
UNIT 4 LIMIT GAUGING

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4.1 INTRODUCTION

Gauging, done in manufacturing processes, refers to the method by which it is determined quickly whether or not the dimensions of the checking parts in production, are within their specified limits. It is done with the help of some tools called gauges. A gauge does not reveal the actual size of dimension.

A clear distinction between measuring instruments and gauges is not always observed. Some tools that are called gauges are used largely for measuring or layout work. Even some are used principally for gauging give definite measurement.

High carbon and alloy steels have been the principal material used for many years. Objections to steel gauges are that they are subjected to some distortion because of the heat-treating operations and that their surface hardness is limited. These objections are largely overcome by the use of chrome plating or cemented carbides as the surface material. Some gauges are made entirely of cemented carbides or they have cemented carbides inserted at certain wear points.

Objectives

After studying this unit, you should be able to

- understand the fundamental of the gauges and their classifications, and
- explain the working principles of various types of gauges and their applications.

4.2 GAUGES AND THEIR CLASSIFICATIONS

Gauges are the tools which are used for checking the size, shape and relative positions of various parts but not provided with graduated adjustable members. Gauges are, therefore, understood to be single-size fixed-type measuring tools.

Classifications of Gauges

- (a) Based on the standard and limit
 - (i) Standard gauges
 - (ii) Limit gauges or “go” and “not go” gauges
- (b) Based on the consistency in manufacturing and inspection
 - (i) Working gauges
 - (ii) Inspection gauges
 - (iii) Reference or master gauges
- (c) Depending on the elements to be checked
 - (i) Gauges for checking holes
 - (ii) Gauges for checking shafts
 - (iii) Gauges for checking tapers
 - (iv) Gauges for checking threads
 - (v) Gauges for checking forms
- (d) According to the shape or purpose for which each is used
 - (i) Plug
 - (ii) Ring
 - (iii) Snap
 - (iv) Taper
 - (v) Thread
 - (vi) Form
 - (vii) Thickness
 - (viii) Indicating
 - (ix) Air-operated

4.2.1 Standard Gauges

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. A standard gauge should mate with some snugness.

4.2.2 Limit Gauges

These are also called ‘go’ and ‘no go’ gauges. These are made to the limit sizes of the work to be measured. One of the sides or ends of the gauge is made to correspond to maximum and the other end to the minimum permissible size. The function of limit gauges is to determine whether the actual dimensions of the work are within or outside the specified limits. A limit gauge may be either double end or progressive. A double end gauge has the ‘go’ member at one end and ‘no go’ member at the other end. The ‘go’ member must pass into or over an acceptable piece but the ‘no go’ member should not. The progressive gauge has ‘no go’ members next to each other and is applied to a workpiece with one movement. Some gauges are fixed for only one set of limits and are said to be solid gauges. Others are adjustable for various ranges.

4.3 WORKING GAUGES, INSPECTION GAUGES AND REFERENCE GAUGES

To promote consistency in manufacturing and inspection, gauges may be classified as working, inspection, and reference or master gauges :

Working Gauges

Working gauges are those used at the bench or machine in gauging the work as it being made.

Inspection Gauges

These gauges are used by the inspection personnel to inspect manufactured parts when finished.

Reference Gauges

These are also called master gauges. These are used only for checking the size or condition of other gauges and represent as exactly as possible the physical dimensions of the product.

4.4 GAUGES FOR CHECKING ELEMENTS

Hole Gauge

It is used to check the dimensions of the hole present in the element.

Shaft Gauge

It is used to check the dimensions of the shaft.

Taper Gauge

It is used to check the dimensions of the tapers.

Thread Gauge

It is used to check the threading of the element.

Form Gauge

It is used to check the forms of the elements.

4.5 GAUGES COMMONLY USED IN PRODUCTION WORK

Some of the important gauges which are commonly used in production work have been discussed as follows :

4.5.1 Plug Gauges

These gauges are used for checking holes of many different shapes and sizes. There are plug gauges for straight cylindrical holes, tapered, threaded square and splined holes. Figure 4.1 shows a standard plug gauge used to test the nominal size of a cylindrical hole. Figure 4.2 shows a double-ended limit plug gauge used to test the limits of size. At one end, it has a plug minimum limit size, the 'go' end and; at the other end a plug of maximum limit, the 'no go' end. These ends are detachable from the handle so that they may be renewed separately when worn in a progressive limit plug gauge. The 'go' and 'no go' section of the gauge are on the same end of the handle. Large holes are gauged with annular plug gauges, which are shell-constructed for light weight, and flat plug gauges, made in the form of diametrical sections of cylinders.

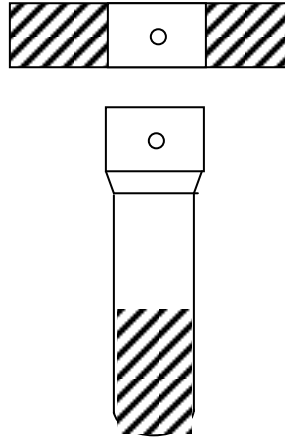


Figure 4.1 : Standard Ring and Plug Gauges

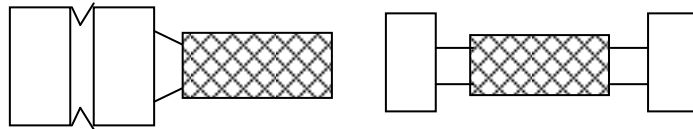


Figure 4.2 : Progressive and Double Ended Limit Plug Gauges

4.5.2 Ring Gauges

Ring gauges are used to test external diameters. They allow shafts to be checked more accurately since they embrace the whole of their surface. Ring gauges, however, are expensive to manufacture and, therefore, find limited use. Moreover, ring gauges are not suitable for measuring journals in the middle sections of shafts. A common type of standard ring gauge is shown in Figure 4.1. In a limit ring gauge, the 'go' and 'no go' ends are identified by an annular groove on the periphery. About 35 mm all gauges are flanged to reduce weight and facilitate handling.

4.5.3 Taper Gauges

The most satisfactory method of testing a taper is to use taper gauges. They are also used to gauge the diameter of the taper at some point. Taper gauges are made in both the plug and ring styles and, in general, follow the same standard construction as plug and ring gauges. A taper plug and ring gauge is shown in Figure 4.3.

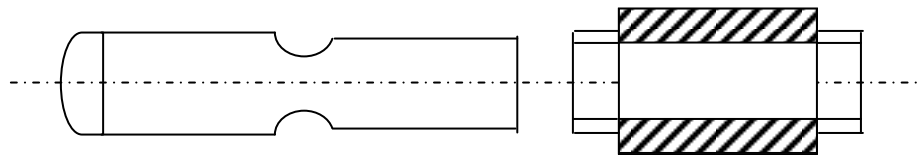


Figure 4.3 : Taper Plug and Ring Gauge

When checking a taper hole, the taper plug gauge is inserted into the hole and a slight pressure is exerted against it. If it does not rock in the hole, it indicates that the taper angle is correct.

The same procedure is followed in a ring gauge for testing tapered spindle.

The taper diameter is tested for the size by noting how far the gauge enters the tapered hole or the tapered spindle enters the gauge. A mark on the gauge shows the correct diameter for the large end of the taper.

To test the correctness of the taper two or three chalk or pencil lines are drawn on the gauge about equidistant along a generatrix of the cone. Then the gauge is inserted into the hole and slightly turned. If the lines do not rub off evenly, the taper is incorrect and the setting in the machine must be adjusted until the lines are rubbed equally all along its

length. Instead of making lines on the gauge, a thin coat of paint (red led, carbon black, Prussian blue, etc.) can be applied.

The accuracy of a taper hole is tested by a taper limit gauge as shown in Figure 4.4. This has two check lines 'go' and 'no go' each at a certain distance from the end of the face. The 'go' portion corresponds to the minimum and 'no go' to the maximum dimension.

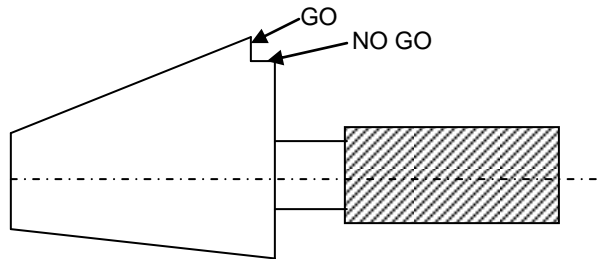


Figure 4.4 : Limit Taper Plug Gauge

4.5.4 Snap Gauges

These gauges are used for checking external dimensions. Shafts are mainly checked by snap gauges. They may be solid and progressive or adjustable or double-ended. The most usual types are shown in Figure 4.5.

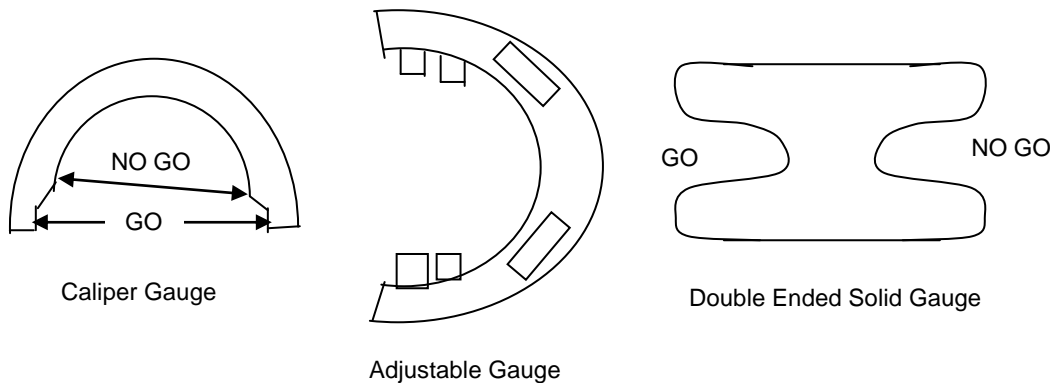


Figure 4.5 : Snap Gauges

- (a) Solid or non-adjustable caliper or snap gauge with 'go' and 'no go' each is used for large sizes.
- (b) Adjustable caliper or snap gauge used for larger sizes.

This is made with two fixed anvils and two adjustable anvils, one for 'go' and another for the 'no go'.

The housing of these gauges has two recesses to receive measuring anvils secured with two screws. The anvils are set for a specific size, within an available range of adjustment of 3 to 8 mm. The adjustable gauges can be used for measuring series of shafts of different sizes provided the diameters are within the available range of the gauge.

- (iii) Double-ended solid snap gauge with 'go' and 'no go' ends is used for smaller sizes.

4.5.5 Thread Gauges

Thread gauges are used to check the pitch diameter of the thread. For checking internal threads (nut, bushes, etc.), plug thread gauges are used, while for checking external threads (screws, bolts, etc.), ring thread gauges are used. Single-piece thread gauges serve for measuring small diameters. For large diameters the gauges are made with removable plugs machined with a tang. Standard gauges are made single-piece. Common types of thread gauges are shown in Figure 4.6.

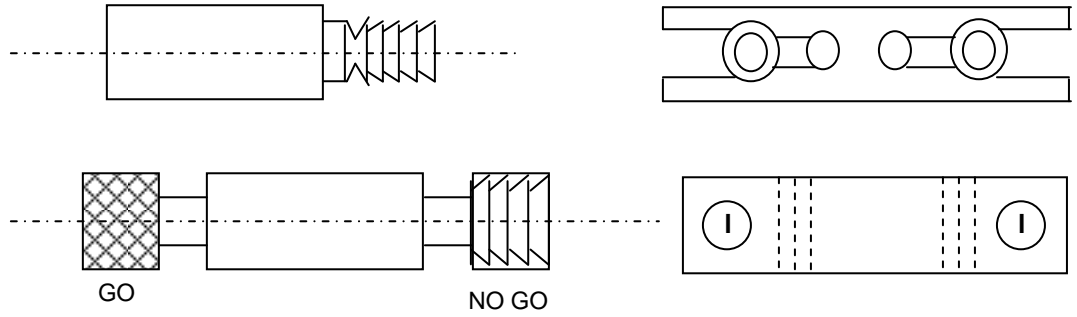


Figure 4.6 : Thread Gauge

Standard plug gauges may be made of various kinds :

- (a) Plug gauge with only threaded portion.
- (b) Threaded portion on one end and plain cylindrical plug on opposite end to give correct “core” diameter.
- (c) Thread gauge with core and full diameters.

Limit plug gauges have a long-thread section on the ‘go’ and a short-threaded section on the ‘no go’ end to correspond to the minimum and maximum limits respectively.

Roller rings gauges, similarly have ‘go’ and ‘no go’ ends. They may also be solid and adjustable.

Roller Snap gauges are often used in production practice for measuring external threads. They comprise a body, two pairs ‘go’ rollers and two pairs ‘no go’ rollers.

Taper thread gauges are used for checking taper threads. The taper-ring thread gauge are made in two varieties – rigid (non-adjustable) and adjustable. The “go” non-adjustable ring gauges are full threaded while the ‘no go’ have truncated thread profile.

4.5.6 Form Gauges

Form gauges may be used to check the contour of a profile of workpiece for conformance to certain shape or form specifications.

Template Gauge

It is made from sheet steel. It is also called profile gauge. A profile gauge may contain two outlines that represent the limits within which a profile must lie as shown in Figure 4.7.

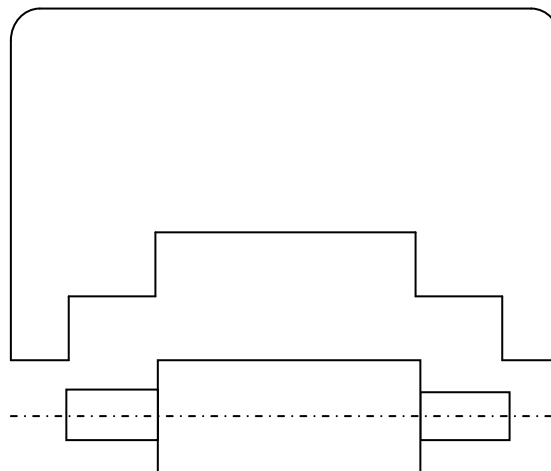


Figure 4.7 : A Template Gauge

4.5.7 Screw Pitch Gauges

Screw pitch gauges serve as an everyday tool used in picking out a required screw and for checking the pitch of the screw threads. They consist of a number of flat blades which are cut out to a given pitch and pivoted in a holder as shown in Figure 4.8. Each blade is stamped with the pitch or number of thread per inch and the holder bears an identifying number designating the thread it is intended for. The sets are made for metric threads with an angle 60° , for English threads with an angle of 55° .

A set for measuring metric threads with 30 blades has pitches from 0.4 to 0.6 mm and for English threads with 16 blades has 4 to 28 threads per inch.

In checking a thread for its pitch the closest corresponding gauge blade is selected and applied upon the thread to be tested. Several blades may have to be tried until the correct is found.

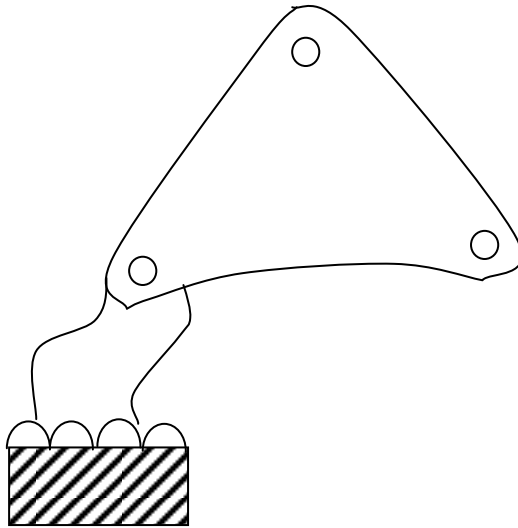


Figure 4.8 : Screw Pitch Gauge

4.5.8 Radius and Fillet Gauges

The function of these gauges is to check the radius of curvature of convex and concave surfaces over a range from 1 to 25 mm. The gauges are made in sets of thin plates curved to different radius at the ends as shown in Figure 4.9. Each set consists of 16 convex and 16 concave blades.

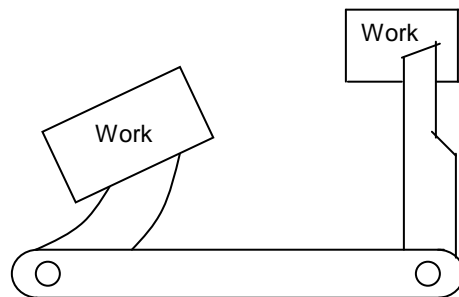


Figure 4.9 : Radius and Fillet Gauges

4.5.9 Feller Gauges

Feller gauges are used for checking clearances between mating surfaces. They are made in form of a set of steel, precision machined blade 0.03 to 1.0 mm thick and 100 mm long. The blades are provided in a holder as shown in Figure 4.10. Each blade has an indication of its thickness. The Indian standard establishes seven sets of feller gauges : Nos 1, 2, 3, 4, 5, 6, 7, which differ by the number of blades in them and by the range of thickness. Thin blades differ in thickness by 0.01 mm in the 0.03 to 1 mm set, and by 0.05 mm in the 0.1 to 1.0 mm set.

To find the size of the clearance, one or two blades are inserted and tried for a fit between the contacting surfaces until blades of suitable thickness are found.

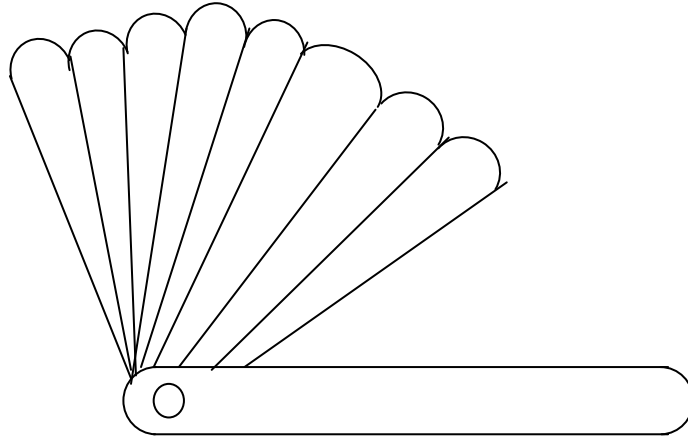


Figure 4.10 : Feller Gauge

4.5.10 Plate and Wire Gauges

The thickness of a sheet metal is checked by means of plate gauges and wire diameters by wire gauges. The plate gauge is shown in Figure 4.11. It is used to check the thickness of plates from 0.25 to 5.0 mm, and the wire gauge, in Figure 4.12, is used to check the diameters of wire from 0.1 to 10 mm.

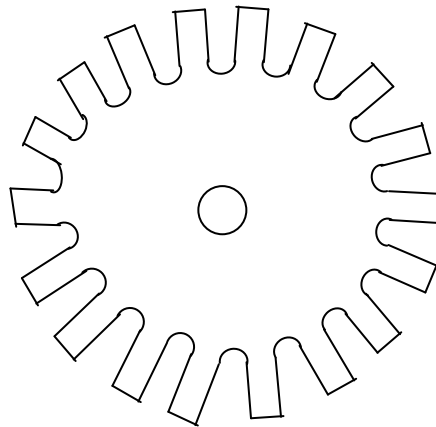


Figure 4.11 : Plate Gauge

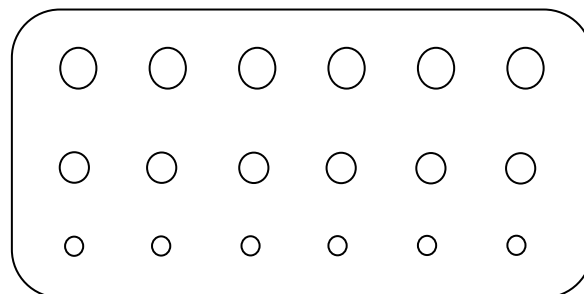


Figure 4.12 : Wire Gauge

4.5.11 Indicating Gauges

Indicating gauges employ a means to magnify how much a dimension deviates, plus or minus, from a given standard to which the gauge has been set. They are intended for measuring errors in geometrical form and size, and for testing surfaces for their true position with respect to one another. Beside this, indicating gauges can be adapted for checking the run out of toothed wheels, pulleys, spindles and various other revolving parts of machines.

Indicating gauges can be of a dial or lever type, the former being the most widely used.

4.5.12 Air Gauges

Pneumatic or air gauges are used primarily to determine the inside characteristics of a hole by means of compressed air. There are two types of air gauges according to operation: a flow type and a pressure type gauge. The flow type operates on the principle of varying air velocities at constant pressure and the pressure type operates on the principle of air escaping through an orifice.

SAQ 1

- (a) What are gauges?
- (b) Classify the gauges based on the purposes for which they are used.
- (c) What is the difference between standard gauges and limit gauges?

SAQ 2

- (a) What are the functions of the following gauges :
 - (i) Form gauge
 - (ii) Taper gauge
 - (iii) Reference gauge
 - (iv) Feller gauge
 - (v) Air gauges
- (b) Mention the name of the gauge that can be used for checking each of the following :
 - (i) Shaft
 - (ii) Wire
 - (iii) Wheels
 - (iv) Pulleys
 - (v) Screw
 - (vi) Nut
 - (vii) Bolt
 - (viii) Hole
- (c) Mention the types of material used for making gauges.

4.6 SUMMARY

Gauging is the method by which it is determined quickly whether or not the dimensions of the checking parts, in the production, are within their specified limits. The tools which are used for the same are called gauges.

Materials which are used for making gauges are high carbon and alloy steels, cemented carbides, etc.

Gauges can be classified mainly as follows :

- (a) Based on the standard and limit
 - (i) Standard gauge
 - (ii) Limit gauge
- (b) Based on the consistency in manufacturing process and inspection
 - (i) Working gauge
 - (ii) Inspection gauge
 - (iii) Reference gauge
- (c) According to the shape or purpose for which each is used
 - (i) Plug
 - (ii) Ring
 - (iii) Snap
 - (iv) Taper
 - (v) Thread
 - (vi) Form
 - (vii) Indicating
 - (viii) Feller
 - (x) Air-gauges

4.7 KEY WORDS

Standard Gauges	: These are made to the nominal size of the parts to be tested.
Limit Gauges	: These are 'go' and 'no go' gauges.
Plug Gauges	: These are used for checking holes of many different shapes and sizes.
Ring Gauges	: External diameter measuring gauges.
Taper Gauges	: Taper testing gauges.
Snap Gauges	: These are used for checking shafts.
Thread Gauges	: These are used for pitch diameter of the thread.
Form Gauges	: These are used to check the contour of a profile.
Feller Gauges	: For checking the clearance between the mating surfaces.
Indicating Gauges	: To measure the position of the surfaces.
Air Gauge	: To measure inside characteristics of a hole using air.

4.8 ANSWERS TO SAQs

SAQ 1

- (a) Gauges are the tools which are used for checking the size, shape and relative positions of various parts.

- (b)
 - (i) Plug gauges
 - (ii) Ring gauges
 - (iii) Taper gauges
 - (iv) Thread gauges
 - (v) Snap gauges
 - (vi) Indicating gauges
 - (vii) Air gauges
- (c) 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 dimensions of the part to be checked, whereas the limit gauges are made to the limit sizes of the work to be measured.

SAQ 2

- (a)
 - (i) **Gauge :** It may be used to check the contour of a profile of a workpiece for conformance to certain shape or form specifications.
 - (ii) **Taper Gauge :** It is used to check the taper. It is also used to measure the diameter of the taper at some point.
 - (iii) **Reference Gauge :** It is used only for checking size or condition of other gauges.
 - (iv) **Snap Gauge :** It is used for checking external diameters. Shafts are mainly checked by the snap gauges.
 - (v) **Feller Gauge :** It is used for checking clearances between mating surfaces.
 - (vi) **Air Gauges :** It is used primarily to determine the inside characteristics of the hole by means of compressed air.
- (b)
 - (i) **Shaft :** Snap gauges, Ring gauges.
 - (ii) **Wire :** Wire gauges.
 - (iii) **Wheels :** Indicating gauges.
 - (iv) **Pulleys :** Indicating gauges.
 - (v) **Screw :** Thread gauges.
 - (vi) **Nut :** Thread gauges.
 - (vii) **Bolt :** Thread gauges.
 - (viii) **Hole :** Plug gauges.
- (c)
 - (i) High carbon and alloy steel.
 - (ii) Cemented carbides.