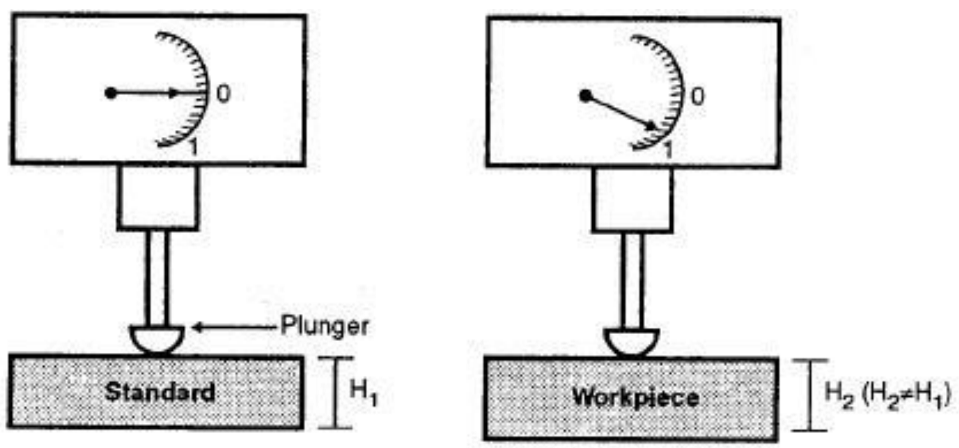
Comparators

Comparators can give precision measurements, with consistent accuracy by eliminating human error. They are employed to find out, by how much the dimensions of the given component differ from that of a known datum. If the indicated difference is small, a suitable magnification device is selected to obtain the desired accuracy of measurements. It is an indirect type of instrument and used for linear measurement. If the dimension measured, is lesser or greater than the standard, then the difference will be shown on the dial. It gives only the difference between actual and standard dimension of the workpiece. To compare the height of the job H2 with the standard job of height H1.



(a) (b)

Initially, the comparator is adjusted to zero on its dial with a standard job in position as shown in Figure (a). The reading H1 is taken with the help of a plunger. Then the standard job is replaced by the work-piece to be checked and the reading H2 is taken. If H1and H2 is different, then the change i~ the dimension will be shown on the dial of the comparator. Thus difference is then magnified 1000 to 3000 X to get the clear variation in the standard and actual job. In short, Comparator is a device which

(1) Picks up small variations in dimensions.
(2) Magnifies it.
(3) Displays it by using indicating devices, by which comparison can be made with some standard value.

Classification:

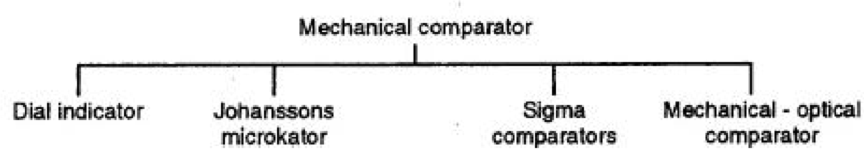
1. Mechanical Comparator: It works on gears pinions, linkages, levers, springs etc.
2. Pneumatic Comparator: Pneumatic comparator works by using high pressure air, valves, back pressure etc.
3. Optical Comparator: Optical comparator works by using lens, mirrors, light source etc.
4. Electrical Comparator: Works by using step up, step down transformers.
5. Electronic Comparator: It works by using amplifier, digital signal etc.
6. Combined Comparator: The combination of any two of the above types can give the best result.

Characteristics of Good Comparators:

1. It should be compact.
2. It should be easy to handle.
3. It should give quick response or quick result.
4. It should be reliable, while in use.
5. There should be no effects of environment on the comparator.
6. Its weight must be less.
7. It must be cheaper.
8. It must be easily available in the market.
9. It should be sensitive as per the requirement.
10. The design should be robust.
11. It should be linear in scale so that it is easy to read and get uniform response.
12. It should have less maintenance.
13. It should have hard contact point, with long life.
14. It should be free from backlash and wear.

Mechanical Comparator:

It is self controlled and no power or any other form of energy is required. It employs mechanical means for magnifying the small movement of the measuring stylus. The movement is due to the difference between the standard and the actual dimension being checked



The method for magnifying the small stylus movement in all the mechanical comparators is by means of levers, gear trains or combination of these. They are available of different make and each has it's own characteristic. The various types of mechanical comparators are dial indicator, rack and pinion, sigma comparator, Johansson mikrokator.

Johansson Mikrokator:

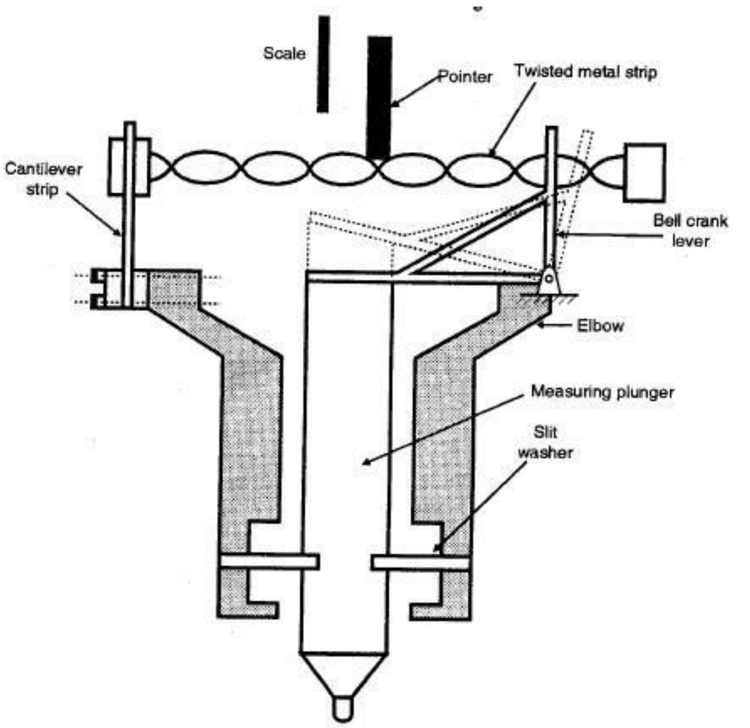
This comparator was developed by C.F. Johansson.

Principle:

It works on the principle of a Button spring, spinning on a loop of string like in the case of Children’s toys.

Construction:

The method of mechanical magnification is shown in Figure. It employs a twisted metal strip. Any pull on the strip causes the centre of the strip to rotate. A very light pointer made of glass tube is attached to the centre of the twisted metal strip. The measuring plunger is on the slit washer and transmits its motion through the bell crank lever to the twisted metal strip. The other end of the twisted metal strip is fastened to the cantilever strip. The overhanging length of the cantilever strip can be varied to adjust the magnification of the instrument. The longer the length of the cantilever, the more it will deflect under the pull of the twisted metal strip and less rotation of the pointer is obtained.



When the plunger moves by a small distance in upward direction the bell crank lever turns to the right hand side. This exerts a force on the twisted strip and it causes a change in its length by making it further twist or untwist. Hence the pointer at the centre rotates by some amount. Magnification up to 5000X can be obtained by this comparator

Advantages of Mechanical Comparator:

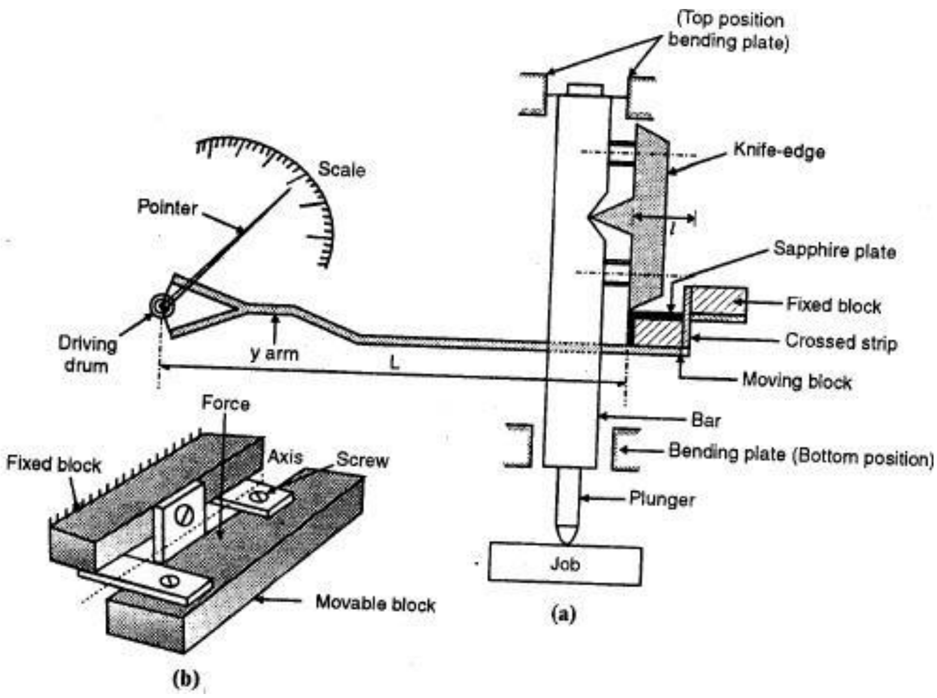
1. They do not require any external source of energy.
2. These are cheaper and portable.
3. These are of robust construction and compact design.
4. The simple linear scales are easy to read.
5. These are unaffected by variations due to external source of energy such air, electricity etc.

Disadvantages:

1. Range is limited as the pointer moves over a fixed scale.
2. Pointer scale system used can cause parallax error.
3. There are number of moving parts which create problems due to friction, and ultimately the accuracy is less.
4. The instrument may become sensitive to vibration due to high inertia.

Sigma Comparator:

The plunger is attached to a bar which is supported between the bending plates at the top and bottom portion as shown in Figure (a)



The bar is restricted to move in the vertical direction. A knife edge is fixed to the bar. The knife edge is attached to the sapphire plate which is attached to the moving block. The knife edge extorts a force on the moving block through sapphire plate. Moving block is attached to the fixed block with the help of crossed strips as shown in Figure (b). When the force is applied on the moving block, it will give an angular deflection. A Y-arm which is attached to the moving block transmits the rotary motion to the driving drum of radius r. This deflects the pointer and then the reading is noted.

If l = Distance from hinge pivot to the knife
edge L = Length of y-arm
R = Driving drum radius
D Length of the pointer
Then the total magnification = (L/l) *(D/R)

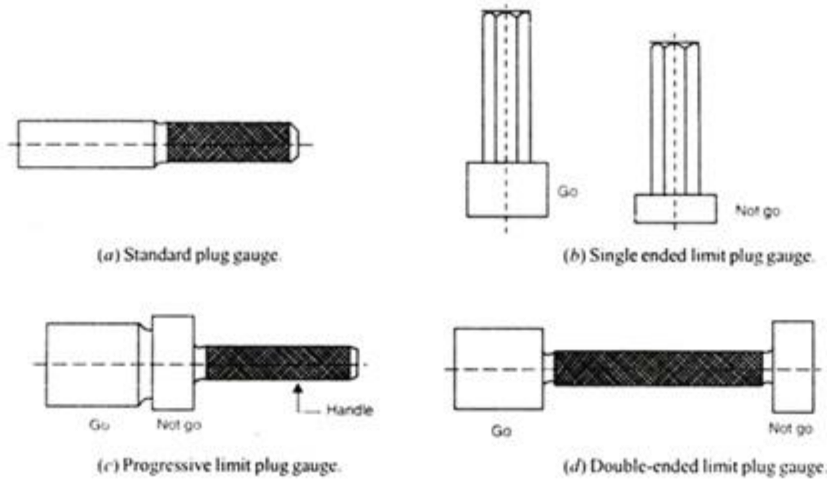
Types of Limit Gauges

The types are: 1. Plug Gauge, 2. Pin Gauge, 3. Snap Gauge, 4. Ring Gauge, 5. Calliper Gauge,

6. Thickness or Feeler Gauge, 7. Radius or Fillet Gauge and 8. Screw Pitch Gauge.

1. Plug Gauge:

A plug gauge is a cylindrical type of gauge, used to check the accuracy of holes. The plug gauge checks whether the whole diameter is within specified tolerance or not. The ‘Go’ plug gauge is the size of the low limit of the hole while the ‘Not-Go’ plug gauge corresponds to the high limit of the hole.

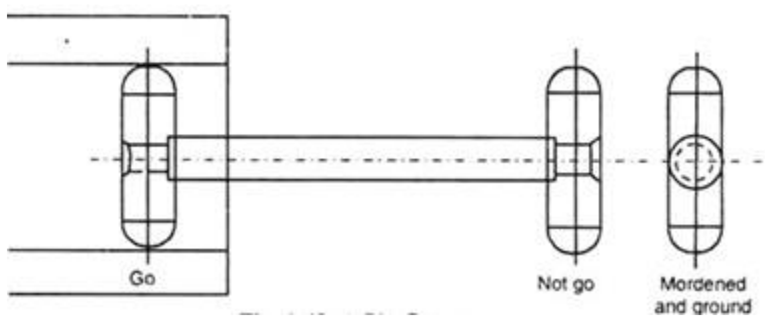


(a) Standard plug gauge. (b) Single ended limit plug gauge. (c) Progressive limit plug gauge. (d) Double-ended limit plug gauge.

It should engage the hole to be checked without using pressure and should be able to stand in the hole without falling.

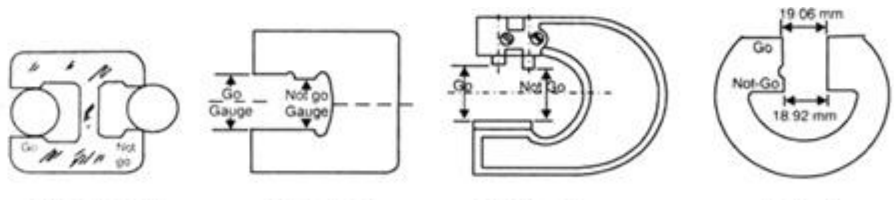
2. Pin Gauge:

When the holes to be checked are large than 75mm, such as automobile cylinder, it is convenient to use a pin gauge as shown in Figure. During measurement, the gauge is placed lengthwise across the cylinder bore and measurement is made. These gauges are especially useful in measurement of width of grooves or slots.



3. Snap Gauge:

A snap gauge is a U-Shaped frame having jaws, used to check the accuracy of shafts and male members. The snap gauge checks whether the shaft diameter is within specified tolerances or not. The ‘Go’ snap gauge is the size of the high (maximum) limit of the shaft while the ‘Not-Go’ snap gauge corresponds to the low (minimum) limit of the shaft. Snap gauges are available in different designs. Snap gauge may be single ended or double ended. Snap gauge may have fixed or adjustable jaws. Generally Go and Not-Go both the features are provided in a single jaw. Snap gauges are light in weight, easy to operate, sufficiently rigid, and is designed to permit interchangeability of many parts. These are available in the size of 150-600 mm with tubular frames.



(a) Double-ended. (b) Combined. (c) Adjustable gap. (d) Fixed.

4. Ring Gauge:

A ring gauge is in the form of a ring, used to check the shafts and male members. The "Go' and 'Not Go' members may be separate or in a single ring. The opening or hole in the Go gauge is larger than that in the Not-Go gauge.

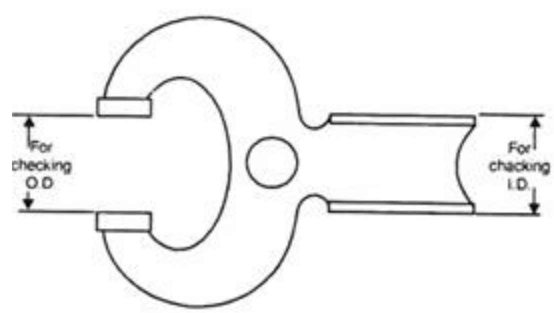
(a) (b)

Ring gauges are of three types:

(a) Plain ring gauge, (b) Taper ring gauge, and (c) Thread ring gauge.

5. Calliper Gauge:

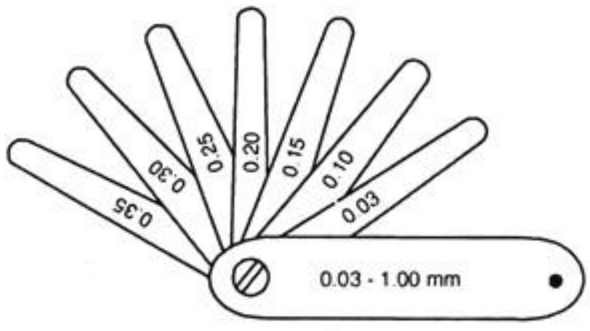
A calliper gauge is similar to a snap gauge, but it is used to check both the inside and outside dimensions. It's one end check the inside dimensions (hole diameter) while it's another end checks outside dimensions (shaft diameter).



6. Thickness or Feeler Gauge:

Thickness or feeler gauge is frequently used to measure clearances between components. These gauges are ideal for measuring narrow slots, clearances, setting small gap, and determining fit between mating parts. An important application of feeler gauge is for adjusting the spark gap between the distributer points of an automobile. A feeler gauge consists of a set of narrow strips or blades of sheet to a thickness marked on each strip. The complete set consists of a number of strips of different thickness assembled together as shown in figure. The width of each strip is generally available to 12.5mm.

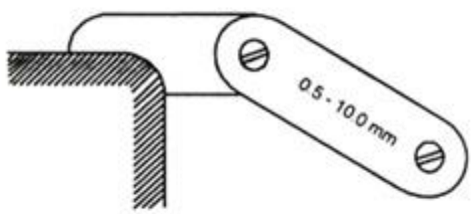
During use, it is essential that the blades should neither be forced nor slide freely between the mating parts. The standard has recommended seven sets of feeler gauges of different number of blades. A typical eight blade set of feeler gauge is shown in Figure.



7. Radius or Fillet Gauge: Radius gauge are supplied in sets, are used:
(a) To check concave and convex radii on corners or shoulders.

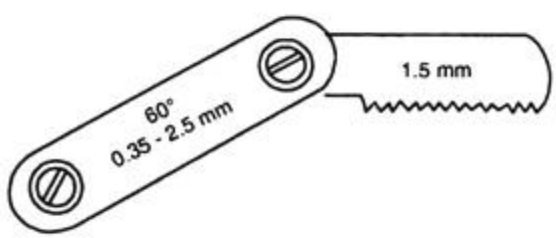
(b) For layout work and inspection of components.

(c) As a template when grinding of cutting tools.



8. Screw Pitch Gauge:

A screw pitch gauge is also called thread gauge is looks similar to that of a feeler gauge. Each strip or blade has several teeth, which are accurately shaped to the standard thread form. These are used for checking the pitch of a screw thread. They are available with 55° and 60° included thread angles. They are also available in metric and inch pitches.



TAYLOR’ S PRINCIPLE

It states that GO gauge should check all related dimensions. Simultaneously NOGO gauge should check only one dimension at a time.

Maximum metal condition

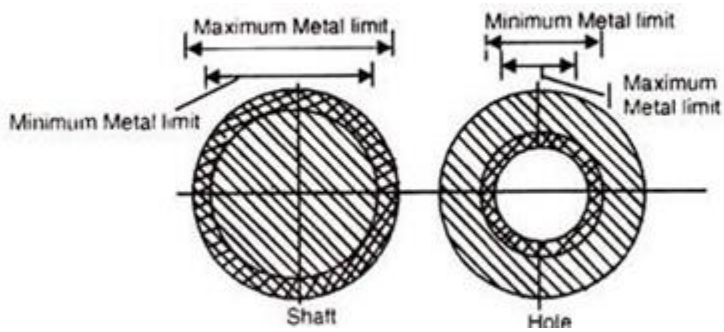
It refers to the condition of hole or shaft when maximum material is left on i.e. high limit of shaft and low limit of hole.

Minimum metal condition

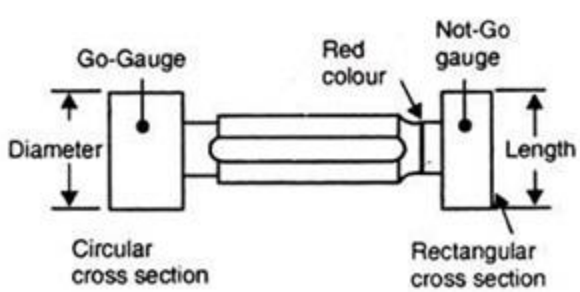
If refers to the condition of hole or shaft when minimum material is left on such as low limit of shaft and high limit of hole.

The Taylor’s Principle of gauge design gives two statements which are discussed here:

Statement 1:
The “Go” gauge should always be so designed that it will cover the maximum metal condition (MMC), whereas a “NOT-GO” gauge will cover the minimum (least) metal condition (LMC) of a feature, whether external or internal.



Statement 2:
The “Go” gauge should always be so designed that it will cover as many dimensions as possible in a single operation, whereas the “NOT-GO” gauge will cover only one dimension. Means a Go plug gauge should have a full circular section and be of full length of the hole being checked as in shown figure.



According to the first statements let us take examples of a bearing (hole) and a shaft whose dimensions are to be controlled.

Example 1: For Bearing (Hole):

Dimensions of bearing to be controlled $= 38.00^{+0.70}_{-0.00}$

High limit of hole = 38.70 mm tow limit of hole = 38.00 mm

Maximum Metal Limit of hole (Low limit of hole) = 38.00 mm "Go" gauge dimension become = 38.00 mm Minimum Metal Limit of hole (high limit of hole) = 38.70 mm "Not -Go" gauge dimension become = 38.70 mm

For the bearing (hole) to be within 38.00Sqq mm the Go-gauge should enter and NOT-GO gauge should refuse to enter. If the GO-gauge does not enter, the hole is smaller in dimension and if the NOT-GO gauge also goes in the hole, then the hole is bigger in dimension.

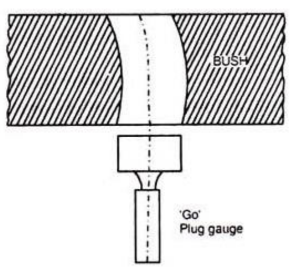
Example 2: For a shaft:

Dimensions of shaft to be controlled $38.00^{+0.20}_{-0.04}$mm High limit of shaft $=$ 37.98mm Low limit of shaft $=$ 37.96 mm

Maximum Metal and Limit of shaft (high limit of shaft) = 37.98 mm "GO" gauge dimension become = 37.98mm Minimum Metal Limit of shaft (low limit of shaft) = 37.96 mm "NOT-GO" gauge dimension become = 37.96mm.

For the shaft to be within $38.00^{-0.020}_{-0.04}$ mm the Go-gauge should slide over and NOT-GO gauge should not slide over the shaft. Is the GO-gauge does not go (slide) then the shaft is bigger in dimension and if NOT-GO gauge slide over the shaft, then the shaft size is smaller in dimension.

According to the second statement, Let us take an example of checking of a bush (hole), as shown in Fig



Example 3:

If a short length Go-plug gauge is employed to check the curved bush, it will pass through all the curves of the bend busing. This will lead to wrong selection of curved bush.

On the other hand, a GO-plug gauge of adequate length will not pass through a bent or curved bush. This eliminates the wrong selection. The length of NOT-GO gauge is kept smaller than GO-gauge.