MACHINING

Level - III

Learning Guide 10

Unit of Competence: Perform Fitting and Assembly

Module Title: Performing Fitting and Assembly

LG Code: <u>IND MAC3 10 0217</u>

Instruction Sheet	Learning Guide #1

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Determine die parts to be fitted with one another
- Fit die and mould parts
- Machine assembly holes
- Assemble die and mould

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Identifying Weld requirements from specifications and/or drawings.
- Determining Correct size, type and quantity of materials/ ***preparing*** components for compliance with the job specifications
- Aligning Material assembles/ to specification require.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 61.
3. Read the information written in the information "Sheet.
4. Accomplish the "Self-check test.
5. Do the "LAP test".

INTRODUCTION

These days small, medium and heavy industries are using automatic machines. But bench and fitting work also plays a significant role for completing and finishing a job to the desired accuracy. Most of semi-finished works can be accomplished with fairly good degree of accuracy in a reasonable time through various kinds of quick machining operations. They still require some minor operations to be performed to finish the job by hand. The term bench work denotes the production of an article by hand on the bench. Where as fitting is the assembling of parts together and removing metals to secure the necessary fit, and may or may not be carried out at the bench. These two types of work require the use of a large number of hand tools and other devices or equipment’s that involve a number of operations for accomplishing the work to the desired shape and size. Some of the commonly used tools are discussed as under.

TOOLS USED IN FITTING SHOP

Tools used in bench and fitting shop are classified as under.

1. Marking tools
2. Measuring devices
3. Measuring instruments
4. Supporting tools
5. Holding tools
6. Striking tools
7. Cutting tools
8. Tightening tools, and
9. Miscellaneous tools

The above-mentioned tools are further classified and discussed as under.

1. Marking Tools

These are sub classified as steel rule, circumference rule, straight edge, flat steel square, scriber, semi-circular protractor, divider, trammel, prick punch, centre punch, try square, bevel square, vernier protractor, combination set and surface gauge.

2. Measuring Devices

Commonly used measuring devices and instruments used in bench and fitting shop are fillet and radius gauge, screw pitch gauge, surface plate, try square, dial gauge, feeler gauge, plate gauge and wire gauge.

3. Measuring Instruments

Line measuring and end measuring devices. While using line measuring device, the ends of a dimension being measured are aligned with the graduations of the scale from which the length is read directly such as scales or steel rules. Whereas, with end measuring device, the measurement is taken between two ends as in a micrometer, Vernier calipers and gauge block, etc. End measuring devices are commonly used for measuring accurate and precision dimensions of components. Some measuring instruments are employed for measuring linear dimensions and others are suitable for determining angular or geometric dimensions. Few measuring instruments are also kept for reference purposes as standards of comparison. The main measuring instruments are listed as under.

(*i*) Linear measurements

(A) Non-precision instruments

1. Steel rule
2. Calipers
3. Dividers
4. Telescopic gauge
5. Depth gauge

(B) Precision instruments

1. Micrometers
2. Vernier calipers
3. Vernier depth gauges
4. Vernier height gauges
5. Slip gauges

(C) Comparators

(D) Coordinate measuring machines

(*ii*) Angular measurements

(A) Non-precision instruments

1. Protector
2. Engineers square
3. Adjustable bevel
4. Combination set

(B) Precision instruments

1. Bevel protector
5. Angle gauges
6. Sine bar
7. Clinometers
8. Autocollimators
9. Sprit level

(*iii*) Surface measurement

1. Straight edge
2. Surface gauge
3. Surface table
4. Optical flat
5. Profile-meter

4. Supporting Tools

These are vee-block, marking table, surface plate, and angle plate.

5. Holding Tools

These are vices and clamps. Various types of vices are used for different purposes. They include hand vice, bench vice, leg vice, pipe vice, and pin vice. The clamps are also of different types such as c or g clamp, plane slot, goose neck, double end finger, u-clamp, parallel jaw, and clamping block.

6. Striking Tools

These are various types of hammers such as ball peen hammer; straight peen hammer; cross-peen hammer; double face hammer; soft face hammer.

7. Cutting Tools

These involve various types of files, scrapers, chisels, drills, reamers, taps, snip or shear and hacksaws.

Files. There are different types of files such as flat, square, round, triangular, knife, pillar, needle and mill.

Scrapers. These are flat, hook, triangular, half round types.

Chisels. There are different types of chisels used in fitting work such as flat chisel, cross cut chisel, diamond point chisel, half round chisel, cow mouth chisel and side cutting chisel.

The other cutting tools are drills, reamers, taps, snips, hacksaws (hand hacksaw and power hacksaw) etc.

8. Tightening Tools

These are pliers and wrenches, which are sub classified as under.

Pliers. These are namely ordinary, needle nose, and special type.

Wrench. These are open single ended, open double ended, closed ended adjustable, ring spanner, offset socket, t- socket, box wrench, pipe wrench and Allen wrench.

Miscellaneous Tools

These are die, drifts, counter sink tools, counter boring tools, spot facing bit and drill press. Some of above mentioned important tools are discussed as under.

Measuring Tools

Steel Rule

Steel rule is generally employed for purpose of measuring rough dimensions and laying out them. It is always advisable to start measuring from 1 cm mark because the end of the rule is generally worn out

Circumference Rule

It is commonly used for measuring or laying out or as a straight edge. The specialty in this rule is that the circumference can be taken directly, below the diameter dimension.

Straight Edges

There are two types of straight edges namely four edge type (Fig. 19.1(a)) and bridge type (Fig. 19.1(b)) which are made of carbon tool steel and alloy steel. They are generally flat graduated bar of steel with one longitudinal edge beveled. Straight edges come in various lengths commonly varying from 2.5 mm up to one meter and above. They are mostly used for scribing long straight lines.

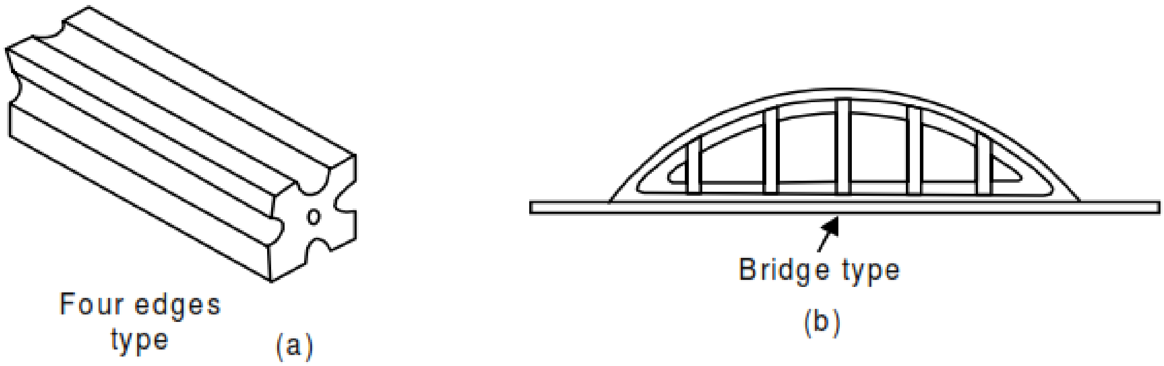


Fig. 19.1 Straight edges

Flat Steel Square

It is a piece of flat hardened steel with graduations on either end. It is commonly used for marking lines in the perpendicular direction to any base line.

Scribers

Fig. 19.2 shows the various types of scribers, which are sometimes called the metal worker's pencil. These are made up of high carbon steel and are hardened from the front edge.

Scriber is used for scratching lines on the sheet metal during the process of laying out a job.

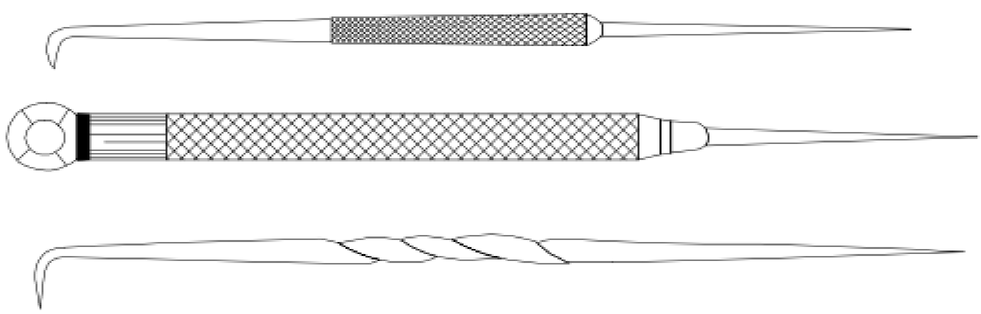


Fig. 19.2 Scribers

Bever Protractor

The bevel protector (Fig. 19.3) is an instrument used for testing and measuring angles within the limits of five minutes accuracy. The common components of this instrument are base, disc which is fitted with a pivot at the center and carries a datum line. On this pivot of the protector, the dial is allowed to rotate when the clamping nut is released. The other unit clamps the blade rigidly to the dial. The blade can be moved lengthwise. Vernier scale is also provided on the disc to take reading for accurate measurement. Dial is graduated in degrees over an arc.

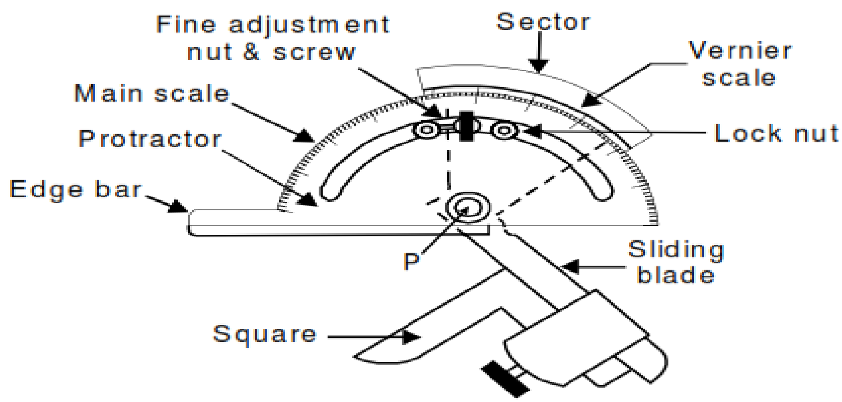


Fig. 19.3 Bevel protector

Divider

It is used for marking and drawing circle and arcs on sheet metal.

Trammel

Trammel is used for marking and drawing large circles or arcs, which are beyond the scope of dividers.

Prick Punch

Fig. 19.4 shows the prick punch, which is used for indentation marks. It is used to make small punch marks on layout lines in order to make them last longer. The angle of prick punch is generally ground to 30° or 40° whereas for center punch it is kept 60 °or 90°.

Centre Punch

Fig. 19.4 shows the center punch, which is used for locating center for indentation mark for drilling purposes.

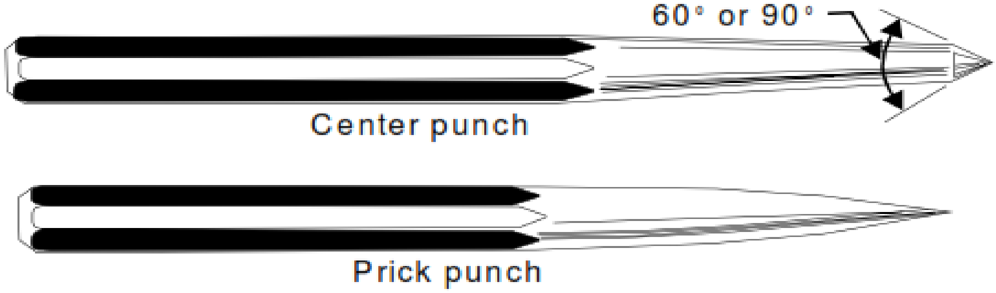


Fig. 19.4 Typical prick and centre punch

Surface Gauge or Scribing Block

Fig. 19.5 illustrate the surface gauge which is a principal marking tool used generally in the fitting and the machine shops. It is made in various forms and sizes. It consists of a cast iron sliding base fitted with a vertical steel rod. The scriber or marker is positioned or set into an adjustable device using a knurled nut at one end. The scriber can be loosened or tightened by means of the nut. The marker is used to set it at any desired inclination, moved to and from inside the hole accommodating it or adjust its height along the vertical pillar. It is commonly used in conjunction with either a surface plate or marking table. It is used for locating centers of round rod held in V- block, describing straight lines on work held firmly in its position by means of a suitable device like angle plate and also in drawing a number of lines parallel to a true surface. This device is a very simple form of surface gauge and it is largely being replaced by a more accurate instrument called universal surface gauge.

Universal Surface Gauge

Fig. 19.6 shows the universal surface gauge, which is an improved variety of the surface gauge simple scribing block. It is designed in such as way that appreciably finer adjustments can be made very quickly. It consists of a cast base perfectly machined and ground at the top, bottom and all sides. The base of the gauge usually carries a V-shaped slot at the bottom so as to render it suitable for use on round objects. Two guide pins are provided at the rear end of the base, which can be pressed down to project below the base of the gauge. These pins can also be used against the edge of the surface plate or any other finished surface for guiding the instrument during marking and scribing work. A swivel bolt is provided at the top of the base in which the spindle is fitted. This spindle can be swung and locked in any desired position by means of the adjusting screw, which is provided with a knurled nut at its end for this purpose. For marking purposes, the scriber is fitted in an adjustable screw on the spindle and is capable of being adjusted at any inclination and height along the spindle. A rocker is provided at the top of the base and it carries an adjusting screw at its rear end. During operation, the spindle is secured in the swivel bolt and is set at a desired inclination. The adjustable scriber is swiveled and set at approximately the required height. On bringing the point of the scriber at the exact correct height, finer adjustments are then made using adjusting screw provided on the rocker. Therefore, this gauge is commonly employed for scribing parallel lines at desired heights from a plane surface, comparing the trueness of two similar heights, setting out a desired height and similar other operations, and forms an indispensable instrument of bench work.

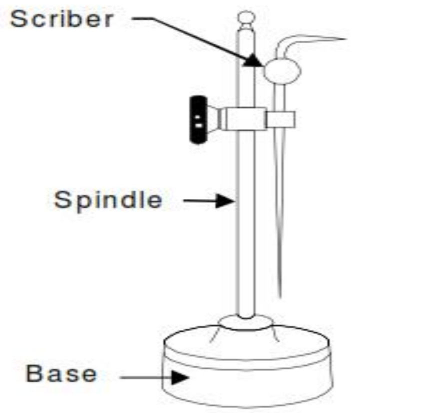


Fig. 19.5 A surface gauge or scribing block

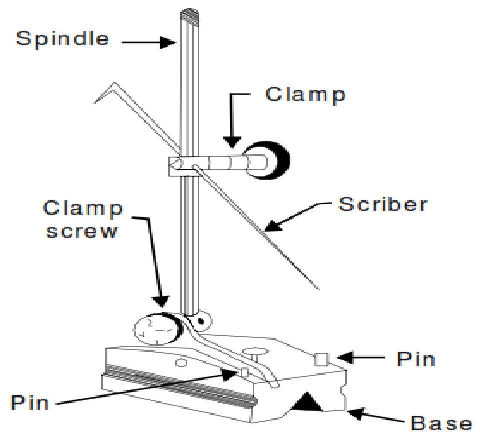


Fig. 19.6 A universal surface gauge

Measuring Devices

There are some general purpose measuring devices such as fillet and radius gauge, screw pitch gauge, surface plate and try square which are described as under.

Fillet and Radius Gauge

Fig. 19.7 shows the fillet and radius gauge, which is similar in construction to a screw pitch gauge and carries a similar metal case containing a number of steel blades in it. One set of blades, mounted on one end of the case carries concave end faces and the other set at the other end of the case, carries blades, which have convex end formations. The radii of the curvatures of the end formations are of different dimensions and thus provide a fairly wide range for quick checking and measuring of curvature. This instrument is highly useful for measuring and checking the inside and outside radii of fillets and other round surfaces.
The fillet and radius gauges are made in thin strong strips curved to different radii at end. The use of this gauge is depicted through Fig. 19.8.

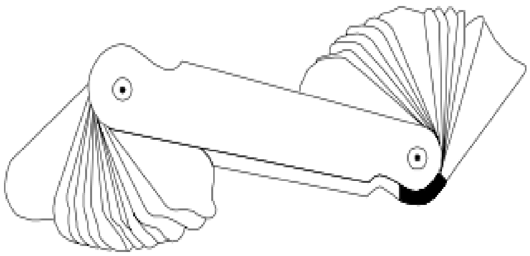


Fig. 19.7 A fillet and radius gauge

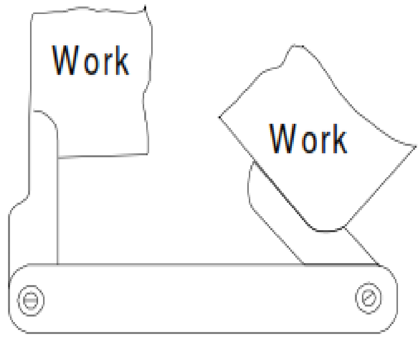


Fig. 19.8 A use of fillet and radius gauge

Screw Pitch Gauge

Fig. 19.9 shows the screw pitch gauge, which is a highly fool-proof, very effective and fairly accurate instrument used to identify or check the pitch of the threads cut on different threaded items. It consists of a case made of metal carrying a large number of blades or threaded strips which have teeth of different pitches, cut on their edges and markings corresponding to these pitches on their surfaces. In operation, different blades are applied or tried on the threads one after the other and when any one of them is found meshing with the cut teeth, the relevant reading is read directly from the marking on the matching blade surface. This gauge can be commonly used to measure or check the pitches of both external and internal threads. The free ends of the screw pitch gauge blades are generally made narrow for enabling them to enter the hollow parts easily while checking the internal threads. In some instruments, the blades are made to have markings both for the pitches as well as a value equal to double the depth of the threads. The latter quantity helps in determining quickly the drill size to be used before tapping.

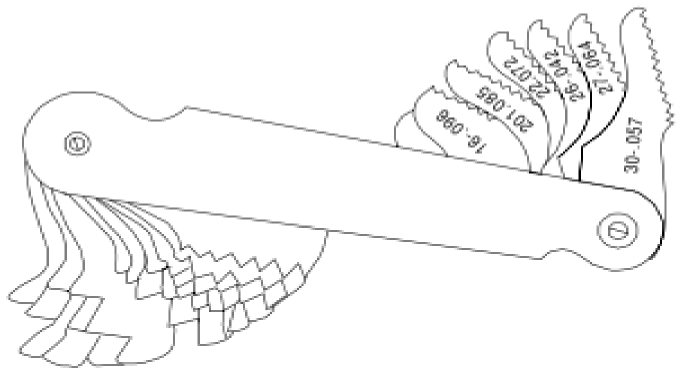


Fig. 19.9 A screw pitch gauge

Surface Plate

Fig. 19.10(a) shows the surface plate, which is a cast iron plate having generally a square top well planed and square with adjacent machined faces. The top surface of the plate is finished true by means of grinding and scrapping. It possesses a cast iron base, which is also machined true to keep the top surface of the plate in a perfect horizontal plane. Its specific use is in testing the trueness of a finished surface, testing a try square, providing adequate bearing surface for V-block (Fig. 19.10(b)) and angle plates, etc. in scribing work.

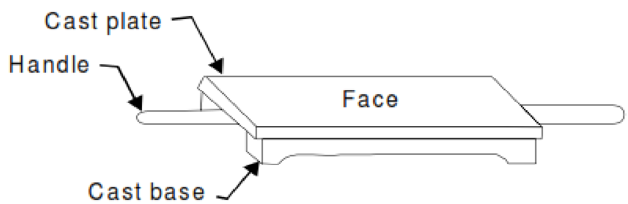


Fig. 19.10(a) A surface plate

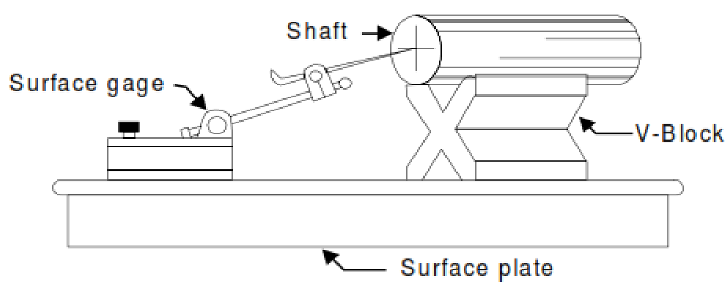


Fig. 19.10(b) A use of surface plate and v-block

Try Square

Fig. 19.11 shows the try square, which is also known as engineer's try square. It is very important tool required for scribing straight lines at right angles to a true surface or testing the trueness of mutually normal surfaces. It is made in different sizes out of steel pieces. In construction, it is similar to a carpenter's try square but is comparatively more accurate. It can be made either in one piece or in two pieces. It consists of a steel blade fitted into a steel stock of rectangular cross-section. It is sufficiently hardened and tempered to suit the need. Some precision kind of try squares is made with their blades having beveled edges properly ground and finished square. Both inner and outer surface of the blade are kept truly at right angles to the corresponding surfaces of the stock. In order to maintain this trueness, this tool should be handled with due care and should never be used as a striking or supporting tool or other work. The accuracy of this tool should be frequently checked to ensure the trueness as it affects the accuracy of the finished job to a significant extent. For checking the accuracy or trueness of a try square, the try square is made to lie flat on the top surface of a surface plate with the stock touching a machined edge of the plate. A straight line is marked along the outer edge of the blade and then the square turned over to take a new position. Another straight line is described along the outer edge of the blade in this new position of the try square. If both lines coincide with each other as they seems to be as one line only, then the try square can be said as true.

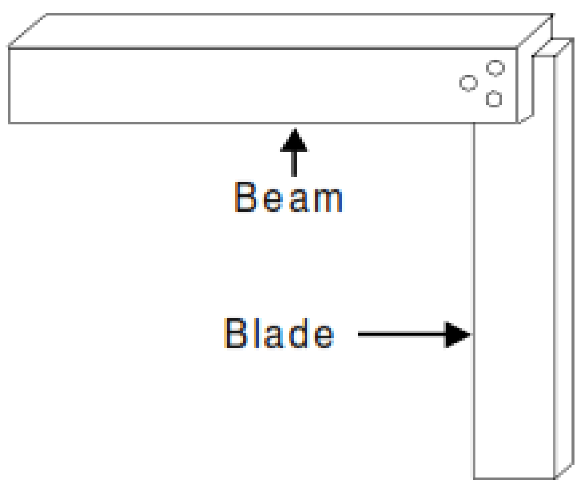


Fig. 19.11 A try square

Measuring Instruments

Some common measuring instruments generally used in bench work or fitting shop are micrometer, Vernier caliper, depth gauge, and Vernier height gauge. These are discussed as under.

Micrometers

The micrometers are commonly employed for measuring small dimensions with extreme accuracy of 0.01 mm. They may be of the three kinds (*a*) External micrometer for measuring external dimensions, (*b*) Internal micrometer for measuring internal dimensions, and (*c*) Depth micrometer for measuring depths. For measuring a dimension in external micrometer, the work piece is held between the fixed anvil face and the spindle face of the micrometer. The spindle of the micrometer is allowed to move linearly towards the work by rotating thimble. When the spindle will touch the work piece properly, the ratchet will give its sound. The small locking lever is then rotated to clamp the spindle so that reading can be taken more accurately. Outside micrometers are used for measuring the outside dimensions of jobs, such as diameter of a bar, rod and thickness of plate. Generally, until and unless they are provided with the Vernier attachment, the former can read up to 1/1000 or 0.001 inch and the latter up to 0.01 mm. The former are known as inches micrometers and the latter metric micrometers, which are gradually replacing the former due to the introduction or adopting of metric system. Inside micrometers are commonly used for measuring inside dimensions of the objects, such as inside dia. of a hole, width of a slot or cavity, etc. The outside micrometers are the most extensively used in industrial applications. All the micrometers, irrespective of the fact as to whether they carry graduations in inches or millimeters, are similar in construction. An out side micrometer is discussed as under.

OUTSIDE MICROMETER

Fig. 19.12 shows an outside micrometer. It consists of the following main parts.

1. Metallic frame
2. Axial graduated sleeve
3. Circumferential screwed spindle
4. Hardened steel anvil
5. Thimble
6. Ratchet stop screw
7. Lock nut

Micrometer works commonly on the principle of nut and bolt assembly. The sleeve carries inside threads at the end, which forms the nut, and the screwed part of the spindle passes through it. The spindle and the thimble are secured to each other such that by rotating the thimble the spindle rotates. With the result, when the thimble is revolved, it advances towards or retards away from the fixed anvil, together with the spindle of the micrometer. The sleeve carries the graduations, which, in conjunction with the beveled and graduated part of the thimble, give the measure of the opening between the end faces of the anvil and the spindle. The ratchet arrangement provided at the end of the thimble prevents the spindle from pressing further against the surface of the piece being measured after the required feel has been attained, thus facilitating a uniform reading and preventing the instrument from being damaged. Lock nut or locking lever is used for locking the micrometer for a desired amount of time after taking or setting the reading. The construction of the outside micrometer is discussed as under.

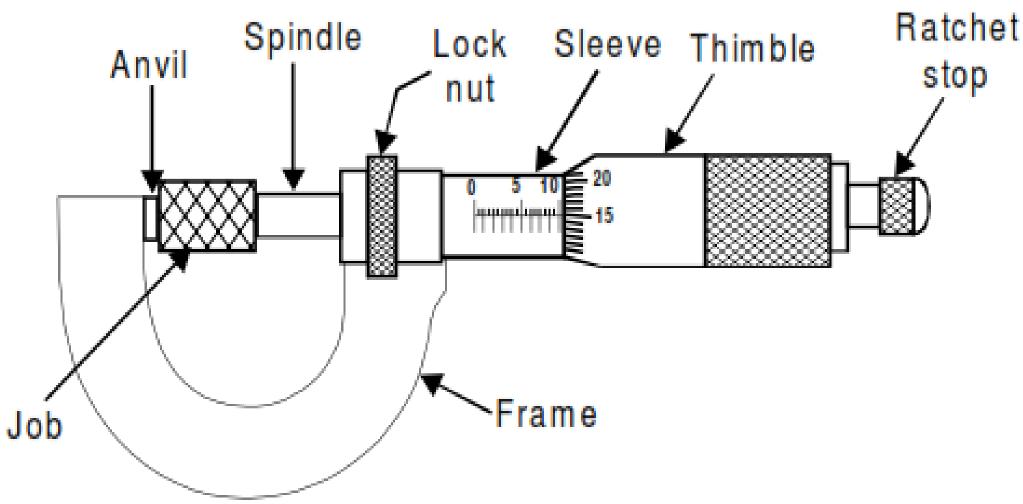


Fig. 19.12 Outside micrometer

COMMON PARTS OF OUTSIDE MICROMETER

(1) **Frame.** The U frame of micrometer is made of steel, cast steel, malleable cast iron or light alloy.
(2) **Hardened anvil.** It protrudes from the frame for a distance of at least 3 mm for holding and supporting the jobs for measurement.
(3) **Screwed spindle.** It does the actual measuring and possesses threads of 0.5 mm pitch.
(4) **Barrel or Sleeve.** It has datum or fiducially line and fixed graduations.
(5) **Thimble.** This is a tubular cover fastened with the spindle and moves with the

spindle. The beveled edge of the thimble is divided into 50 equal parts, every fifth being numbered.

(6) **Ratchet.** This part is commonly recognized as friction stop of the micrometer, which acts as a precautionary measure also. It is a small extension to the thimble in which the ratchet slips when the pressure on the screw exceeds a certain amount. This produces uniform reading and prevents any damage or distortion of the instrument.

(7) **Spindle clamp.** It is used to lock the instrument at any desired setting or at any particular reading .

READING ON MICRO METER

It works on the fine assembly of nut and bolt principle where pitch of both nut and bolt plays a big role. The graduation on the barrel of micrometer is in two parts, namely one above the reference line and the other below. The higher line graduation above the reference line is graduated in 1 mm intervals. The first and every fifth are long and numbered 0, 5, 10, 15, 20 and 25. The lower or small graduations are graduated in mm intervals but each graduation shall be placed at the middle of the two successive upper graduations to be read 0.5 mm. The micrometer screw has a pitch of 0.5 mm, while the thimble has a scale of 50 divisions round its circumference. Thus, on making or rotating through one complete turn, the thimble moves forward or backward by one thread pitch of 0.5 mm, and one division of its scale is, therefore, equivalent to a longitudinal movement of $0.5 \times 1/50$ mm = 0.01 mm. It is the value of one division on the thimble, which is the least that can be correctly read with the help of a micrometer and is known as the least count. For measurement, the job is kept between the end of the spindle and the fixed anvil, which is fitted to the frame. When the micrometer is closed, the line marked 0 (zero) on the thimble coincides with the line marked 0 (zero) on the graduated sleeve. In metric outside micrometer, the pitch of the spindle screw is 0.5 mm and the graduations provided on the spindle of the micrometer are in millimeters and subdivided into 0.5 mm. Now in one turn of the thimble of the micrometer, owing to the 0.5 mm. pitch of the spindle screw, the spindle will move through 0.5 mm and therefore, the corresponding opening between the faces of the fixed anvil and the spindle will be 0.5 mm. This opening will go on increasing by the same distance 0.5 mm for each further rotation of the thimble. The beveled edge of the thimble carries 50 equal divisions on its periphery in which every 5th division is marked. It is seen above that for one complete turn of the thimble the spindle moves through 0.5 mm. Now let the thimble is rotated one small division on its beveled edge i.e. 1/50 of the turn. The corresponding displacement of the spindle will then be 0.5 × 1 / 50 = 0.01mm. Depth micrometer is used for measuring depth of holes and is shown in Fig. 19.13. Screw thread micrometer (Fig. 19.14) is used to measure the pitch diameter of the thread to an accuracy of 0.01mm and 0.001 inches. It comprises of similar parts as that of outside micrometer accept the shapes of fixed and moveable anvils. The fixed and moveable anvils possess the thread profiles for thread adjustment for measurement of the pitch diameter.

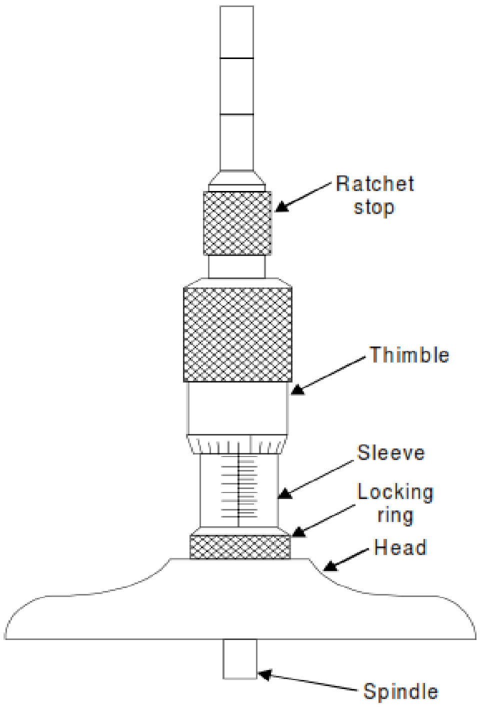


Fig. 9.13 A depth micrometer

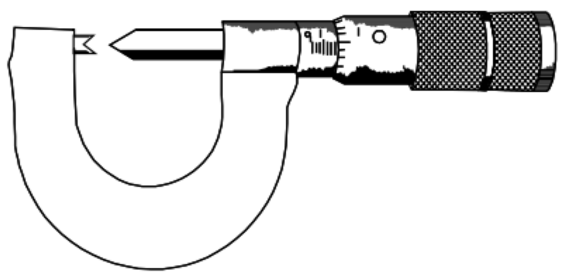


Fig. 9.14 A screw thread micrometer

Steel Rule

It is the simplest measuring tool just like a scale used in fitting shop. A six inch semi flexible rule is shown in Fig. 19.15 Other types of rules are described in the chapter on carpentry shop. Most of the dimensions are measured by the steel rule in workshops.

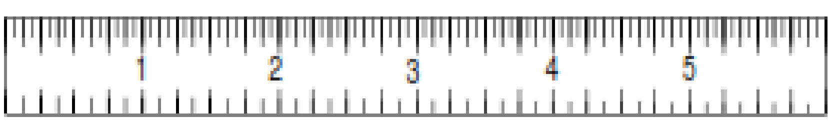


Fig. 9.15 A steel rule

Caliper

Calipers are generally of two types inside and outside to make internal or external measurements. They do not have direct scale reading. They transfer the measurement from jobs to scale or vice versa. Fig. 19.16 shows a simple outside caliper. The caliper is held in a rule as shown in Fig. 19.17 to read the size. It is used to make external measurement such as thickness of plates, diameter of sphere and cylinders. Fig. 19.18 shows the standard spring joint outside caliper.

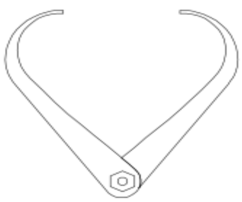


Fig. 9.16 A simple outside caliper

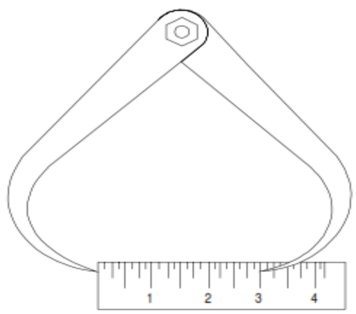


Fig. 9.17 A caliper held in rule

Fig. 9.18 A standard spring joint outside caliper

Vernier Caliper

Fig. 19.19 shows the Vernier caliper, which is commonly used to measure accurately

(1) outside diameters of shafts,
(2) thicknesses of various parts,
(3) diameters of holes or rings and
(4) internal dimensions of hollow jobs or articles.

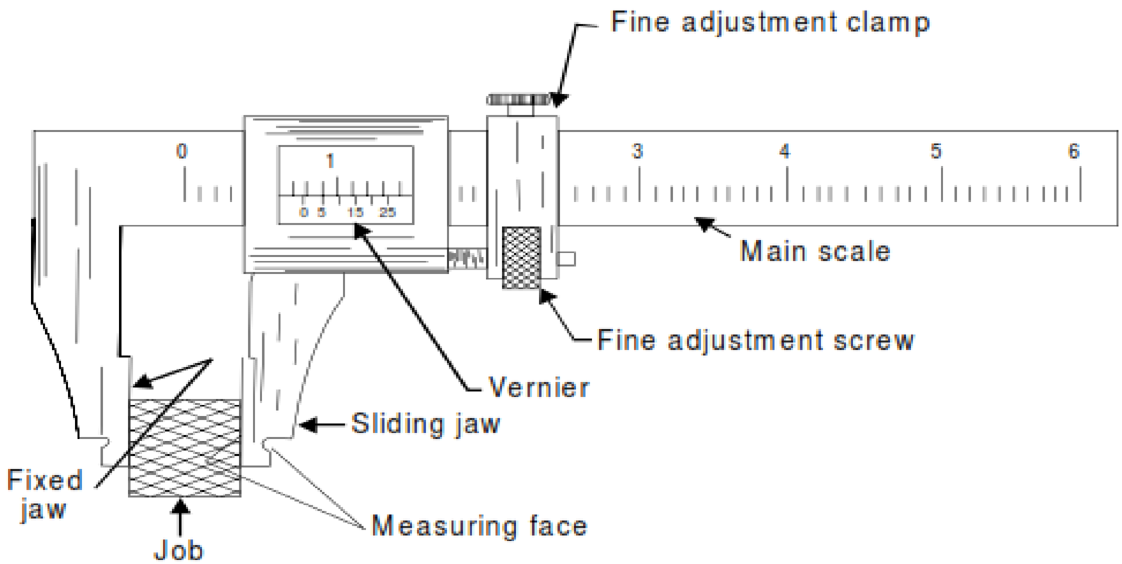


Fig. 19.19 A vernier caliper

It works on the principle of Vernier and can measure the dimensions to an accuracy of 0.02 mm. For making a measurement of external dimensions, the job is placed between the fixed and the movable jaws. The movable or the sliding jaw is moved until it almost contacts the job kept against the fixed jaw. The sliding jaw assembly of the Vernier caliper that carries the fine adjustment screw should be clamped to the graduated beam with the help of adjustment clamp. The two jaws are then brought into contact with the job by moving the sliding jaw with the help of fine adjustment screw. The jaws should make now definite contact with the job but should not be tight. The main slide assembly is then locked to the beam with help of clamp. The caliper is then carefully removed from the job to prevent springing the jaws and the reading is taken. For making a measurement of internal dimensions, the job is placed outward between the fixed and the movable jaws meant for measuring inner dimension.

Vernier Depth Gauge

Vernier depth gauge is basically employed for checking depths of blind holes such as grooves, slots, depth of key ways and heights of shoulders, etc. The principle on which it works is the same as that of a Vernier caliper. It is available with similar measuring accuracies as the Vernier caliper and readings are taken the similar manner. It consists of a movable head with a base, which moves along the beam. A main scale on the beam and Vernier scale on the sliding head with fine adjustment screw are incorporated in the similar manner as in a Vernier caliper.

Vernier Height Gauge

Fig. 19.20 illustrates the Vernier height gauge, which is employed for measuring the height of parts and in precision marking work. It consists of a heavy base, an accurately finished bottom, a vertical bar mounted square to the base, carrying the main scale, a sliding head with Vernier, an auxiliary head with fine adjustment screw and nut and a bracket attached to the sliding head. This bracket is provided with a clamp by means of which interchangeable jaws can be fixed over there. The jaws can be fixed for measuring height or replaced by scribing jaws according to requirement or need. The graduations on the height gauge are given in Fig. 19.21.

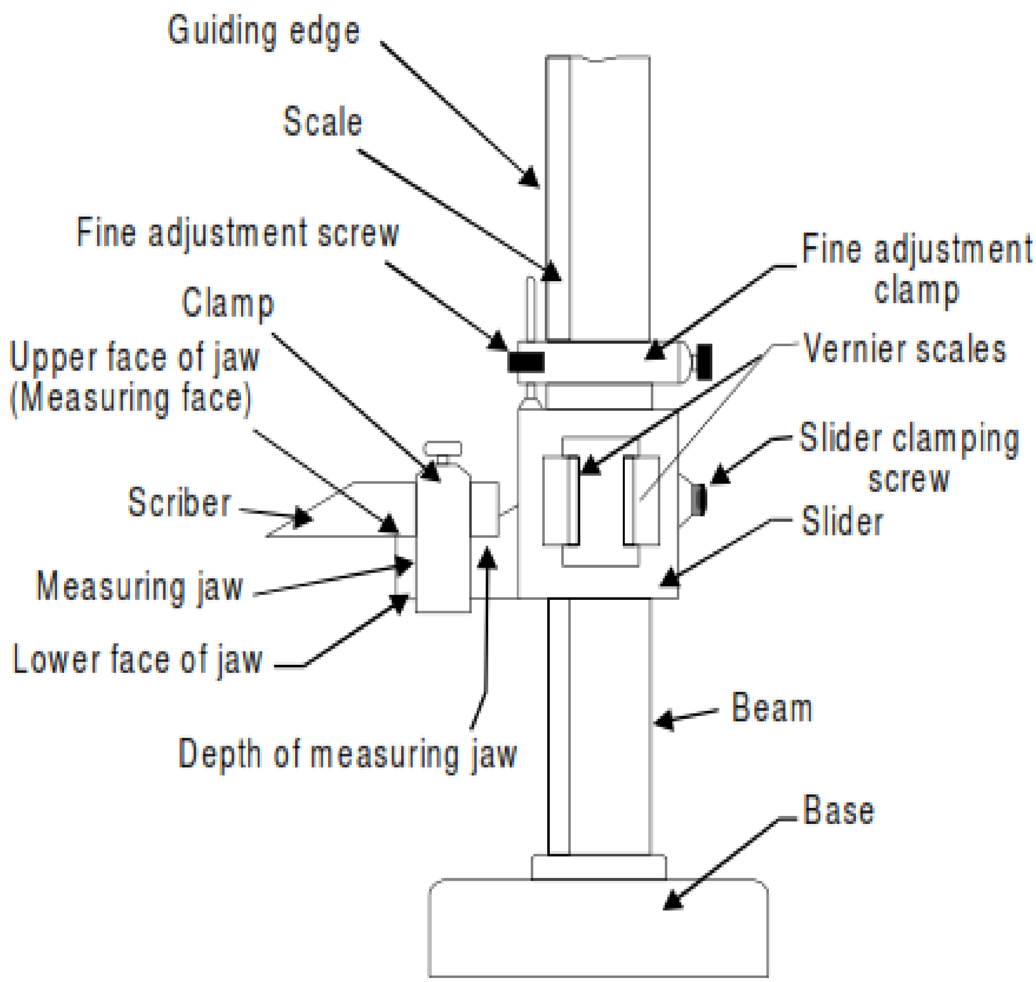


Fig. 19.20 A vernier height gauge

Wire Gauge

The wire gauge is a flat and circular steel sheet metal piece having slots all along its periphery as shown in Fig. 19.22. These slots have different standard sizes, which are engraved near their bottom. The size of each slot represents the correct diameter of the wire or thickness of the sheet of which it represents the gauge. The gauge number varies inversely as the size of the wire. That is the higher the gauge number, the thinner the wire and vice versa.

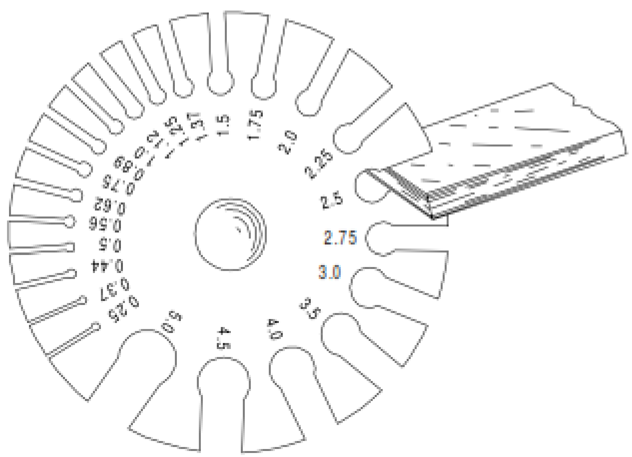


Fig. 19.22 A wire gauge

Dial Indicators

The dial indicators are also known as dial gauges and are shown in Fig. 19.23 (a, b). They are generally used for testing flatness of surfaces and parallelism of bars and rods. They are also used for testing the machine tools. They are available in both metric as well as in inches units. Inches dial indicator of 0.001" measuring accuracy is in commonly used but they are also available up to an accuracy of 0.0001". The commonly used metric dial indicator has an accuracy of 0.01 mm. Those having 0.001 mm accuracy are also available, however they are used in highly precision measurement work.

Bevel Gauge

An adjustable bevel gauge is widely used for checking, comparing or transferring angles and laying out work. It comprises of two adjustable blades, which can be positioned into almost any orientation to adjust any required angle. However, the direct reading is not obtained and the angle must be set or checked from some other angular measuring instrument.

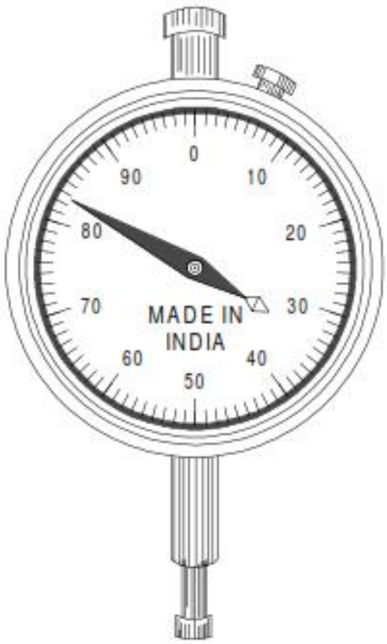


Fig. 19.23 (a) A continuous type dial indicator

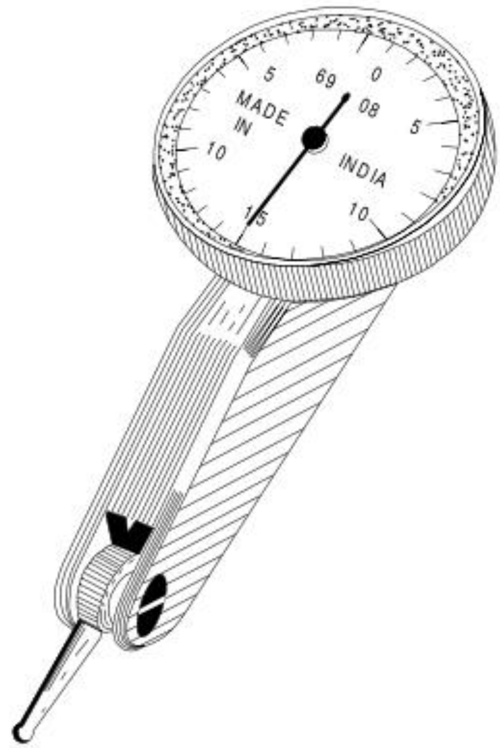


Fig. 19.23 (b) A dial indicator of Brown and Sharp Co.

Combination Set

Combination set is an important instrument which has the combination of instruments namely square head, a center head, and a bevel protractor and sprit level as depicted in Fig. 19.24. It is a very useful instrument frequently utilized in the bench work and machine shop measurements. The three portions of the combination set are used separately being held in at any desired position by nuts which engage in a slot machined on the whole length of the beam at its back. The beam of the instrument acts as a rule, which is marked in inches or centimeters or in both for measuring the length and height as and when required. The square head possesses one edge square to the rule, giving a right angle, where as the other edge form an angle of 45°. It is provided with a spirit level. The scale on the protractor may be divided into degrees or a Vernier attached whereby the angle can be measured in degrees and minutes. It is also fitted with a spirit level to help in leveling the work of setting it at an angle. The center head with the rule fastened to it is called a center square. It has two arms at right angles to one another and is so set on the rule that this angle is exactly divided in two by the edge of the rule. It may be used to find the center of a round bar or shaft. Spirit level is commonly used for checking levels and other measurement. It is designed to handle measurements, layout and checking of angles. The square head is used for checking 90° angle or as a square as shown in Fig 19.25. The protractor head may be utilized with a rule to measure angles or to measure the slope of a surface as shown in Fig. 19.26.

Semi-circular Protractor

It resembles with a semi-circular protractor and is commonly used is geometrical drawings.

Protractor used in sheet metal work is made from steel and often required for making or measuring angles.

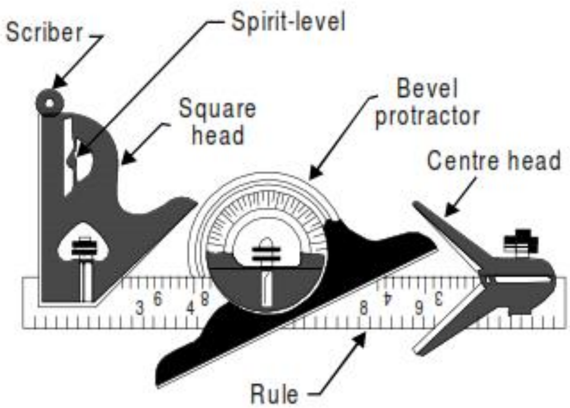


Fig. 19.24 A combination set

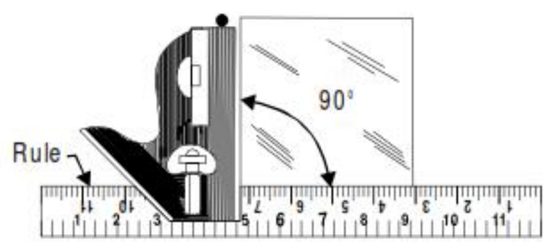


Fig. 19.25 Checking 90° angle using combination set

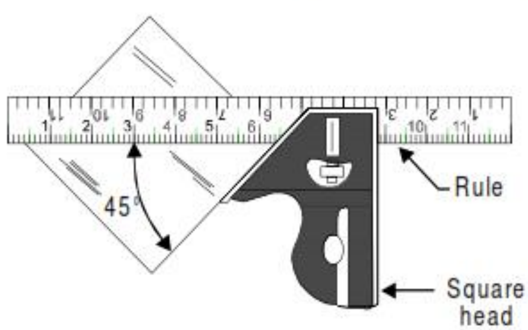


Fig. 19.26 Checking 45° angle using combination set

Slip Gauges

Slip gauges are also called as precision gauges blocks. They are made of rectangular blocks using alloy steel, which are being hardened before finishing them to size of high degree of accuracy. They are basically used for precise measurement for verifying measuring tools such as micrometers, comparators, and various limit gauges. The distance between two opposite faces determines the size of the gauge. They are made in higher grades of accuracy. The grade most commonly used in the production of components, tools, and gauges is Grade I, for rough work. Grade II and for checking other gauges. They are supplied in sets, the size of which varies from a set of about 112 pieces down to one containing 32 pieces. In English measurement there are five sets containing 81,49,41,35 and 28 pieces. An 81-set has a wide range of combination but for general purpose a 49-set is usually preferred. The measurement is made by end to end assembly of slip gauge blocks and very little pressure in wring form is being applied.

Inspection Gauges

Inspection gauges are commonly employed to avoid costly and lengthy process of testing the component dimensions. Fig. 19.27 represented the principle of limit gauging. These gauges are basically used for checking the size, shape and relative positions of various parts. These are of fixed type measuring devices and are classified as standard and limit. Standard gauges are made to the nominal size of the part to be tested and have the measuring member equal in size to the mean permissible dimension of the part to be checked. Limit gauges or "go" and "no go" gauges are made to the limit sizes of the job to be measured. Sides or ends of the gauge are made corresponding to maximum and minimum permissible size of the job for its acceptance or rejection. The objective of limit gauges is to identify whether the actual dimensions of the work are within or outside the specified limits of acceptance. The double end kind of limit gauge has the GO portion at one end and the NO GO portion at the other end. GO portion must pass into or over an acceptable piece but the NO GO portion should not pass. Inspection gauges may be classified as working, inspection, and reference or master gauges. The working and inspection gauges are generally employed for inspection of components from stage to stage.

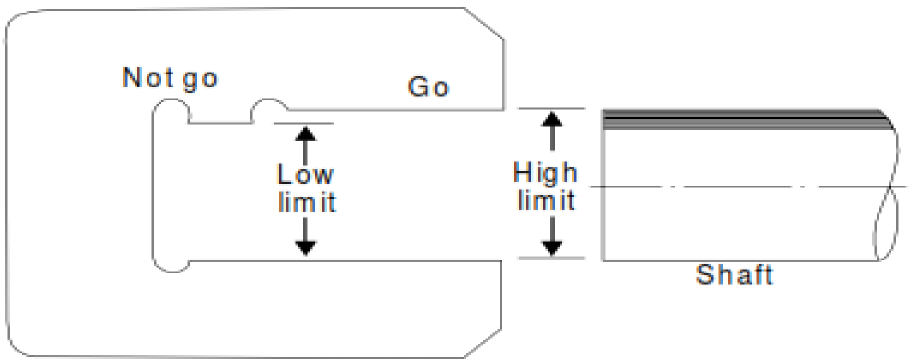


Fig. 19.27 A principle of limit gauge

Reference or master gauges are needed only for checking the size or condition of other gauges. The gauges are generally classified into:

1. Gauges for checking shafts
2. Gauges for checking holes
3. Gauges for checking forms
4. Gauges for checking threads
5. Gauges for checking tapers

The gauges commonly used in production work are

1. Progressive or step plug gauge (Fig. 19.28(a))
2. Thread plug gauge (Fig. 19.28(b))
3. A combination of internal and external non adjustable gauges (Fig. 19.28(c))

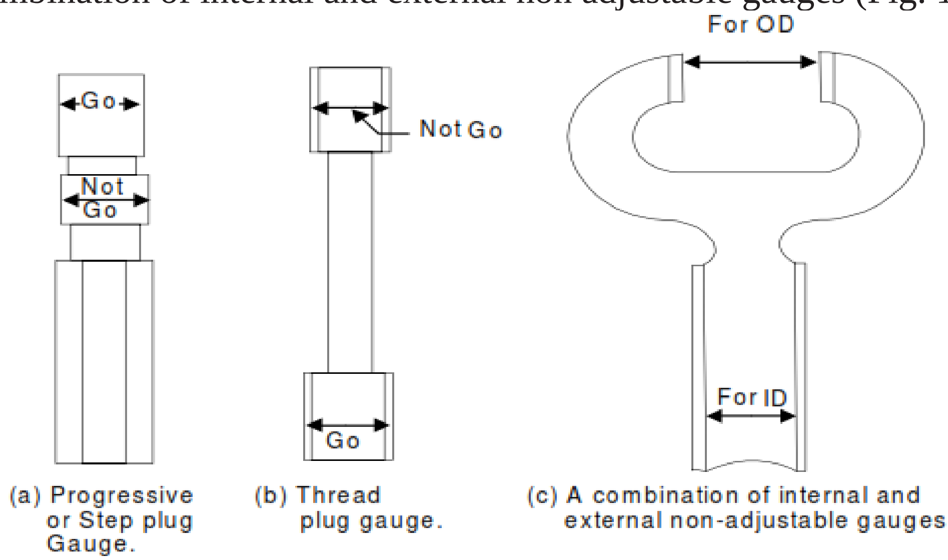


Fig. 19.28 Types of gauges

4. Ring gauge
5. Snap gauges (Fig. 19.29)

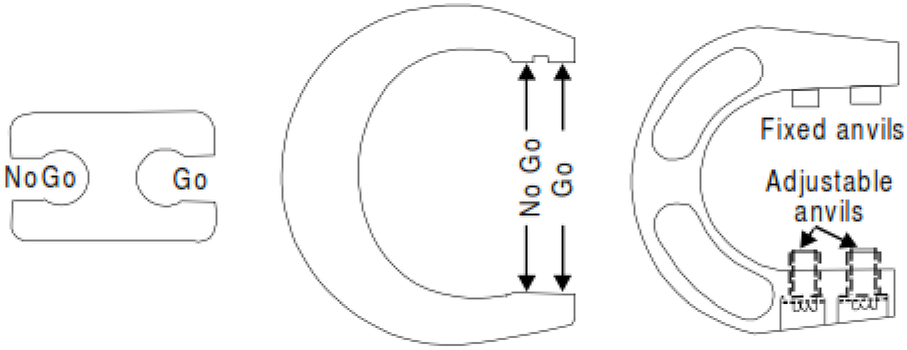


Fig. 19.29 Snap gauges

6. Feeler gauge (Fig. 19.30)

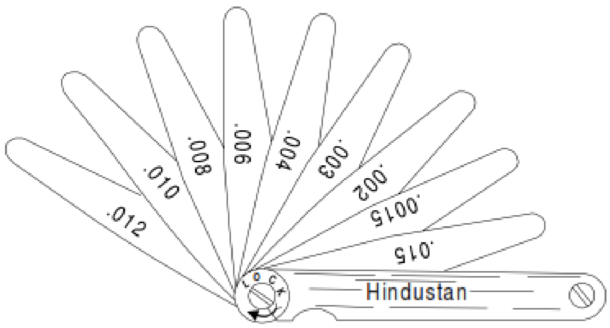


Fig. 19.30 A feeler gauge

7. Wire gauge
8. Template gauge
9. Adjustable gap gauge (Fig. 19.31)
10. Screw pitch gauge (Fig. 19.9)
11. Fillet and radius gauge

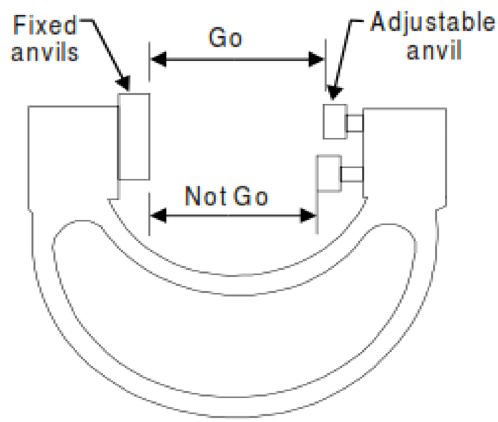


Fig. 19.31 An adjustable gap gauge

For manufacturing the above gauges, high carbon and alloy steels materials are commonly employed for manufacturing or production of gauges. Steel gauges may be used subject to some distortion during hardening. These difficulties can be overcome by making gauges by use of cemented carbide material or providing chrome plating at the surface of the gauge.

Plug Gauges

These are used for checking cylindrical, tapered, threaded, splined and square holes portions of manufacture components.

Holding Tools

Holding tools used in fitting shop comprises of basically vices and clamps. The clamps are C or G clamp, plane slot, goose neck, double end finger, u-clamp, parallel jaw, and clamping block. The various types of vices used in fitting shop are given as under:

Vices

The vices are hand vice, bench vice, machine vices, carpenter vice, shaper vice, leg vice, pipe vice, and pin vice.

Bench vice

Fig 19.32 shows a bench vice commonly used in fitting shop for holding a variety of jobs.

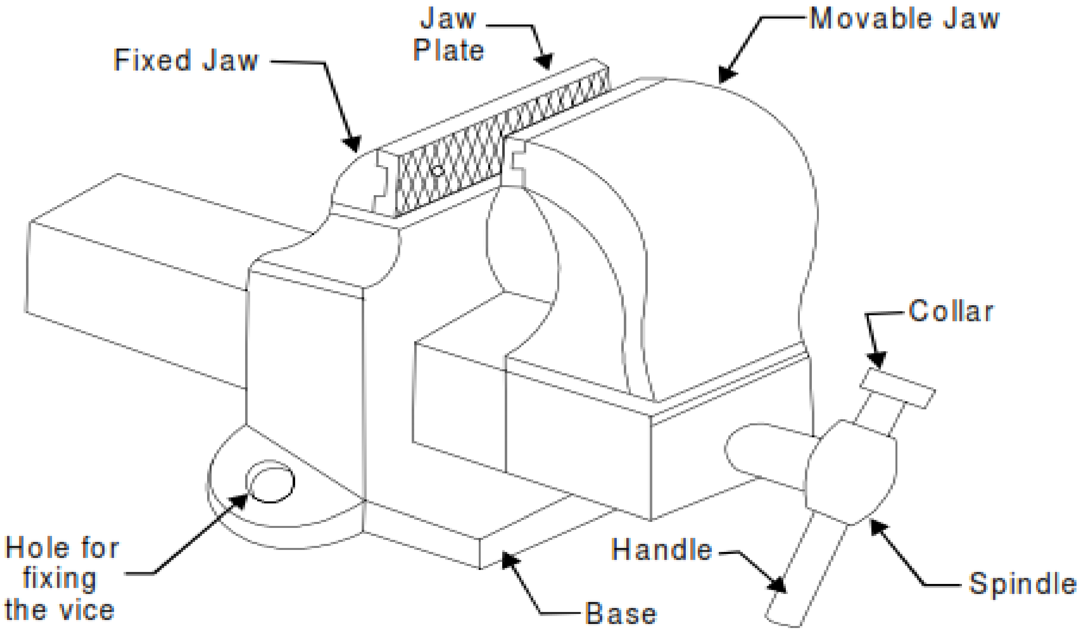


Fig. 19.32 A bench vice

Machine vice

Fig 19.33 and Fig. 19.34 shows machine vice with swivel base and parallel jaw machine vice. These types of vices are commonly used in fitting shop for holding a variety of jobs. They are used for precision work on the machine table like shaping, milling, drilling and grinding. They are generally made of grey cast iron.

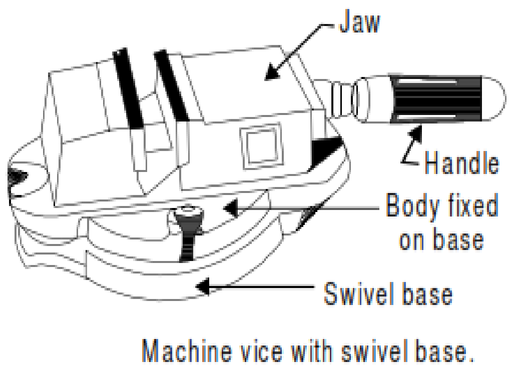


Fig. 19.33 A machine vice with swivel base

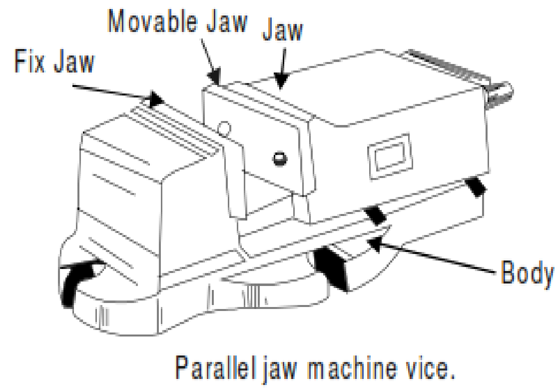


Fig. 19.34 A machine vice with parallel jaw

Universal swivel base machine vice

Fig. 19.35 shows a special type of universal swivel base machine vice made with swiveling head. It is commonly used in fitting shop for holding a variety of jobs. The jobs after holding in jaws can be adjusted at any angle either horizontally or vertically with the help of swelling head.

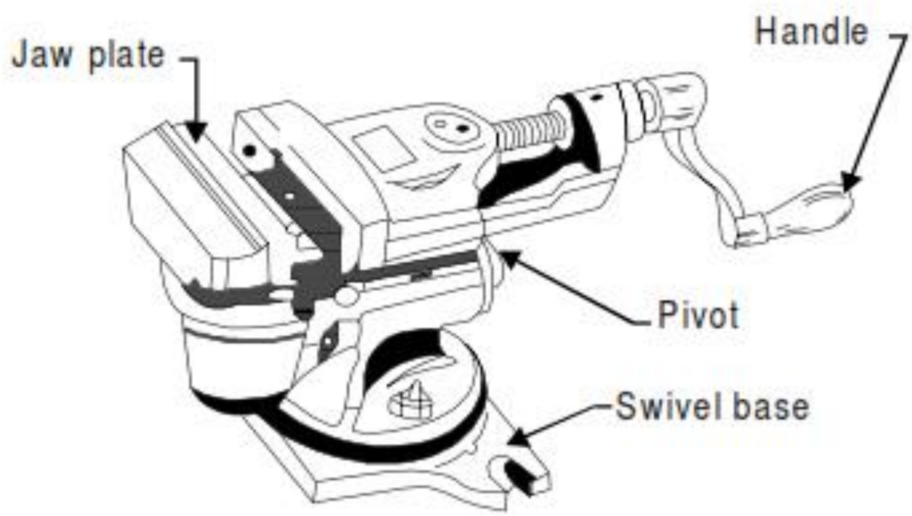


Fig. 19.35 A universal swivel base machine vice

Toolmaker's vice

Fig 19.36 shows a small tiny vice known as tool maker vice. It is commonly used by tool maker, watch maker, die maker and goldsmith for holding a variety of small parts for carrying some operation.

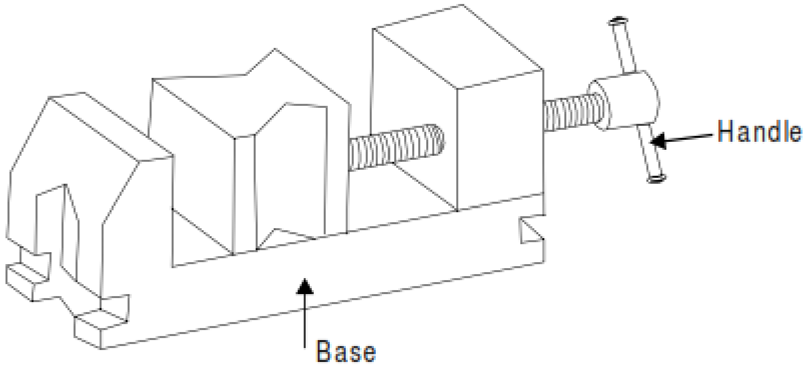


Fig. 19.36 A tool maker's vice

Hand vice

Hand vice is shown in Fig. 19.37 which is utilized for holding keys, small drills, screws, rivets, and other similar objects which are very small to be easily held in the bench vice. This is made in various shapes and sizes. It consists of two legs made of mild steel which hold the jaws at the top and are hinged together at the bottom. A flat spring held between the legs which tend to keep the jaws open. Its jaws can be opened and closed by a wing nut which moves through a screw that is fastened to one leg and passes through the other.

Pin vice

Pin vice is used for holding round jobs of small diameter such as wire and pins, during working. It also forms a very useful handle for small files. It consists of a handle and a tapered nose covering a small collet chuck at its end. The chuck carries the jaws which are operated by turning the handle. It is commonly used by a watch maker.

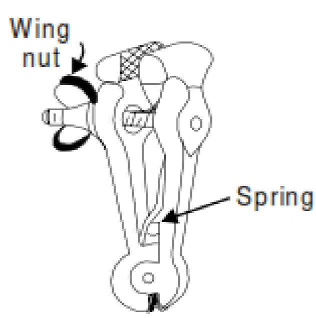


Fig. 19.37 Hand vice

Clamping Devices

There are two types of clamps namely C clamp and tool maker clamp. A C-clamp is shown in Fig. 19.38 which is used for gripping the work during construction or assembly work. Whereas tool maker clamp (Fig. 19.39) is used for gripping or holding smaller jobs.

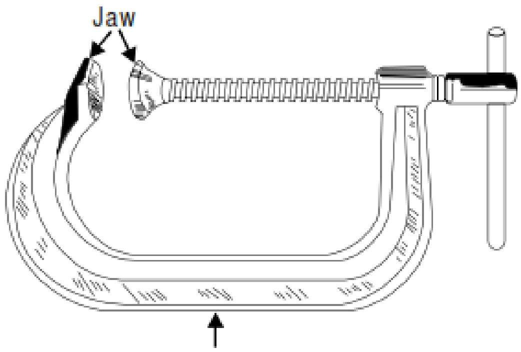


Fig. 19.38 C-clamp

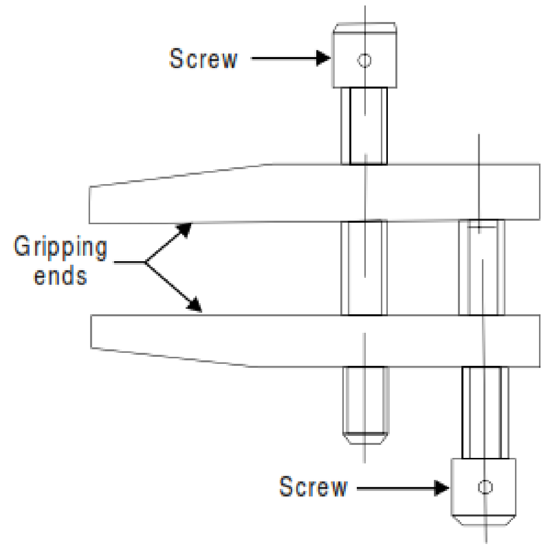


Fig. 19.39 A tool maker clamp

Cutting Tools

The important common cutting tools are discussed below

Files

The widely used hand cutting tool in workshops is the file. It is a hardened piece of high-grade steel with slanting rows of teeth. It is used to cut, smooth, or fit metal parts. It is used file or cut softer metals. It consists of the following parts as shown in Fig. 19.40. The tang is the pointed part, which fitted into the handle. The point is the end opposite the tang. The heel is next to the handle. The safe edge or side of a file is that which has no teeth. It is classified on bases of type or cut of teeth and sectional form.

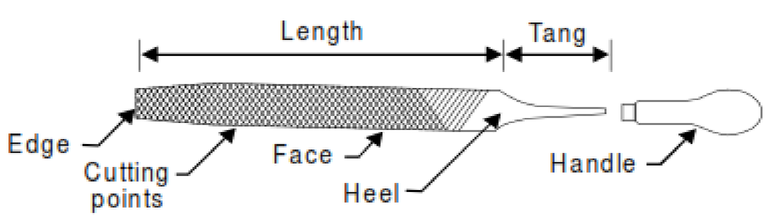


Fig. 19.40 Parts of a file

Size of a File

Size of a file is specified by its length. It is the distance from the point to the heel, without the tang. Files for fine work are usually from 100 to 200 mm and those for heavier work from 200 to 450 mm in length.

Classification of Files

The files are classified on basis of type of cuts, grade and shapes. These are further sub classified as under

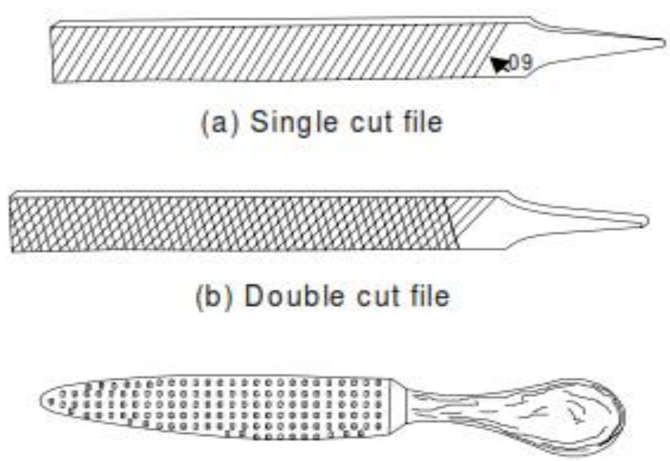
(A) Type of Cut

The most commonly used files according to cuts of teeth are shown in Fig.19.41.

(*i*) Single

(*ii*) Double and

(*iii*) Rasp



(a) Single cut file

(b) Double cut file

(c) Rasp cut file.

Fig. 19.41 Types of files according to cuts of teeth

(B) Grade of Cut

Files are cut with teeth of different grades. Those in general are

(*i*) Smooth

(*ii*) Second cut

(*iii*) Bastered

(*iv*) Rough

(**C) Shape of File**
Common shapes of files are having different cross sections, which cover most requirements.

Cut or teeth on files
Teeth or cuts of files can be categorized into two groups namely single cut and double cut. In single cut files, the teeth are cut parallel to other across the file at an angle of about 60° to the center line of the file. Such types of file are named as flats and are widely used on hard metal.
A double-cut file possesses two sets of teeth, the over-cut teeth being cut at about 60° and the up cut at 75 to 80° to the center line.
Single-cut and double-cut files are further classified according to the coarseness or spacing between the rows of the teeth. In descending order of roughness, such files are listed as:
(*i*) Smooth
(*ii*) Dead smooth
(*iii*) Rough
(*iv*) Bastard
(*v*) Second cut
(*vi*) Super smooth

These files are used for finishing general surface work. Both faces of file are double cut and both edges are single cut. Such files are commonly tapered in width and thickness.
General classification of files based on shapes or cross sections are shown in Fig. 19.42 along with their uses are as under:

Hand files
Hand files are commonly used for finishing surface work. Both faces of the file are double cut. Either both edges are single cut or one is uncut to provide a safe edge.

Flat files
Flat files are generally used for filing flat surfaces in fitting shop.

Triangular files
Triangular files are commonly used for filing corners between 60° and 90°. They are double cut on all faces.

Square files
Square files are commonly used for filing in corners in jobs. They are double cut on all sides and tapers.

Round files
Round files are generally used for opening out holes and rounding inside corners. Rough, bastard, second cut and smooth files under 15 cm in length are single cut.

Half round files
These files comprises of flat and half round sides. The flat side of half round file is used for general work and the half round side for filing concave surfaces. These files are double cut on the flat side. The curved side is single cut, smooth or second cut.

Knife-edge files
These files are commonly used for cleaning out acute-angled corners. The two faces of these files are double cut, while the edge is single cut. These files are made in sizes from 10 to 20 cm of various shapes and cuts. They are extremely delicate and are used for fine work such as pierced designed in thin metal.

Pillar files
These files are used for finishing narrow slots. Both faces are double cut and either both edges are single cut or one is uncut to provide a safe edge of the file.

Needle files
Needle files are generally used for filling keys tooth wheels of clocks and other curved surfaces.

Mill files
Mill files are commonly used for filing half round recess and gullet of mill saw.

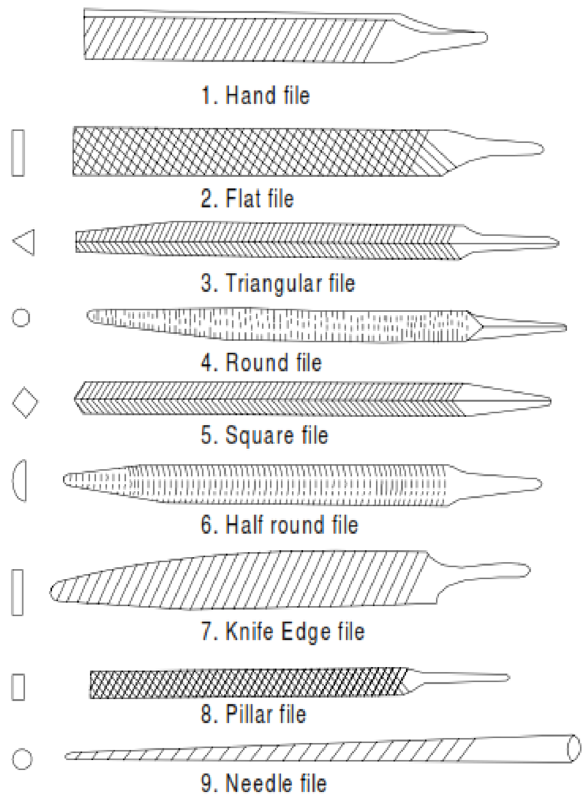


Fig. 19.42 General classification of files based on shapes or cross sections

Scrapers

Scrapers are made up of old files and the cutting edge of scraper is hardened and tempered. They are mainly used to scrap metal surfaces by rubbing the work surface. They also produce a bearing surface, which has been filed or machined earlier. The scrapers are hand cutting tools used for removing metal from surfaces in form of thin slices or flakes to produce smooth and fine surfaces. Machined surfaces are not always perfectly true. If a very true surface is needed, the high spots must be located and removed. It is normally done with the help of a scraper. The scrapers are made in a variety of lengths from 100 mm upwards and in many shapes, depending upon the type of work to be done. The following types of scrappers according to shape are commonly classified as

(*i*) Flat

(*ii*) Hook

(*iii*) Triangular

(*iv*) Half round

Fig 19.43 shows various scraper which are generally used for scraping job work in fitting shop. These are discussed as under.

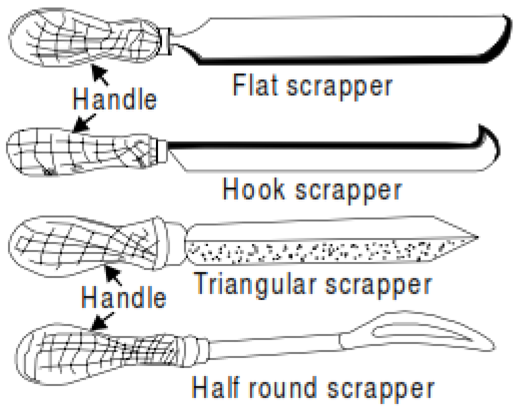


Fig. 19.43 Common types of scraper

Flat scrapers

Flat scrapers are commonly used for removing slight irregularities on a flat surface. When the surface has been scraped with strokes in one direction, it must then be scraped with strokes at 90° to the first ones.

Hook scrapers

Hook scrapers are widely used for scraping minor job work in fitting shop.

Triangular scrapers

These are generally used to finish bearings in the same way as the half round scrapers, but since they come to a sharp point at the tip they removes burrs at the edge of small holes which a half round scraper could not enter. The faces of the scraper are hollow ground to give the tool three cutting edges which are simpler to sharpen than the edges of the half round scraper.

Half-round scrapers

These types of scrapers are widely used for scraping internal cylindrical surfaces. They are used to remove high spots in bore & and bearings to give the right type of fit to the mating shaft or journal.

Scrapers are stored carefully for protection of cutting edges from damage.

Chisel

Chisel is one of the most important tools of the sheet metal, fitting and forging shop. It is widely used for cutting and chipping the work piece. It is made of high carbon steel or tool steel. It is in the form of a rod having cutting edge at one end, hexagonal or octagonal body and striking head at the other end. The size of a chisel is described by its length and width of edge. When the cutting edge becomes blunt, it is again sharpened by grinding. For cutting the job or work piece with the chisel, it is placed vertically on the job or work piece and hammering is carried out upon its head. But for chipping, the chisel is inclined at 40°-70° with the job or work piece. The angle of the cutting edge of the chisel is 35°-70°according to the metals to be cut.

Drill

Drill is a common tool widely for making holes in a metal piece in fitting shop. It is generally held in chuck of bench drilling machine shown in Fig. 19.44. It usually consists of two cutting edges set at an angle with the axis. There are three types of drills: (*a*) flat drill, (*b*) straight fluted drill and (*c*) twist drill. For fast and accurate drilling work twist drills are commonly used. A general twist drill comprises the cutting angle of 118° and to obtain the correct diameter of the hole. It should be ground with both lips at 59° to the axis of the drill, with equal lengths of the cutting edges. The various hand drills and their operations are shown in Fig. 19.45.

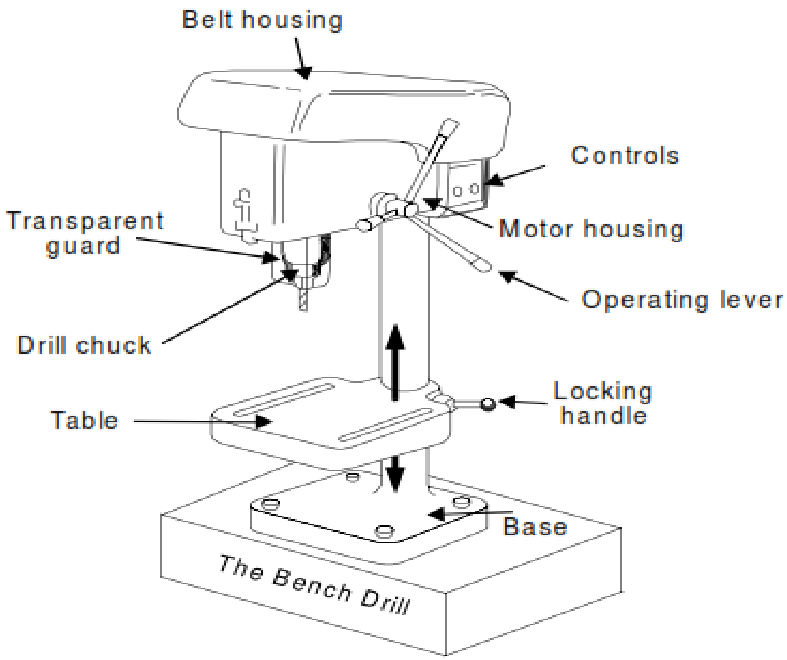


Fig. 19.44 A bench drilling machine

Reamer

The drill does not always produce the correct hole some time with good finish. Thus a correct hole is produced with good finish of a pre drilled hole using a reamer. A common hand reamer is shown in Fig. 19.46. It is commonly employed to remove minimum amount of metal (100 to 150 microns for rough reaming and 5 to 20 micron for fine reaming) from the hole. During reaming operations, the job should be properly supported and rigidly held. A stock wrench of appropriate size for holding the reamer is used. The reamer must be kept in its correct position relative to the job. It must be run slowly and excessive feed must be avoided. It should be always be turned in the cutting direction. Sufficient amount of cutting fluid should also be employed. When removing the reamer, it must be turned in the cutting direction. Reamers with blunt or chipped edges must not be used.

Machine reamer

Machine reamer is designed for slow speeds for use on drill presses, lathes, vertical milling machines etc. It is chamfered on the front side of cutting edge. It possesses straight or tapered shanks and comprises of either straight or spiral flutes.

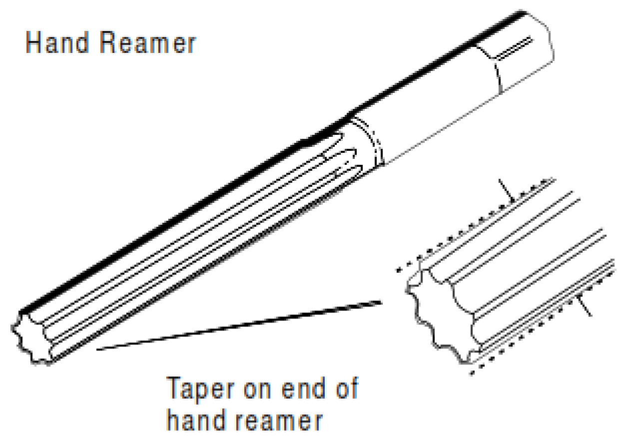


Fig. 19.46 A common hand reamer

TAPS

Taps are used for cutting or producing internal threads of either left or right hand kind in nuts or pre-drilled holes. Taps are threaded externally. The threads being cut by grinding to give a high class finish. Taps are made up of alloy steel or hardened steel. To provide cutting edges, grooves known as flutes are ground along the threaded portion of the tap so that the thread is divided into rows of teeth. The number of flutes on tap varies from two to eight whereas four being the most common. The flutes acts as channels to carry away the chips formed during tapping or cutting threads. The nomenclature of a typical tap is shown in Fig. 19.47. Taps are may be of many types such as hand taps, machine taps, pipe taps, solid taps, straight and bend shank taps. Hand taps are usually made in sets of three: **(1) taper tap (2) plug tap (3) bottoming tap** as shown in Fig. 19.48. The taper tap is tapered off for 8 or 10 threads, and is used first, cutting to the full thread gradually. The intermediate tap usually has two or three threads chamfered. The second tap can finish a through hole. The plug tap has a full-sized un-tapered thread to the end and is the main finishing tap. In the case of blind hole, a plug tap must be used.

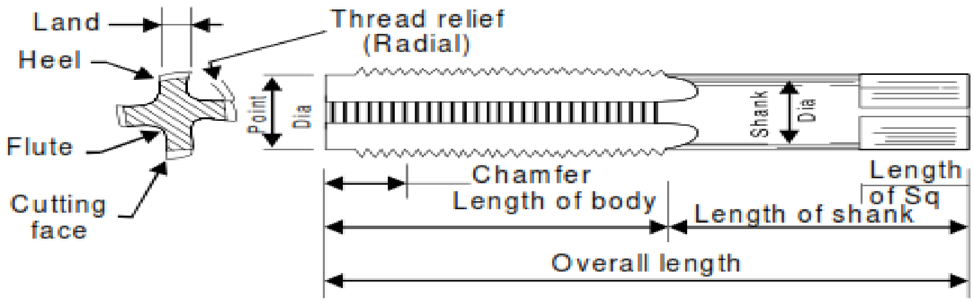


Fig. 19.47 Nomenclature of tap

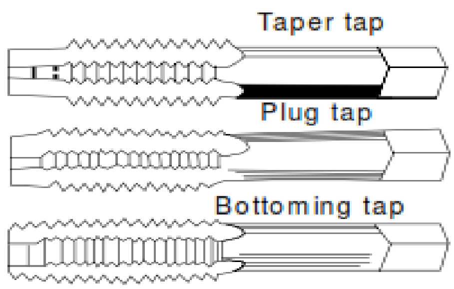


Fig. 19.48 Types of hand taps

Hand snip or shear

Various kinds of snips or shears are described in chapter pertaining to sheet metal work. They are commonly employed for cutting or shearing metal sheets to required shapes and sizes. Few snips are available for making straight or circular cuts. The most common types of snips in use are:

(*a*) Straight snips,

(*b*) Bent snips and

(*c*) Slitting shears

Hand hacksaw

Hand hacksaws are made in two types namely a fixed frame and adjustable frame oriented as shown in Fig.19.49 and Fig.19.50. The former possesses solid frame in which the length cannot be changed and where as the latter comprises the adjustable frame which has a back that can be lengthened or shortened to hold blades of different sizes. The hand hacksaws are commonly used for sawing all soft metal. They consist of a frame, handle, prongs, tightening screw and nut, and blade as shown in figure. Its frame is made to hold the blade tightly. However a power operated hacksaw can also be used for cutting raw materials in sizes in case of continuous cutting generally occurring frequently in fitting or in machine shops.

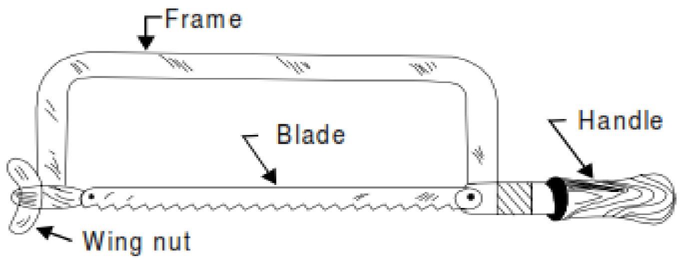


Fig. 19.49 A fixed frame hacksaw

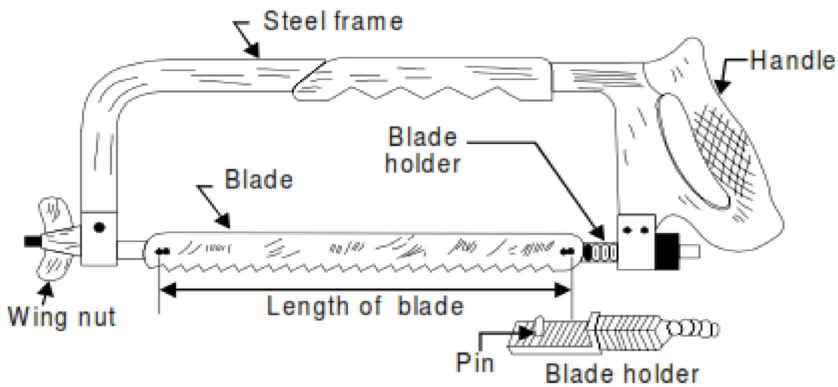


Fig. 19.50 An adjustable frame hacksaw

Striking Tools

Various types of hammers (such as ball peen hammer, straight peen hammer, cross-peen hammer, double face hammer and soft face hammer) are acting as striking tools. These types have been described in chapters relating to sheet metal work and forging work. The common type of ball peen hammer and their parts are shown in Fig. 19.51.

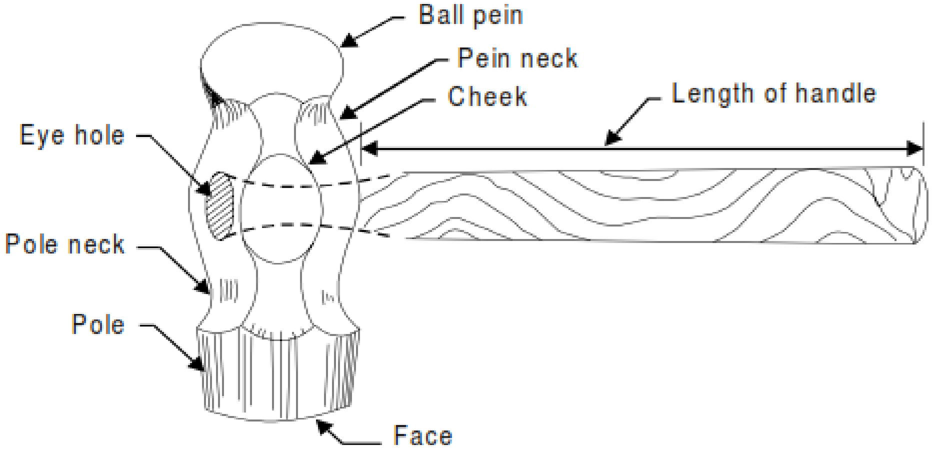


Fig. 19.51 Common type of ball peen hammer and their parts

Tightening Tools

The tightening tools include pliers, screw driver and wrenches, which are discussed as under.

1. Pliers

Pliers are namely ordinary needle nose and special type. Fig 19.52(a) shows a long nose pliers and Fig. 19.52(b) shows a combination pliers. These are commonly used by fitter and electrician for holding a variety of jobs.

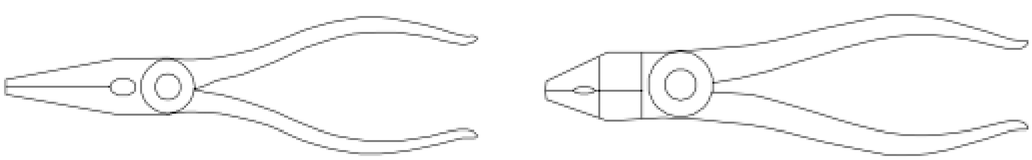


Fig. 19.52 Long nose pliers and combination pliers

2. Screw driver

Screw driver is a screw tightening tool. The most commonly used standard screw driver with its parts is shown in Fig 19.53. It is generally used by hand for tightening the screws. It is also of various types depending upon the kind of work.

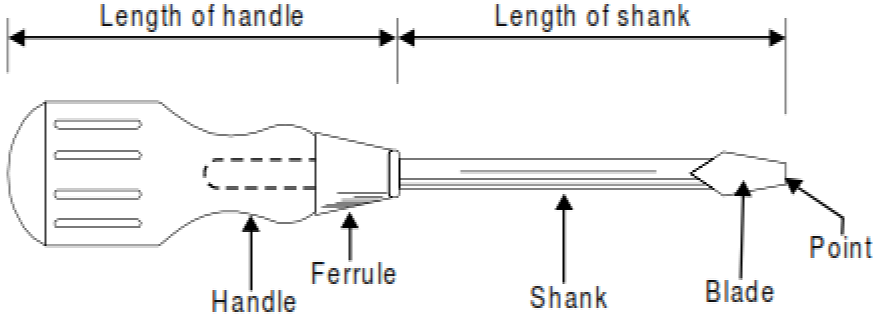


Fig. 19.53 Standard screw driver with its parts

3. **Wrenches**

Wrenches are commonly known as spanners. These generally come in sets and are commonly identified by numbers. These are of various types and few general types involve open single ended, open double ended, closed ended adjustable, ring spanner, offset socket, t-socket, box wrench, pipe wrench and Allen wrench.

OPERATIONS PERFORMED IN FITTING WORK

The operations commonly performed in bench and fitting work may be classified as under.

1. Marking	2. Chipping
3. Filing	4. Scrapping
5. Sawing	6. Drilling
7. Reaming	8. Tapping
9. Grinding and	10. Polishing

Some common operations are discussed as under.

Grinding

Grinding is generally called as fine machining or finishing operations of removing materials from surface usually 0.25-0.50 mm in most operations through the use of grinding wheel. Grinding wheel is highly useful in removing extra unwanted metal and sharpening cutting tools such as chisels, drill, taps, and other cutting tools. It may be used to finish almost all surface, which has been previously roughly shaped by some other processes or to remove the extra material which is too hard to be removed by other machining processes. The accuracy in fine grinding is in few microns or even less. In grinding, the work is held pressed against the high speed rotating grinding wheel and the metal gets reduced by abrasion. Grinding wheel is generally made from silicon carbide or aluminum oxide. It is generally made up of particles of hard substance called the abrasive and is embedded in a matrix called the bond. These abrasives form the cutting points in a wheel and are termed as grains. The abrasives are of generally two types namely natural and artificial. Emery and corundum are two natural abrasives, while carborundum and aloxite are artificial abrasives. The hardness or softness of the wheel is dependent on the amount and kind of the bonding material. Generally, hard wheels of aloxite are used for grinding soft materials and soft wheels of carborundum for grinding hard materials using various types of grinding machines known as grinders. In wet grinding, large amount of coolant over the work and on wheel face is provided. Coolant will remove heat generated during grinding and promotes long wheel life and produces very good surface finish. The cutting face of a grinding wheel should be kept in a true, clean and sharp conditioned shape for obtaining efficient cutting. Suitable dressers are also employed periodically for reconditioning and dressing of glazed or blunt wheels. Grinder may be various types such as cylindrical grinder, surface grinder, pedestal grinder, tool and cutter grinder, centre-less grinder, internal grinder and jig grinder and profile grinder. Fig. 19.54 illustrates the surface grinding machine and principle of surface grinding. Fig. 19.55 illustrates the principle of cylindrical grinding.

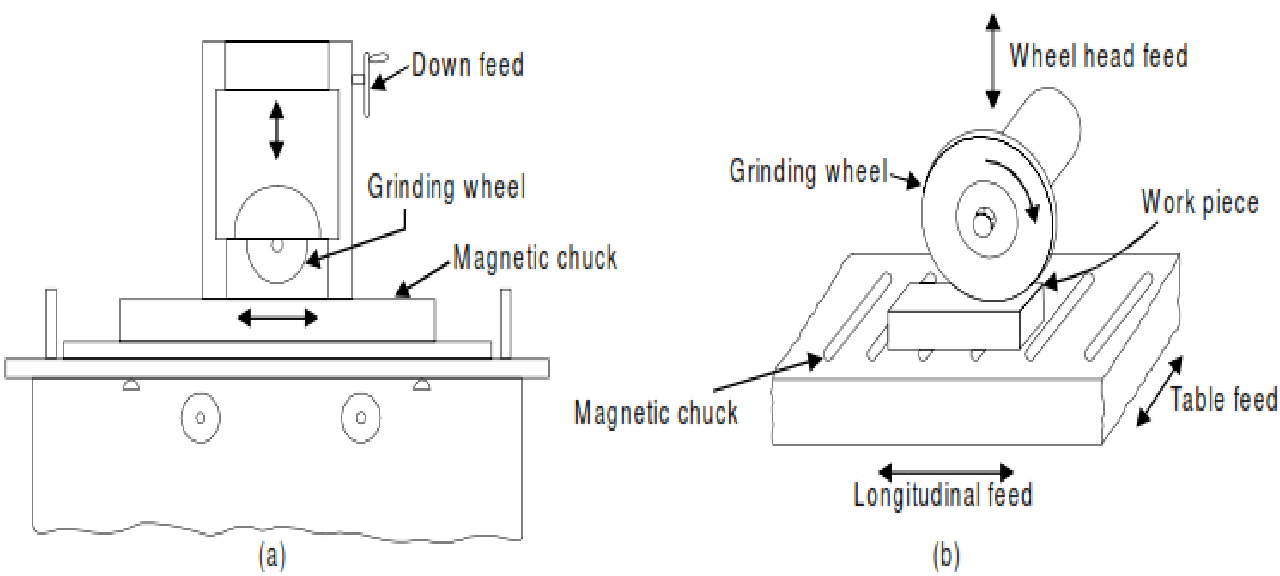


Fig. 19.54 Surface grinding machine and its principle

Polishing

Polishing is surfacing finishing process for producing a flat, scratch-free, mirror-like finish. It consists of fine grinding, intermediate grinding, rough polishing, and fine polishing. Initially the surface to be polished is roughly ground to remove deep cut off marks. Then the intermediate grinding is done with fine emery or silicon carbide (Carborundum) papers decreasing in grit size in three to four stages to remove grinding marks. Emery papers are graded from fine to coarse. This polishing operation may be performed by hand or mechanically using the rotating disks. The motion in polishing of work on polishing wheel should always be straight and the polishing strokes should cover the whole length of the surface being polished. Finer grade emery disc pr polishing wheel should be used for the fine finish work. Polishing is commonly performed on utensils.

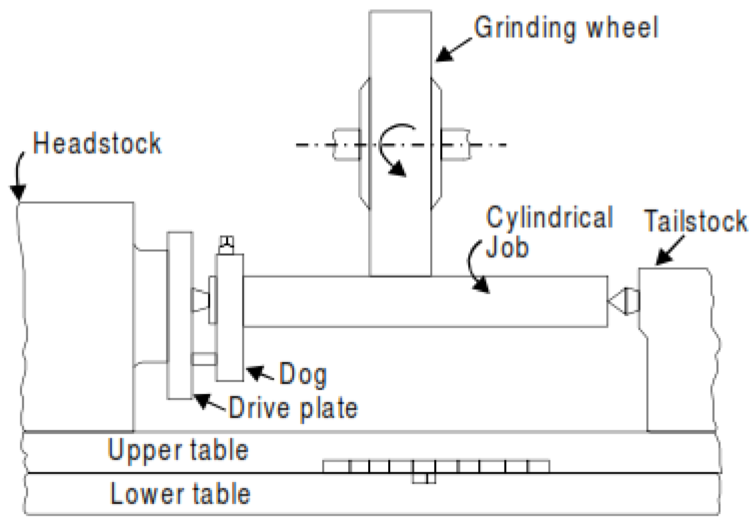


Fig. 19.55 Principle of cylindrical grinding

Surface Coating

The various manufacturing processes such as casting, forging, machining, hot working, cold working and joining processes etc. produce different surfaces. Therefore for getting desired surface of the part, subsequent surface preservation processes are needed. These preservation processes are called as surface coating of metals. Coatings on surfaces are employed on most metal parts, either for protective or for decorative or for both purposes. The main objectives of coatings involve for the purpose of decoration, surface protection, corrosion resistance and providing of a hard surface. The surface covering with coating must be uniform and free from runs, checks or peelings. Coatings are commonly applied to the finished components to form the final product. For successful coating, clean and smooth surface finishes is required for assuring good adhesion during coating. Cleaning operations are performed both preparatory to finishing operations and after finishing operations. They are primarily used to remove dirt, oil, oxides, scale, and other harmful ingredients that ultimately affect the life of the product. There are various methods of cleaning, drying, and competitive means of applying the coating. However, the various processes involved in preparing work for coating and applying the coatings are closely interrelated. Galvanizing, Parkerizing, electroplating and painting are the common surface coating processes employed for protecting the surfaces of the work pieces.

Joining methods

Some method of joining parts together is used throughout industry, to form either a complete product or an assembly. The method used depends on the application of the finished product and whether the parts have to be dismantled for maintenance or replacement during service. There are five methods by which parts may be joined:

- mechanical fasteners – screws, bolts, nuts, rivets;
- soldering;
- brazing;
- welding;
- adhesive bonding.

Mechanical fasteners are most widely used in applications where the parts may need to be dismantled for repair or replacement. This type of joint is known as non-permanent. The exception would be the use of rivets, which have to be destroyed to dismantle the parts and so form a permanent joint. Welding and adhesives are used for permanent joints which do not need to be dismantled – any attempt to do so would result in damage to or destruction of the joints and parts. Although soldered and brazed joints are considered permanent, they can be dismantled by heating for repair and replacement.

Mechanical fasteners

Mechanical fasteners can be made from many materials but most bolts, nuts and washers are made from carbon steel, alloy steel, or stainless steel depending upon their industrial use. Carbon steel is the cheapest and most common for general use.

To prevent corrosion, mechanical fasteners may be plated or coated in some way, again depending on the application. The most common surface treatments are zinc, nickel and cadmium. Phosphate coatings are also used but have limited corrosion resistance.

➢ Machine screws

These are used for assembly into previously tapped holes and are manufactured in brass, steel, stainless steel and plastics (usually nylon) and threaded their complete length. Various head shapes are available, as shown in Fig. 13.1. Depending on the style, thread diameters are generally available up to 10 mm, with lengths up to 50 mm. For light loading conditions where space is limited, a headless variety known as a grub screw is available. A typical application would be to retain a knob or collar on a shaft. Although Fig. 13.1 shows head types with slotted head drives, these screws are available with a variety of head drives as outlined on page 39 with Phillips, Pozidriv and Torx the most common.

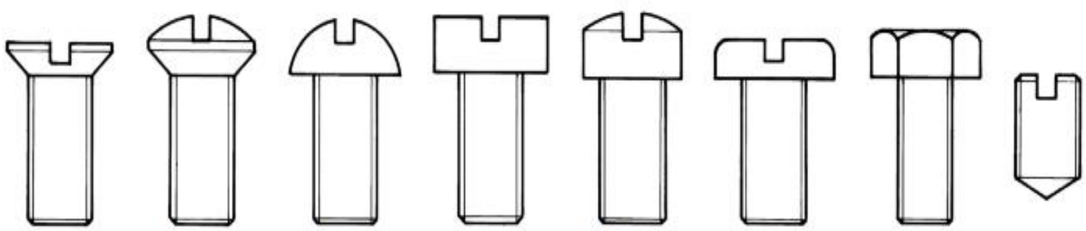


Figure 13.1 Types of screw head

➢ Socket screws

Manufactured in high-grade alloy steel with rolled threads, this type of screw is used for higher strength applications than machine screws. Three head shapes are available, all of which contain a hexagon socket for tightening and loosening using a hexagon key, Fig. 13.2. Headless screws of this type – known as socket set screws – are available with different shapes of point. These are used like grub screws, where space is limited, but for higher strength applications. Different points are used either to bite into the metal surface to prevent loosening or, in the case of a dog point, to tighten without damage to the work, Fig. 13.3.

- **Self-tapping screws**

Self-tapping screws are used for fast-assembly work. They also offer good resistance to loosening through vibration. These screws are specially hardened and produce their own threads as they are screwed into a prepared pilot hole, thus eliminating the need for a separate tapping operation.

There are two types:

- the thread-forming type, which produces its mating thread by displacing the work material and is used on softer ductile materials, Fig. 13.4(a);

- the thread-cutting type, which produces its mating thread by cutting in the same way as a tap. This type has grooves or flutes to produce the cutting action, Fig. 13.4(b), and is used on hard brittle materials, especially where thin wall sections exist, as this type produces less bursting force.

More rapid assembly can be achieved by self piercing-and-tapping screws. These have a special piercing point and a twin-start thread, Fig. 13.4(c).

Used in conjunction with a special gun, they will pierce their own pilot hole in the sheet metal (up to 18 SWG (1.2 mm) steel) or other thin materials and are then screwed home in a single operation.

- **Bolts**

Bolts are used in conjunction with a nut for heavier applications than screws. Unlike screws, bolts are threaded for only part of their length, usually twice the thread diameter. Bright hexagon-head bolts are used in engineering up to 36 mm diameter by 150 mm long. Larger sizes are available in high-tensile materials for use in structural work.

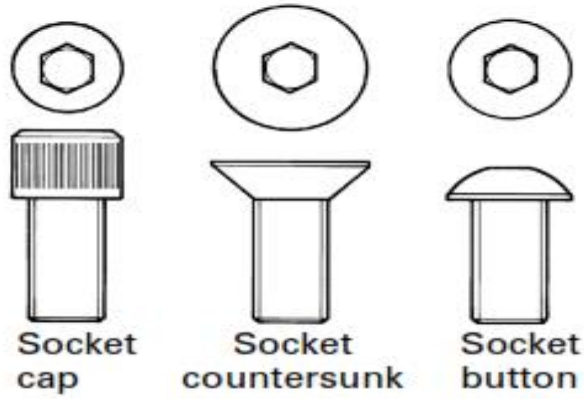


Figure 13.2 Socket screw heads

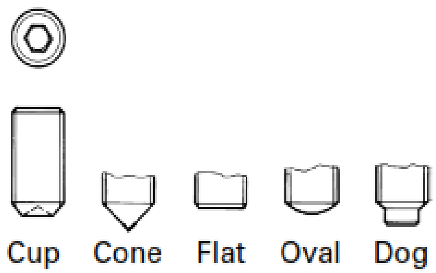


Figure 13.3 Socket set screws

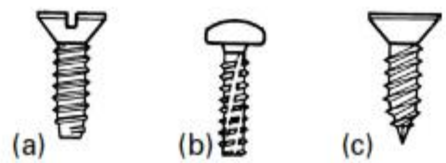


Figure 13.4 Self-tapping screws (a) thread-forming (b) thread-cutting (c) self-piercing-and-tapping

- **Nuts**

Standard hexagon nuts are used with bolts to fasten parts together. Where parts require to be removed frequently and hand tightness is sufficient, wing nuts are used, Fig. 13.5(a). If a decorative appearance is required, a dome or acorn nut can be fitted, Fig. 13.5(b). Where thin sheets are to be joined and access is available from only one side, rivet bushes or rivet nuts are used. These provide an adequate length and strength of thread which is fixed and therefore allows ease of assembly, Fig. 13.5(c). Available in thread sizes up to 12 mm for lighter applications, blind nuts of the type shown in Fig. 13.5(d) can also be used. The nut is enclosed in a plastics body which is pressed into a predrilled hole. A screw inserted into the nut pulls it up and, in so doing, expands and traps the plastics body. Spring-steel fasteners are available which as well as holding also provide a locking action. If access is available from both sides, a flat nut can be used, Fig. 13.5(e), or from one side a J-type nut can be used, Fig. 13.5(f). In their natural state these nuts are arched, but they are pulled flat when the screw is tightened.

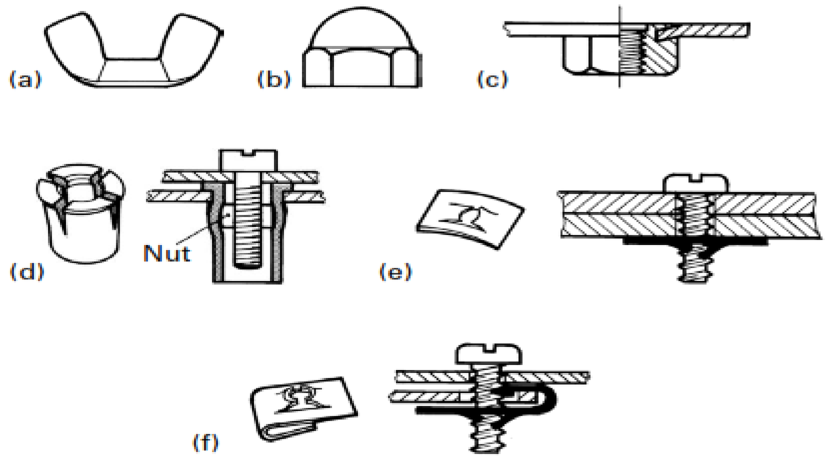


Figure 13.5 Types of nut (a) wing (b) dome or acorn (c) rivet bush or nut (d) blind (e) flat spring steel fastener and (f) J type fastener

- Washers

Washers distribute the tightening load over a wider area than does a bolt head, screw head or nut. They also keep the surface of the work from being damaged by the fastener. Plain flat washers spread the load and prevent damage to the work surface. Flanged nuts are available with a plain flange at one end which acts as an integrated, non-slipping washer. The flange face may be serrated to provide a locking action but can only be used where scratching of the work surface is acceptable (Fig. 13.6).

Figure 13.6 Flanged nuts

- **Spring tension pins**

These pins are made from spring steel wrapped round to form a slotted tube, Fig. 13.7. The outside diameter is produced larger than the standard-size drilled hole into which it is to be inserted. When inserted in the hole, the spring tension ensures that the pin remains securely in position and cannot work loose. A chamfer at each end of the pin enables it to be easily inserted in the hole, where it can be driven home using a hammer. Pins of this type are now being used to replace solid hinge pins, split pins, rivets and screws, eliminating the need for reaming, tapping, counterboring and countersinking. They are available in a range of diameters from 1 mm to 12 mm and lengths from 4 mm to 100 mm.

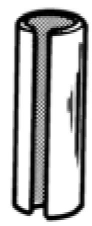


Figure 13.7 Spring tension pin

- **Locking nuts**

The simplest method of locking a nut in position is by applying a lock nut. Lock nuts are a little over half the thickness of a standard nut. When used in conjunction with a standard nut and tightened, the lock nut is pushed against the thread flanks and locked, Fig. 13.9(a).

Slotted and castle nuts are used in conjunction with wire or a split pin through a hole in the bolt to prevent the nut from working loose, Fig. 13.9(b).

Self-locking nuts are available which are easy to assemble and do not require a hole in the bolt or the use of a split pin. One type, known as a 'Nyloc ' nut, Fig. 13.9(c), incorporates a nylon insert round the inner top end of the nut. As the nut is screwed on, the nylon yields and forms a thread, creating high friction and resistance to loosening. A second type, known as an 'Aerotight ' stiff nut, Fig. 13.9(d), has two arms formed on top of the nut. These arms, which are threaded, are deflected inwards and downwards. When the nut is screwed on, the arms are forced into their original position and the resistance of these arms gives a good grip on the thread, preventing it from working loose. A third type, known as a 'Philidas ' self-locking nut, Fig. 13.9(e), has a reduced diameter above the hexagon. Two slots are cut opposite each other in the reduced diameter and the metal above the slots is pushed down, which upsets the thread pitch. When screwed in position, the thread is gripped by the upset portion, preventing the nut from working loose. A fourth type, known as a torque lock nut, Fig. 13.9(f), has the top part of the nut deformed to an elliptical shape which grips the thread as the nut is applied. This ensures close contact between the threads, preventing the nut from working loose.

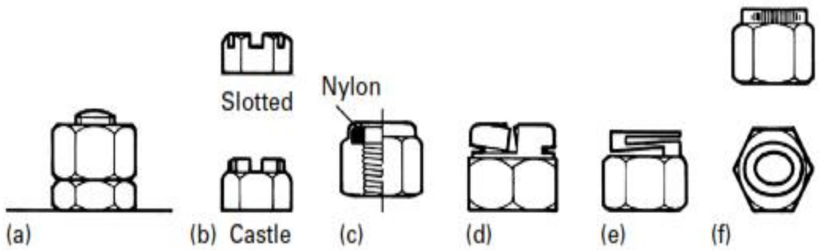


Figure 13.9 Locking nuts (a) standard lock nut (b) slotted and castle nuts (c) 'Nyloc' nut (d) 'Aerotight' nut (e) 'Philidas' self-locking nut (f) torque lock nut

- Locking washers

A locking washer is inserted under the head of a screw, bolt or nut to prevent it working loose during service.

A tab washer may be used, similar to a plain washer with the addition of a tab which is bent up on the hexagon face of the nut, screw or bolt to prevent it working loose, Fig. 13.10(a).

Helical-spring locking washers are commonly used as locking devices and are available for threads up to 24 mm diameter. They may be of square or rectangular section in a single coil, with the ends of the coil raised in opposite directions. These ends form sharp points which dig into the surfaces. In addition, the spring is flattened during the tightening of the screw, bolt or nut, which gives constant tension during use, Fig. 13.10(b).

Shake-proof washers are used for thread sizes up to 16 mm and can have external or internal teeth. The teeth are twisted out of flat so that the washer bites into the surfaces as it is compressed during tightening, Fig. 13.10(c). Where rigid permanent fixing is required on shafts, a range of spring fixing washers which eliminate the use of threads and nuts is available. One type is shown in Fig. 13.10(d). As it is pushed on to the shaft, the 'prongs ' are deformed and bite into the shaft and cannot be removed without destroying it. This type is available up to 25 mm diameter and can be used on all types of material, including plastics.

Figure 13.10 Locking washers (a) tab (b) helical spring (c) shake proof (d) spring fixing

- **Circlips**

Circlips are used to lock a variety of engineering features. An external circlip, Fig. 13.11(a), usually fitted in a groove in a shaft, prevents the shaft from moving in an axial direction or prevents an item fitted to the end of a shaft from coming loose, e.g. a bearing or pulley. Similarly, an internal circlip, Fig. 13.11(b), can be used in a groove to prevent an item such as a bearing from coming out of a recess in a housing and will withstand high axial and shock loading. Circlips are available in sizes from 3 mm to 400 mm and larger and are manufactured from high-carbon spring steel. Lugs with holes are provided for rapid fitting and removal using circlip pliers. Smaller shafts can use a variation of the circlip, known as an E-type circlip, or retaining ring, Fig. 13.11(c). These provide a large shoulder on a relatively small diameter, e.g. rotating pulleys can act against the shoulder. Wire rings or snap rings, Fig. 13.11(d), can be used as a cost-effective replacement for the traditional type of circlip in both internal and external applications such as the assembly of needle bearings and needle cages and sealing rings.

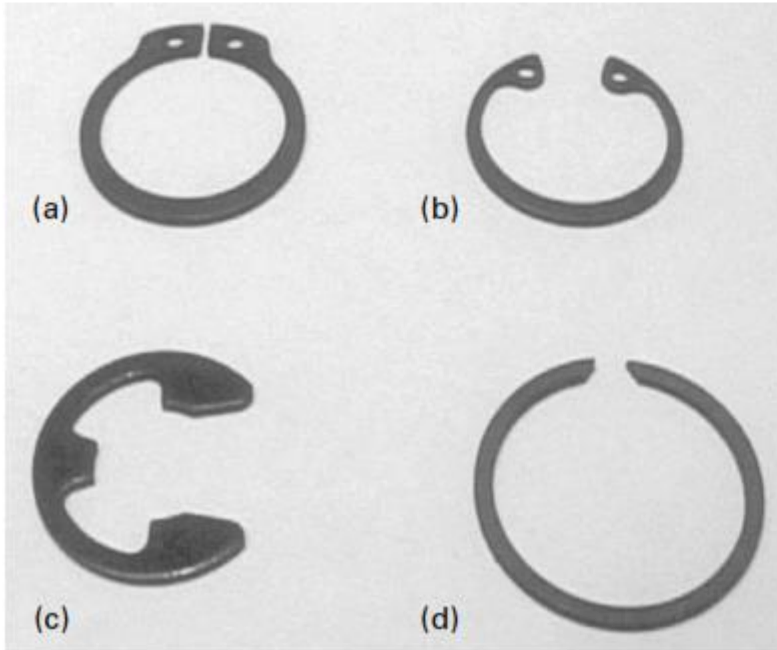
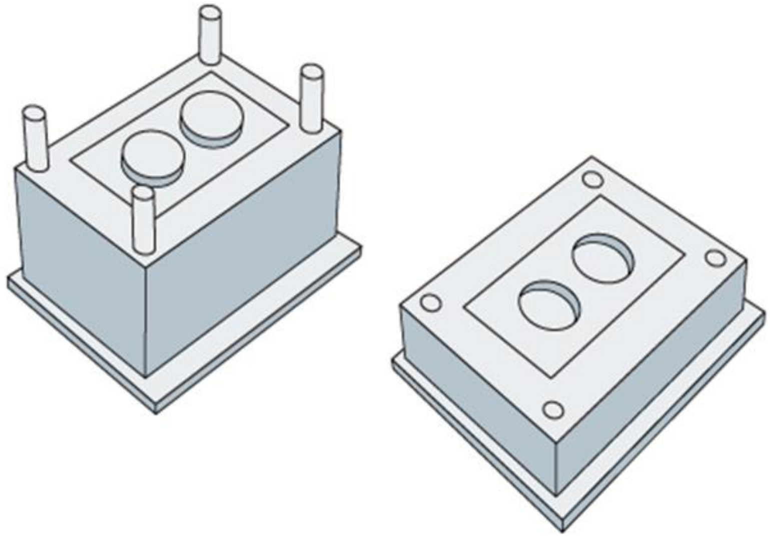


Figure 13.11 Circlips

Dies (molds)

Overview and Classification

Molds and dies are tools that are essential to mass production in present-day manufacturing. Both are key elements in manufacturing—for example, molds are used in injection molding to shape resin as well as in casting, and dies are used in stamping. Today's techniques are able to create micron-order precision molds and dies, contributing to the mass production of products with the same shape and quality in a wide range of areas.
Dies and molds are both tools for shaping. Dies are used to shape sheet metal and other metal forms. A typical application is the making of automobile body parts. On the other hand, molds are used in injection molding such as with melted resin or casting molten metal.



Die and Mold Machining

Materials for dies and molds include tool steels with carbon or chromium content, as well as die steel, high-speed steel, and cemented carbide. Recently, ceramics have also been adopted as a material. Materials used for dies and molds are mostly hard and difficult to cut. For this reason, dies and molds are cut using machining centers or other NC machining tools, but the products generally go through subsequent processes such as grinding for added precision.
Furthermore, electrical discharge machining is used to produce dies and molds with even greater detail. Electrical discharge machining uses sparks from an electrical discharge to melt the surface of the workpiece during machining. Not only is this method capable of producing precision metalworking, it also supports the creation of complex three-dimensional shapes.

Die and Mold Manufacturing Today

The proliferation of machining centers makes it seem like die making is possible for anyone with the right equipment. However, die manufacturing is still considered a high-skill task due to the need to have techniques and skills that cover the entire process, including CAD designing, the selection of materials and machining methods, and performing minute machining that cannot be done through automated procedures.
Furthermore, even shorter turnarounds for die delivery are requested nowadays as product lifecycles are shorter and production includes smaller lots of numerous

items. On another note, the emergence of 3D printers is expected to drastically change the way dies and molds are manufactured. Today, further innovations in mold and die technology are imperative.

Die and Mould Parts

We fabricate the precise parts for the die and mould. The dies and moulds are important machine tools having significant role in the modern manufacturing process. As a prominent manufacturer, supplier and exporter we provide high quality, precise die and mold as per specification. The moulds and dies are used in many kinds of machineries and equipment's like office goods, glass containers, construction materials and equipment's, toys and sundries, house hold goods, industrial machinery, electric machinery and equipment.

These industries are producing bulk production of the goods; need the dies and moulds, which are classifieds in to plastic mould, forging moulds and dies, press dies, ceramic dies, powder metallurgy dies and rubber dies. These moulded items are used in many industries of which plastic moulded products are widely used in many products like TV sets, QA equipment and consumer electric and electronic products, as well as in ballpoint pens, food containers, lunch boxes and pet bottles. We understands the magnitude of the dies and moulds for the production of the articles, we do not compromise with the qualities. The accuracy of the die is the determinable factor for the accuracy of the parts or products. As Dies and moulds is so magnificent fraction of the production line, the best performance of the dies and moulds lead the chances most for the best production. We always make the customer, well informed about the progress of the manufacturing process. We make use of the latest tools and methods for the fabrication.

Mold

Mold or die are the common terms used to describe the tooling used to produce plastic parts in molding.
Traditionally, molds have been expensive to manufacture. They were usually only used in mass production where thousands of parts were being produced. Molds are typically constructed from hardened steel, pre-hardened steel, aluminium, and/or beryllium-copper alloy. The choice of material to build a mold from is primarily one of economics, steel molds generally cost more to construct, but their longer

lifespan will offset the higher initial cost over a higher number of parts made before wearing out. Pre-hardened steel molds are less wear resistant and are used for lower volume requirements or larger components. The steel hardness is typically 38-45 on the Rockwell-C scale. Hardened steel molds are heat treated after machining. These are by far the superior in terms of wear resistance and lifespan. Typical hardness ranges between 50 and 60 Rockwell-C (HRC). Aluminium molds can cost substantially less, and when designed and machined with modern computerized equipment, can be economical for molding tens or even hundreds of thousands of parts. Beryllium copper is used in areas of the mold which require fast heat removal or areas that see the most shear heat generated. The molds can be manufactured by either CNC machining or by using Electrical Discharge Machining processes

Mold Design

Molds separate into two sides at a parting line, the A side, and the B side, to permit the part to be extracted. Plastic resin enters the mold through a sprue in the A plate, branches out between the two sides through channels called runners, and enters each part cavity through one or more specialized gates. Inside each cavity, the resin flows around protrusions (called cores) and conforms to the cavity geometry to form the desired part. This is similar to someone squeezing clay between their hands so that when it is removed, it matches the shape of the hollow of their cupped hands.

The amount of resin required to fill the sprue, runner and cavities of a mold is a shot. When a core shuts off against an opposing mold cavity or core, a hole results in the part. Air in the cavities when the mold closes escapes through very slight gaps between the plates and pins, into shallow plenums called vents. To permit removal of the part, its features must not overhang one another in the direction that the mold opens, unless parts of the mold are designed to move from between such overhangs when the mold opens (utilizing components called Lifters).

Sides of the part that appear parallel with the direction of draw (the direction in which the core and cavity separate from each other) are typically angled slightly with (draft) to ease release of the part from the mold, and examination of most plastic household objects will reveal this. Parts with bucket-like features tend to shrink onto the cores that form them while cooling, and cling to those cores when the cavity is pulled away. The mold is usually designed so that the molded part reliably remains on the ejector (B) side of the mold when it opens, and draws the runner and the sprue out of the (A) side along with the parts. The part then falls freely when ejected from the (B) side. Tunnel gates tunnel sharply below the parting surface of the B side at the tip of each runner so that the gate is sheared off of the part when both are ejected.

Ejector pins are the most popular method for removing the part from the B side core(s), but air ejection, and stripper plates can also be used depending on the application. Most ejection plates are found on the moving half of the tool, but they can be placed on the fixed half if spring loaded. For thermoplastics, coolant, usually water with corrosion inhibitors, circulates through passageways bored through the main plates on both sides of the mold to enable temperature control and rapid part solidification.

To ease maintenance and venting, cavities and cores are divided into pieces, called inserts, and sub-assemblies, also called inserts, blocks, or chase blocks. By substituting interchangeable inserts, one mold may make several variations of the same part.

More complex parts are formed using more complex molds. These may have sections called slides, that move into a cavity perpendicular to the draw direction, to form overhanging part features. Slides are then withdrawn to allow the part to be released when the mold opens. Slides are typically guided and retained between rails called gibs, and are moved when the mold opens and closes by angled rods called horn pins and locked in place by locking blocks, both of which move cross the mold from the opposite side.

Some molds allow previously molded parts to be reinserted to allow a new plastic layer to form around the first part. This is often referred to as over molding. This system can allow for production of one-piece tires and wheels.

2-shot or multi-shot molds are designed to "over mold" within a single molding cycle and must be processed on specialized injection molding machines with two or more injection units. This can be achieved by having pairs of identical cores and pairs of different cavities within the mold. After injection of the first material, the component is rotated on the core from the one cavity to another. The second cavity differs from the first in that the detail for the second material is included. The second material is then injected into the additional cavity detail before the completed part is ejected from the mold. Common applications include "soft-grip" toothbrushes and free lander grab handles.

The core and cavity, along with injection and cooling hoses form the mold tool. While large tools are very heavy weighing hundreds and sometimes thousands of pounds, with the aid of a forklift or overhead crane, they can be hoisted into molding machines for production and removed when molding is complete or the tool needs repairing.

A mold can produce several copies of the same parts in a single "shot". The number of "impressions" in the mold of that part is often incorrectly referred to as cavitation. A tool with one impression will often be called a single cavity (impression) tool. A mold with 2 or more cavities of the same parts will likely be referred to as multiple cavity tooling. Some extremely high production volume molds (like those for bottle caps) can have over 128 cavities.

In some cases multiple cavity tooling will mold a series of different parts in the same tool. Some toolmakers call these molds family molds as all the parts.

Mold Assembly and Fitting

Mold assembly is one of the most critical steps of mold making procedure, all the parts machined or purchased need to be put together and required to be work functionality. Mold assembly job requires comprehensive understanding of mold structure as well as injection molding. Quality of mold assembly determines the mold precision, injection productivity. The work instructions below can be treated as a guide for mold makers.

All parts are machined correct and clean, the work tools required are available and the workplace is well organized, before assembling the mold, all the components must be check and verified.

- Make sure all surfaces are polished accordingly, especially the deep rib - it could cause serious de-molding problem if it was not polished properly.
- Check all sharp edges of cavity and cores, all sharp edges that have no function requirement must be broken 0.01 radius.
- Verify that the mold gate and runner size is correct according to design; make sure the runner is polished.
- The mold base should have correct markings, pay bar slots between parting line, clamp plates, support plates and ejector plates, check if lifting holes for

each plate is available and mark with correct thread dimension, and the lifter bar as well.

- ❖ Check if the sprue and nozzle are in correct size, check if the location ring is correct.
- ❖ Check if the knock out holes dimension, layout and clamping slot is correct.
- ❖ Check if the part surfaces, deep ribs, sliders, pins, end of mold flow are all properly vented.
- ❖ All pins, cores, sleeves must be marked for correct location, check the dimension and fitting clearance include length and head.
- ❖ Assure that ID is engraved on cavities on multi-cavity molds, verify that part number is engraved.
- ❖ Verify that all moving parts, such as ejector blades, slides, lift cores, etc. are of dissimilar material or nitrided to prevent galling.
- ❖ Ensure the water line is through, marked in and out correctly, make sure the water line tube will not interfere with clamp slots.
- ❖ Type of steel, hardness, location and detail number must be marked. All parts, including those parts that are interchangeable, will be identified for position in a way that assures the locations mark is always clearly visible even after assembly.
- ❖ All slides, core pins, angle pins, cam locks and guide pins must be greased.
- ❖ Check all the mechanism; make sure they are all smooth and functional.
- ❖ Check all the fitting tolerance, including pins, cores, sliders, lifters.
- ❖ Check if cavity and core inserts are higher than parting line, .004 minimum (.002 each above cavity and core retainer plate).
- ❖ Close the mold; check if there is still clearance between cavity and core retainer plates. This clearance should be .004 minimum. If a runner is in cavity or core retainer plate, leave this section flush with cavity and core inserts and check if it affects return pins. Return pins should make contact with A-side retainer plate.
- ❖ Ensure that all slides, core pins, angle pins and guide pins are greased.
- ❖ All limit switches must be orientated properly for wiring and function.
- ❖ Verify preload of all pillars, +002 to +004, preload on return pins, +.001 to +.002 inch.
- ❖ Check hydraulic cylinders for length of stroke.
- ❖ Check if insulator plates are installed, slide locks and parting line locks work properly.
- ❖ Move ejector plate back and forth to verify that it moves freely.

- Push ejector plate forward and check if all pins, sleeves, lift cores and all other moving components spin freely.
- With ejector plate forward, push ejector blades, sleeves, lift cores and all other moving components in and out to verify correct clearance.
- Open and close mold on bench in a injection molding machine sequence to verify that the early return system functions properly. Check if slides clear ejector pins, lift cores and any other moving parts with sufficient clearance.