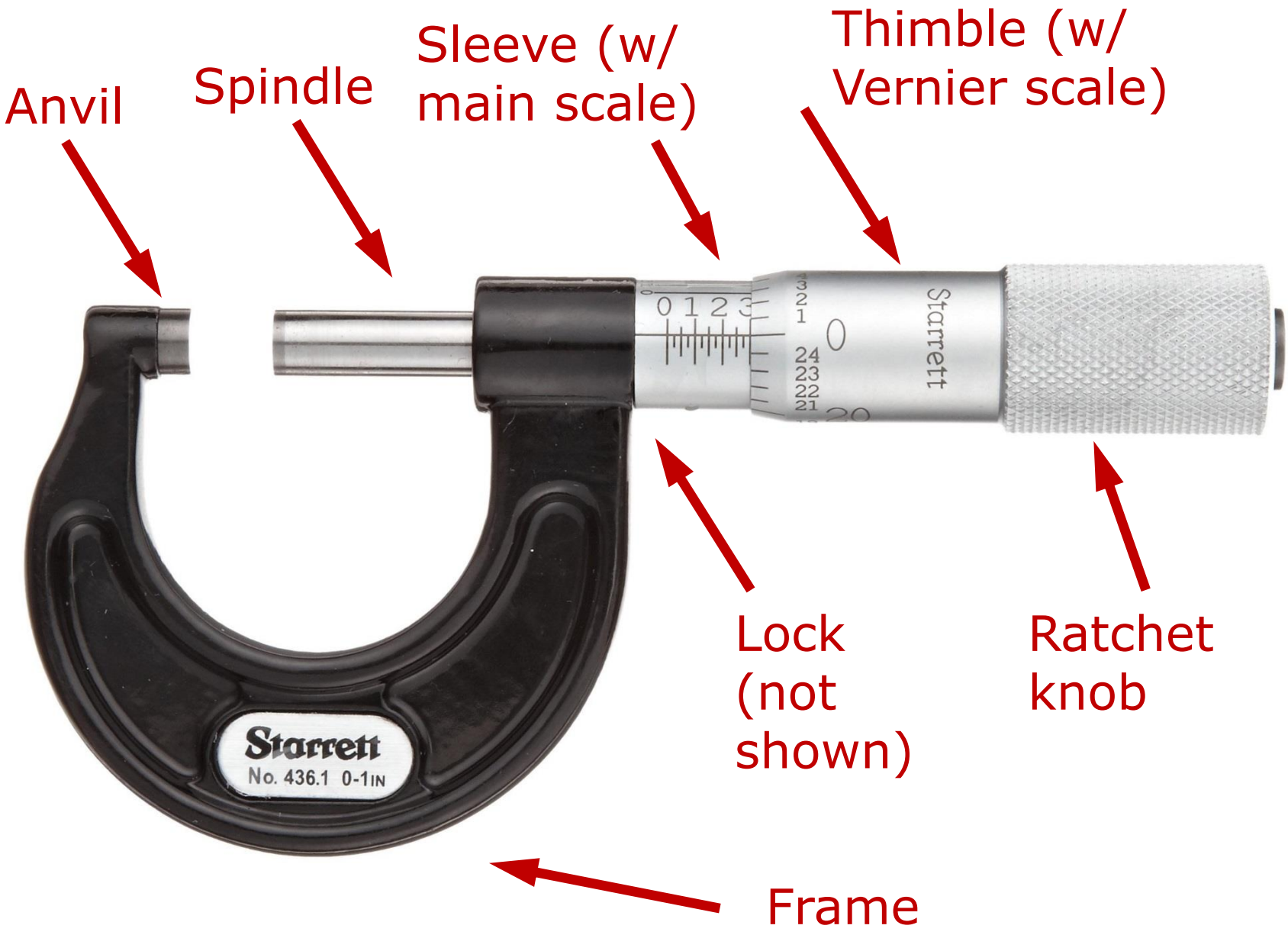
Micrometers

The Micrometer




Mechanical
Assembly

Threaded Fasteners

Benefits of threaded fasteners

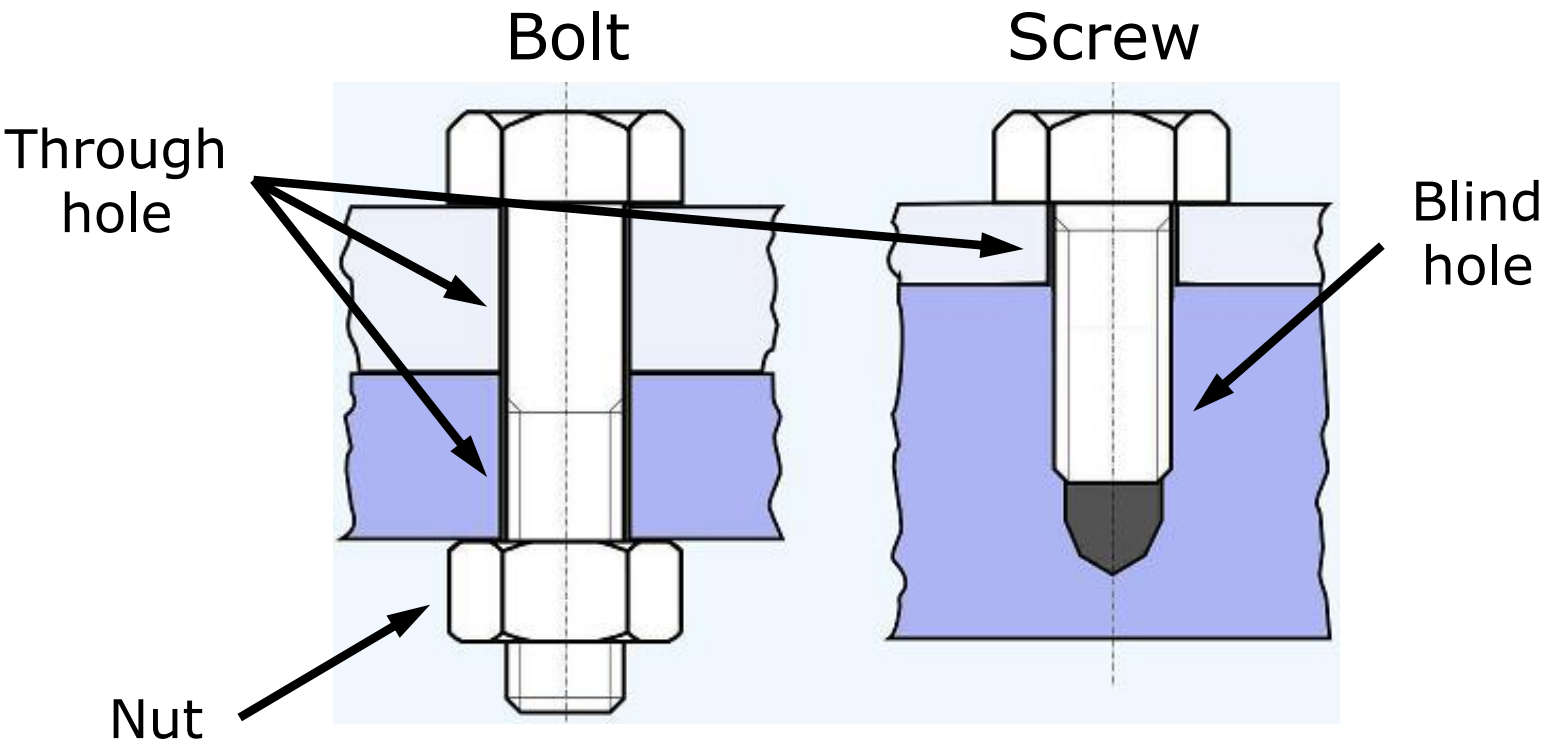
- Ease of assembly
- Allows disassembly and maintenance/repair of assemblies
- Large products may be transported as smaller features/subassemblies and assembled on site
- Often easier to manufacture and join components than produce complex geometries

Set (glued) necks require experienced luthiers for repairs
e.g. Les Paul

Through neck are difficult to repair

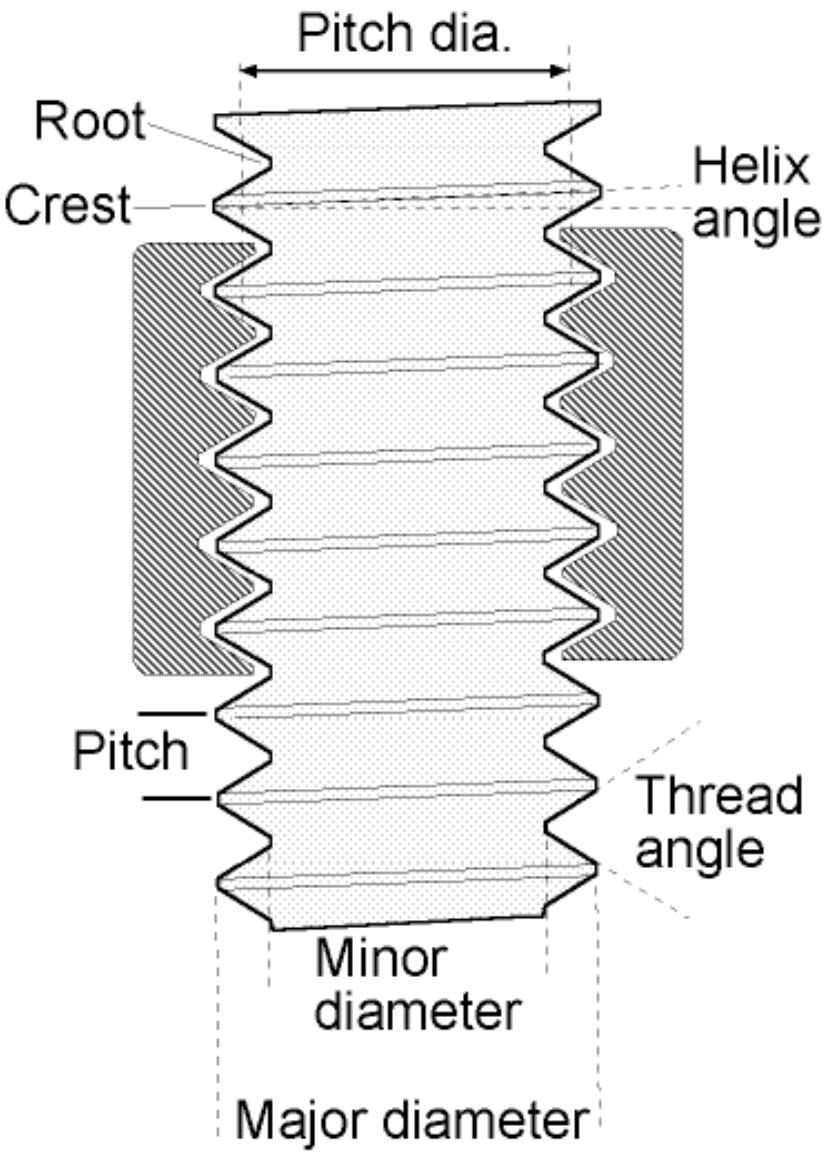
Bolt on necks are easily replaced
e.g. Fender

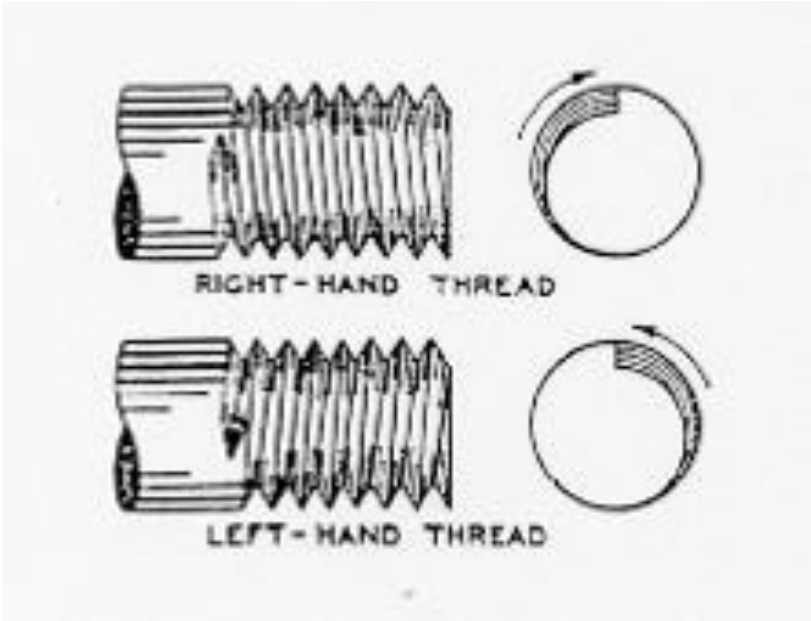
Screw Terminology



A bolt utilizes a nut whereas a screw engages with a feature

Thread Terminology





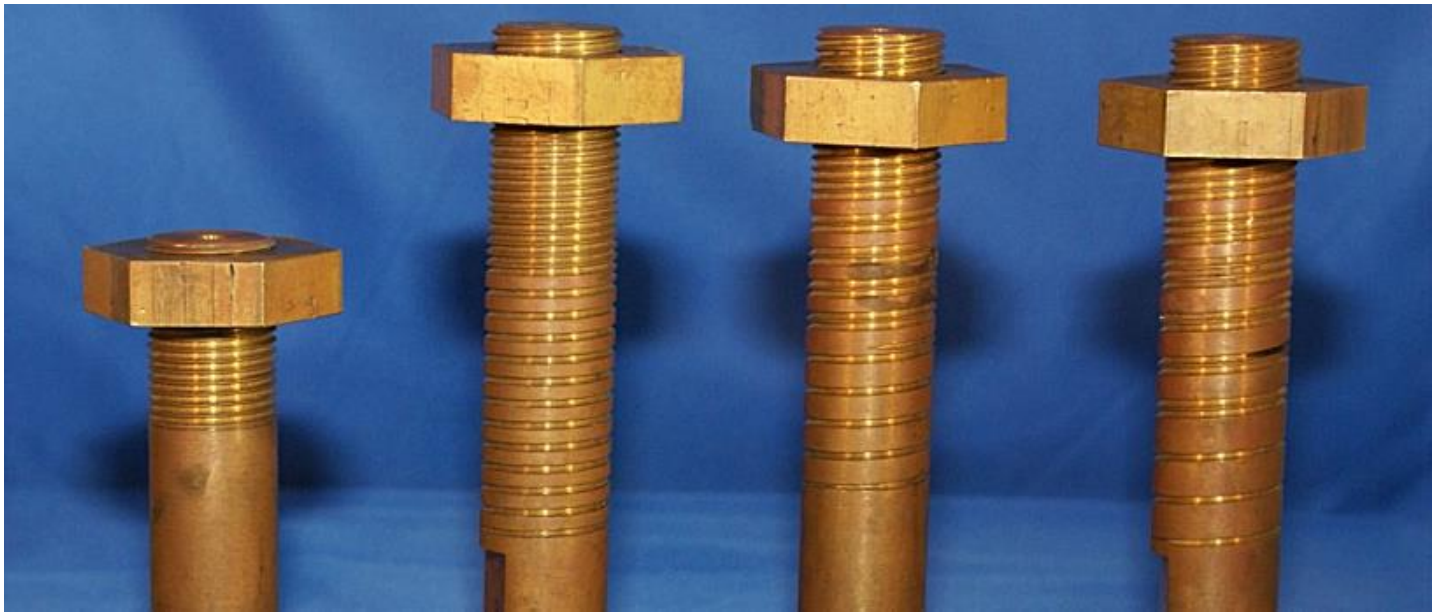
Most common applications utilize a right hand thread (lefty loosy, righty tighty)

Thread Terminology

Multistart or multiple thread screws increase the threading speed and are often used on CNC machines to increase traversal speed

The lead (engagement per revolution) is *n* x pitch where *n* is the number of starts

Single thread | Double thread | Triple thread | Quadruple thread



Machine Screws and Capscrews

Machine screws and capscrews have the same general geometry and are designed to be inserted into tapped holes

Capscrews are generally of higher tolerance and are generally manufactured from higher strength

Machine Screws and Capscrews

Pan

Button

Large Diameter (Truss)

Round

Extra-Wide Low Profile Head

Binding

Fillister

Cheese

Hex

Flat

Oval

Phillips

Slotted

Combination (Phillips/Slotted)

Slotted with Vent

Torx

Hex

Pozidriv

Tamper-Resistant Pin-in-Torx

Tamper-Resistant Tri-Groove

Tamper-Resistant One-Way

Tamper-Resistant Drilled Spanner

Socket Head Capscrews

Socket head cap screws (allen bolts) have a head diameters nominally 1.5 times that of the major diameter and a head height equal to the shank diameter

Like capscrews, these fasteners are typically fabricated from high strength materials

Socket Head Capscrews

Standard

Button

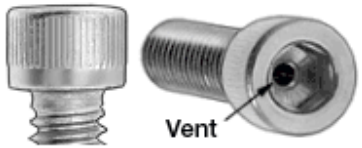
Flat

Drilled Head
Wire screws together to prevent loosening from vibration.

Flange Socket

Flange Button

Low



Vented
Vented hole is drilled through entire length.

Hex Socket

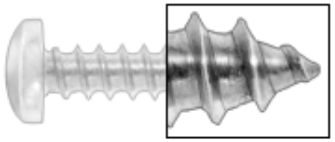
Torx

Tamper Resistant Pin-in-Hex Socket

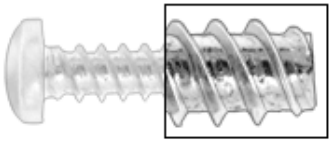
Tamper Resistant Pin-in-Torx

Tamper Resistant High Security
Screws are unique configuration from McMaster-Carr.

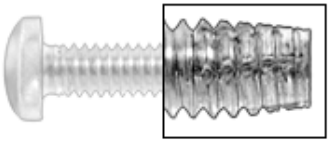
Self-tapping Screws



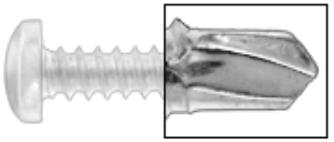
Sheet Metal Screws
Have a pointed end and widely spaced threads. Self-starting in thin sheet metal. In thicker materials, a drilled hole is recommended.



Thread-Forming Screws
Have a blunt point and fine threads. Form threads in metal, plastic, and plywood. A drilled hole is required.



Thread-Cutting Screws
Have blunt, tapered, tap-fluted end that cuts machine screw threads and ejects material as it turns. Use in metal, plastic, and plywood. A drilled hole is required.



Self-Drilling Screws
Drill their own hole, tap a thread, and fasten material in a single operation. Excellent for use in sheet metal.

Wood Screws


Flat


Ribbed Flat Head


Self-Sinking Flat Head


Self-Sinking Flat Head with Washer


Self-Sinking Ribbed Flat Head


Pan


Oval


Round


Large Diameter Round Head (Timber Screws)


Round Head Square Neck (Carriage Screws)


Round Head Ribbed Neck (Carriage Screws)


Hex Head (Lag Screws)


Hex Flange Head (Lag Screws)


Phillips


Slotted


Square


Combination (Phillips/Square)


Hex

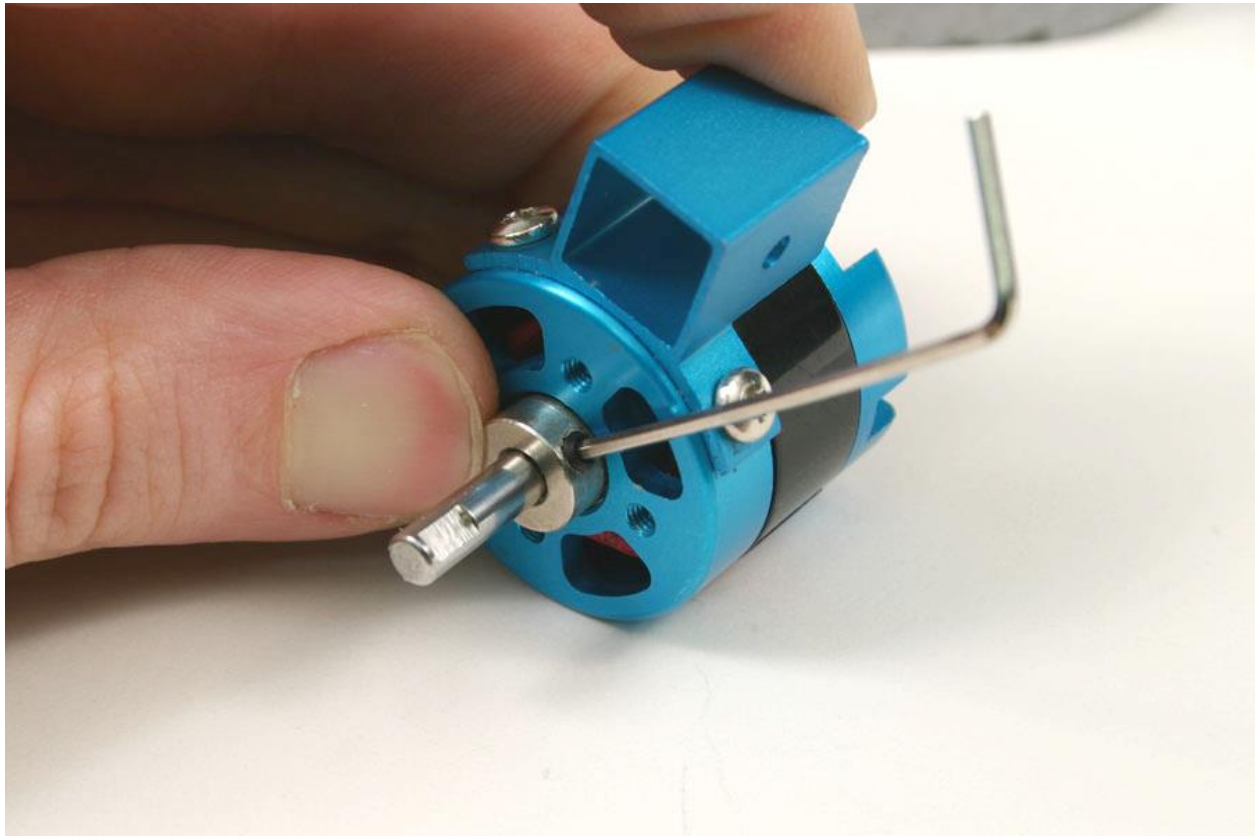

Torx


Uni-Drive

Set Screws

Set screws are often used to secure against torsional loads (e.g. gear on shaft, knob on shaft)

Set screws can minimize tooling requirements for attachment



Set Screws

Blind screws (grub screws) have no heads

Standard Socket
The most common screw style.

Self-Locking Socket
Locking element increases holding power. Perfect for tough jobs.

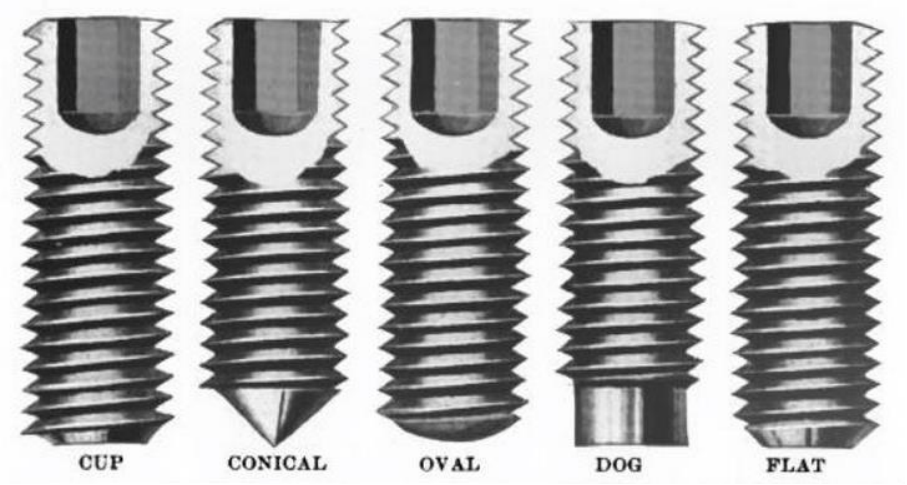
Hollow-Lock Socket
Often used to lock other set screws in place, to hold pins, and to adjust spring tension.

Slotted
Install with a standard slotted screwdriver.

Square Head
Easy to access by hand or with a wrench when you need more torque.

Swivel Pad Socket
Pad swivels to make maximum contact against angled surfaces.

Set Screws



Cup
Most popular style. Thin edge digs into contact surface for high holding power.

Knurled Cup
Knurls improve grip and prevent backing out or loosening.

Vented Cup
Vent fluids and gases while holding parts securely in place.

Cone
Highest holding power of any point style. Sharp tip wedges into surface.

Flat
Best for making frequent adjustments. Tip won't mar contact surface.

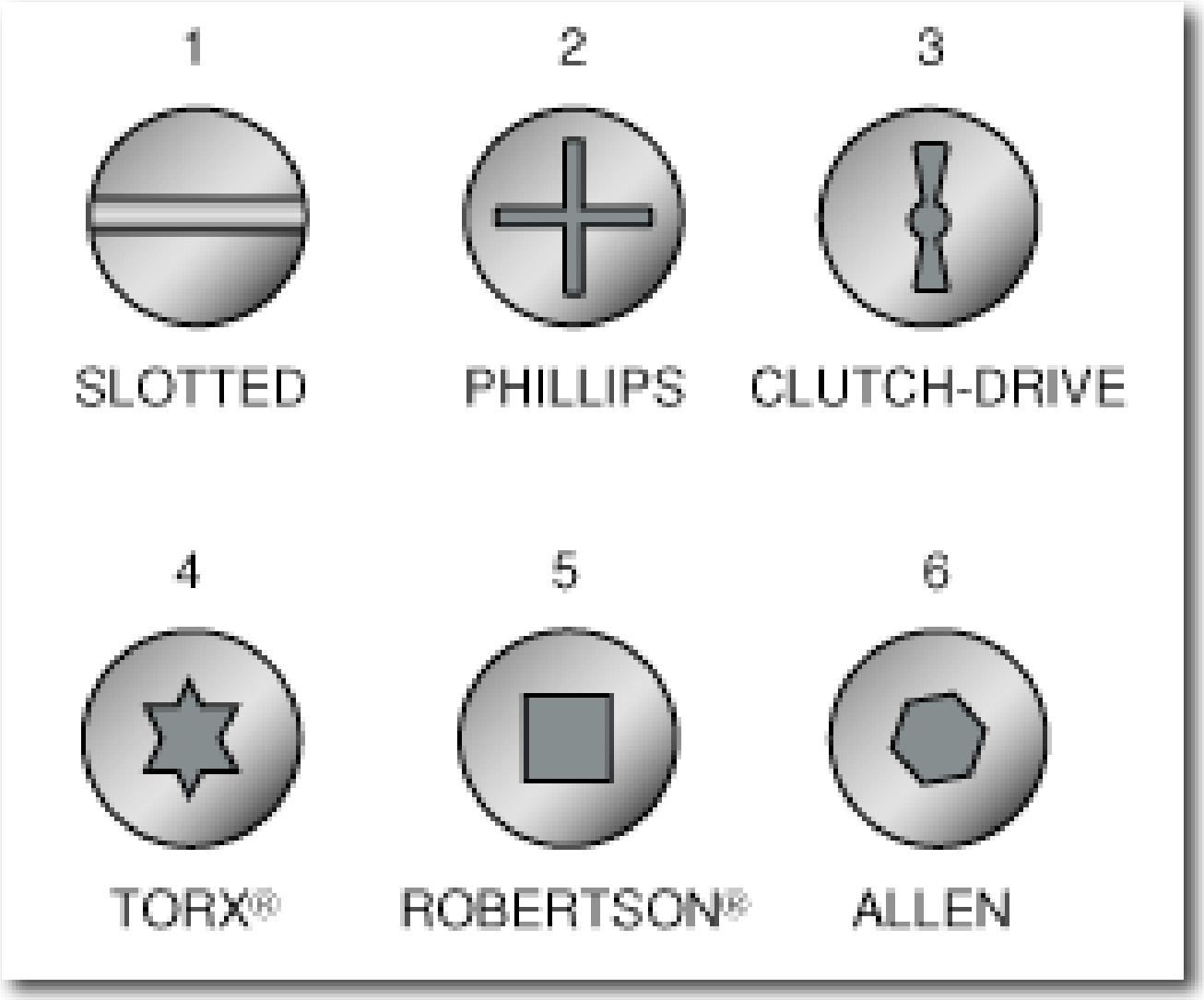
Oval
Ideal for making frequent adjustments. Tip has small contact area causing little damage.

Extended Point
Also known as dog point and pilot point set screws. Often used in place of dowel pin.

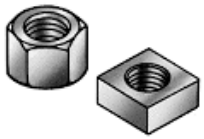
Soft Tip
Rigid yet soft tip conforms to texture and curves of surface without marring.

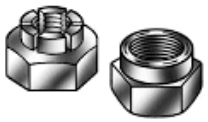
Swivel Ball Bearing
Also known as ball-ended thrust screws. Ball bearings swivel in all directions.

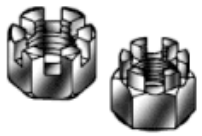
Common Drives

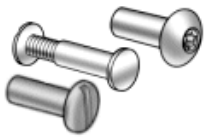


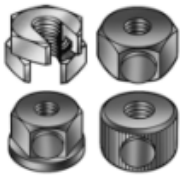
Nuts


Machine Screw and Hex Nuts


Locknuts

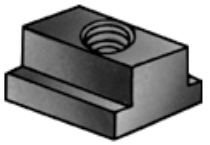

Slotted Nuts

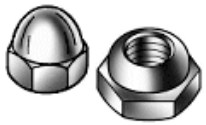

Barrel Nuts (Binding Barrels)


Quick-Threading Nuts


Flange Nuts

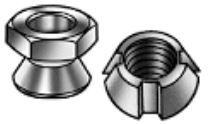

Coupling Nuts


T-Slot Nuts


Acorn Nuts


Wing Nuts

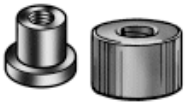

Thumb Nuts


Tamper-Resistant Nuts


Push Nuts and Retainers


Weld Nuts


Allen Nuts


General Purpose Acme Nuts


Strut Channel Nuts

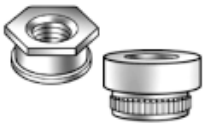

Slip Joint Nuts


Handle Nuts


Binding Nuts


Regulator and Welding Hose Fitting Nuts


Speed Nuts


Captive Nuts


Thin Nuts with Specialty Threads

Washers


Round Hole


Square Hole


Slotted


D (Clipped)


Spherical


Laminated


Notched


Tag Hole


Spring Lock


Tooth Lock


Belleville


Retaining


Wave

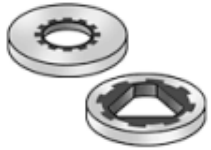

Finger Spring

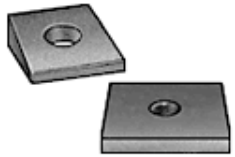

Wedge Lock


Countersunk

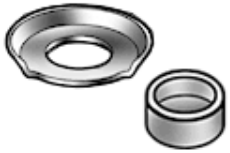

Bonded


Waffle

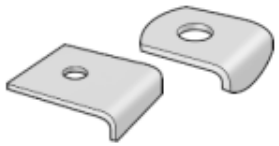

Pressure-Sealing


Square


Shoulder

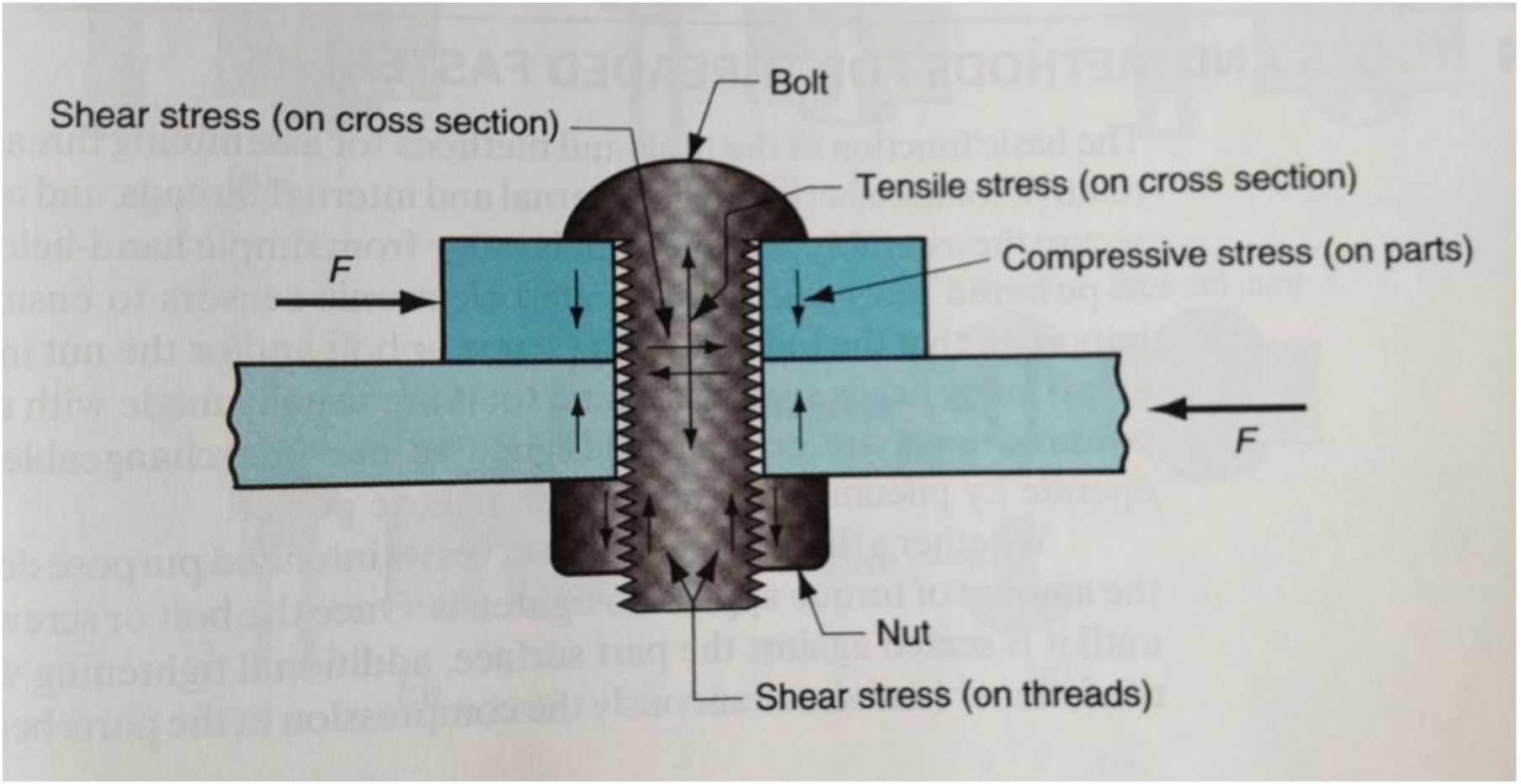

Cup


Structural


Flange

Loading

The general rule is that screws / bolts should be axially preloaded in excess of the service load



Manufacturing a Screw

See: http://youtu.be/3kxcw08p_oY

Interference Fits

Interference (press) fits are used for seating bearings, bushings, or watertight seals

The quality of the fit/seal depends critically on the difference in sizing between the seated feature and its reciever.

Interference Fits

Young's modulus

Interference of fit

Interference stress (effective stress)

$$\sigma_e = \frac{2Ei}{D_p}$$

Pin diameter