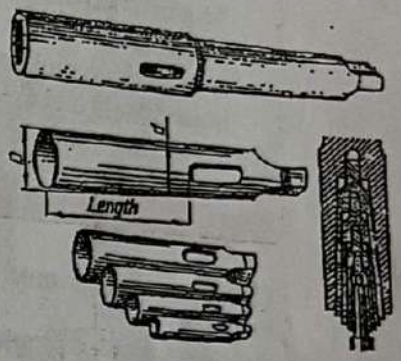
Cutting tools with taper shank are held in the taper hole of the spindle. Tools that are too small to fit the taper hole in the spindle of the machine are held in a small taper hole in a socket, the shank of which fits the spindle hole. If the socket makes too long an extension, a sleeve may be used. Sockets and sleeves are made in all necessary sizes.



Holding the drill in the spindle hole

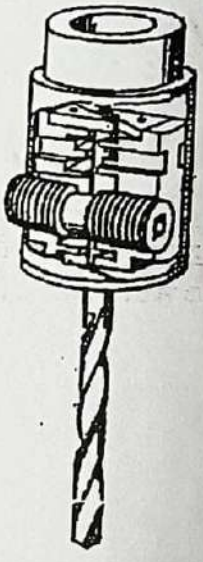


Removing a drill with a drill drift

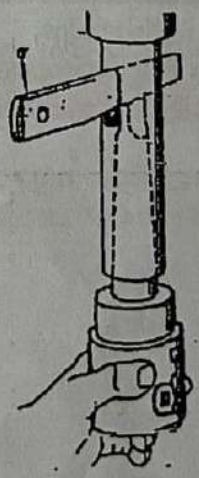


Socket (above) and a set of sleeves

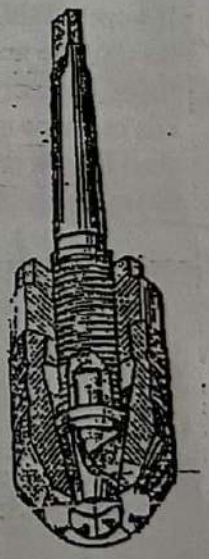
Cutting tools with straight shank are held in drill chucks. The drill chuck itself is provided with a taper shank, which fits the taper hole in the spindle. Drill chucks are made in various sizes.



Two-jaw chuck



Two-jaw chuck being removed by a drill drift



Three-jaw chuck in closed position

Work Holding Devices:

Work is held on the drill press by means of clamps, vises and jigs. Clamping with clamps, bolts and parallels is very slow and not very accurate. Also a vise does not accurately locate work under the drill.

General Rules for Drilling:

1. Always examine a drill for size and sharpness before using it.
2. Have the shank of the drill and socket, or of the chuck, clean, dry, and tight in the spindle.
3. Be sure the setup is arranged so that the drill will clear as it goes through the work, and not cut into the parallels table, or vice.
4. A drill will follow a hole already made. A pilot hole will keep a larger drill from running.
5. When the drill "breaks through" at the end of the cut, it has a tendency to "dig in". Especially when hand feed is used, care must be taken or a broken drill will result.
6. A squeak indicates undue friction. The cause should be looked for immediately and the fault corrected.

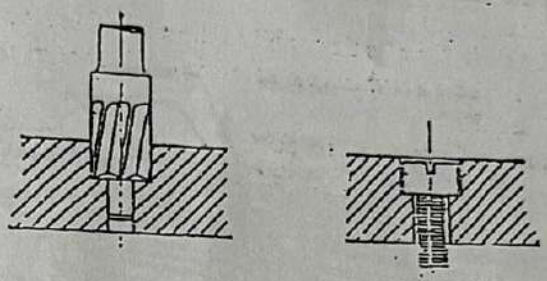
Safety Rules in Drilling:

1. Chuck wrenches must be removed from drill chucks before starting the machine.
2. Never attempt to hold work under the drill by hand. Always clamp work to table.
3. Run drill at proper speed; forcing or feeding too fast may result in broken or splintered drills and serious injuries.
4. Change belt for speed regulation only when power is "Off" and the machine has come to a dead stop.
5. If work should slip from clamp, never attempt to stop it with your hands. Stop the machine and make adjustments.
6. If drill stops in work, shut off the motor and start drill by hand.
7. File or scrape all burrs from drilled holes.
8. Do not reach around or in back of a revolving drill.
9. Keep your head back and well away from any moving part of the drill press.

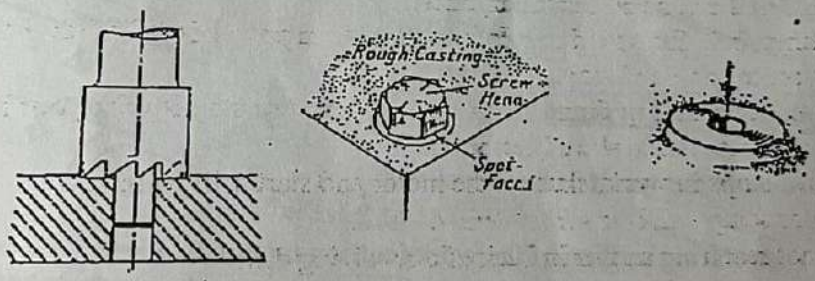
مطلوب سلاسلہ نہ

COUNTERBORING, SPORT FACING, COUNTERSINKING

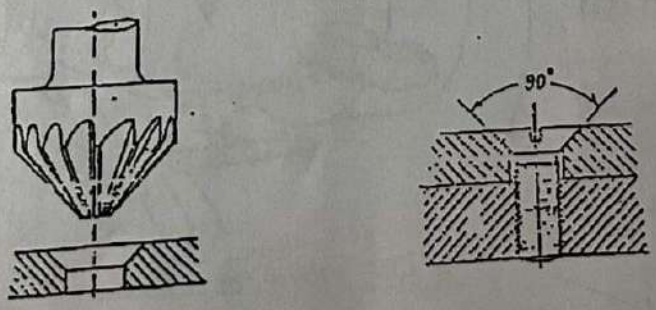
1. ***COUNTERBORING*** is the process of increasing the diameter of a hole for a certain distance down for the head of a screw or bolt, which should not project above the surface of the work.



2. ***SPOT FACING*** is the process of facing a rough surface around a hole, to provide a flat seating for a washer, bolt head, or nut.



3. ***COUNTERSINKING*** is the process of tapering a hole a certain distance for the head of screws or rivets and for taking away the burr of a hole.



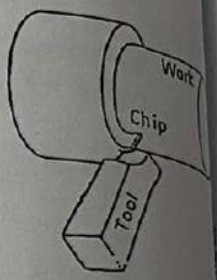
Tools:

The tools used in core drilling, boring, counterboring, countersinking and spot facing are made from alloy tool steel (HSS).

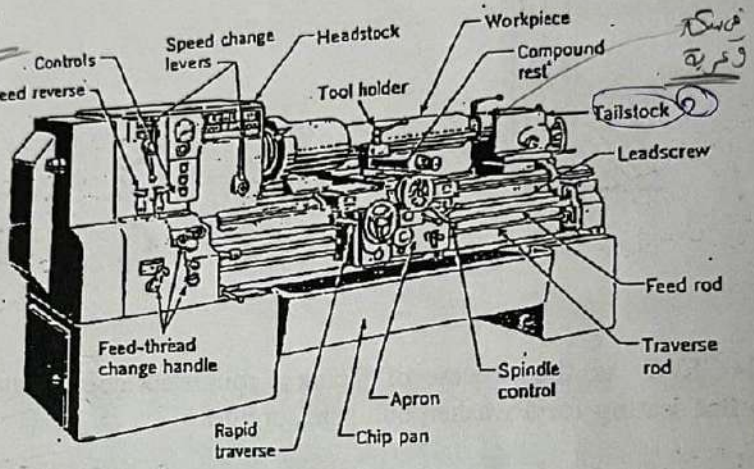
Turning

Definition:

Turning is a chip removing process performed on a machine tool called lathe. The function of the lathe is, primarily, the production of cylindrical surfaces.



Turning

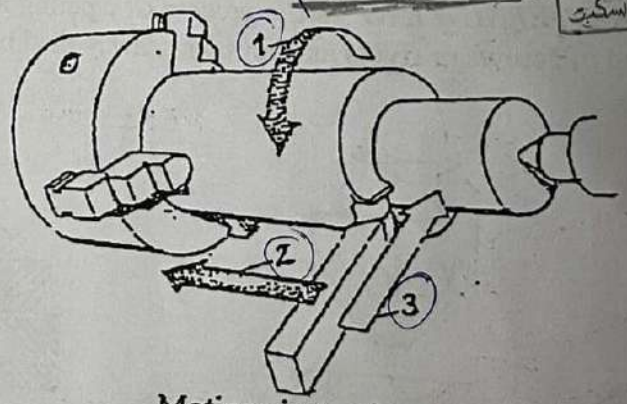


Lathe

Principles of Turning:

Turning is the result of three motions:

1. The rotating motion of the work (cutting motion).
2. The tool traveling either longitudinal or cross to the work-axis (feed motion).
3. The tool is set to the desired depth of cut (adjusting motion).

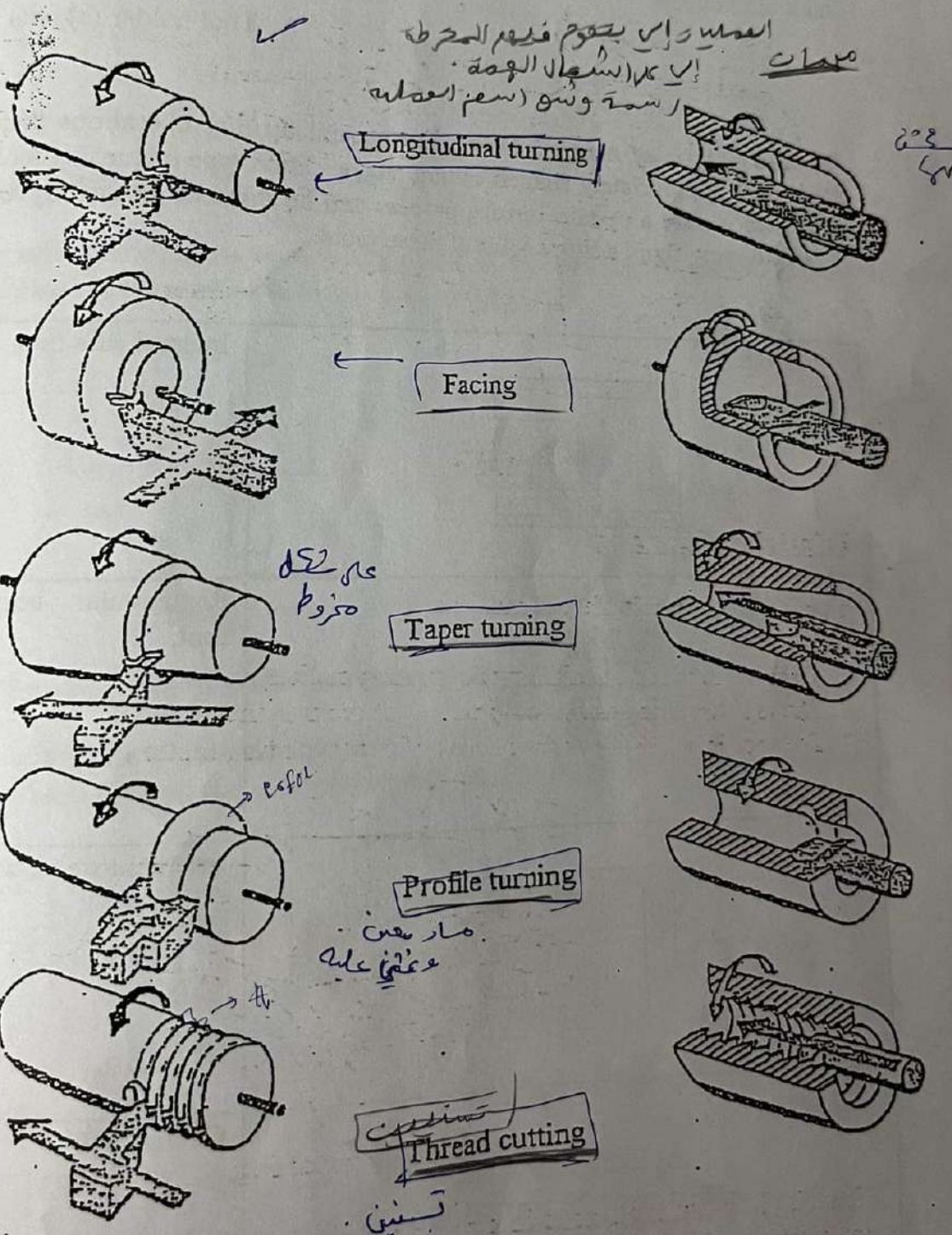


Motions in turning

The single-point tools used in turning are ground differently for the different cutting operations. But all of them are subject to the same geometry of cutting edges. The accuracy obtained in turning depends on the condition of the lathe as well as on the

abilities of the lathe operator. In most cases an accuracy of 0.01 mm can be considered as a good result.

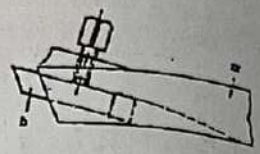
The lathe is the most versatile and useful of all machine tools and is used in producing a great variety of machine parts having circular cross-sections. The following figures show some turning processes.



Turning Tools:

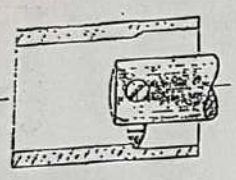
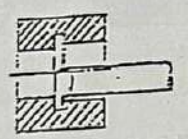
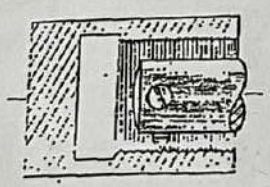
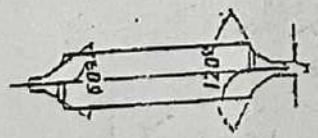
Carbon tool steels and high-speed steels, cemented carbides and ceramic materials are used in manufacturing single-point turning tools.

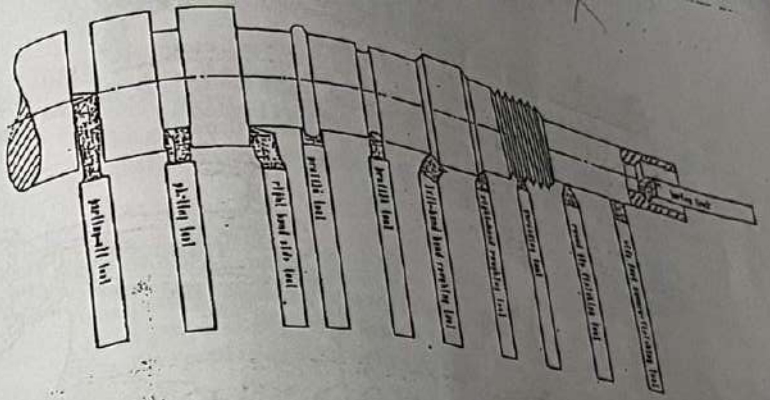
Tool holders are specially made for clamping of small tool bits. They are manufactured of cheap structural steel and save expenditure on tool steel.



Tool holder (a) with tool bit (b)

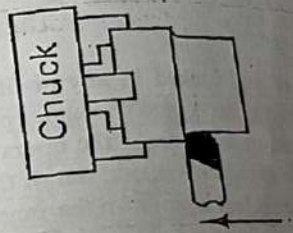
Various shapes of turning tools: For special turning operations there are turning tools with appropriately shaped cutting edges. Each type of turning tool is so shaped that with it only a certain turning process can be done economically and accurately. The following figures show some of these tools.

	Internal side tool.
	Rectangular bent undercutting tool.
	Internal thread cutting tool.
	Center drill.

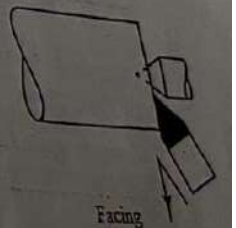


The Lathe:

Usually in turning the work revolves and the tool is fed either parallel to the work axis (turning) or perpendicular to the work axis (facing).



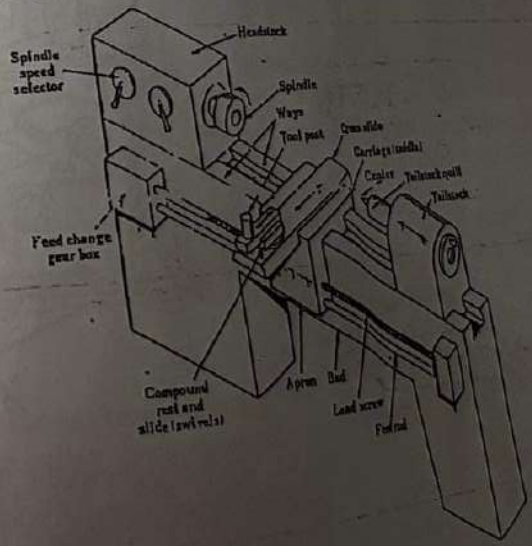
Turning

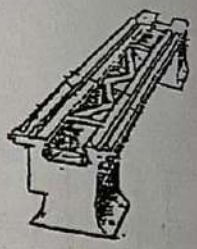


Facing

So the requirements a lathe has to meet are:

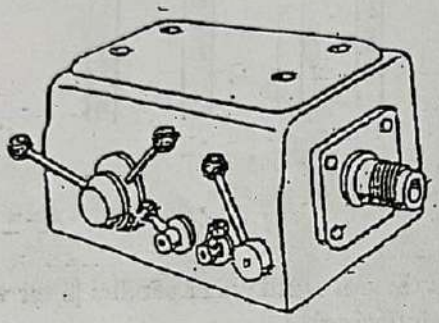
1) to hold the work and rotate it.
2) to hold the tool and move it either parallel or perpendicular to the work axis.



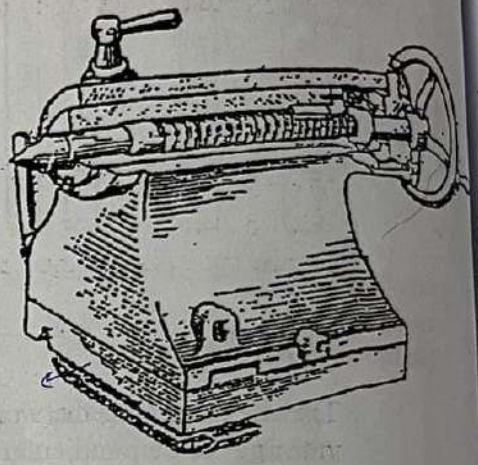


The lathe bed is the base, made of cast iron, on top of which are the ways, both V and flat. These ways are rails that support the carriage and the tailstock.

The headstock consists of the headstock casting, where the spindle, the gears and the mechanism for obtaining the various spindle speeds are located.



Headstock



Tailstock

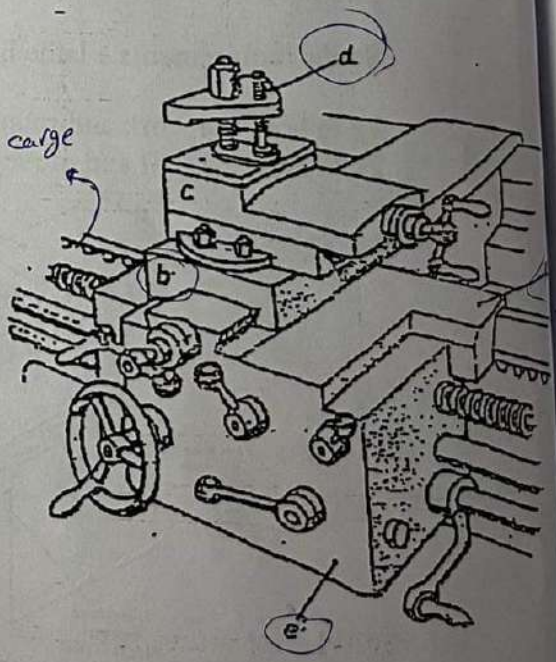
The tailstock can be moved along the bed and locked in any position. It has two castings (1) and (2). The lower one rests on the ways, and the upper one is fastened to it. The upper casting can be moved toward or away from the operator to offset the tailstock for taper turning. A hollow spindle (3) moves in and out of the upper casting by turning the tailstock wheel (9). This spindle has a taper on the inner end, in which the dead center (5) fits.

The carriage has five parts:

a) *The saddle* is an H-shaped casting that fits over the bed and slides along the ways.

b) *The cross slide* is mounted to the saddle. A handle is turned to move the cross slide transversely (crosswise) from the operator.

c) *The compound slide* on top of the cross slide can be turned in a 360-degree circle and locked in any position. It, too, has a slide in which the upper part of the casting can be moved in and out with the compound-slide handle.



Carriage: a: saddle, b: cross slid, c: compound slide, d: tool post, e: apron

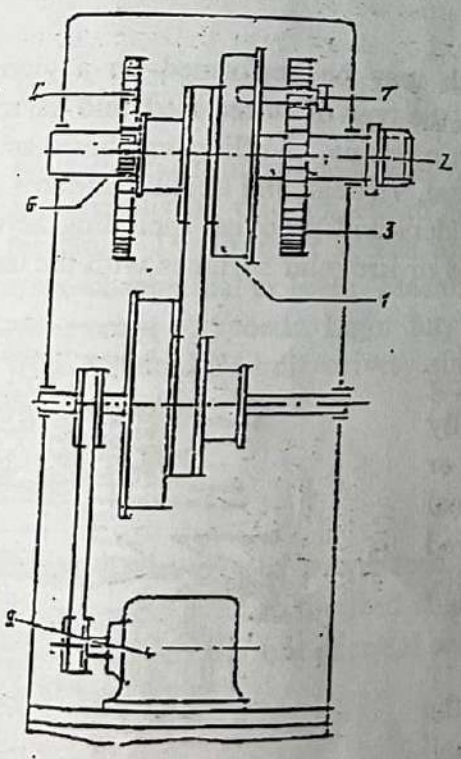
d) *The tool post* is fastened on top of the compound slide.

e) ***The apron*** fastens to the saddle and hangs over the front of the bed. It contains the gears, clutches, and levers for operating the carriage by hand or with power. The apron handwheel is rotated to move the carriage longitudinally (back and forth). This hand-wheel is attached to a pinion that meshes with a rack under the front of the bed.

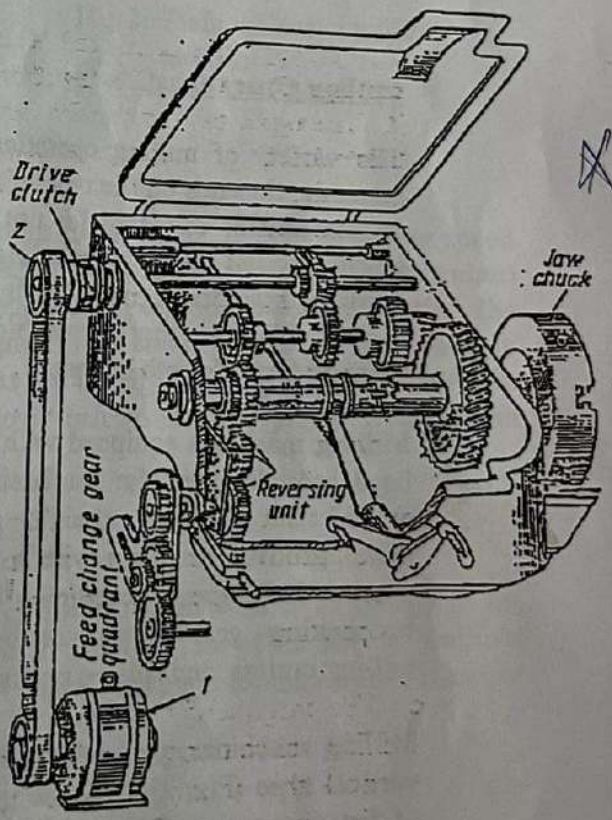
The Main Drive:

The power for turning is provided by an electric motor. On ***belt-driven lathes***, direct-drive power is delivered through belts to a step pulley that turns the spindle. The spindle speed is changed by moving the belt to different positions.

In ***modern lathes***, the functions are performed by the ***speed gearbox***, which consists of gears, shafts and other parts arranged inside the cast-iron headstock housing. The rotation of motor (1) is transmitted by a belt to pulley (2). Pulley (2) gives power to the gearbox.



Belt-drive headstock with back gear
1 = step pulley, 2 = main spindle, 3 = face gear
4 = back gear, 5 = back gear, 6 = gear
7 = driving pin, 8 = back gear shaft
9 = electric motor



Speed gearbox of lathe

Milling Machine Operations

The Milling Machine:

A milling machine employs one or more revolving cutters to shape the workpiece (Fig. 1).

Milling cutters are usually multiple toothed and are driven by the machine spindle to which they are securely fastened. The workpiece is usually held in a vise or fixture attached to a movable table. Cutting takes place by feeding the workpiece against the revolving cutter. On some very large machines, however, the revolving cutter is fed past the stationary workpiece.

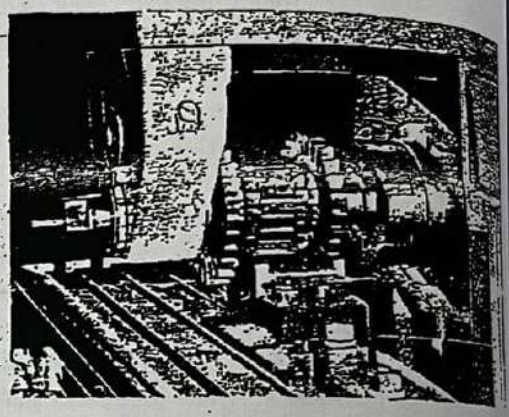


Fig. 1: Milling a casting with several cutters mounted on the arbor of a horizontal milling machine.

Milling Operations:

The variety of milling operations, which may be performed on a given milling machine, depends on the type of machine, the type of cutter used, and the accessories or attachments available for use with the machine. Milling machines are used for machining flat surfaces, including horizontal, vertical, and angular surfaces. They are used for machining many kinds of shoulders and grooves, including keyways, and T-slots. They are used to machine formed or irregular surfaces with the use of many types of formed-tooth cutters.

Milling machines equipped with a dividing head may be used for machining equally spaced flat surfaces, straight groove, or spiral grooves on parts with a cylindrical shape. This type of machining is involved in making gears, taps, reamers, drills, milling cutters, and splines on shafts.

Milling machines, particularly those of the vertical type (Fig. 2), may be used for all of the common hole-machining operations which normally are performed on a drill press.

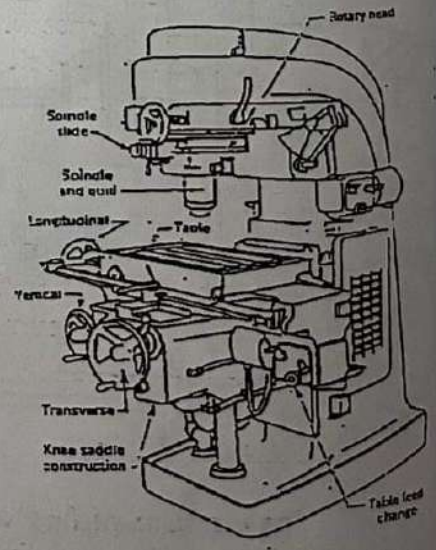


Fig. 2: Fixed head vertical milling machine