LANDMARK UNIVERSITY, OMU-ARAN

LECTURE NOTE: 1
COLLEGE: COLLEGE OF SCIENCE AND ENGINEERING
DEPARTMENT: MECHANICAL ENGINEERING
PROGRAMME: MECHANICAL ENGINEERING

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Course code: MCE 314
Course title: WORKSHOP PRACTICE
Credit unit: *2 UNITS.*
Course status: *compulsory*

Course Content:–

The topics in this course are: workshop safety; Workshop fitting and measurement; Sheet metal work; lathe work; Milling; Machine Shop and Metal Work Training; Plastic Technology Training; Injection moulding, rotational moulding, compression moulding; CAD and CNC machining; Hands-on-experience of students on all workshop equipment.

FITTING

1 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 equipments 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.

2 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.

- **Markeing Tools**

These are sub classified as steel rule, circumference rule, straight edge, flat steel square, bevel square, vernier protractor, combination set and surface gauge.

- **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.

- **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.

- **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. Profilo-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.

9. 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. 1(a)) and bridge type

(Fig. 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.

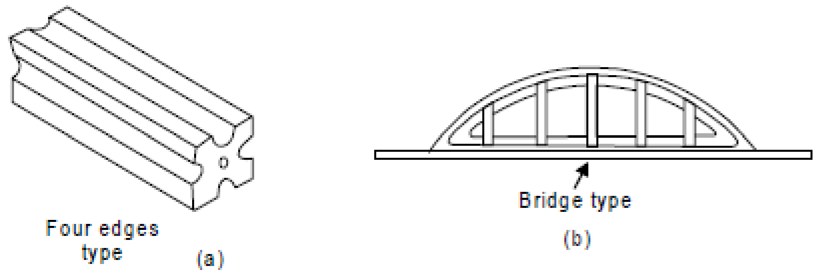

Fig. 1 Straight edges

- **Flat Steel Squrae**

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. 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.

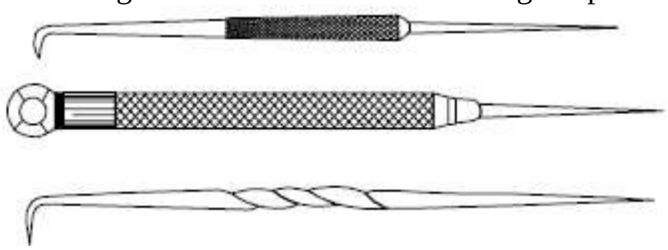

Fig. 2 Scribers

- **Bever Protractor**

The bevel protector (Fig. 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 centre 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.

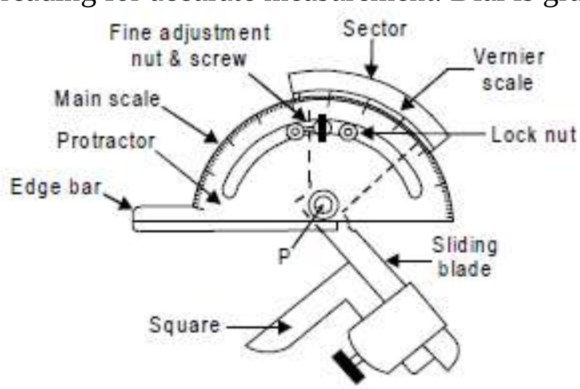

Fig. 3. Bevel protector

- **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. 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 centre punch it is kept 60 °or 90°.

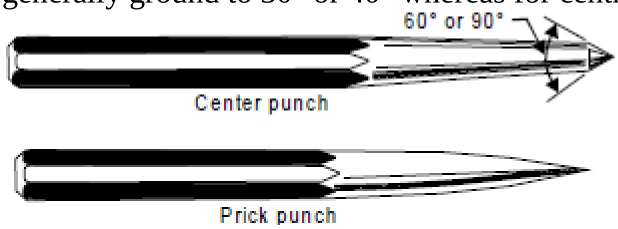

Fig. 4 Typical prick and centre punch

- **Centre Punch**

Fig. 4 shows the centre punch, which is used for locating centre for indentation mark for drilling purposes.

- **Surface Gauge or Scribing Block**

Fig. 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 fro 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 centres 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.

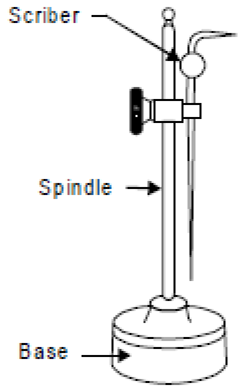

Fig. 5 A surface gauge or scribing block

- **Universal Surface Gauge**

Fig. 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.

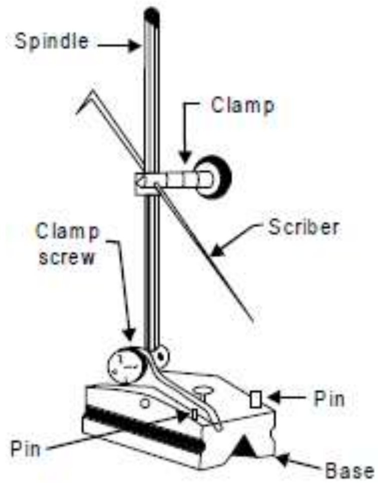

Fig. 6 A universal surface gauge

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. 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.

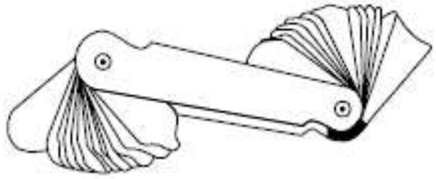

Fig. 7 A fillet and radius gauge

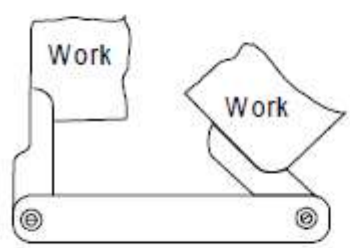

Fig. 8 A use of fillet and radius gauge

- **Screw Pitch Gauge**

Fig. 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.

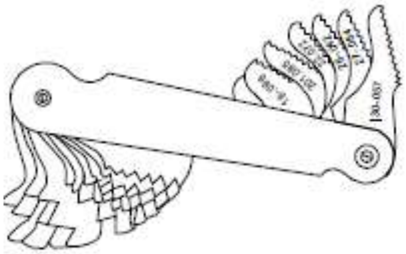

Fig. 9 A screw pitch gauge

- **Try Square**

Fig. 10 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 behandled 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.

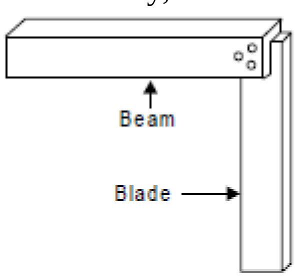

Fig. 10 A try square

- **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. 11 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

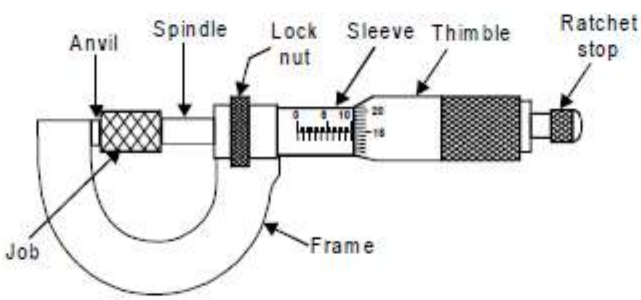

Fig. 11 Outside micrometer

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.

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 $0.5 \times 1 / 50 = 0.01$mm. Depth micrometer is used for measuring depth of holes and is shown in Fig. 12. Screw thread micrometer (Fig. 13) 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.

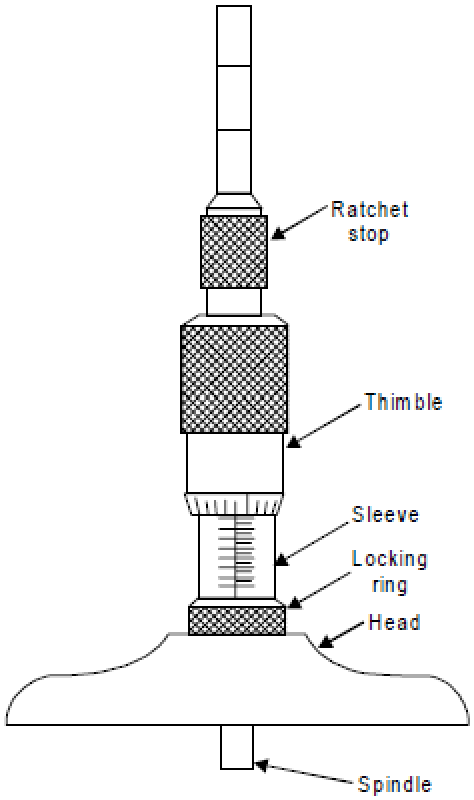

Fig. 12 A depth micrometer

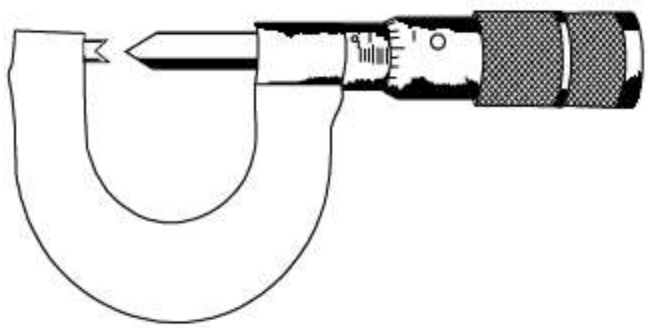

Fig. 13 A screw thread micrometer

- **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. 14 Other types of rules are described in the chapter on carpentry shop. Most of the dimensions are measured by the steel rule in workshops.

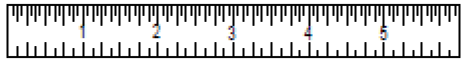

Fig. 14 A steel rule

- **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.15 shows a simple outside caliper. The caliper is held in a rule as shown in Fig. 16 to read the size. It is used to make external measurement such as thickness of plates, diameter of sphere and cylinders. Fig. 17 shows the standard spring joint outside caliper.

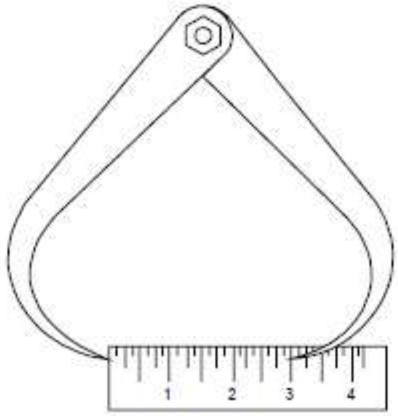

Fig. 15 A simple outside **Fig. 16** A caliper held in rule **Fig. 17** A standard spring caliper joint outside caliper

- **Vernier Caliper**

Fig. 18 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.

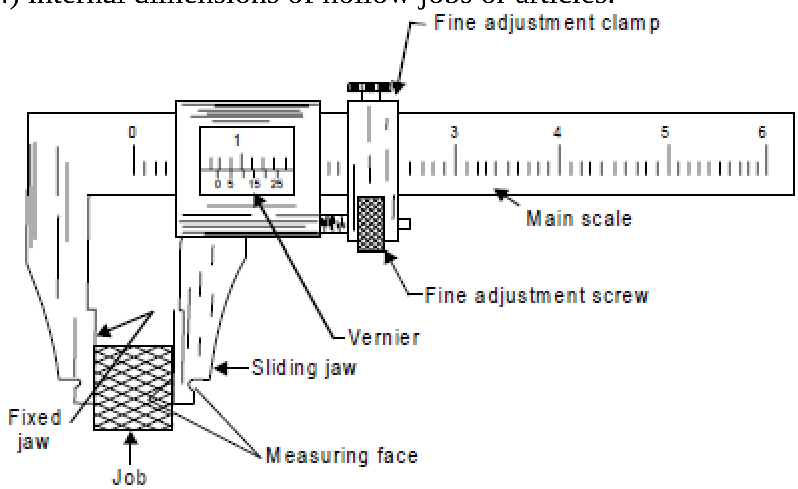

Fig. 18 A vernier caliper

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. 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. 20.

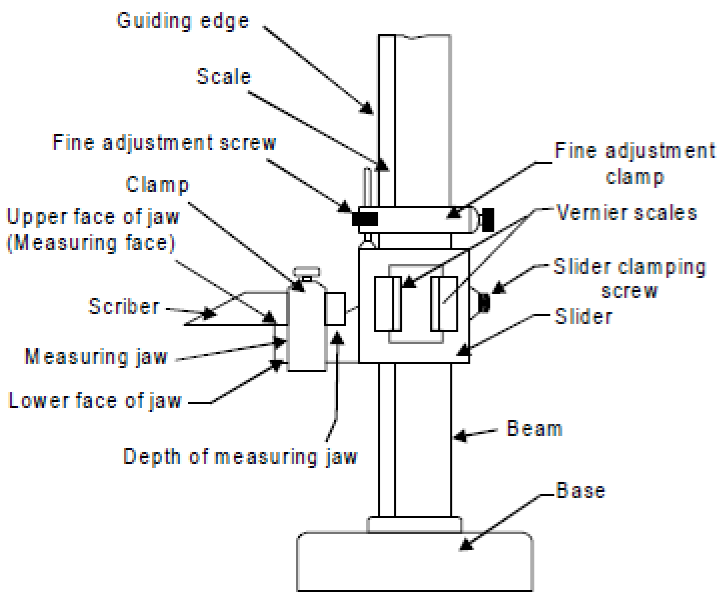

Fig. 19. A vernier height gauge

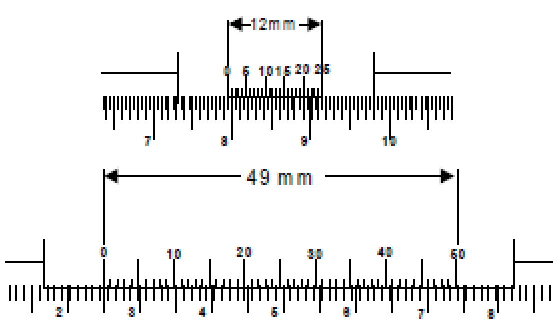

Fig. 20 A graduation on the vernier height gauge

- **Wire Guage**

The wire gauge is a flat and circular steel sheet metal piece having slots all along its periphery as shown in Fig. 21. 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.

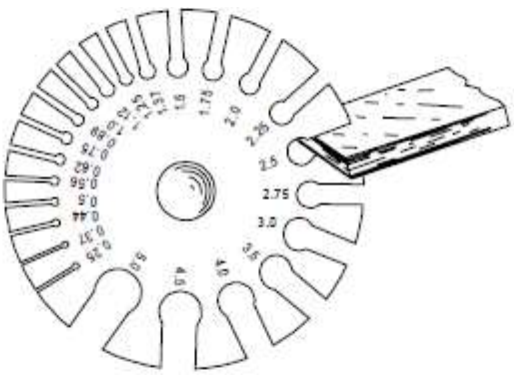

Fig. 21 A wire gauge

- **Dial Indicators**

The dial indicators are also known as dial gauges and are shown in Fig. 22 (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.

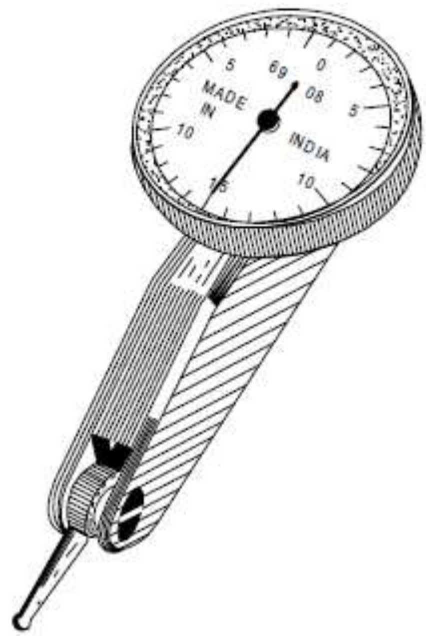

Fig. 22 (a) A continuous type dial indicator

Fig. 22 (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 centre head, and a bevel protractor and sprit level as depicted in Fig. 23. 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 centre head with the rule fastened to it is called a centre 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 centre 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 24. The protractor head may be utilized with a rule to measure angles or to measure the slope of a surface as shown in Fig. 25.

19.2.3.11 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.

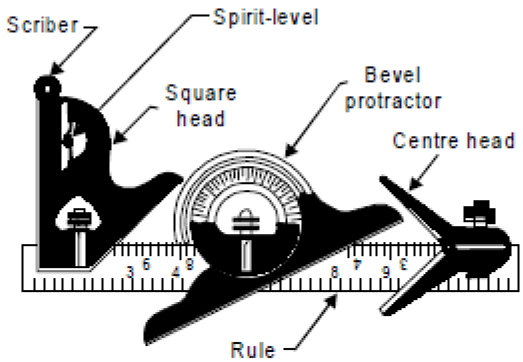

Fig. 23 A combination set

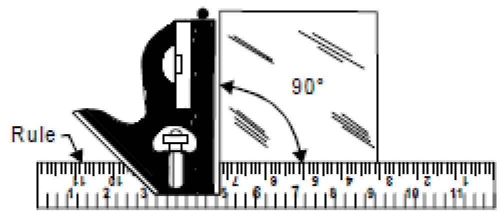

Fig. 24 Checking 90° angle using combination set

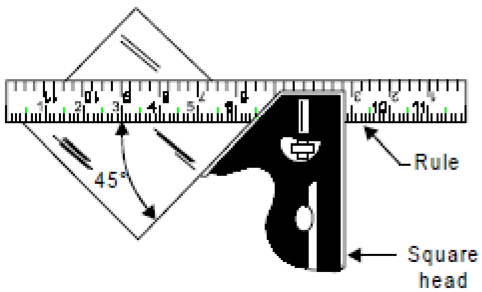

Fig. 25 Checking 45° angle using combination set

- **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. 26 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.

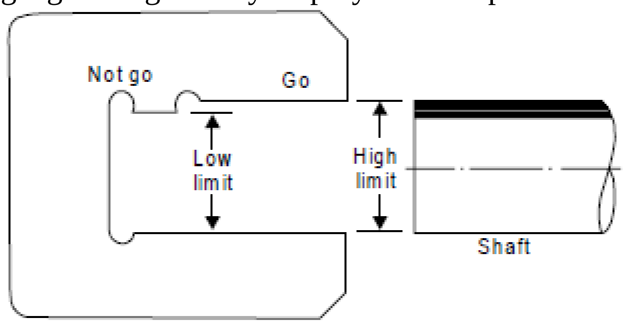

Fig. 26 A principle of limit gauge

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. 27(a))
2. Thread plug gauge (Fig. 27(b))
3. A combination of internal and external non adjustable gauges (Fig. 27(c))

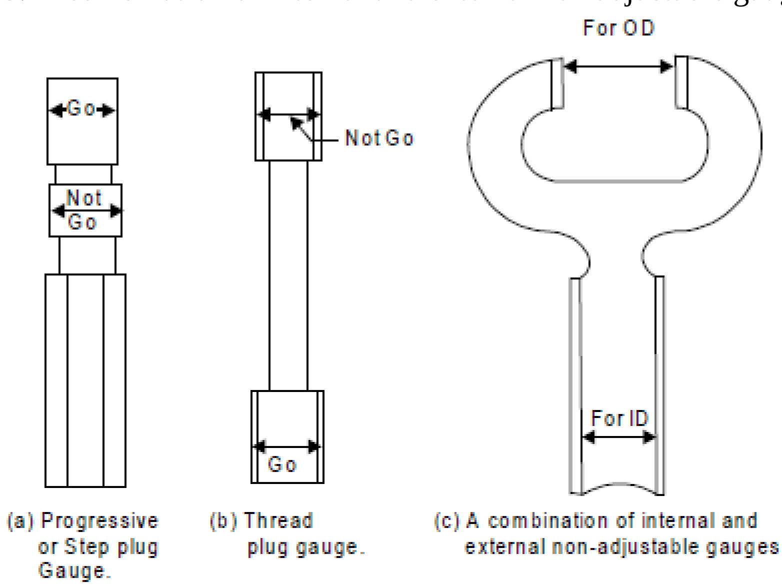

Fig. 27 Types of gauges

4. Ring gauge
5. Snap gauges (Fig. 28)

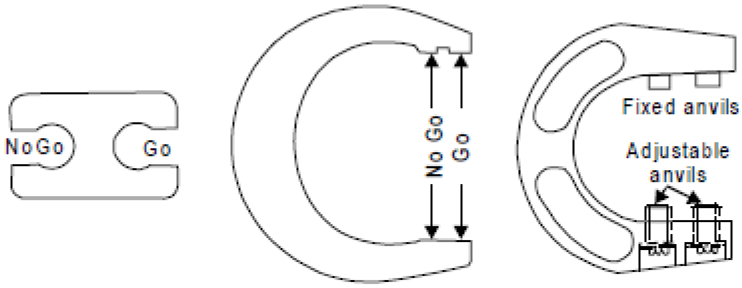

Fig. 28 Snap gauges

6. Feeler gauge (Fig. 29)

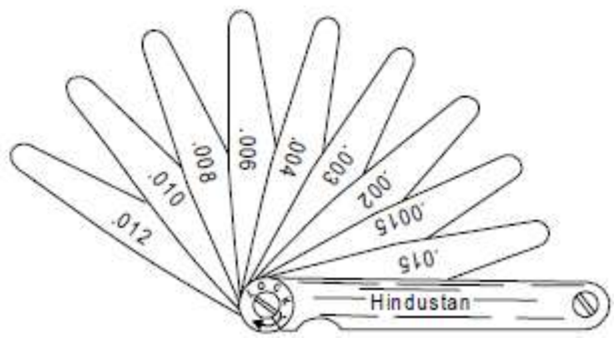

Fig. 29 A feeler gauge

7. Wire gauge
8. Template gauge
9. Adjustable gap gauge (Fig. 30)
10. Screw pitch gauge (Fig. 8)
11. Fillet and radius gauge

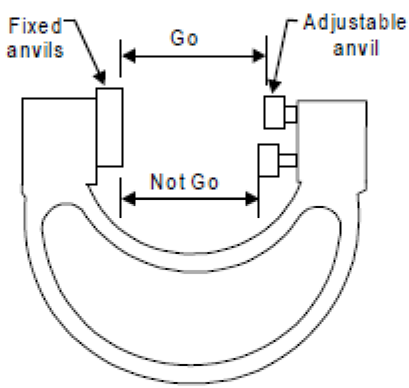

Fig. 30 An adjustable gap gauge

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.