02-Dimensional Metrology

Dimensions: In addition to mechanical and physical properties of materials, other factors that determine the performance of a manufactured product include the dimensions and surfaces of its components.

Tolerances: When fabricating a given component, it is nearly impossible and very costly to make the part to the exact dimension given on the drawing. Instead, a limited variation is allowed from the dimension, and that allowable variation is called a tolerance.

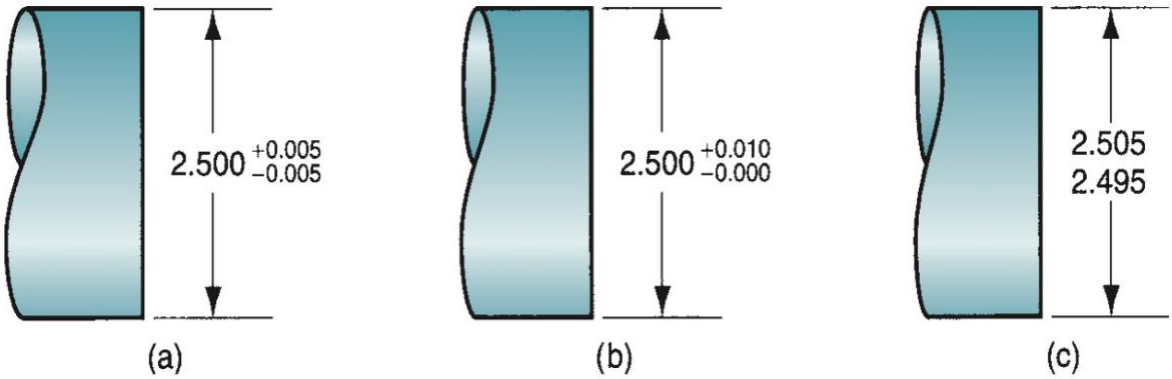

Figure 2.1 Three ways to specify tolerance limits for a nominal dimension of 2.500: (a) bi- lateral, (b) unilateral, and (c) limit dimensions.

The basic parameters used by design engineers to specify sizes of geometric features on a part drawing include dimensions and tolerances, flatness, roundness, and angularity.

Conventional measuring instruments and gages:

1. Calipers
2. Micrometer
3. Dial Indicators
4. Bevel protractor

1. Calipers:

A variety of graduated calipers are available for various measurement purposes. The simplest is the slide caliper, which consists of a steel rule to which two jaws are added, one fixed at the end of the rule and the other movable, shown in Figure 2.1.

a. Slide calipers can be used for inside or outside measurements, depending on whether the inside or outside jaw faces are used.

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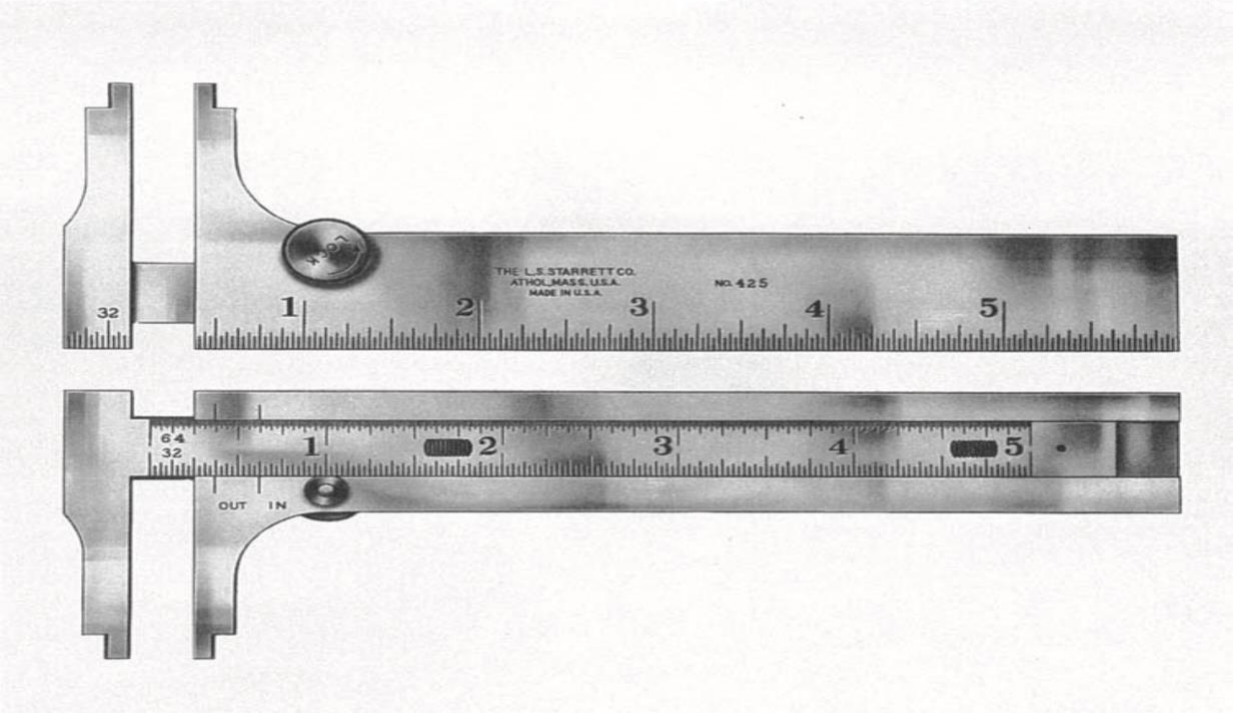

Figure 2.2: Slide caliper, opposite sides of instrument shown

b. Vernier caliper: A refinement of the slide caliper is the vernier caliper, shown in Figure 2.3. In this device, the movable jaw includes a vernier scale, named after P. Vernier (1580–1637), a French mathematician who invented it. The vernier provides graduations of 0.01 mm in the SI (and 0.001 inch in the U.S. customary scale), much more precise than the slide caliper.

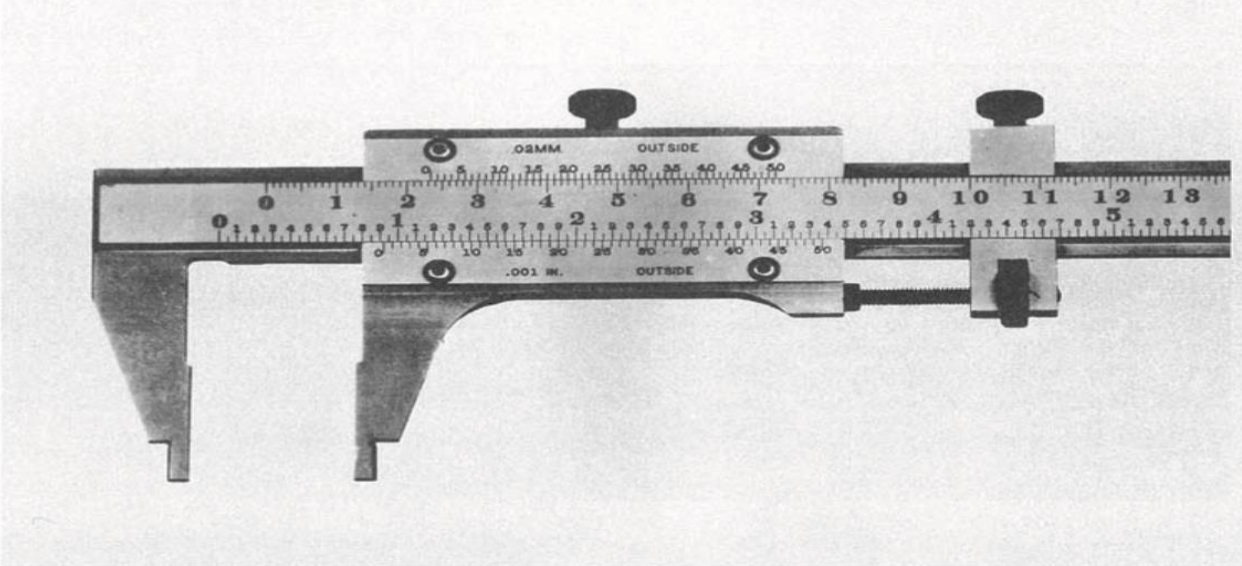

Figure 2.3: Vernier caliper.

2. Micrometer:

The most common micrometer types are:

(1) external micrometer, Figure 2.4, also called an outside micrometer, which comes in a variety of standard anvil sizes.

(2) internal micrometer, or inside micrometer, which consists of a head assembly and a set of rods of different lengths to measure various inside dimensions that might be encountered.

(3) depth micrometer, similar to an inside micrometer but adapted to measure hole depths.

(a) External micrometer

(b) Internal micrometer

(c) Depth micrometer

Figure 2.4: Three types of micrometers.

3. Dial Indicators:

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 2.5), which converts and amplifies the linear movement of a contact pointer into rotation of a dial needle.

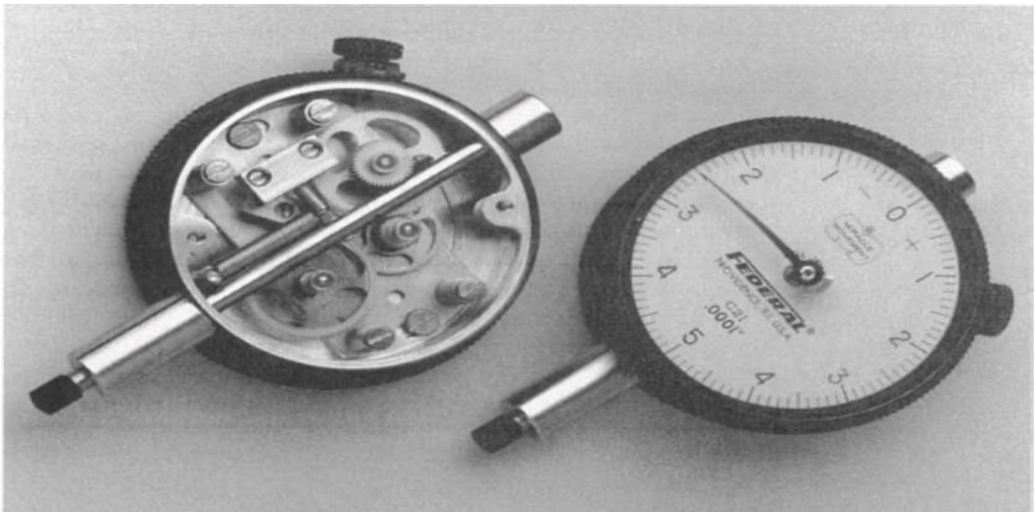

Figure 2.5: Dial indicator: top view shows dial and graduated face; bottom view shows rear of instrument with cover plate removed.

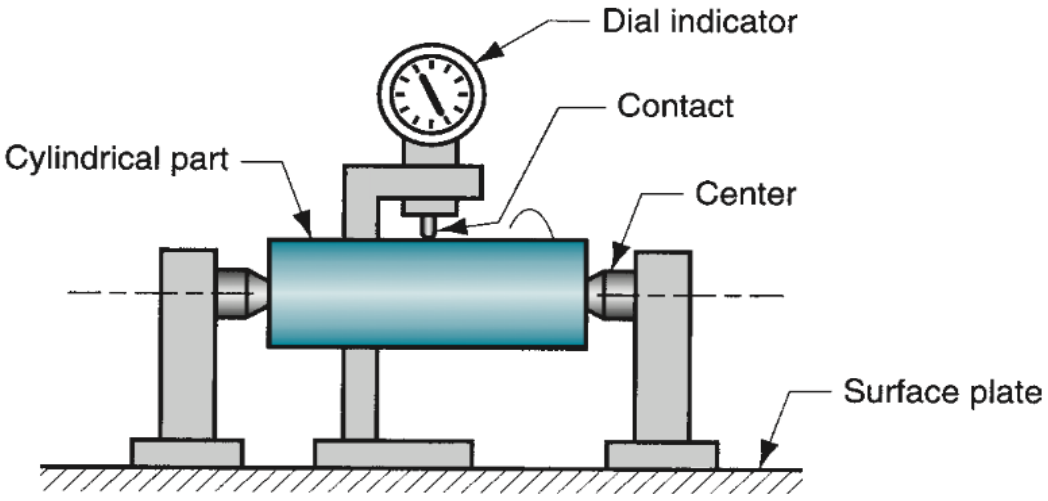

Figure 2.6: Dial indicator setup to measure runout; as part is rotated about its center, variations in outside surface relative to center are indicated on the dial.

4. Bevel protractor:

Angles can be measured using any of several styles of protractor. A simple protractor consists of a blade that pivots relative to a semicircular head that is graduated in angular units (e.g., degrees, radians). To use, the blade is rotated to a position corresponding to some part angle to be measured, and the angle is read off the angular scale. A bevel protractor (Figure 2.7)

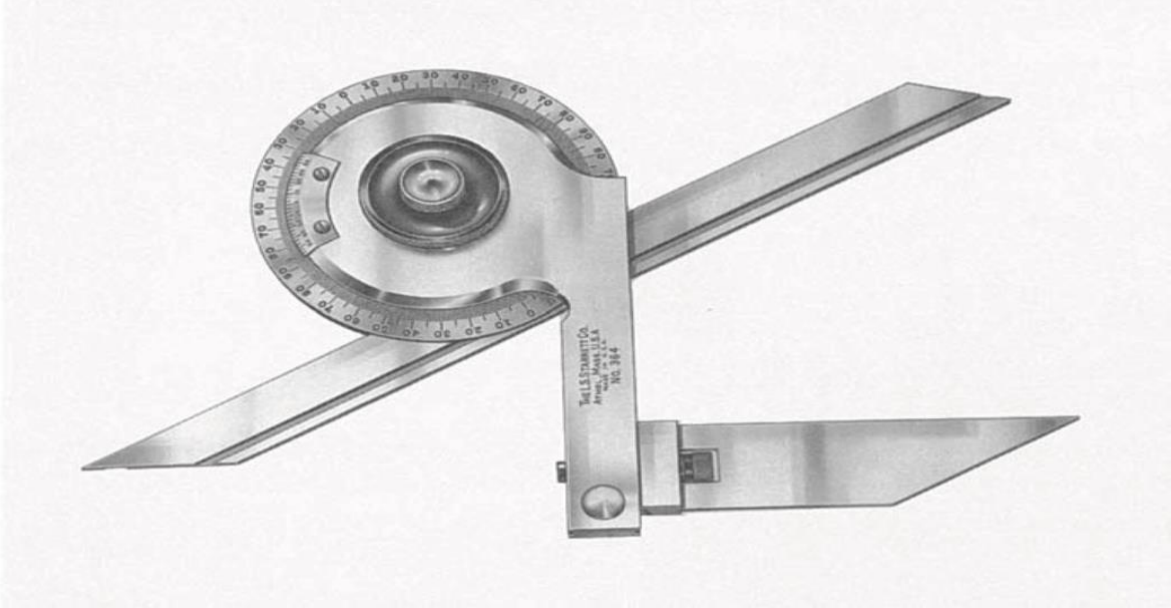

Figure 2.7: Bevel protractor with vernier scale.