Bolts and Fixings

What is a fastener?

A device to locate or hold parts

As a technician you will become skilled at removing, reconditioning, replacing, and installing fasteners.

Used to join together the various parts of equipment that come in many forms

Nuts & Bolts
Washers
Screws
Clips
Clamps
Studs
Rivets
Studs
Spot Welding
Soldering
Splines/Keys/RollPins
Glue/Silicone/Adhesives
Crimped (Sheet metal seams, electrical connections)

External Threads (Male Threads)

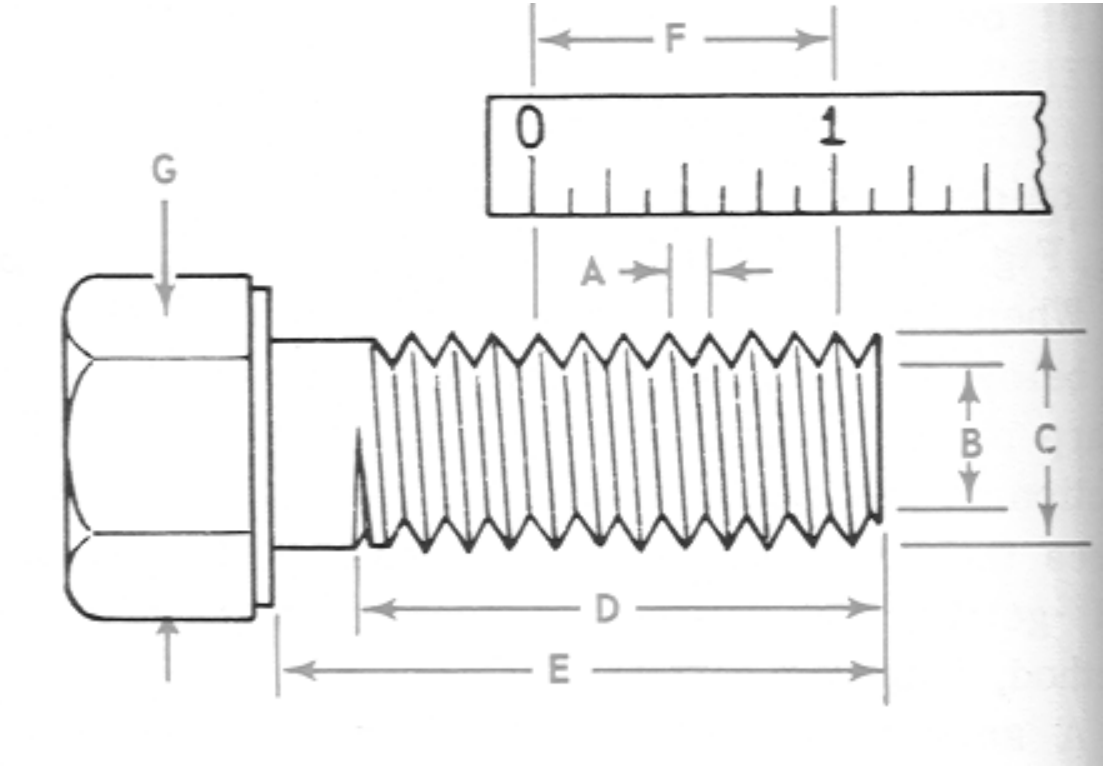
Bolts, Studs, Screws

Internal Threads (Female Threads)

Nuts, Threaded holes

Identifying and Nuts Bolts and Thread Forms

Important bolt measurements



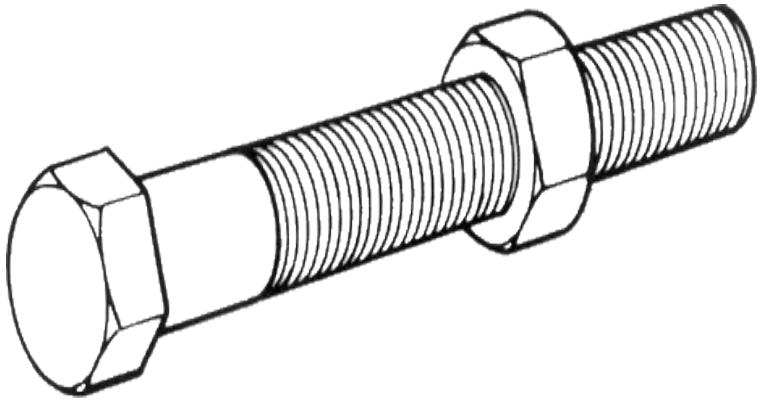
A. Pitch C. Diameter D. Thread length E. Screw length
F. Threads per inch G. Head size

5/16” UNC X 1 ½” Bolt

Diameter

Coarse

1 ½” Long



5/16” - 13 X 1 ½” Bolt

Major Diameter

13 Threads/inch

Total Length

THREAD TYPE

TYPE OR PITCH REFERS TO CONSTRUCTION OF THREAD

NUMBER OF THREADS PER INCH FOR UNIFIED OR IMPERIAL (UNC BSW)

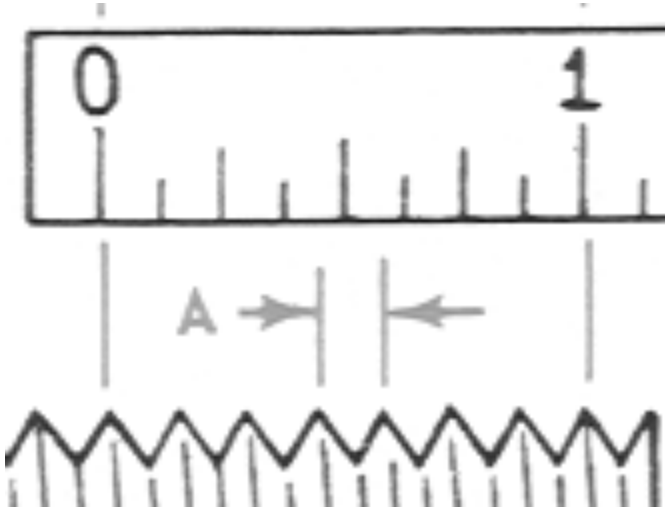
OR UNIT LENGTH OF ONE COMPLETE THREAD FOR METRIC (METRIC FINE OR COURSE)

Imperial Threads use British and American Standards

UNF - National Fine UNC – National Coarse

Standard bolts come in two thread pitch's forms
Coarse & Fine the British BSW or BSF

THREAD PITCH IMERIAL



From 0-1 shows that you have 7 TPI Threads per inch.
(US and Imperial standards)

THREAD PITCH METRIC

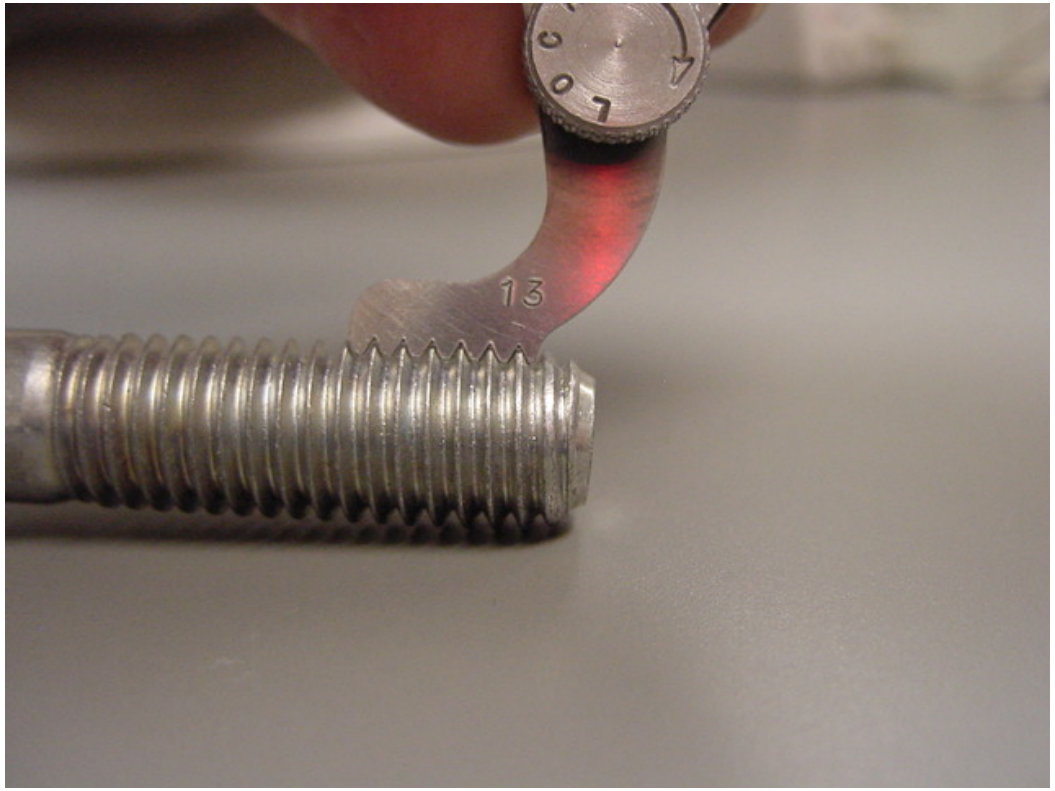
SIMILAR TO IMPERIAL SYSTEM
THREAD DIAMETER IS EXPRESSED IN MILLIMETERS (mm)
THREAD PITCH IS DIFFERENT
THREAD SIZE IS DETERMINED BY MEASURING THE DISTANCE IN MILLIMETERS FROM CREST OF ONE THREAD TO CREST OF NEXT ONE.

Example 1.00, 1.25, AND 1.50

Thread pitch gauge

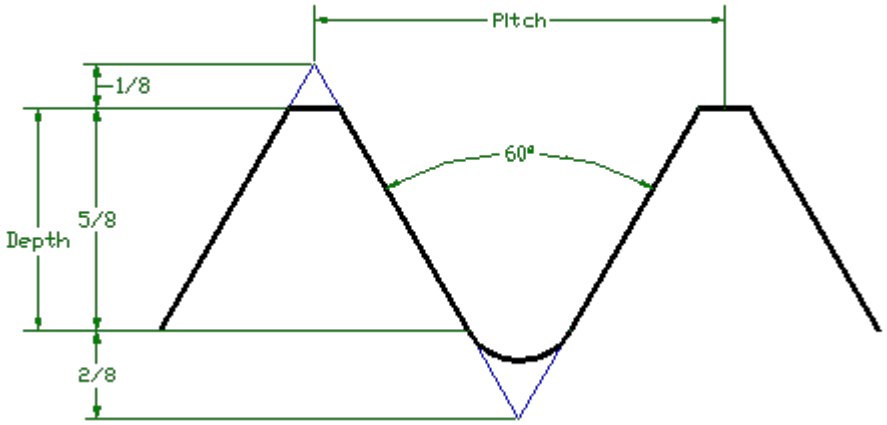
Used to find the pitch of the threads come in metric and imperial standard

Thread pitch gauge



This bolt has 13 threads per inch

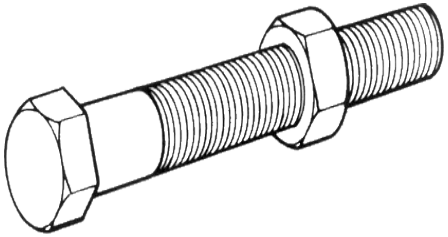
Metric and American thread forms both conform to the same profile, a series of equilateral triangles with the crests chopped off and the roots rounded,



Where as the Imperial BSW and BSF have a thread form angle of 55 deg. See the ZEUS book for more information.

Bolt Grade

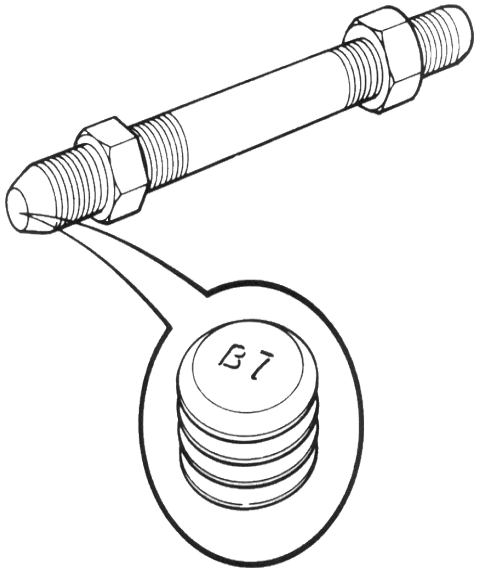
Bolt Grade is important and easy to identify



Bolts

Bolts and nuts are made from mild steel and have limited qualities of strength and durability.

The use of bolts is therefore limited to low pressure lines.

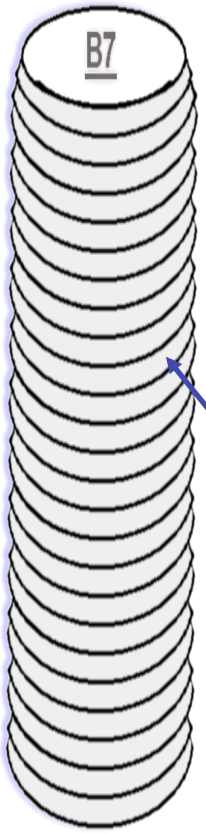


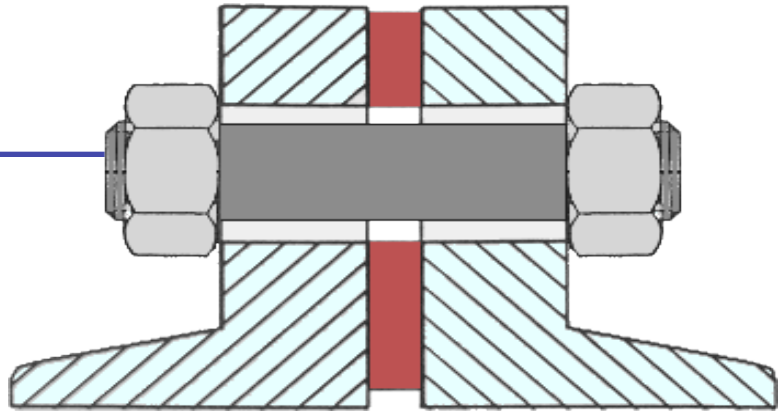
Stud Bolts

These are made from higher quality steel than machined bolts and are used at higher pressures. B7 is the common carbon steel grade with 2H nuts, and B8 the common stainless steel grade with grade 8 nuts.

Because of the different ranges in temperature and pressure it is important that the correct bolt is used. The most commonly used stud on site is the ‘B7’.

The temperature range for this is approximately - 15 to 400º C. The identification mark is stamped on the end of the bolt.





In general terms Set-bolt or Set-screw are any style of bolt with a full length thread up to the underside of the head were as Bolts are only partially threaded

Fine Threaded Fasteners

Stronger Thread

Less likely to come loose

Slow to assemble

Easier to ruin the thread (cross thread)

Fine Threaded in General

Stronger Thread:-

It’s not stress area, but the volume of thread metal remaining in actual engagement under load, and the ability to distribute that load over all threads, that determines pull out strength.

What replacement nut and bolt fastener should you use?

Same hardness or GRADE

Same Length

Same Diameter

Same Thread Pitch

Same Plating or Material

Always use the same plating or material as the original fastener

Nuts and Bolts are not all the same.

They must be compatible with the other metals they contact

Many have special plating to resist corrosion

The material or plating will change the general torque (or tightening) value.

Bolt Installation Summary

1. In determining proper bolt length - no more than one to two threads should left exposed.
2. Use a torque wrench whenever possible and determine torque values based on the manufactures guidelines .
3. Be sure bolt and nut threads are clean and dry.
4. Use smooth, even pulls when tightening.
5. A typical installation includes a bolt, one washer and a nut.

Nuts

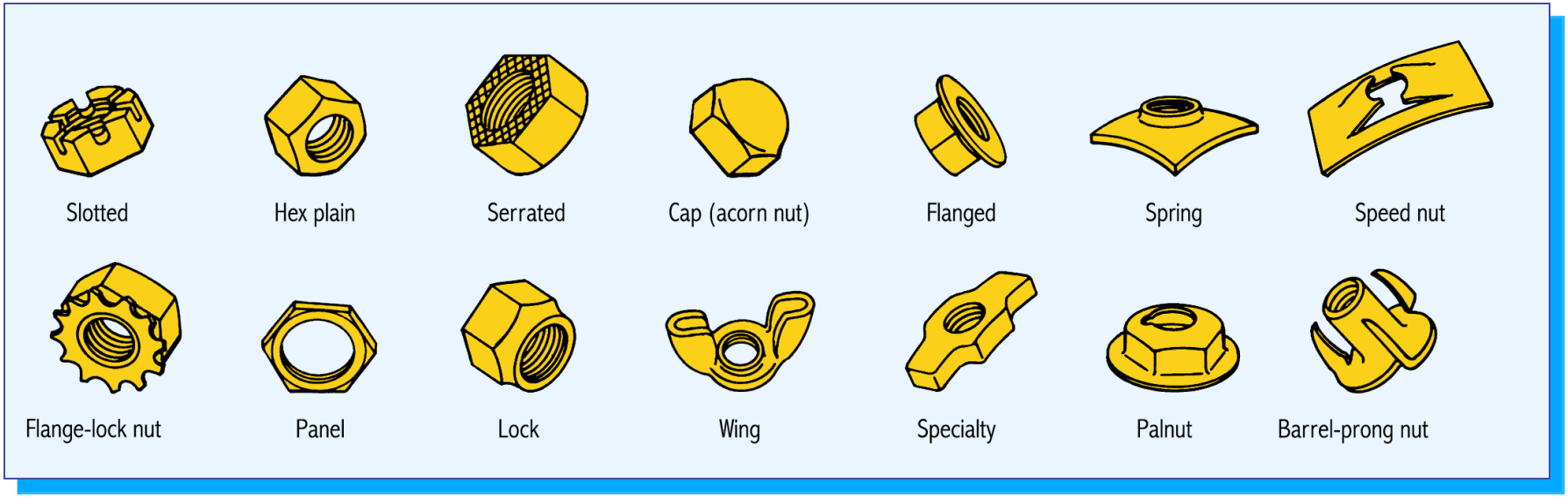
Hex Nut – Most common

Castle Nut – locks with a split pin

Locking Nut – Nylon Patch (center, top)

Wing Nut – No tool required

Nut Types

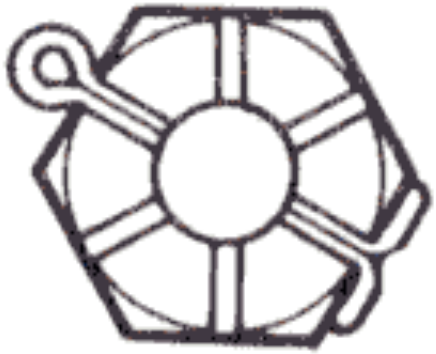


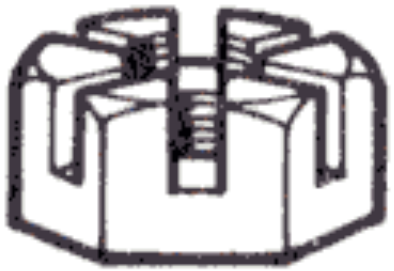
Common types of nuts used in industry and vehicles

Do fasteners need to be locked in place?

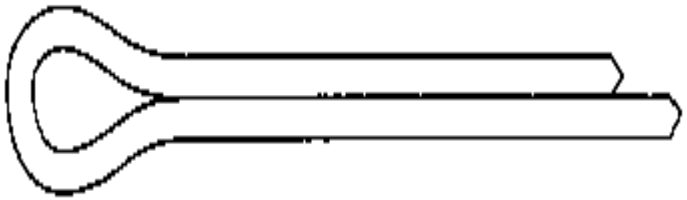
How some nut are locked in place?

Split pins, locking tabs, and self locking nuts are often used.

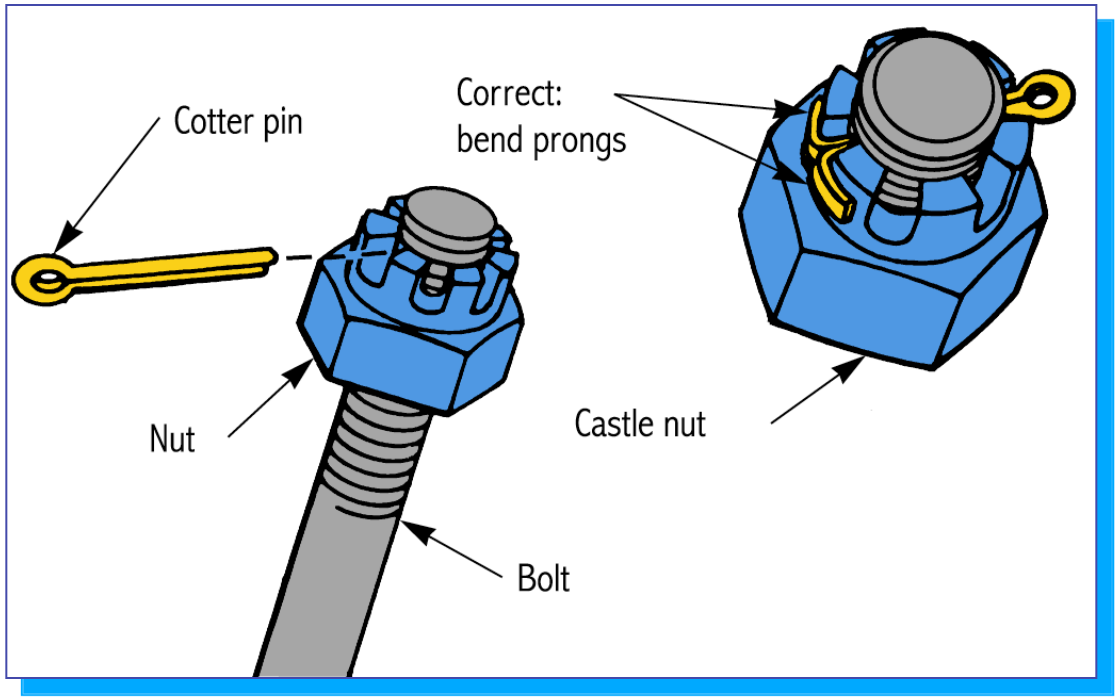




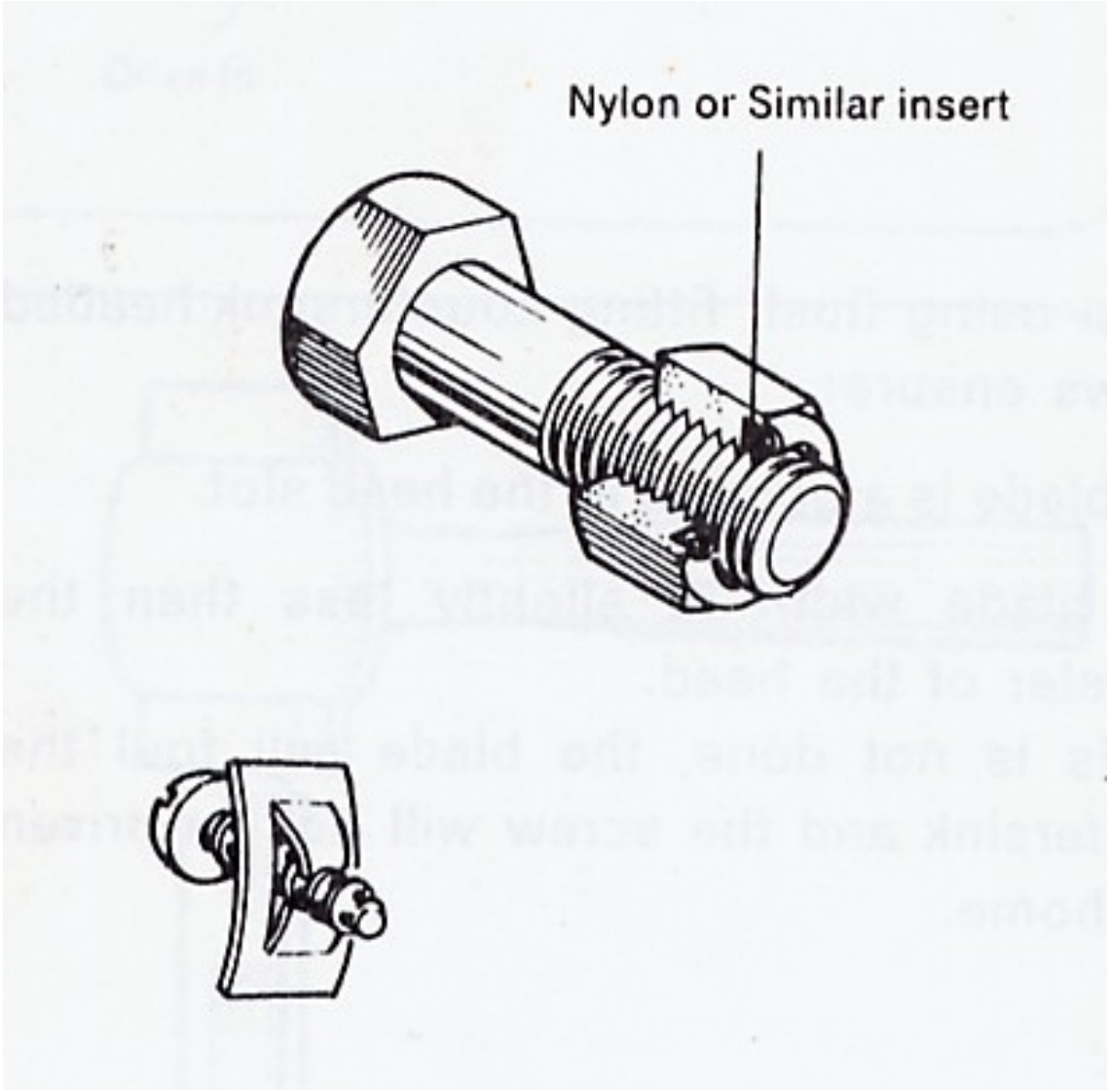
Split pins, should replace these with new ones to ensure they do not fail

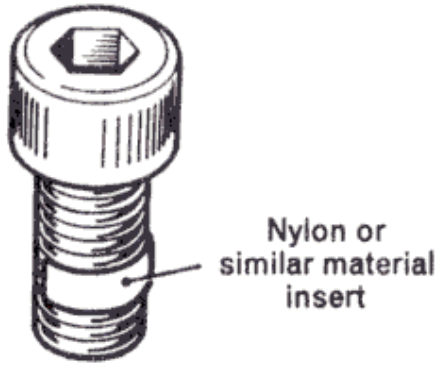


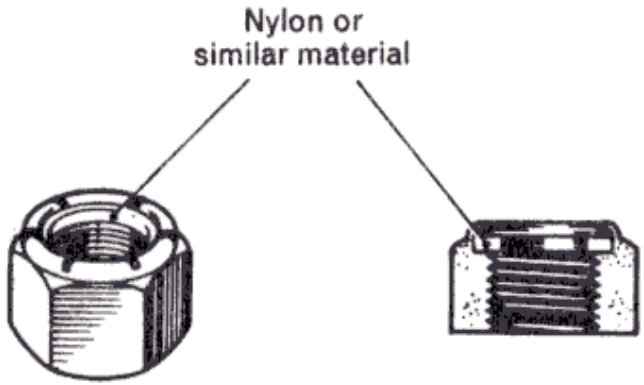
Castle Nut and Split Pin



Split pin keeps the nut from turning and possibly coming off


Nylon or Similar insert


Nylon or
similar material
insert


Nylon or
similar material

Washer Types

Used under bolt heads and nuts

Two basic types of washers are used:

- flat washers
- lock washers

Flat washer

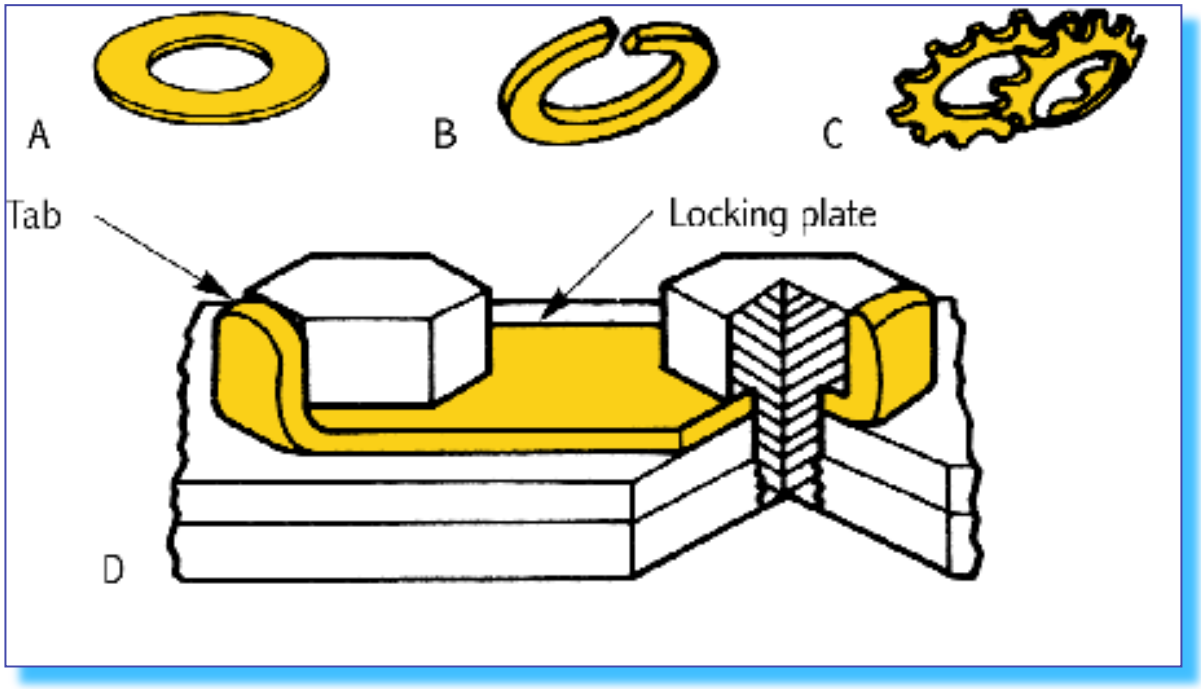
- increases the clamping surface under the fastener
- prevents the bolt or nut from digging into the part

Lock washer

- prevents the bolt or nut from becoming loose under stress and vibration

Lock tabs or lock plates

- perform the functions of both flat washers and lock washers
- increase clamping surface area and secure the fastener

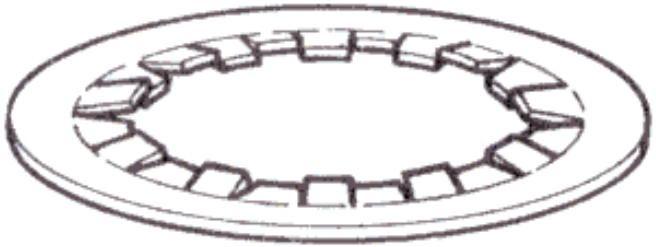


A. Plain flat washer
B. Split lock washer
C. Toothed lock washer
D. Lock plate

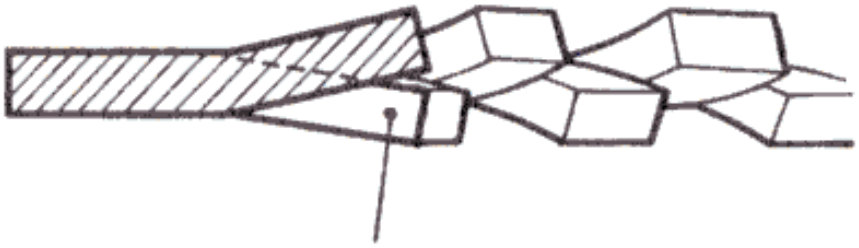
Star or Lock washers

Internal Tooth lock washer

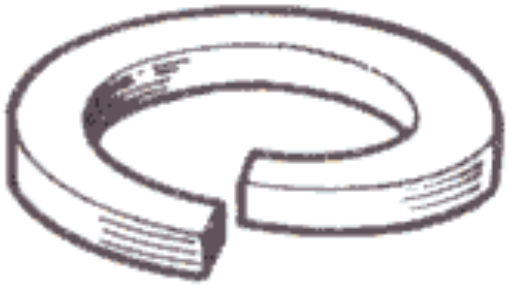
External Tooth lock washer



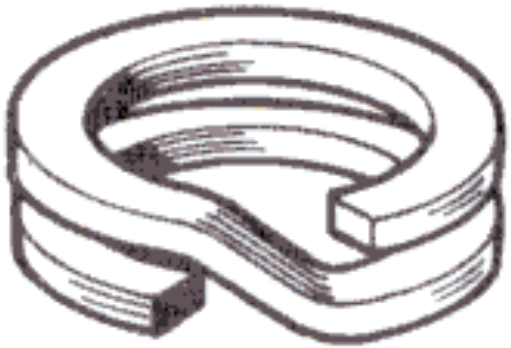
Star Washer



Spring Washer



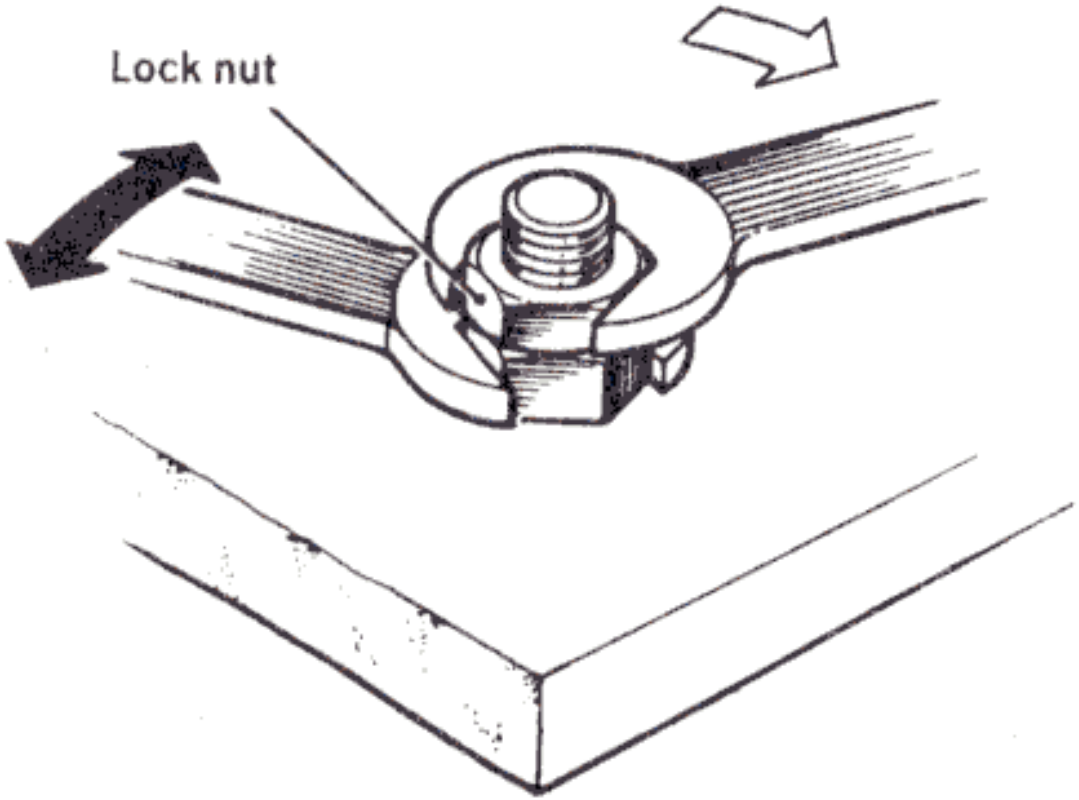
Single coil



Double coil

Tab washer

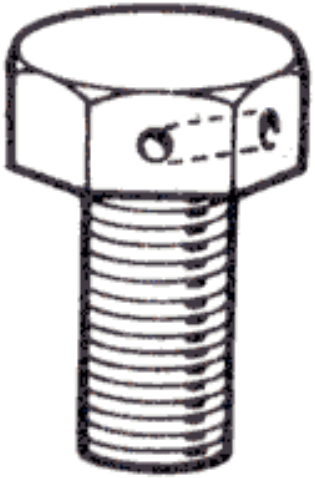
Crinkle washer


Lock nut

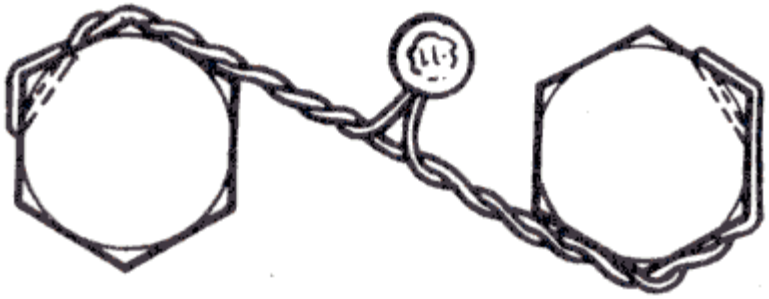
Lock nuts are used to preventing in service loosening. The use of two nuts together forms a very effective locking mechanism. When used to lock a standard nut, the lock nut (the thinner one) should be placed between the normal nut and the bolted surface so that the normal nut, rather than the locking nut takes the full bolt load

This Way

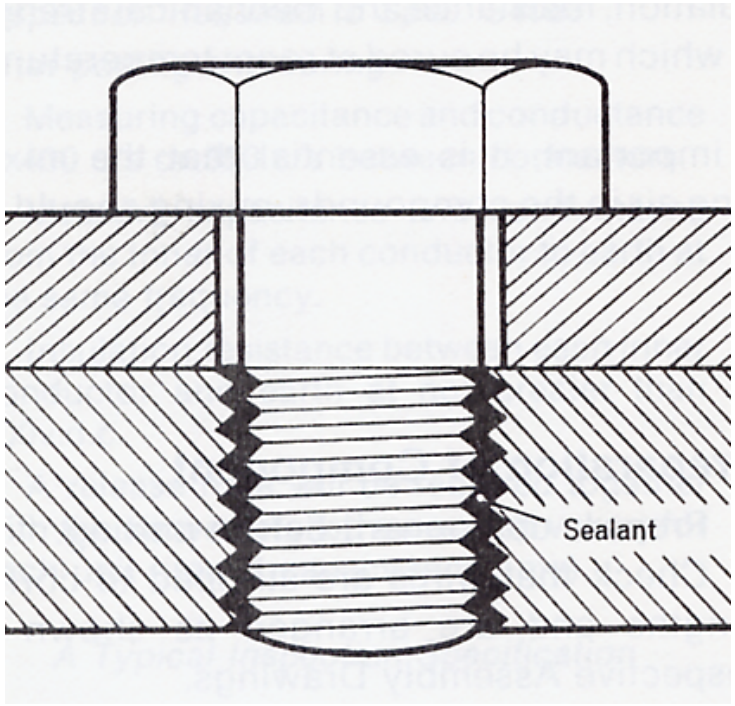
Not This

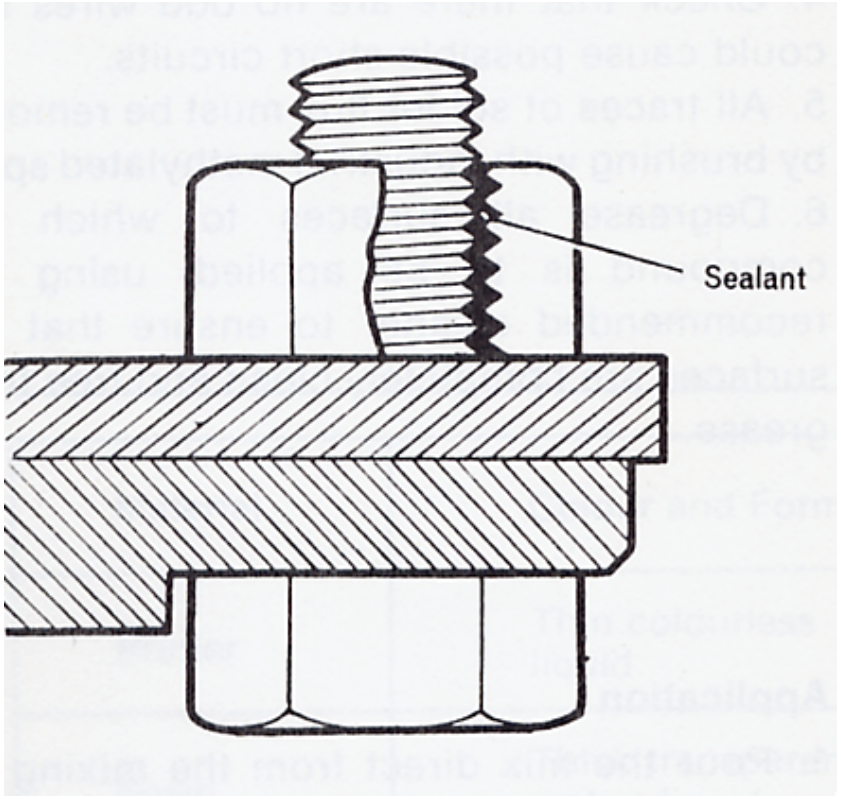


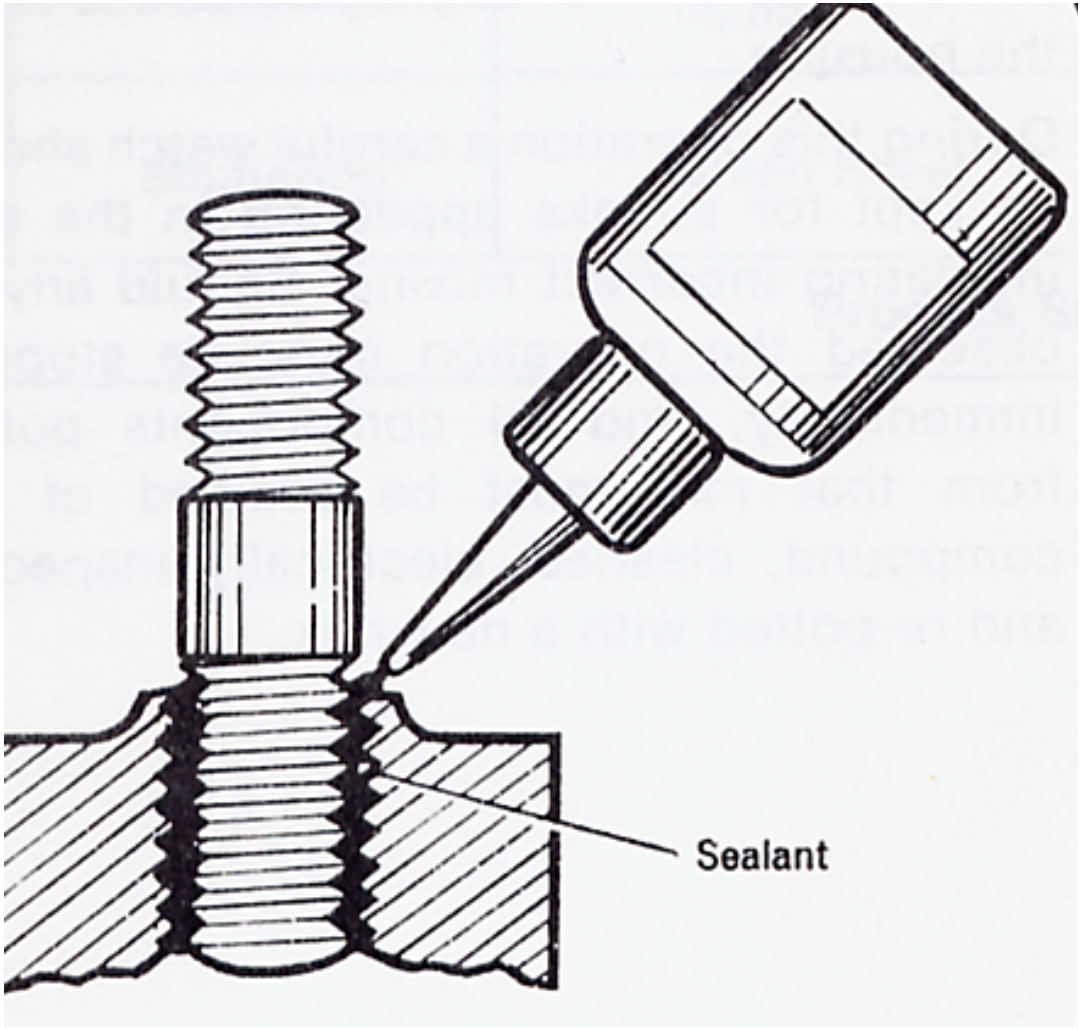
Wiry Locking



Nut or Thread Lock






Sealant

Bolt Tightening Sequence

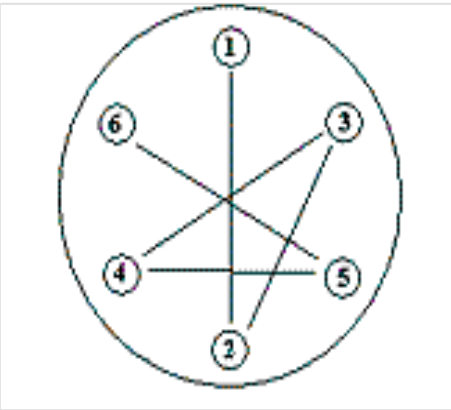
Used to make sure that parts are fastened evenly

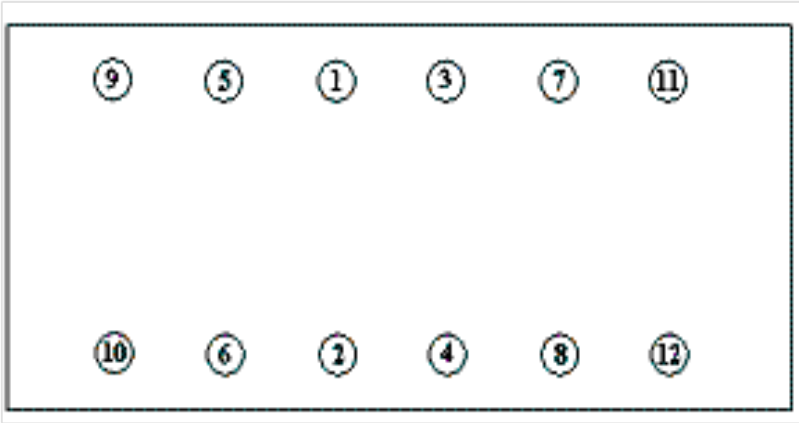
Creates an even, gradual clamping force along the entire mating surface of the parts

Crisscross pattern is often recommended

Tightening Sequences

Tightening End cover or Flange



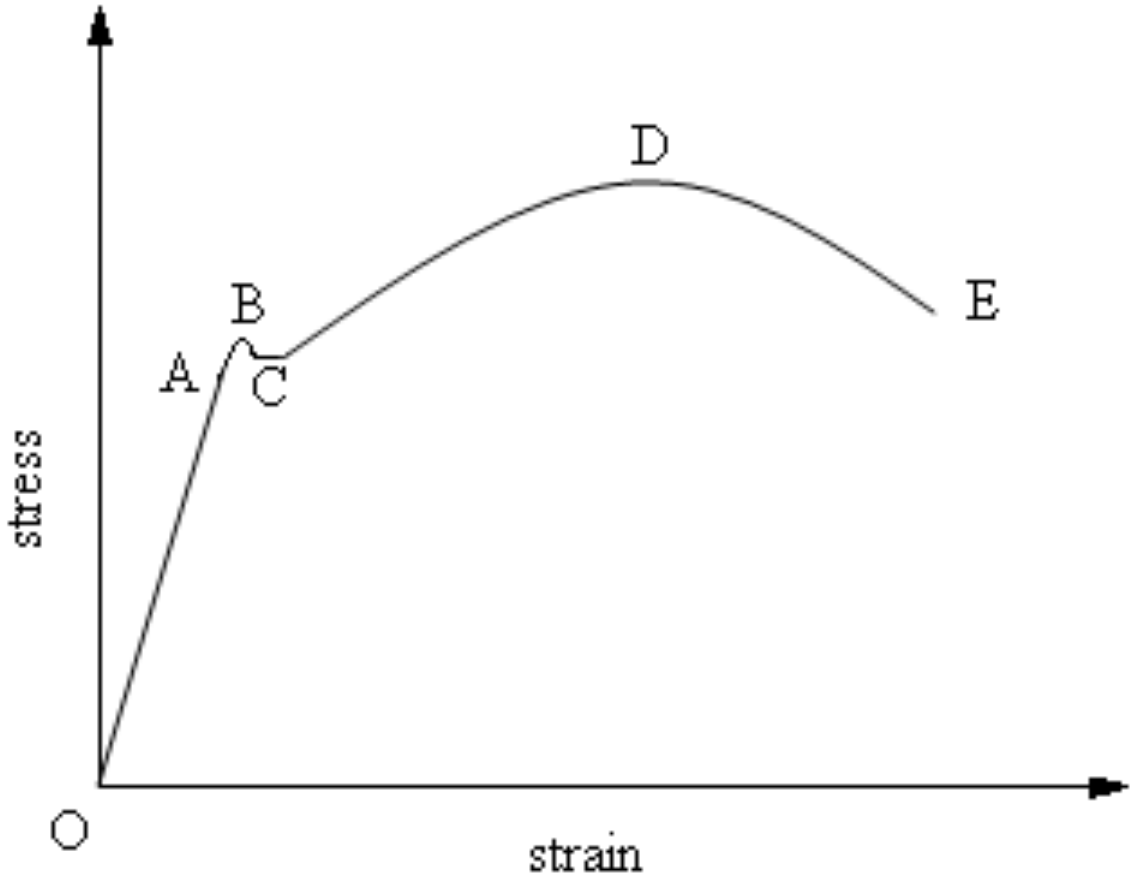


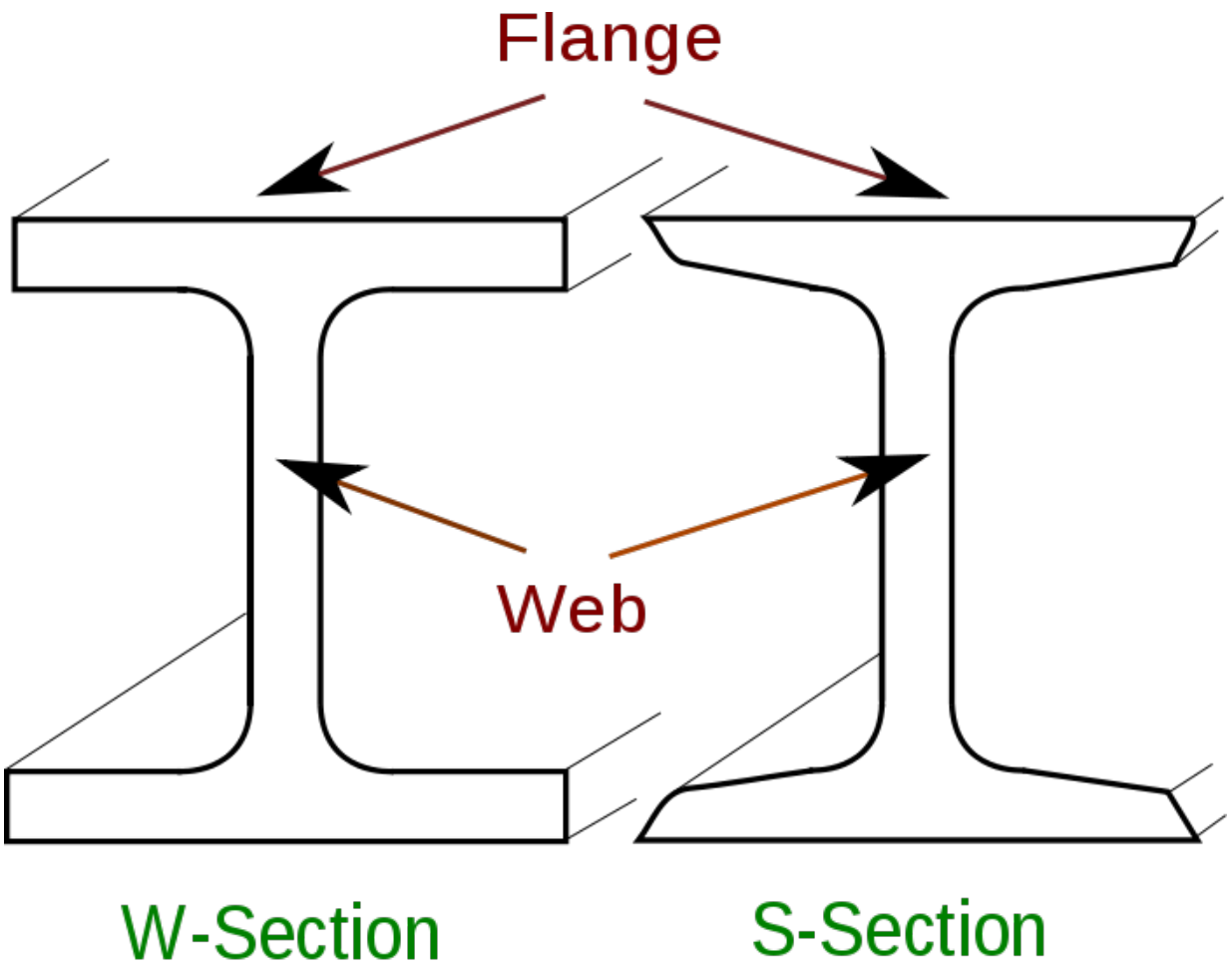
Tightening multiple bolts

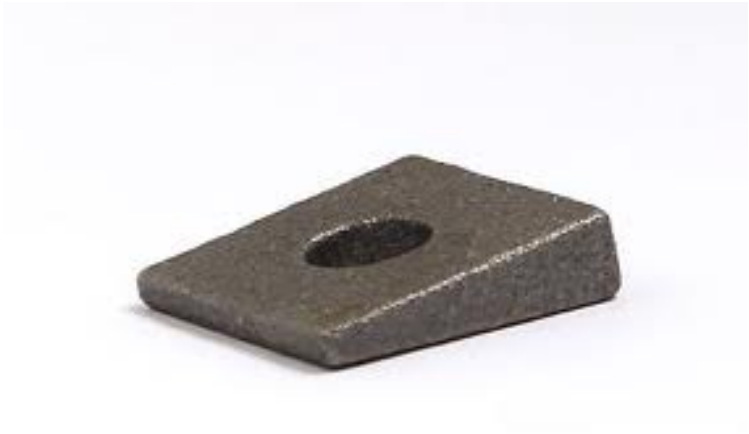
Bolt Tightening or Torque

Methods of Applying Bolt Torque

Young's Modulus of Elasticity







Bolt Stretched passed the yield point

If we turn the bolt ¼ turn then the threads will engage the mating threads and stretch the bolt ¼ of the value of the pitch,

Torque

How does force create rotation?

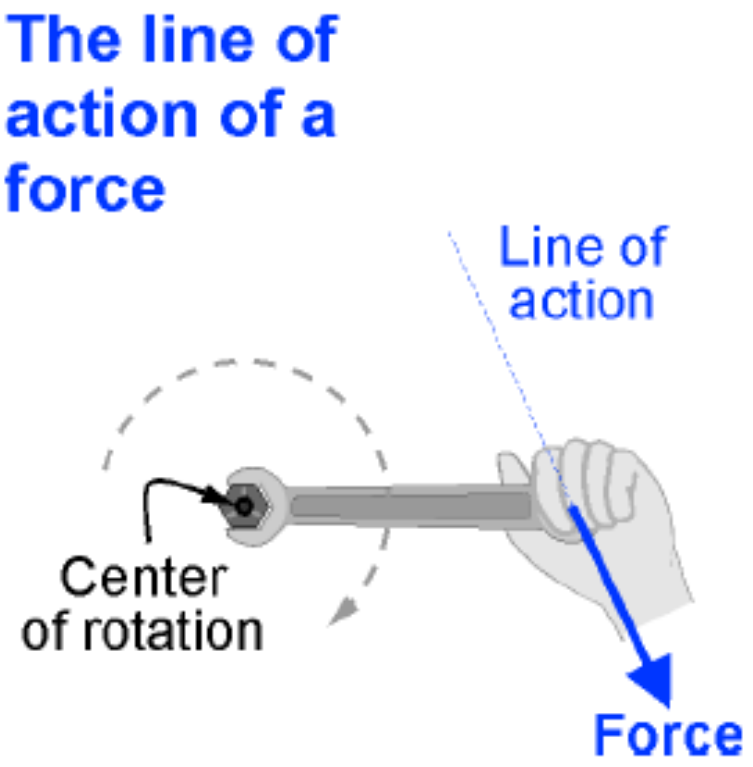
A torque is an action that causes objects to rotate.

Torque is not the same thing as force.

For rotational motion, the torque is what is most directly related to the motion, not the force.

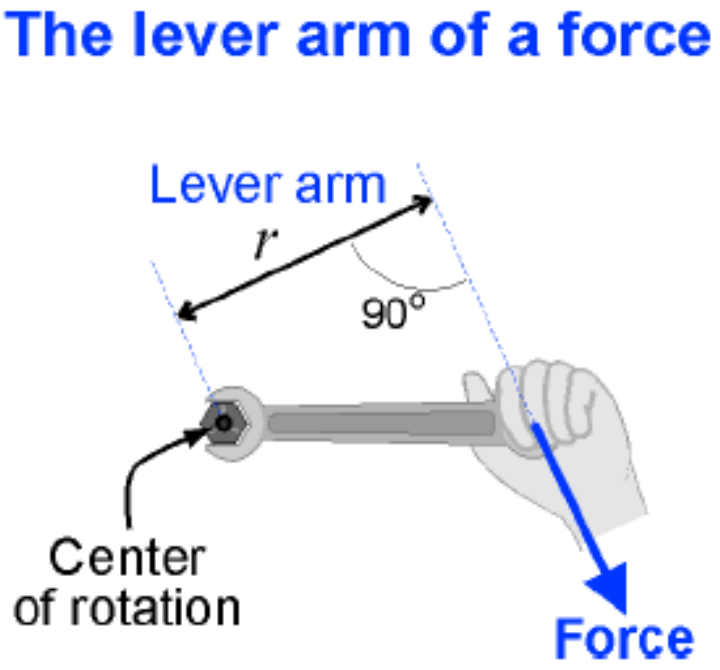
Torque is created when the line of action of a force does not pass through the center of rotation.

The line of action is an imaginary line that follows the direction of a force and passes though its point of application.

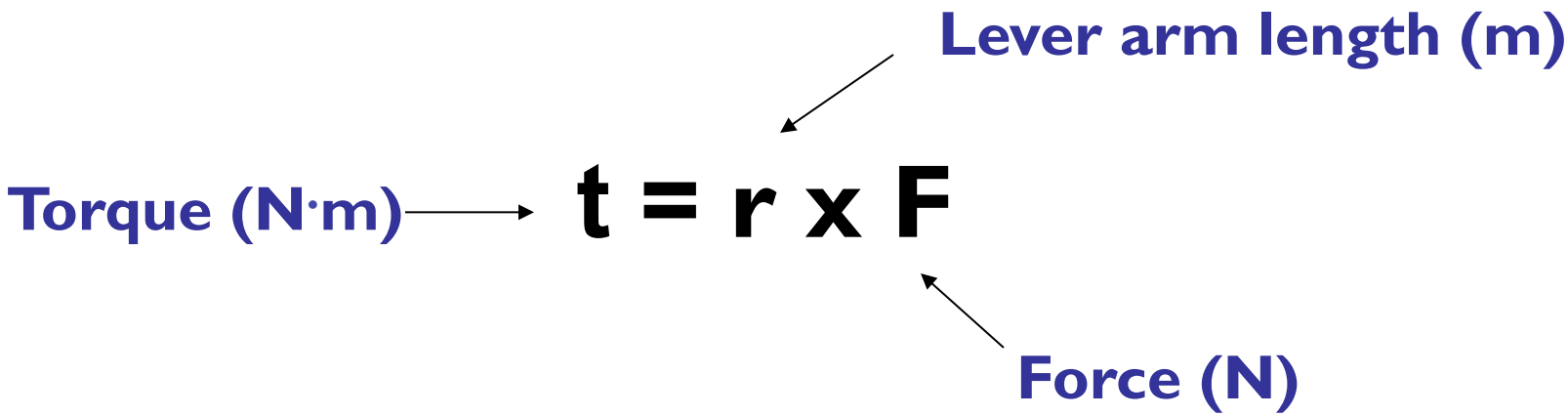


To get the maximum torque, the force should be applied in a direction that creates the greatest lever arm.

The lever arm is the perpendicular distance between the line of action of the force and the center of rotation

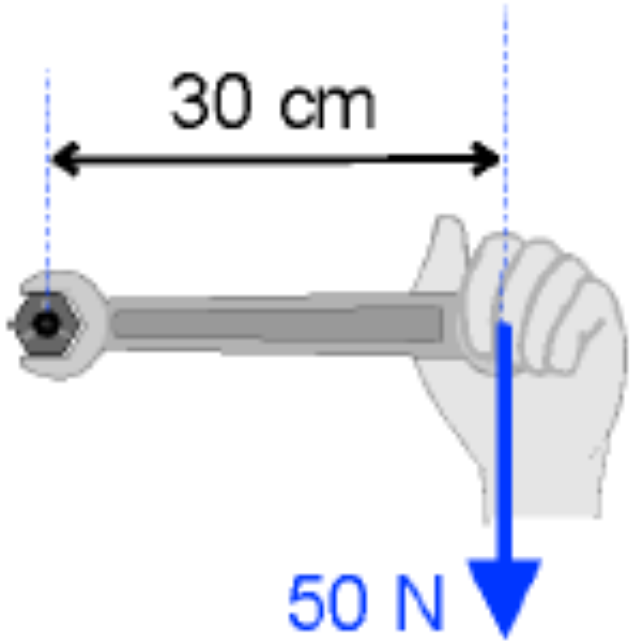


Torque



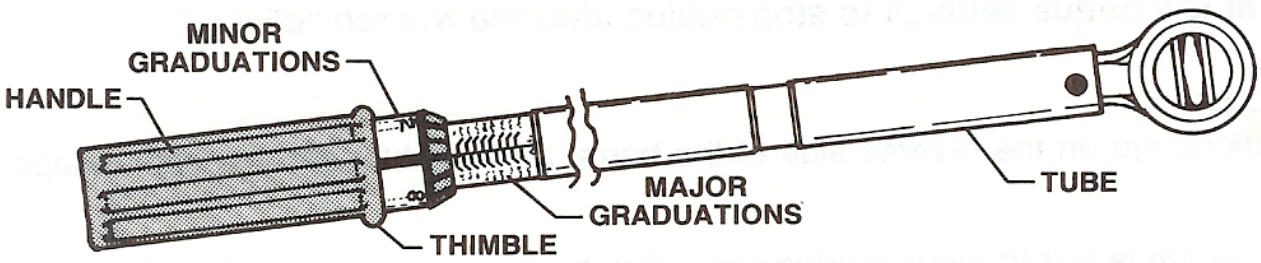
To Calculate a torque

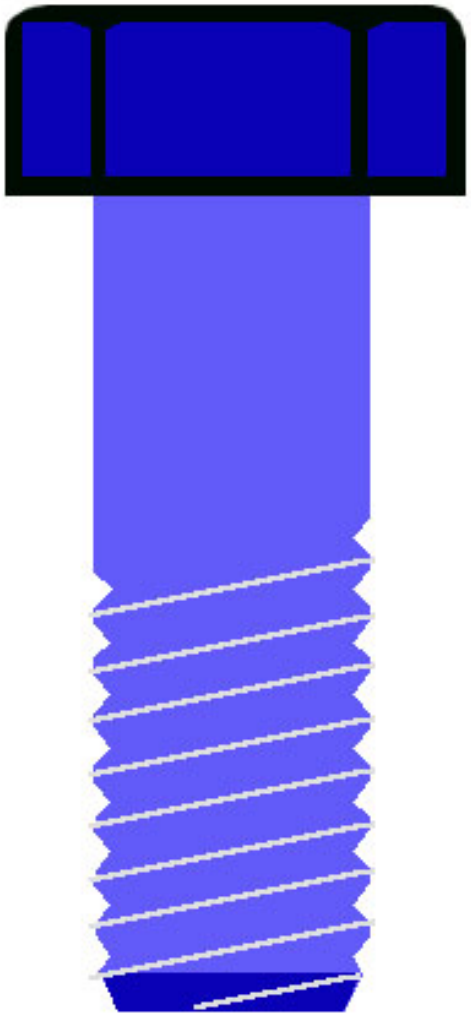
A force of 50 newtons is applied to a wrench that is 30 centimeters long.



Calculate the torque if the force is applied perpendicular to the wrench so the lever arm is 30 cm.

A torque wrench is a reasonably accurately measure of the torque applied to a nut or bolt to tighten it properly. When used properly, a torque wrench can help avoid damaging the fastener or the parts with which the fastener interacts





45%-55% to overcome friction of head surface.

Only 10% of force is used to stretch bolt.

35%-45% to overcome friction of threads.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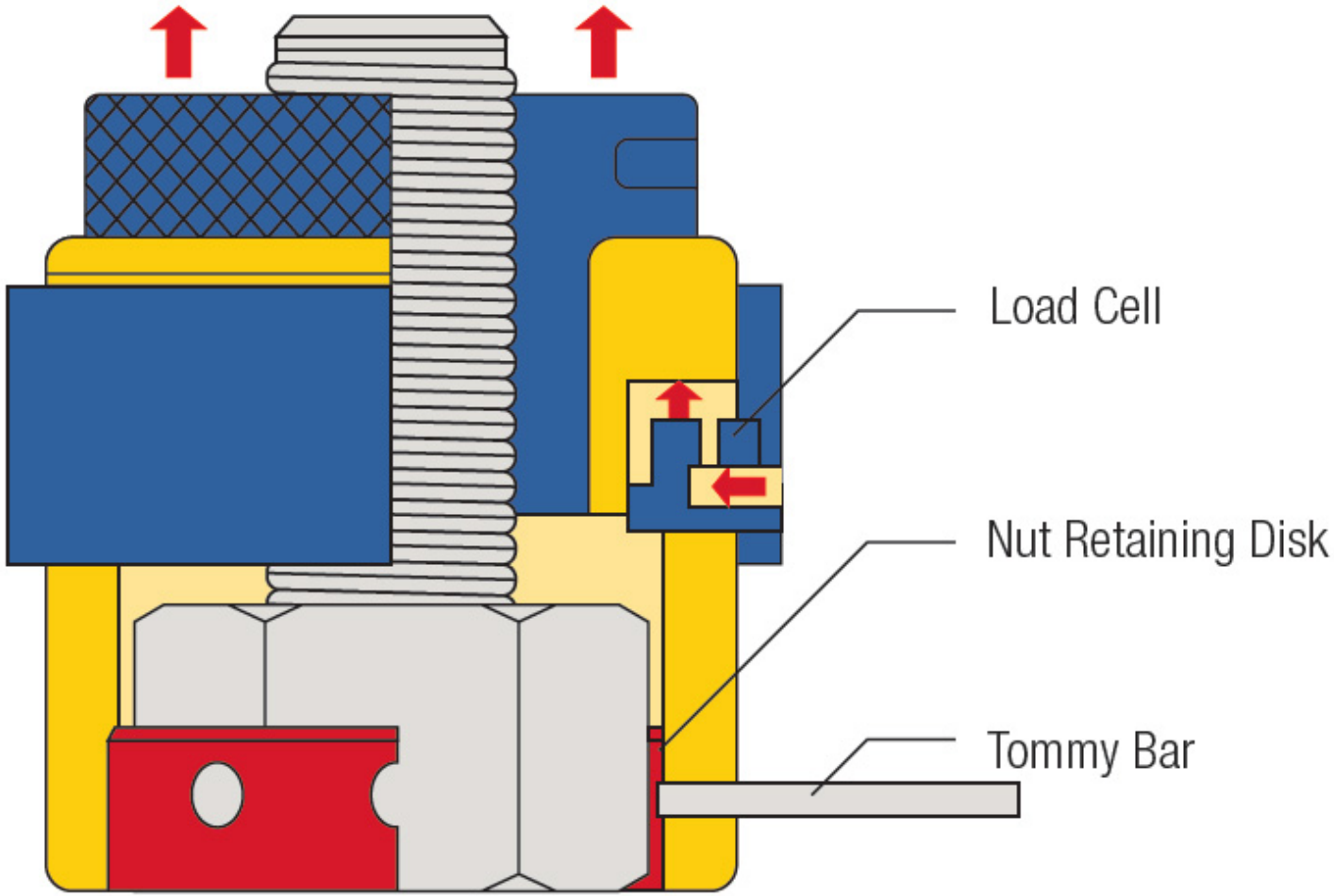
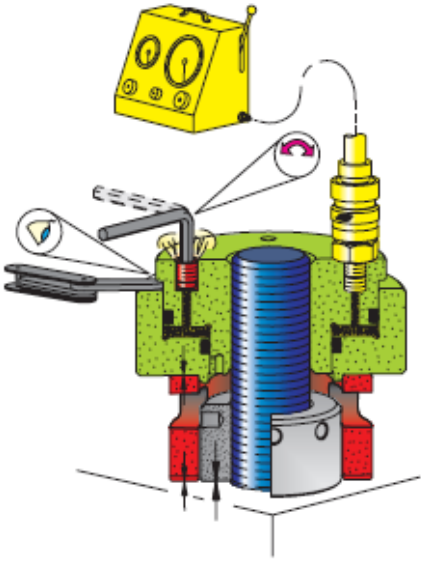
Other Methods of Bolt Stretching

Hydraulic bolt-tensioning or bolt stretching tools because they stretch the bolts in a way that is completely free of friction and torsion. No bending stress in the bolt, only tensile stress and all bolt are simultaneous tensioned

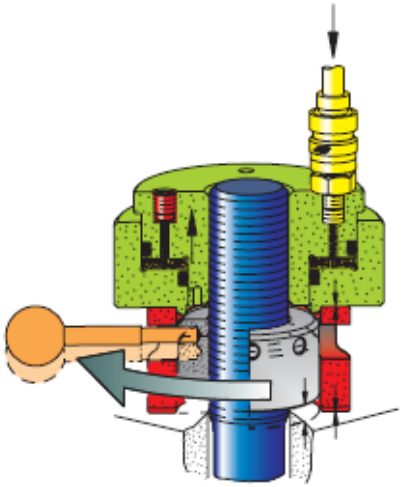

Load Cell
Nut Retaining Disk
Tommy Bar

Hydraulic Tightening

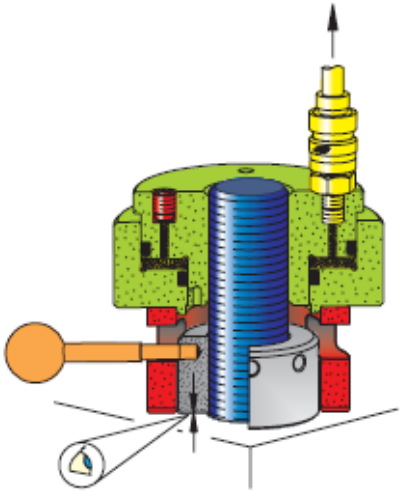
Clean the contact surfaces
Mount the hydraulic jack



Raise the pressure
Turn the nut



Release the pressure
Remove the hydraulic jack

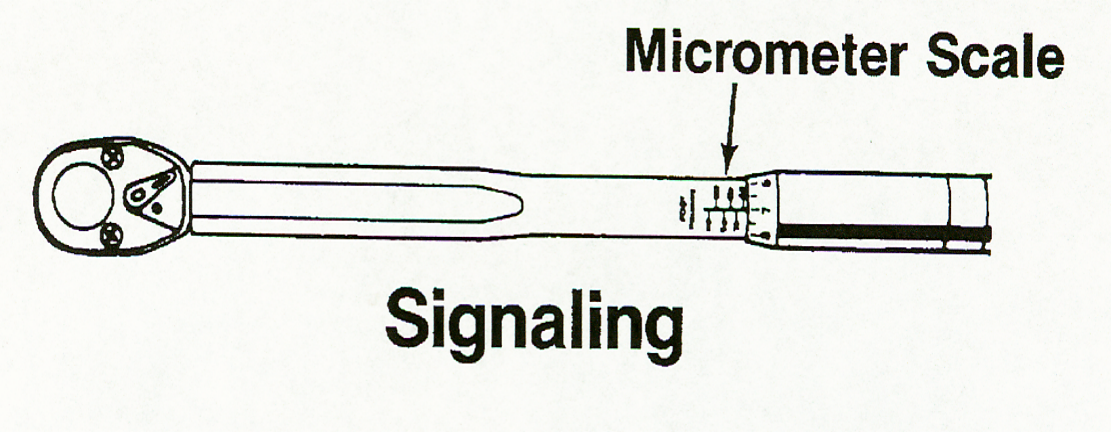


- Correct tightening force
- Even tightening of studs

Torque – Bolt Installation

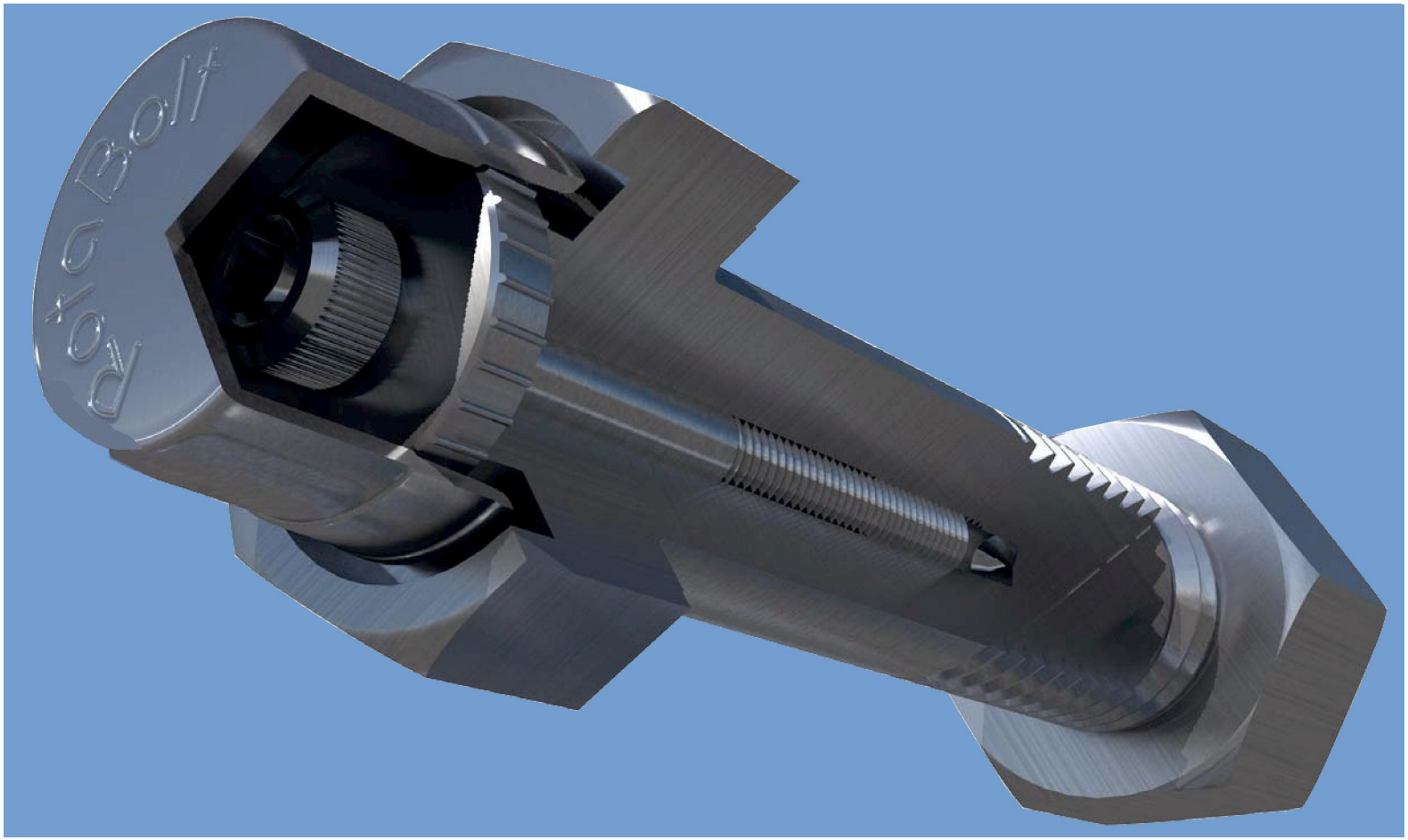
- If unsure, to avoid over tightening use a torque wrench and always refer to a table of torque values for nuts and bolts.
- Be aware the torque wrench values depend on a perfect set-up and a calibrated wrench.
- For general maintenance activities spanner have been designed to give the required torque and you should all develop a feel the correct torque and only use tightening systems when it is absolutely necessary

Typical Torque Wrenches



TURN OF THE NUT METHOD

Angle controlled Tightening.


Bolt

It is important to not "over tighten" or "under tighten" a bolt or the nut attached to a bolt.

The torque values are based on the size of bolt.

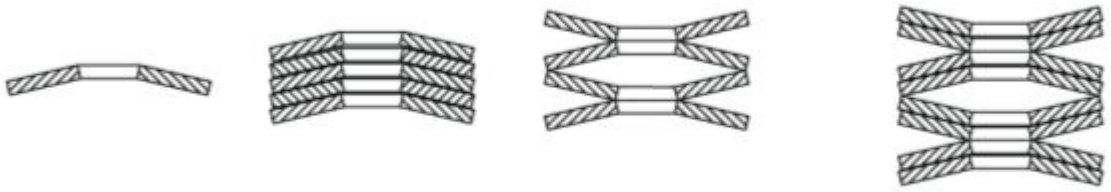
Over tightening may cause too much stress on the bolt, nut or equipment.

What happens if the torque values are exceeded or the bolt material is stretched beyond its elastic limit.

All steel bolts elongate approximately 0.001-in. per inch of length for each 30,000 psi of tensile stress. Consequently, the longer a bolt the more reliable it will be than a shorter bolt for any dynamic loading.

Bolting systems are sometimes purposely extended using tubes or even “Belleville Washers” to improve their loading performance

VARIOUS CONFIGURATIONS OF BELLEVILLE WASHERS



Bolt Installation Summary

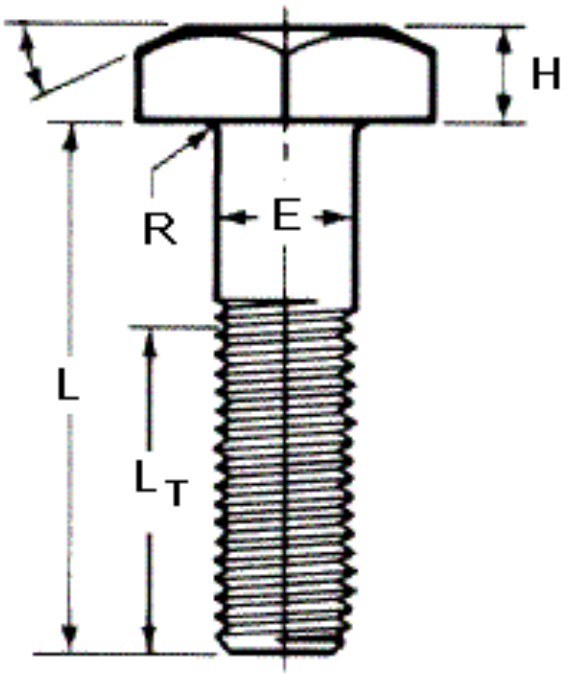
- Whenever possible, bolts and studs should be installed with 1-1/2 to 2 threads protruding.
- Use a torque wrench as and when it is deemed relevant and always determine the torque values based on the size of bolt.
- Be sure bolt and nut threads are clean and lubricated.
- Use smooth, even pulls when tightening.
- A typical installation will always require a tightening sequence to give good alignment and even pressure.
- Ensure an appropriate thread locking mechanism is used if required.

Fastener Failures

Rivets, pin fasteners, and special purpose fasteners are some commonly used fasteners

Threaded fasteners are considered to be any threaded part that may be removed after assembly. Bolts are commonly used threaded fasteners

Some common locations for fastener failures are listed below:



Head to shank failure.

First thread inside the nut.

Transition from thread to shank.

THREAD REPAIR

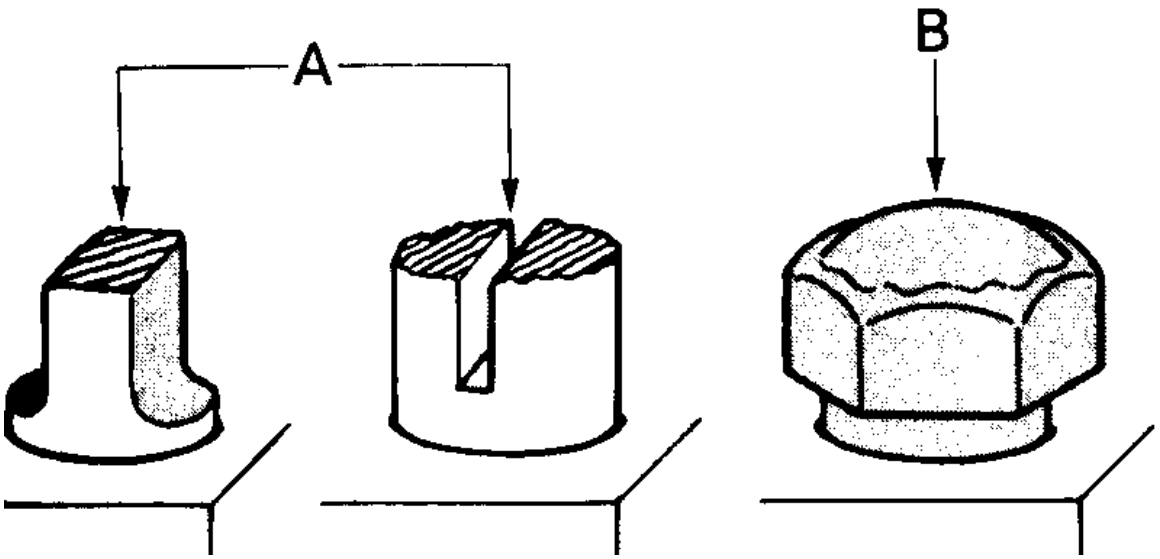
If a bolt head has sheared off or a stud has seized in a blind hole, they can be prove very difficult to remove.

The first thing you need to do is soak it with penetrating oil.

If it is broken off flush use a hammer and punch to see if it will turn out for you.

If the end of the broken bolt is not flat use a saw or grinder to flatten it out.

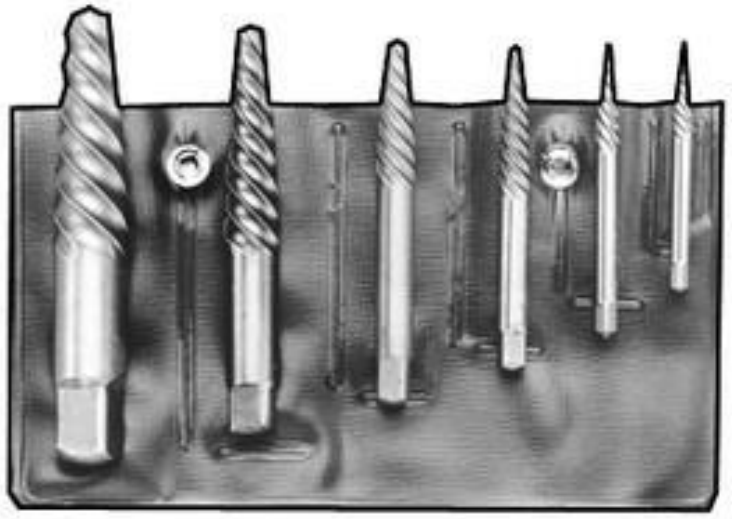
If end of bolt is sticking out try lock nuts or mole grips to remove it or even reshape head, cut a screwdriver slot or flats



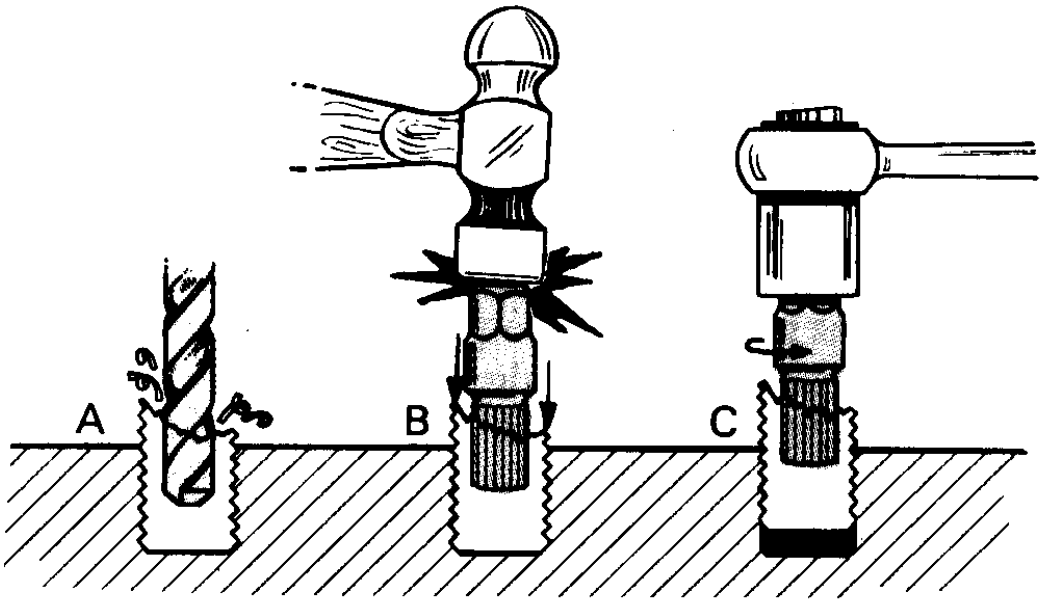
Center punch, then drill a small hole all the way through the stud, insert penetrating oil and leave it to soak in.

Then drill again for the largest possible easy out but leaving enough stud wall thickness so the stud does not burst.

Lightly tap the extractor with a hammer and then remove with a wrench. Use light pressure.

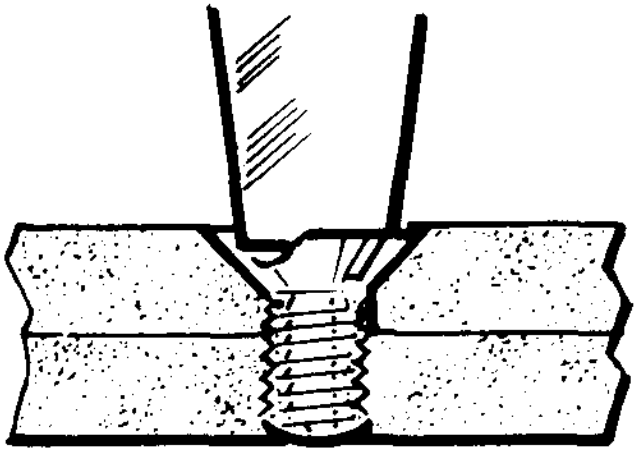


An alternative type of extractor with parallel flutes.

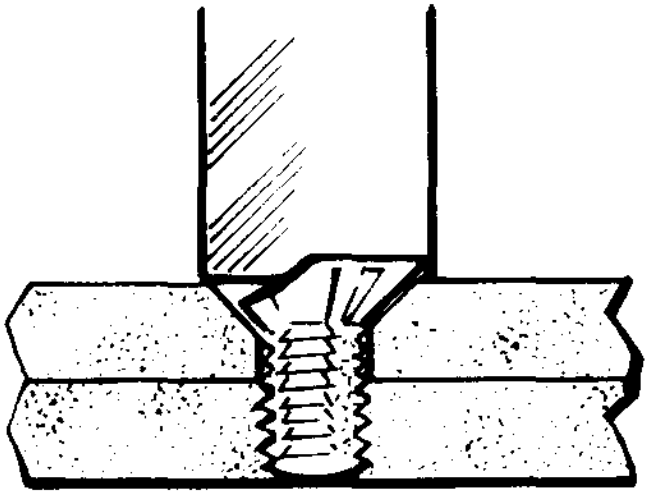


THREAD REPAIR

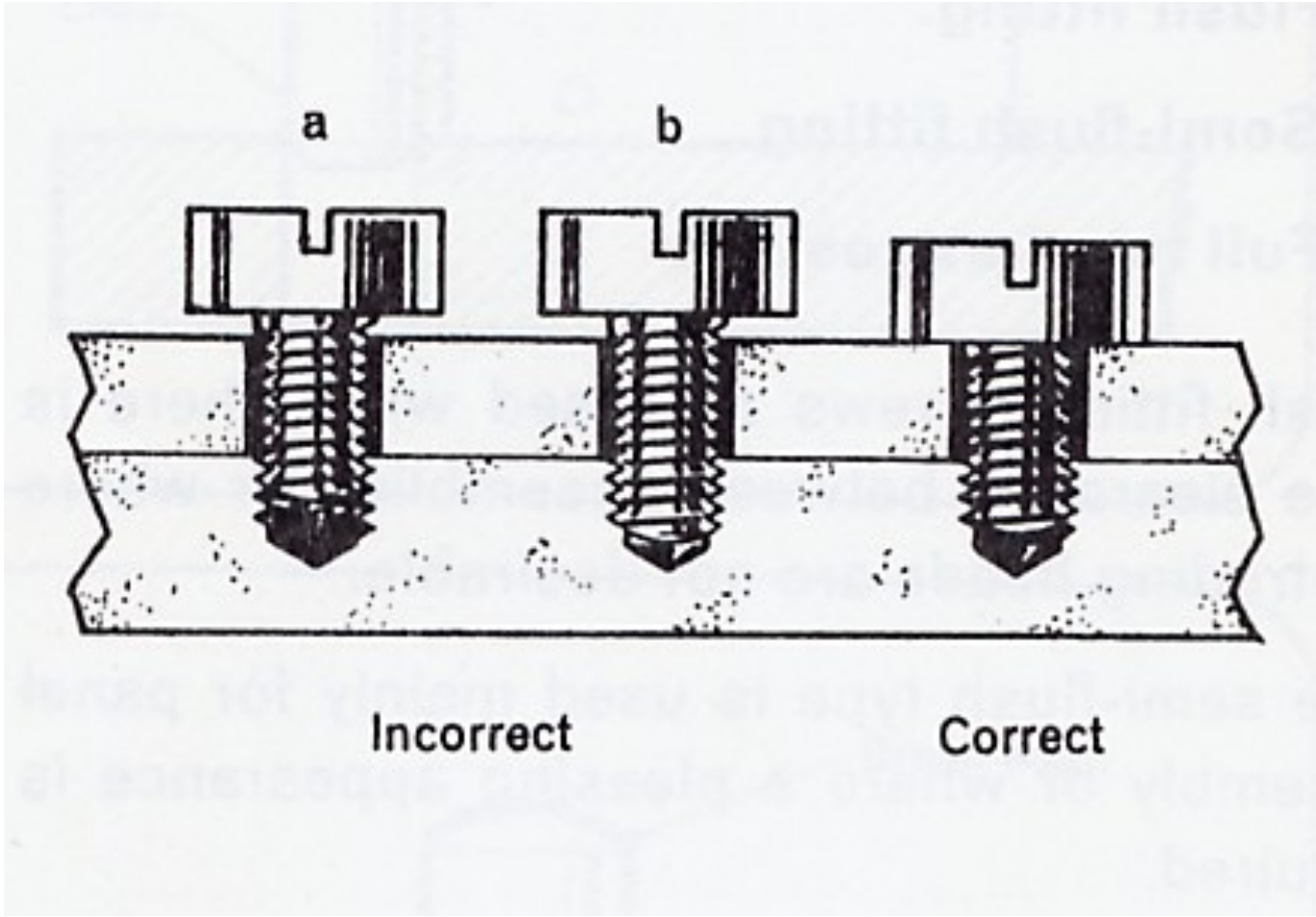
- Heli Coil EZ-LOK
- Make sure you use the right drill & tap size

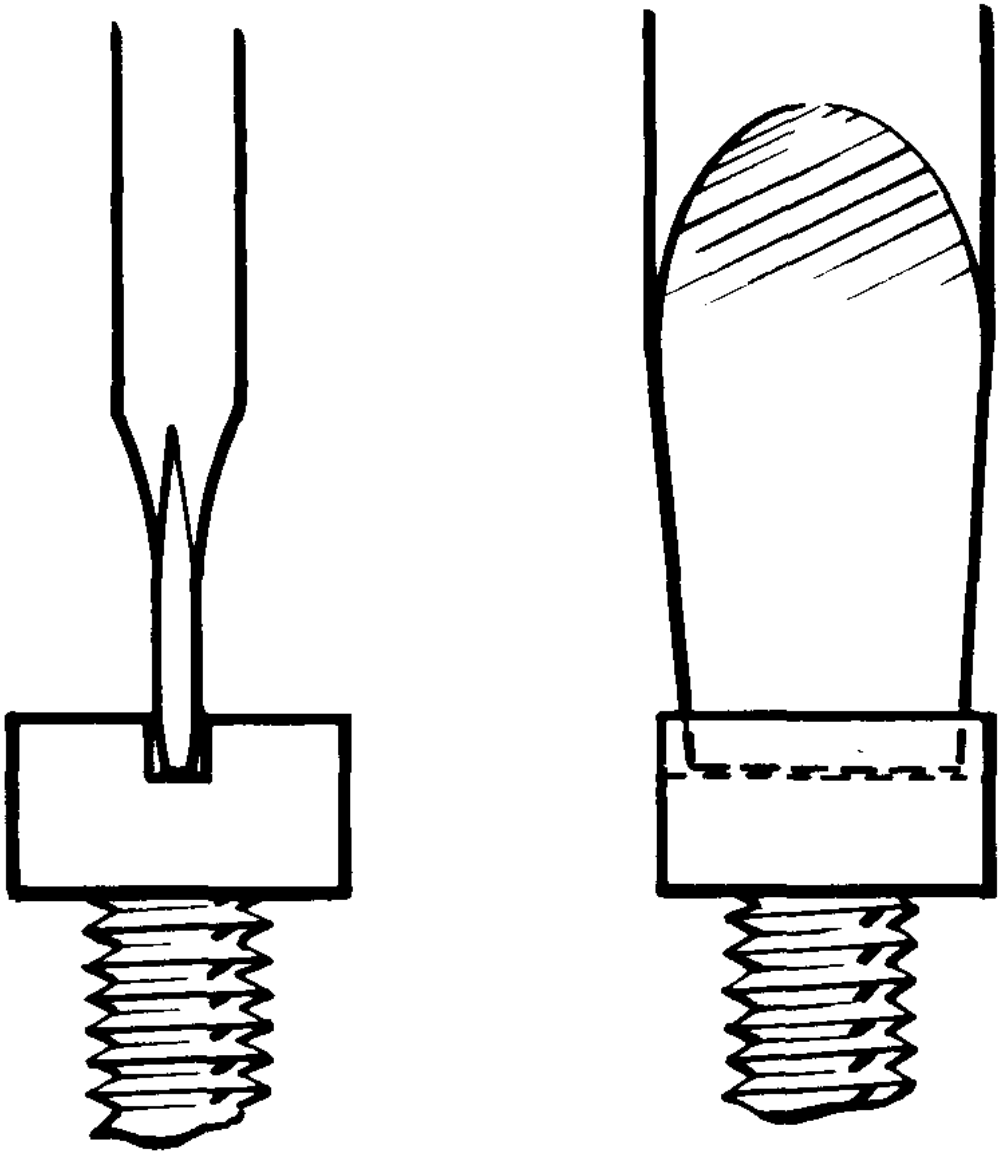


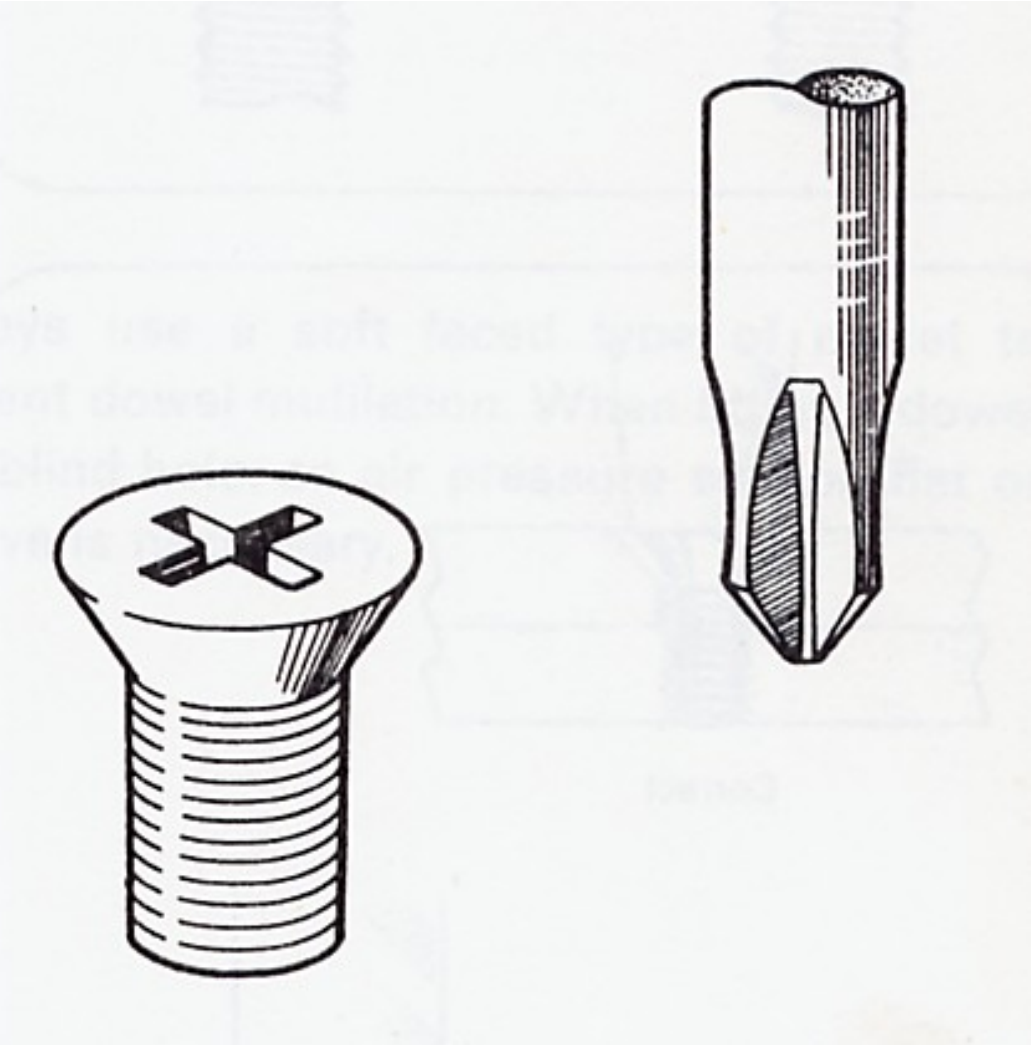
CORRECT

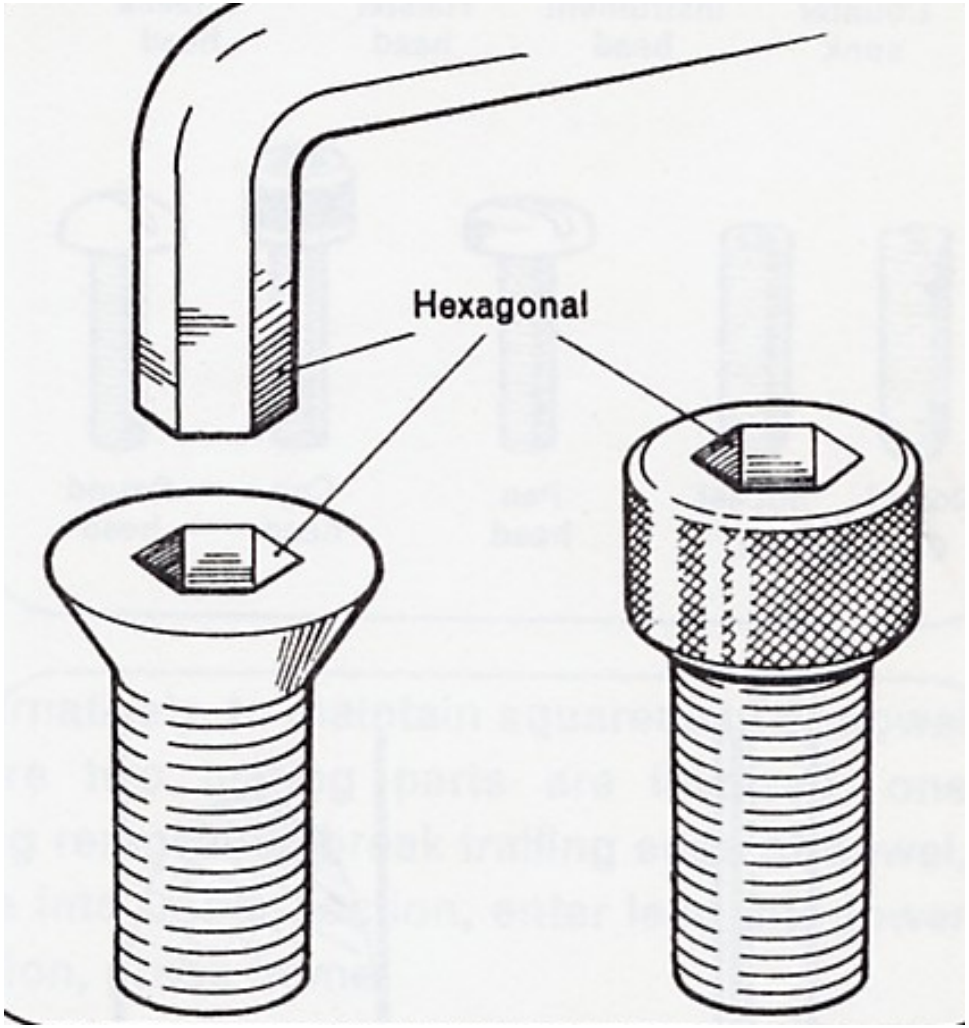


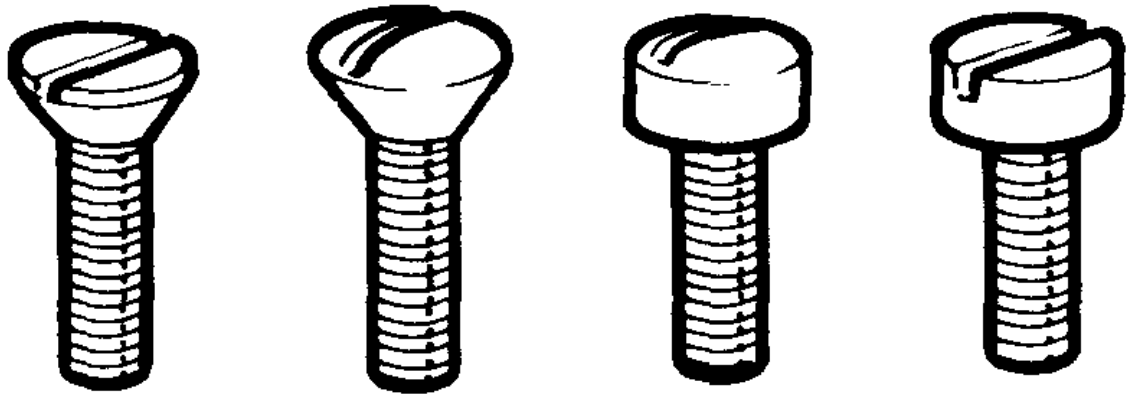
INCORRECT


a
b
Incorrect
Correct






Hexagonal

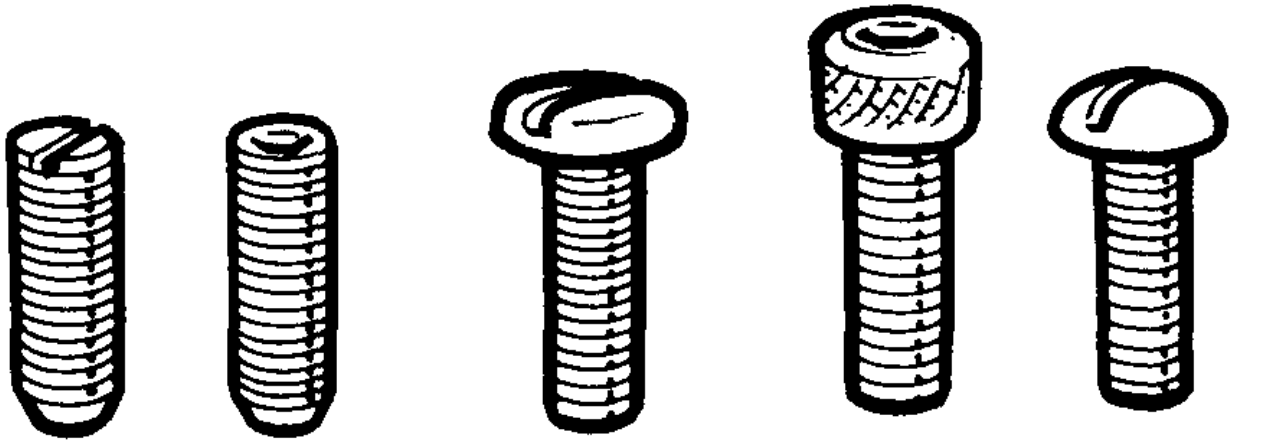


COUNTER SUNK

INSTRUMENT HEAD

FILLISTER HEAD

CHEESE HEAD



SLOTTED GRUBSCREWS

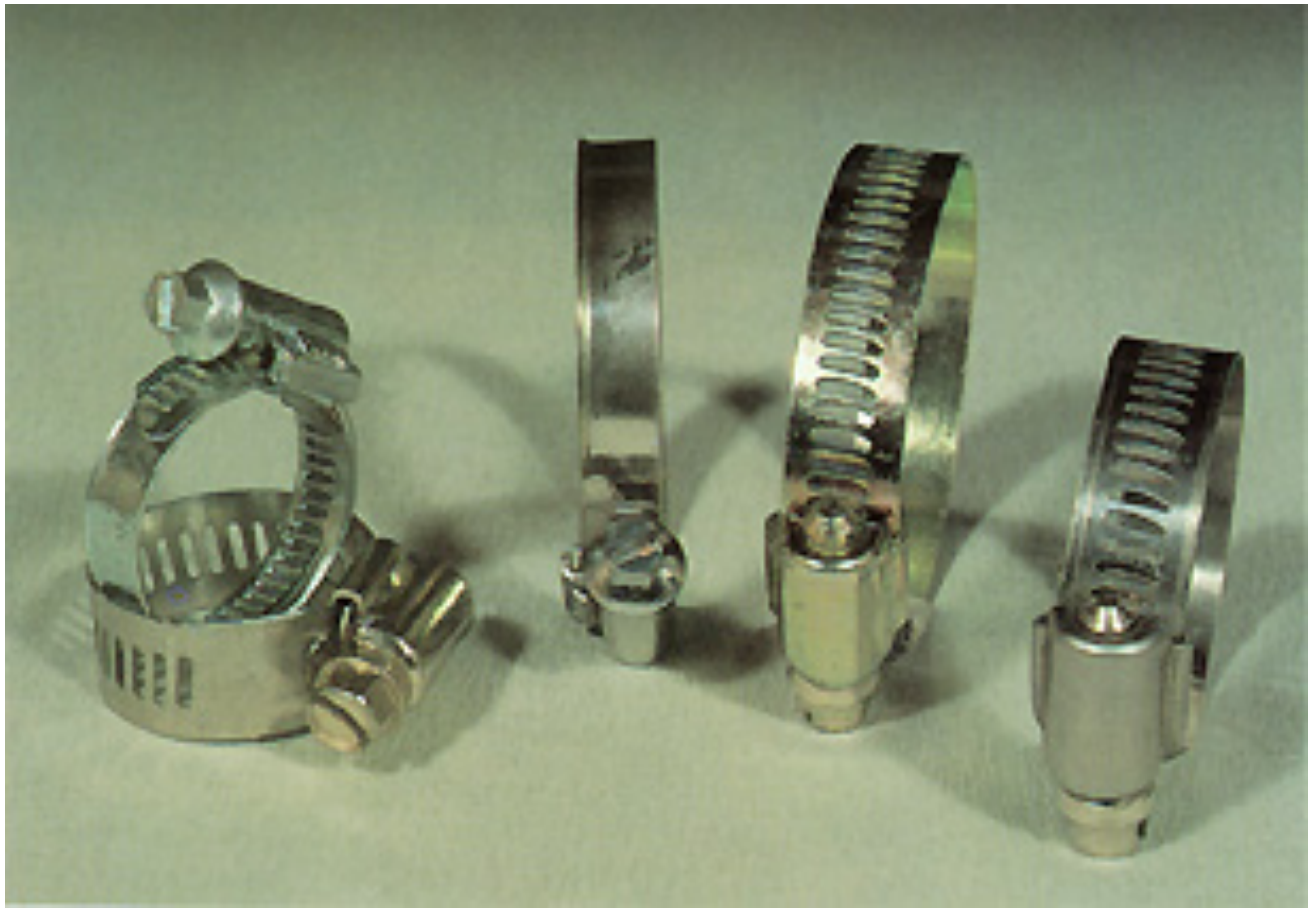
SOCKET

PAN HEAD

CAP HEAD

ROUND HEAD


Torx Screw & Rivet
Screw
Hex Bolt & Nut



Hexagonal head bolt clamp

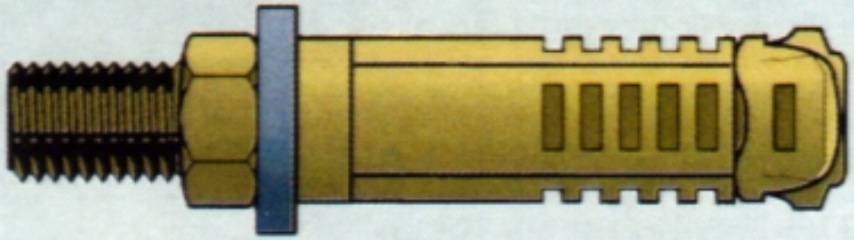
Drilltite Fasteners are self-drilling screws for metals and other materials.

Features

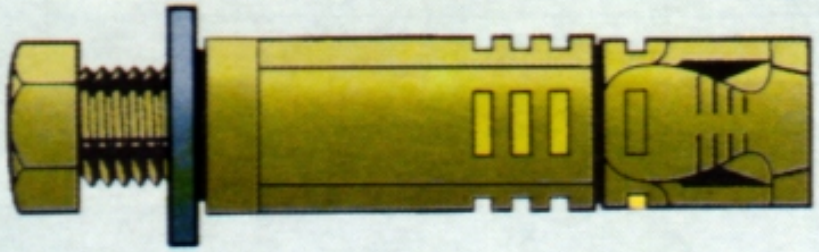
- Sharp point
- Dual process points; cold-formed and milled
- Variety of point styles
- Variety of thread forms

Benefits

- Eliminates drilling and tapping operations
- Facilitates hole alignment
- Provides "new" drill for each hole
- Assures accurately sized holes
- Speeds assembly operations

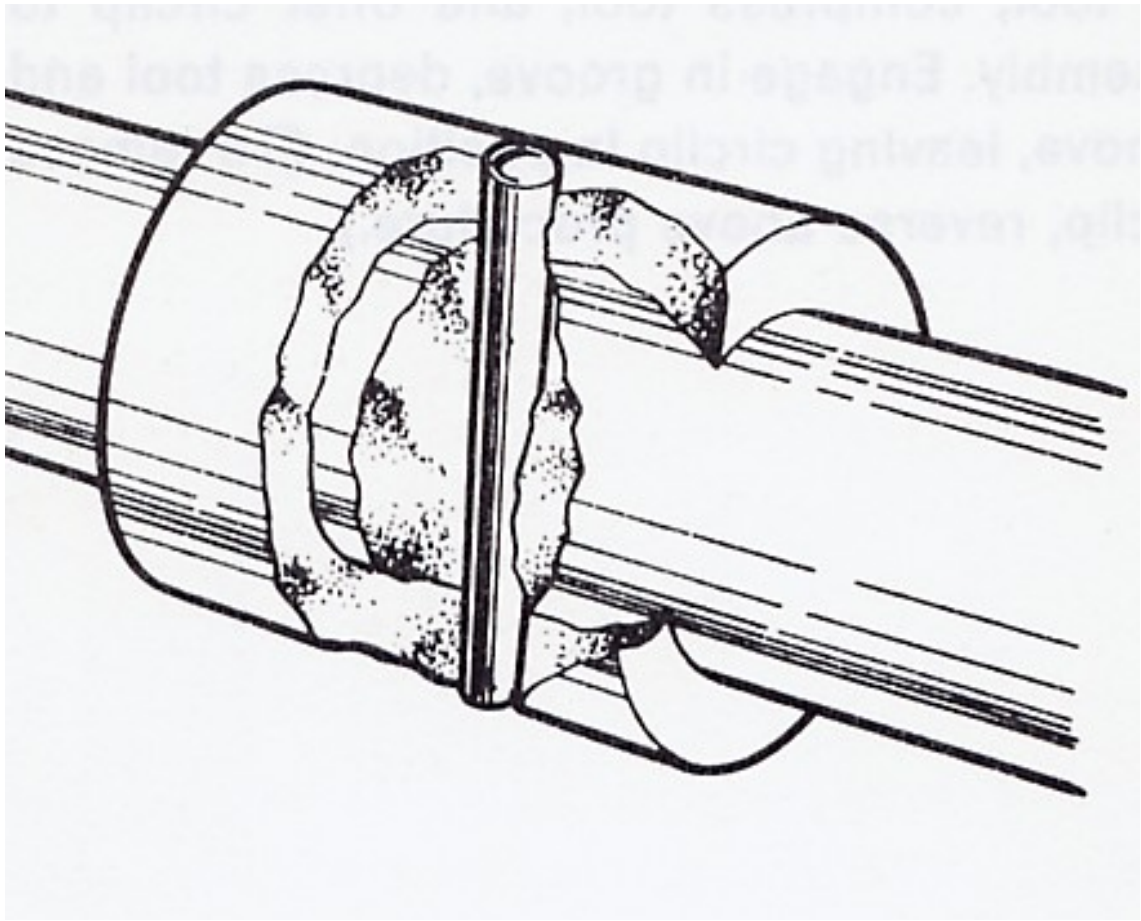


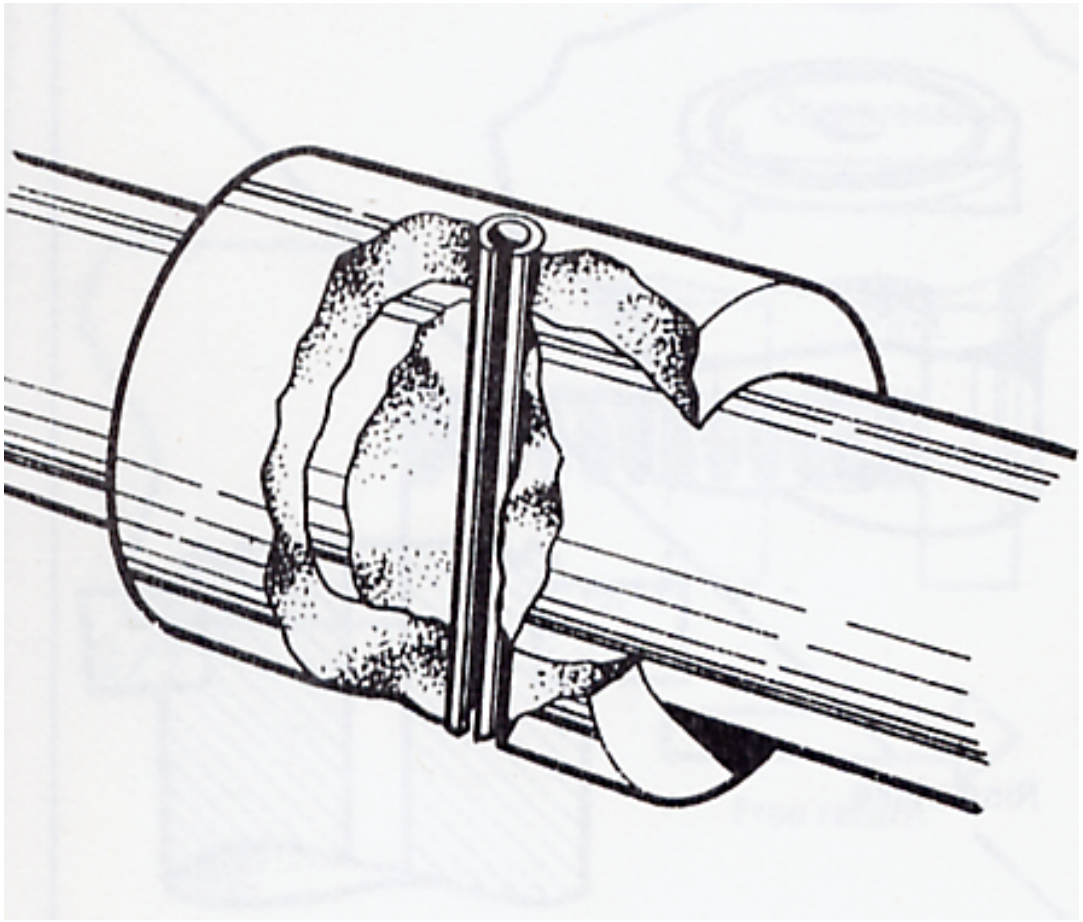
Heavy Duty Projecting Bolt

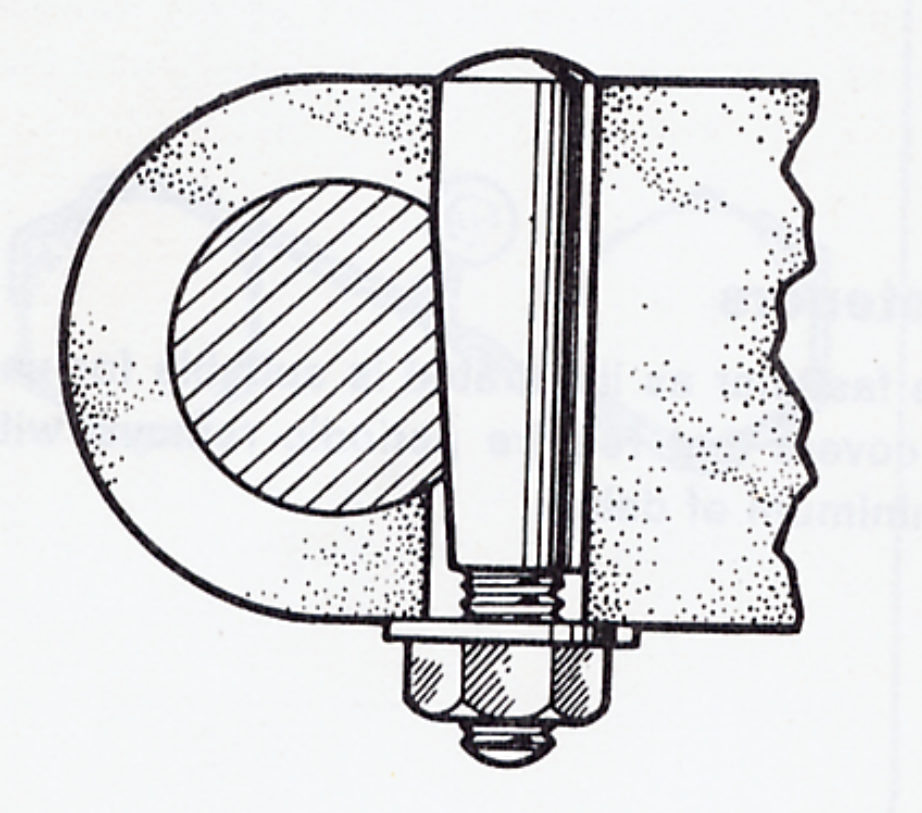


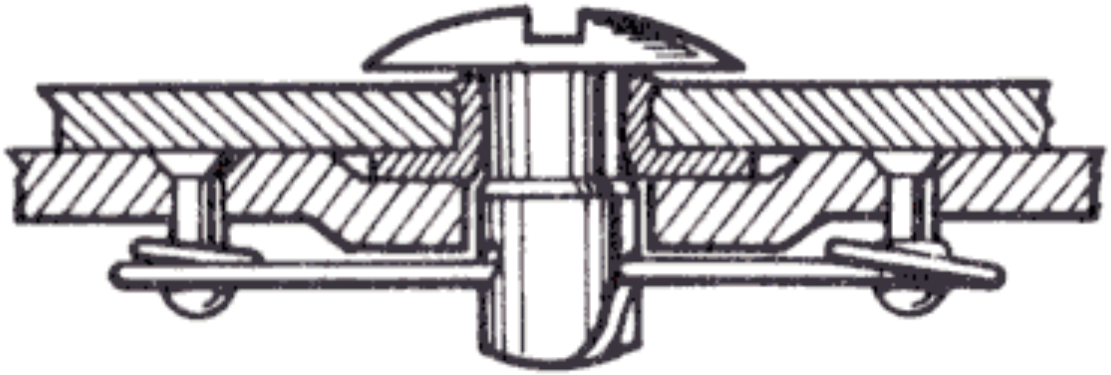
Heavy Duty Loose Bolt

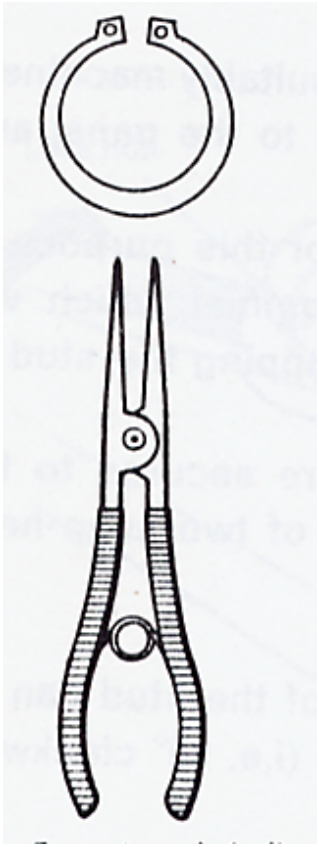

BBA

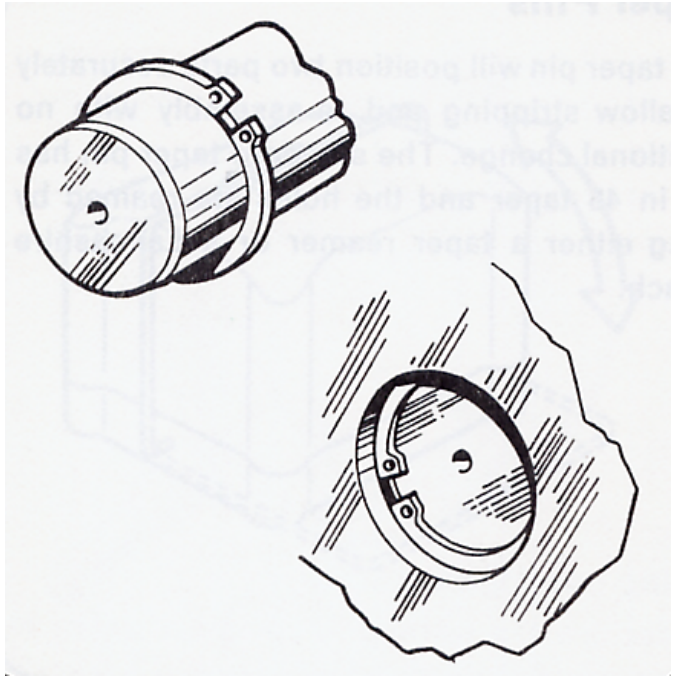


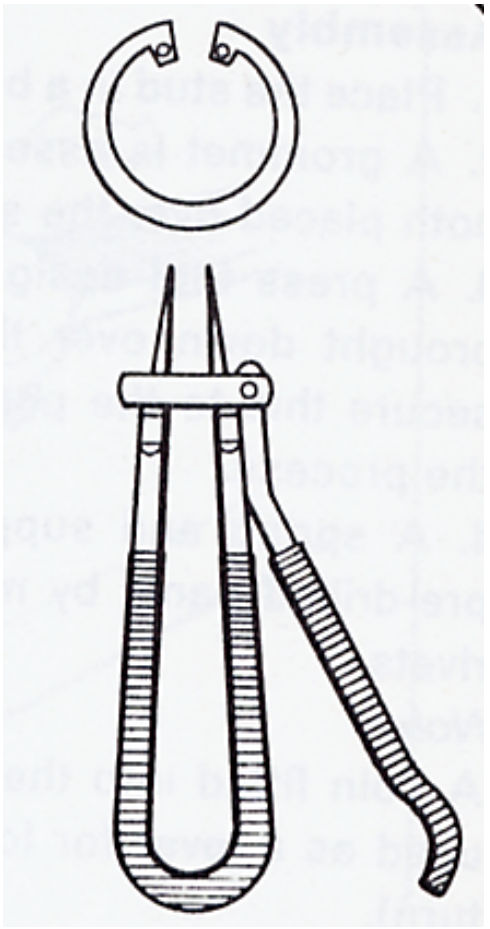


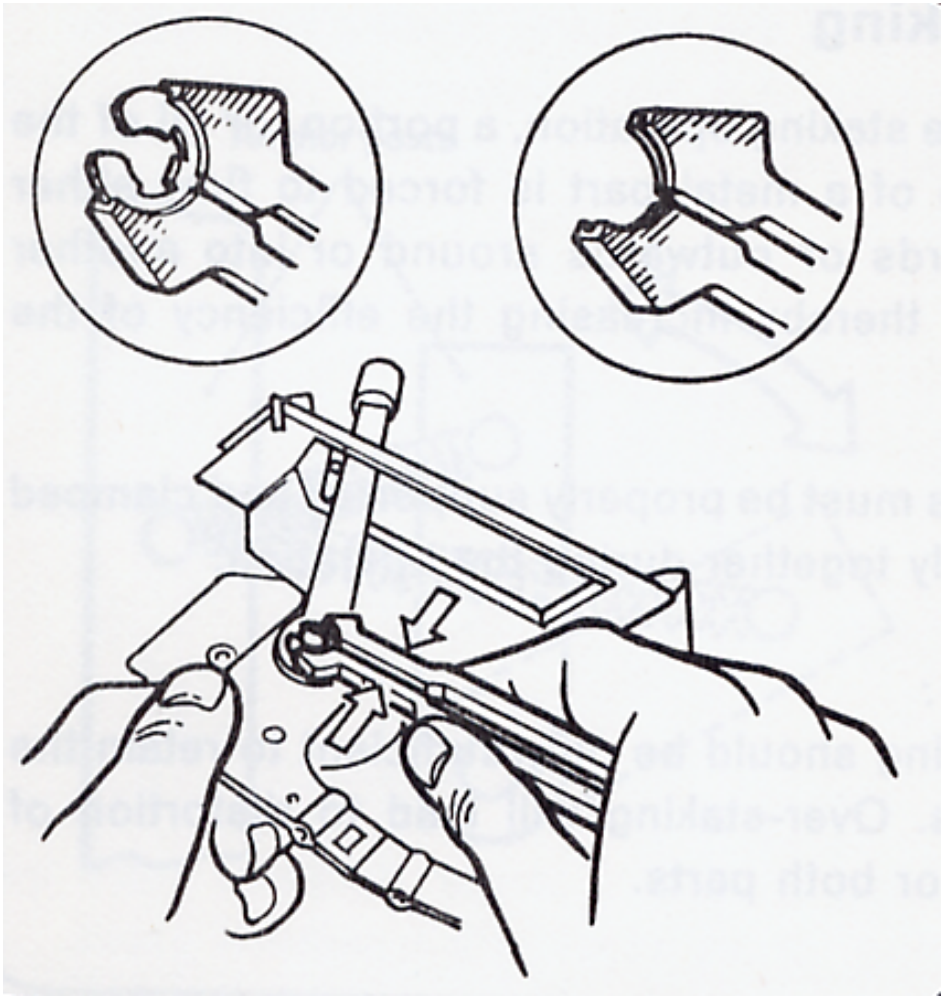


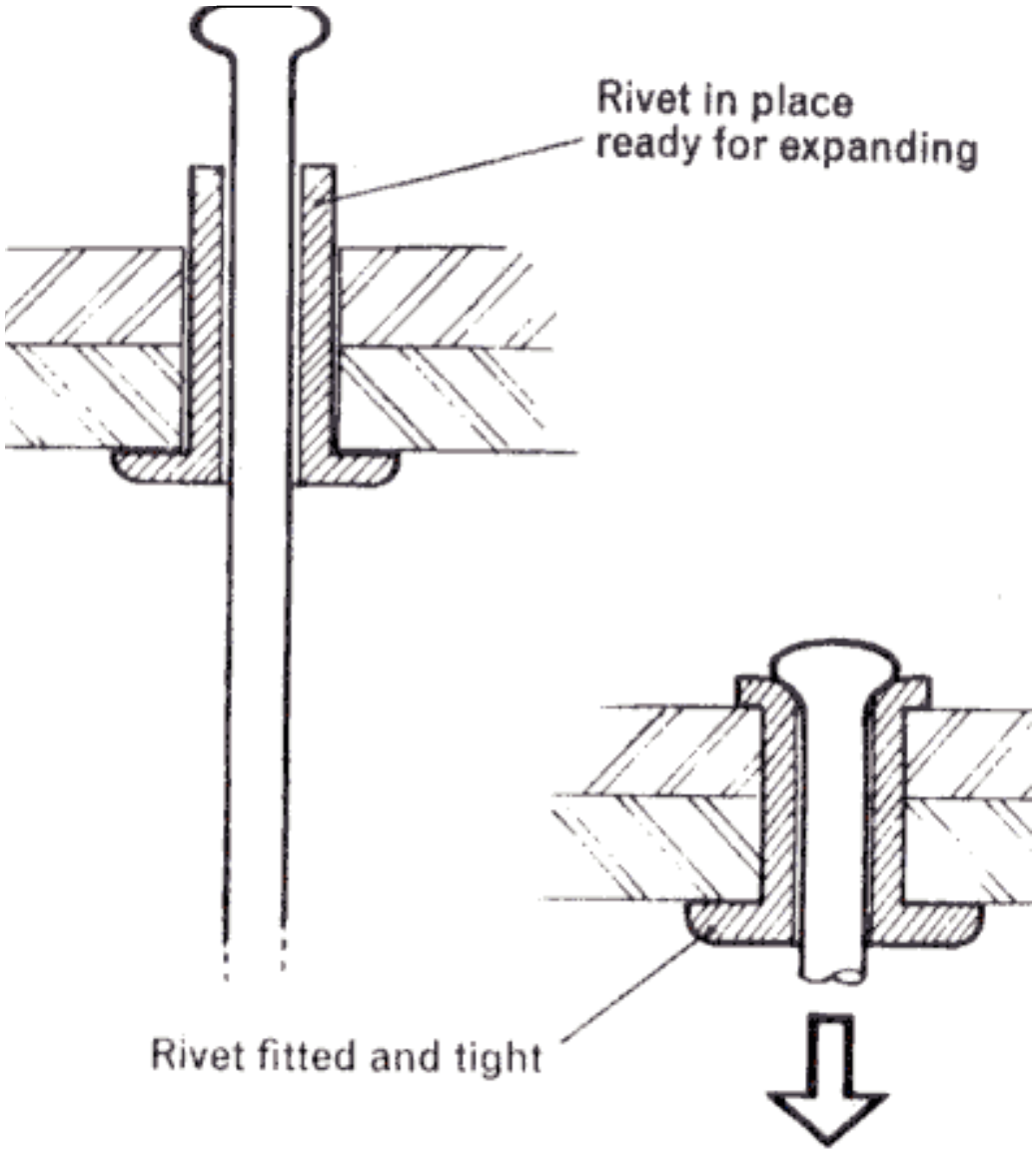


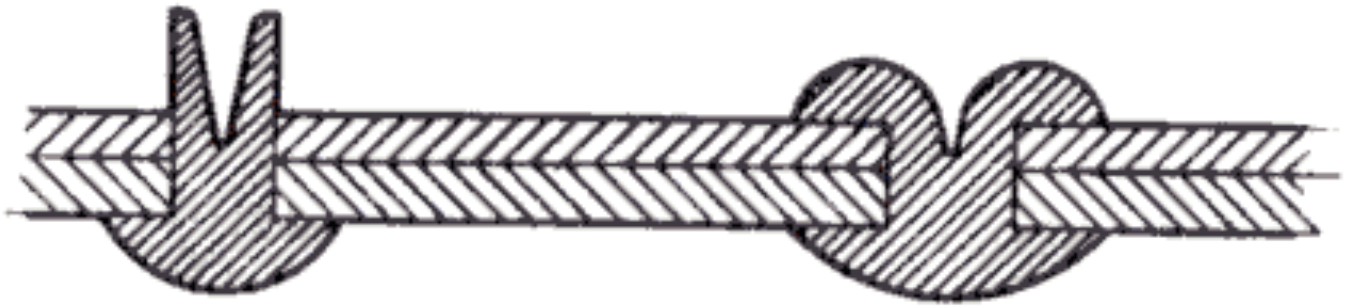


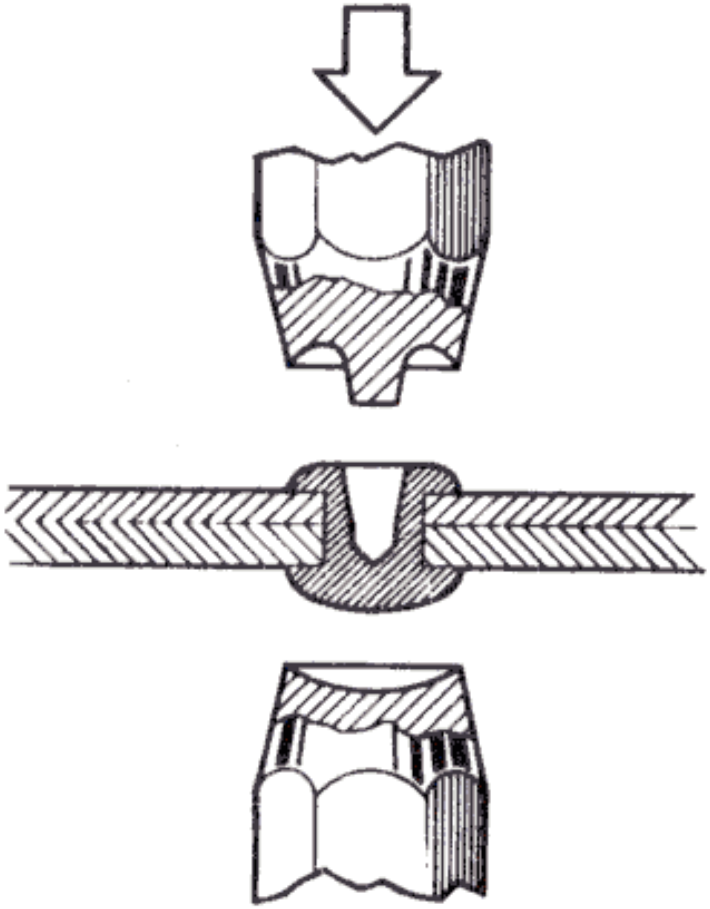


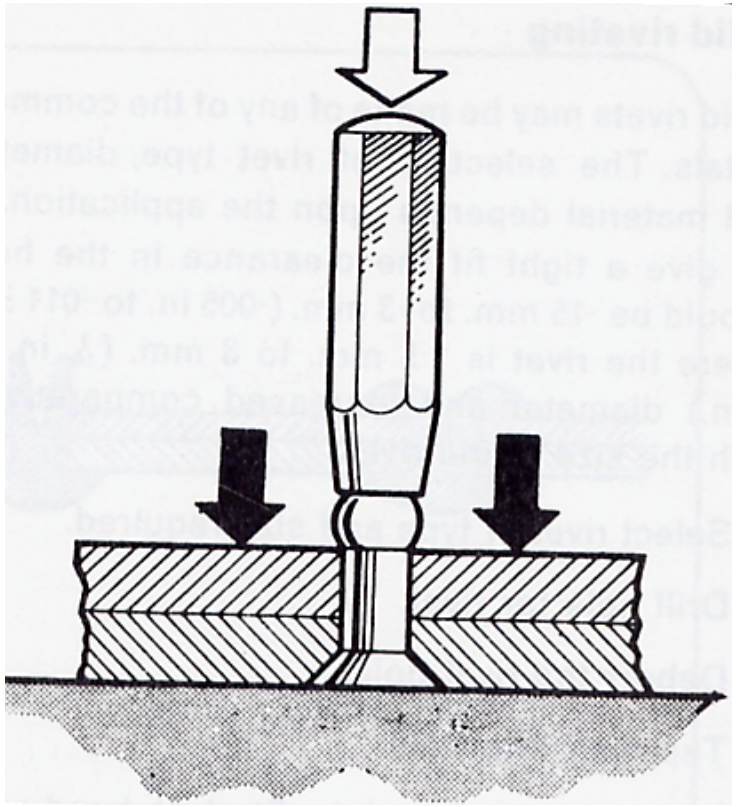


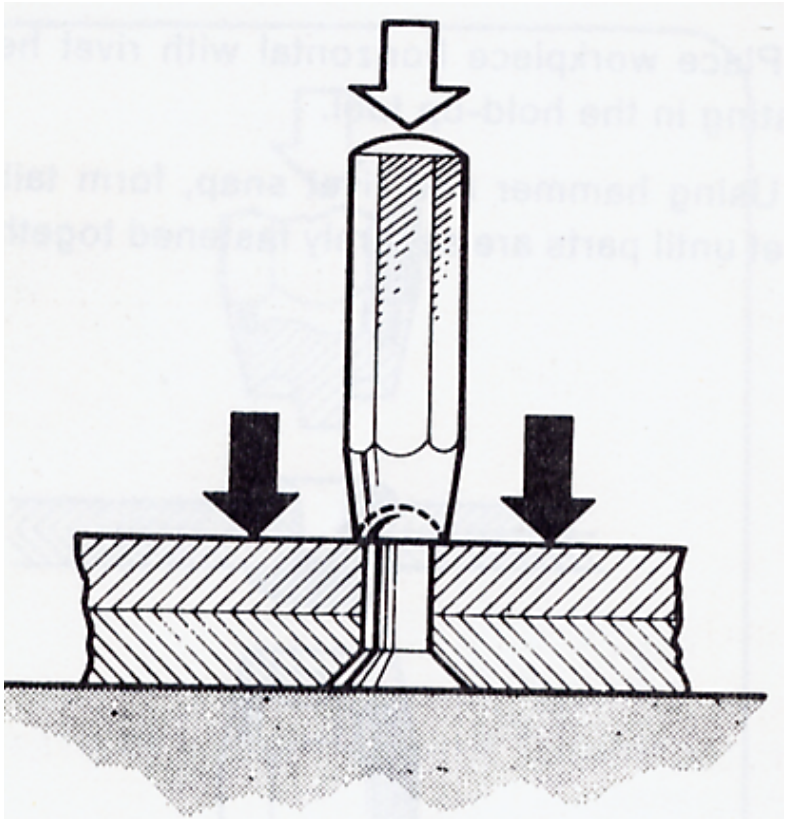












The End
Any Questions?