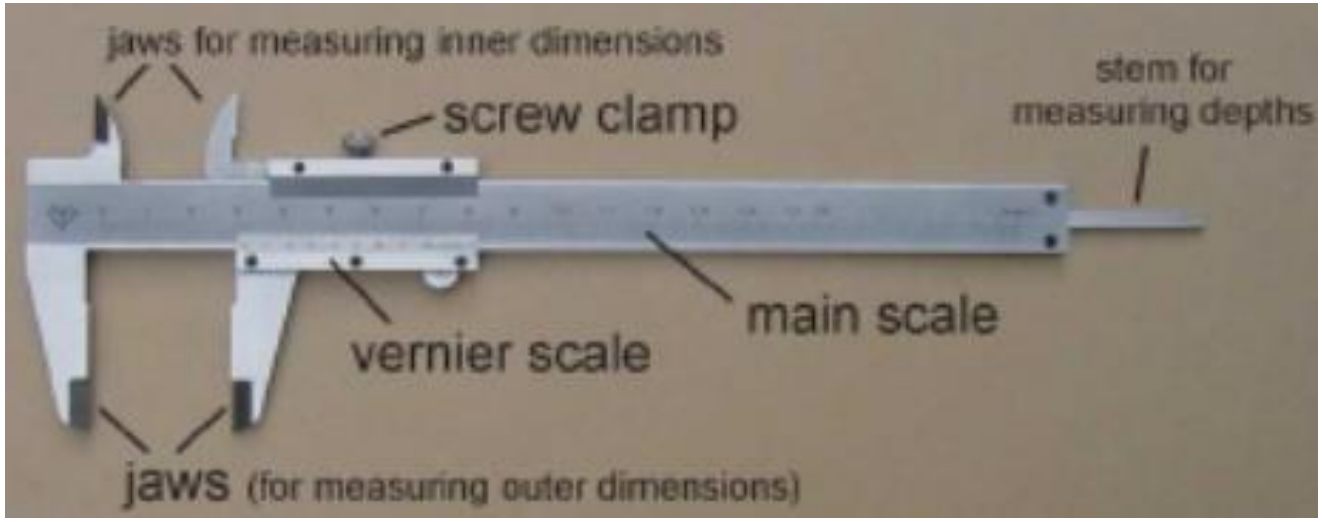
Lesson 2

Linear Measuring Instruments

Linear Measuring Instruments …

Vernier Instruments



- The principle of Vernier is that when two scales or divisions slightly different in size are used, the difference between them can be utilized to enhance the accuracy of measurement.
- The Vernier caliper essentially consists of two steel rules and these can slide along each other. One of the scales, i.e., main scale is engraved on a solid L-shaped frame. On this scale cm graduations are divided into 20 parts so that one small division equals 0.05 cm. One end of the frame contains a fixed jaw which is shaped into a contact tip at its extremity.

Linear Measuring Instruments …

Vernier height gauge (construction) …

- Vernier height gauge is similar to Vernier caliper but in this instrument the graduated bar is held in a vertical position and it is used in conjunction with a surface plate.

Construction: A vernier height gauge consists of:

- A finely ground and lapped base. The base is massive and robust in construction to ensure rigidity and stability.
- A vertical graduated beam or column supported on a massive base.
- Attached to the beam is a sliding vernier head carrying the vernier scale and a clamping screw.
- An auxiliary head which is also attached to the beam above the sliding vernier head. It has fine adjusting and clamping screw.
- A measuring jaw or a scriber attached to the front of the sliding vernier

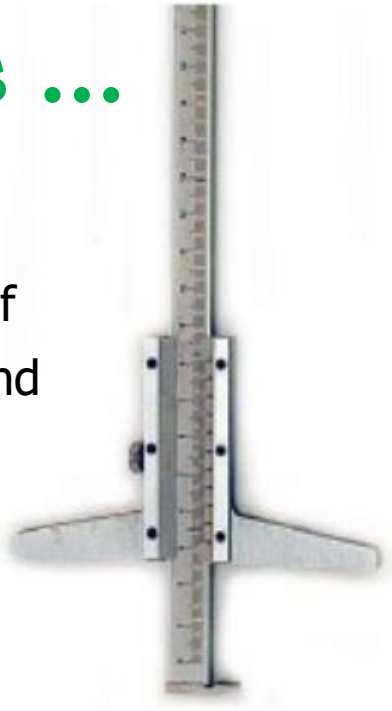
Linear Measuring Instruments …

Vernier height gauge (use)

- The Vernier height gauge is designed for accurate measurements and marking of vertical heights above a surface plate datum.
- It can also be used to measure differences in heights by taking the Vernier scale readings at each height and determining the difference by subtraction.
- It can be used for a number of applications in the tool room and inspection departments. The important features of Vernier height gauge are:
  - All the parts are made of good quality steel or stainless steel.
  - The beam should be sufficiently rigid square with the base.
  - Measuring jaw should have clear projection from the edge of the beam at least equal to the projection of the base from the beam.
  - The upper and lower gauging surfaces of the measuring jaw shall be flat and parallel to the base.
  - The scriber should also be of the same nominal depth as the measuring jaw so that it may be reversed.
  - The projection of the jaw should be at least 25 mm.
  - The slider should have a good sliding fit for all along the full working length of the beam.
  - Height gauges can be provided with dial gauges instead of vernier.

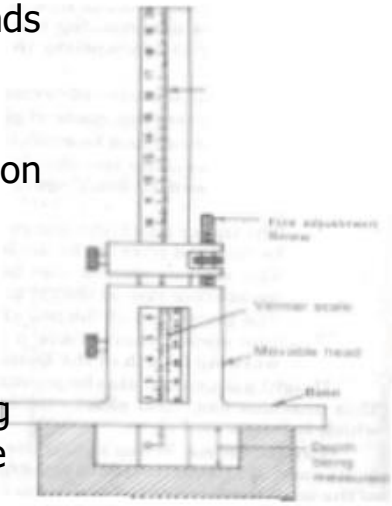
Linear Measuring Instruments …

Vernier Depth Gauge



Vernier depth gauge is used to measure the depths of holes, slots and recesses, to locate center distances etc. It consists of

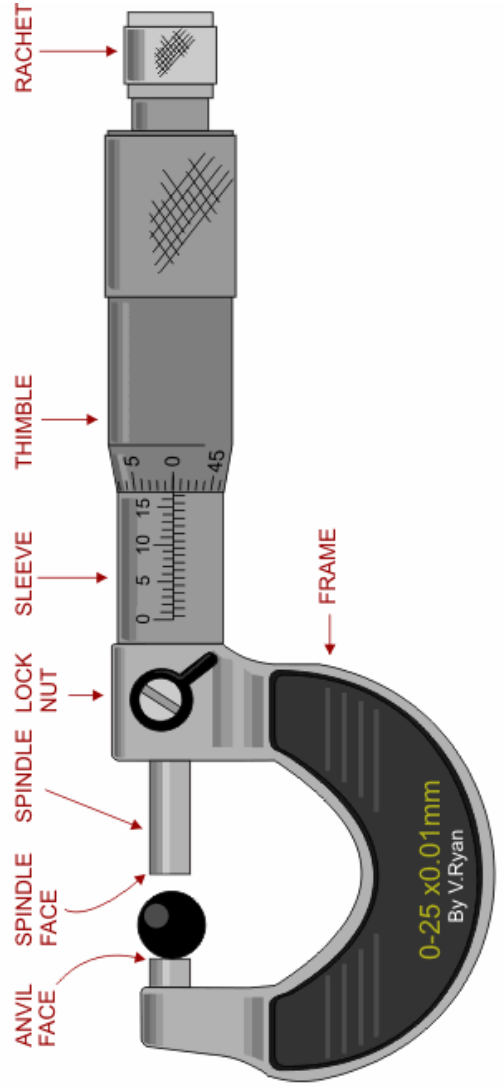
- A sliding head having flat and true base free from curves and waviness.
- A graduated beam known as main scale. The sliding head slides over the graduated beam.
- An auxiliary head with a fine adjustment and a clamping screw.
    - ✓ The beam is perpendicular to the base in both directions and its ends square and flat.
    - ✓ The end of the sliding head can be set at any point with fine adjustment mechanism locked and read from the Vernier provided on it .. the beam is lowered into the hole until it contacts the bottom surface of the hole.
    - ✓ The final adjustment depending upon the sense of correct feel is made by the fine adjustment screw. The clamping screw is then tightened and the instrument is removed from the hole and reading taken in the same way as the Vernier caliper. The reference surface should be satisfactorily true, flat arid square.



Linear Measuring Instruments …

Micrometers

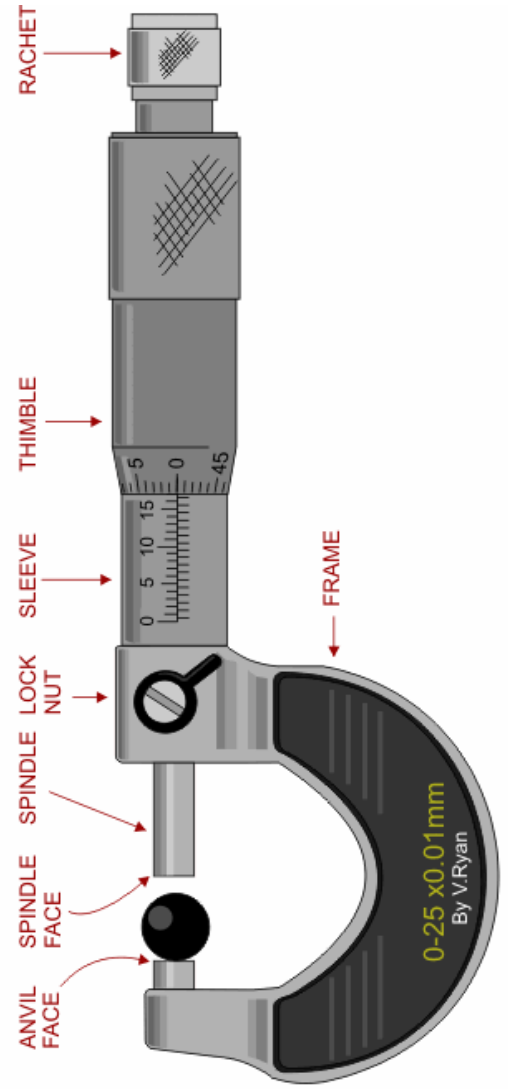
- **Micrometer calipers**. Engineers frequently rely on the micrometer caliper to obtain accurate measurements to 1/1000 of an inch or centimeter.
- Useful particularly for measuring relatively short lengths and the diameter of journals or cylinders.
- The common commercial micrometer consists of a frame; an anvil, or fixed measuring point; a spindle; a sleeve, or barrel; and a thimble. The spindle has threads cut on the portion that fits inside the sleeve.
- The thimble fits over the end of the sleeve, and rotating the thimble turns the spindle.



Linear Measuring Instruments …

Micrometers

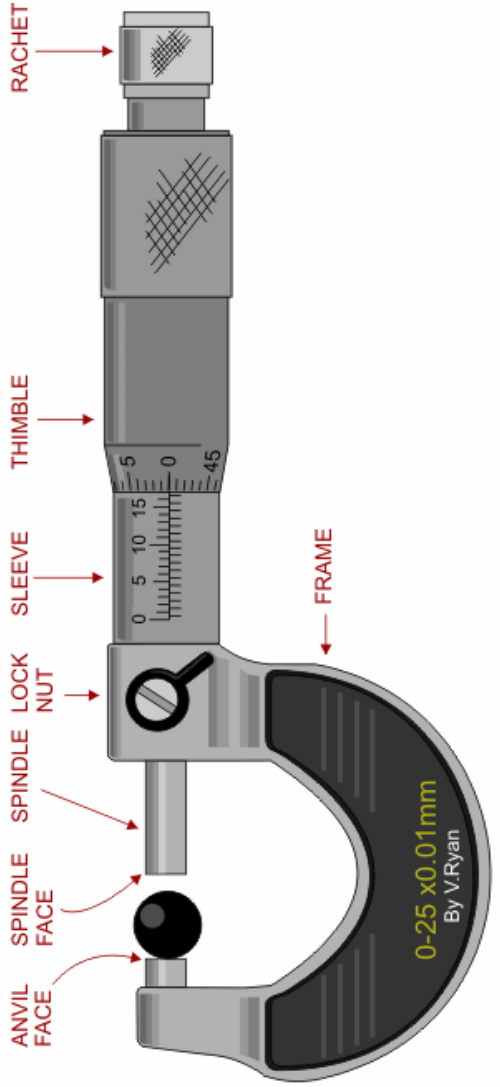
- The micrometer screw gauge consists of an accurate screw having about 10 or 20 threads per cm and revolves in a fixed nut.
- The end of the screw forms one measuring tip and the other measuring tip is constituted by a stationary anvil in the base of the frame. The screw is threaded for certain length and is plain afterwards. The plain portion is called sleeve and its end is the measuring surface.
- The spindle is advanced or retracted by turning a thimble connected to the spindle. The spindle is a slide fit over the barrel and barrel is the fixed part attached with the frame.
- The barrel is graduated in unit of e.g., 0.05 cm. i.e. 20 divisions per cm, which is the lead of the screw for one complete revolution.



Linear Measuring Instruments …

Micrometers

- The thimble has got several, e.g., 25 divisions around its periphery on circular portion. Thus it subdivides each revolution of the screw in 25 equal parts, i.e. each division corresponds to 0.002 cm. A lock nut is provided for locking a dimension by preventing motion of the spindle.
- Ratchet stop is provided at the end of the thimble cap to maintain sufficient and uniform measuring pressure so that standard conditions of measurement are attained.
- Ratchet stop consists of an overriding clutch held by a weak spring.
- When the spindle is brought into contact with the work, the clutch starts slipping and no further movement of the spindle takes place by the rotation of ratchet. In the backward movement it is positive due to shape of ratchet.

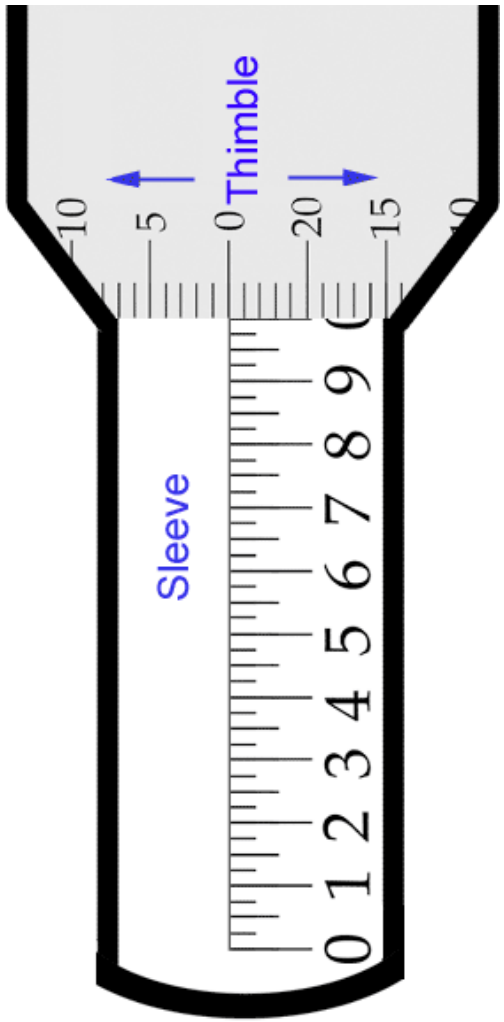


Linear Measuring Instruments …

Micrometers Reading

- The **Sleeve** does not move. It looks like a ruler with ten numbers. The space between each number is divided into quarters. As the **Thimble** rotates around this Sleeve it covers up, or reveals the numbers marked on the Sleeve.

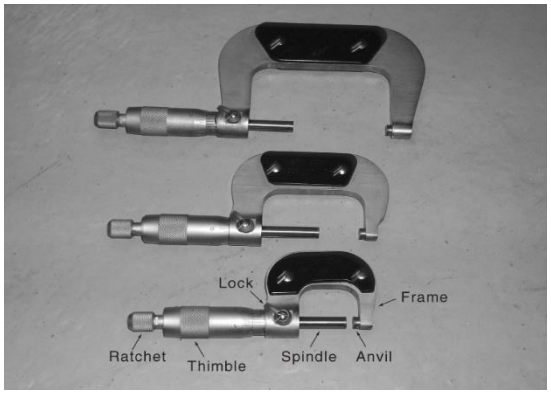
- **Sleeve**: In this case, the micrometer sleeve is divided into 10 equal parts, each of these parts is equal to .100" (1 tenth of an inch). Each of these 10 parts is divided into 4 equal parts. Each of these 4 subdivisions is equal to .025" or one 40th of an inch. More simply, the line on the sleeve marked "1" represents .100", the line marked "2" represents .200" and so forth.

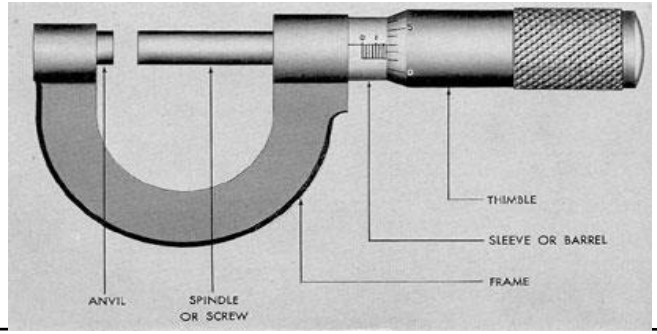


Linear Measuring Instruments …

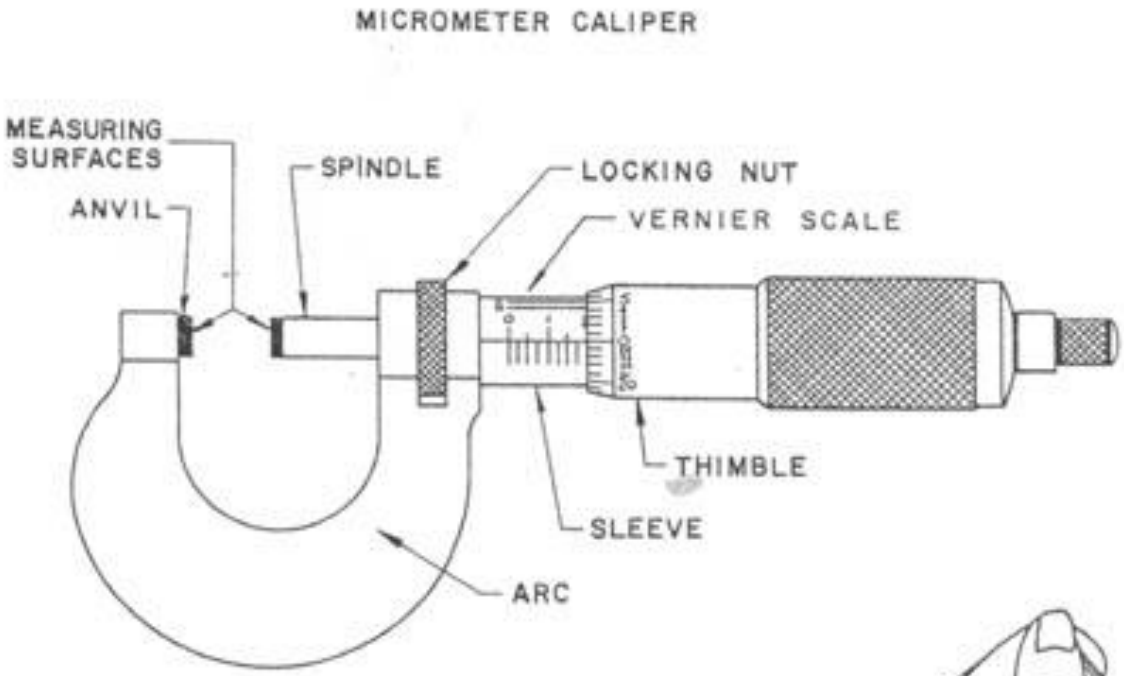
Precautions in Using Micrometers

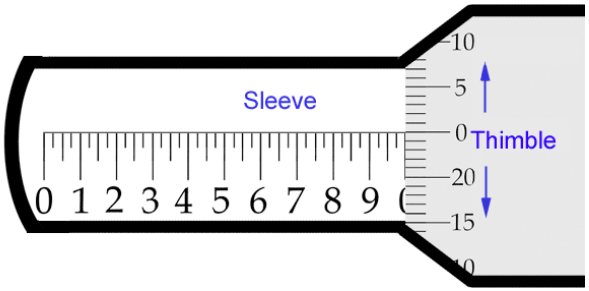
- Micrometer should be cleaned of any dust and spindle should move freely.
- The part must be held in left hand and the micrometer in right hand.
- Forefinger and thumb are placed near the thimble to rotate it and the middle finger supports the micrometer.
- The micrometer dimension is set slightly larger than the size of the part and part is slid over the contact surfaces of micrometer gently. The thimble is then turned till the measuring pressure is applied.
- For circular parts, the micrometer must be moved over representative arc so as to note max. dimension only.
- Micrometers are available in various sizes and ranges, and corresponding micrometer should be chosen depending upon the dimension.
- Errors in reading may occur due to lack of flatness of anvil, lack of parallelism of the anvils at part of scale or throughout, inaccurate setting of zero reading, etc. various tests to ensure these conditions should be carried out from time to time.





Linear Measuring Instruments …



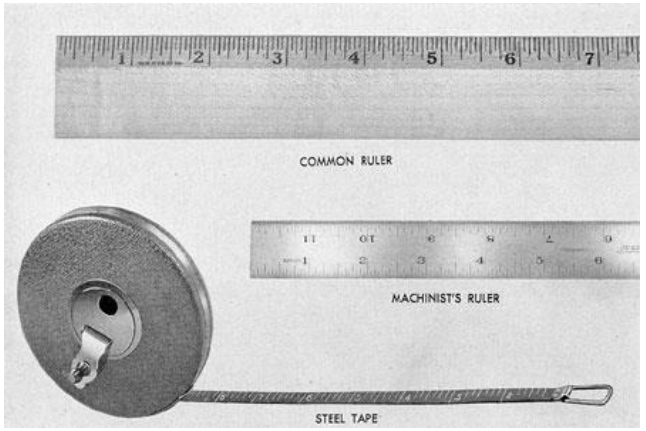


- The part must be held in left hand and the micrometer in right hand.

Linear Measuring Instruments …

Rulers and Tapes

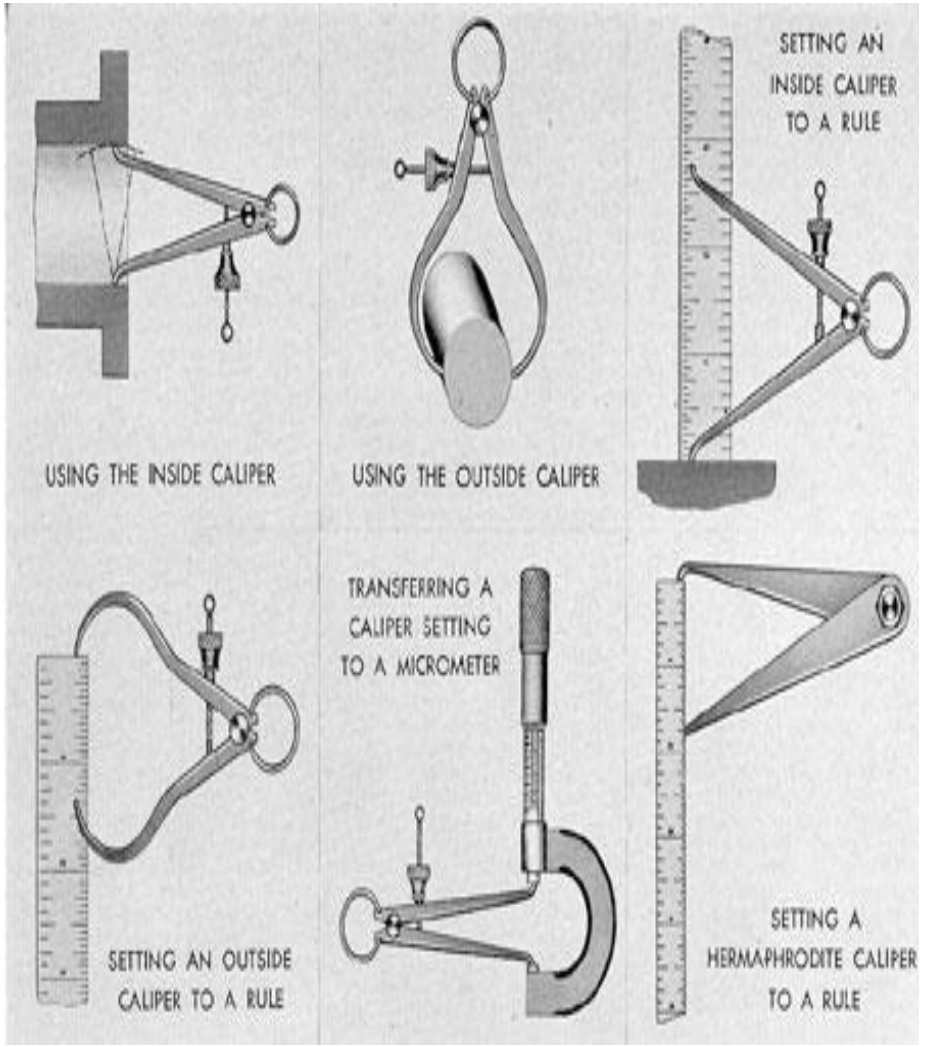
- The most common method of obtaining straight-line distances when tolerances are not a major factor.
- A ruler may be graduated into USC (i.e. feet, inches) or metric (meters, centimeters), or fractions thereof (… fractions may be graduated to subdivisions as small as 1/10 or 1/100 of an inch or cm.
- Rulers and tapes used in engineering works are most frequently made of metal, plastic or wood.
- Care should be exercised in using metal rulers and tapes, especially if extreme accuracy is required. The margin of error due to expansion or contraction of the instrument from changes in temperature can be considerable.



Linear Measuring Instruments …

Calipers

- A caliper is a device used to measure distance between opposite sides of an object (… can be as simple as a compass with inward or outward-facing points)
- Engineers and machinists frequently use calipers together with rulers or tapes to secure accurate measurements of inside and outside diameters.



Linear Measuring Instruments …

Feeler Gauges

- Precision-machined piece of metal that is flat or round
- May be USC or metric
- Used for measuring "gaps" or the space between two objects
- Proper usage requires practice
- Consists of thin blades of metal of various thicknesses (etched on the blade). There is generally a blade or strip for each of the most commonly used thicknesses (e.g., for USC units 0.002 inch, 0.010 inch, and .015 inch).

Linear Measuring Instruments …

Feeler Gauges used for

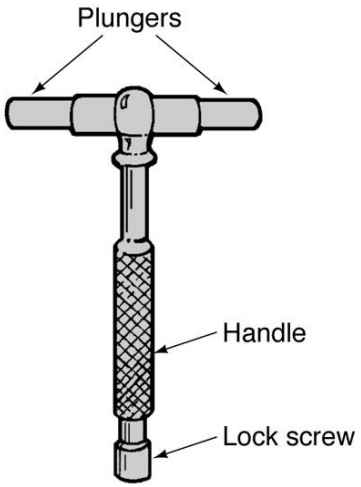
- Valve lash
- Measure spark plug gap
- Head flatness
- Thrust distance in Crankshaft
- Ignition point gap (Old Vehicles)

Linear Measuring Instruments …

- **Feeler gauges** are principally used in determining clearances between various parts of machinery.
- Probably the most common use is determining valve clearance. Various blades are inserted between the tappet and the push rod until a blade of the feeler gage is found that will just slide between the two surfaces without too much friction or sticking. The thickness of the blade then determines the clearance.
- Or, a particular feeler of proper thickness may be selected and the tappet adjusted until the feeler will just slide between the tappet and push rod with out catching.

Linear Measuring Instruments …

Telescopic Gauges



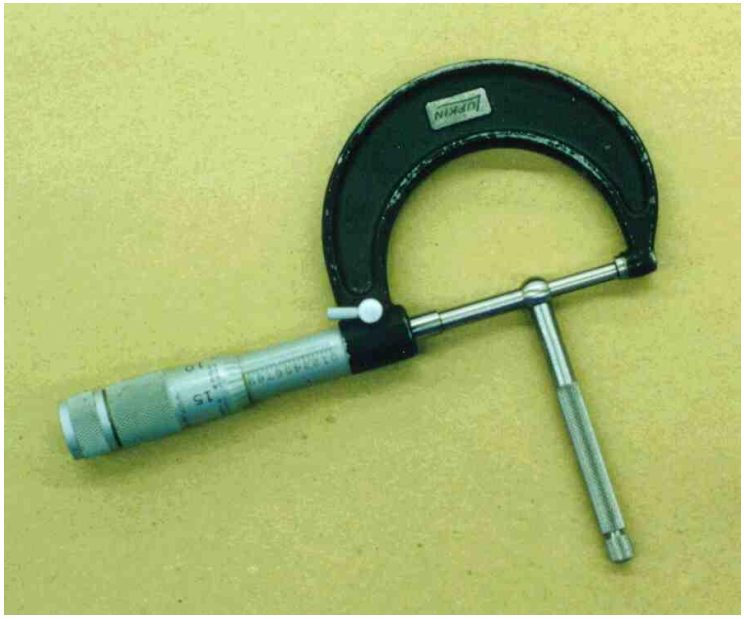
- The telescopic gauge is used for measuring internal diameter of holes, slots and grooves etc. It consists of a handle with two rods in a tube at one end and a working screw at the other end. The rods having spherical contacts can slide within a tube and are forced apart by an internal spring.

- Used with outside micrometers to measure inside diameters
- Various lengths and T-shaped
- Extensions are spring-loaded
- Leg has a rotatable handle to lock extensions in place

Linear Measuring Instruments …

Telescopic Gauges

- The locking screw can lock the rods at any desired position through a spring. While taking measurements, the rods are pressed closer and inserted into the hole to be measured. The rods then open out to touch the metal surface, of the hole on both sides. They are then locked in position by means of a locking screw.



- Once gauge is removed, measure the dimension across the tip with outside micrometer…

Linear Measuring Instruments …

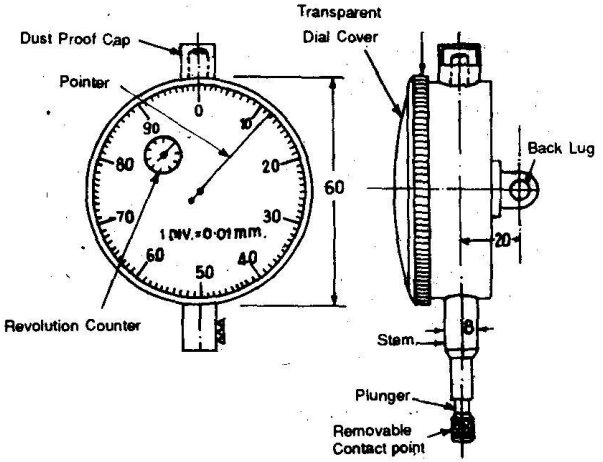
Bore Gauges

- The dial bore gauges shown in fig. are for miniature hole measurements.
- The gauge is supplied with a set of split ball measuring contact points which are hard chrome-plated to retain original spheres.
- Along with the measuring probes, setting rings are also provided to zero set the indicator whenever the probes are interchanged.

Linear Measuring Instruments …

Dial indicators

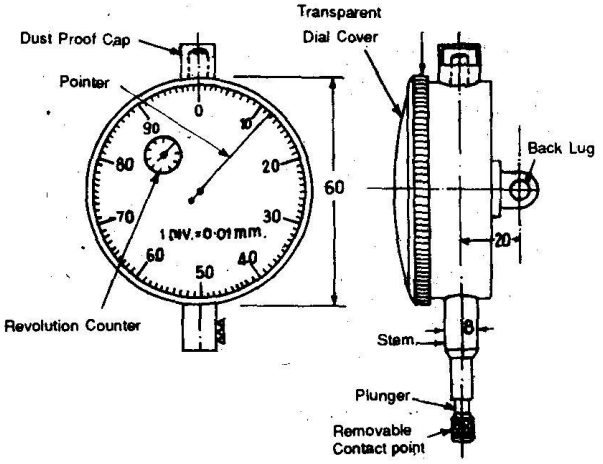
- Dial indicators are small indicating devices using mechanical means such as gears and pinions or levers for magnification system. They are basically used for making and checking linear measurements.
- Many a times they are also used as comparators. Dial indicator, in fact is a simple type of mechanical comparator.
- When a dial indicator is used as an essential part in the mechanism, any set up for comparison measurement purposes is called as a gauge.



Linear Measuring Instruments …

Dial indicators

- The dial indicator measures the displacement of its plunger or a stylus on a circular dial by means of a rotating pointer.
- Dial indicators are very sensitive and versatile instruments.
- Dial indicators require little skill in their use than other precision instruments, such as micrometer Vernier calipers, gauges etc.
- However, a dial indicator by itself is not of much unless it is properly mounted and set before using for inspection purposes.

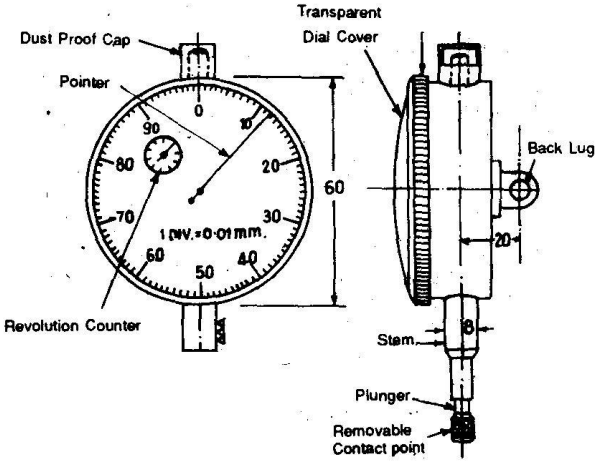


Linear Measuring Instruments …

Dial indicators Uses

By mounting a dial indicator on any suitable base and with various attachments, it can be used for variety of purposes as follows.

- Determining errors in geometrical forms, e.g., ovality out-of-roundness, taper etc.
- Determining positional errors of surfaces, e.g., in squareness, parallelism, alignment etc.
- Taking accurate measurements of deformation (extension compression) in tension and compression testing of material.
- Comparing two heights or distances between narrow limits (comparator).

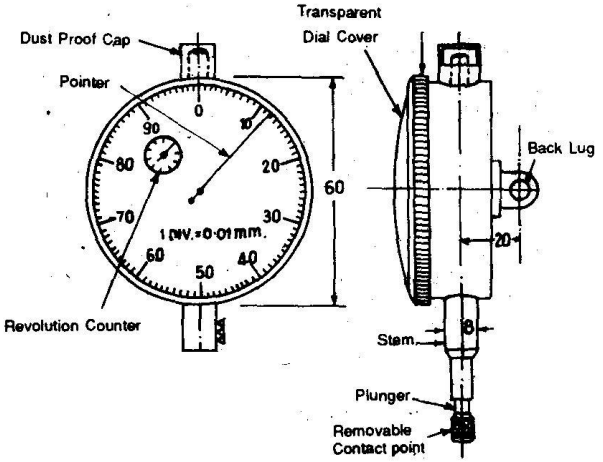


Linear Measuring Instruments …

Dial indicators Uses

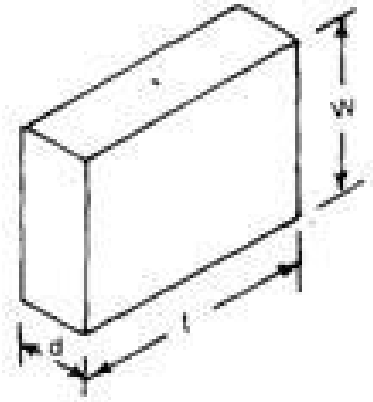
The practical applications of the use of dial indicator are:

- To check alignment e.g., of lathe centers by using a suitable accurate bar between centers.
- To check trueness e.g., of milling machine arbors.
- To check parallelism e.g., of the shaper ram with table surface or like.

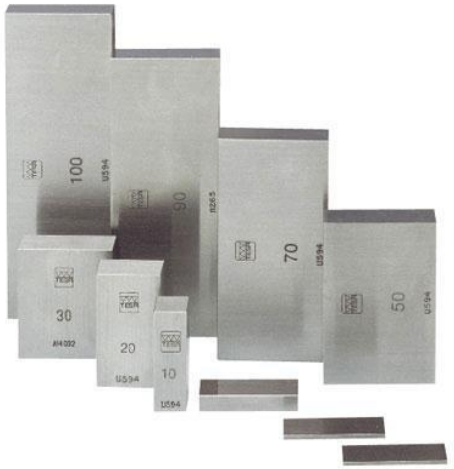


Linear Measuring Instruments …

Slip Gauges



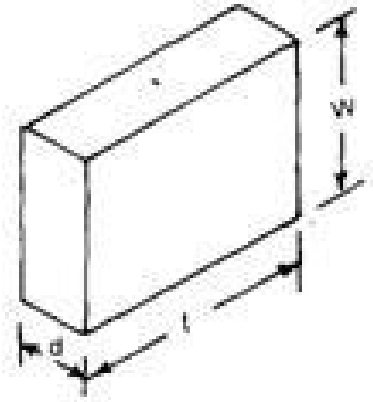
- Slip gauges or gauge blocks (a.k.a Johanson Gauges) are universally accepted standard of length
- Are rectangular, of high grade steel with exceptionally close tolerances. Are suitably hardened through out to ensure maximum resistance to wear.
- Are stabilized by heating and cooling successively in stages to remove hardening stresses. Are carefully finished by high grade lapping to a high degree of finish, flatness and accuracy.
- Their working faces are made truly flat and parallel. Slip gauges are also made from tungsten carbide which is extremely hard and wear resistance.
- The cross-sections are 9 mm x 30 mm for sizes up to 10 mm and 9 mm x 35 mm for larger sizes. Any two slips when perfectly clean may be wrung together. The dimensions are permanently marked on one of the measuring faces of gauge blocks

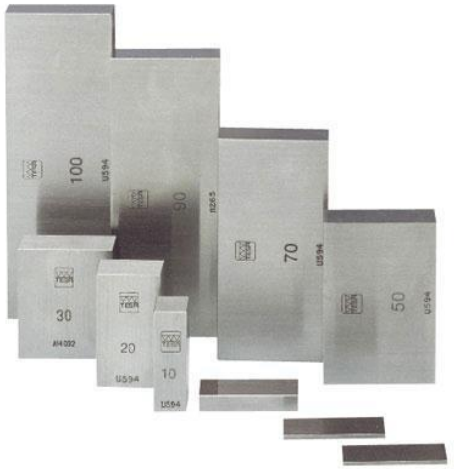


Linear Measuring Instruments …

Slip Gauge blocks are used for:

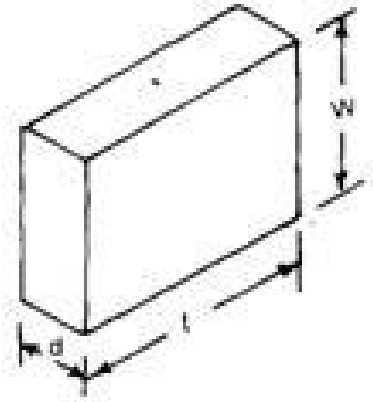
- Direct precise measurement, where the accuracy of the work piece demands it.
- For checking accuracy of Vernier calipers, micrometers, and such other measuring instruments.
- Setting up a comparator to a specific dimension.
- For measuring angle of work piece and also for angular setting in conjunction with a sine bar.
- The distances of plugs, spigots, etc. on fixture are often best measured with the slip gauges or end bars for large dimensions.
- To check gap between parallel locations such as in gap gauges or between two mating parts.



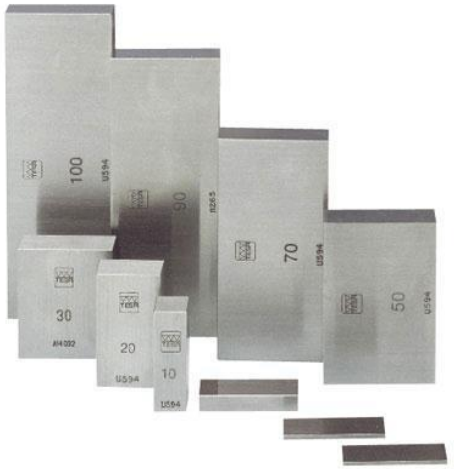


Linear Measuring Instruments …

Slip Gauge blocks



- **The requirements of gauge blocks are,**
  - The actual size must be known
  - The faces must be parallel
  - The surface must have a smooth finish
  - The surfaces must be flat



- **The materials gauge blocks are made from are selected for,** hardness, temperature stability, corrosion resistance, and high quality finish.

End...