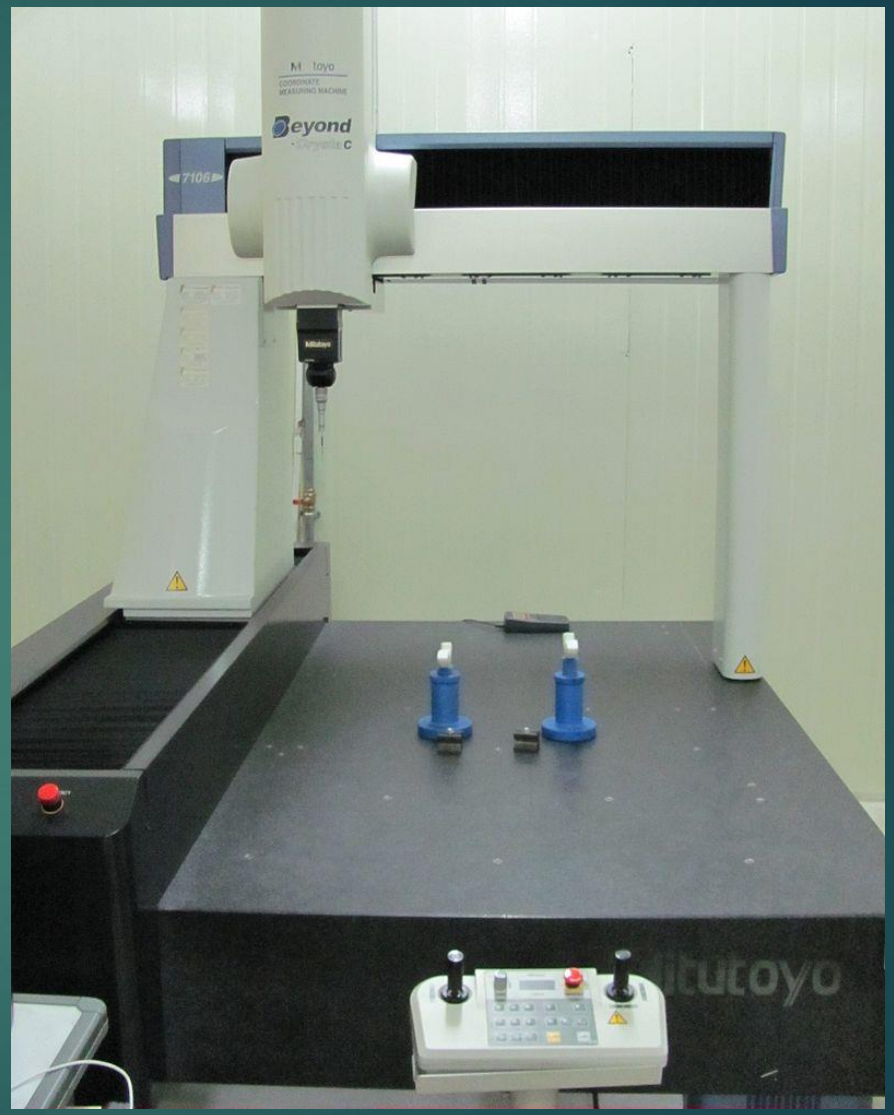
Principle of Metrology

Somnath Chattopadhyaya



Learning Objective

- **Principle of Metrology**
- Introduction to commonly used mechanical devices: gauges/indicator and levels,
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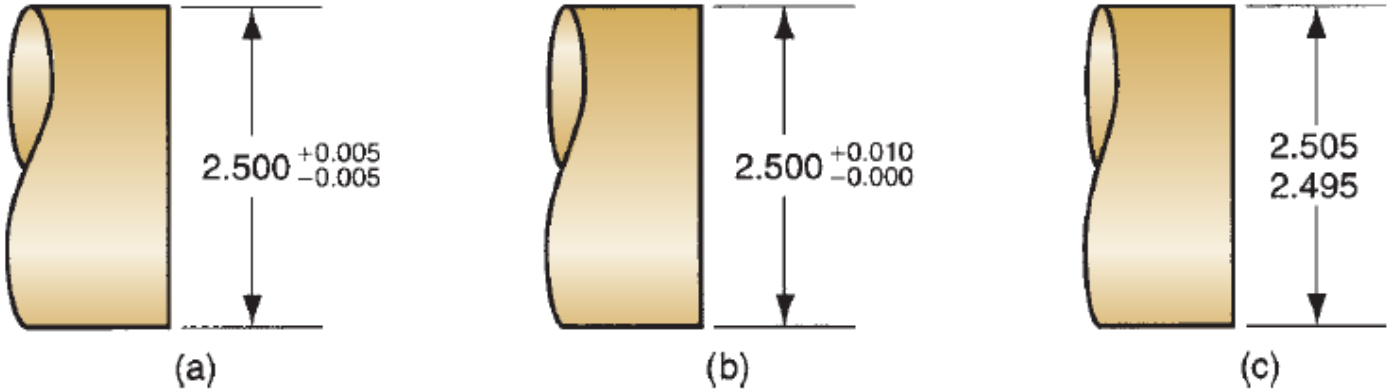
Inspection Principles

- ***Inspection*** involves the use of measurement and gaging techniques to determine whether a product, its components, subassemblies, or starting materials conform to design specifications.

Inspection Principles

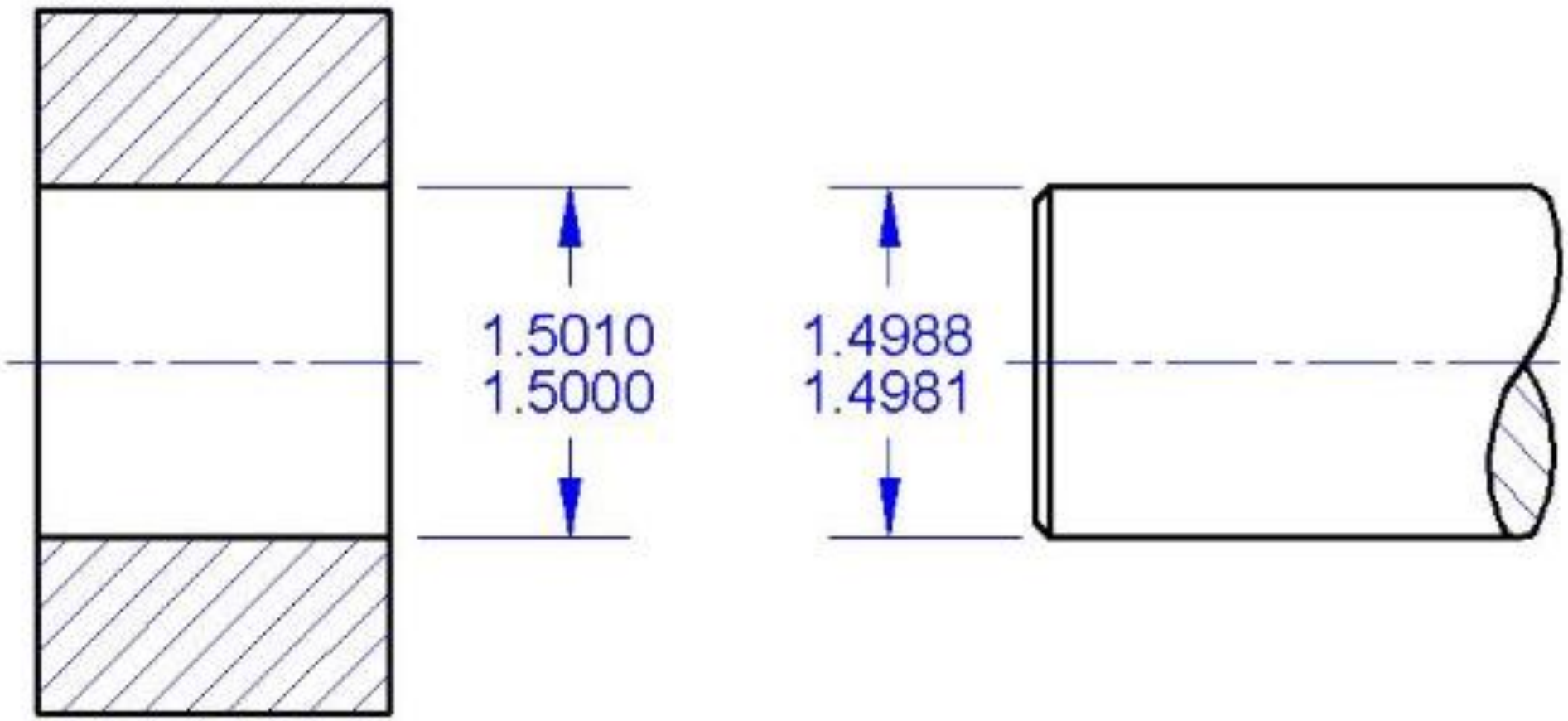
- The design specifications are established by the product designer and for mechanical products they refer to dimensions, tolerances, surface finish, and similar features.
- Inspection is performed before, during, and after manufacturing.

Geometric Attributes



Three ways to specify tolerance limits for a nominal dimension of 2.500: (a) bilateral, (b) unilateral, and (c) limit dimensions.

Precision Dimensioning



Measurement

- ***Measurement*** is a procedure in which an unknown quantity is compared with a known standard, using an accepted and consistent system of units.

System of Units

- Two systems of units have evolved in the world:
- (1) the U.S. customary system (U.S.C.S.), and
- (2) the International System of Units (or SI, for Systeme Internationale d'Unites), more popularly known as the metric system.
- Both systems are used in parallel throughout this book. The metric system is widely accepted in nearly every part of the industrialized world except the United States, which has stubbornly clung to its U.S.C.S.
- Gradually, the United States is adopting SI.

Definition of Geometric Attributes

Angularity—The extent to which a part feature such as a surface or axis is at a specified angle relative to a reference surface. If the angle = 90°, then the attribute is called perpendicularity or squareness.

Circularity—For a surface of revolution such as a cylinder, circular hole, or cone, circularity is the degree to which all points on the intersection of the surface and a plane perpendicular to the axis of revolution are equidistant from the axis. For a sphere, circularity is the degree to which all points on the intersection of the surface and a plane passing through the center are equidistant from the center.

Concentricity—The degree to which any two (or more) part features such as a cylindrical surface and a circular hole have a common axis.

Cylindricity—The degree to which all points on a surface of revolution such as a cylinder are equidistant from the axis of revolution.

Flatness—The extent to which all points on a surface lie in a single plane.

Parallelism—The degree to which all points on a part feature such as a surface, line, or axis are equidistant from a reference plane or line or axis.

Perpendicularity—The degree to which all points on a part feature such as a surface, line, or axis are 90° from a reference plane or line or axis.

Roundness—Same as circularity.

Squareness—Same as perpendicularity.

Straightness—The degree to which a part feature such as a line or axis is a straight line.

Measurement

- Measurement provides a numerical value of the quantity of interest, within certain limits of accuracy and precision.
- ***Accuracy*** is the degree to which the measured value agrees with the true value of the quantity of interest.
- A measurement procedure is accurate when it is absent of systematic errors, which are positive or negative deviations from the true value that are consistent from one measurement to the next.

Precision

- ***Precision*** is the degree of repeatability in the measurement process.
- Good precision means that random errors in the measurement procedure are minimized.
- Random errors are usually associated with human participation in the measurement process.
- Examples include variations in the setup, imprecise reading of the scale, round-off approximations, and so on.
- Nonhuman contributors to random error include temperature changes, gradual wear and/or misalignment in the working elements of the device, and other variations.

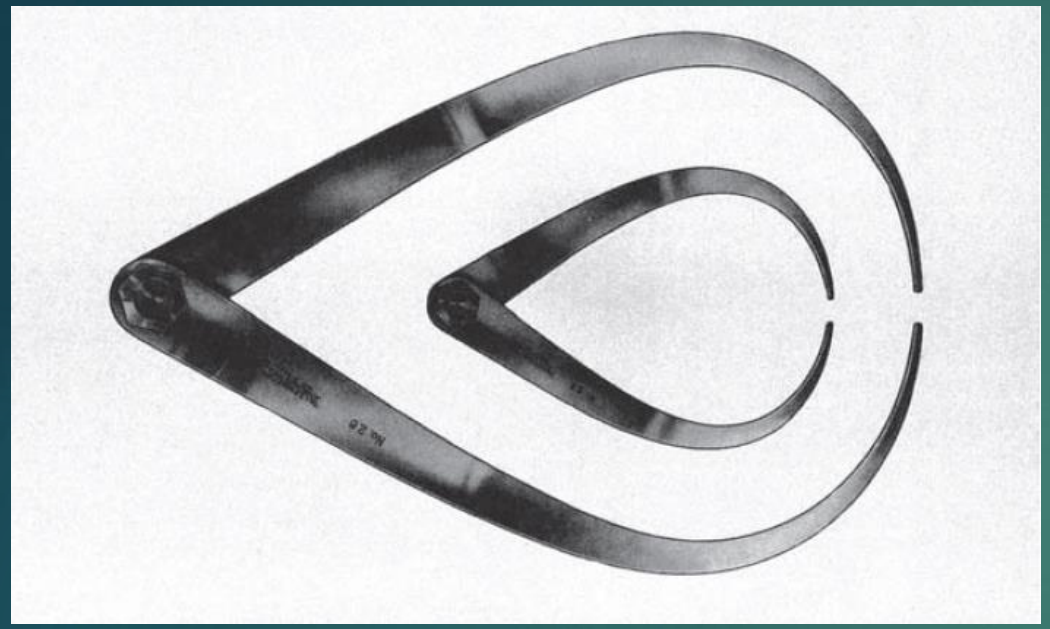
Gaging

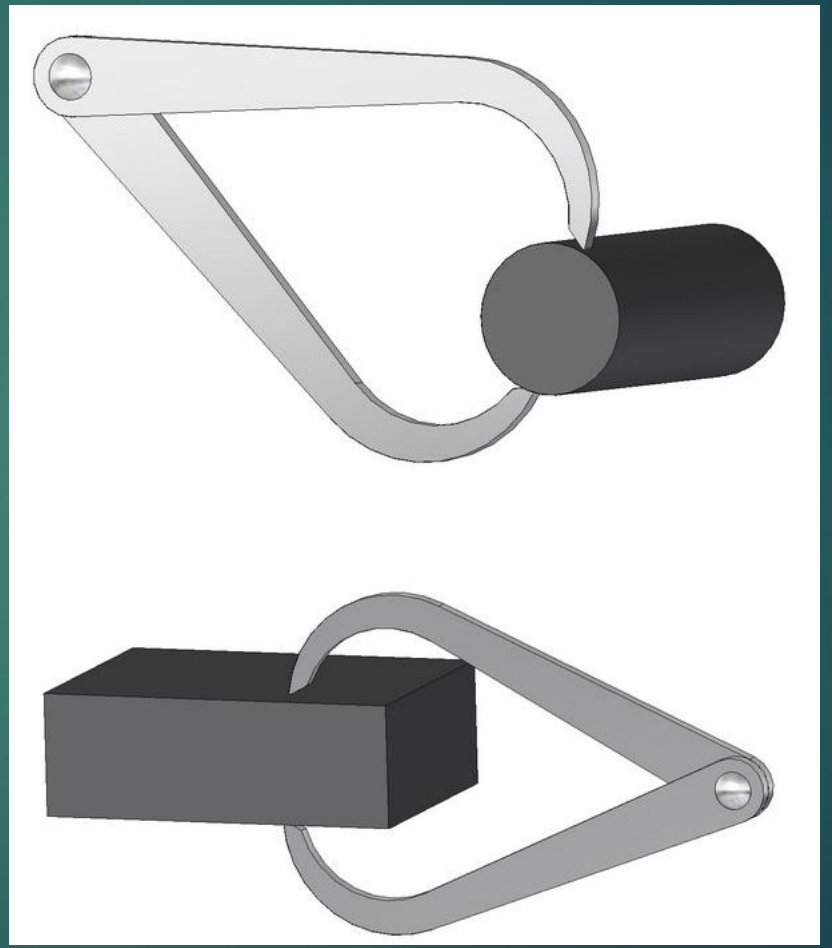
- Closely related to measurement is gaging.
- ***Gaging*** (also spelled ***gauging***) determines simply whether the part characteristic meets or does not meet the design specification.
- It is usually faster than measuring, but scant information is provided about the actual value of the characteristic of interest.

Inspection Issues

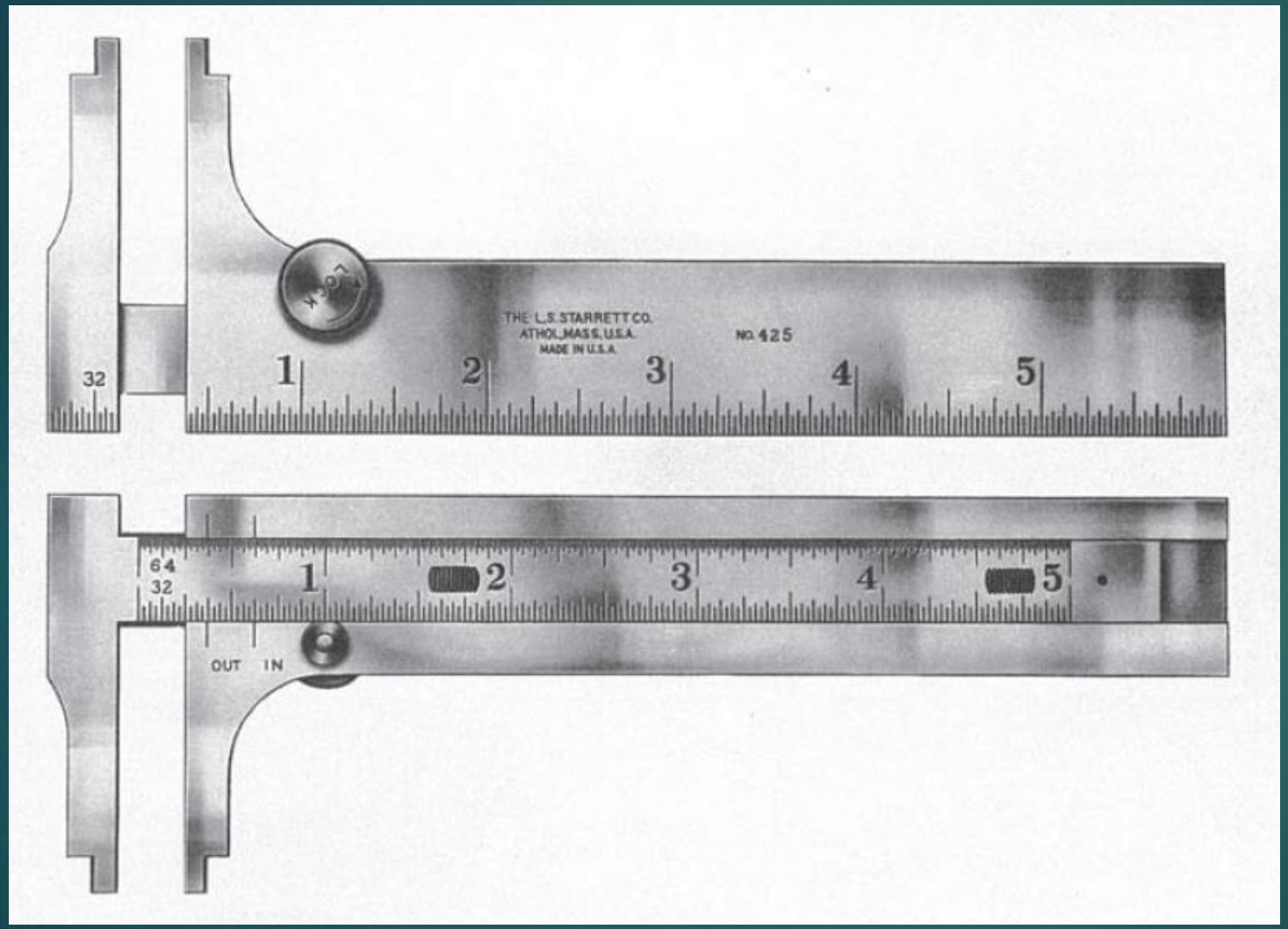
- The incoming materials and starting parts are inspected upon receipt from suppliers; work units are inspected at various stages during their production; and the final product should be inspected prior to shipment to the customer.
- There is a difference between inspection and testing, which is a closely related topic.
- Whereas inspection determines the quality of the product relative to design specifications, testing generally refers to the functional aspects of the product.

Two sizes of Outside Calipers

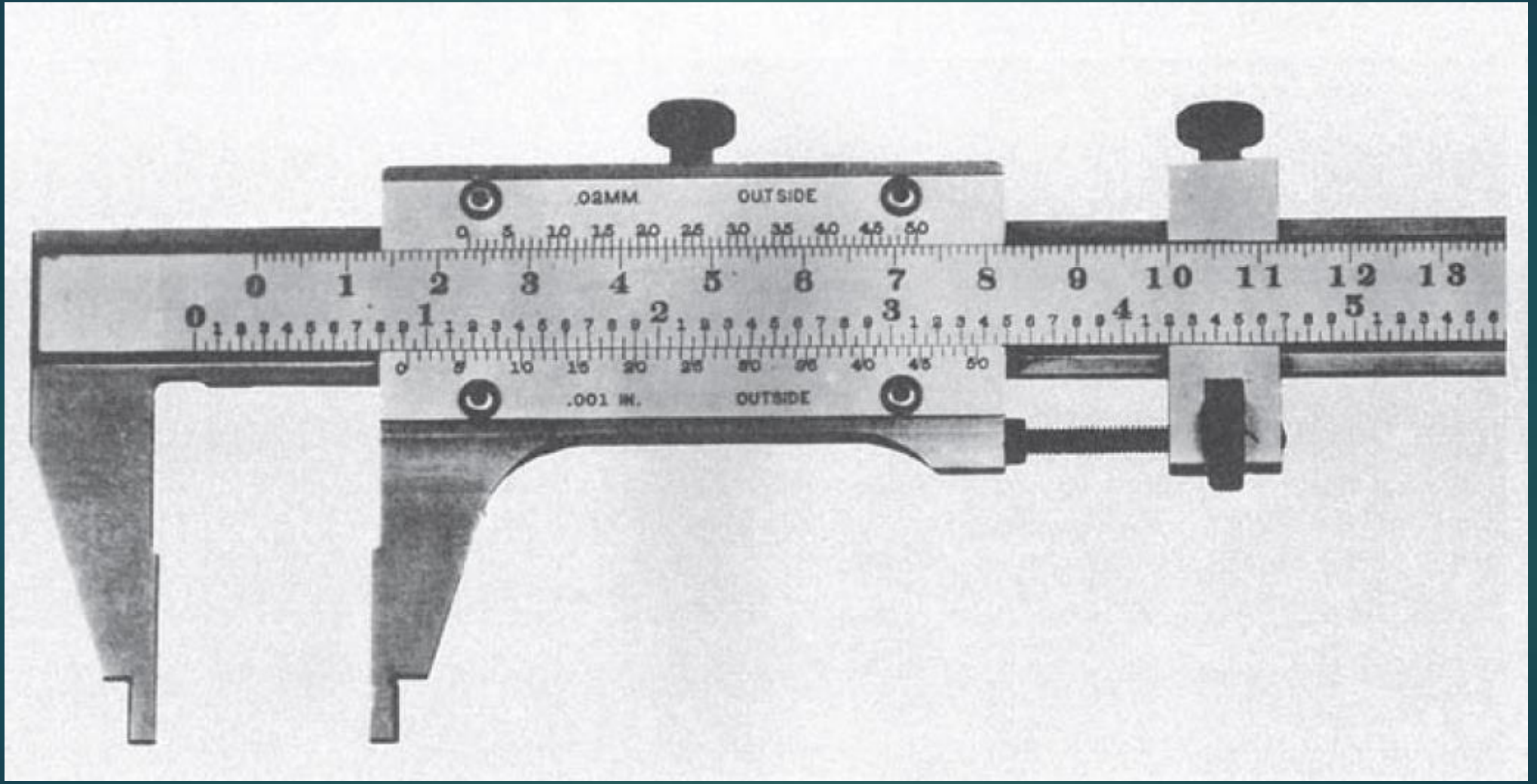




Slide Caliper



Vernier Caliper

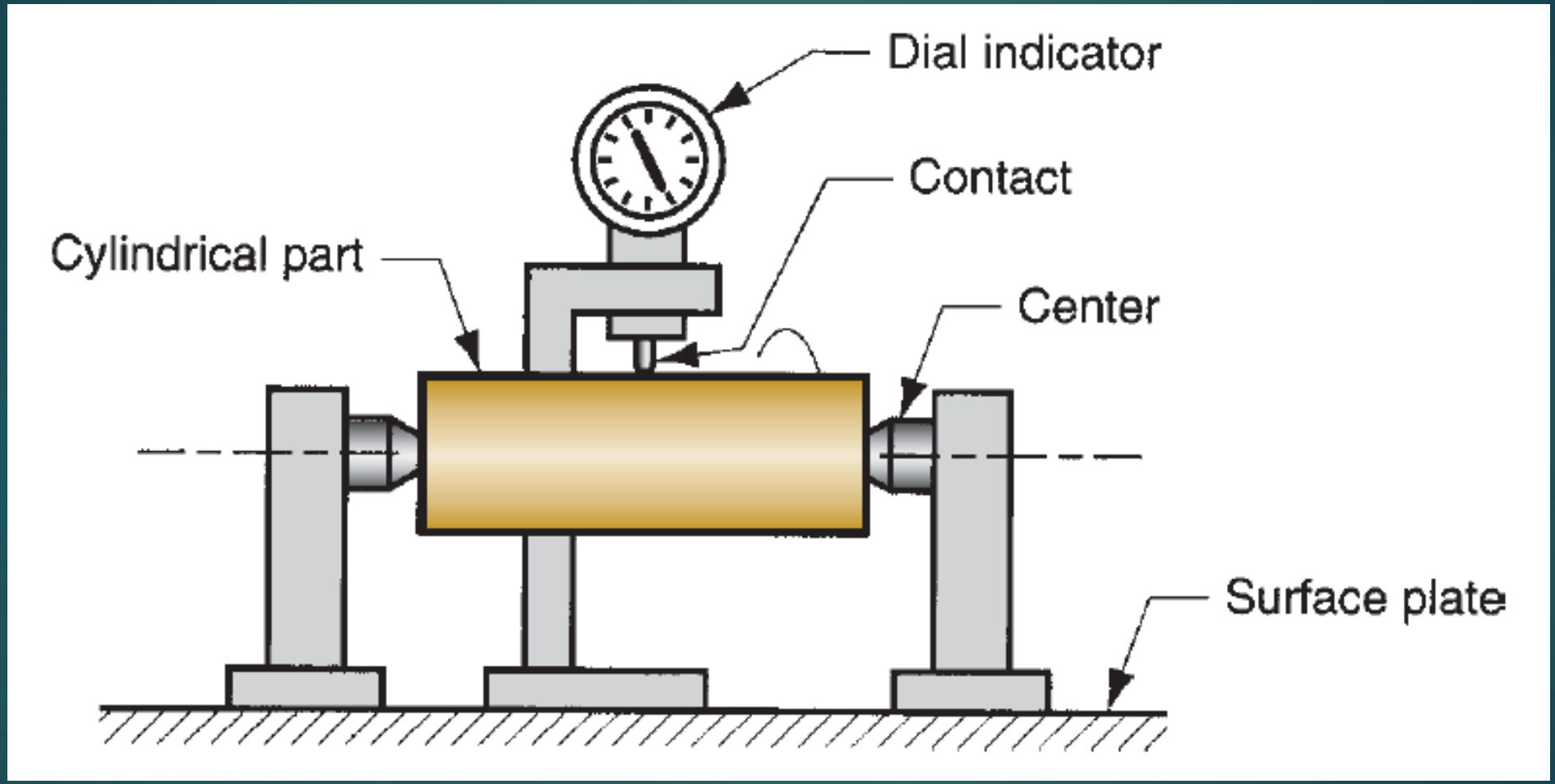


Micrometer

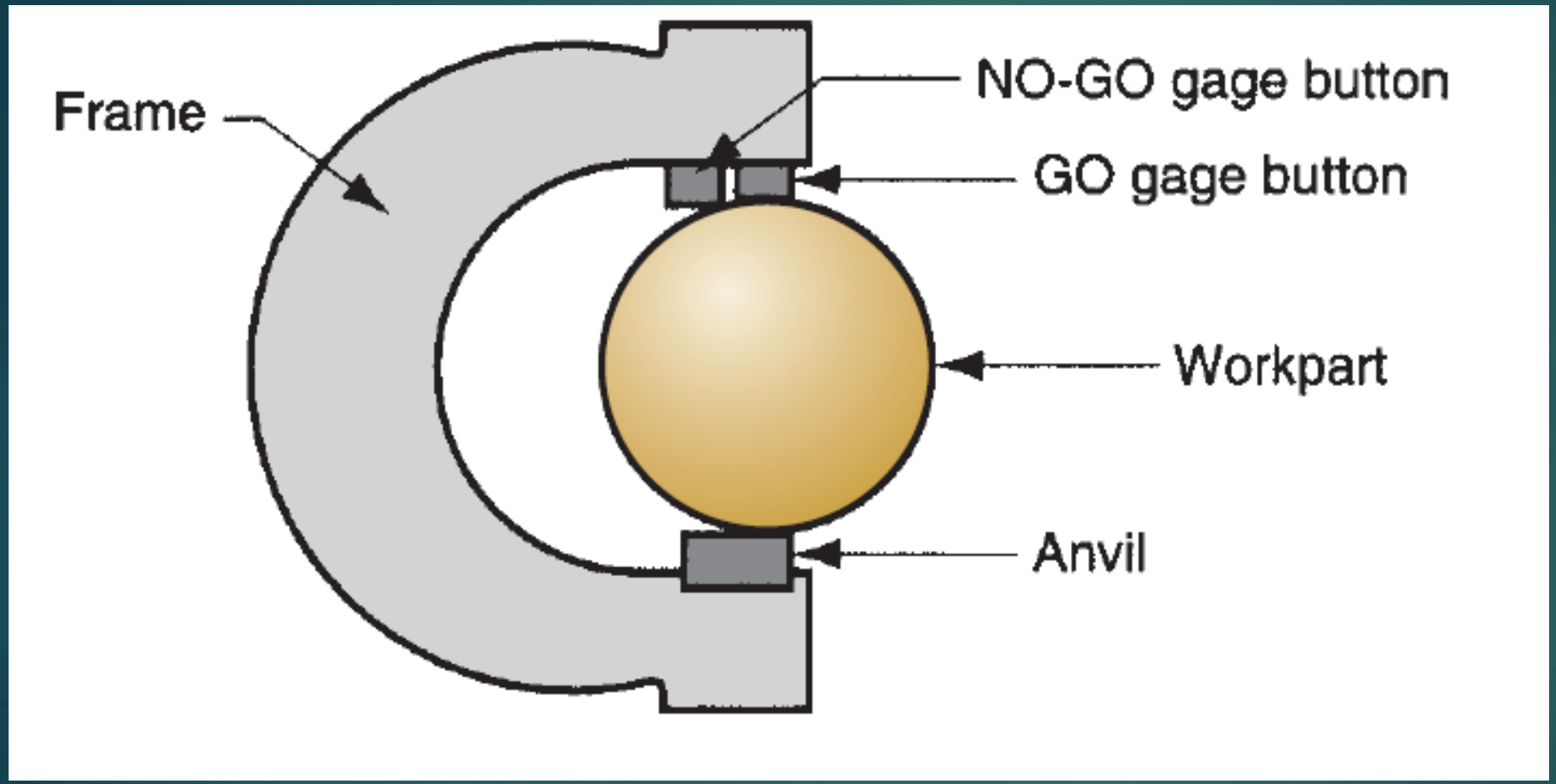
Dial Indicators

Mechanical Gages: Dial Indicators ***Mechanical gages*** are designed to mechanically magnify the deviation to permit observation. The most common instrument in this category is the ***dial indicator***, Figure 5.6, which converts and amplifies the linear movement of a contact pointer into rotation of a dial needle. The dial is graduated in

Use of Dial Indicator

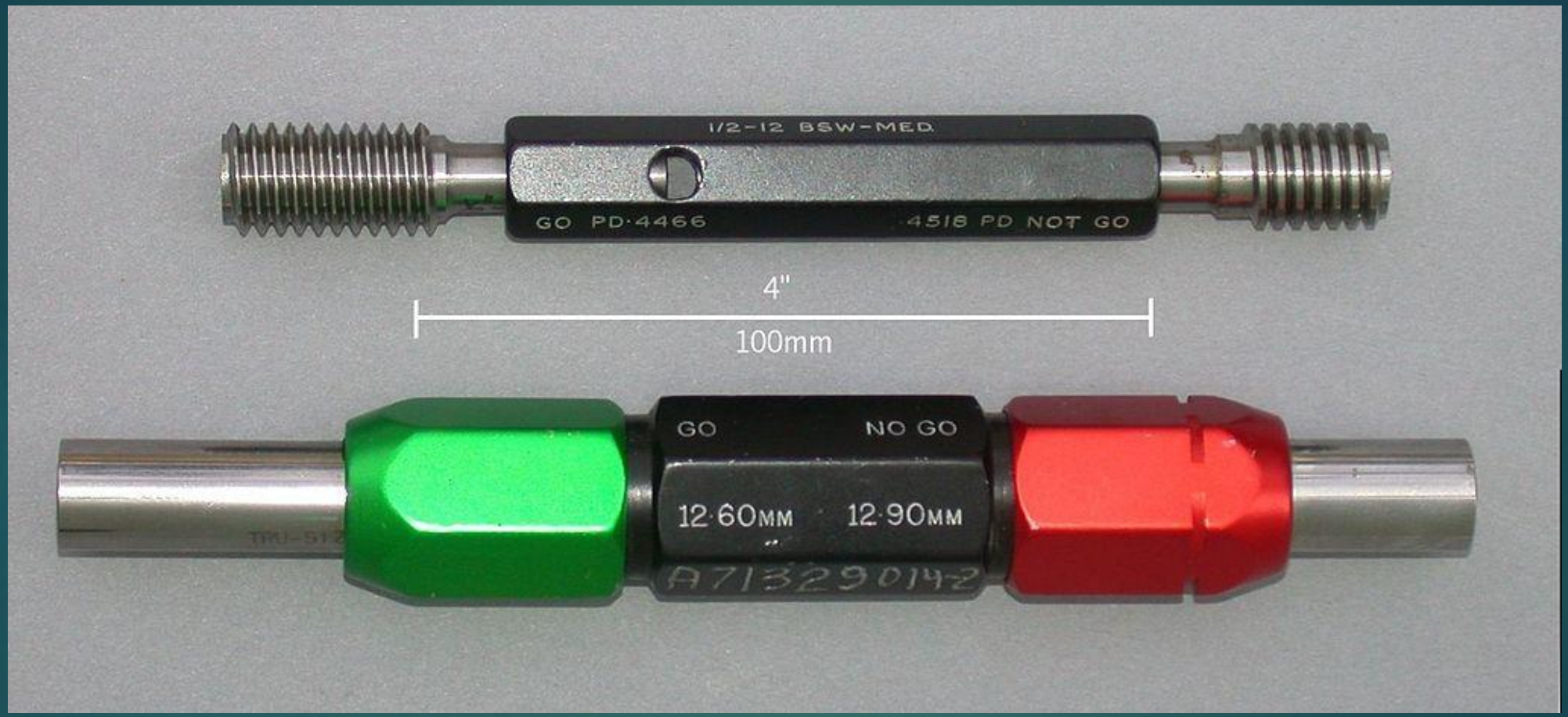


Snap Gauge



Measurement with a dial indicator

Plug Go Gauge & NOGO Gauge



Ring gauge

Snap gauges


Thank you