

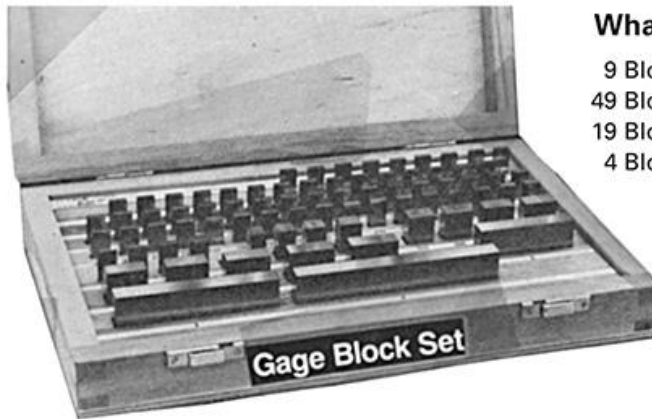
Measurement

Seven Standards of Measurement

❖ Provide the basics for all other units of measurement

- Length
- Time
- Mass
- Temperature
- Ampere
- Candela
- Mole

Gage Blocks



What's in the box

9 Blocks	0.1001	through 0.1009 in.	in steps of 0.0001 in.
49 Blocks	0.101	through 0.149 in.	in steps of 0.001 in.
19 Blocks	0.050	through 0.950 in.	in steps of 0.050 in.
4 Blocks	1.000	through 4.000 in.	in steps of 1.000 in.

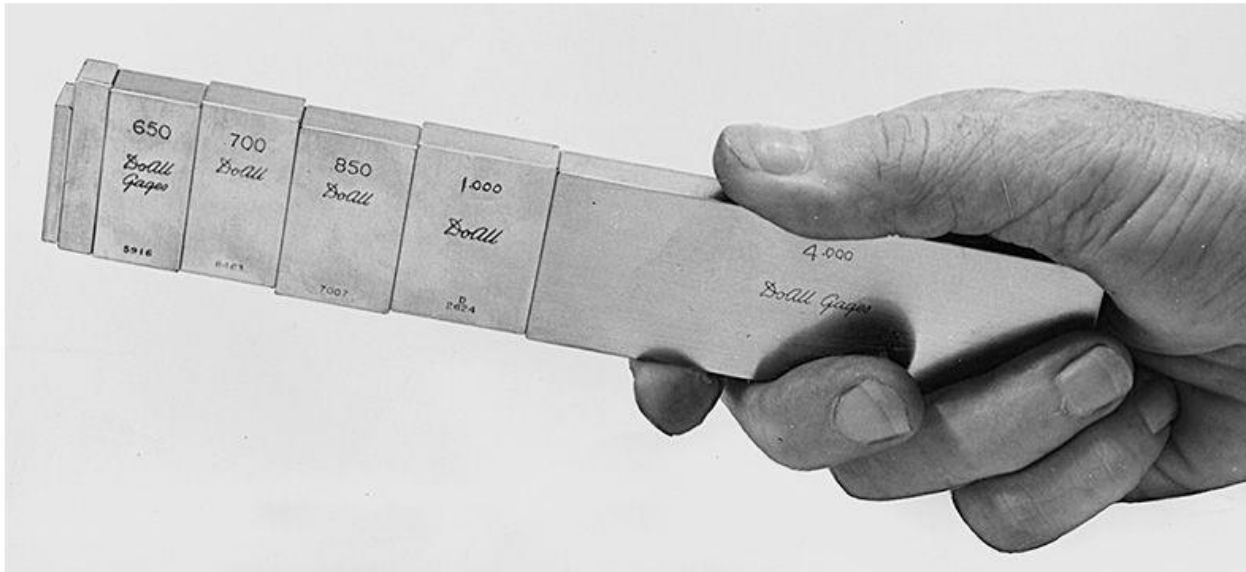


← Lapped and mirror polished to a very low micro-surface finish.

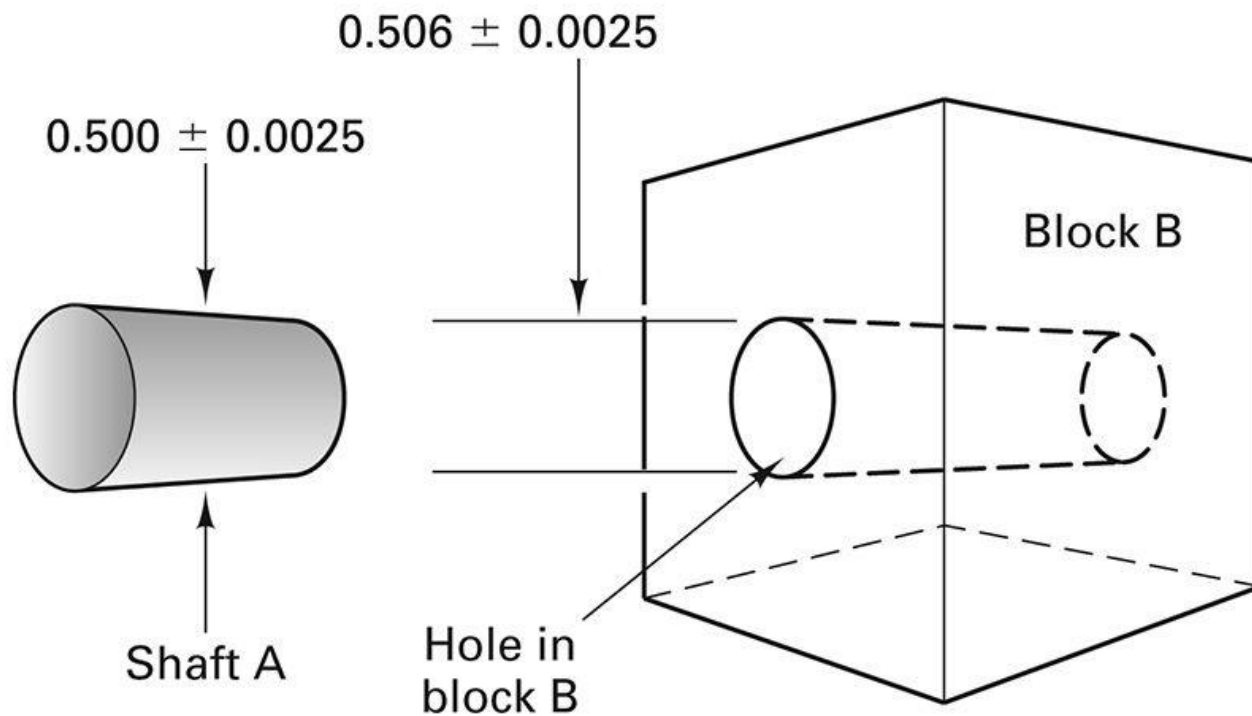


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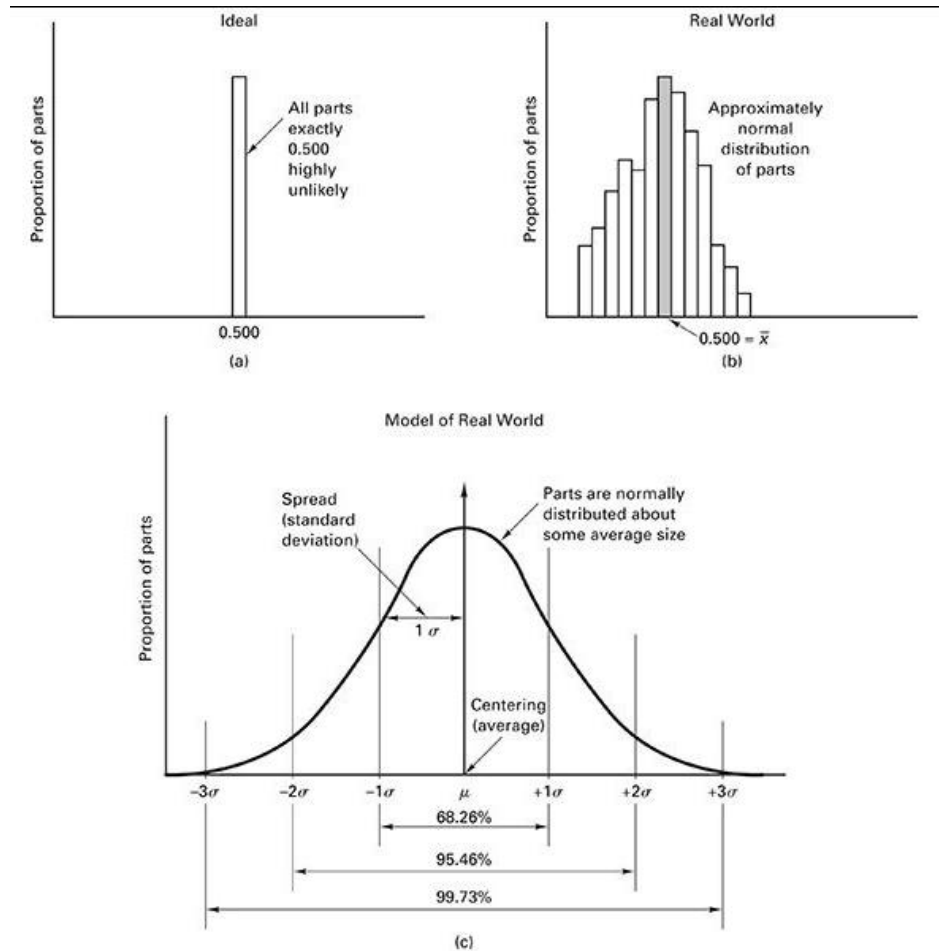
Gage Blocks wrung together



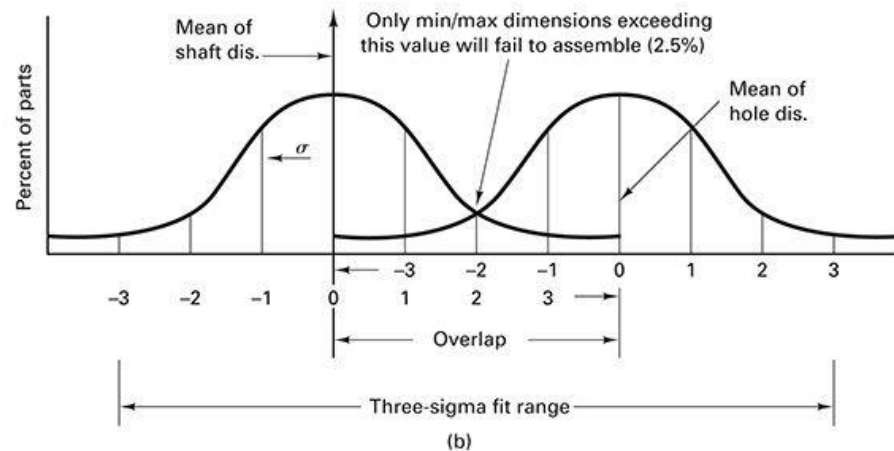
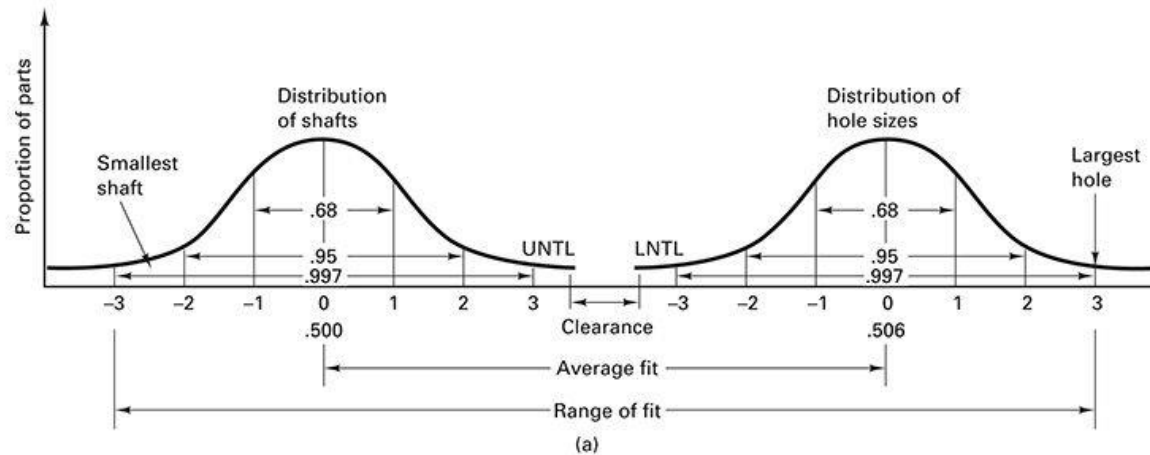
Mated Parts



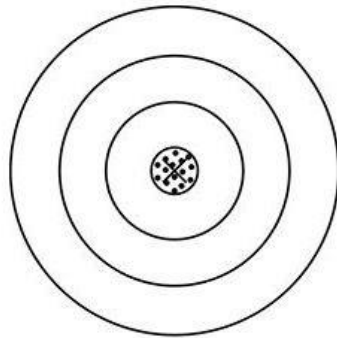
Normal Distribution



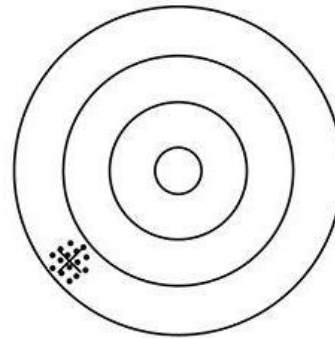
Distributions of Mating Parts



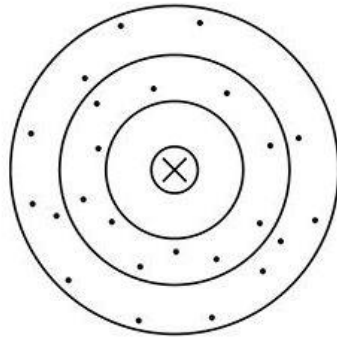
Accuracy Versus Precision



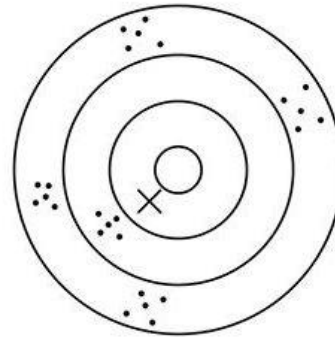
(a) Accurate and precise



(b) Precise, not accurate

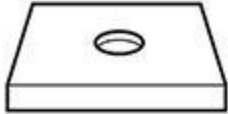
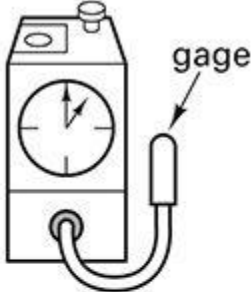

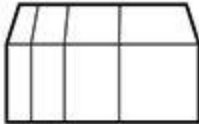


(c) Accurate, not precise

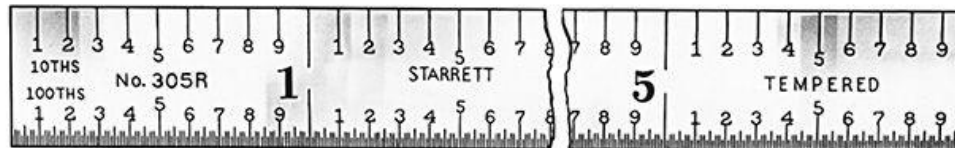


(d) Precise within sample
Not precise between samples
Not accurate overall or within sample

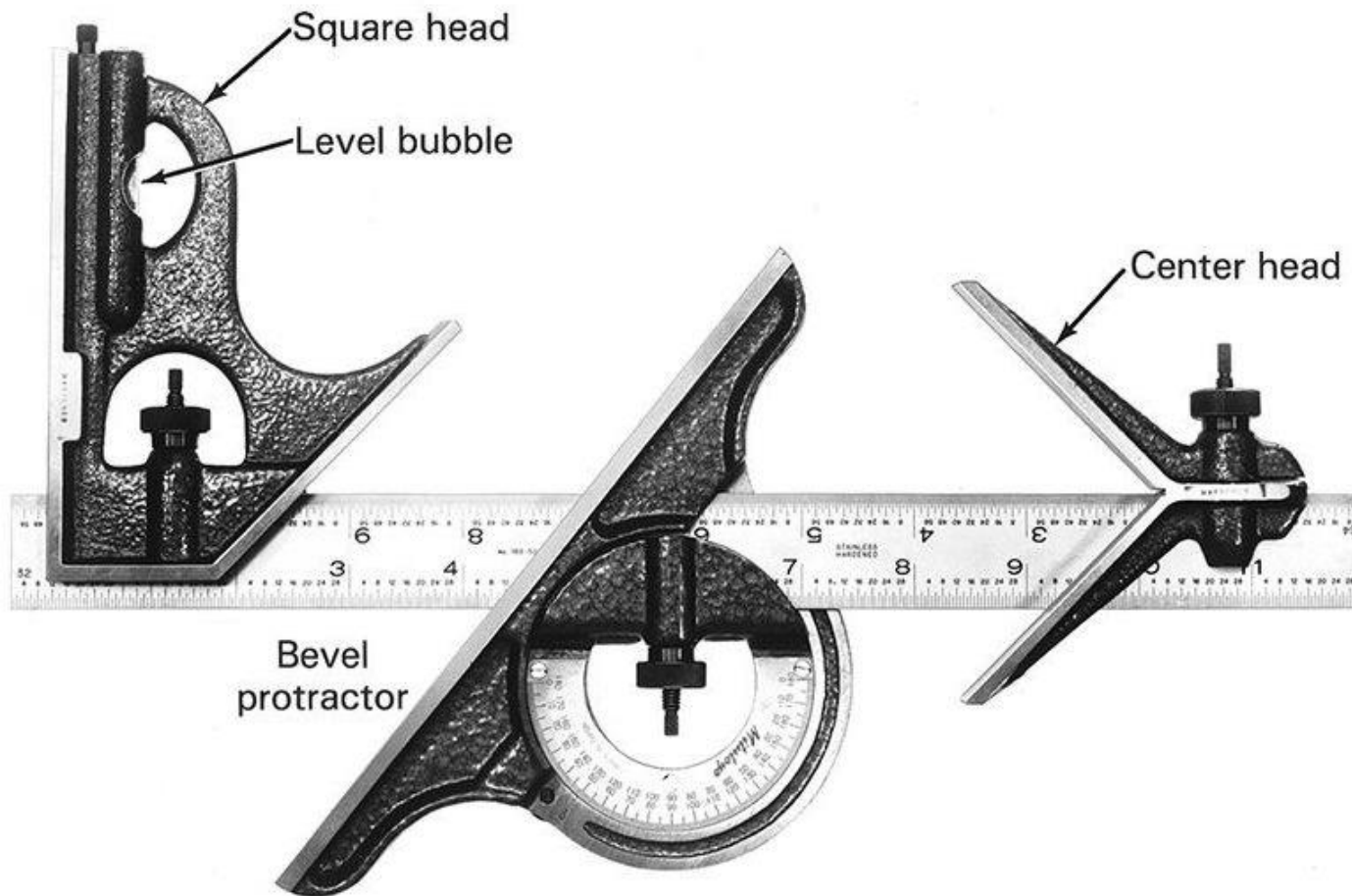
Rule of 10 for Inspection

 <p>Tolerance needed on part ± 0.001 on hole diameter</p>	 <p>Precision needed on gage ± 0.0001 in.</p>	 <p>To check and set the air gage, needs to be ± 0.00001 in.</p>	 <p>In the manufacture of the master gage, a standard of precision of at least ± 0.000001 in. is needed</p>
Workpiece	Air gage or working gage	Master gage	Reference end standard

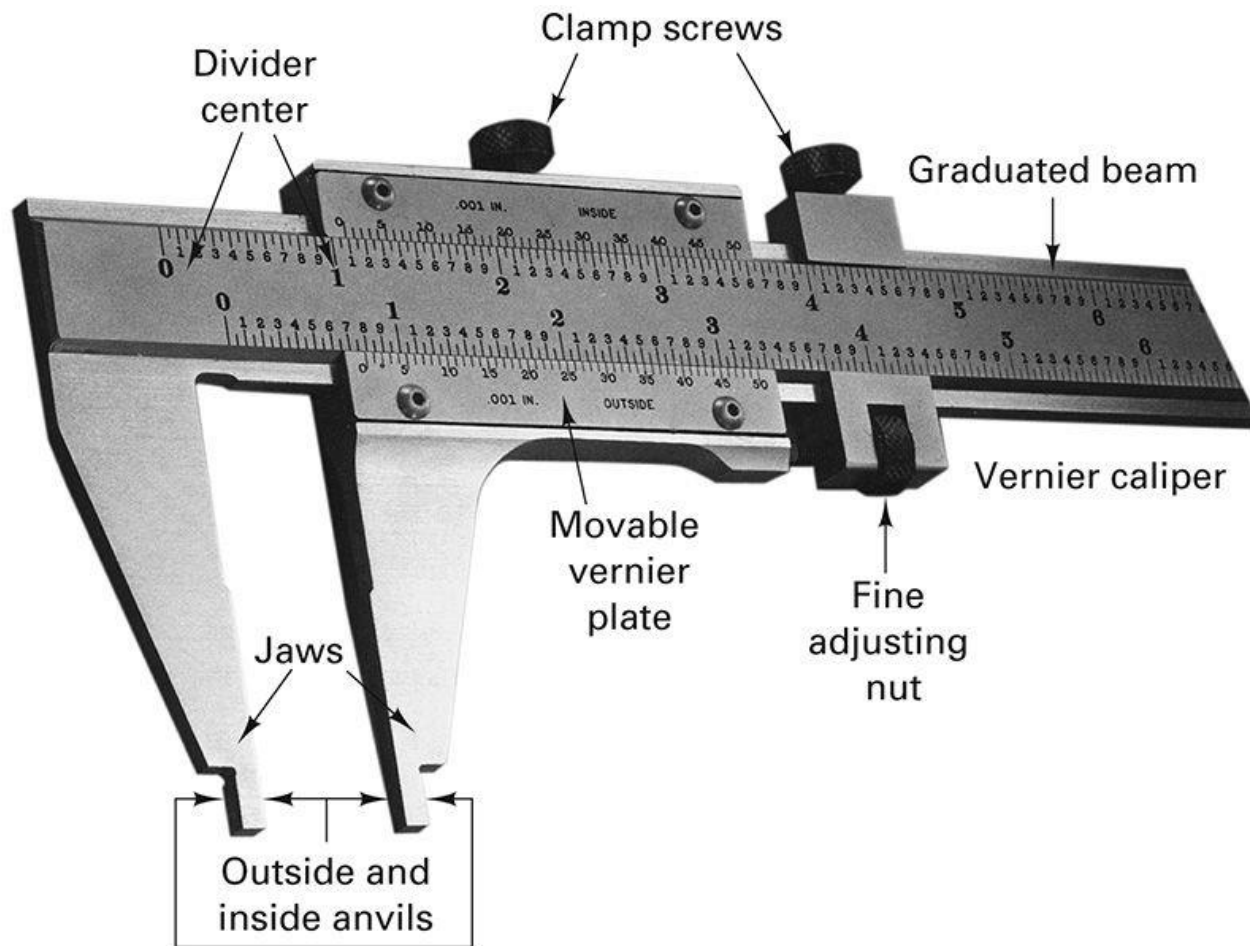
Machinist's Rules



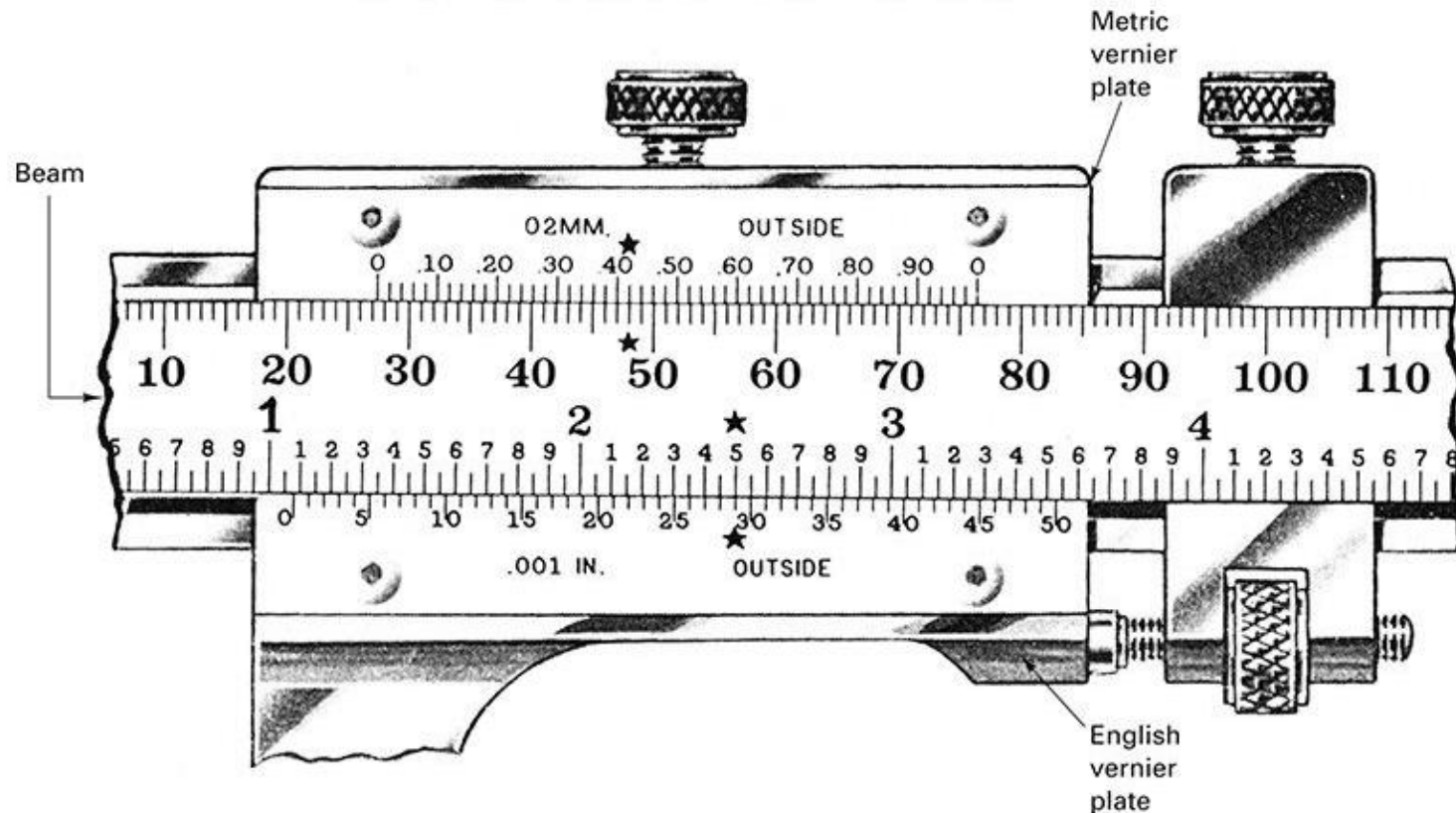
Combination Set



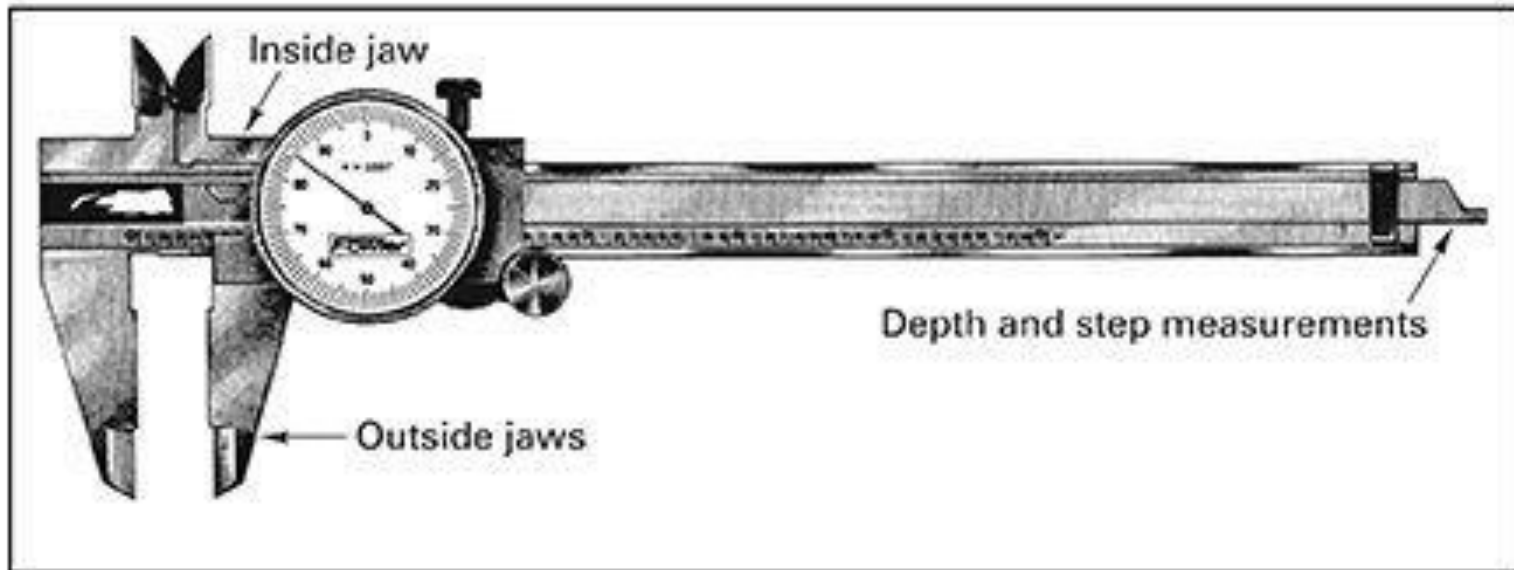
Vernier Caliper



Vernier Caliper Scale



Dial Caliper

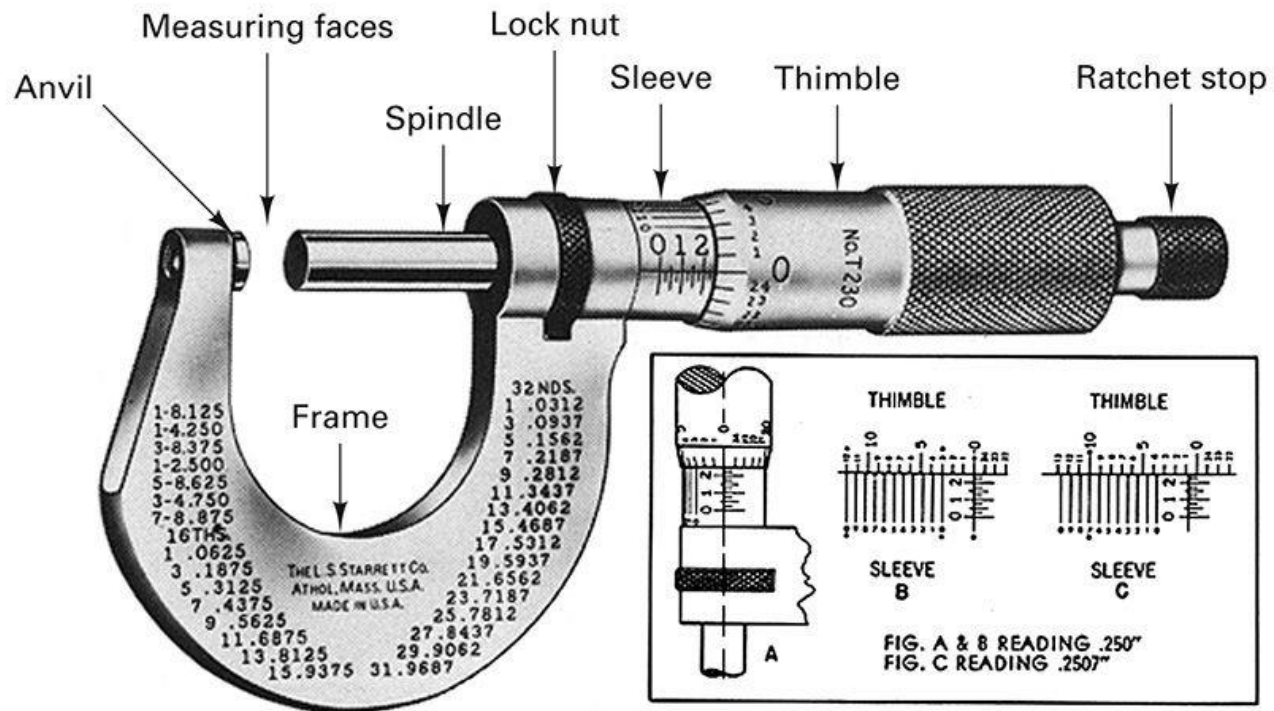


Dial caliper with 0.001-in. accuracy



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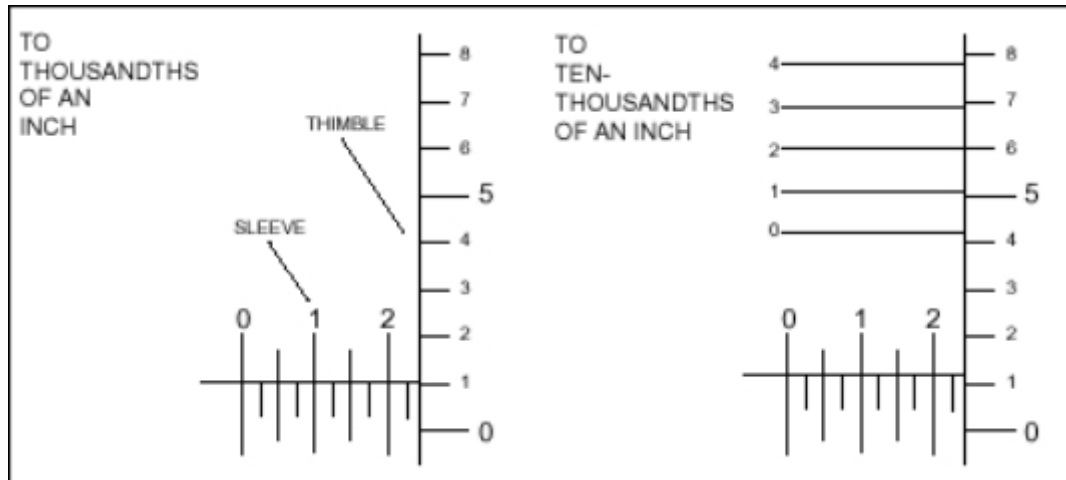
Micrometer





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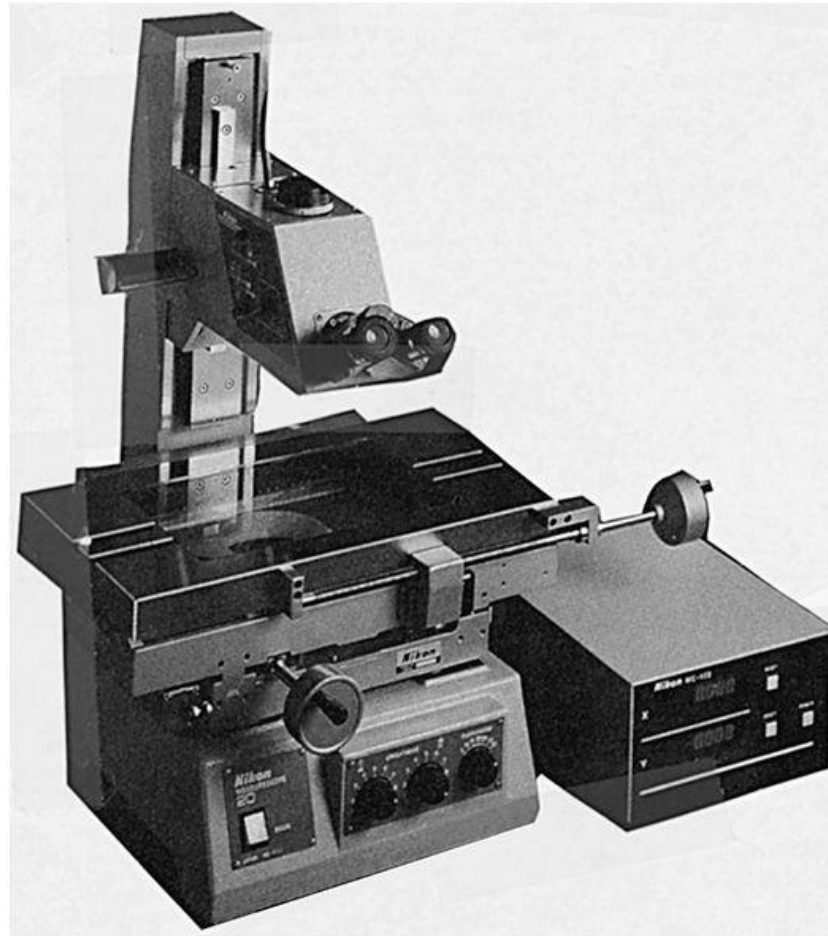
Micrometer



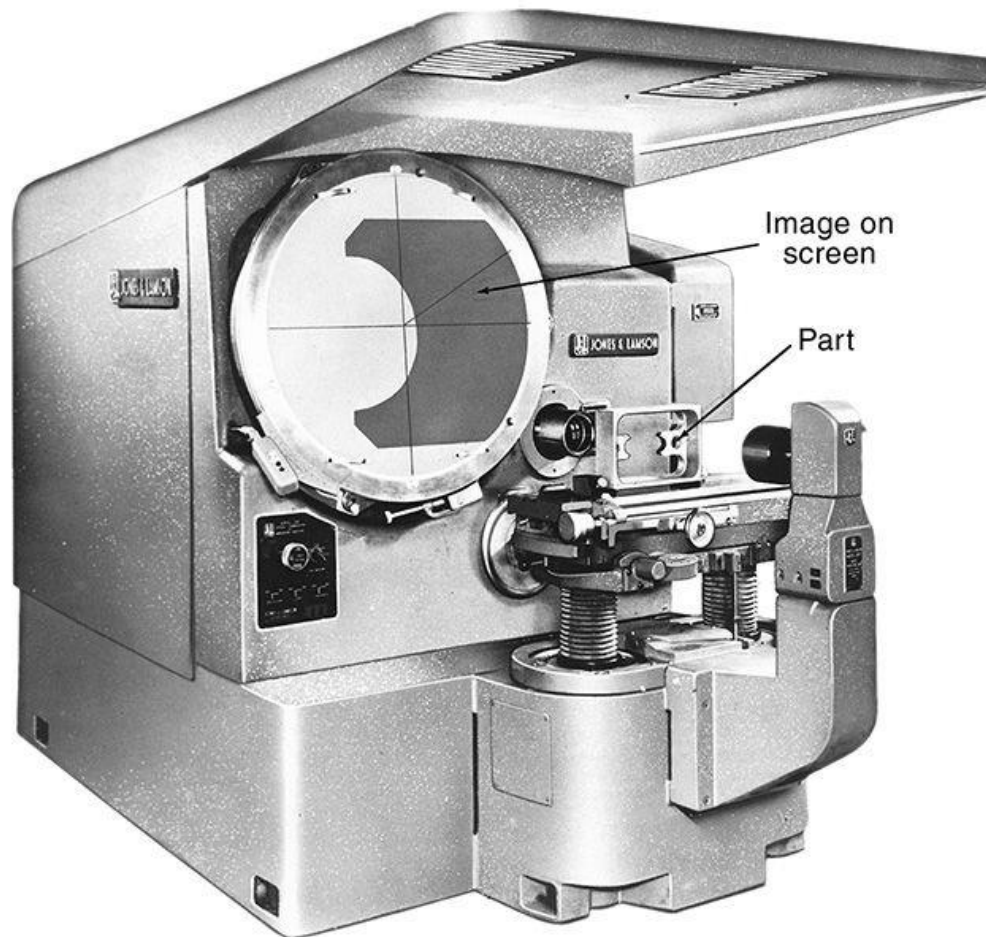
$$\begin{array}{r}
 0.2'' \\
 + 0.025'' \\
 + 0.001'' \\
 \hline
 0.226''
 \end{array}$$

$$\begin{array}{r}
 0.2'' \\
 + 0.025'' \\
 + 0.001'' \\
 + 0.0002'' \\
 \hline
 0.2262''
 \end{array}$$

Toolmaker's Microscope



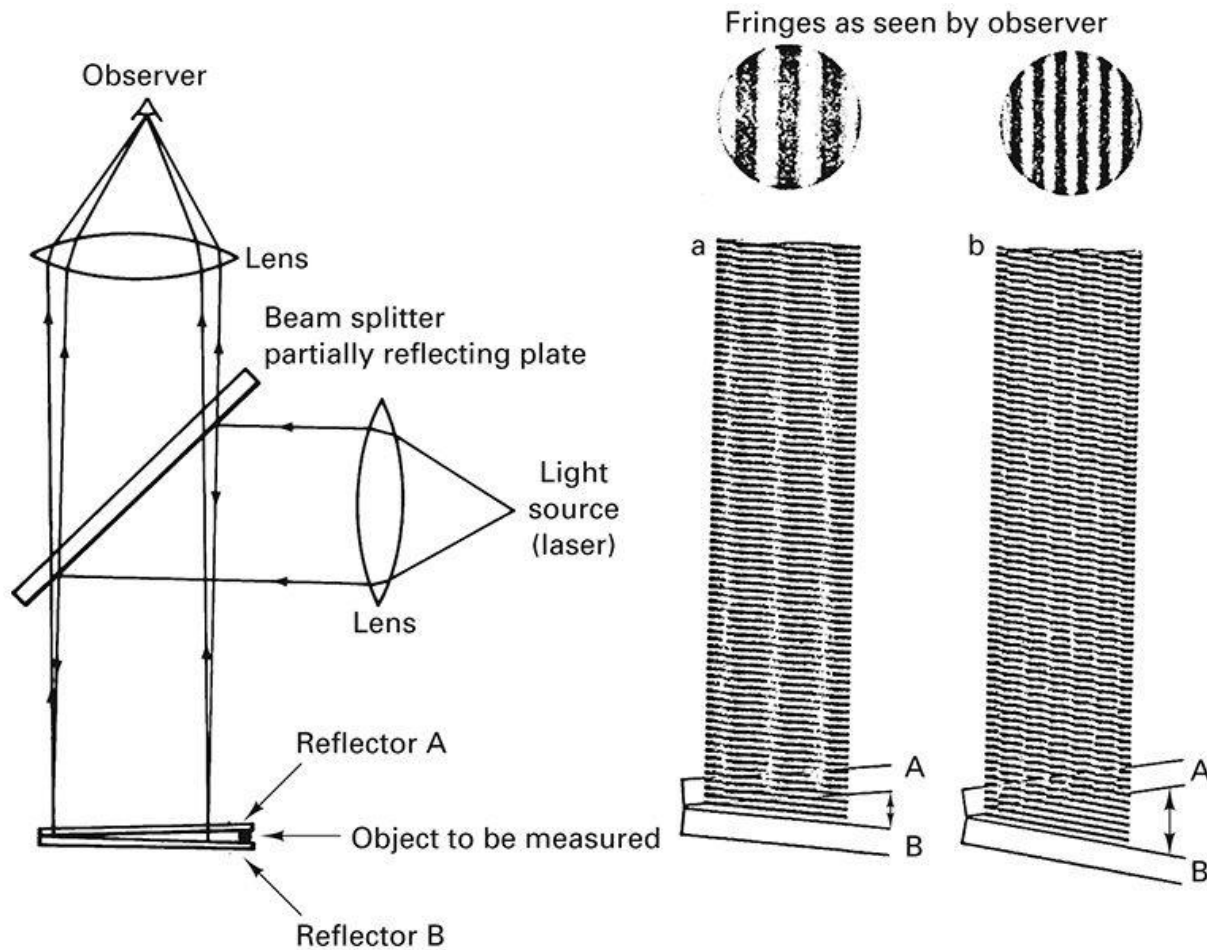
Optical Comparator



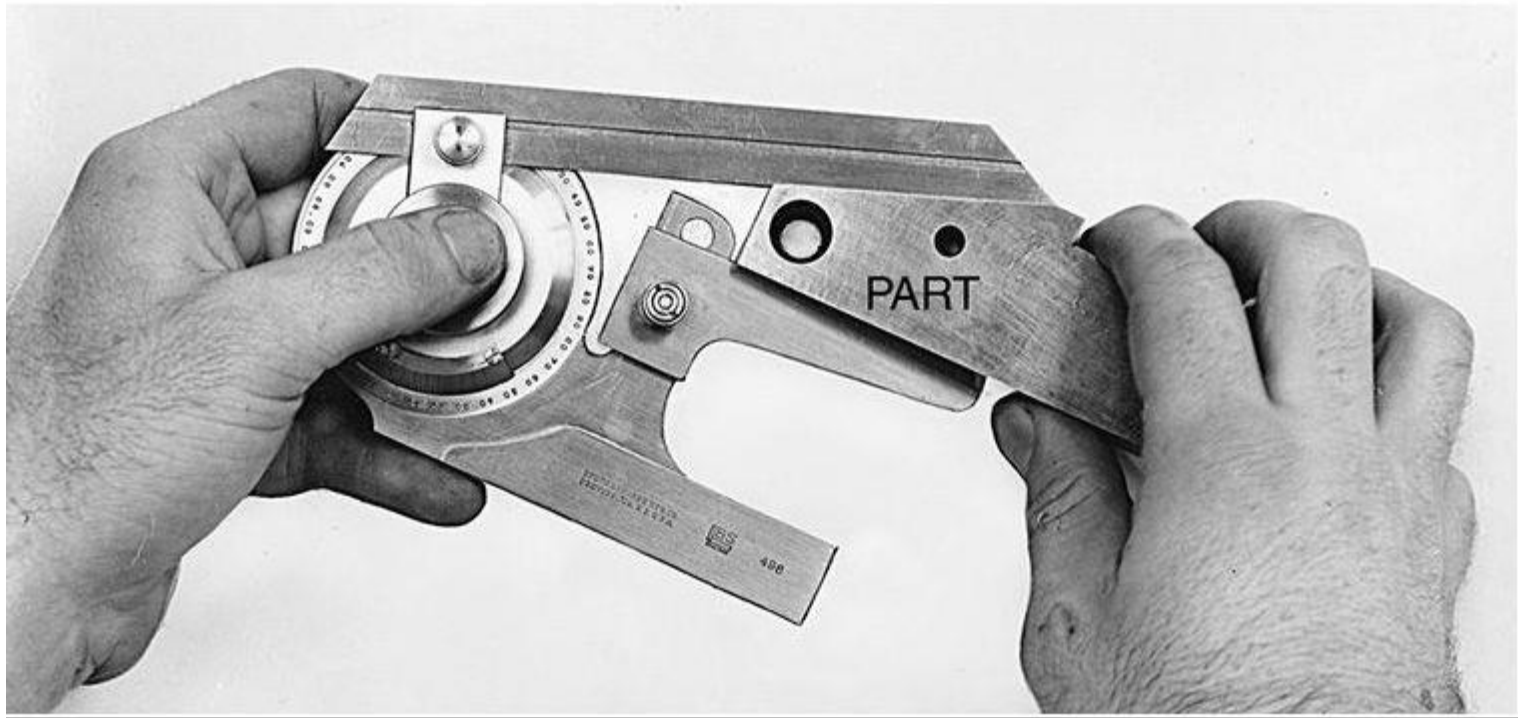


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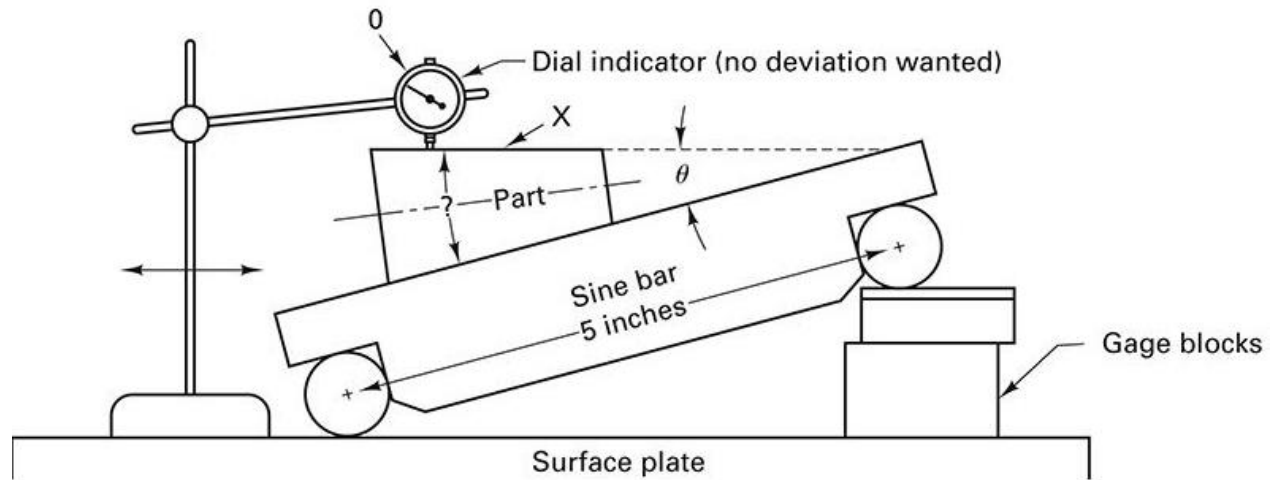
Interferometry



Bevel Protractor



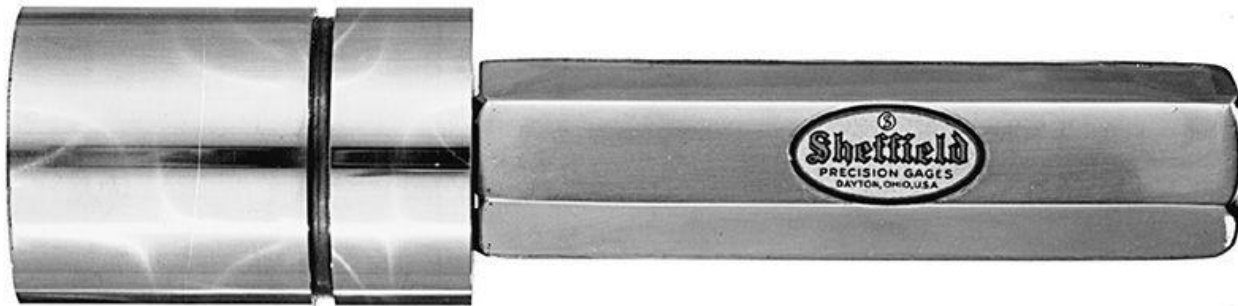
Sine Bar



Double-Ended Plug Gage Go/No-Go



Step-type Plug Gage



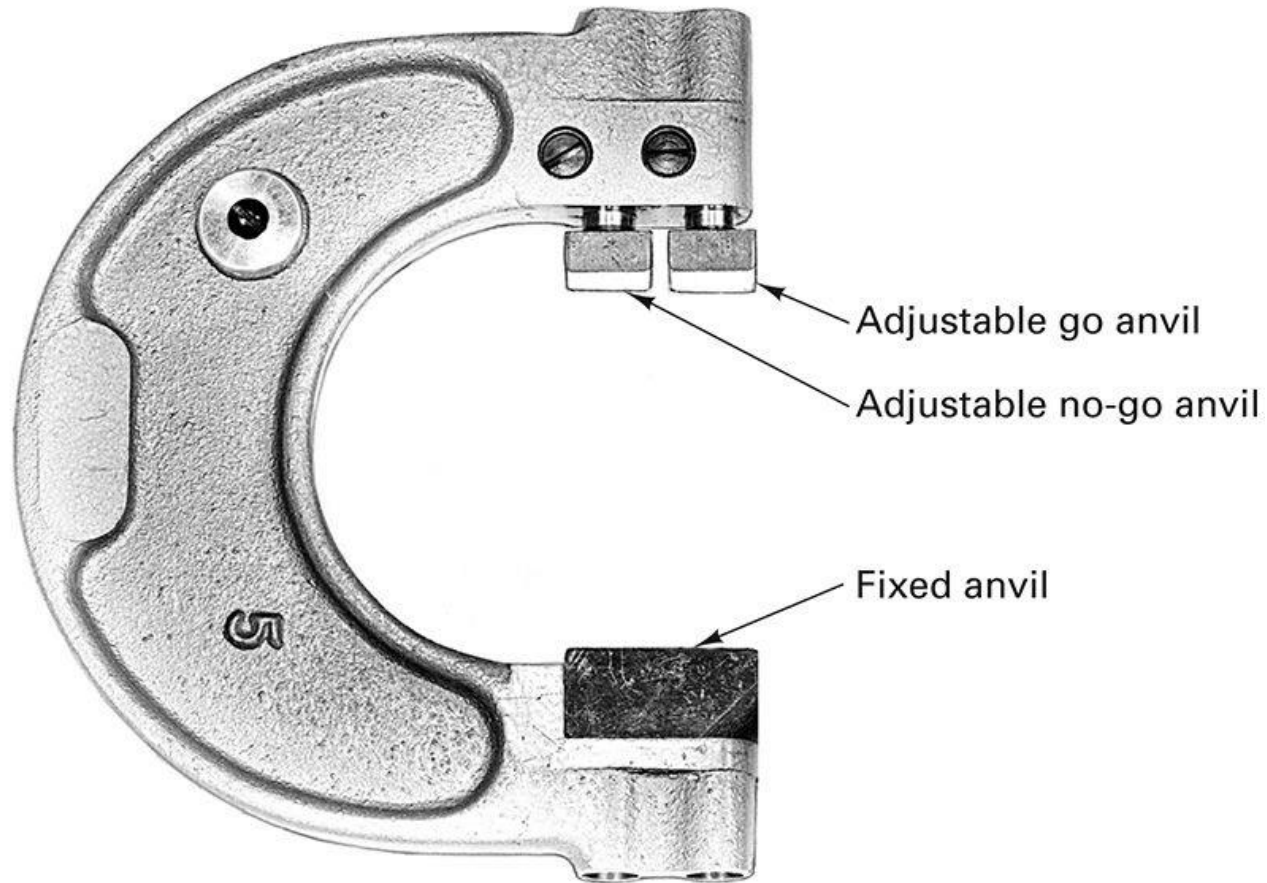
Ring Gages

No-Go (max) on left, with knurling groove.

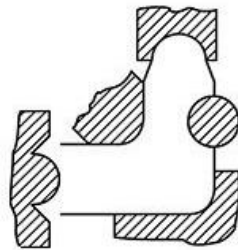
Go (min) on right, without groove



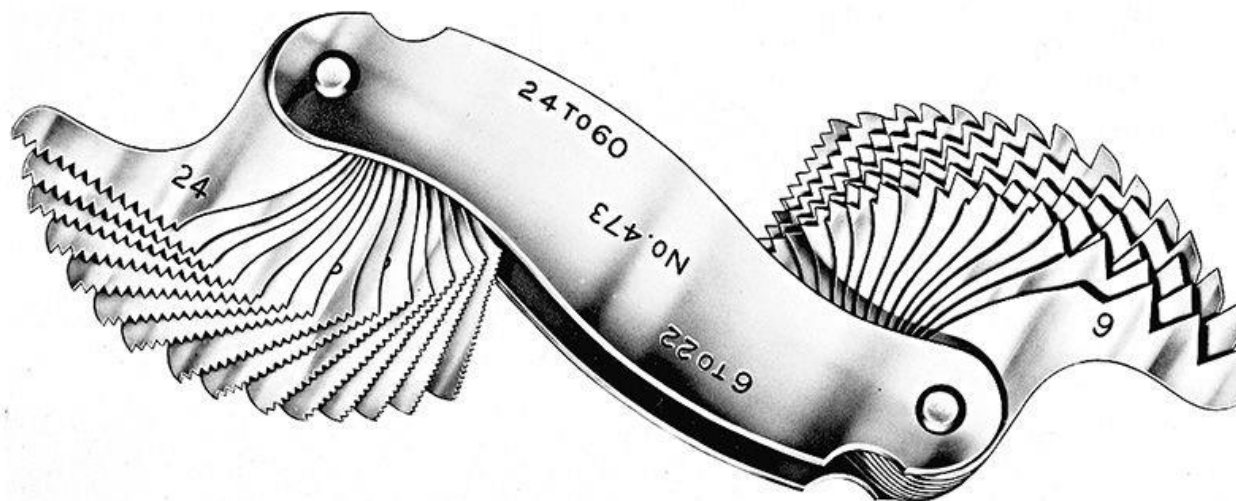
Adjustable Snap Gage



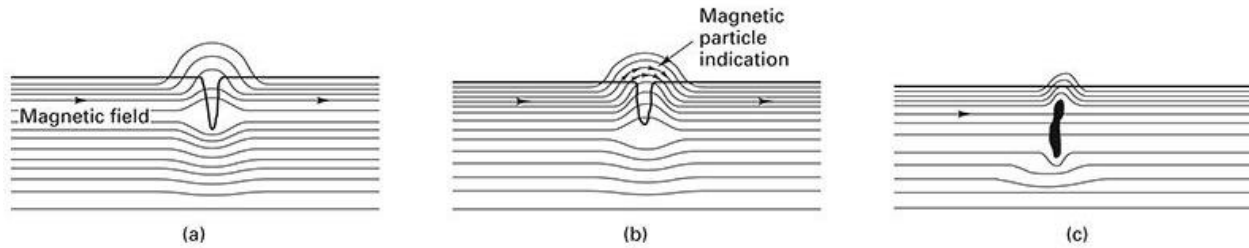
Radius Gages



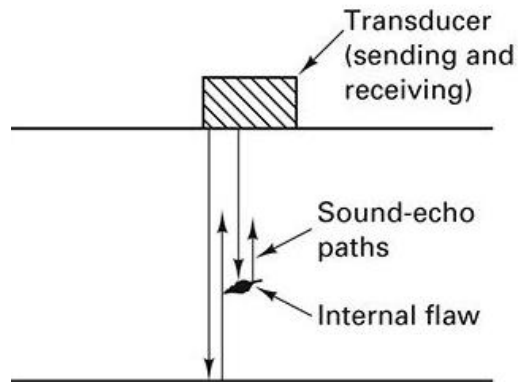
Thread Pitch Gages



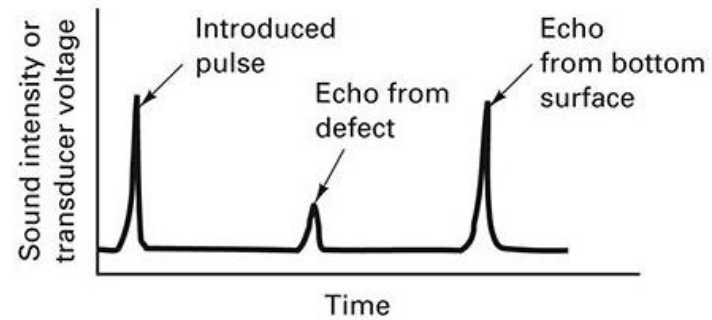
Magnetic Particle Inspection



Ultrasonic Inspection



(a)



(b)

Radiography X-Ray Inspection

