

INSPECTION OBJECTIVES:

Inspection is the process of measuring the qualities of a product or service in terms of established standards

Quality control is a process that measures output relative to standard, and acts when output doesn't meet standards.

The purpose of quality control is to assure that processes are performing in an acceptable manner.

When to inspect

▶ Inspection can occur at three points:

- before production: is to make sure that inputs are acceptable.
- during production: to make sure that the conversion of inputs into outputs is proceeding in an acceptable manner.
- after production: to make a final verification of conformance before passing goods to customers

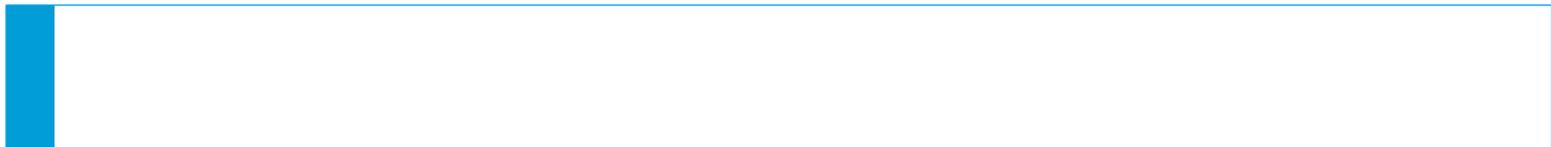
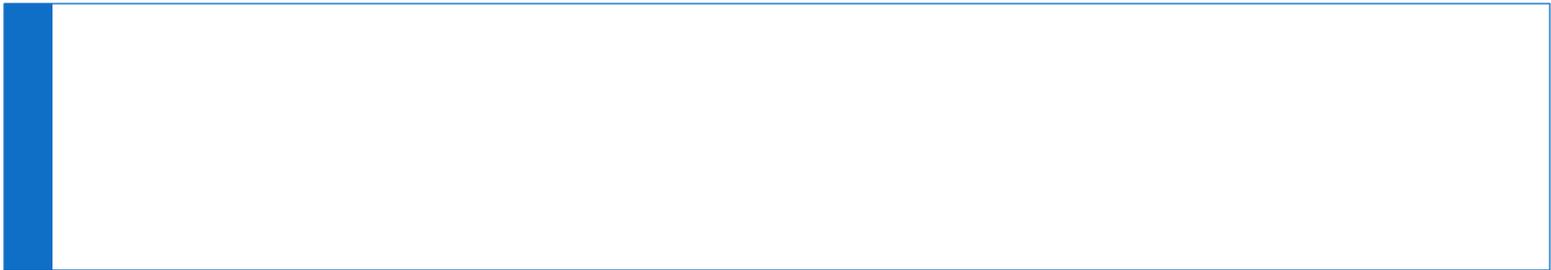


How much to inspect

- ▶ The amount of inspection can range from no inspection to inspection of each item many times.
- ▶ **Low-cost, high volume items** such as paper clips and pencils often require little inspection because:
 1. the cost associated with passing defective items is quite low.
 2. the process that produce these items are usually highly reliable, so that defects are rare.
- ▶ **High-cost, low volume** items that have large cost associated with passing defective items often require more intensive inspection such as airplanes and spaceships.
- ▶ The majority of **quality control applications** ranges between these two extremes.



Measurements and Precision Measuring Devices



Objectives

- ▶ Describe United States Customary (USC) system of measurement
- ▶ Describe metric system
- ▶ Explain how to convert measurements between two measuring systems
- ▶ Explain when and how to read rulers



Objectives

- ▶ Discuss need for feeler gauges and their general use
- ▶ Describe how to read measurements made with micrometers
- ▶ Describe dial indicators and calipers
- ▶ Explain typical uses of vacuum and pressure gauges



Introduction

- ▶ Methods of collecting data depend on what is being measured
- ▶ Check for excessive wear or damage when servicing components
- ▶ Some shops send components out for these measurements and tests



Units of Length

12 inches = 1 foot

3 feet = 1 yard

5 1/2 yards = 1 rod (16 1/2 feet)

Units of Weight

16 ounces = 1 pound

2000 pounds = 1 ton (short)

2240 pounds = 1 ton (long)



LINEAR EQUIVALENCE

Conversion Factors

English to Metric

1 inch =

2.54 centimeters (= 0.254m)

1 foot =

0.3048 meters (= 304.8mm)

5,280 feet = 1 mile =

1.34 kilometers

Metric to English

1 centimeter =

1 meter =

1 kilometer =

Measuring Systems

- ▶ Metric system based on the meter
 - ▶ Most common units in the automotive industry are the centimeter and millimeter
 - ▶ Millimeters are used to express close tolerances of engine measurements
 - ▶ Metric system is based on divisions of ten



Metric System

- ▶ Such units as length, volume, and mass are easily converted to the next higher denomination by using the simple multiplier, 10.



Units of Length

- ▶ 10 millimeters = 1 centimeter
- ▶ 10 centimeters = 1 decimeter
- ▶ 10 decimeters = 1 meter
- ▶ 1000 meters = 1 kilometer

▶ *Units of Weight*

- ▶ 10 milligrams = 1 centigram
- ▶ 10 centigrams = 1 decigram
- ▶ 10 decigrams = 1 gram
- ▶ 1000 grams = 1 kilogram
- ▶ 1000 kilograms = 1 metric ton

Rulers and Tapes

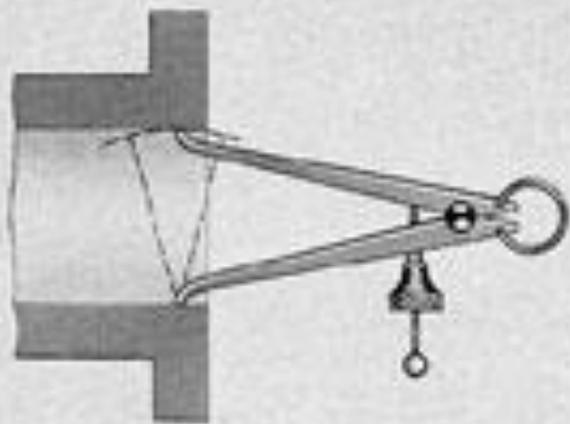
Rulers and tapes. The most common method of obtaining simple measurements of length is by the ruler or tape. A ruler may be graduated into feet, inches, or fractions thereof. Rulers and tapes used in engineering work are most frequently made of metal and the fractions of inches may be graduated to subdivisions as small as $1/64$ or $1/100$ of an inch. 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.



Calipers

- ▶ *Calipers*. Engineers and machinists frequently use calipers to secure accurate measurements of inside and outside diameters.

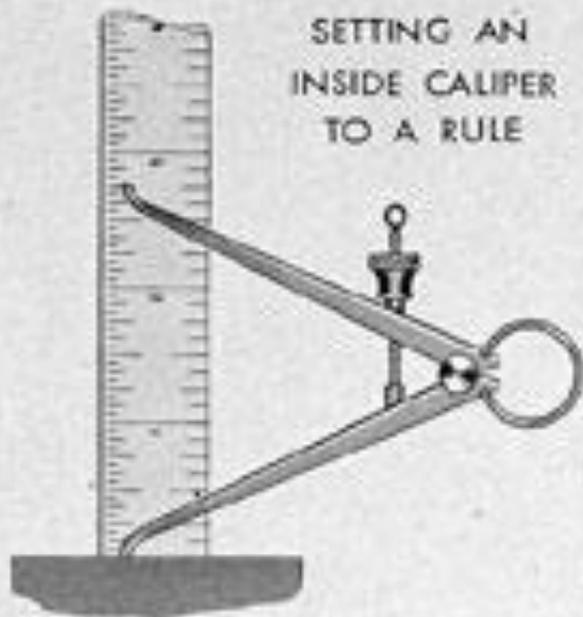




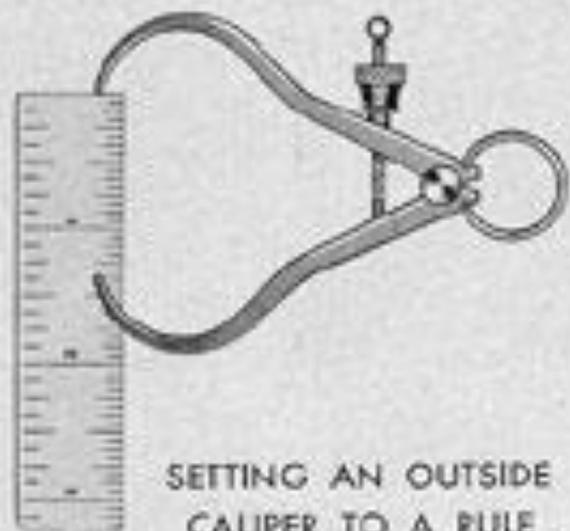
USING THE INSIDE CALIPER



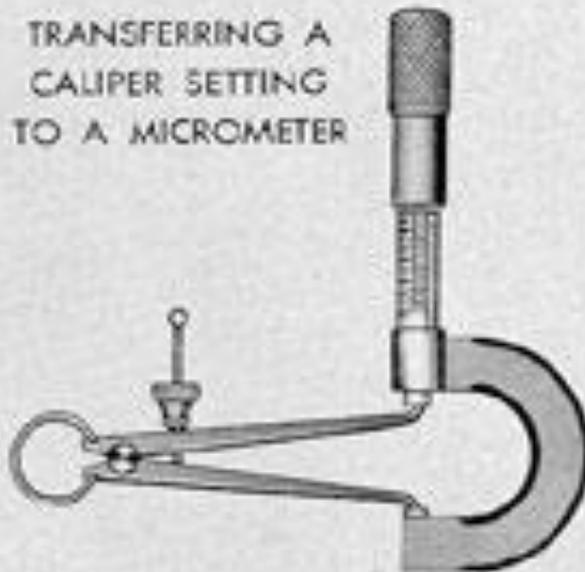
USING THE OUTSIDE CALIPER



SETTING AN INSIDE CALIPER TO A RULE



SETTING AN OUTSIDE CALIPER TO A RULE



TRANSFERRING A CALIPER SETTING TO A MICROMETER



SETTING A HERMAPHRODITE CALIPER TO A RULE

Feeler Gauges

- ▶ **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



Feeler gages 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 without catching.

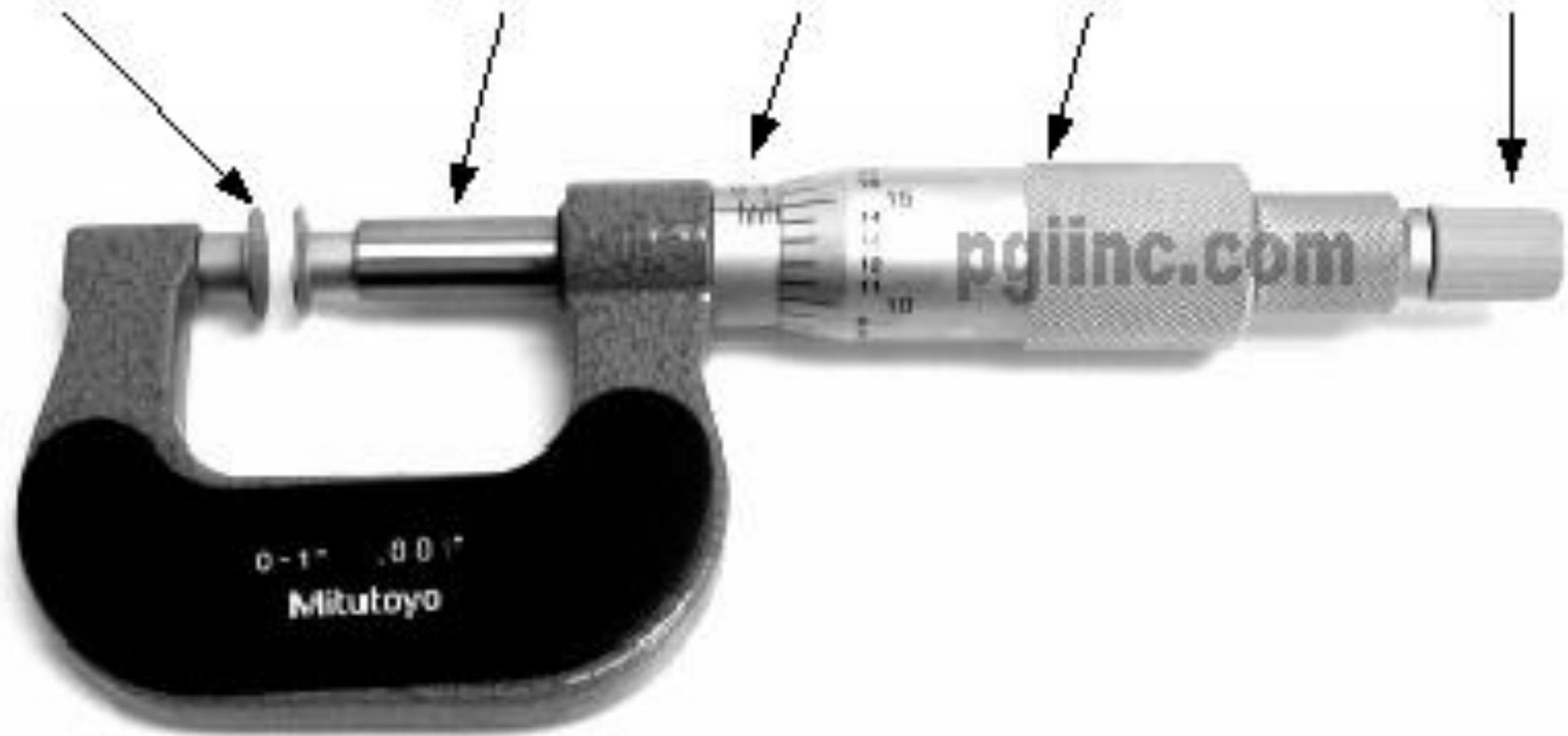
Anvil

Spindle

Sleeve

Thimble

Ratchet



0-1" .001"
Mitutoyo

pgiinc.com



Micrometers

- ▶ *Micrometer calipers.* Engineers frequently rely on the micrometer caliper to obtain measurements accurate to 1/1000 of an inch. This instrument is particularly useful 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 40 to the inch on the portion that fits inside the sleeve. The thimble fits over the end of the sleeve, and rotating the thimble turns the spindle.



Micrometers

- ▶ Micrometers precisely measure different shapes of a component
- ▶ Outside micrometers
 - ▶ Resembles a clamp to measure linear distances
 - ▶ Proper use requires practice and studying the markings of the instrument

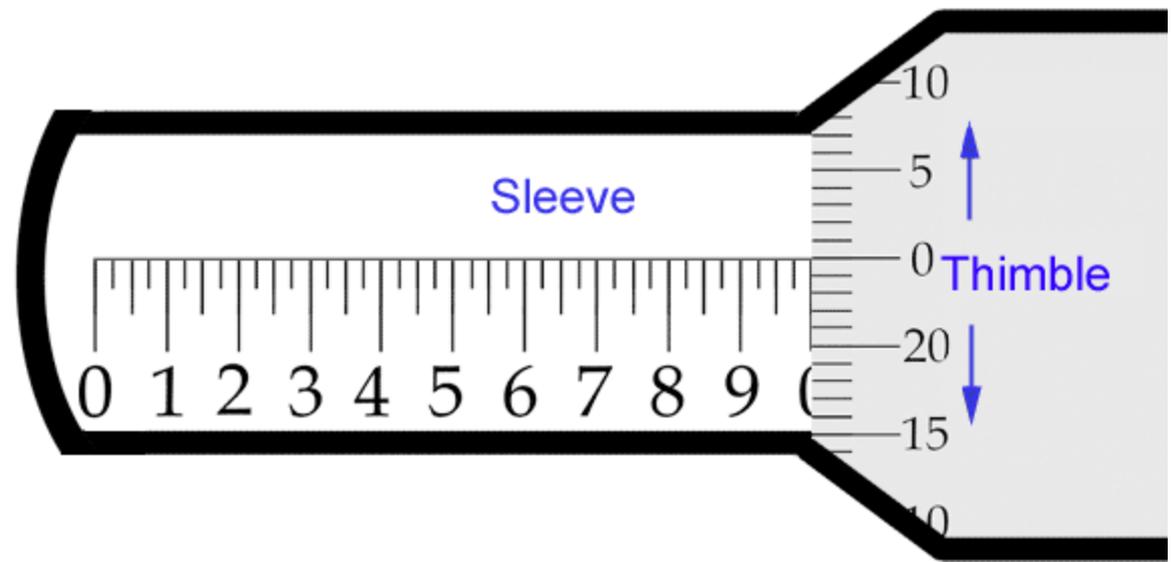


Reading a Micrometer

- ▶ **Sleeve:** 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.



- ▶ 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.

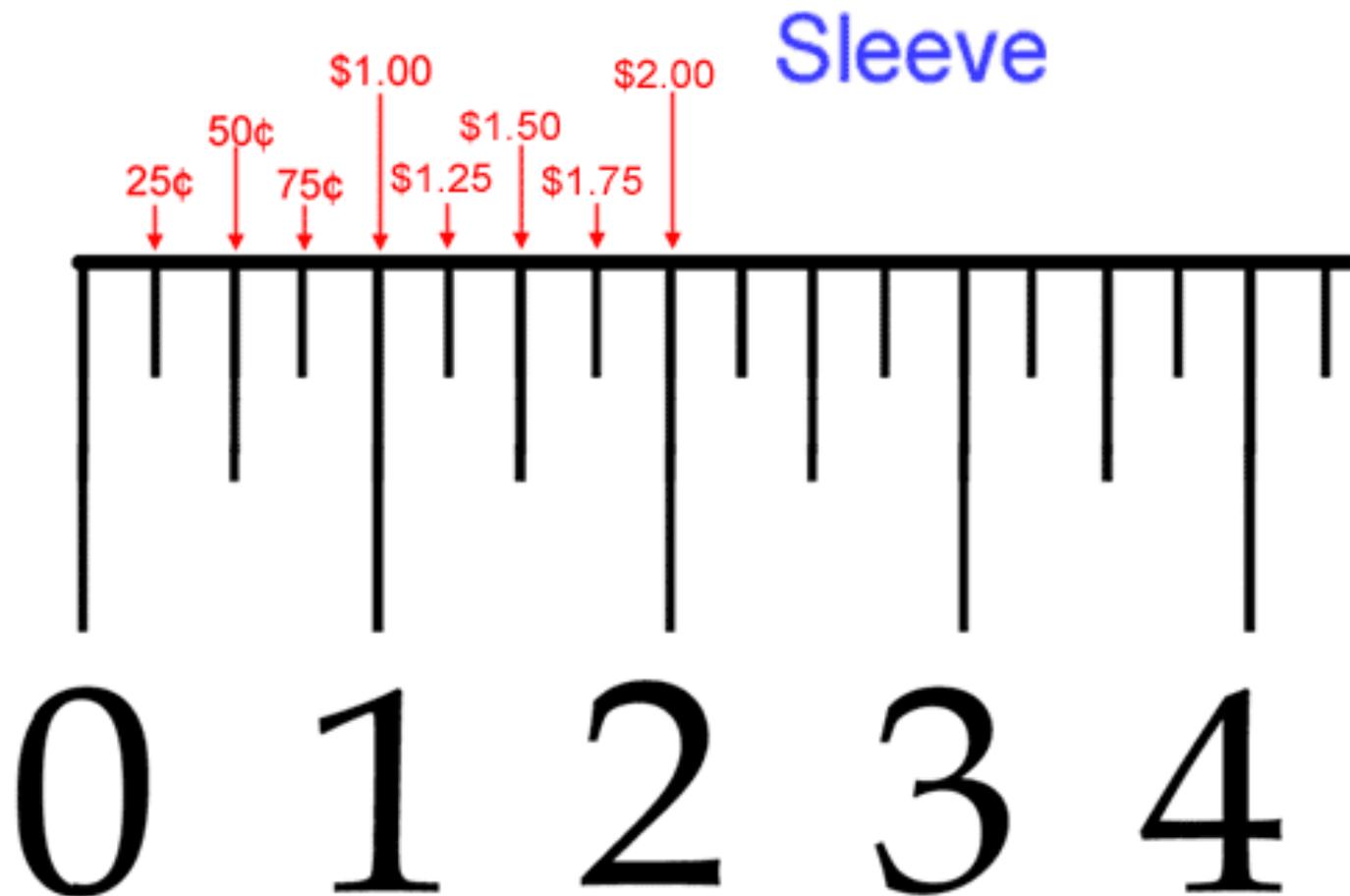


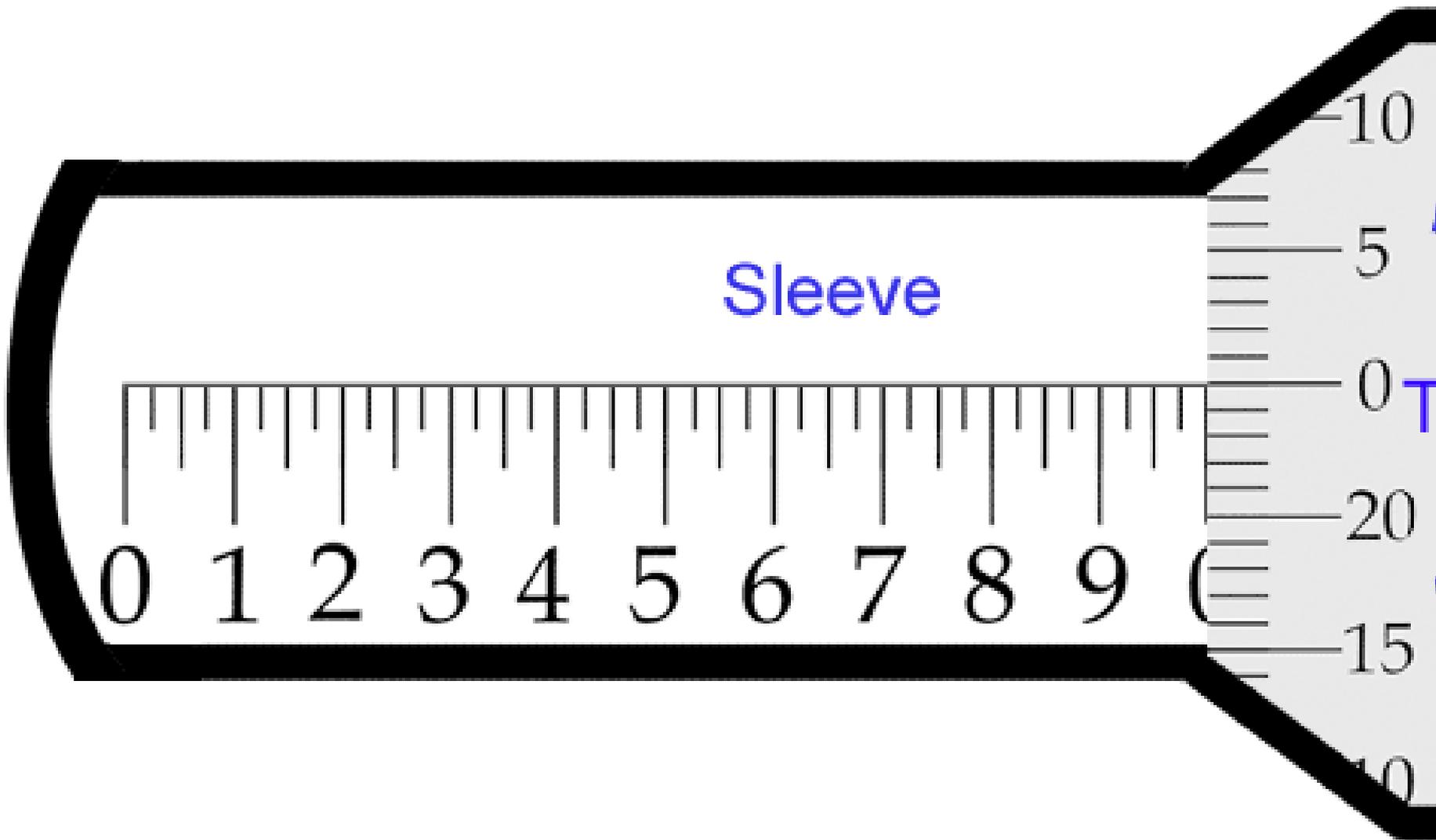
Thimble

The thimble is divided into twenty-five equal parts, each of these parts is equal to $.001''$ and, one complete rotation of the thimble coincides with the smallest division ($.025''$) on the sleeve.

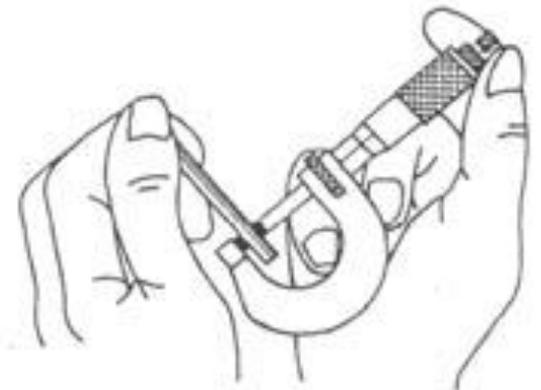
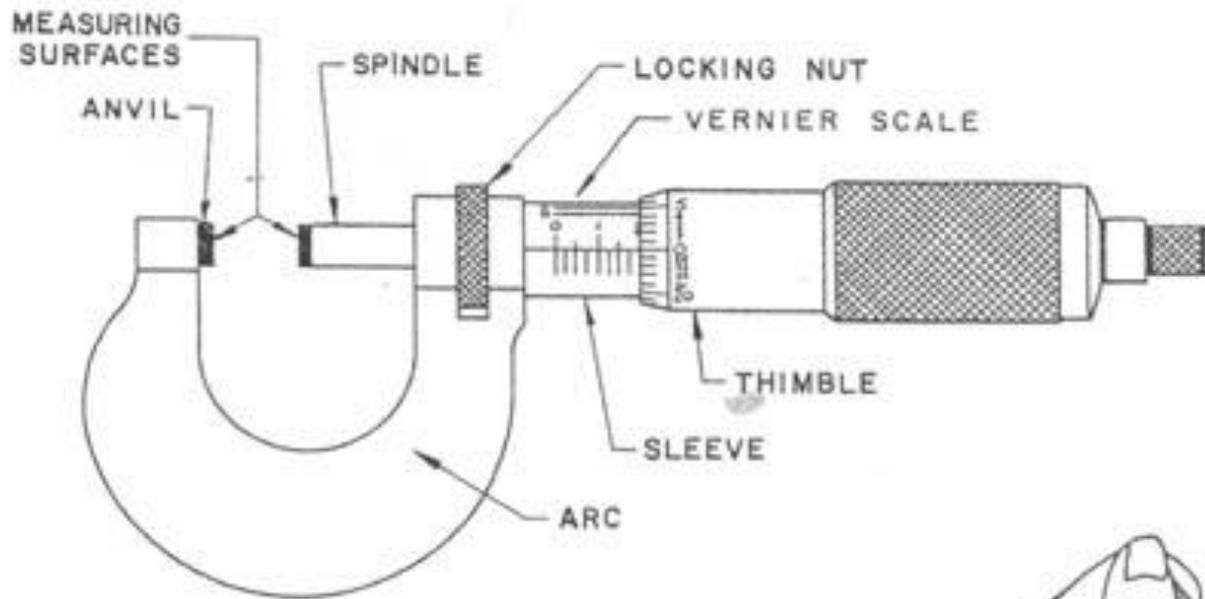


It is easy to read a micrometer if you think of the markings on the Sleeve as dollars and quarters





MICROMETER CALIPER



Micrometers

- ▶ **Micrometer Calibration**

- ▶ In order to measure accurately, the micrometer must be accurate itself
- ▶ Extreme temperatures can affect accuracy



Micrometers

- ▶ Reading a USC Outside Micrometer
 - ▶ Place anvil against work
 - ▶ Rotate thimble to bring spindle into contact with opposite side of work
 - ▶ Use ratchet knob to ensure sufficient contact is made
 - ▶ Remove micrometer and read dial



Inside Micrometers

823 Series Tubular Type



Depth Micrometers



Small Hole Gauges

- ▶ To measure small holes
- ▶ Gauge is straight with a screw handle on one end and a split ball on other
- ▶ Handle is turned to expand ball
 - ▶ Removed and measured with a micrometer



Small Hole Gauges



Dial Indicators

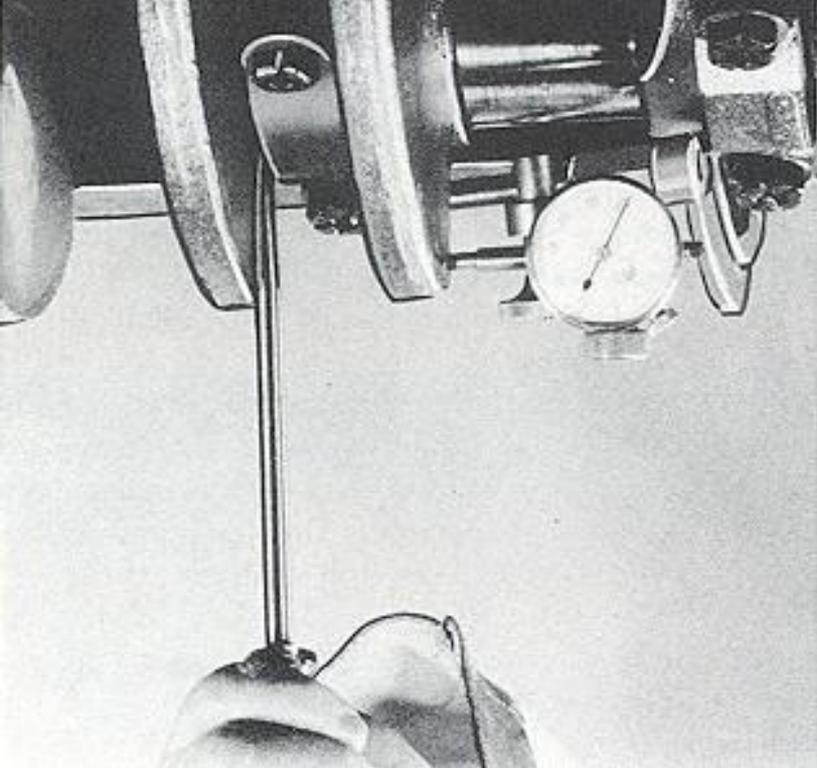
- ▶ **Dial Calipers**
 - ▶ For inside, outside, and depth measurements
 - ▶ Manual scales or digital
 - ▶ USC can measure in 0.001 inch increments
 - ▶ Metric can measure in 2-millimeter increments



Dial Indicators

- ▶ **Dial Indicators**
 - ▶ To check how far components can move
 - ▶ Scale can be USC or metric
 - ▶ Face can be balanced or continuous
 - ▶ To check runout or end play





Pressure and Vacuum Measurements

- ▶ **Pressure Gauges**

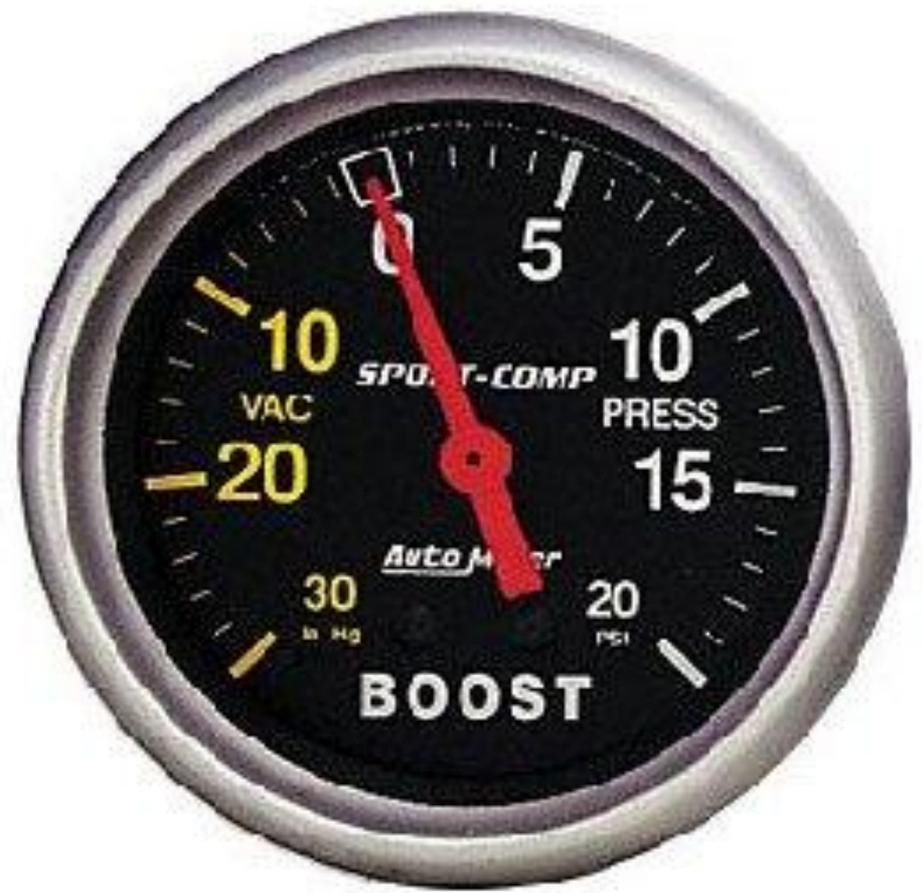
- ▶ Measure amount of pressure applied to a closed, sealed system
- ▶ Fitted into pressure line with appropriate fittings



Pressure and Vacuum Measurements

- ▶ Vacuum Gauges
 - ▶ Mechanical gauge measures difference between atmospheric pressure and current state of system





In-Process Inspection

- ▶ What to inspect?
 - ▶ Key quality characteristics that are related to cost or quality (customer requirements)
- ▶ Where to inspect?
 - ▶ Key processes, especially high-cost and value-added
- ▶ How much to inspect?
 - ▶ All, nothing, or a sample