

MECH 211 – Mechanical Engineering Drawing

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Credits: 3.5

Lecture 10

Contents of the Lecture

Machine Elements

Fasteners, gears, bearings, welding

Machine elements and standards

Non-permanent fasteners: bolts and screws

- Features, representation, assembly representation and note

Other non-permanent fasteners

Permanent fasteners: rivets, joining through soldering, brazing and welding

Assembly drawings

Machine elements: gears, cams, bearings, etc.

Examples of mechanisms and representations

Fasteners

- Use to join two or more components
- Two major categories:
 - Non-permanent fastening methods
 - Permanent fastening methods
- A Boeing 747 has 2.5 million fasteners!



Aerospace Fasteners & Tools



Right Angle Air Drills

We offer a large range of Right Angle Drills with an impressive number of speeds to match your drilling applications. They are available in a wide range of configurations:- 45°, mini 90°, 360°, compact or heavy duty 90°. We have featured 3 models:-



AP15LF282-XX



AP15LN282-XX



AP15LF283-XX

Micro Stop Countersinks

These high speed steel, three flute, piloted countersinks are available in a variety of sizes - we have shown a kit which contains four cutters, the AP62-40, AP62-30, AP62-21 and the AP62-3/16.



Micro Stops

For flush riveting, rivet shaving and collar removal, these Micro Stops have a hardened bushing supporting the spindle and are rated to 3000 rpm. Ball bearing type micro stops also available. We offer a number of different Micro Stops for varying applications - please call our sales team for more information.



Pork Chop Drill Attachment

Fits any 1/4" drill chuck, air or electric. Heavy duty design. Use with threaded bits to drill in difficult to access areas. Note: threaded drill bits also available. Please have diameter and length information available at time of request. **AP362**



Drill Housing & Bushings

Hand held guide to keep drills and taps 90° to work surface - order one housing and interchange the different size bushings of your choice.



Code	Description	Drill
AP783	Housing	N/A
AP783A	Bushing	#40
AP783B	Bushing	3/32
AP783C	Bushing	#30
AP783D	Bushing	1/8
AP783E	Bushing	#21
AP783F	Bushing	3/32
AP783G	Bushing	#10
AP783H	Bushing	3/16
AP783I	Bushing	3/32
AP783J	Bushing	1/4



Nut Plate Drill Jigs

Nut Plate Drill Jigs are available in one lug, two lug, corner and mini anchor nut types in a variety of sizes - we have shown the most common size, please call for our complete list of types and sizes. **AP518J (#10)**



Drill Stops

Designed to provide a sure stop to regulate hole depth, and to prevent chucks from damaging panels, these drill stops feature a unique rounded face. They are colour-coded by size for easy identification.

Code	Colour	Drill
AP145DS-50	Black	#50
AP145DS-40	Zinc	#40
AP145DS-30	Copper	#30
AP145DS-28	Zinc	#28
AP145DS-21	Black	#21
AP145DS-20	Zinc	#20
AP145DS-12	Brass	#12
AP145DS-10	Brass	#10
AP145DS-1/4	Copper	1/4
AP145DS-3/16	Black	3/16



Non-Permanent Fasteners

- Bolts and nuts, machine screws, studs, pins, rings, keys, etc.
- An assembly could be disassembled without destroying the fastener of a part of the assembly



Bolts, Nuts and Machine Screws

- Used to assembly machine parts through the friction obtained in a helical groove made on two conjugated parts
- The threads are cut or rolled in a blank of material (metal) while the conjugate part moves axially on the thread when turned
- Bolts and nuts must have the same geometric features in order to be matted.



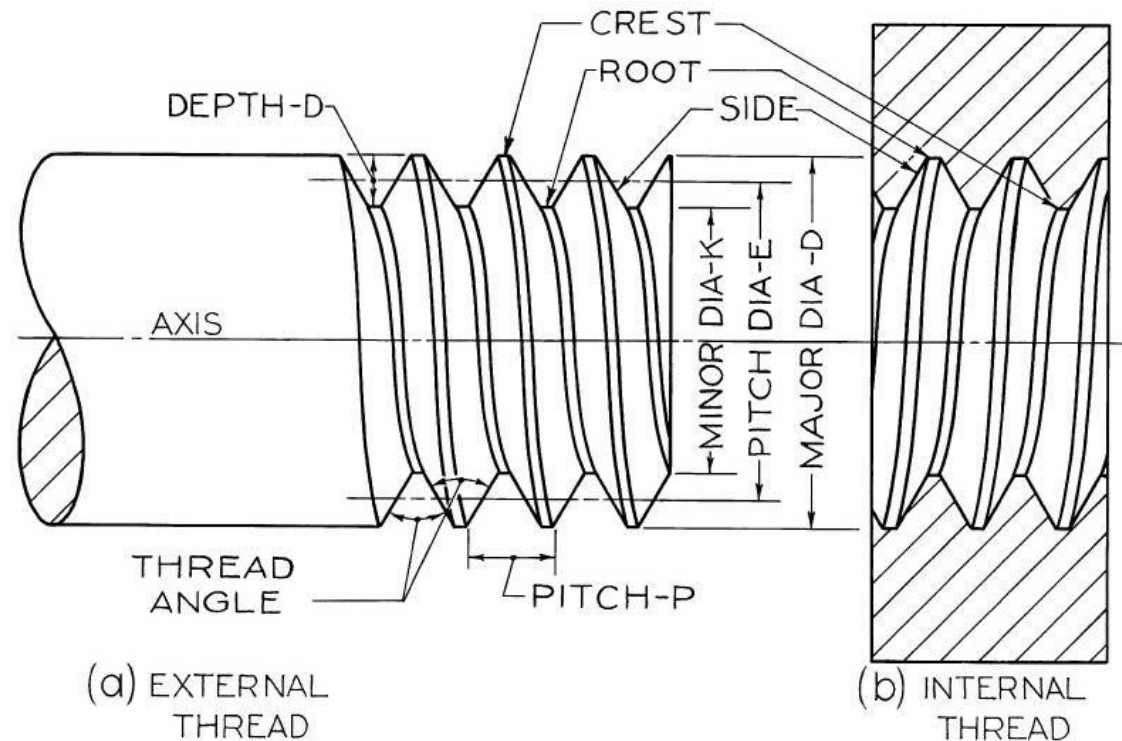
Etc...

Screw and Thread Terminology

Screw Thread: A ridge of uniform section in the form of a helix on the external or internal surface of a cylinder.

Major Diameter: The largest diameter of a screw thread.

Minor Diameter: The smallest diameter of a screw thread.



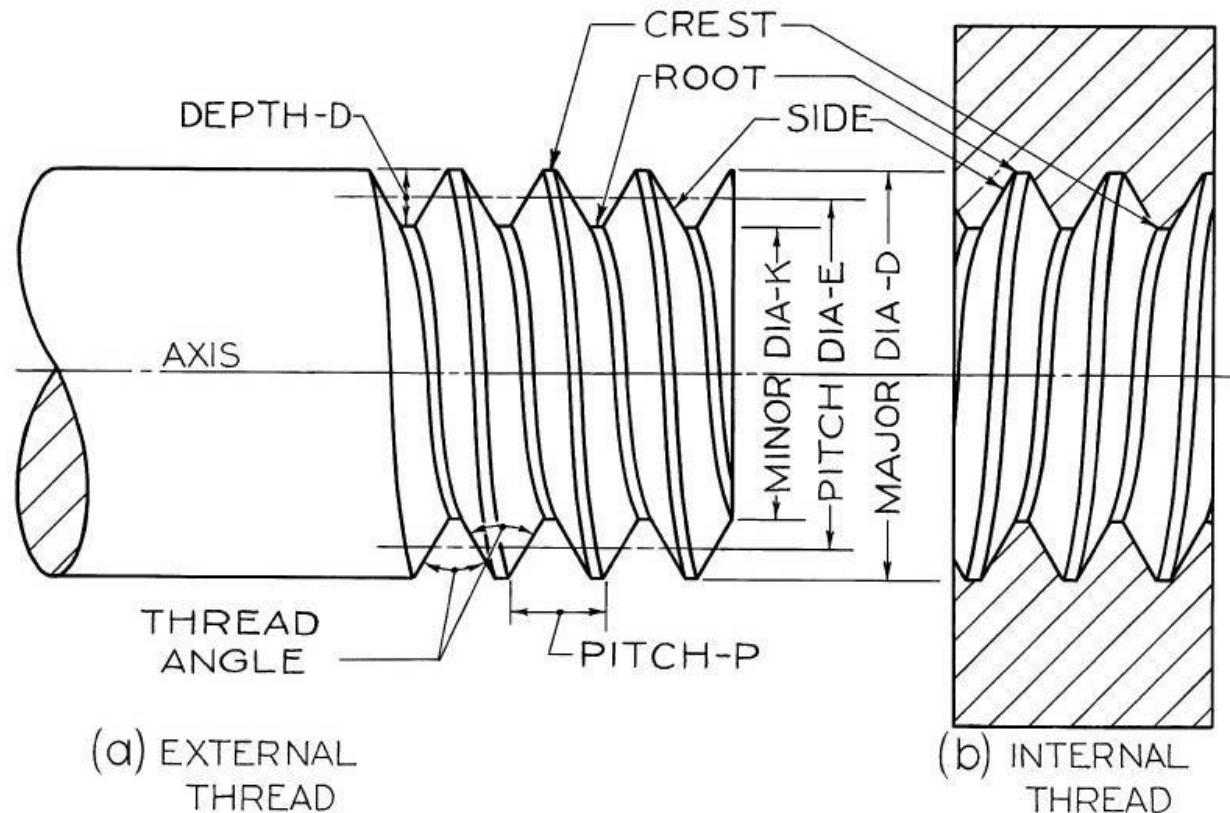
Screw and Thread Terminology

Axis: the longitudinal center line of the original work (blank) or hole.

Chamfer: the angular relief at the beginning or end of the thread to allow easier engagement with the mating part.

Crest: the peak of the top of a thread.

Depth: the distance between the crest and the root.



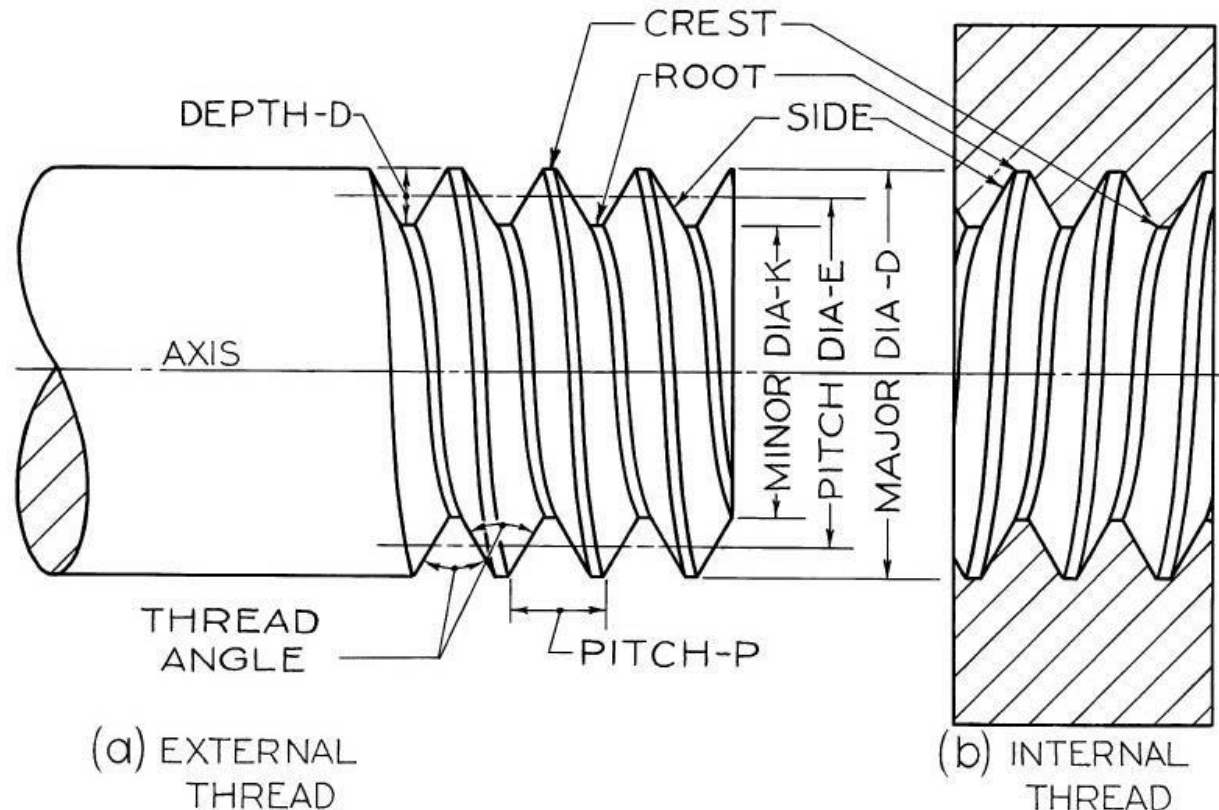
Screw and Thread Terminology

Die: the tool used to perform external threads.

External thread: the screw thread on the outside of a cylindrical surface.

Internal thread: the screw thread on the inside of a cylindrical surface.

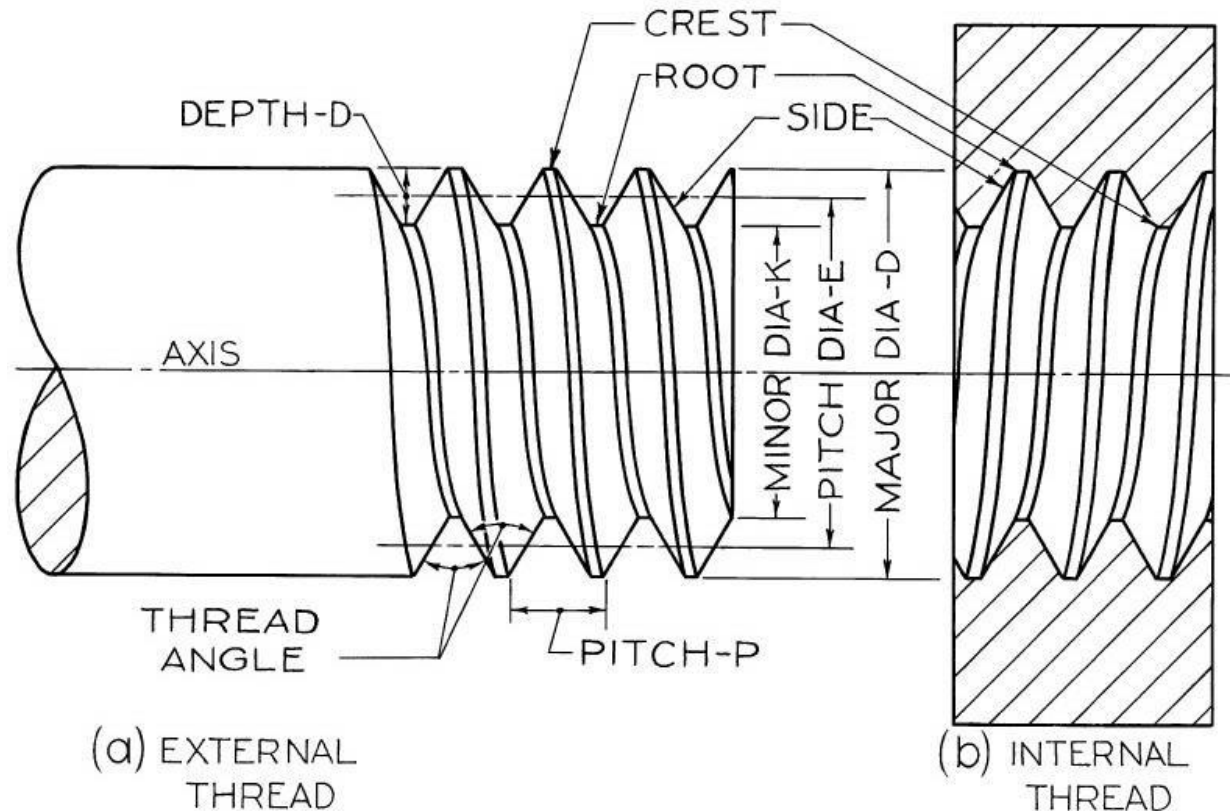
Lead: the distance that a screw will travel along the axis when turned by 360° .



Screw and Thread Terminology

Pitch: the distance between corresponding points on adjacent thread forms, measured parallel to the axis expressed in 1 divided by the number of pitch in one inch.

Pitch diameter: the diameter of an imaginary cylinder that is located equidistant between the major and the minor diameter.



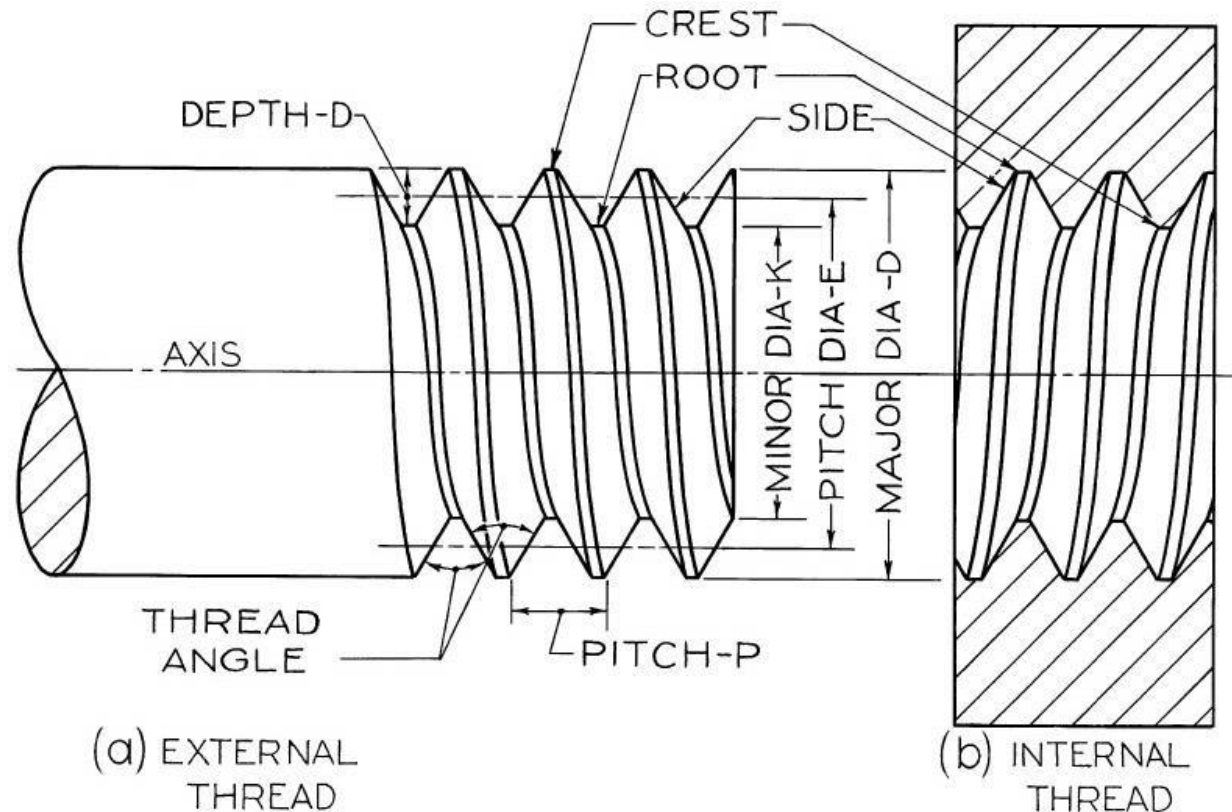
Screw and Thread Terminology

Root: the bottom of the screw thread cut in a cylinder.

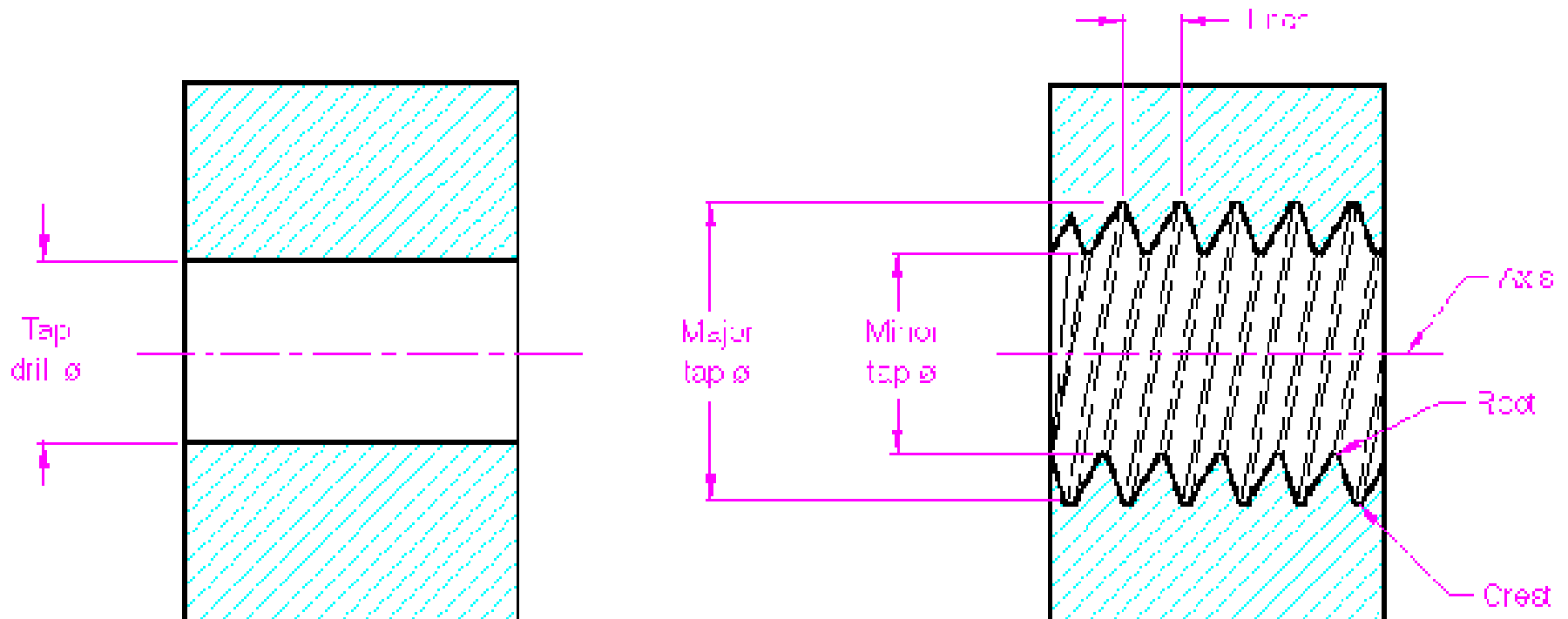
Tap: the tool used to thread holes.

Thread angle: the angle between the surfaces of two adjacent threads.

Thread series: the number of threads per inch for a given diameter.



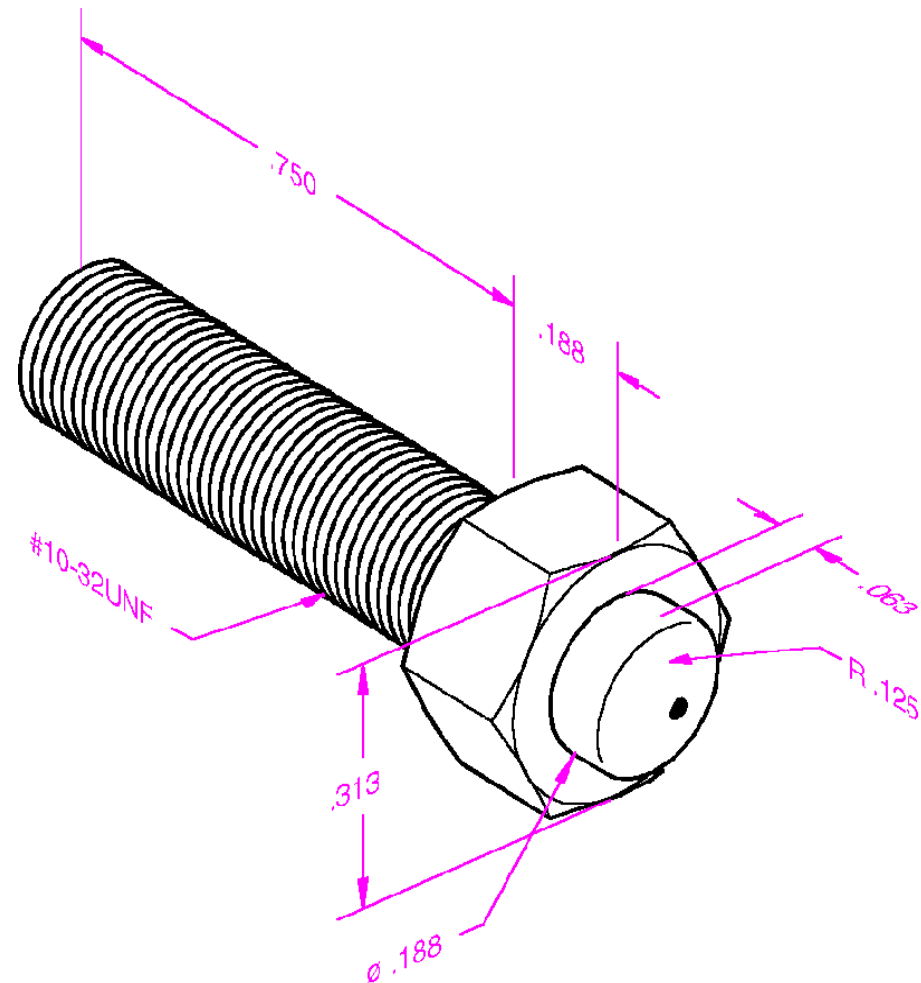
Screw and Thread Terminology



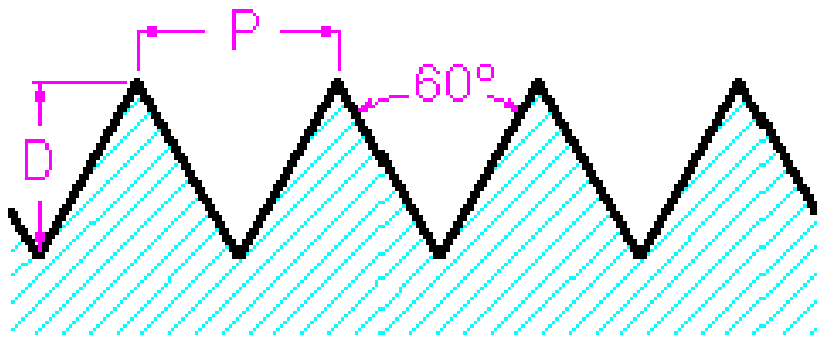
Internal thread=

Thread Specifications Imperial System

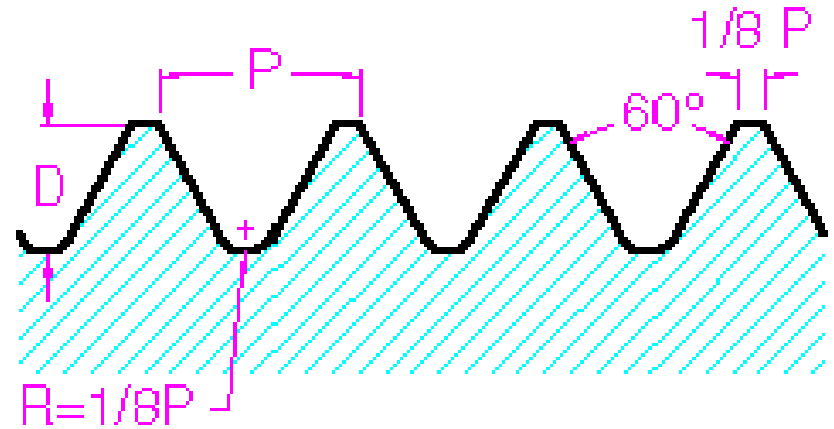
- ANSI Y14.6 - 1998
- Thread form
- Thread series
- Major diameter
- Class of fit
- Threads per inch



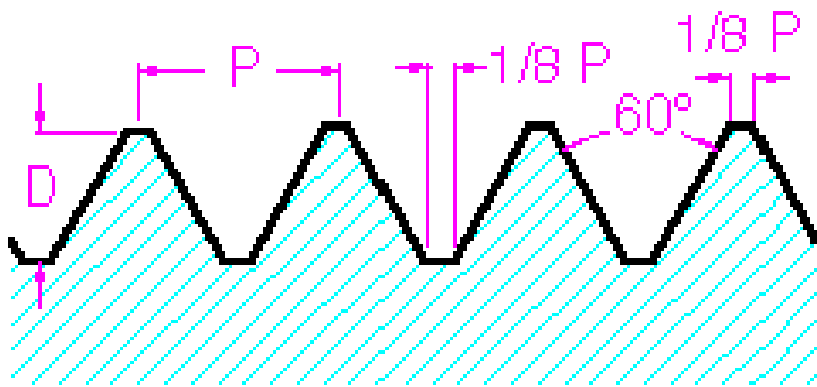
Form



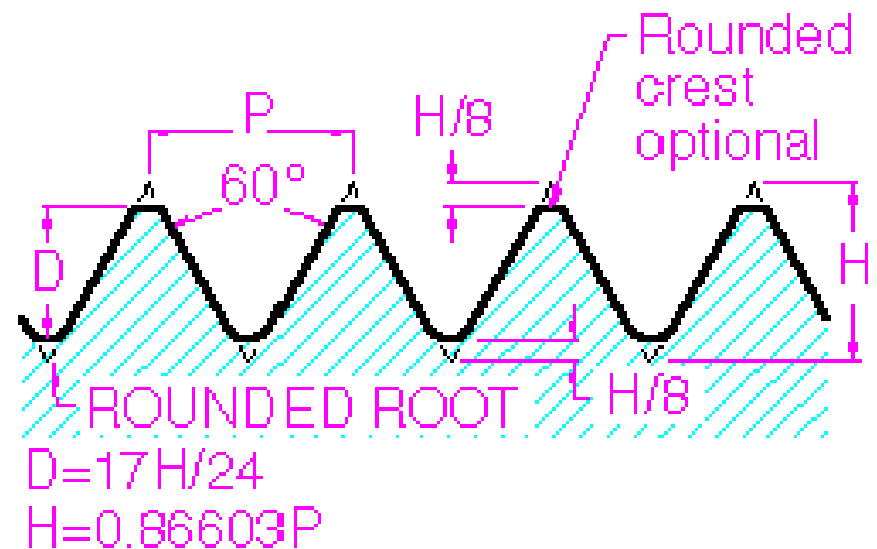
(A) Sharp V



(B) Unified National Round

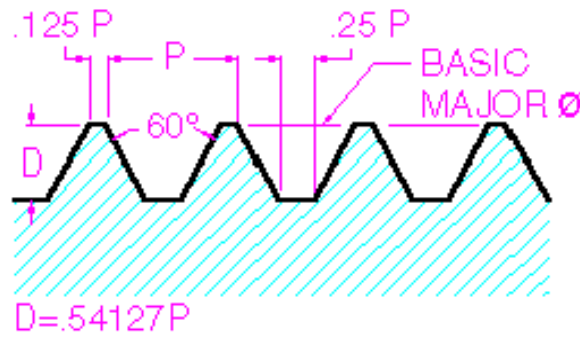


(C) American National

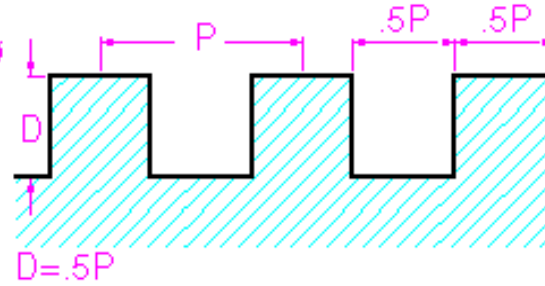


(D) Unified (external)

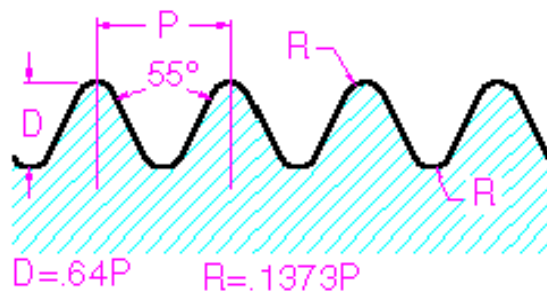
Form



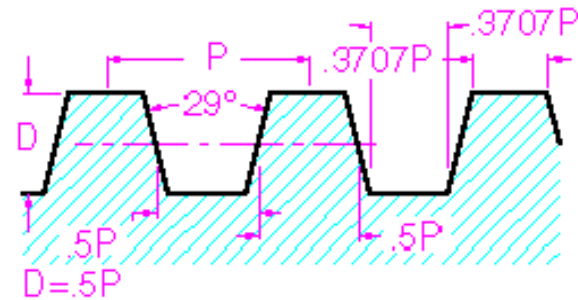
(E) Metric



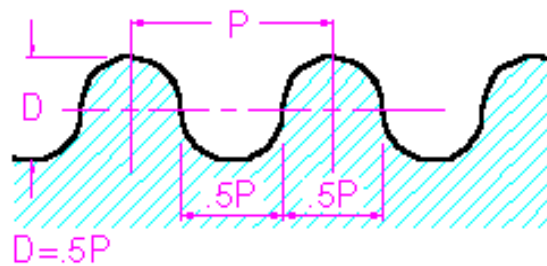
(F) Square



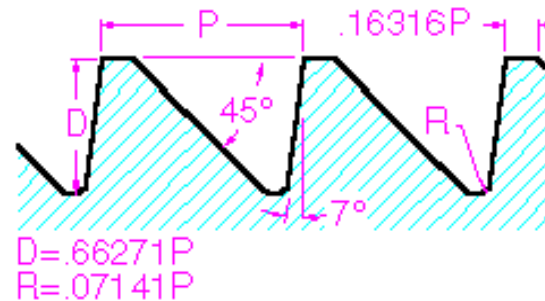
(G) Whitworth Standard



(H) Acme



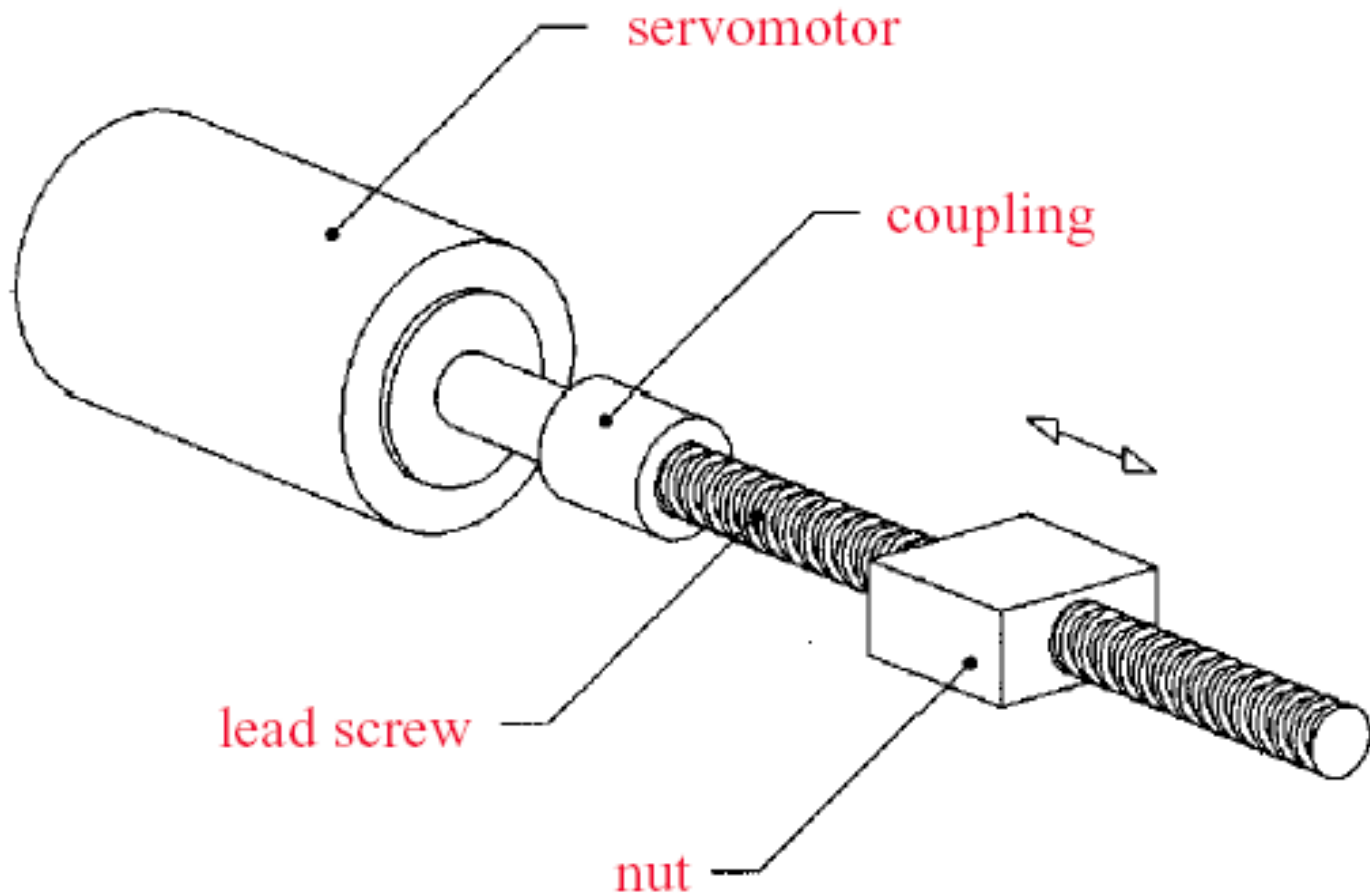
(I) Knuckle



(J) Buttress

Motion and Measurement Screws

Control and positioning applications



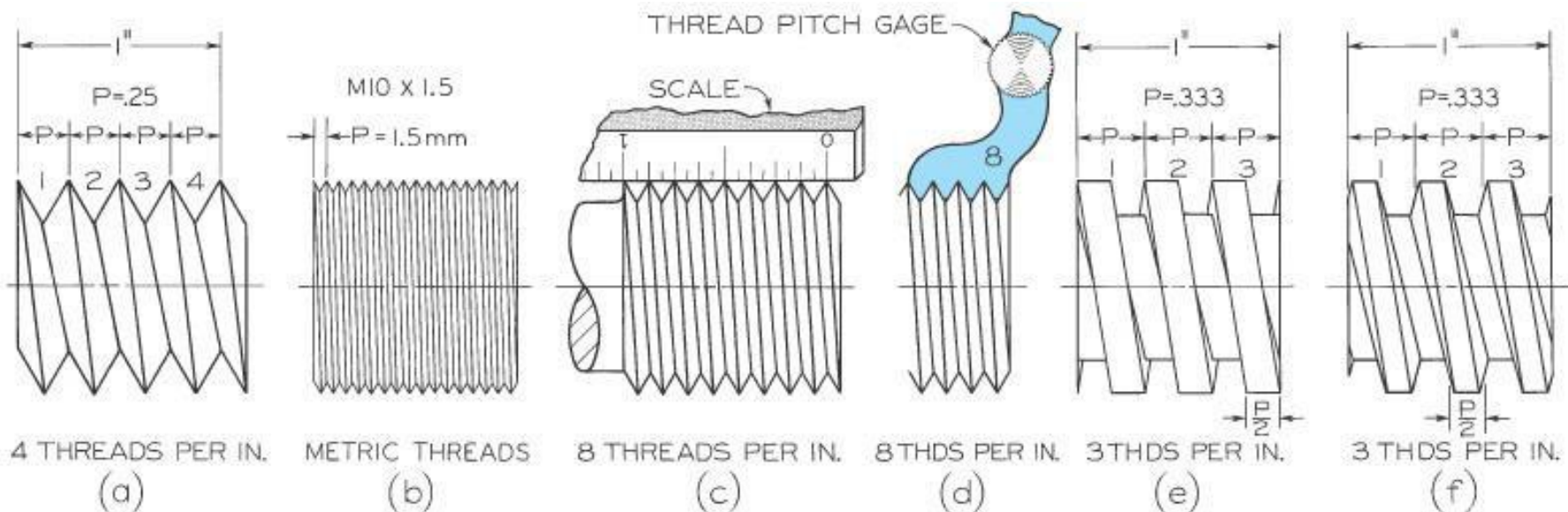
Measuring Thread Pitch

The **Pitch** is the distance parallel to axis between corresponding points in adjacent thread.

The **Pitch** is measured in millimeters for metric thread and indicated along with the major diameter (eg. M10 X 1.5).

Inch threads are defined as threads per inch (TPI).

Thread Pitch is measured with scale or a thread pitch gage.



Thread Series

The **Series** depends on the pitch and the major diameter of the thread.

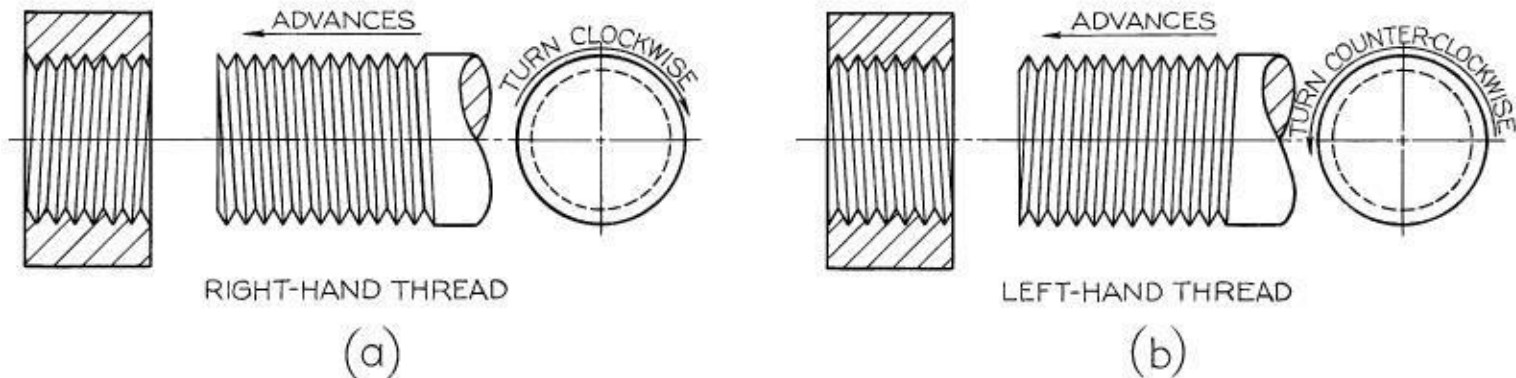
Coarse series threads are used for quick assembly and disassembly of cast iron, soft metals and plastics (UNC)

Fine series threads are used when a great deal of force is necessary for assembly (UNF)

Extra fine series threads are used when the length of engagement is short and the application calls for high degrees of stress (UNEF)

Thread Series

- If not stated in the drawing, threads are always assumed to be **right-hand threads**.
- A bolt that is threaded into a tapered hole should be turned clockwise.
- Some special cases (where the torque may loosen the fastener) may require **left-hand threads**.
- If **left-hand threads** are necessary they will be indicated in the drawing by letters LH after the thread designation.



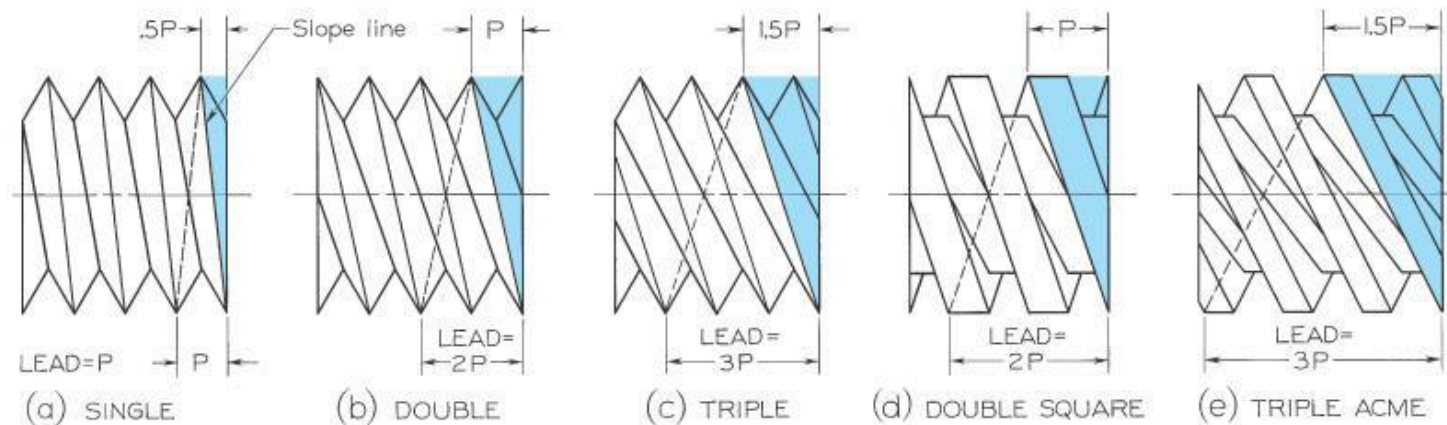
Class of Fit

- Class 1** a loose fit where quick assembly is required and play between parts is acceptable
- Class 2** a high quality general purpose commercial class of fit for bolts, nuts and screws used in mass production
- Class 3** a very high quality threaded fasteners with a close fit used for precision assembly subjected to vibrations

Single and Multiple Thread Forms

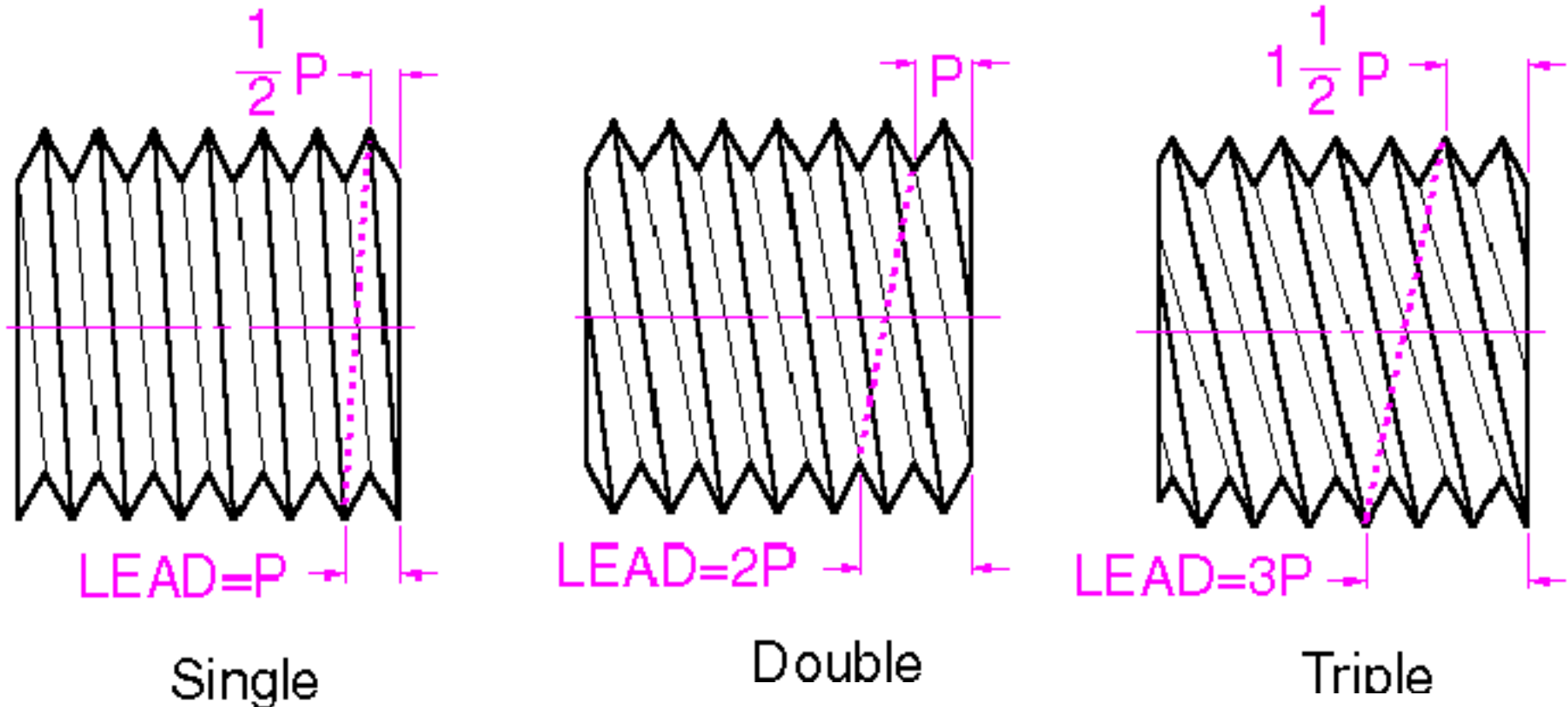
- Single threads have a single ridge in the form of helix and lead = pitch.
- Multiple threads have 2 or more ridges running side by side.
- The slope line is the hypotenuse of the right triangle whose short side = $.5P$ for single threads and p for double and $1.5P$ for triple threads.
- Multiple threads are required when small rotation must give faster movement at low required power (E.g. Toothpaste caps).

Number of starts in a thread



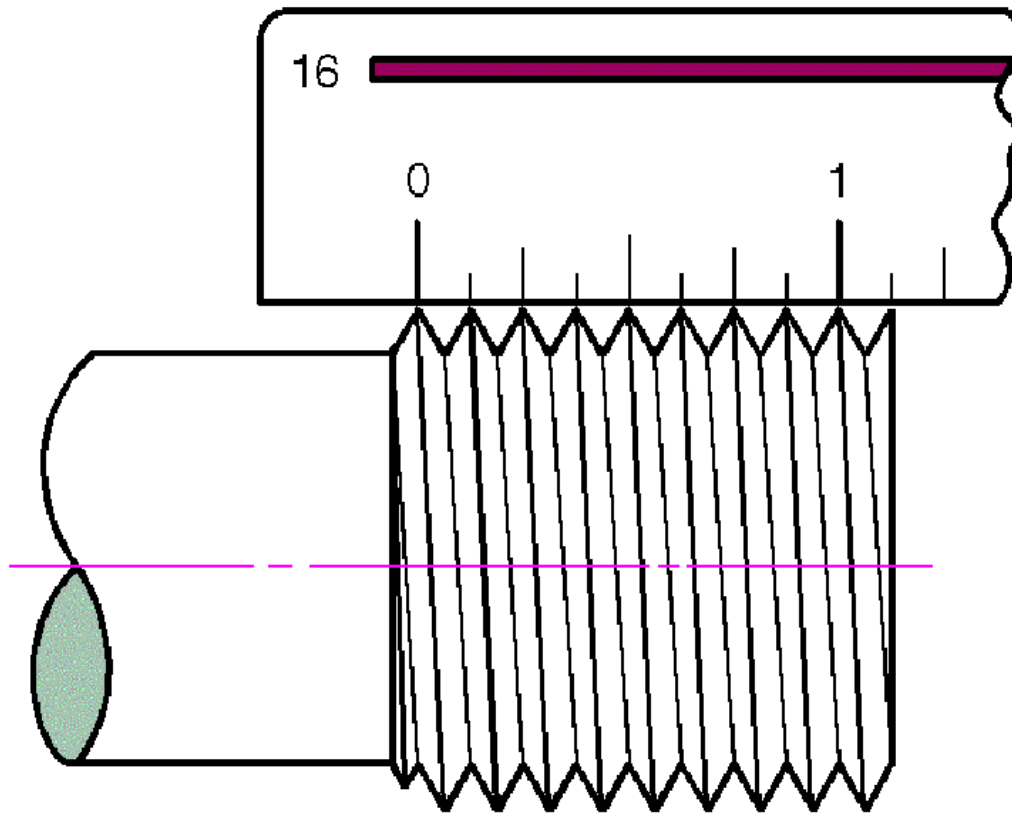
Single and Multiple Thread Forms

Number of starts in a thread

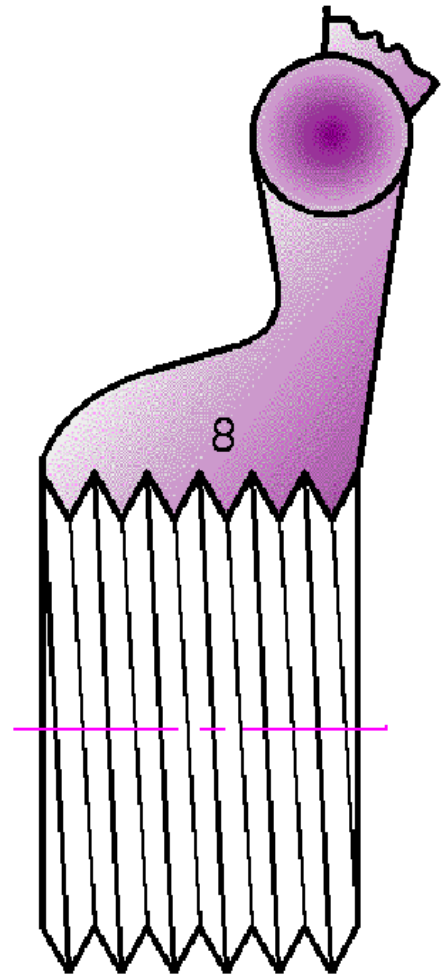


Measuring the Thread Pitch

8 Threads per inch

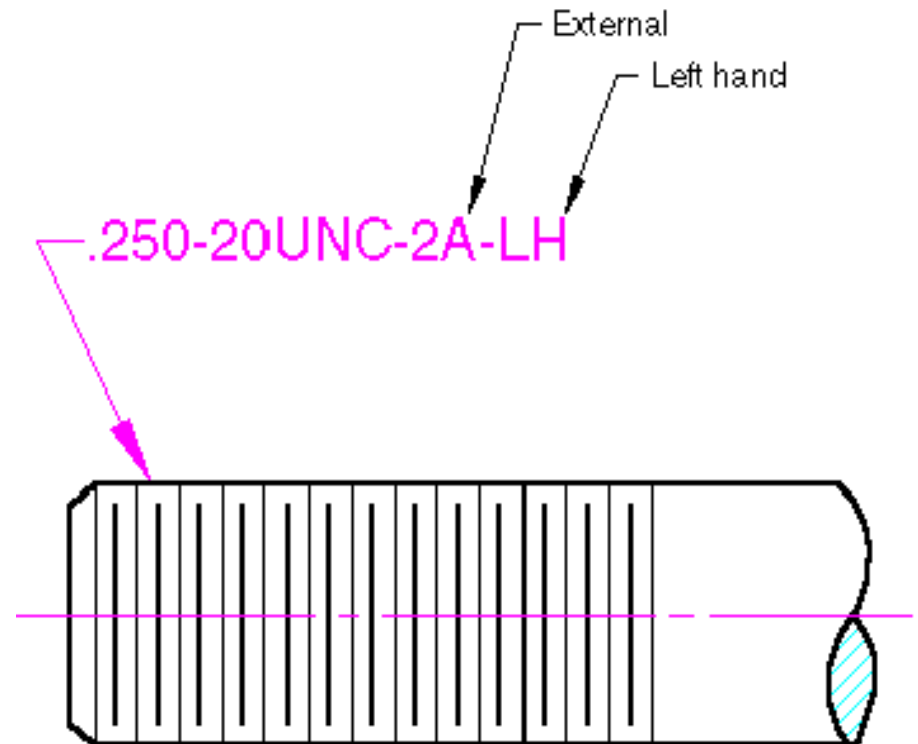
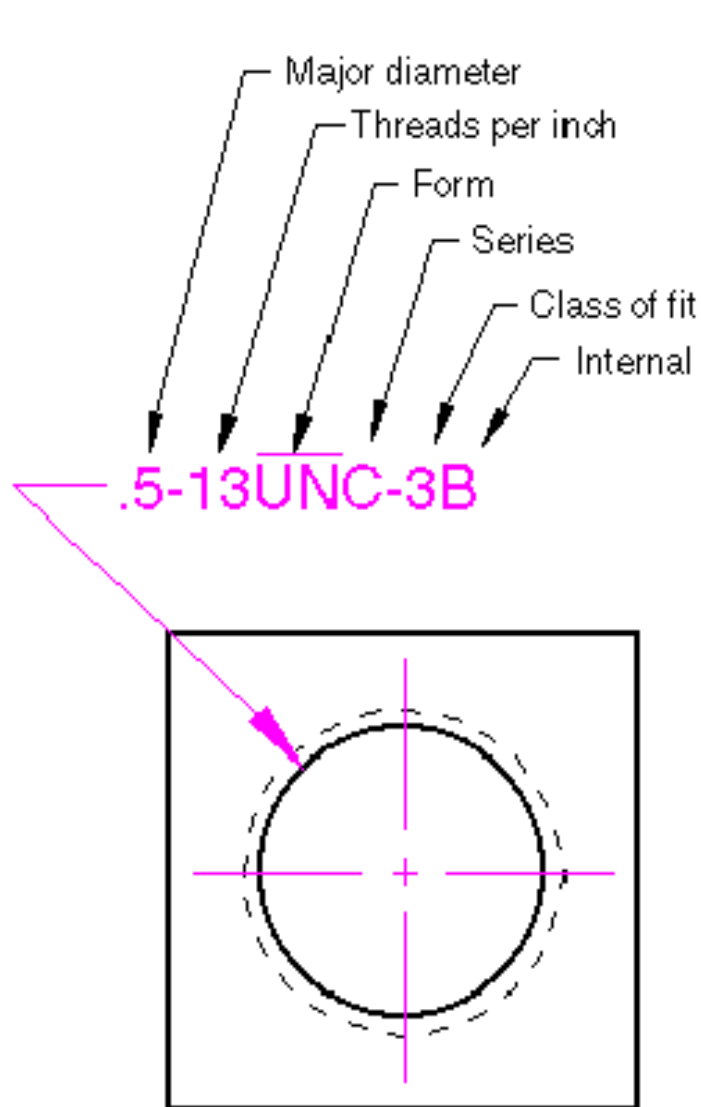


Scale



Thread pitch
gage

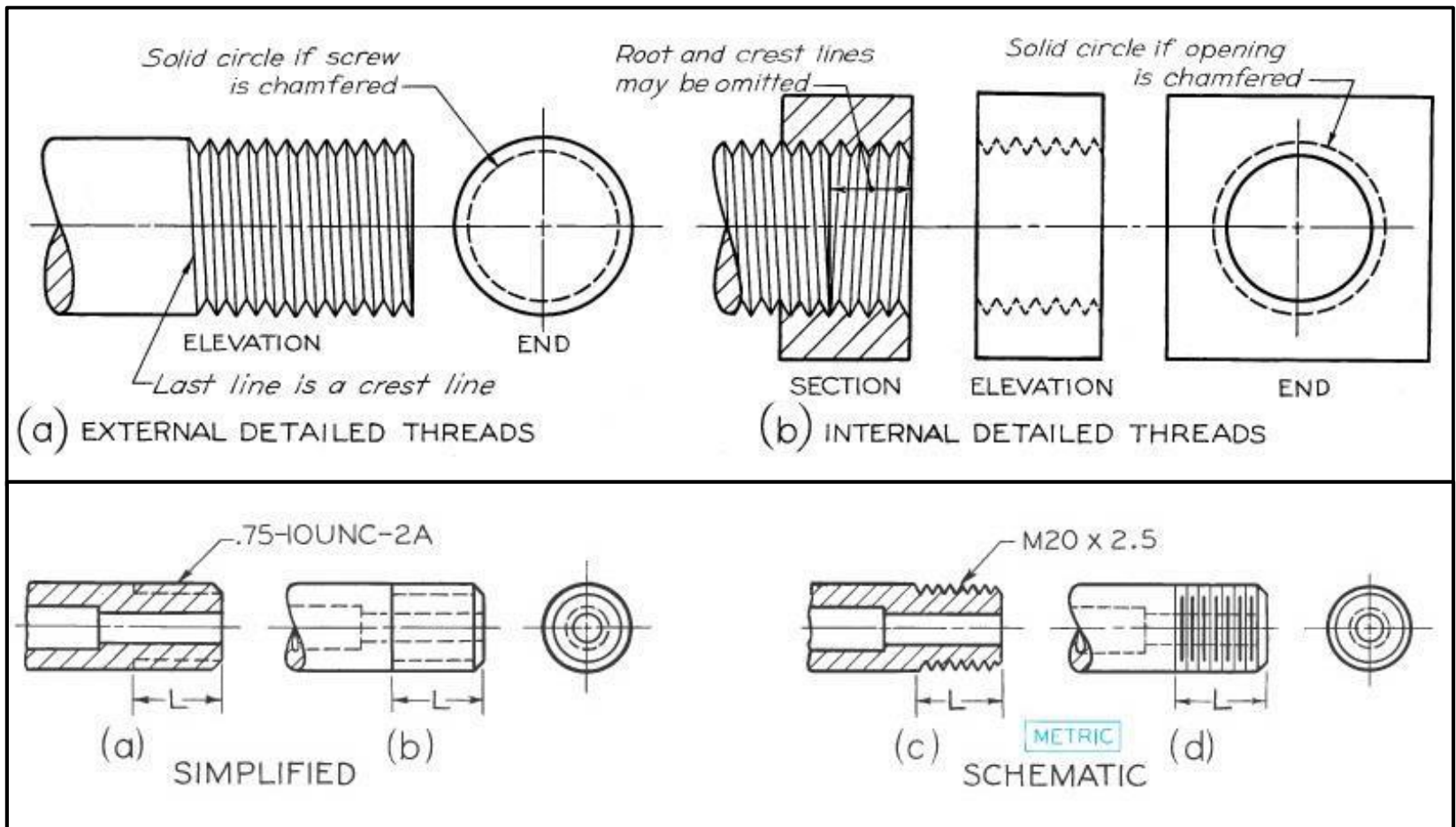
Thread Notes



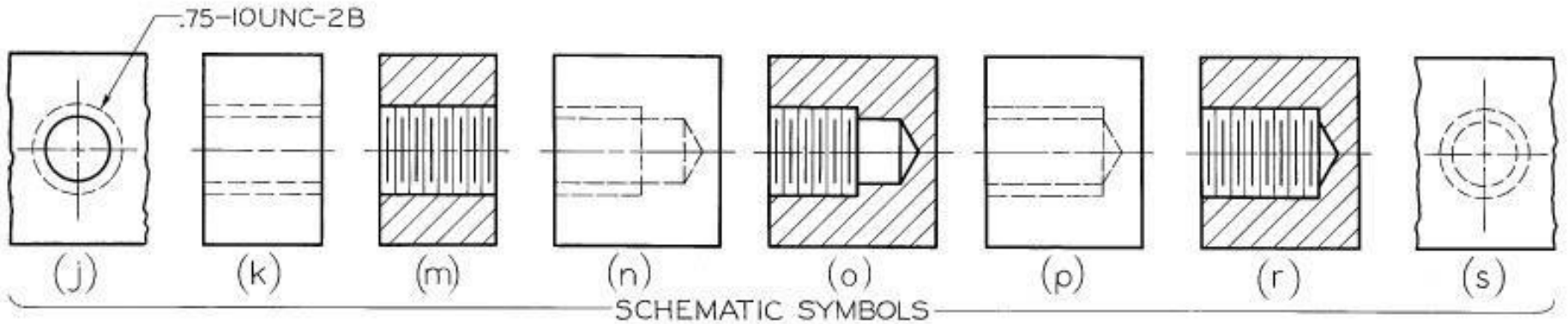
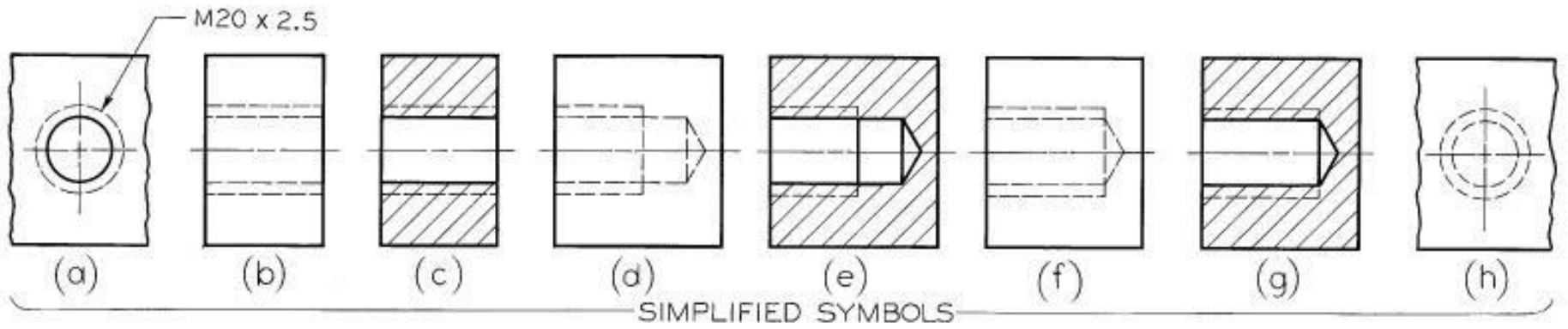
UNC	Means Unified National Coarse
UNF	Means Unified National Fine
UNEF	Means Unified Extra Fine Series
UN	Means Uniform Pitch Series
UNM	Means Unified Miniature Series
NC	Means National Coarse Series
NF	Means National Fine Series
UNR	Means Unified National Round

Thread Symbols

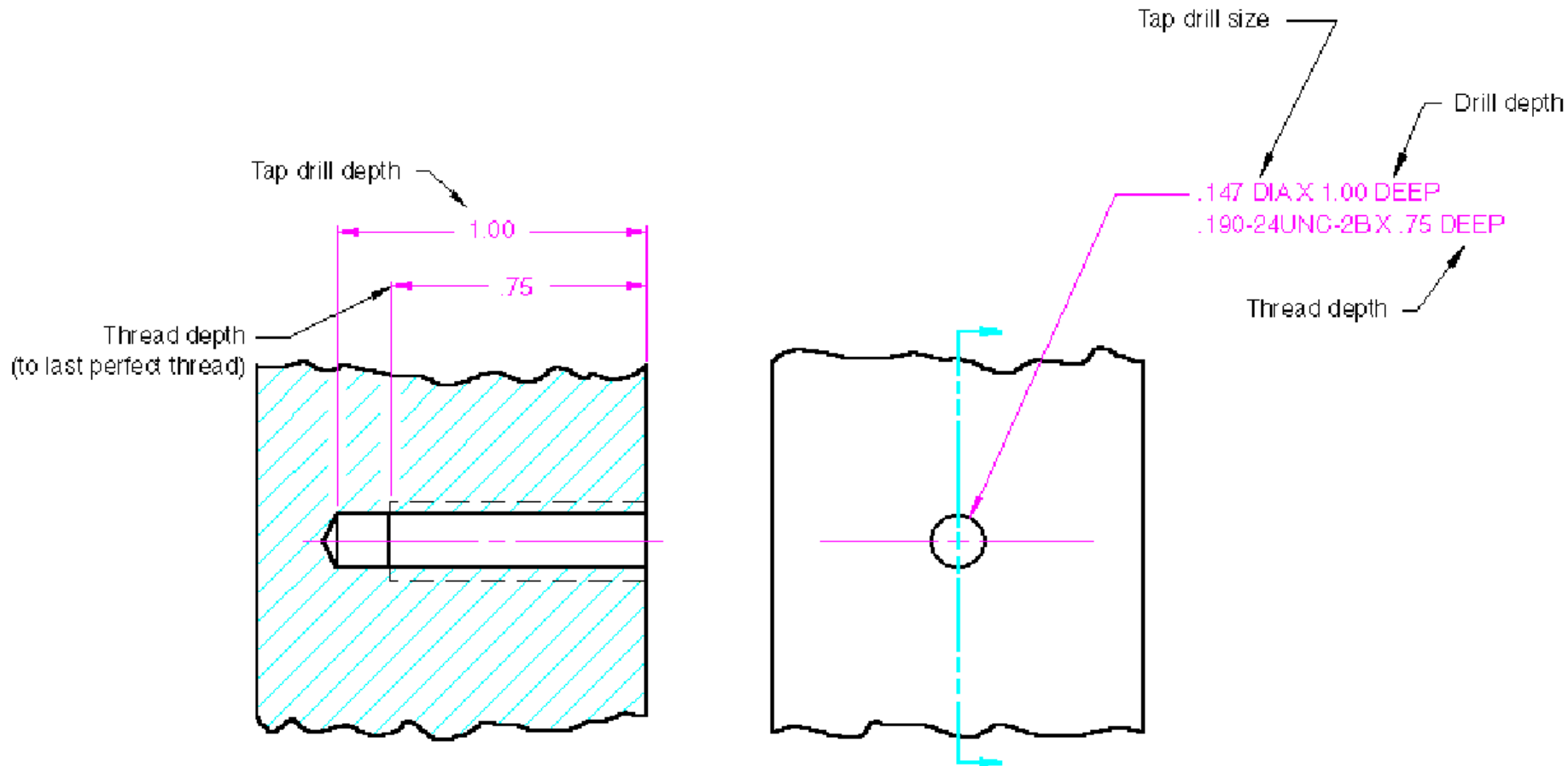
- Can use, simple, schematic or detailed as needed. Simplified is common
- Detailed is more pleasing, so for major dias $>1''$ detailed is preferred



Thread Symbols



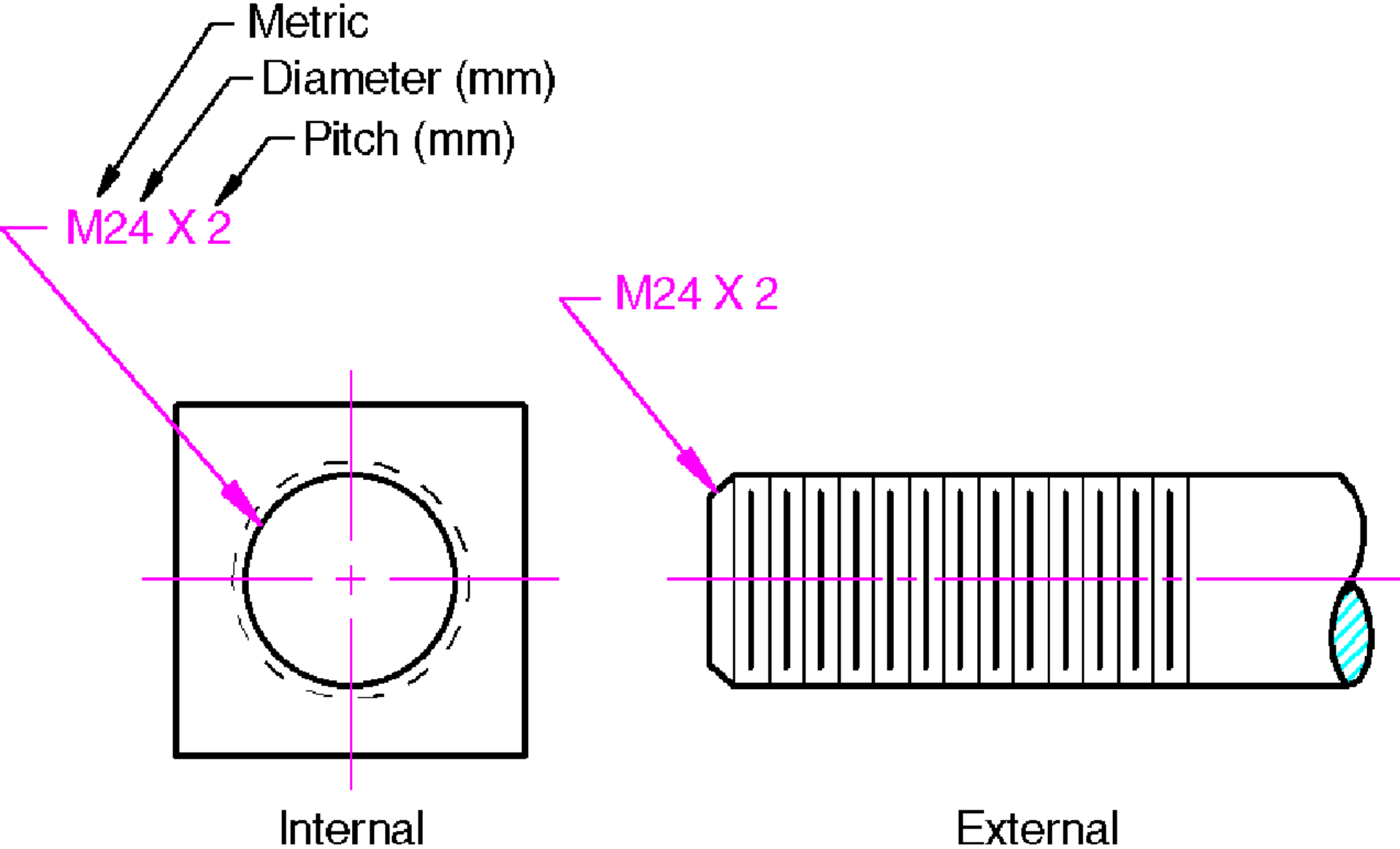
How to Represent a Thread



ISO Representation of Threads

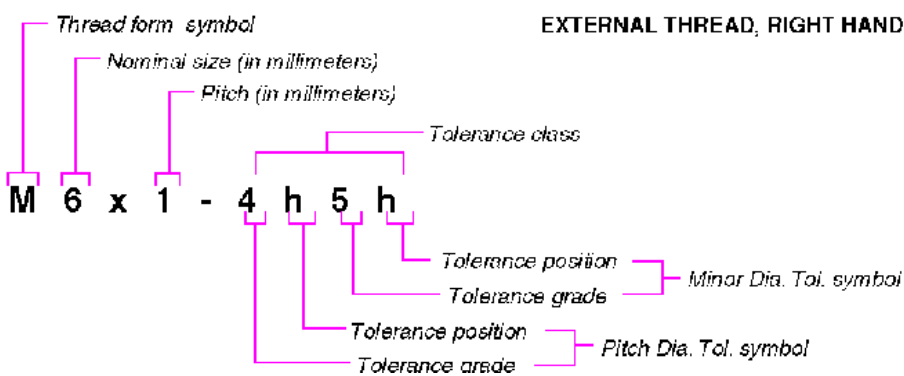
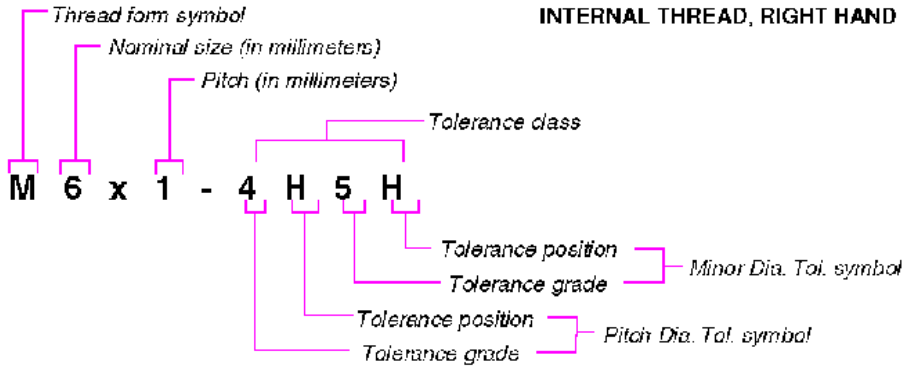
Thread form symbol	M
Nominal size	mm
Pitch size	mm
General purpose tolerance	tolerance class that includes a tolerance position and a tolerance grade for both pitch diameter and minor diameter

Basic Metric Thread Note



Complete threading - metric system

Tolerance specified



The number of the tolerance grades reflects the size of the tolerance

For example, grade 4 < grade 6 < grade 8 tolerances.

In addition to the tolerance grade, a positional tolerance is required.

For external threads:

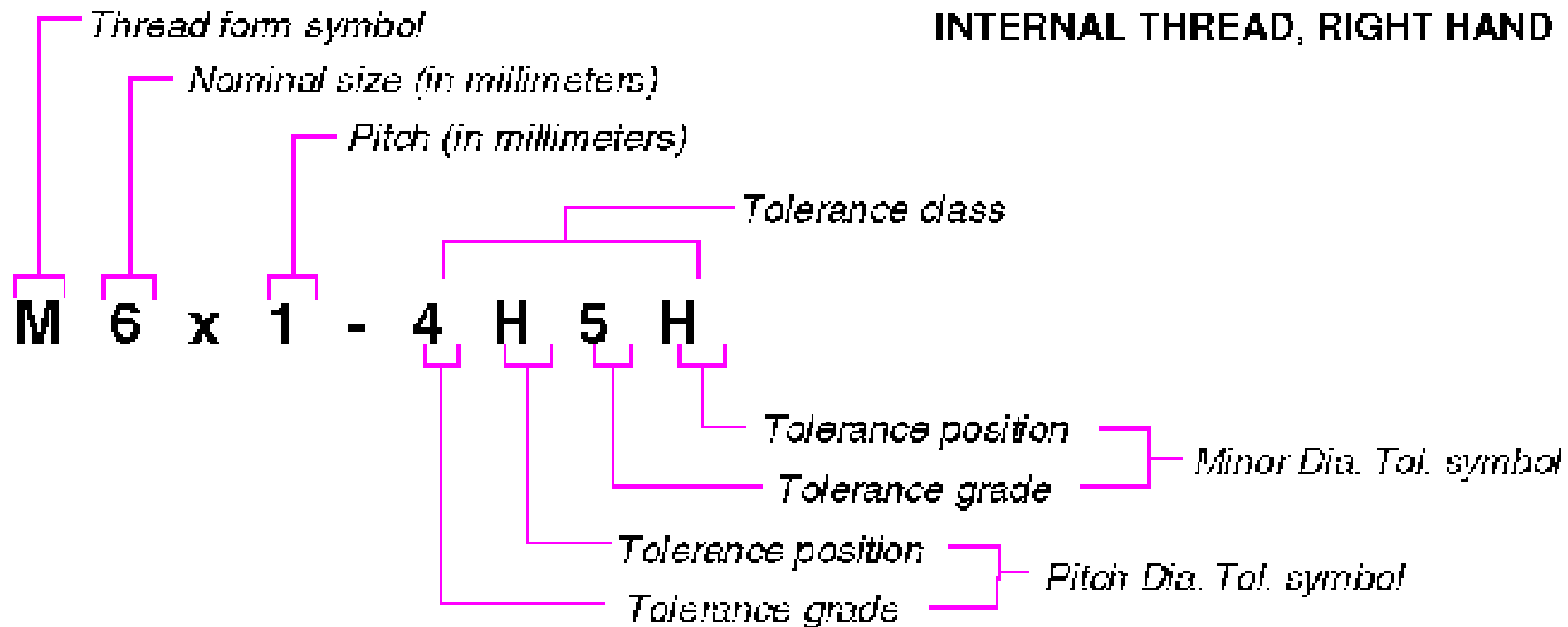
- Tolerance position **e** (large allowance)
- Tolerance position **g** (small allowance)
- Tolerance position **h** (no allowance)

For internal threads:

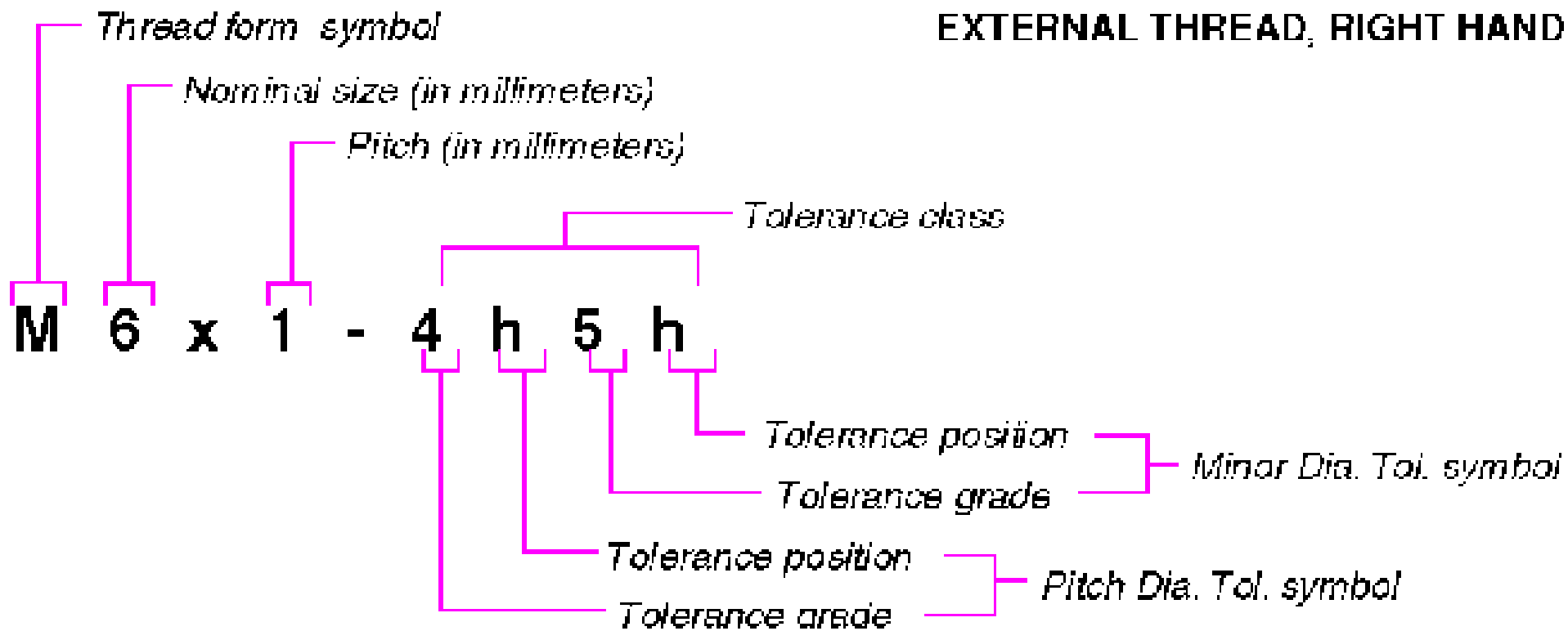
- Tolerance position **G** (small allowance)
- Tolerance position **H** (no allowance)

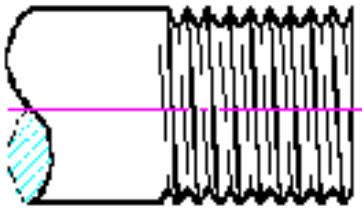
Complete Threading Metric System

Tolerance specified

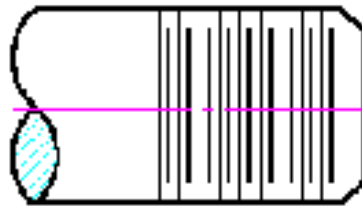


Complete Threading Metric System

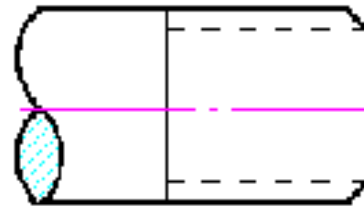




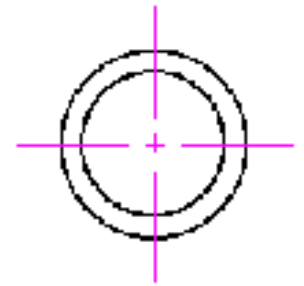
Detailed



Schematic



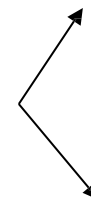
Simplified



End view

External threads

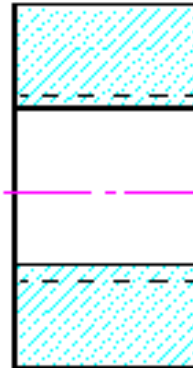
Accepted



Section detailed



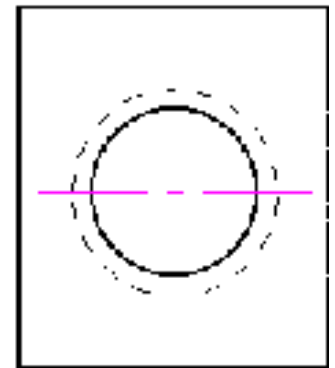
Section schematic



Section simplified



Unsectioned



End view

Internal threads

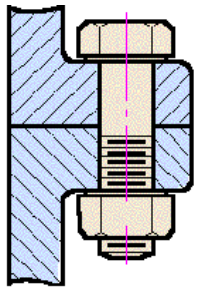
ANSI

Sizes		Basic Major Diameter	Threads per Inch											Sizes	
			Series with Good Pitches			Series with Constant Pitches									
Primary	Secondary		Coarse UNC	Fine UNF	Extra Fine UNEF	1UN	1.5UN	2UN	2.5UN	3UN	3.5UN	4UN	4.5UN		
3		0.0600	--	30	--	--	--	--	--	--	--	--	--	3	
	1	0.0730	64	72	--	--	--	--	--	--	--	--	--	1	
2		0.0860	56	34	--	--	--	--	--	--	--	--	--	2	
	1/2	0.0990	47	56	--	--	--	--	--	--	--	--	--	1/2	
4		0.1120	40	48	--	--	--	--	--	--	--	--	--	4	
5		0.1260	30	44	--	--	--	--	--	--	--	--	--	5	
6		0.1400	32	40	--	--	--	--	--	--	--	--	--	UNC 6	
8		0.1640	32	36	--	--	--	--	--	--	--	--	--	UNC 8	
10		0.1900	24	32	--	--	--	--	--	--	--	--	--	UNF 10	
	1/2	0.2160	24	28	32	--	--	--	--	--	--	UNF	UNF	1/2	
1/4		0.2500	20	28	32	--	--	--	--	--	--	UNC	UNF	1/4	
5/16		0.3125	18	24	32	--	--	--	--	--	--	20	28	5/16	
3/8		0.3750	16	24	32	--	--	--	--	--	--	UNC	20	3/8	
7/16		0.4375	14	20	23	--	--	--	--	16	UNF	JNEF	32	7/16	
1/2		0.5000	12	20	23	--	--	--	--	16	UNF	JNEF	32	1/2	
3/4		0.7500	12	18	24	--	--	--	JNF	16	20	28	32	3/4	
5/8		0.6250	11	18	24	--	--	--	--	12	16	20	28	5/8	
	1 1/16	0.6875	--	--	24	--	--	--	--	12	16	20	28	32	1 1/16
3/4		0.7500	10	16	20	--	--	UNC	--	12	UNF	UNEF	28	32	3/4
	5/16	0.8125	--	--	20	--	--	6	--	2	16	UNEF	28	32	13/16
7/8		0.8750	9	14	20	--	--	6	--	12	16	UNEF	28	32	7/8
	5/16	0.9375	--	--	20	--	--	8	--	12	16	UNF	28	32	15/16
1		1.0000	8	12	20	--	--	8	JNF	16	UNEF	28	32	1	
	1 1/16	1.0625	--	--	13	--	--	8	--	12	16	20	28	--	1 1/16
1 1/8		1.1250	7	12	13	--	--	8	JNF	16	20	28	--	--	1 1/8
	1 3/16	1.1875	--	--	13	--	--	6	--	2	16	20	28	--	1 3/16
1 1/4		1.2500	7	12	13	--	--	6	JNF	16	20	28	--	--	1 1/4
	1 5/16	1.3125	--	--	13	--	--	8	--	12	16	20	28	--	1 5/16
1 3/8		1.3750	6	12	13	--	UNC	8	JNF	16	20	28	--	--	1 3/8
	1 7/16	1.4375	--	--	13	--	--	6	8	12	16	20	28	--	1 7/16
1 1/2		1.5000	6	12	13	--	UNC	8	JNF	16	20	28	--	--	1 1/2
	1 9/16	1.5625	--	--	13	--	--	6	6	2	16	20	--	--	1 9/16
5/8		1.6250	--	--	13	--	--	6	6	2	16	20	--	--	5/8
	1 11/16	1.6875	--	--	13	--	--	6	8	12	16	20	--	--	1 11/16
1 3/4		1.7500	5	--	--	--	--	6	8	12	16	20	--	--	1 3/4
	1 13/16	1.8125	--	--	--	--	--	6	8	12	16	20	--	--	1 13/16
1 7/8		1.8750	--	--	--	--	--	6	8	12	16	20	--	--	1 7/8
	1 15/16	1.9375	--	--	--	--	--	6	0	12	16	20	--	--	1 15/16
2		2.0000	4 1/2	--	--	--	--	6	6	2	16	20	--	--	2
	2 1/8	2.1250	--	--	--	--	--	6	8	12	16	20	--	--	2 1/8
2 1/4		2.2500	4 1/2	--	--	--	--	6	8	12	16	20	--	--	2 1/4
	2 3/8	2.3750	--	--	--	--	--	6	8	12	16	20	--	--	2 3/8
2 1/2		2.5000	4	--	--	UNC	--	6	8	12	16	20	--	--	2 1/2
	2 5/8	2.6250	--	--	--	4	--	6	0	12	16	20	--	--	2 5/8
2 3/4		2.7500	4	--	--	UNC	--	6	6	2	16	20	--	--	2 3/4
	2 7/8	2.8750	--	--	--	4	--	6	8	12	16	20	--	--	2 7/8

Materials for Fasteners

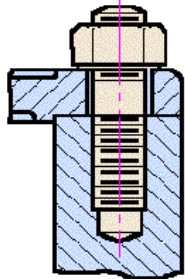
Material	Surface treatment	Useful design temperature limit, °F	Ultimate tensile strength at room temperature, ksi	Comments
Carbon steel	Zinc plate	-65 to 250	55 and up	-----
Alloy steels	Cadmium plate, nickel plate, zinc plate, or chromium plate	-65 to limiting temperature of plating	Up to 300	Some can be used at 900 °F
A-286 stainless	Passivated per MIL-S-5002	-423 to 1200	Up to 220	-----
17-4PH stainless	None	-300 to 600	Up to 220	-----
17-7PH stainless	Passivated	-200 to 600	Up to 220	-----
300 series stainless	Furnace oxidized	-423 to 800	70 to 140	Oxidation reduces galling
410, 416, and 430 stainless	Passivated	-250 to 1200	Up to 180	47 ksi at 1200 °F; will corrode slightly
U-212 stainless	Cleaned and passivated per MIL-S-5002	1200	185	140 ksi at 1200 °F
Inconel 718 stainless	Passivated per QQ-P-35 or cadmium plated	-423 to 900 or cadmium plate limit	Up to 220	-----
Inconel X-750 stainless	None	-320 to 1200	Up to 180	136 ksi at 1200 °F
Waspalloy stainless	None	-423 to 1600	150	-----
Titanium	None	-350 to 500	Up to 160	-----

Bolts, Nuts, Screws



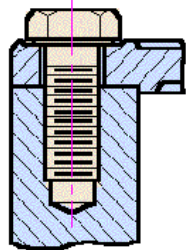
(A)

Bolt



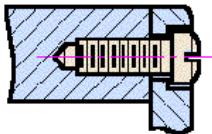
(B)

Stud



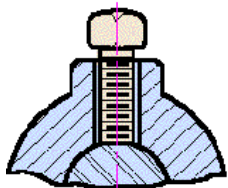
(C)

Cap Screw



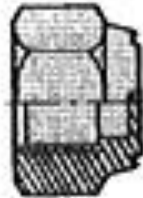
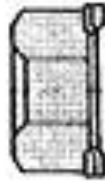
(D)

Machine Screw



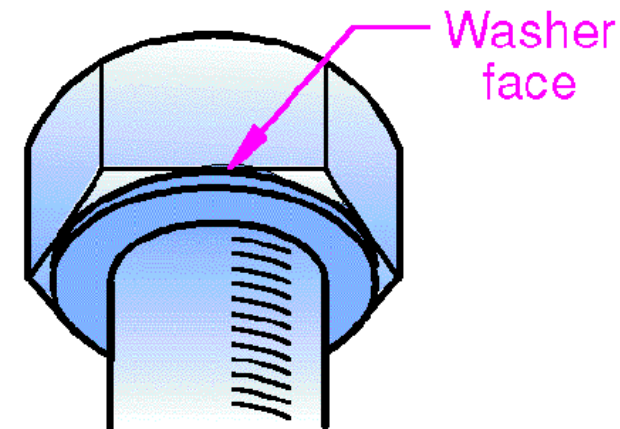
(E)

Set Screw

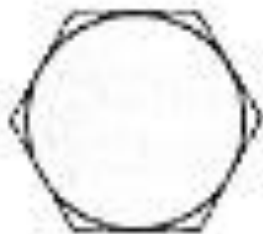


Bolts, Nuts, Screws

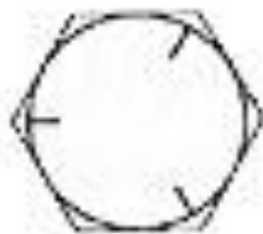
- Large variety of bolts (dimensional, head shape, etc.)
- Material, quality
- Finishing
- Grade



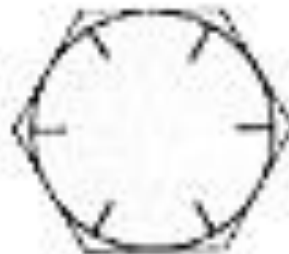
Semifinished
and finished



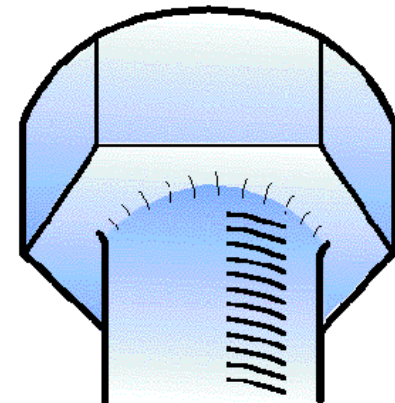
GRADE 2



GRADE 5



GRADE 8

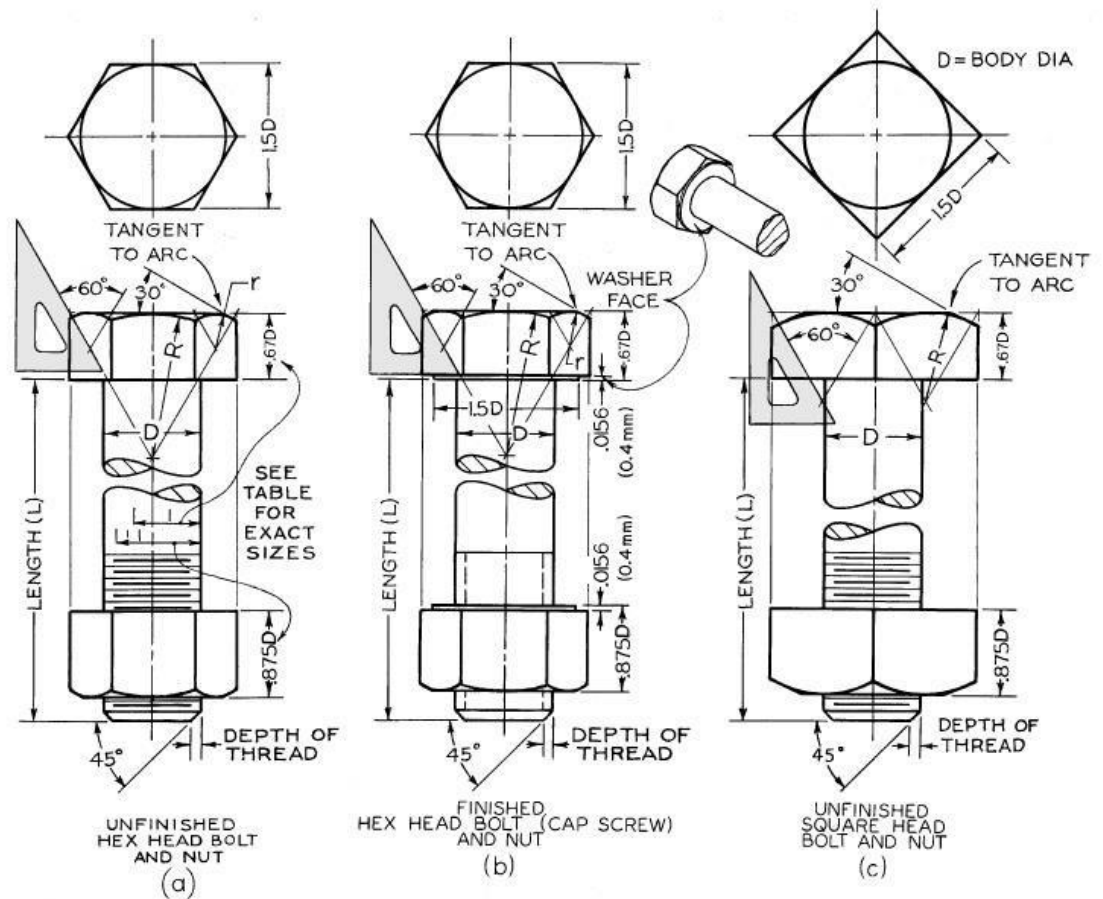


Unfinished

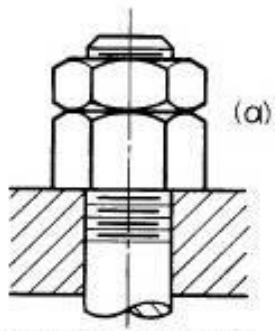
Bolts, nuts and screws

Unfinished bolts are not machined anywhere except for the thread portion.

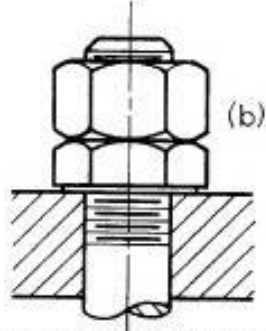
Finished bolts have a machined face to hold a washer at a flush location on parts.



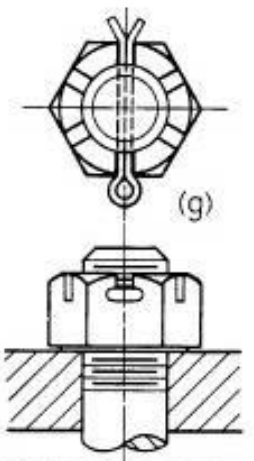
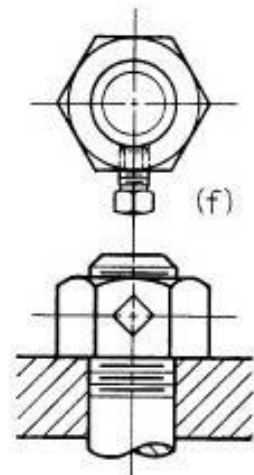
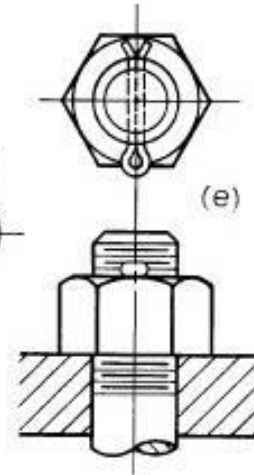
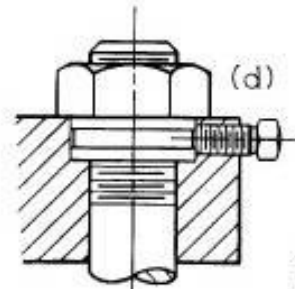
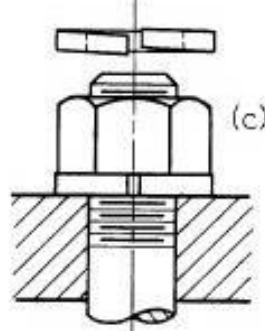
Fastener locking



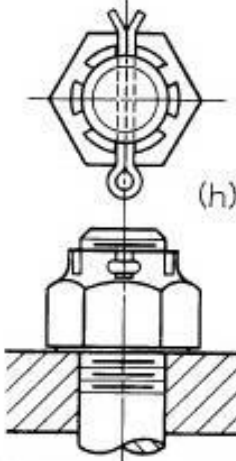
REGULAR UNFINISHED
JAM NUT (AMER STD)



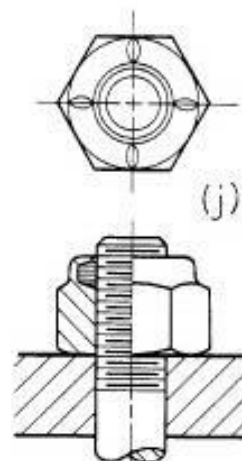
REGULAR SEMI-FINISHED
JAM NUT (AMER STD)



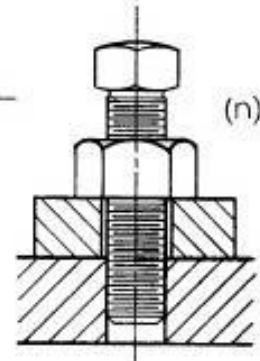
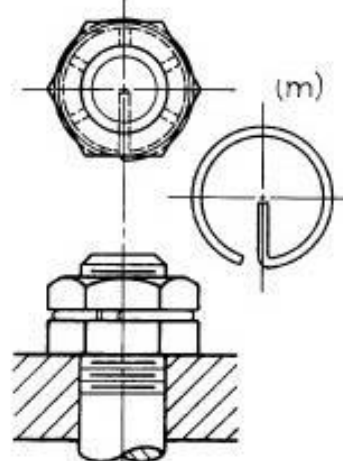
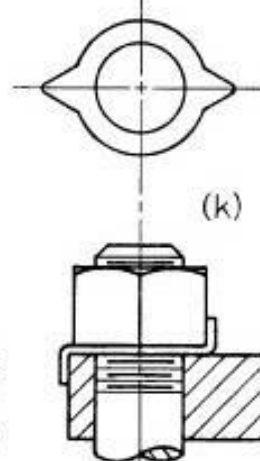
FINISHED SLOTTED
NUT (AMER STD)



FINISHED CASTLE
NUT (AMER STD)

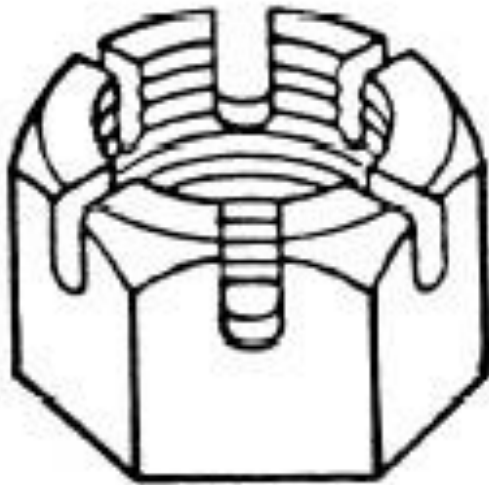


ESNA
STOP NUT

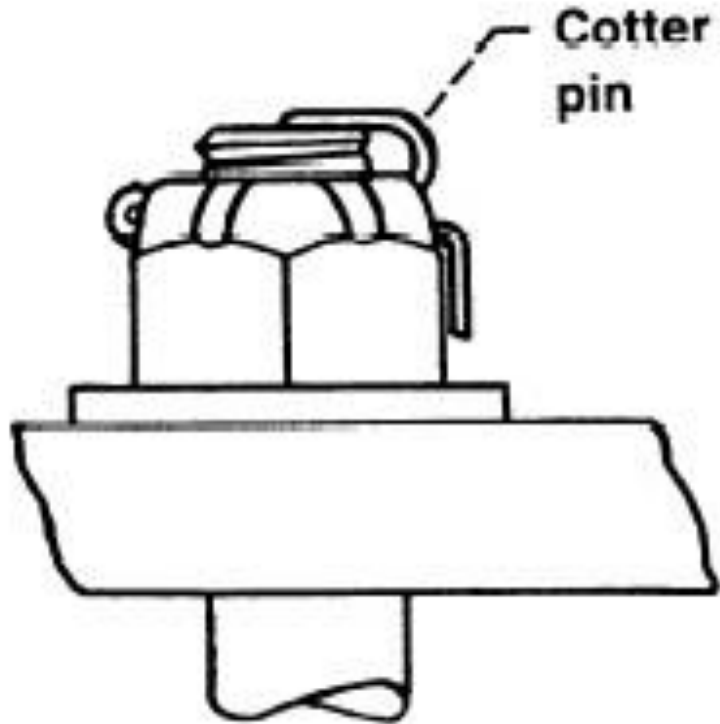


Fastener Locking

Castellated nut



(a)



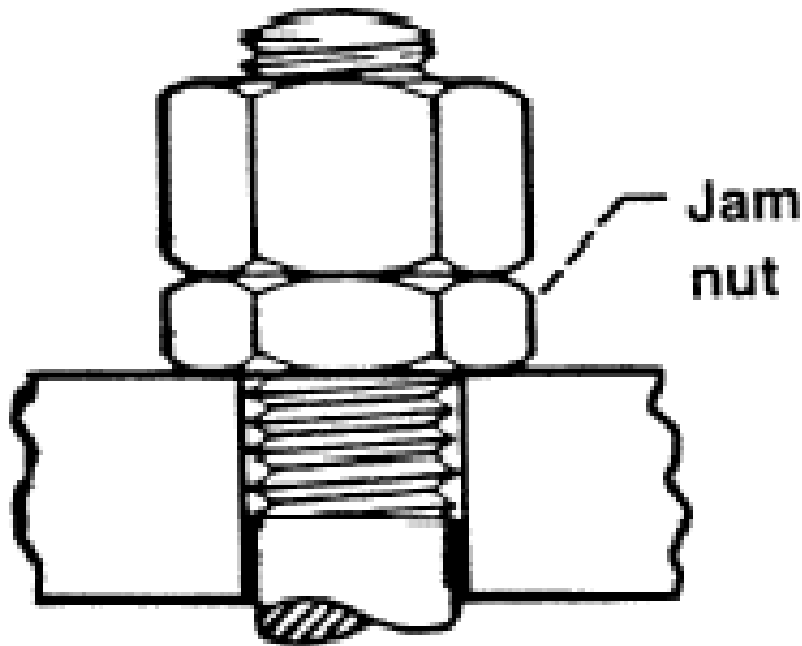
(b)

(a) Slots.

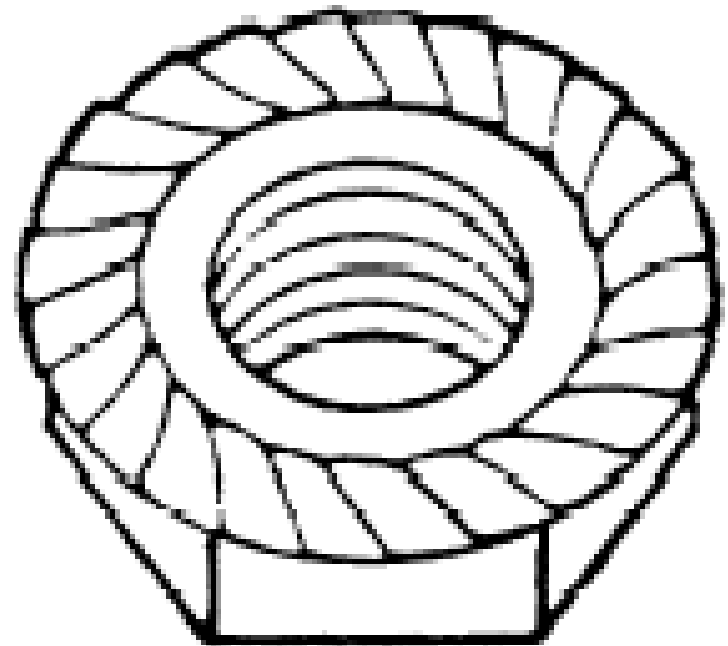
(b) Cotter pin locking.

Fastening Locking

Jam nut

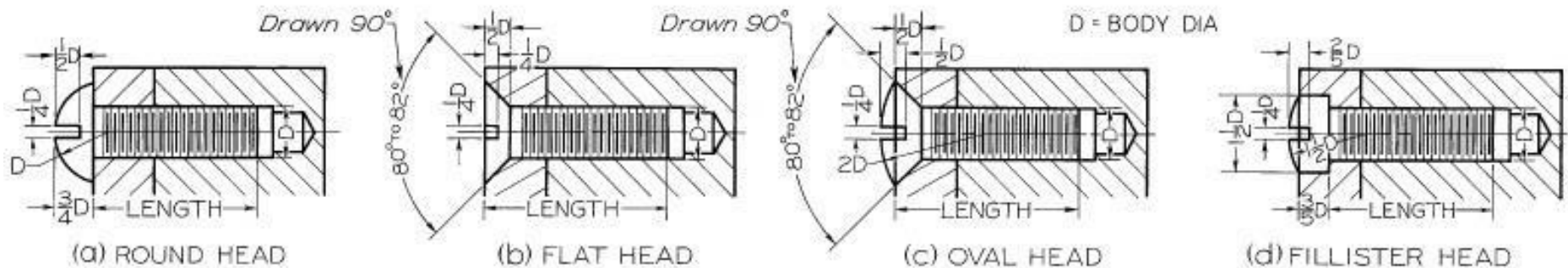


Durlock nut








Standard Cap Screws

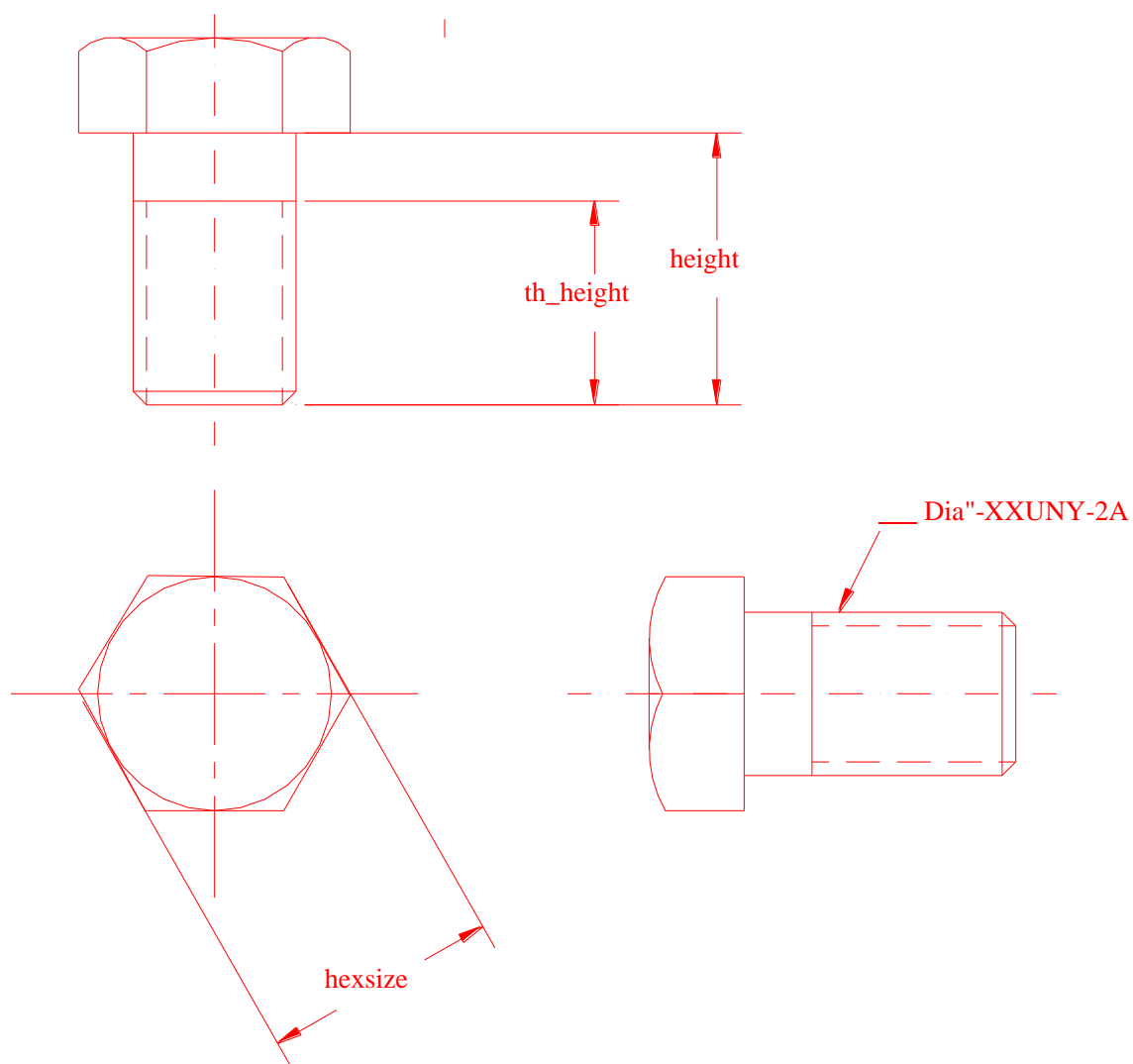
- Similar to cap screws but smaller in size.
- General diameters between .06 to .75 inches.
- Hex head (not shown here) may be slotted if desired.
- Other heads are available as either slotted or recessed.
- Generally used for screwing into thin materials.



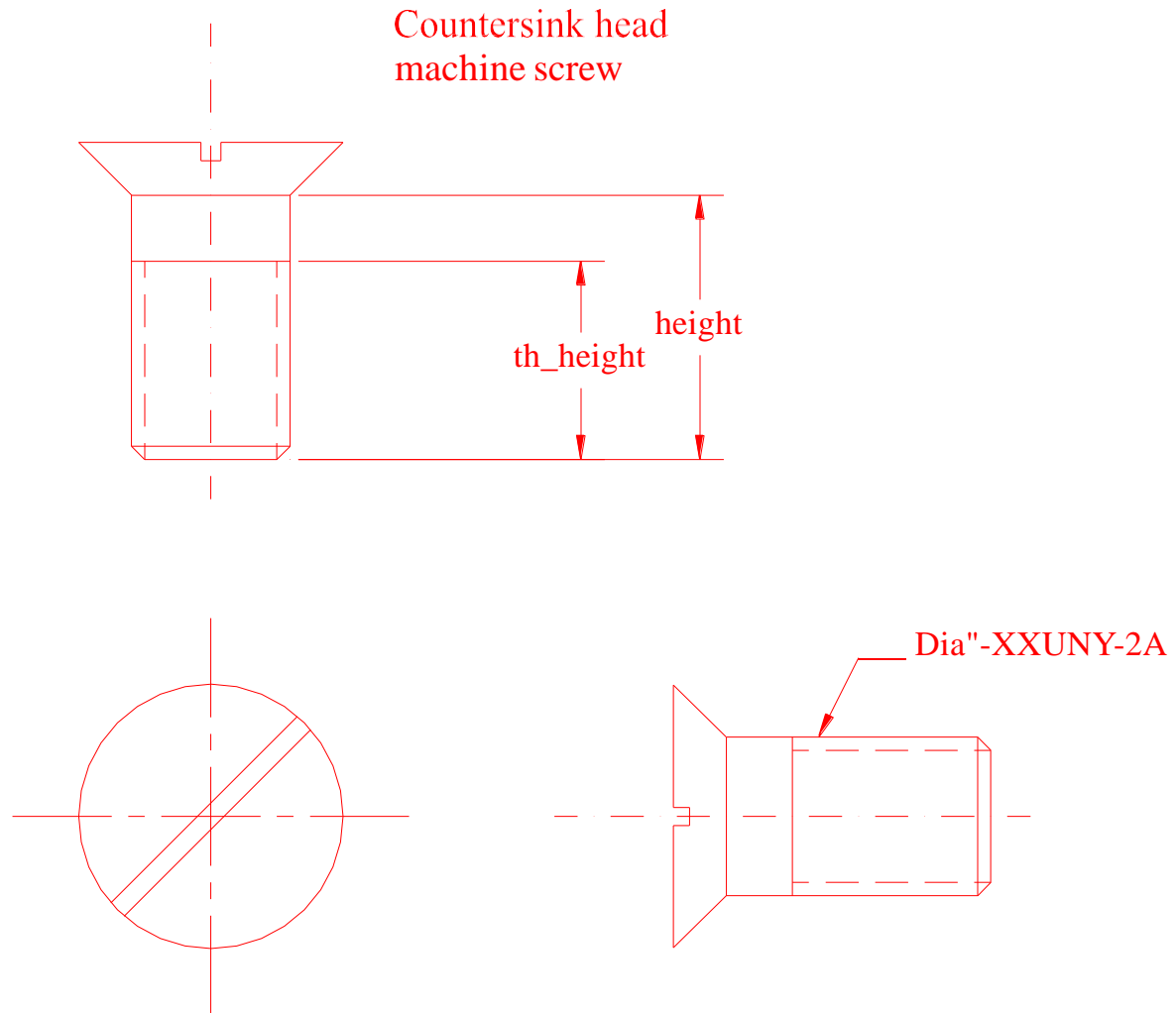
Bolt Grade Markings and Strength Chart

Head Marking	Grade and Material	Nominal Size Range (inches)	Mechanical Properties		
			Proof Load (psi)	Min. Yield Strength (psi)	Min. Tensile Strength (psi)
 No Markings	Grade 2 Low or medium carbon steel	1/4 thru 3/4	55,000	57,000	74,000
		Over 3/4 thru 1-1/2	33,000	36,000	60,000
 3 Radial Lines	Grade 5 Medium Carbon Steel, Quenched and Tempered	1/4 thru 1	85,000	92,000	120,000
		Over 1 thru 1-1/2	74,000	81,000	105,000
 6 Radial Lines	Grade 8 Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 1-1/2	120,000	130,000	150,000
Stainless markings vary. Most stainless is non-magnetic	18-8 Stainless Steel alloy with 17-19% Chromium and 8-13% Nickel	1/4 thru 5/8		40,000 Min. 80,000 – 90,000 Typical	100,000 – 125,000 Typical
		3/4 thru 1		40,000 Min. 45,000 – 70,000 Typical	100,000 Typical
		Above 1			80,000 – 90,000 Typical
Head Marking	Class and Material	Nominal Size Range (mm)	Mechanical Properties		
 8.8	Class 8.8 Medium Carbon Steel, Quenched and Tempered	All Sizes below 16mm	580	640	800
		16mm - 72mm	600	660	830
 10.9	Class 10.9 Alloy Steel, Quenched and Tempered	5mm - 100mm	830	940	1040

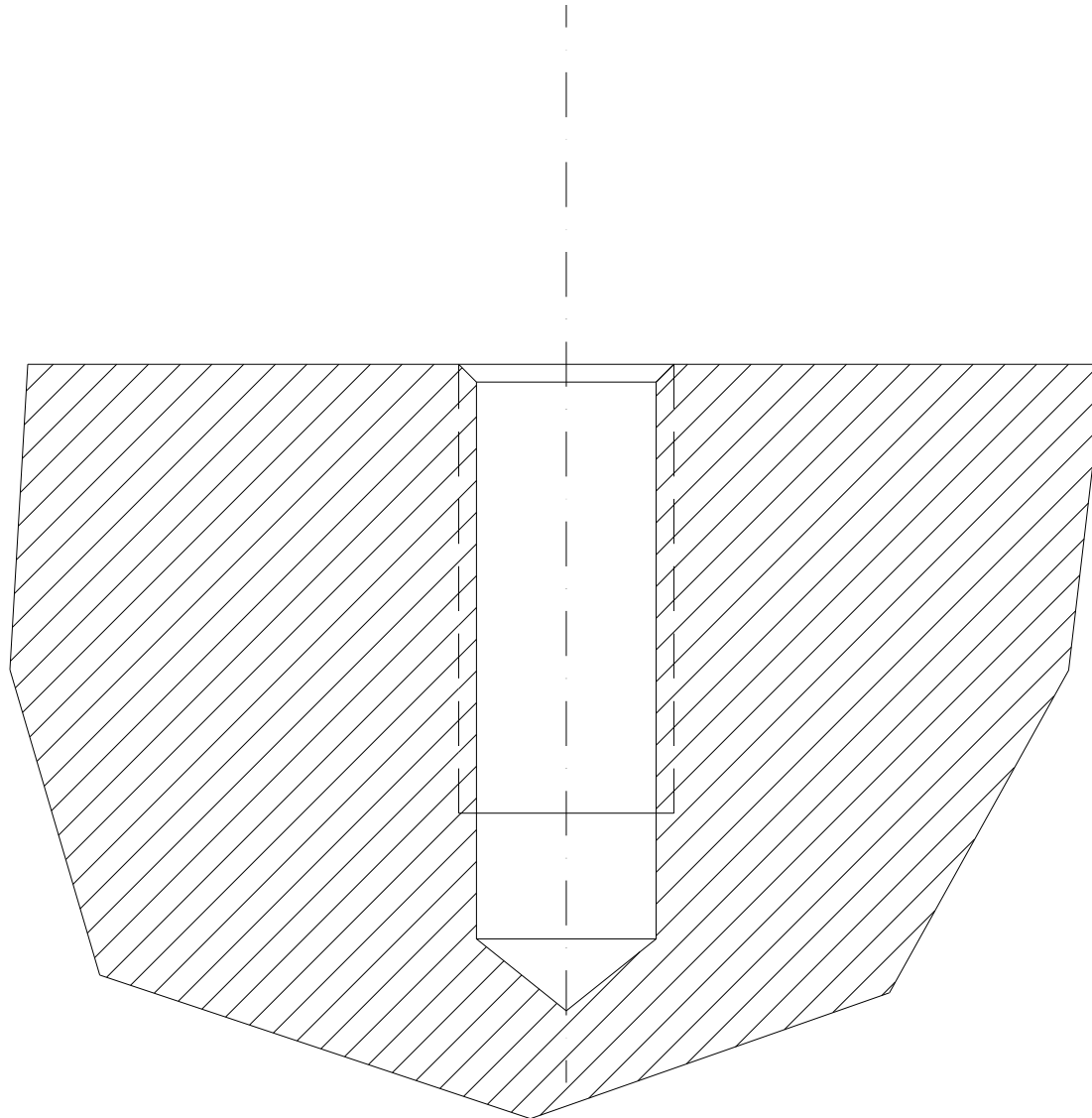
Part Representation



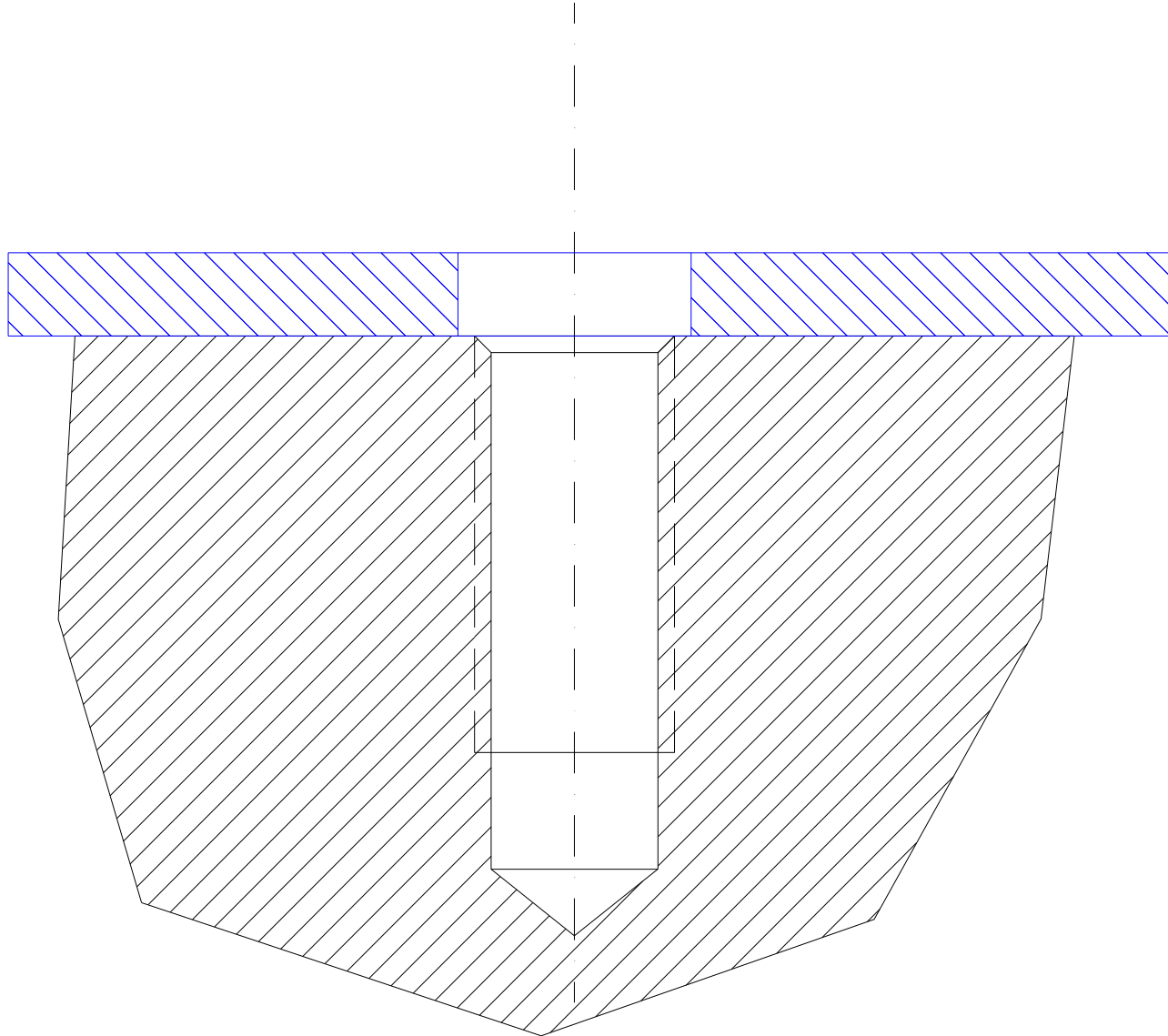
Part Representation



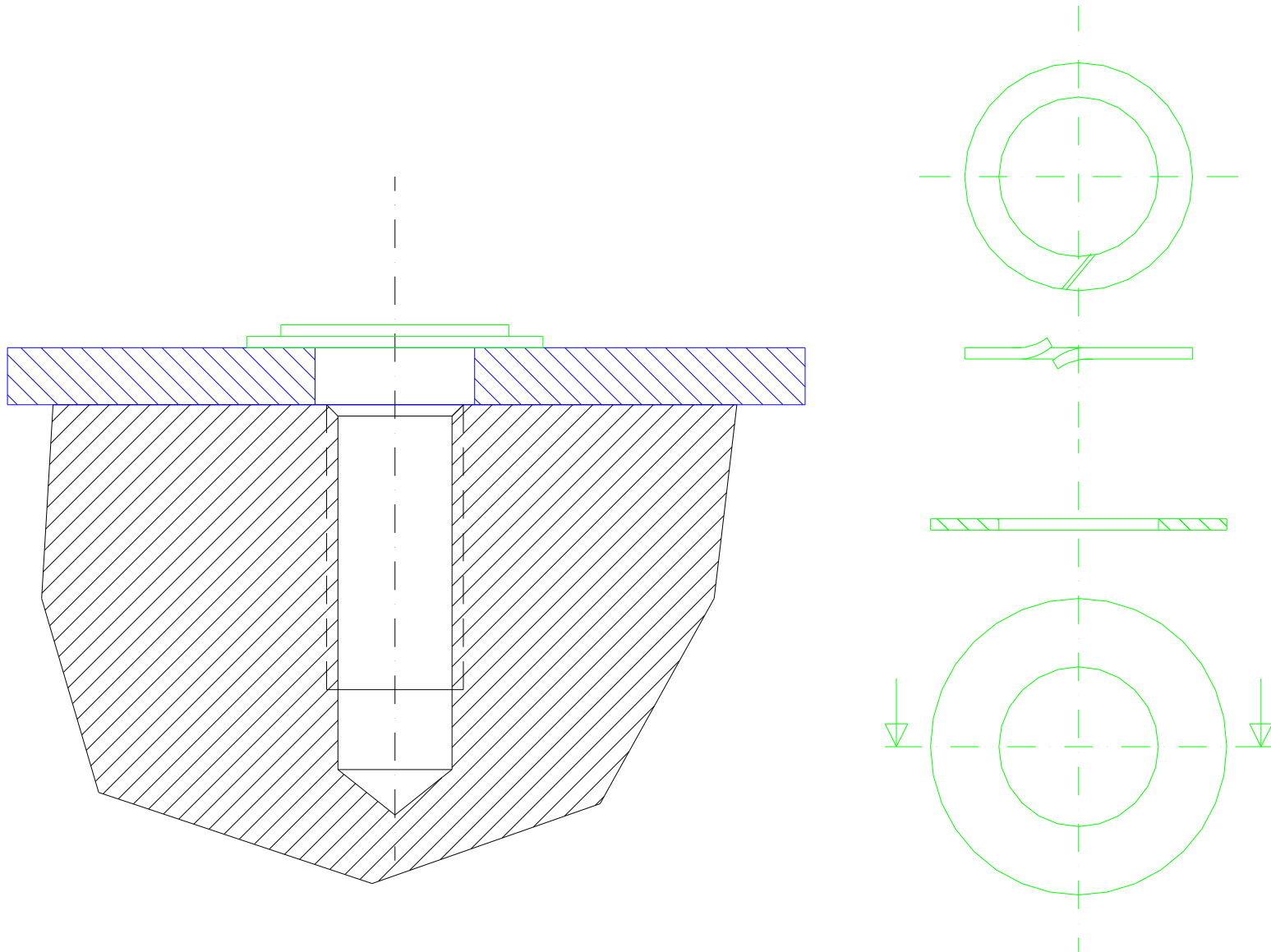
Assembly Representation



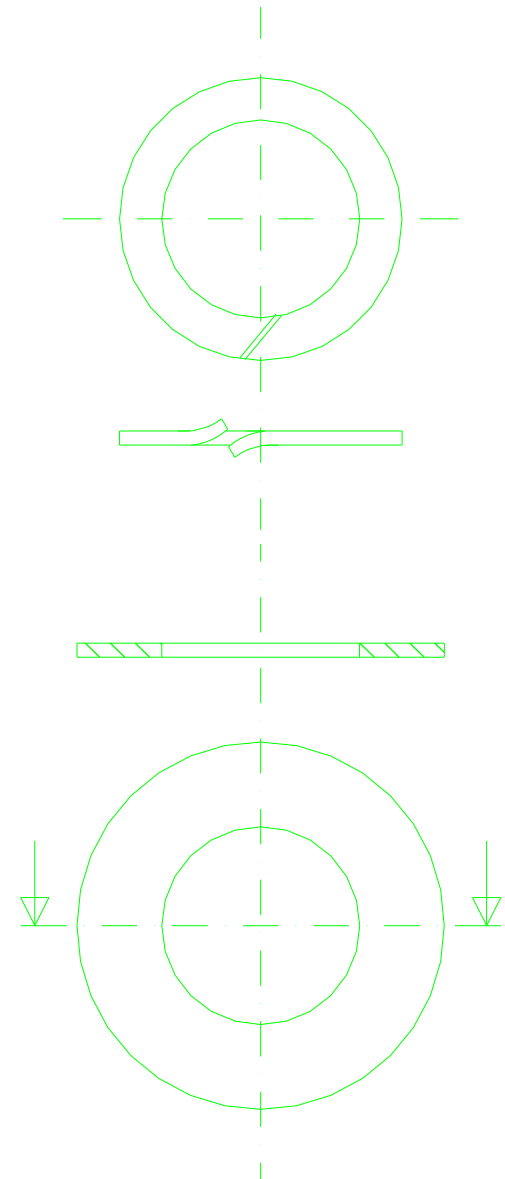
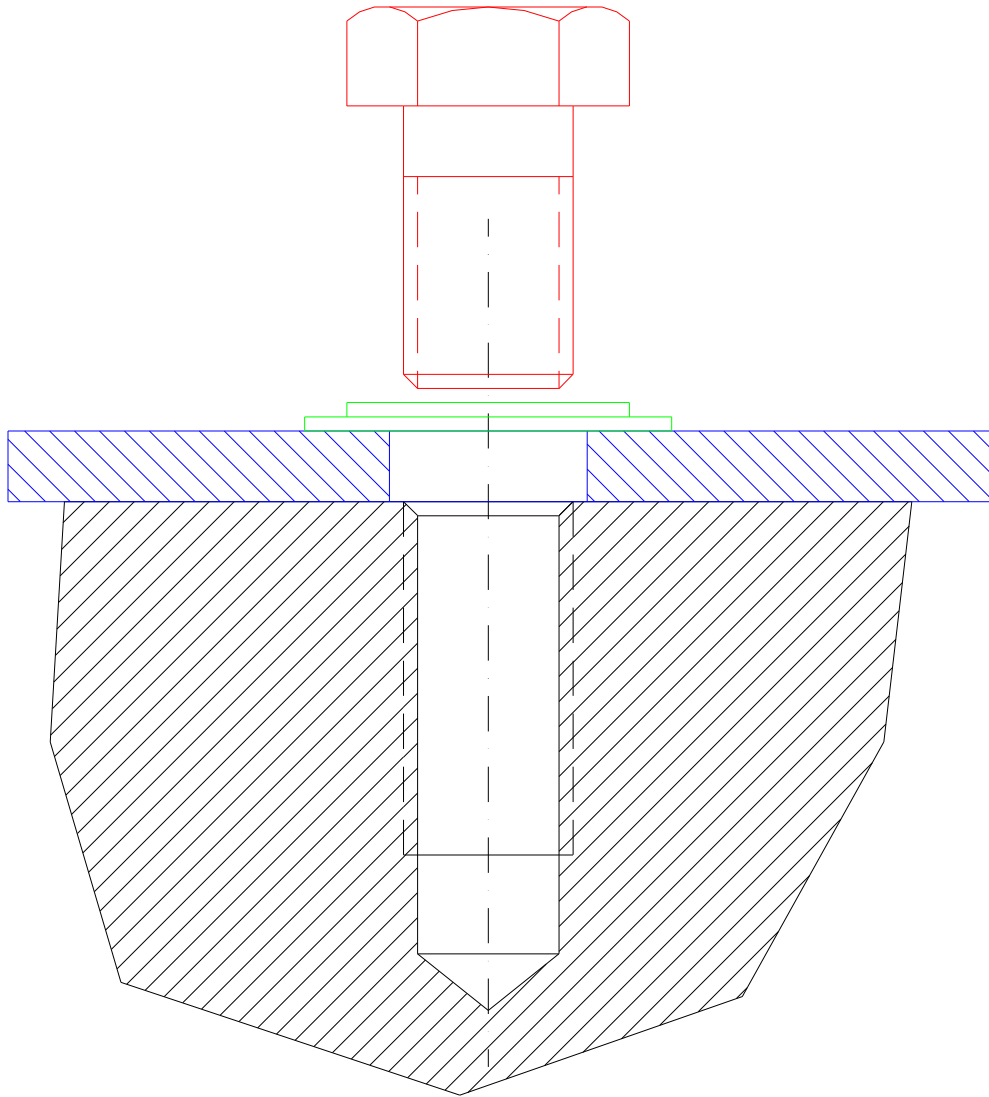
Assembly Representation



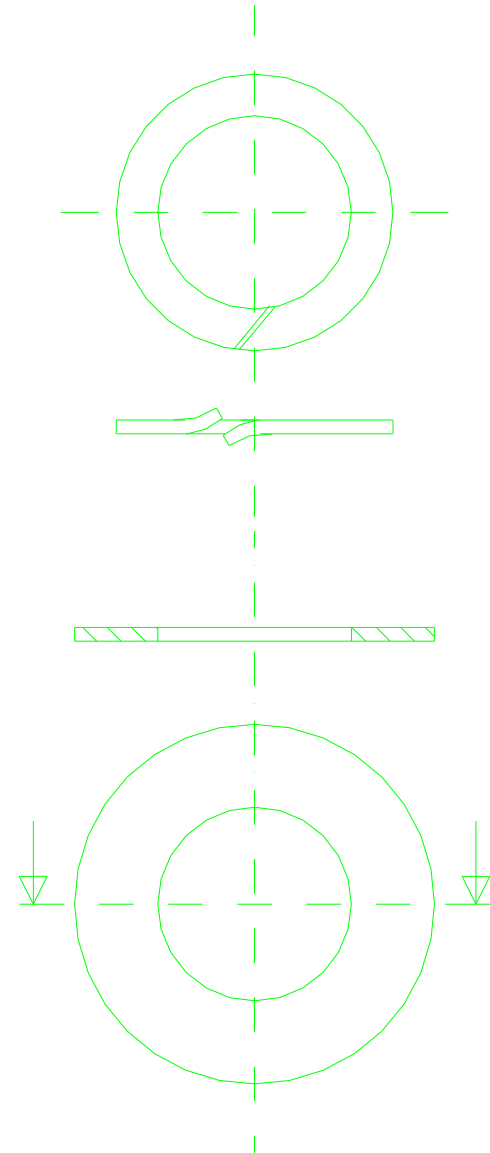
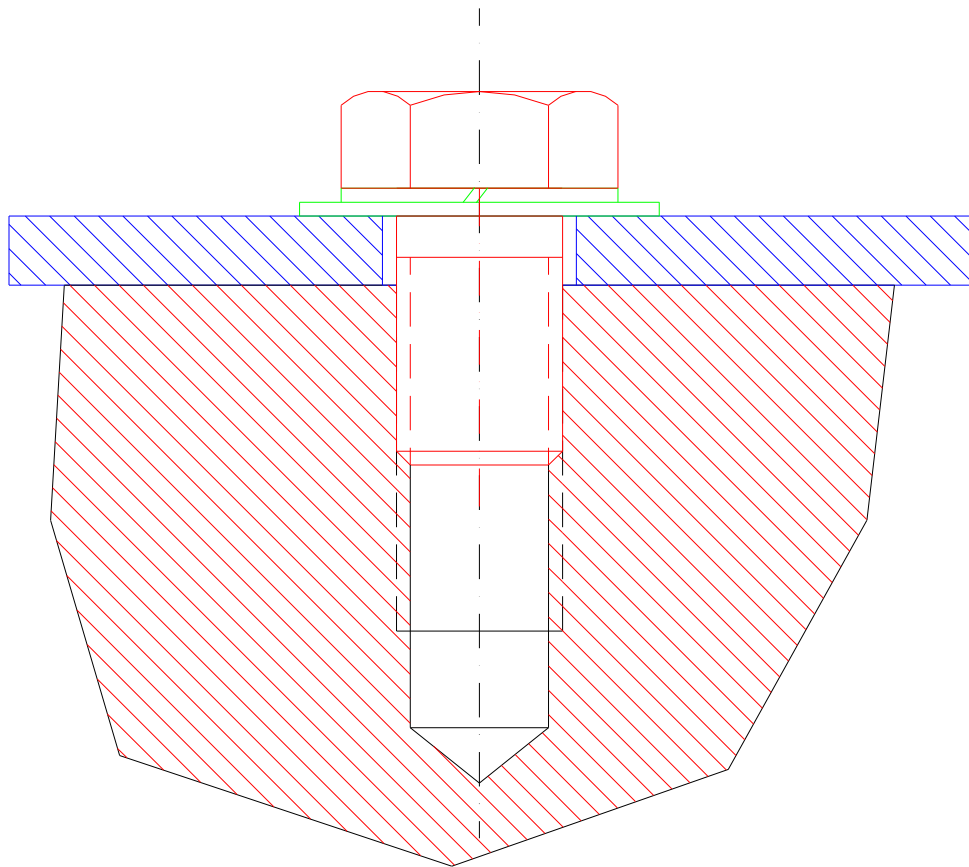
Assembly Representation



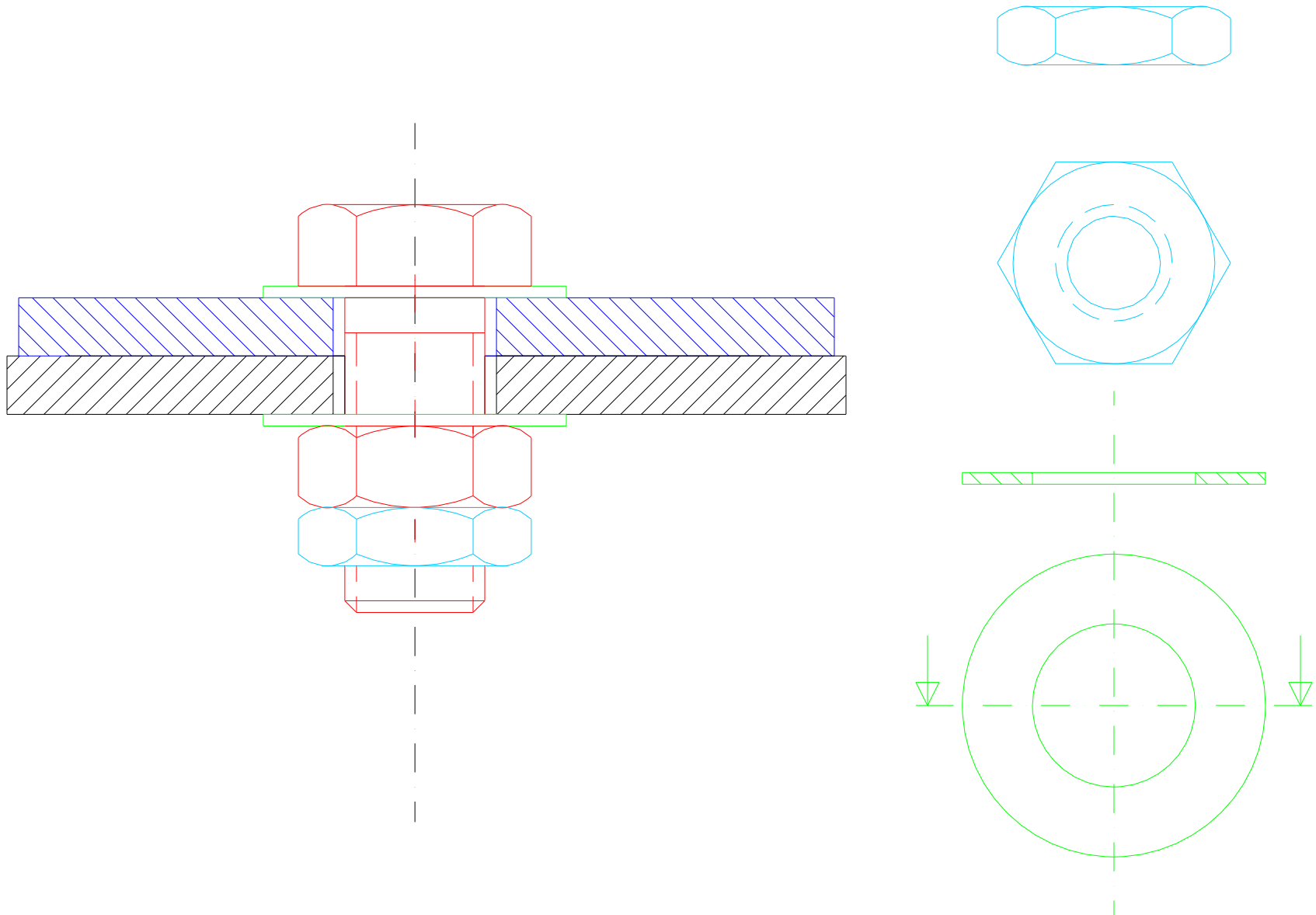
Assembly Representation



Assembly Representation

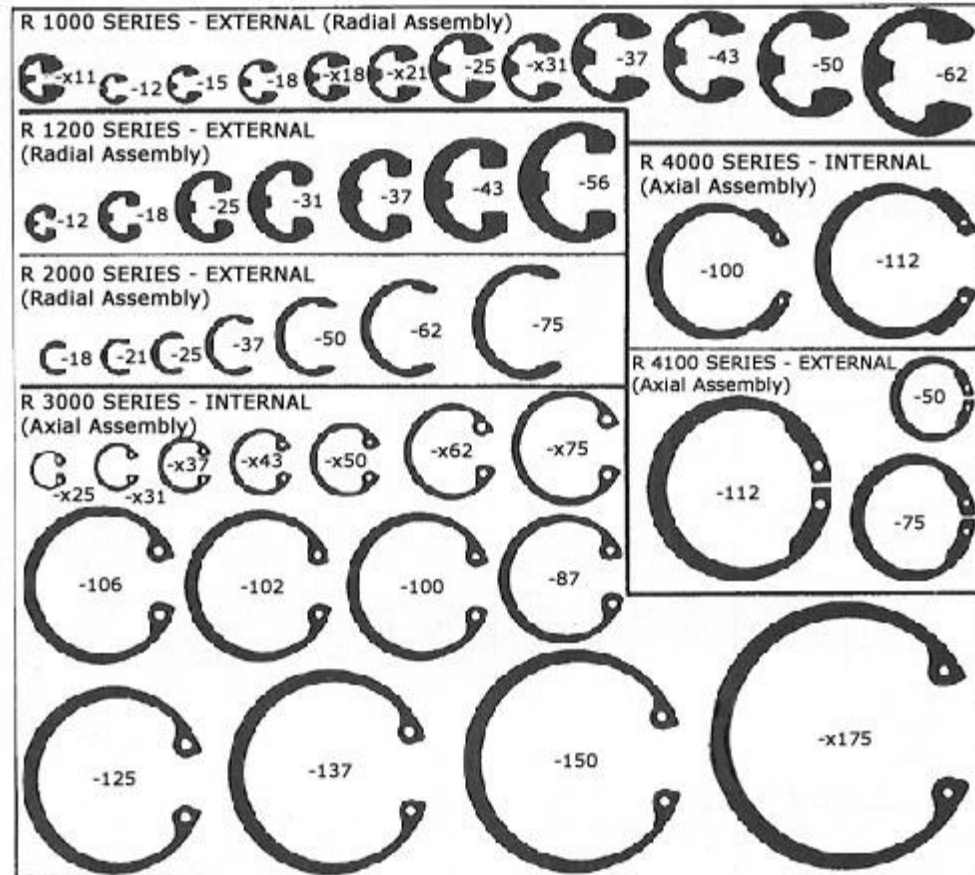
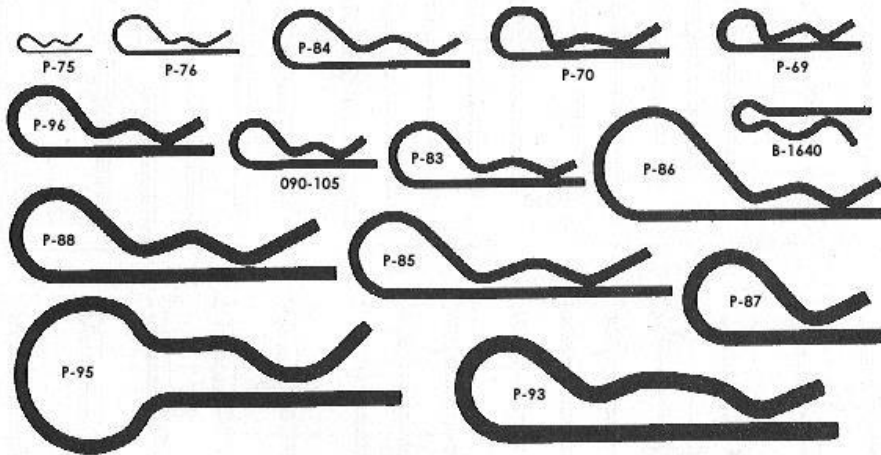


Assembly Representation



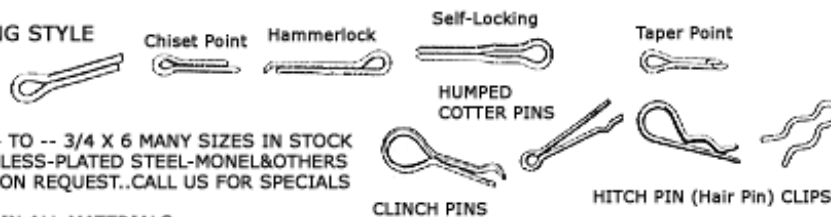
Other Non-Permanent Fasteners

Clips, rings, pins, etc.



COTTER PINS

STANDARD EXTENDED PRONG STYLE
WITH SQUARE CUT ENDS



STANDARDS: FROM 1/32 X 1/4 -- TO -- 3/4 X 6 MANY SIZES IN STOCK
MATERIALS: STEEL-BRASS-STAINLESS-PLATED STEEL-MONEL&OTHERS
OTHER ITEMS: PRICE&DELIVERY ON REQUEST..CALL US FOR SPECIALS

NOT ALL STYLES ARE AVAILABLE IN ALL MATERIALS

DOWEL PINS

PRECISION GROUND



ALLOY STEEL & STAINLESS STEEL
1/16 X 1/4 to 1 x 6 IN ALLOY
PULL DOWELS & OTHER MATERIALS AVAILABLE
(Manufactured to ANSI Standard B 18.8.2 1978)

WE CAN QUOTE ON SPECIALS, TO YOUR SPECS. CALL US!

SPRING PINS

EASILY INSTALLED ECONOMICAL
SELF-LOCKING LONG WEARING



AVAILABLE IN ROLLED, SLOTTED, SPLIT & TENSION
1/16 to 1/2 DIAMETER AND METRIC SIZES
CARBON STEEL PLAIN AND PLATED
TYPE 302 & 420 STAINLESS STEEL

GROOVED PINS*

Positive holding action with six
standard solid pin types and
many specials.



Sizes: 1/16" through 1/2" diameter
1/4" through 4 1/2" long.

High alloy, heat treated pins for extra shear, shock and fatigue resistance.

Materials: Cold drawn low carbon
steel is standard. Other materials
available.

Finishes: Zinc electroplating is
standard. Other finishes available.

TAPER PINS*

TAPER IS 1/4" PER FOOT

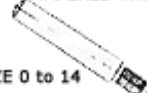
CHECK WITH US FOR PRICES & AVAILABLE

COMMERCIAL
(STANDARD) TYPE



SIZE 8/0 to 14

TAPERED THREADED



SIZE 0 to 14

Where disassembly of parts is expected, the
taper pin, which can be easily driven out of its
sized hole, is a useful fastening element. The
cylindrical pin is made with a taper of 1/4" per
foot measured on the diameter and with rounded
or beveled ends to facilitate driving in reamed
holes.

ESCUTCHEON PINS*

(DRIVE PINS)

ALL SIZES, BRASS & STEEL

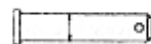
MINIMUM ORDER QUANTITIES REQUIRED, CHECK WITH US.



Commonly used for attaching nameplates and
other light-duty fastening jobs, this pin has a
semispherical head at one end and a long cone
or pinch point at the other. It is usually hammered
into place by hand.

CLEVIS PINS*

ALL TYPES & ALL MATERIALS
COMMERCIAL & AIRCRAFT
STANDARD & SPECIAL



Cotter pin holes are drilled in all pins.

Adjustable
Clevis Pin

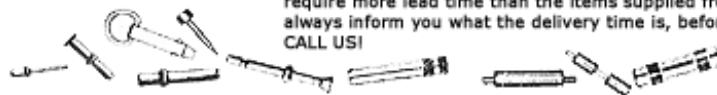


This headed, unthreaded pin is inserted into a
prepared hole and locked in place with a cotter
pin at the chamfered shank end. Disassembly
is possible. Used extensively in both the aircraft
and automotive industries.

CLEVIS PINS ARE AVAILABLE FROM THE SMALLEST 1/8" DIAMETER TO AS LARGE AS HOT FORGINGS WILL PERMIT, CARBON STEEL IS STANDARD UP TO 1".

SPECIAL PINS*

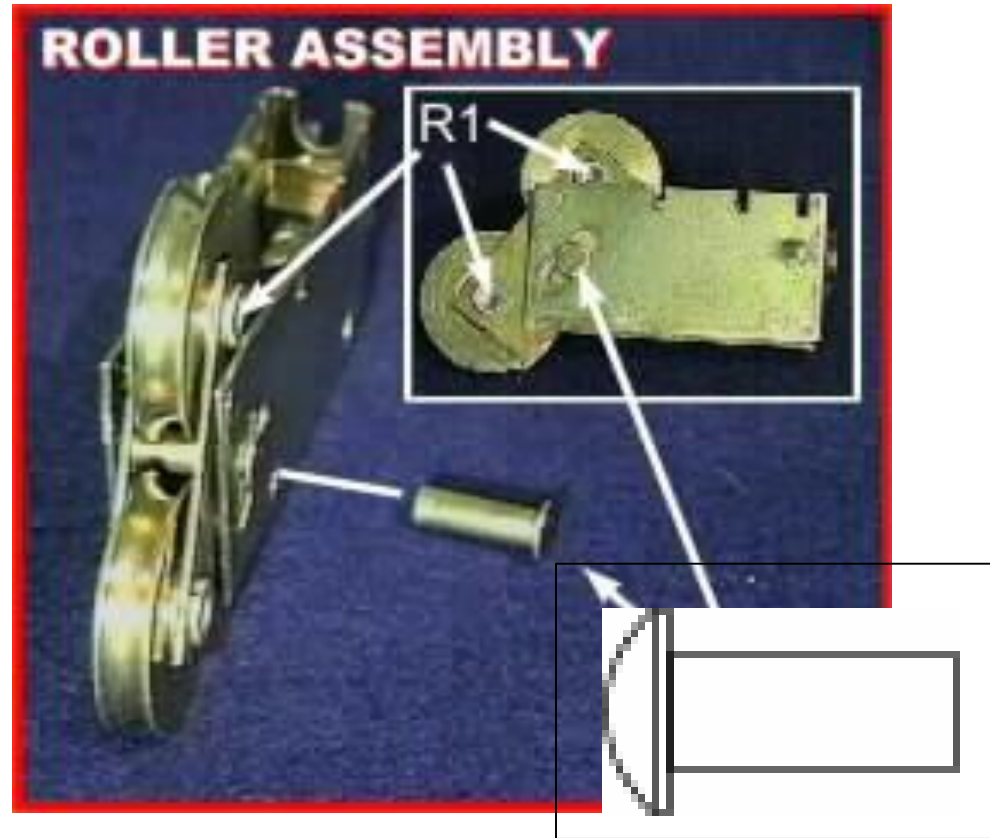
QUOTED TO YOUR
SPECIFICATIONS
& PRINTS.



*These items are supplied from our source factories. They will probably
require more lead time than the items supplied from our stock. We will
always inform you what the delivery time is, before you place your order,
CALL US!

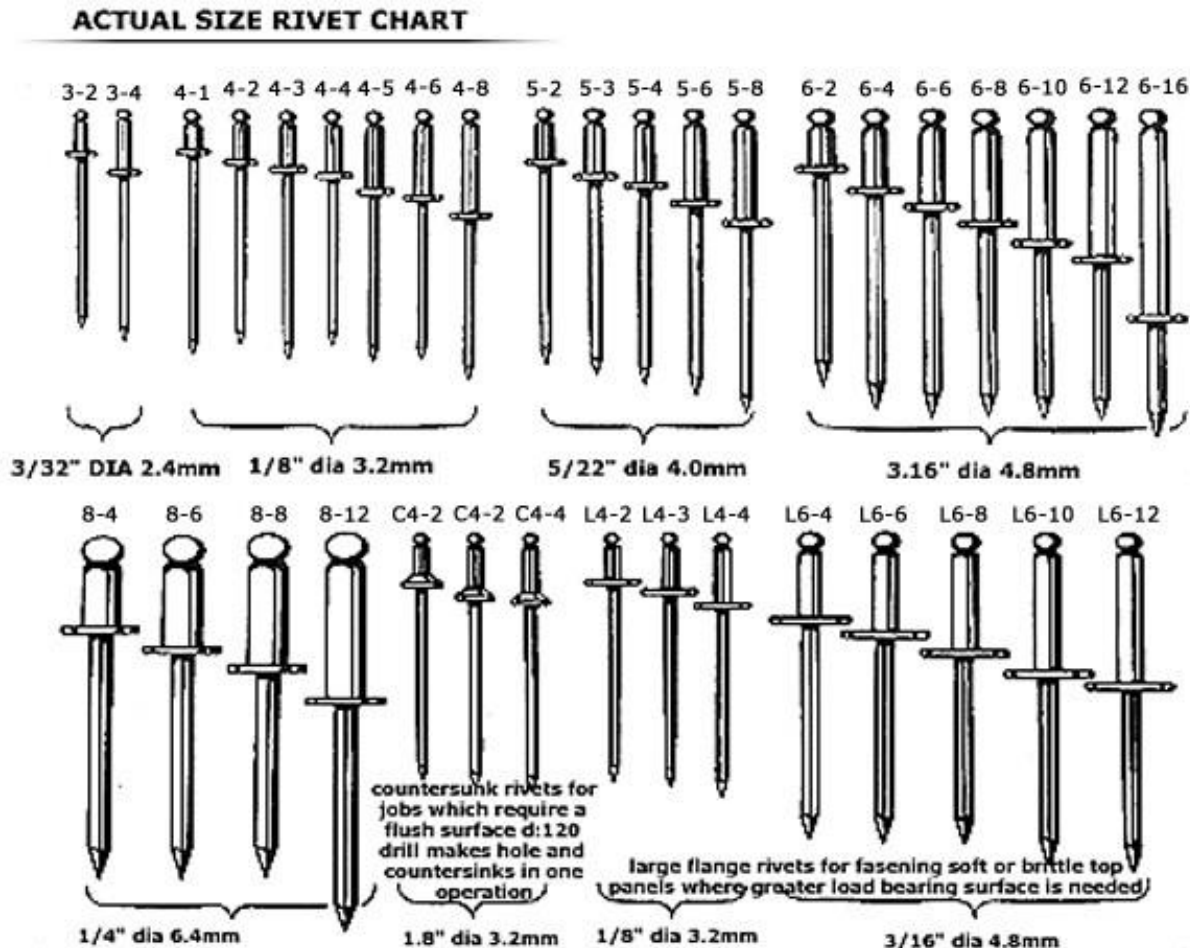
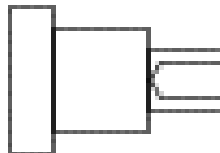
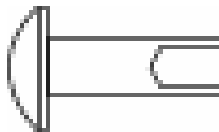
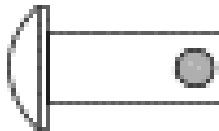
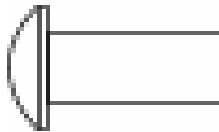
Permanent Fasteners

- Once assembled, the parts of the assembly (including the fastener) would be destroyed to disassemble the assembly.
- Rivets, soldering, brazing, welding.



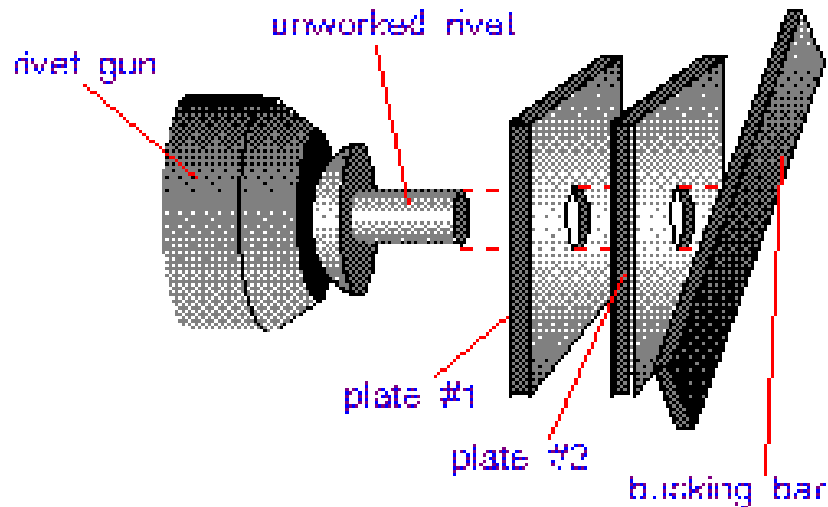
Rivets

Used to permanently fasten mechanical components

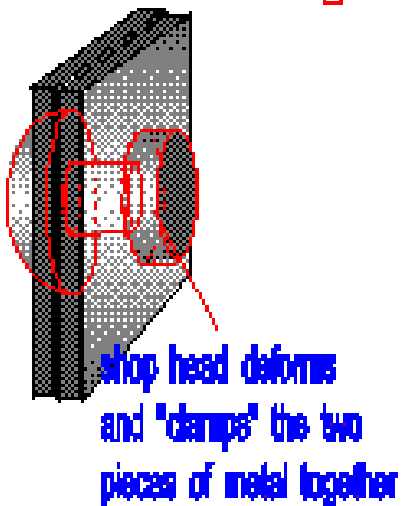


Riveting Process

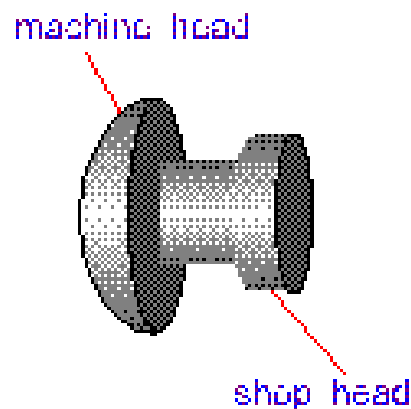
Before Bucking



After Bucking

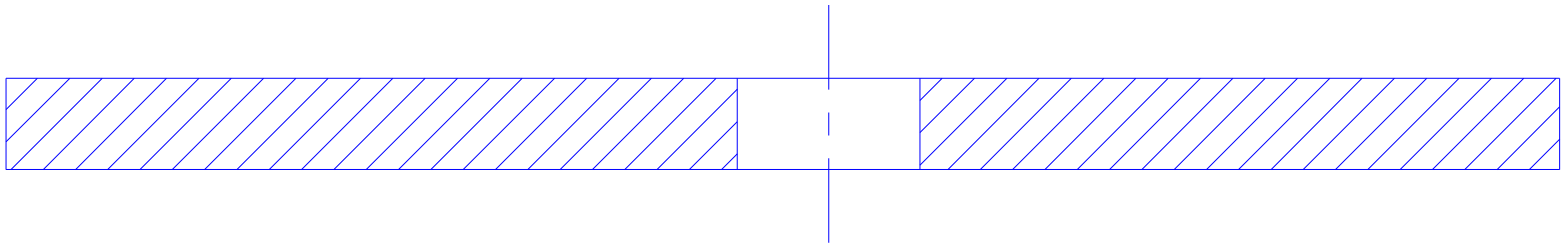


3-D View of a Bucked Rivet

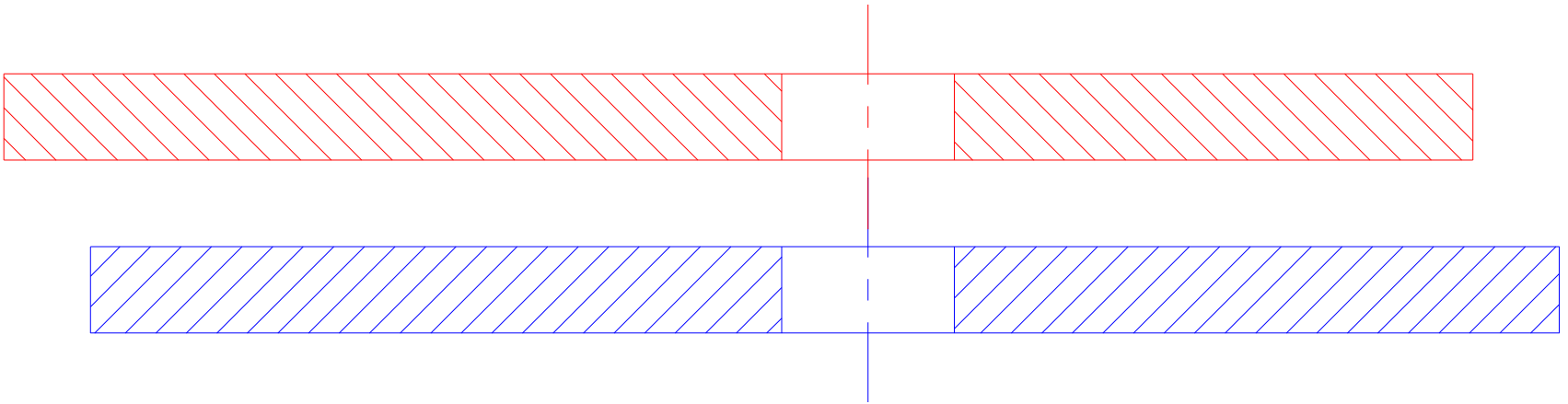


Fastening with Rivets

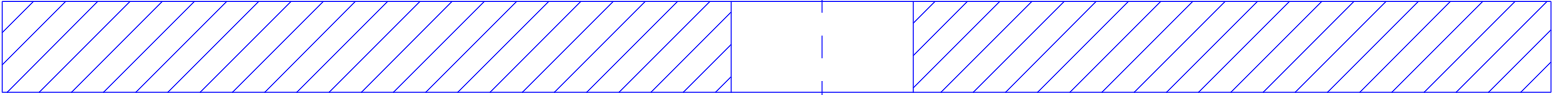
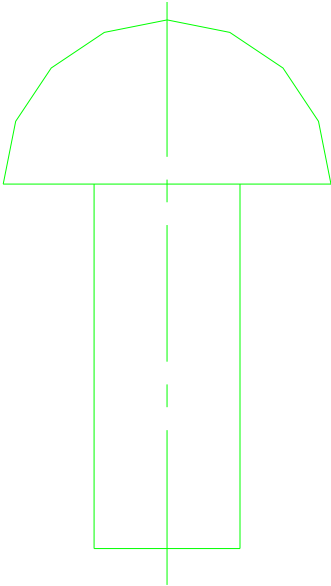
The headless end of the rivet is plastically deformed such that it joins together two components permanently.



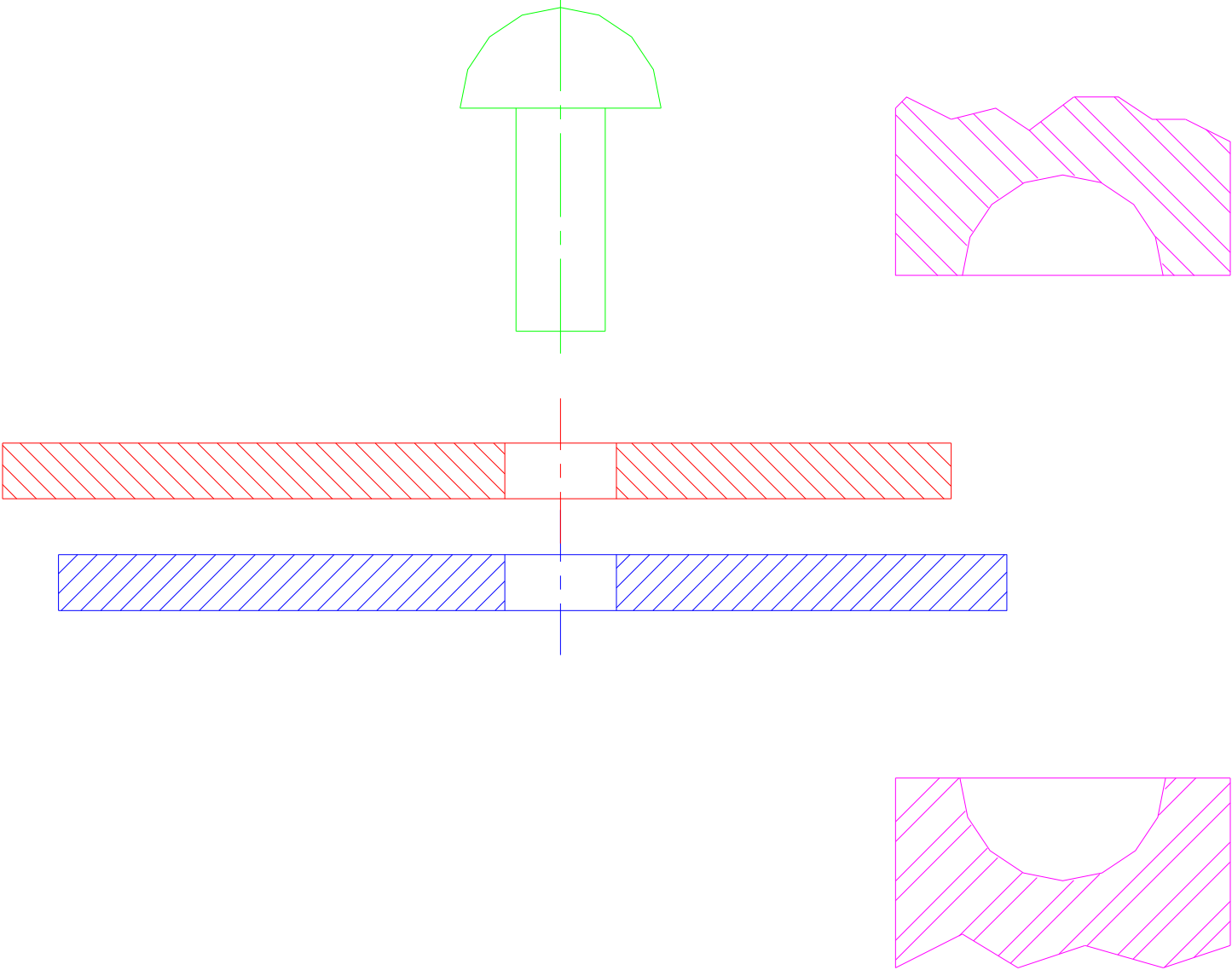
Fastening with Rivets



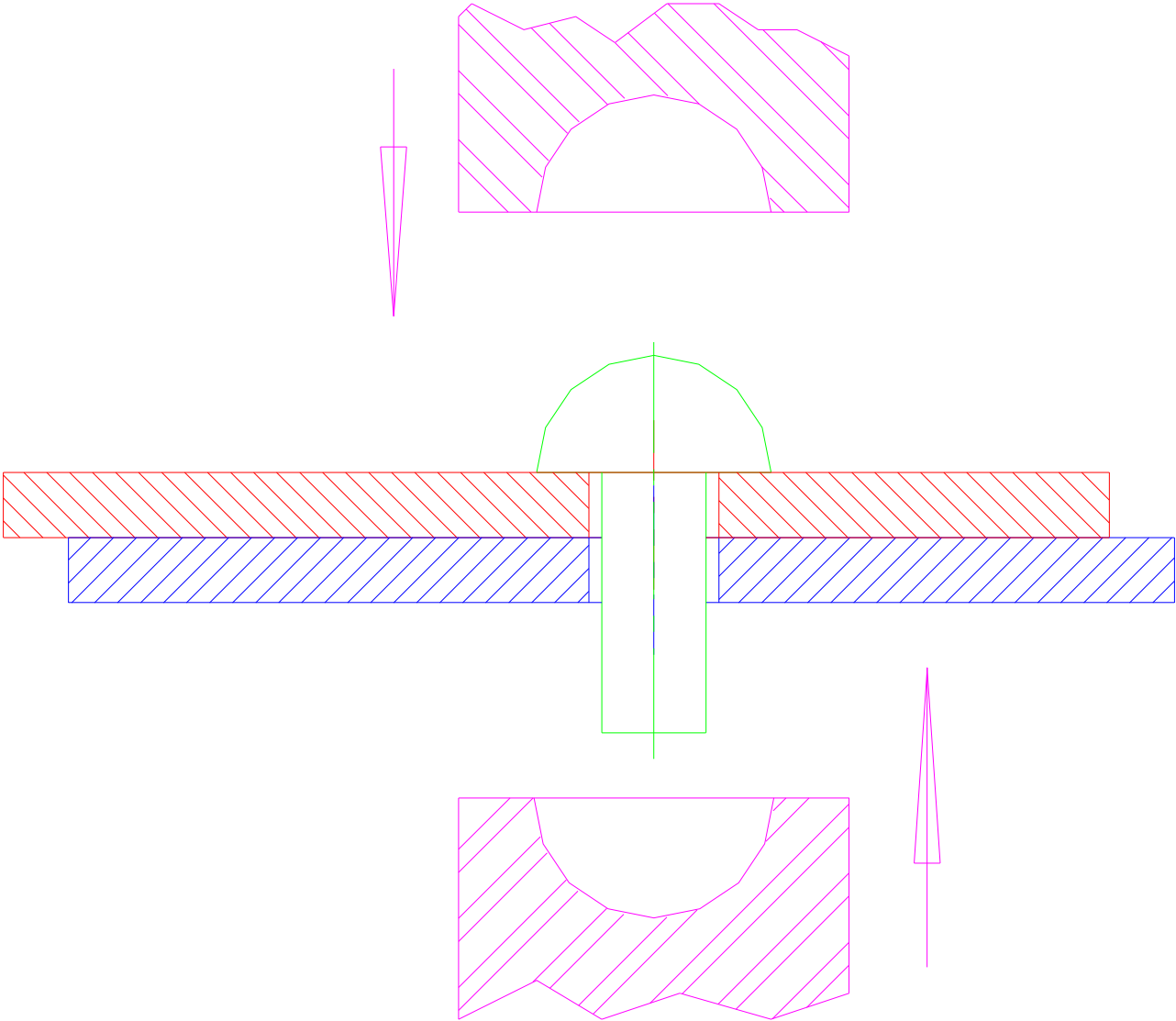
Fastening with Rivets



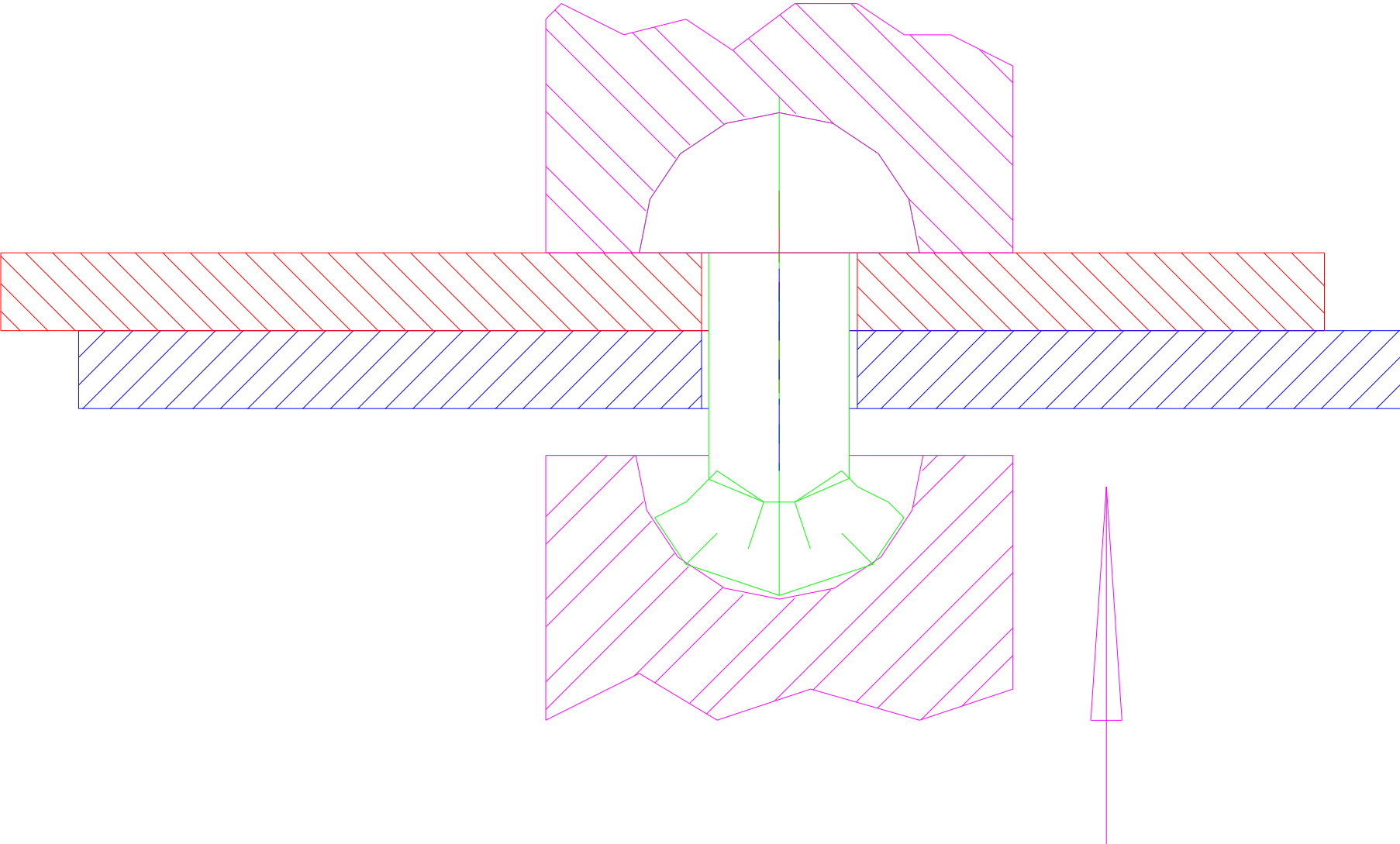
Fastening with Rivets



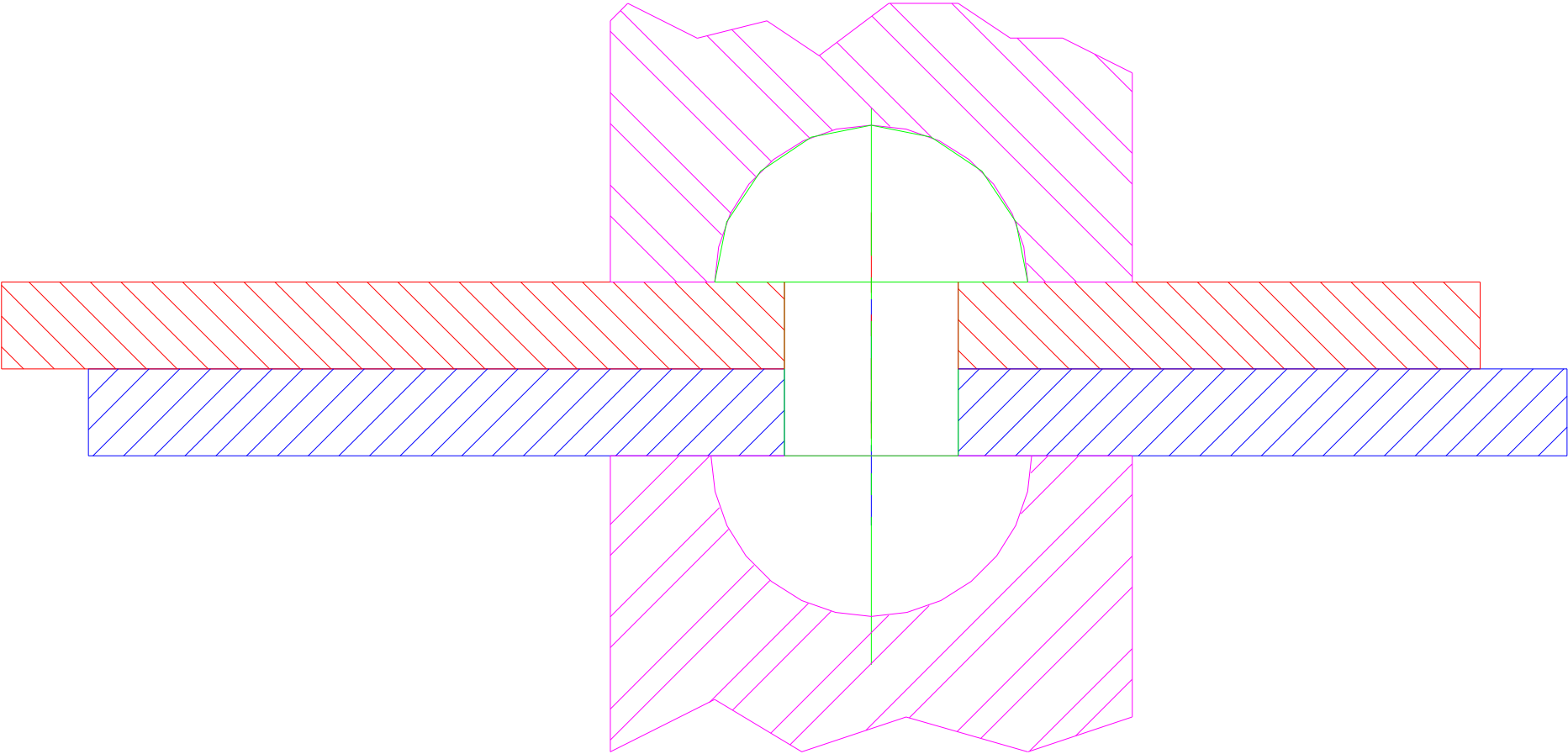
Fastening with Rivets



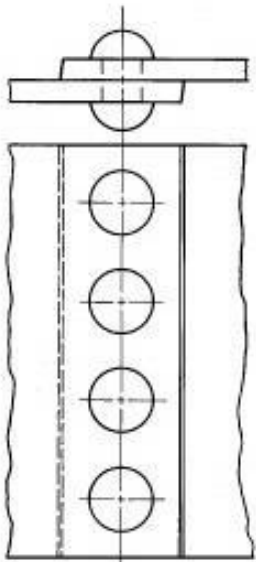
Fastening with Rivets



Fastening with Rivets

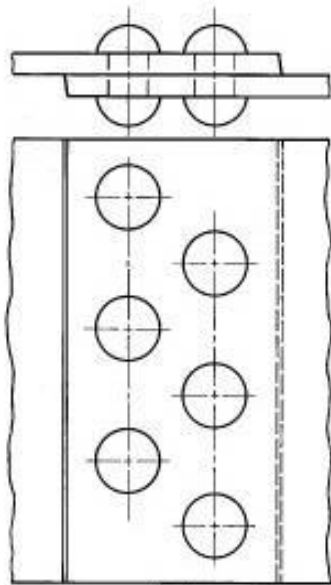


Common Riveted Joints



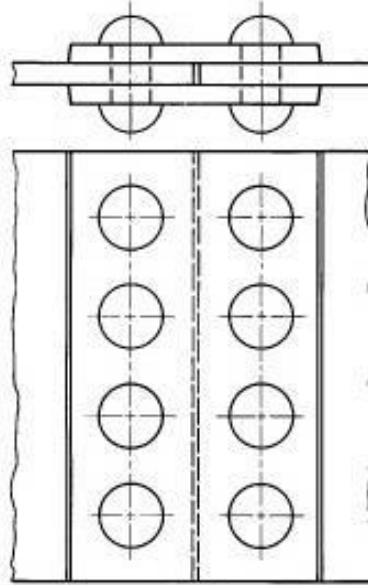
(a)

SINGLE RIVETED
LAP JOINT



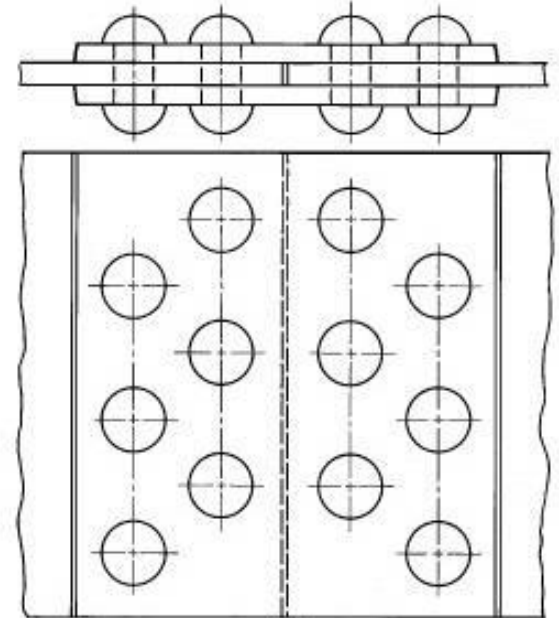
(b)

DOUBLE RIVETED
LAP JOINT



(c)

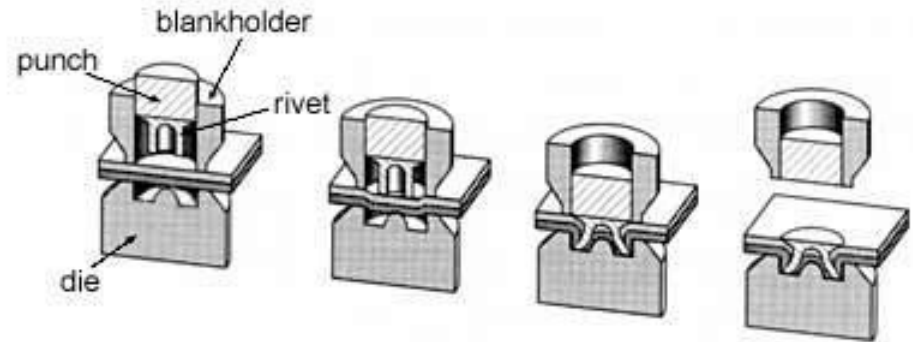
SINGLE RIVETED
BUTT JOINT

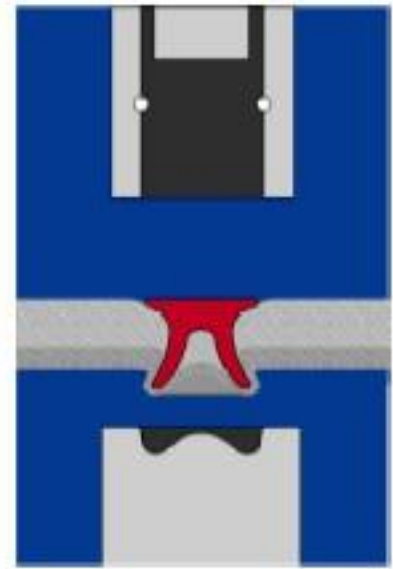
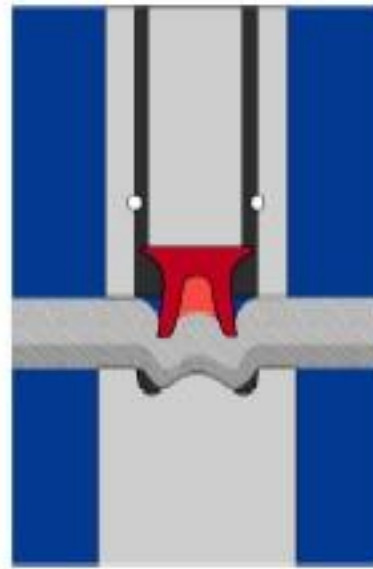
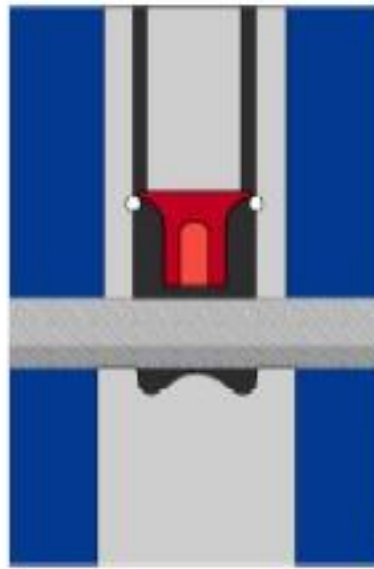
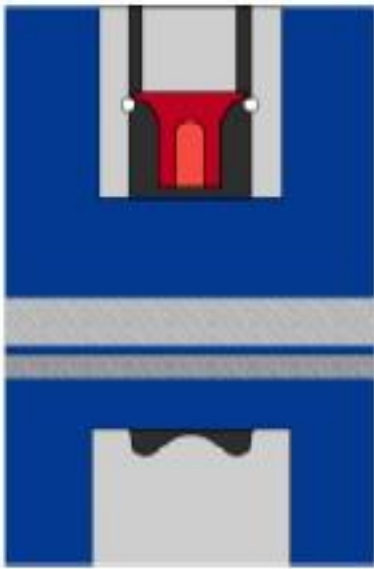


(d)

DOUBLE RIVETED BUTT JOINT

Self Piercing Riveting





Soldering, Brazing, Welding

- Joining of two part using a third component – *filler* that joins the parts when in liquid state.
- Soldering and brazing – low temperature binding materials – Sn-Pb, Cu-Ag alloys.
- Limited capability to face thermo-mechanical loading.

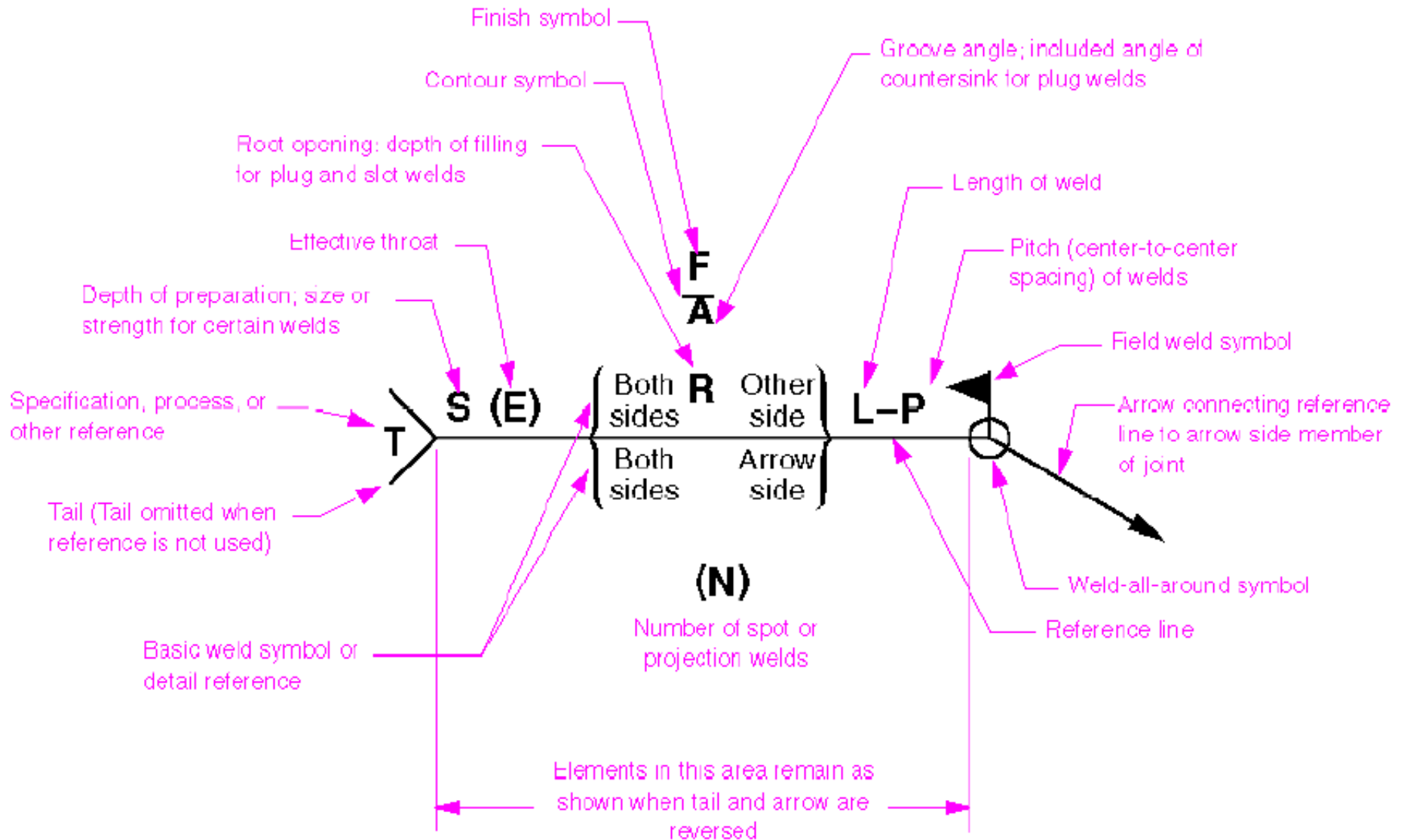
Welding

- Very well regulated activity.
- Requires license to practice.
- Welders bear significant responsibility.
- The activity is based on rigorous rules and regulations.
- Designer prescribe welding based on mechanics of materials calculations.
- Symbols indicate the type of welding.

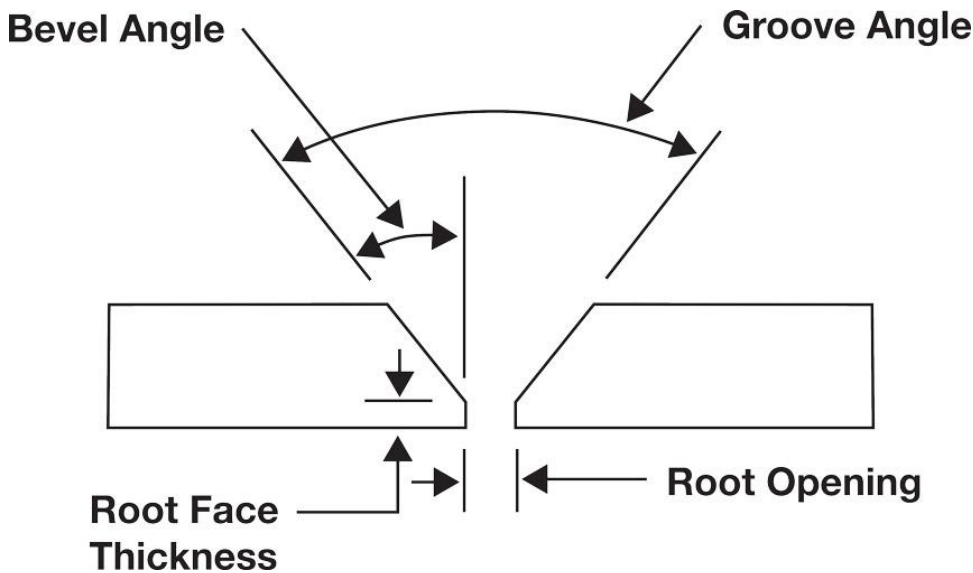
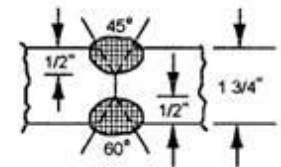
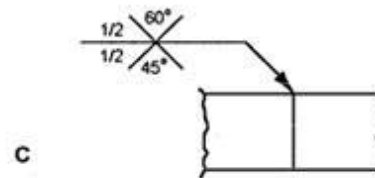
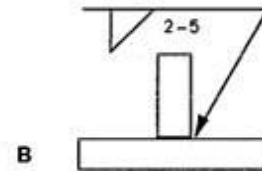
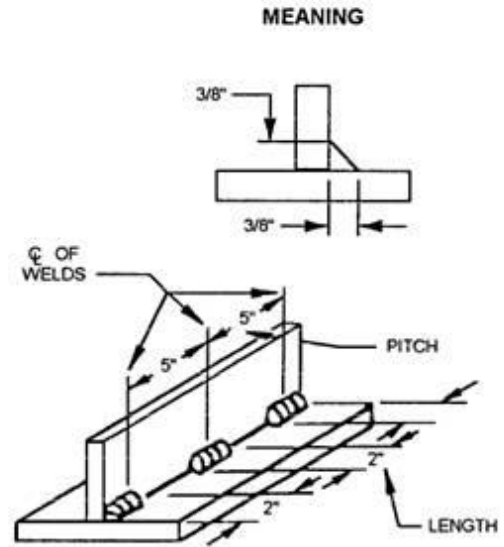
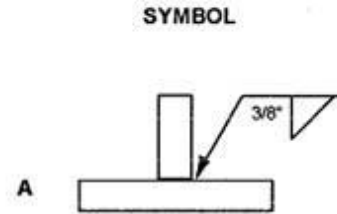
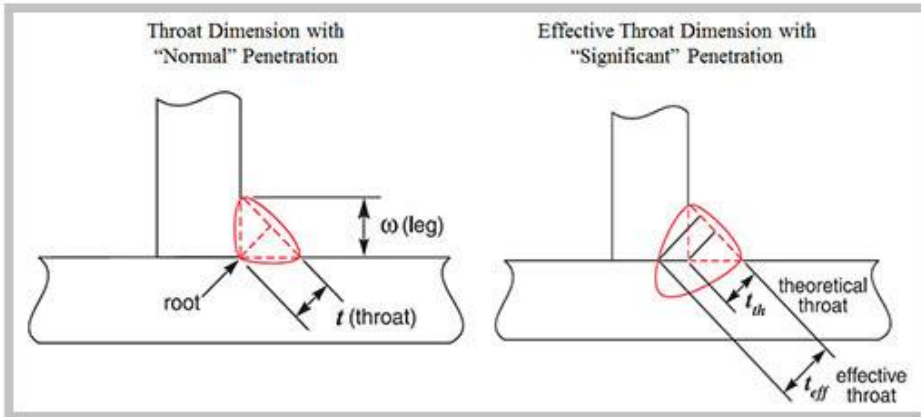
Welding



Basic Welding Symbols



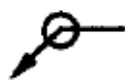


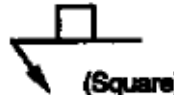
Basic Welding Symbols

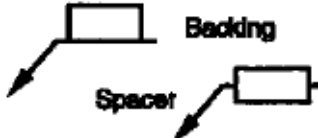





Basic Welding Symbols

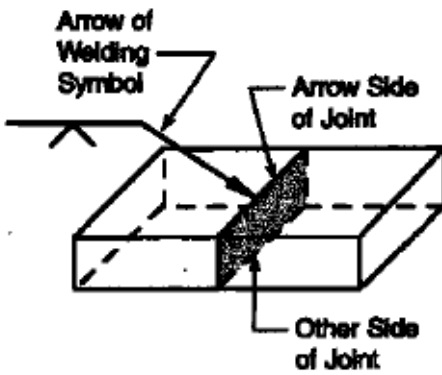
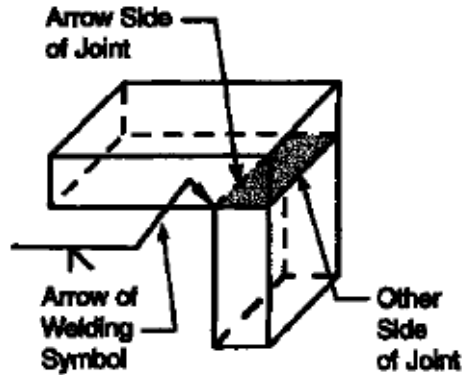
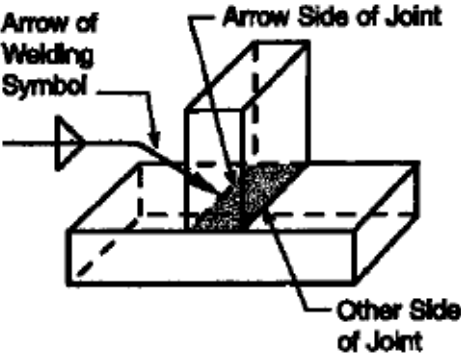
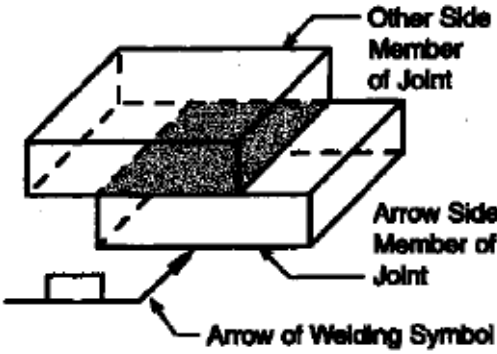
Basic Welding Symbols and Their Location Significance

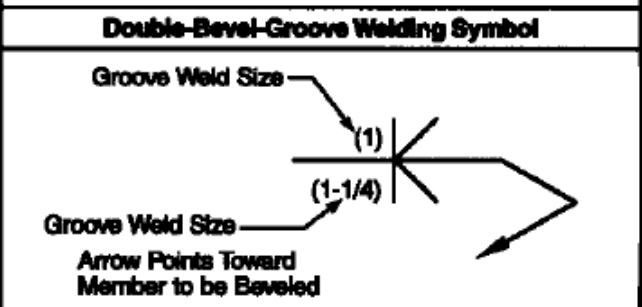
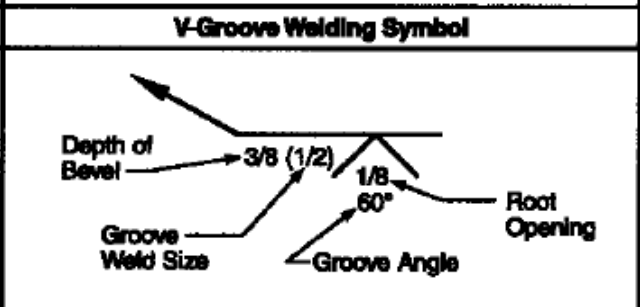
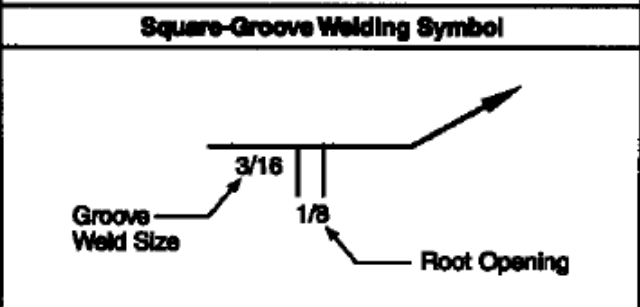
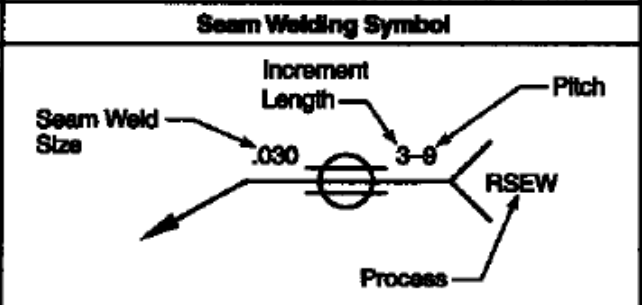
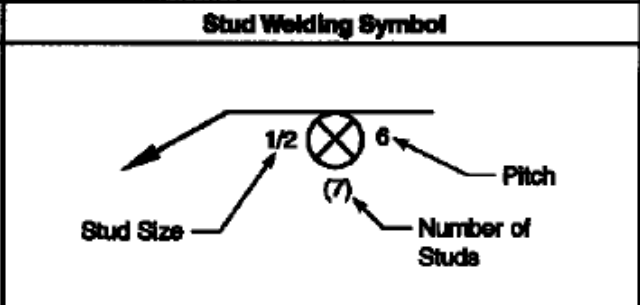
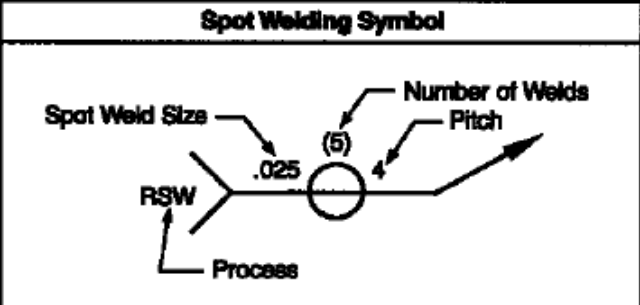
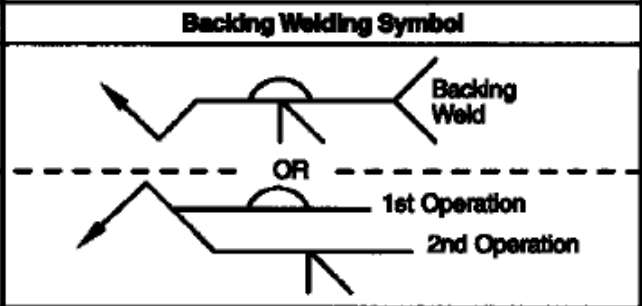
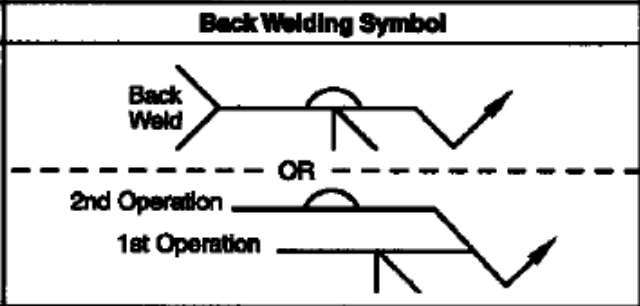
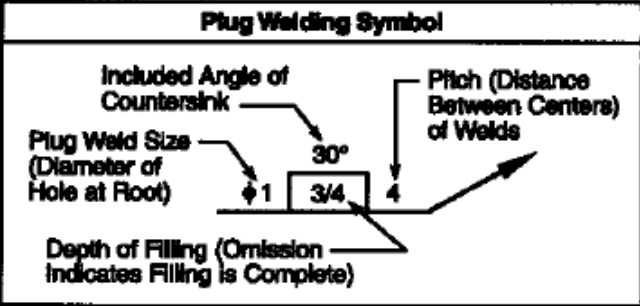
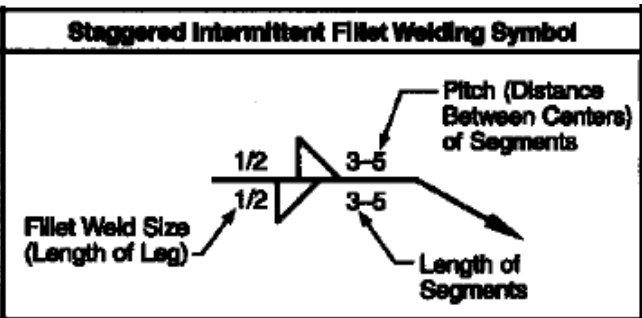
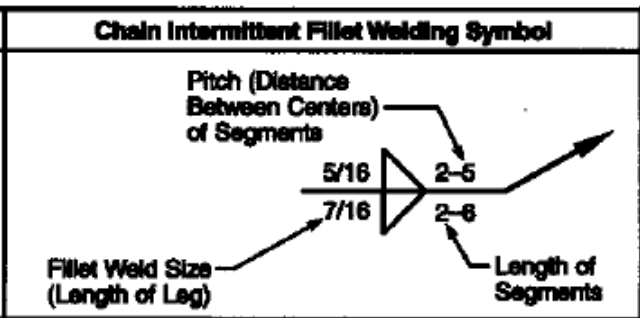
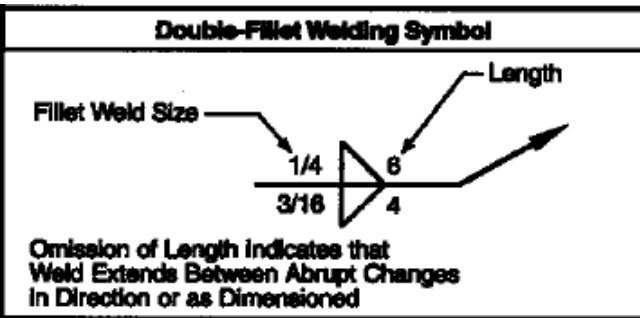
Location Significance	Fillet	Plug or Slot	Spot or Projection	Stud	Seam	Back or Backing	Surfacing	Edge
Arrow Side								
Other Side				Not Used			Not Used	
Both Sides		Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	
No Arrow Side or Other Side Significance	Not Used	Not Used		Not Used		Not Used	Not Used	Not Used
Location Significance	Groove							Scarf for Brazed Joint
	Square	V	Bevel	U	J	Flare-V	Flare-Bevel	
Arrow Side								
Other Side								
Both Sides								

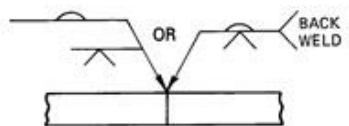
Weld-All-Around	Field Weld	Melt-Thru	Consumable Insert
			 (Square)

Backing/Spacer (Rectangular)	Contour		
	Flush or Flat	Convex	Concave
			

Basic Joints
Identification of Arrow Side and Other Side Joint

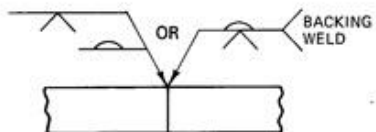
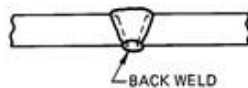
Butt Joint	Corner Joint
	
T-Joint	Lap Joint
	





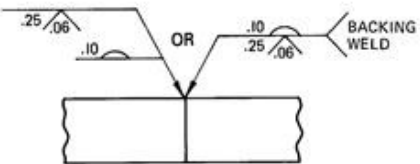
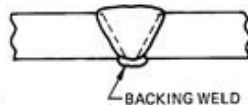
(A) BACK WELD SYMBOL

NOTE: GROOVE WELD MADE BEFORE WELDING OTHER SIDE.

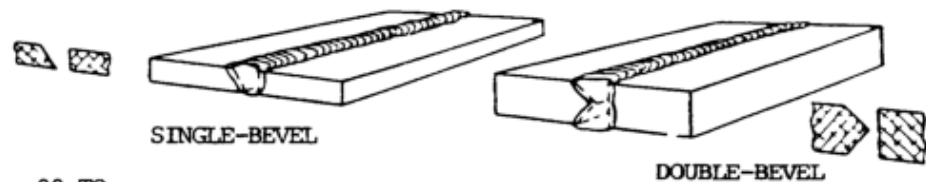
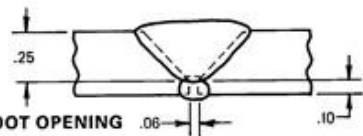


(B) BACKING WELD SYMBOL

NOTE: GROOVE WELD MADE AFTER WELDING OTHER SIDE.

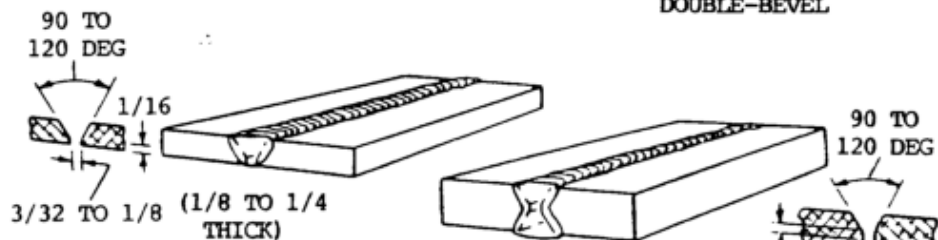


(C) BACKING WELD WITH ROOT OPENING



SINGLE-BEVEL

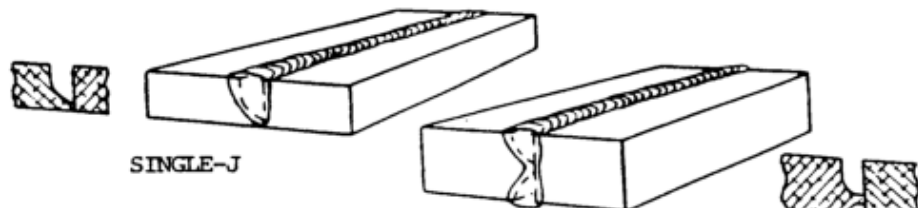
DOUBLE-BEVEL



SINGLE-V

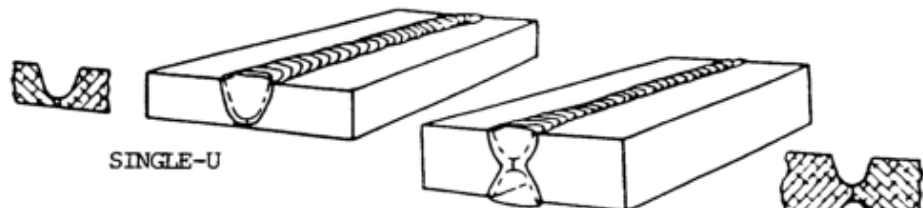
(OVER 1/4 THICK)

DOUBLE V



SINGLE-J

DOUBLE-J



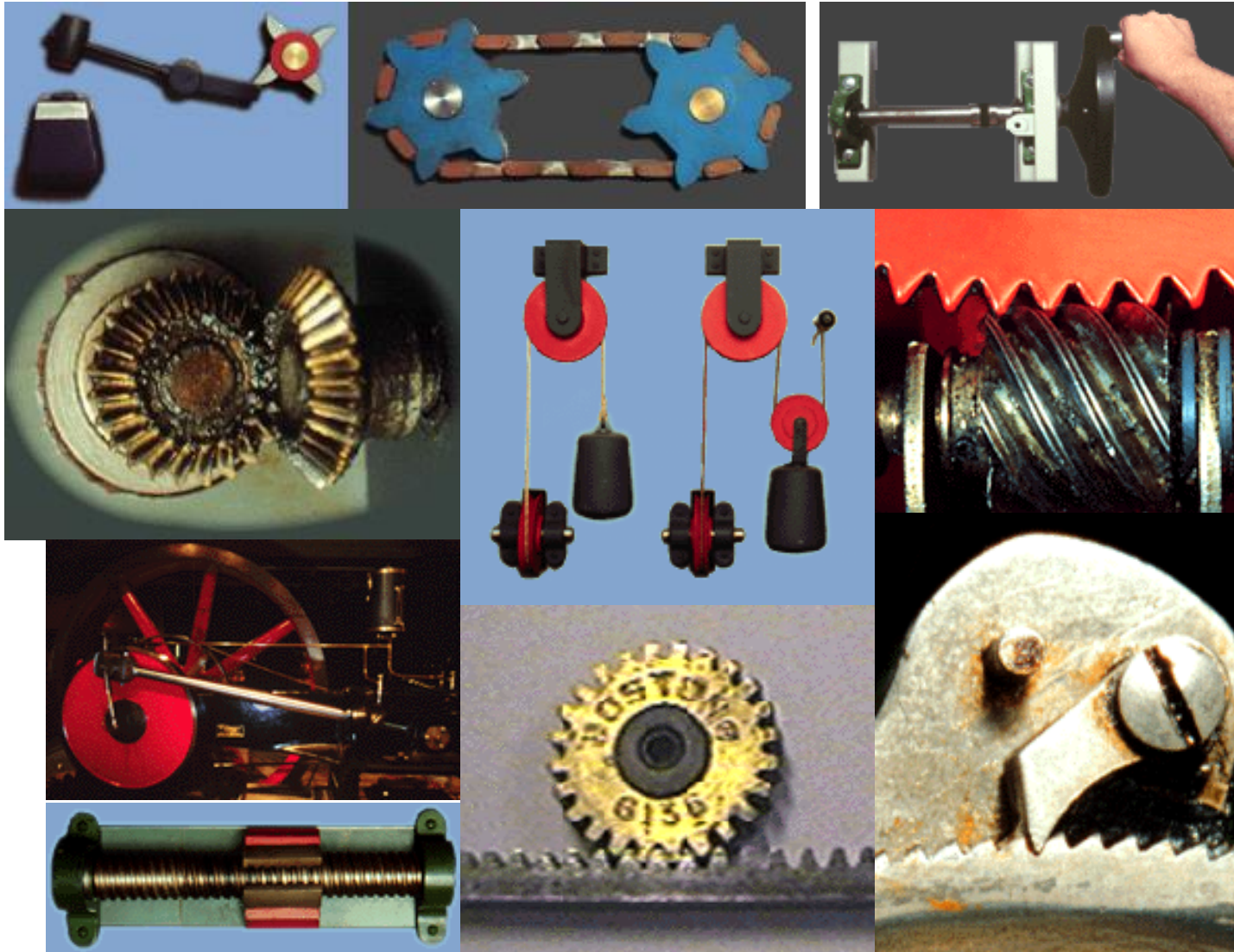
SINGLE-U

DOUBLE-U


NOTE
ALL DIMENSIONS SHOWN
ARE IN INCHES.

Figure 6-27. Types of groove welds.

Machine Elements

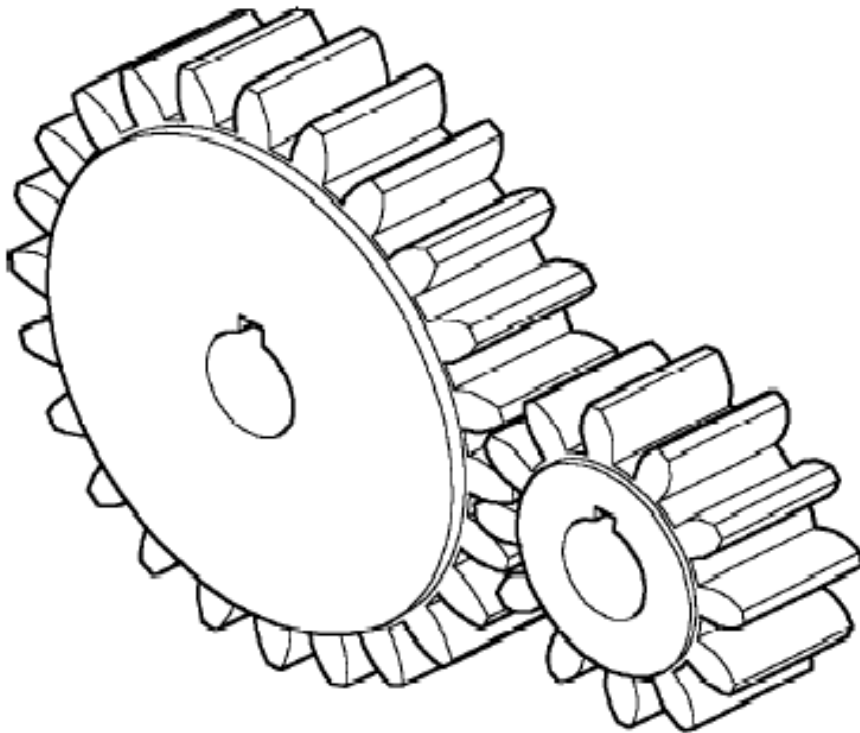


Machine Elements

- Used to transmit power or support elements that transmit power,
 - Gears, belts/pulleys, chain/sprockets, cams/followers,
 - Shafts, bearings,
 - Springs, ratchets, clutches, brakes.
- 

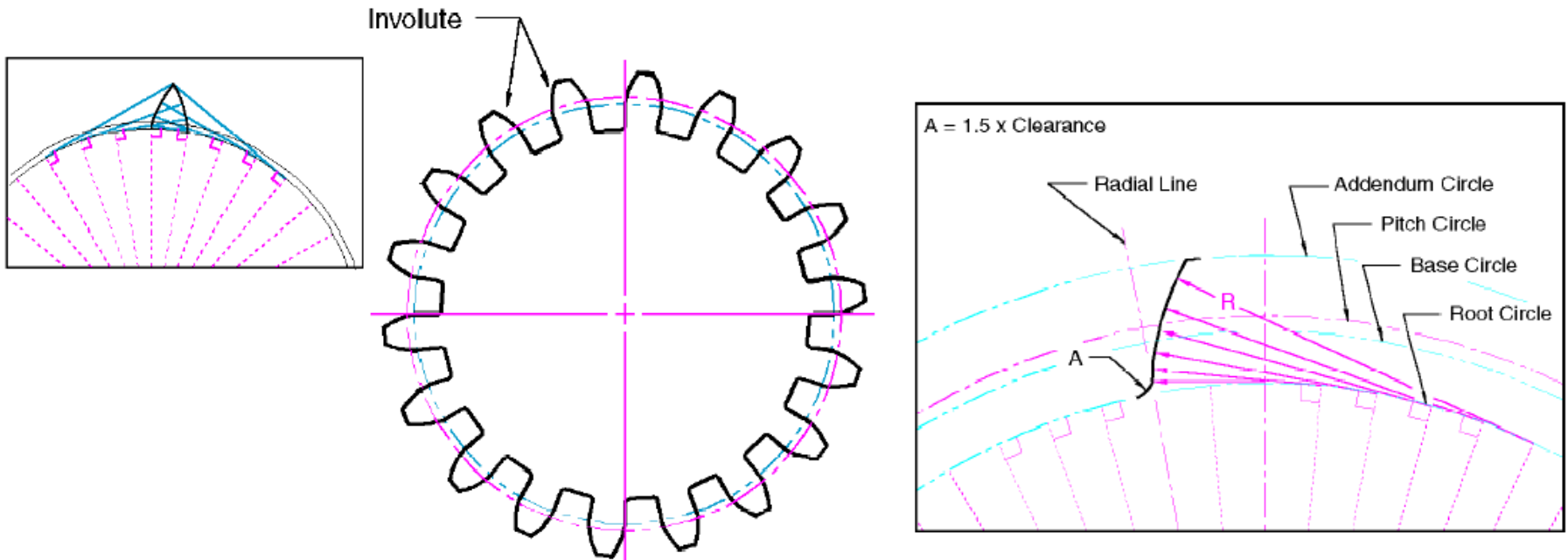
Gears

Gear and pinion mechanisms – power transmission Between two close-positioned shafts.



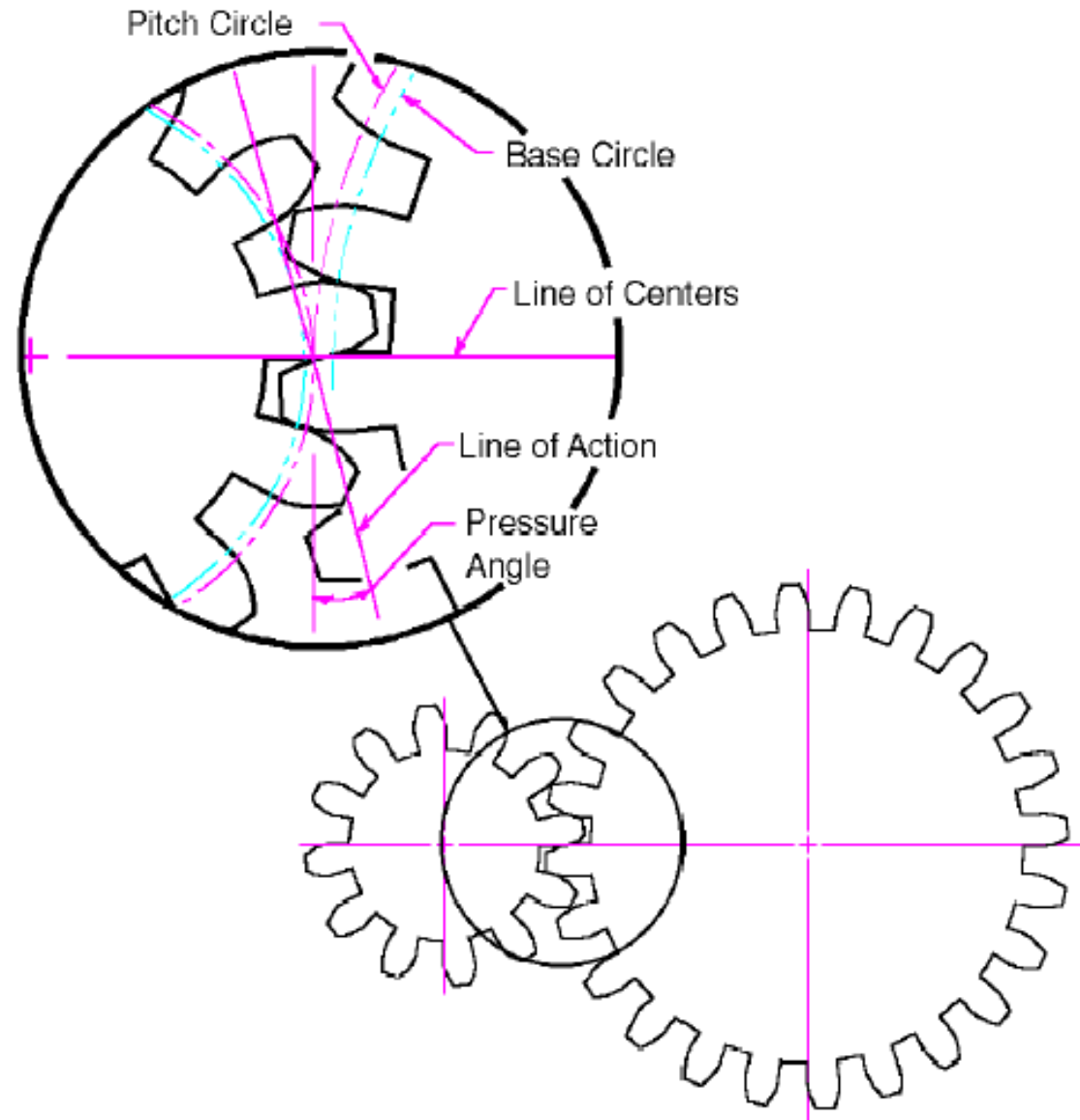
Gears

The profile of the tooth is a portion of an involute (the curve generated by a line that rolls without sliding on a circle).

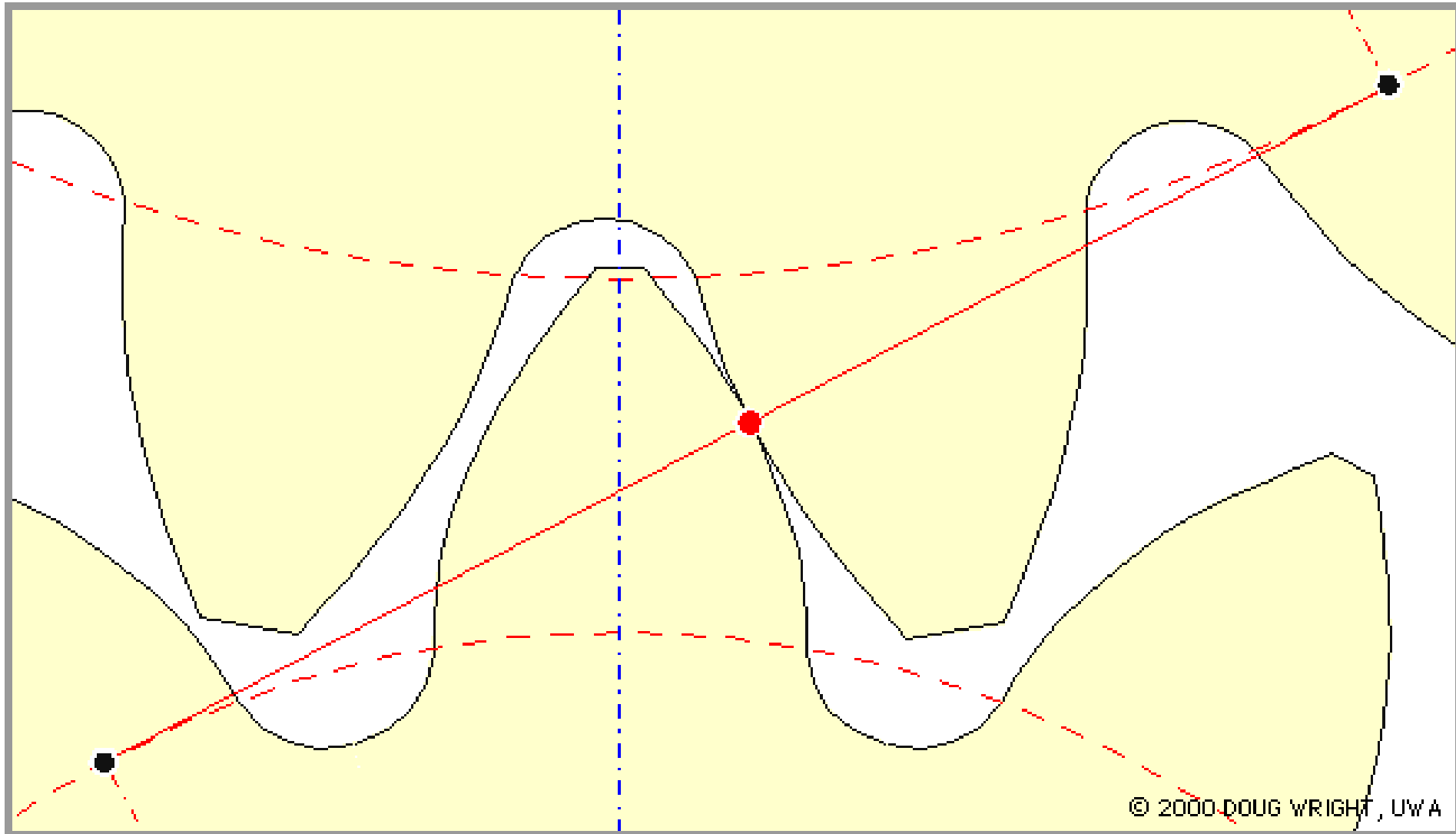


Gears

- Meshing requires the same geometry of teeth
- The rule of meshing – the transmission ratio i

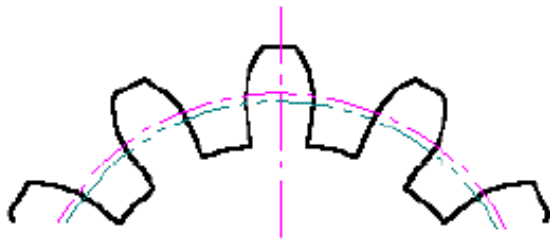


Gears

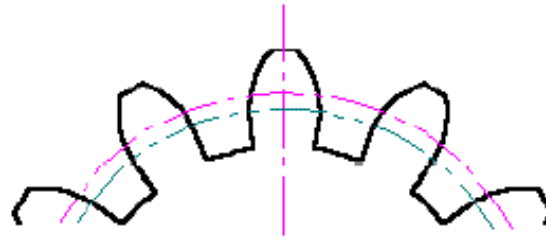


Gears

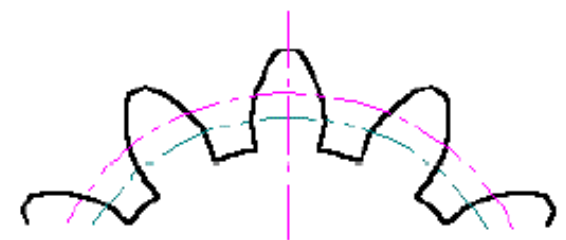
Pressure angle is the direction of the transmitted force versus the normal to the center line.



Pressure Angle
14.5°

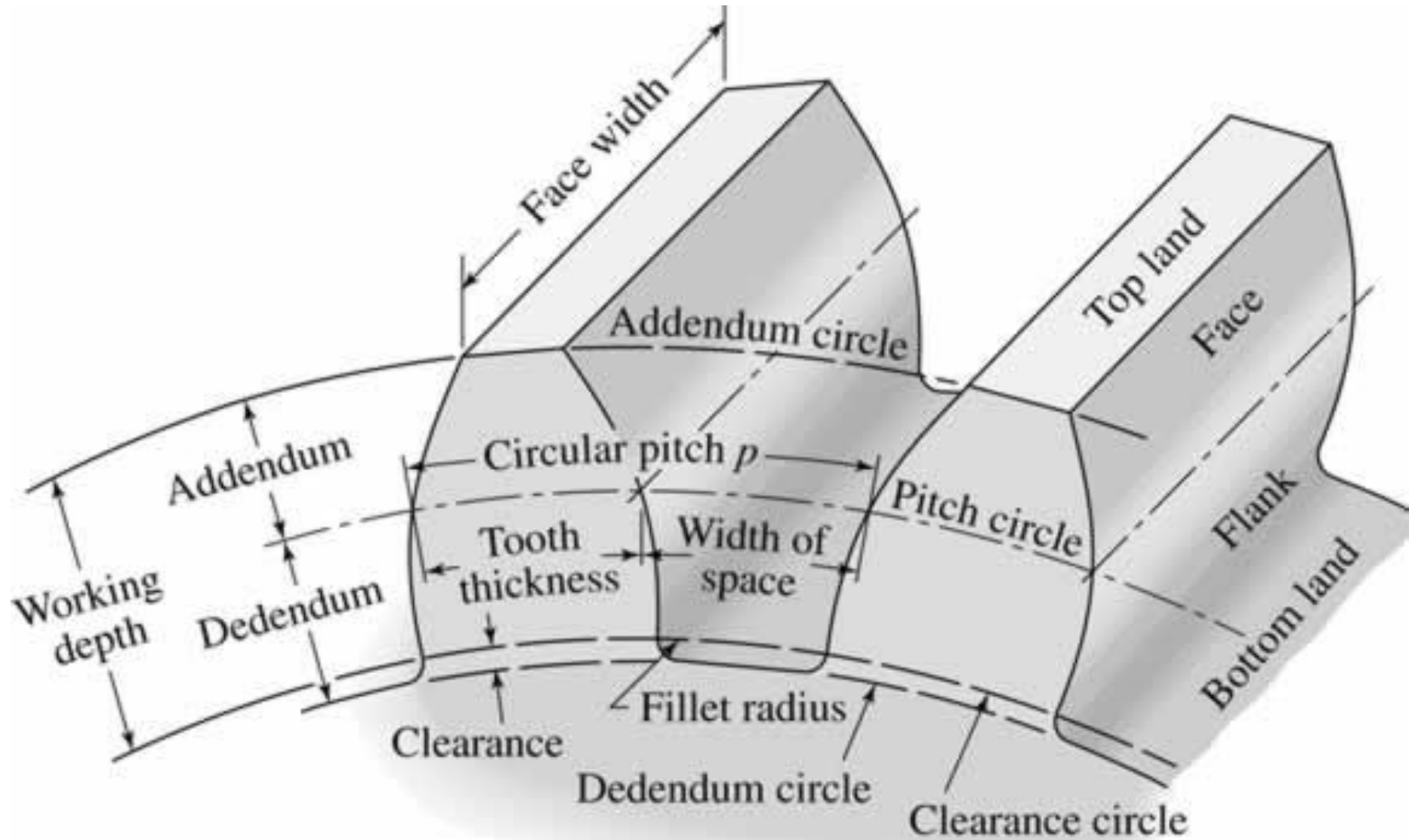


Pressure Angle
20°



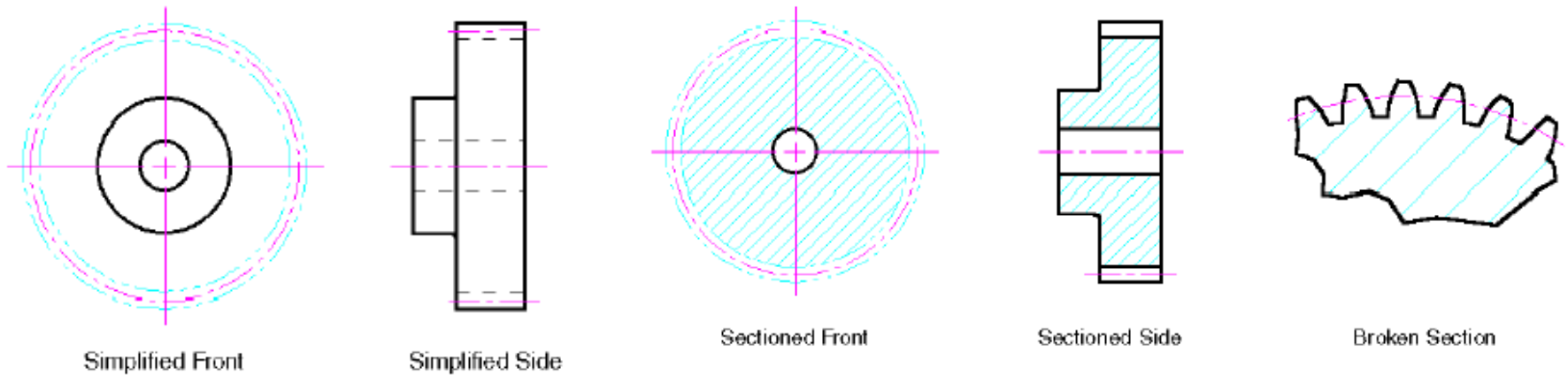
Pressure Angle
25°

Gear Nomenclature



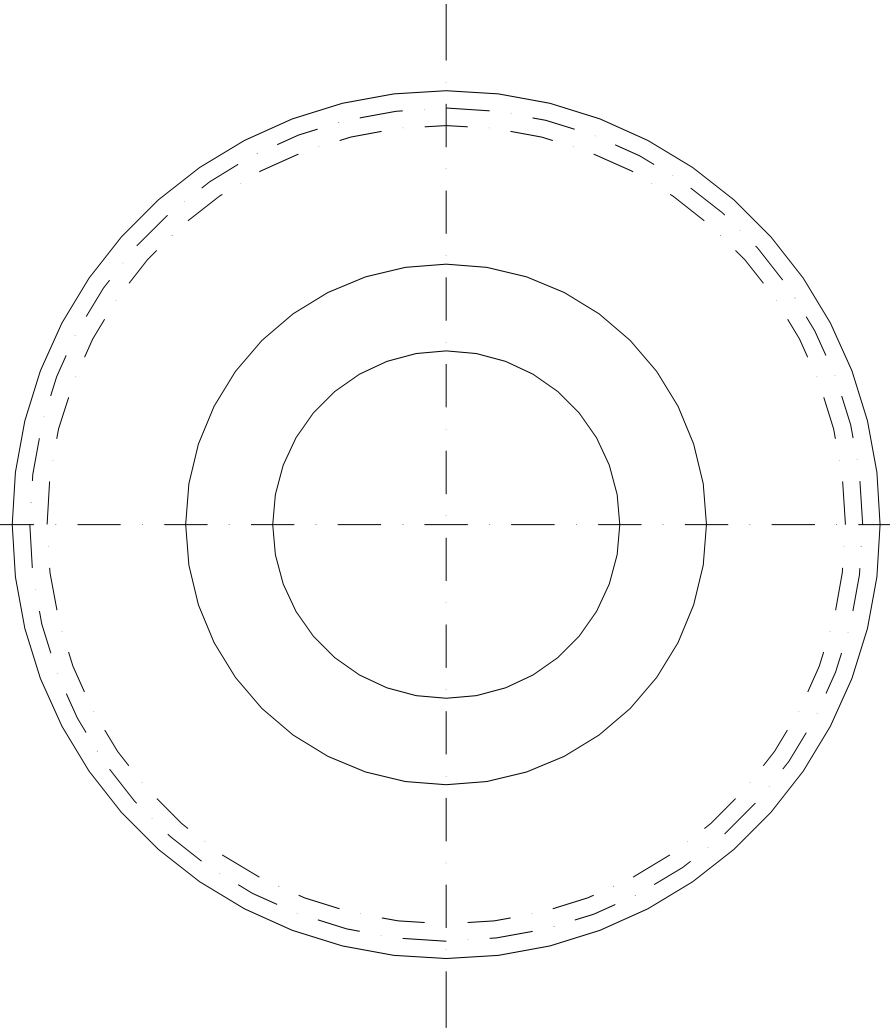
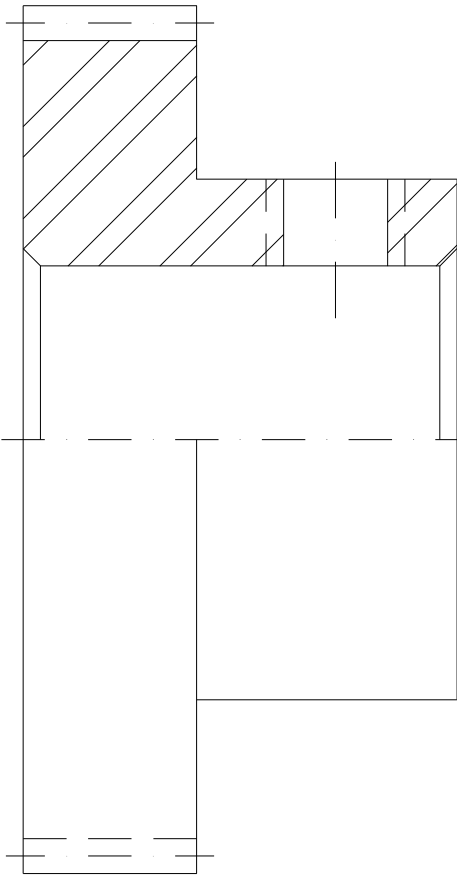
Gear Representation

A table containing cutting data must accompany the representation



This gear is not sectioned unless something inside should be shown

Gear Representation



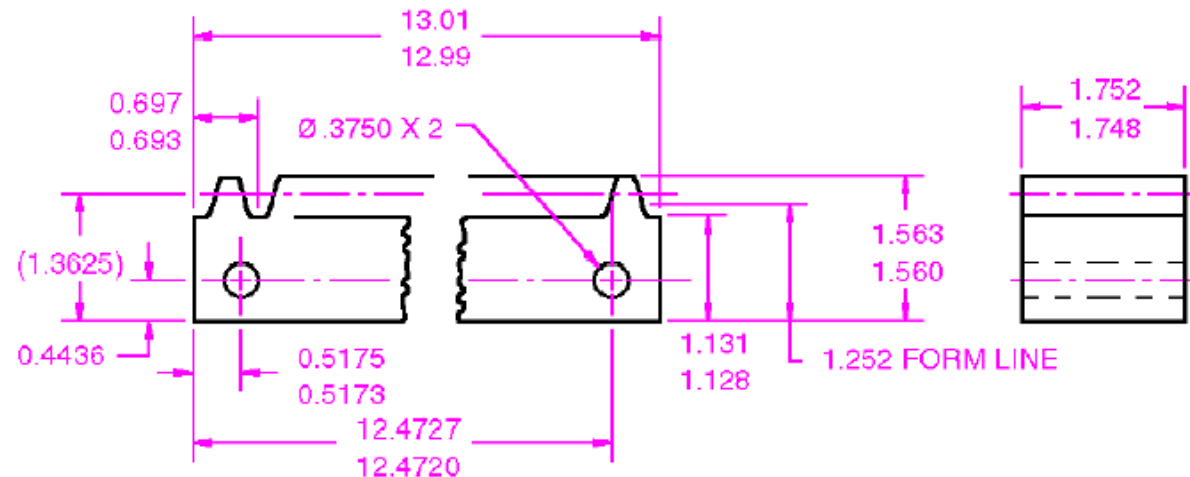
Gears

Rack representation (the cutting data is included)

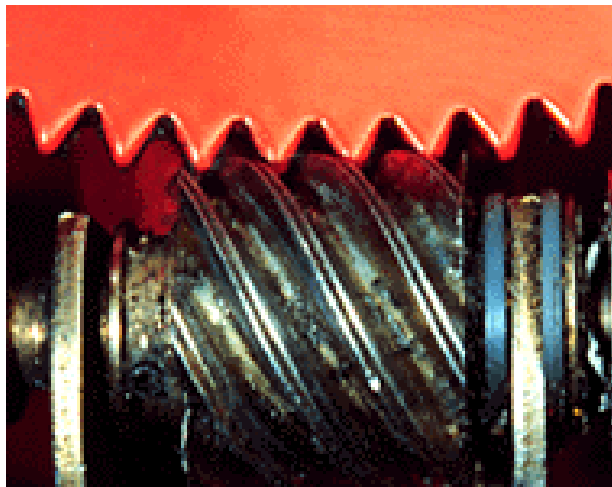
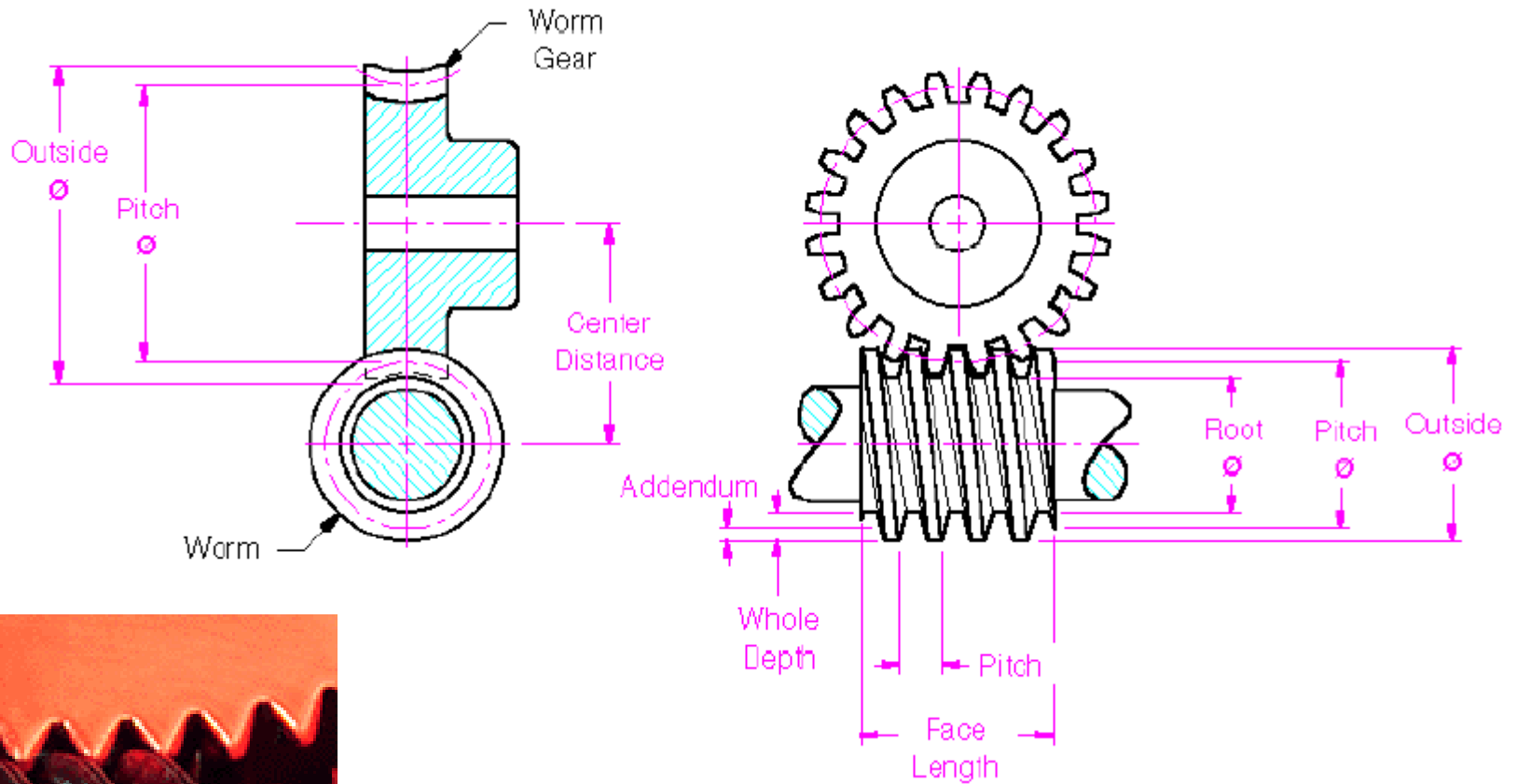


CUTTING DATA	
NUMBER OF TEETH	20
DIAMETRAL PITCH	5
LINEAR PITCH	.6283
PRESSURE ANGLE	14.5°
ACTUAL TOOTH THICK. AT PITCH LINE	.3142
PITCH TOL	.005
INDEX TOL	.005

ALL TOOTH ELEMENT SPECIFICATIONS ARE FROM THE SPECIFIED DATUM.

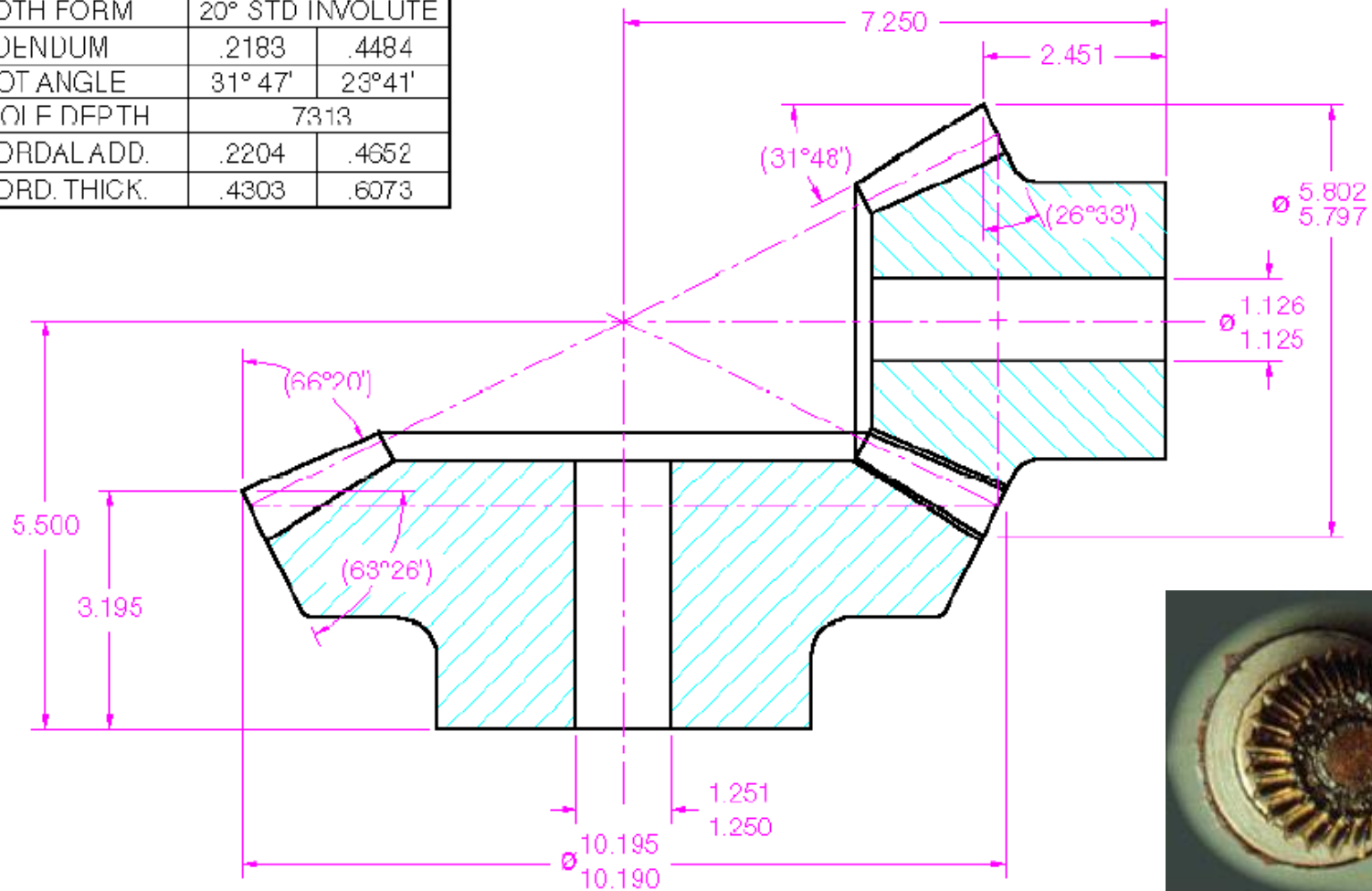


Worm and Gear

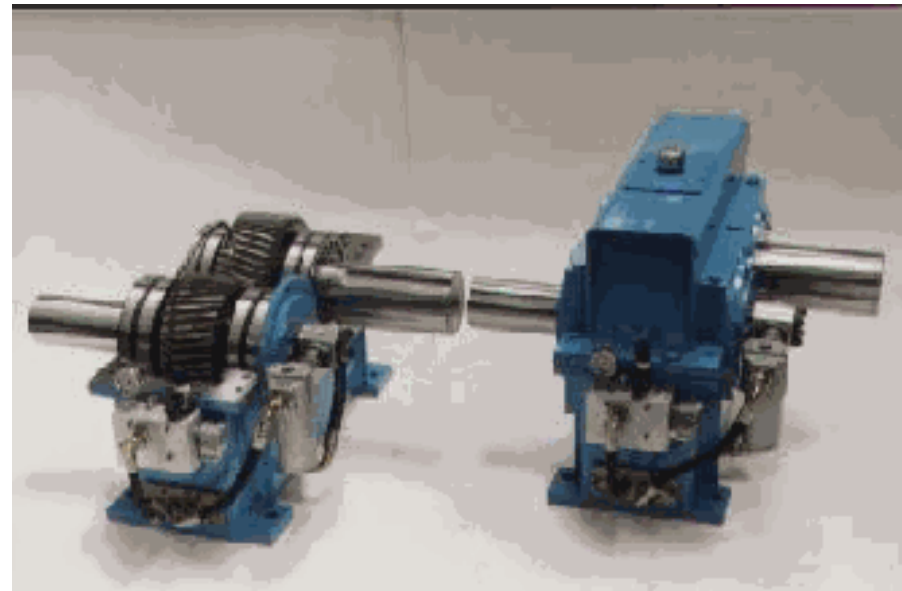


Bevel Gear Assembly

CUTTING DATA		
	GEAR	PINION
NO. OF TEETH	30	15
DIA. PITCH	3	
TOOTH FORM	20° STD INVOLUTE	
ADDENDUM	.2183	.4484
ROOT ANGLE	31° 47'	23° 41'
WHOLE DEPTH	.7313	
CHORDAL ADD.	.2204	.4652
CHORD. THICK.	.4303	.6073



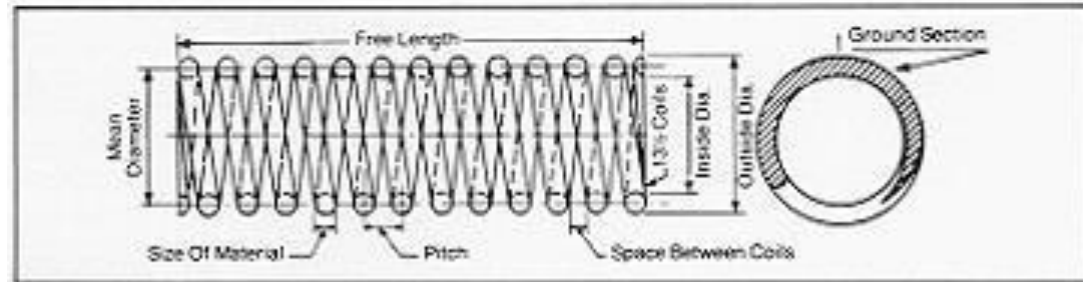
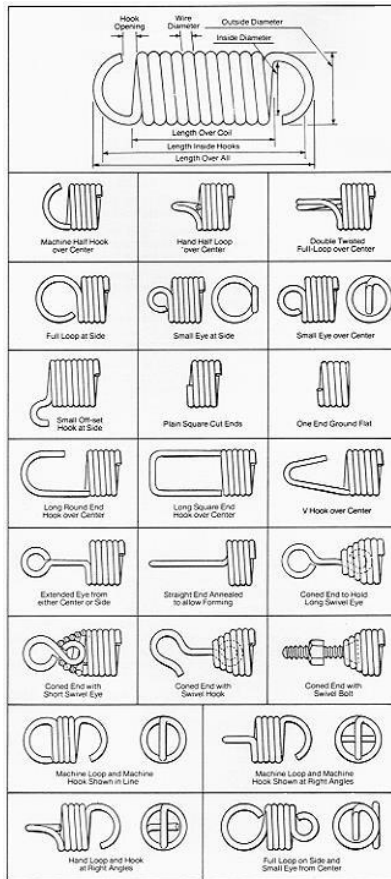
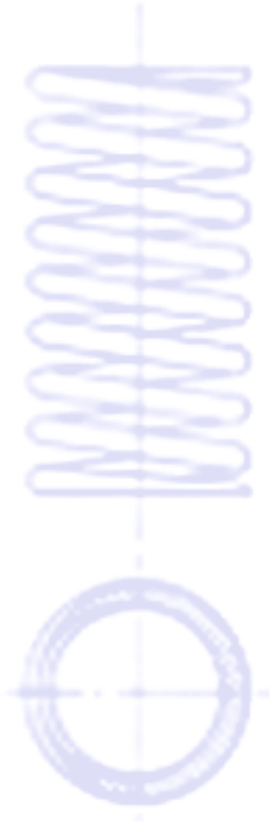
Gears



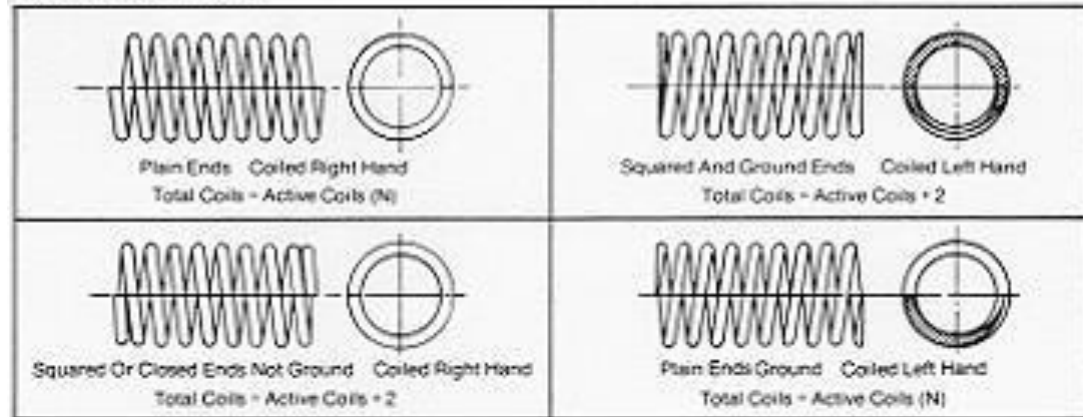


Springs

Used as restoring elements in oscillatory motion of machine elements (followers)



Type of End Finishes



Working drawing of a compression spring – the force diagram is included

FED1+ Compression Spring Software - 1E.FED

File Edit View CAD Database Document QLE Help

$F_1 = 120.3 \pm 73.7 \text{ N}$	Torq k1 = 230	Nmm ²
$F_2 = 280.3 \pm 77.5 \text{ N}$	Torq k2 = 537	Nmm ²
$F_3 = 648.5 \text{ N}$	Torq k = 925	Nmm ²
$F_c = 808.5 \text{ N}$	Torq c = 1154	Nmm ²

Variation of stress Torq k1 = 306 Nmm²
 Safety against fatigue: 1.28
 (Spring Rate R = 64 N/mm)

Illustr. 1. Spring ends lined up and ground
 Illustr. 2. Spring ends lined up
 Illustr. 3. Spring ends lined up, forged and ground

1	No. of Active Coils	n = 4.62
	Total No. of Coils	nt = 6.12
2	Direction of Coils	right <input type="radio"/> left <input type="radio"/>
3	Burting of Spring Ends	no <input type="radio"/> inside <input type="radio"/> outside <input type="radio"/>
4	Working Path (Stroke)	h = 2.5 mm
5	Stress Cycle Frequency	n = 1000/s
6	Range of Working Temp. from	20 to 100 degrees C
7	Wire or Rod Surface	drawn <input checked="" type="radio"/> rolled <input type="radio"/> tipless grinding <input type="radio"/> spring shot-blasted with steel balls <input type="radio"/>
8	Surface Protection:	
9	Material: EN 10270-2 VDC Vergüteter Ventilfederdraht (DIN 17223-2 VD) Permissible Shearing Strain tau perm = 839 N/mm ² Calc. Basis of Shear Modulus G = 71556 N/mm ²	
10	Permissible Deviations according to DIN 2095 Quality Class	
		acc. to DIN 2096
	De, Di, (Dm)	1 2 3
	L0	<input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>
	F1 to Fn	<input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>
	e1, e2	<input type="radio"/> <input type="radio"/> <input checked="" type="radio"/>
	Wire or Rod Diameter d	depending on semifinished goods used acc. to DIN 2076 <input checked="" type="radio"/> acc. to DIN 2077 <input type="radio"/>
11	Manufacturing Tolerance	by:
	a) if the spring force and the spring length are specified	L0 <input type="radio"/>
	b) if the spring force, the spring length and L0 are specified	n and d <input type="radio"/> n and De, Di, (Dm) <input type="radio"/>
	c) if two spring forces and the spring lengths are specified	L0, n and d <input type="radio"/> L0, n and De, Di, (Dm) <input type="radio"/>
12	Supply remaining springs not set <input type="radio"/> not set <input type="radio"/>	
	Springs to be supplied not set may be longer than L0	
13	Additional Information:	

Copying of this document and giving it to other and the use or communication of the contents thereof are forbidden without the express written consent of the manufacturer. In the event of a claim of a patent or the registration of a utility model or design.

				Date	Name
			Check:	14.01.1999	Reiss
			Start:		
n	Quality class 2 to 3	11/06/19	Reiss		
a	W11.0 - Document	12/09/19	Reiss		
Cond	Modification	Date	Name	DIGNSON Lokomotiv Tampere	Replacement for 12349759012345

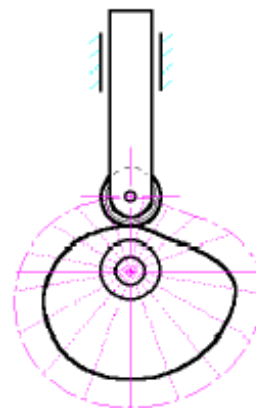
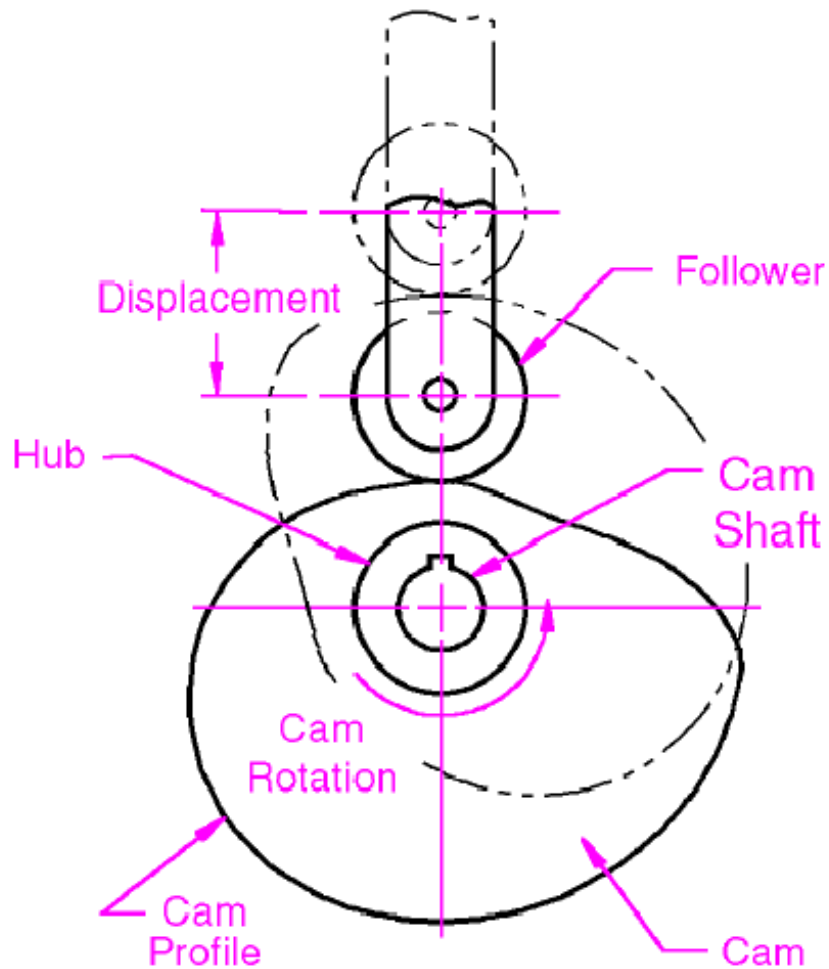
Compression Spring

1 464 619 308

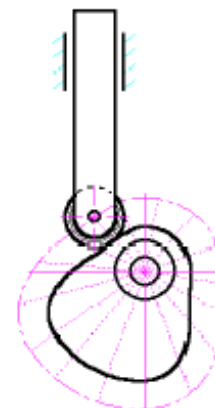
Page
Pg

Redacted by 89999999999999

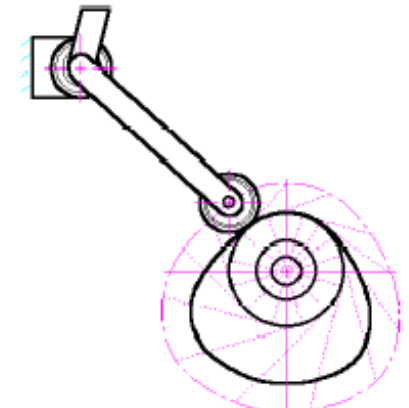
Cams and Followers



In-Line



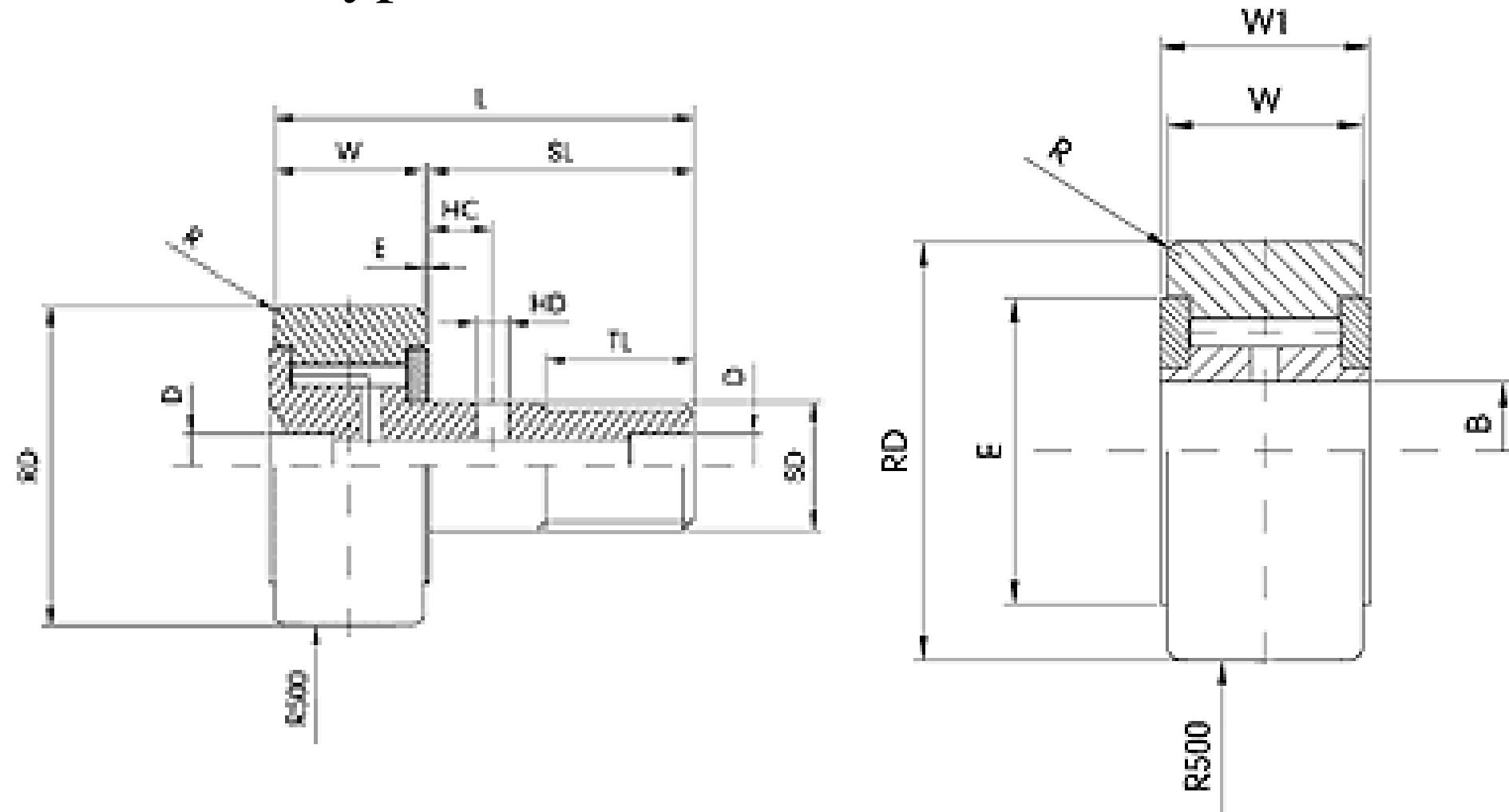
Offset



Pivoted

Cams

Roller-type followers stud and bore

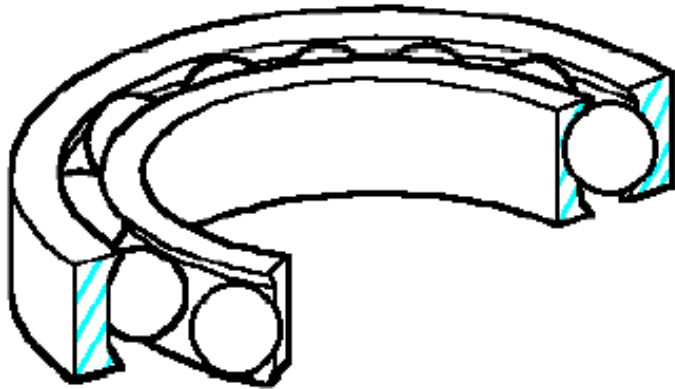


Clutches

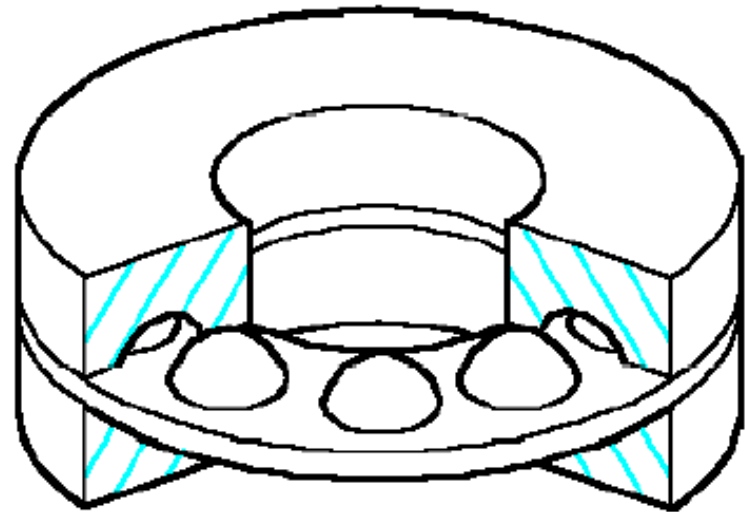
Reduce the high stress when power is coupled to an idle shaft



Bearings

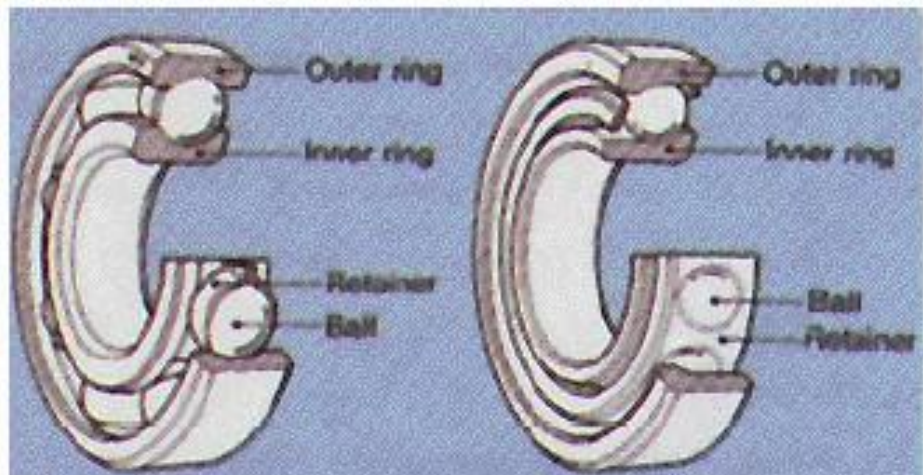


Radial ball bearing

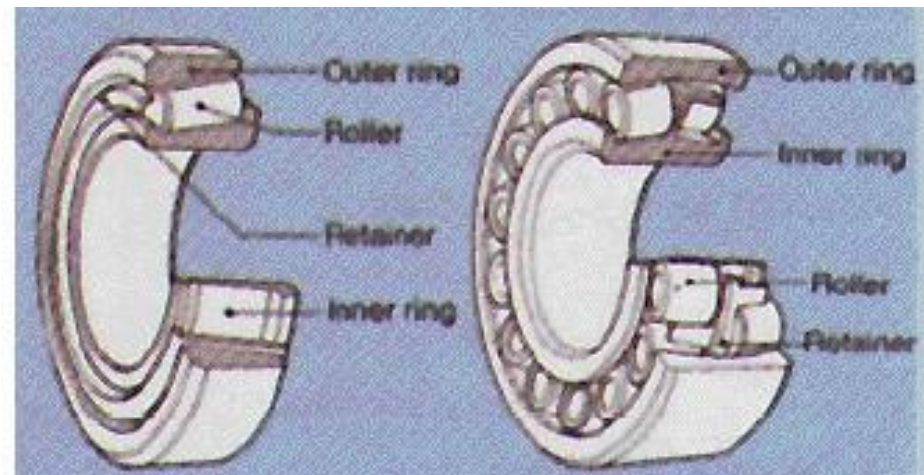


Thrust ball bearing

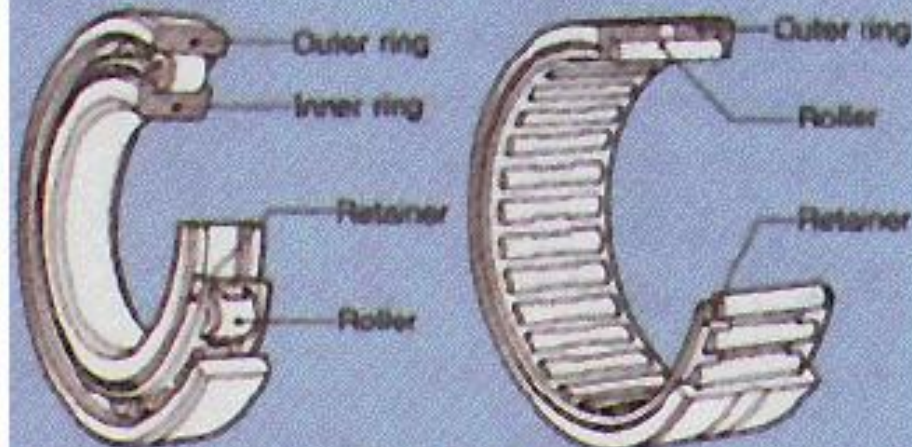
Ball and Roller Bearings



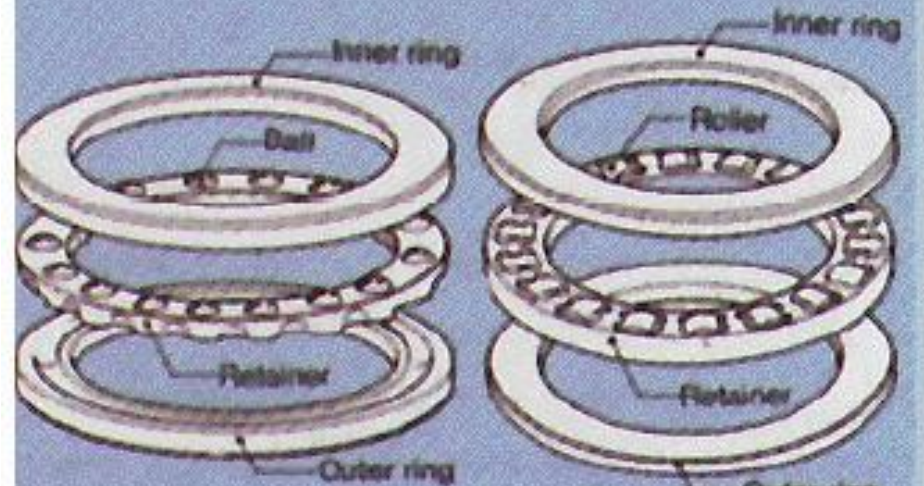
Deep groove ball bearing Angular contact ball bearing



Tapered roller bearing Spherical roller bearing

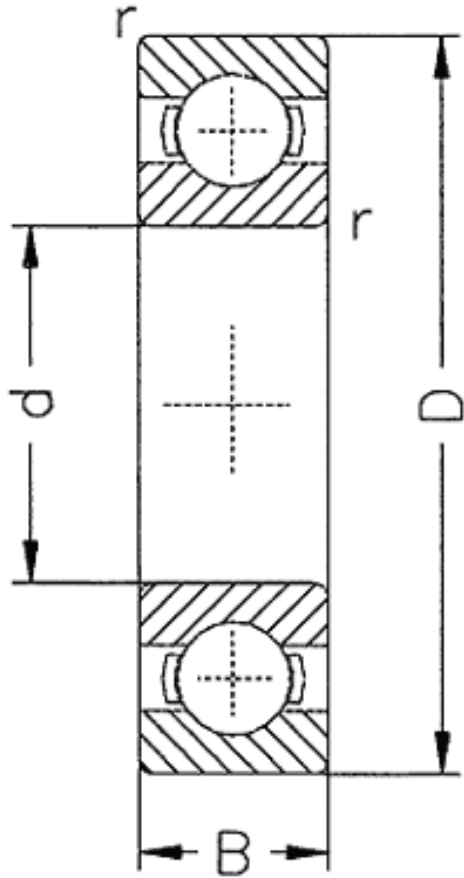


Cylindrical roller bearing Needle roller bearing

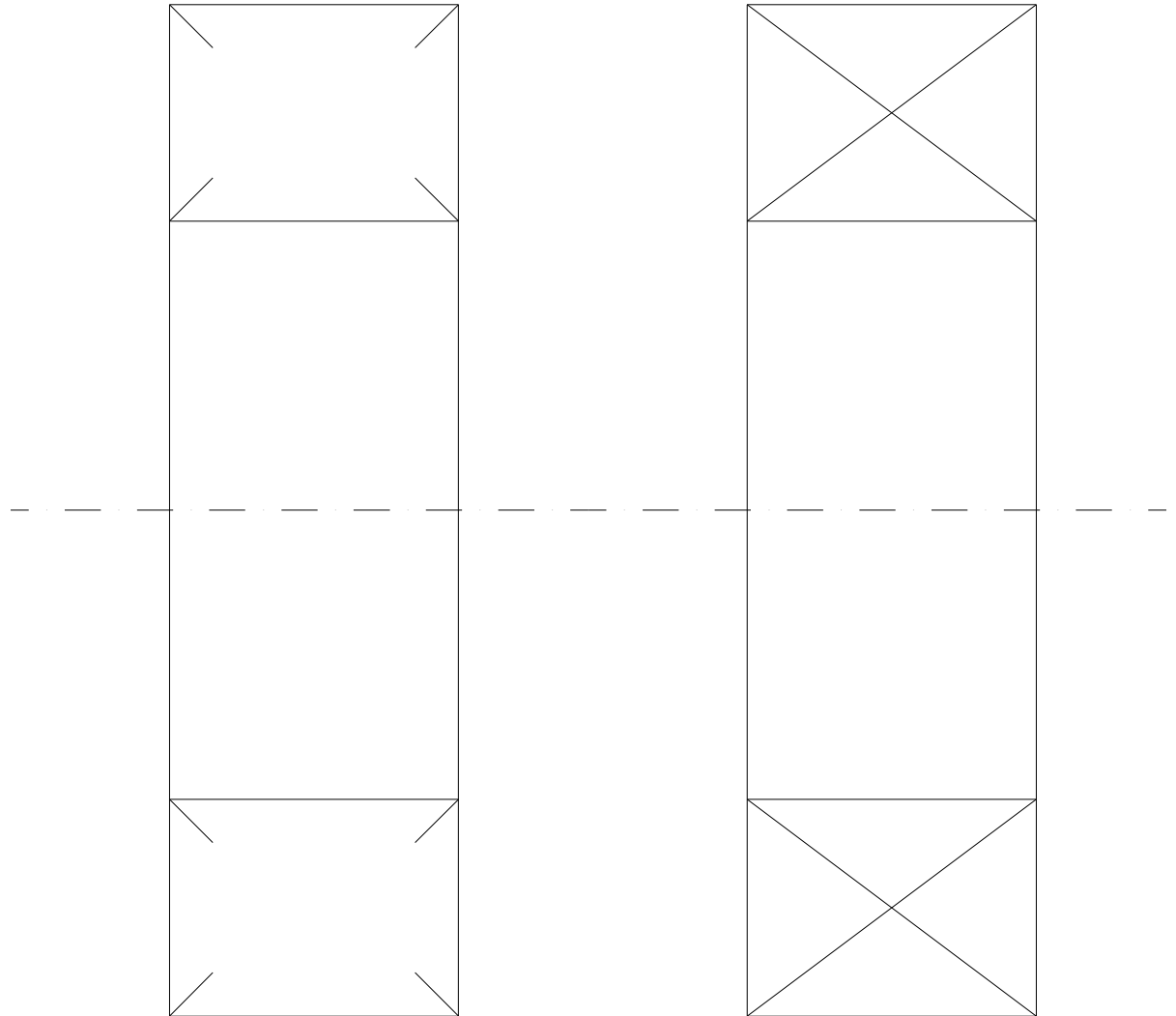


Thrust ball bearing Thrust roller bearing


Ball and Roller Bearings



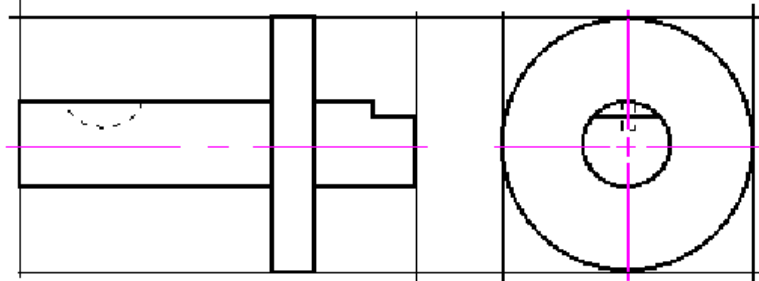
offen



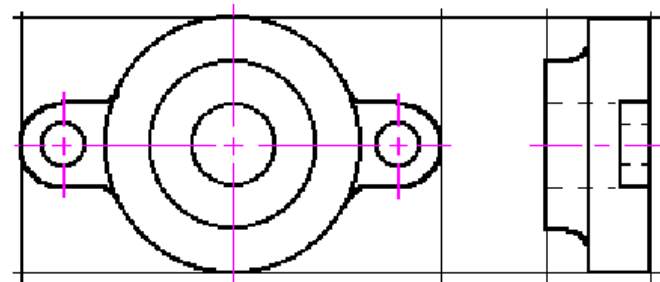
Working Drawings

- One working drawing is made for each non-standard component.
 - All the necessary information to carry out manufacturing must be contained within the drawing.
 - Recommendation: use a reference (textbook) when drawing a working drawing.
 - Assembly working drawing contain the necessary information to perform the assembly of the system.
- 

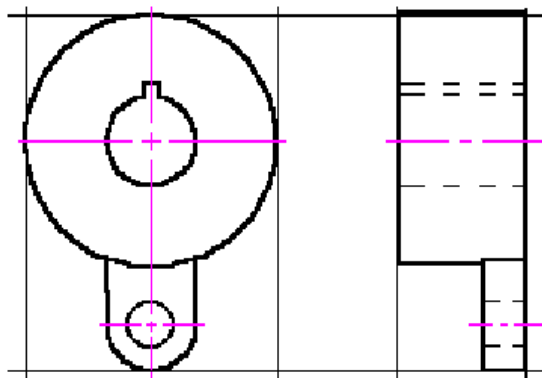
Working Drawings



1. PIN DOWEL



3. BRACKET



2. SLINGER

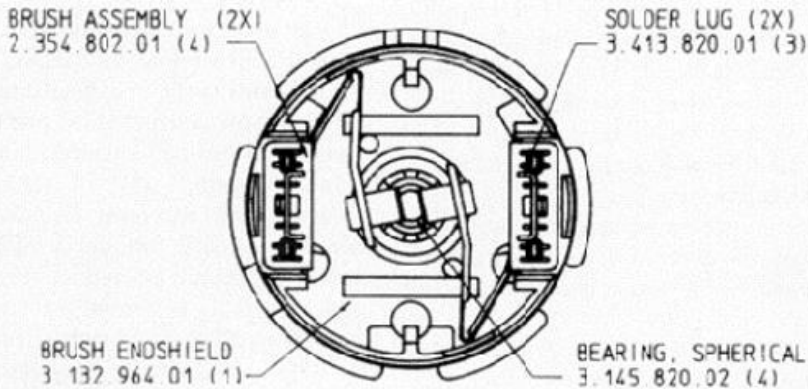
BILL OF MATERIALS

ITEM	QUAN.	DRAWING NO. OR PART NAME	DESCRIPTION
------	-------	--------------------------	-------------

NUMBER REQ:	MATERIAL:	FINISH:		RICHARD D. IRWIN
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS = ± .XX DECIMALS = ± .XXX DECIMALS = ± ANGLES: ± X.X METRIC = ± X.XX METRIC = ±	WEIGHT:	NAME	DATE	TITLE
	DRAWN BY:	Kevin		SLINGER ASSEMBLY
	CHECKED BY:	Bryan		
	APPROVED BY:	Carolyn		REFERENCE DRAWING
	SCALE:		C	DRAWING NUMBER

BE 11 65-90-10
 30mm
 Für diese Zeichnung beziehen sich uns alle Maße nach DIN 34 1er.
 DRAWING CREATED WITH ISO STANDARDS
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TOLERANCES UNLESS OTHERWISE SPECIFIED			TOLERANCES OF ANGLES (UNLESS OTHERWISE SPECIFIED)			Surface Finish	Dimension	Tolerance
mm TO 6	OVER 6 UP TO 30	OVER 30 UP TO 120	mm TO 15	OVER 15 UP TO 30	OVER 30 UP TO 150			
+0.1	+0.2	+0.3	M30	.10	.20			

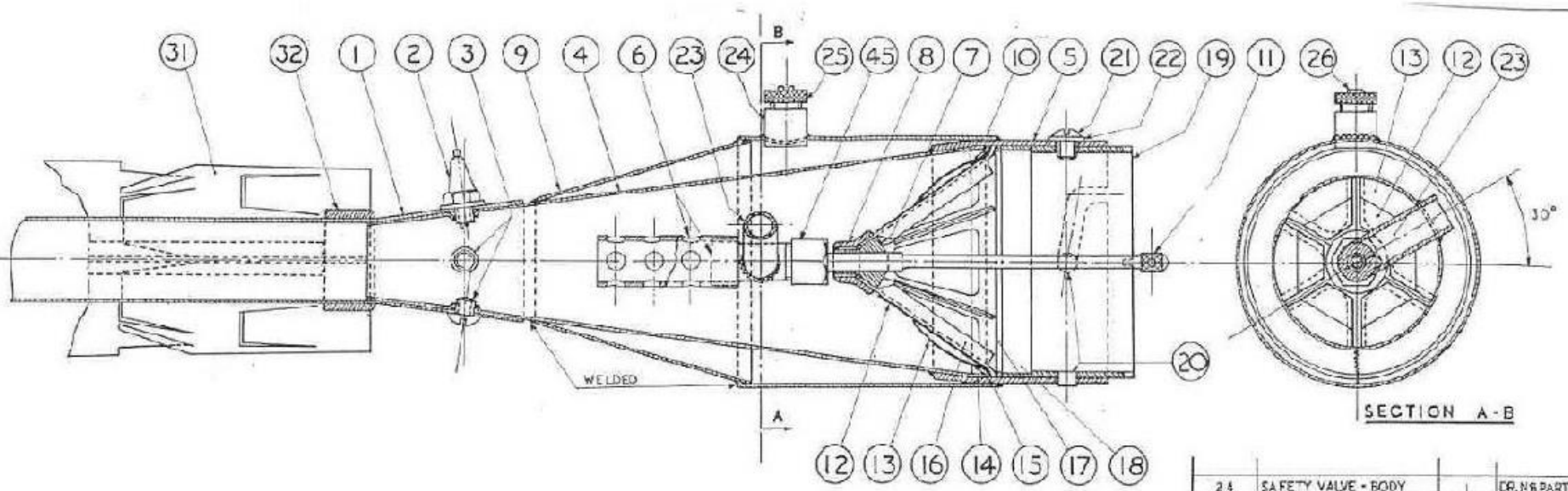


NOTES:

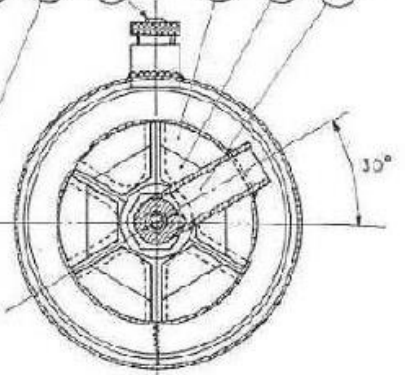
- BRUSH ASSEMBLIES (2.354) AND SOLDER LUGS (3.413) TO BE FULLY SEATED.
- SOLDER LUG (3.413) TO WITHSTAND 30N MINIMUM PUSH-OUT FORCE AFTER ASSEMBLY.

- 01
 PI KN

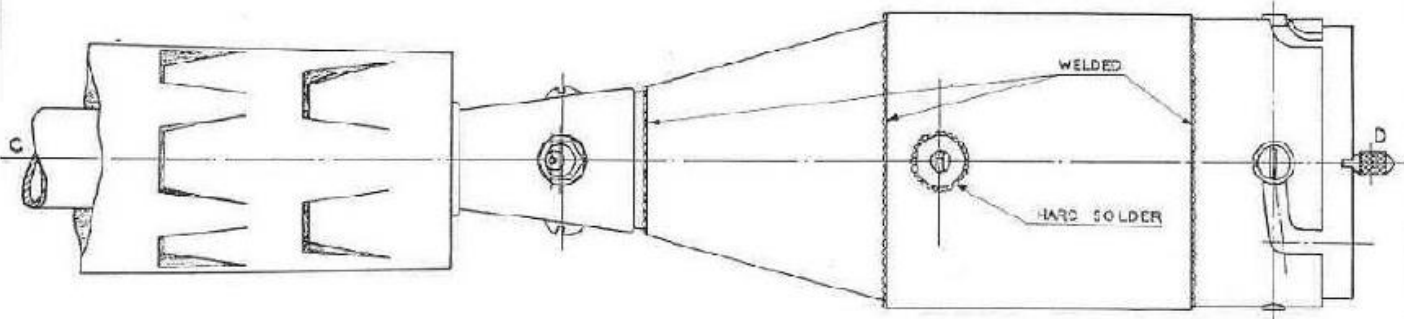
ISO		Material Number		Internal	
150				S	X
				K	X
MEHLER PRODUCTS INC. RALEIGH, NC 27636		Date	2/24/93	Substituted For	
		Drawn	MILLIAN		
		Check	MILLIAN	Replaced By	
		Appr	SR		
Title					Scale
ENDSHIELD ASSEMBLY					2:1
Esper No					
E2.132.01586					
Drawing Number					Sheet
2.132.937.KN (4)					1
					of
					1
1	RELEASED PER ECO 3271-140	2/24/93	JEM	13 56	
01	Change Only With CAD	Date	Name	Use	



LONGITUDINAL SECTION C-D



SECTION A-B

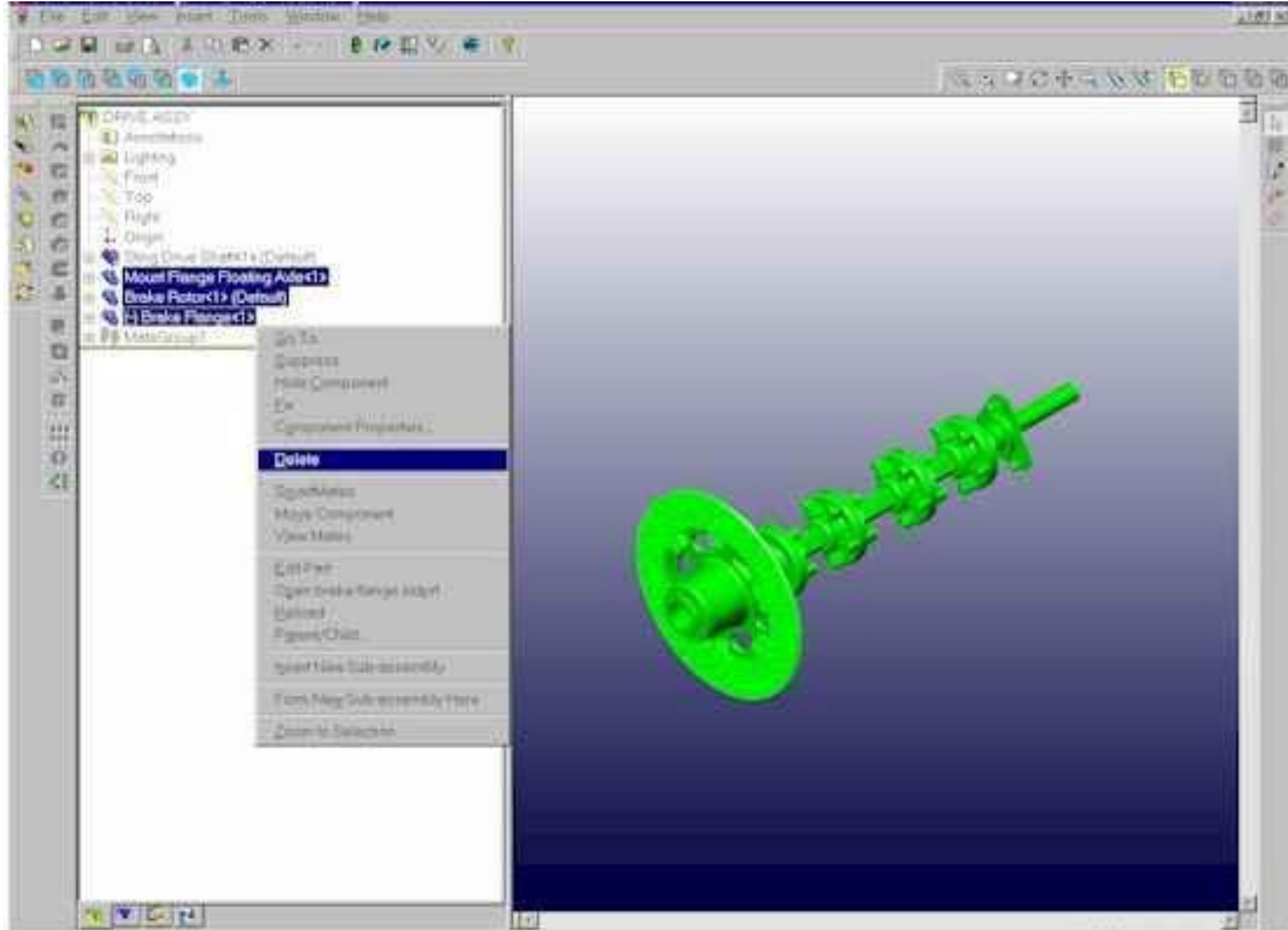


GENERAL ASSEMBLY

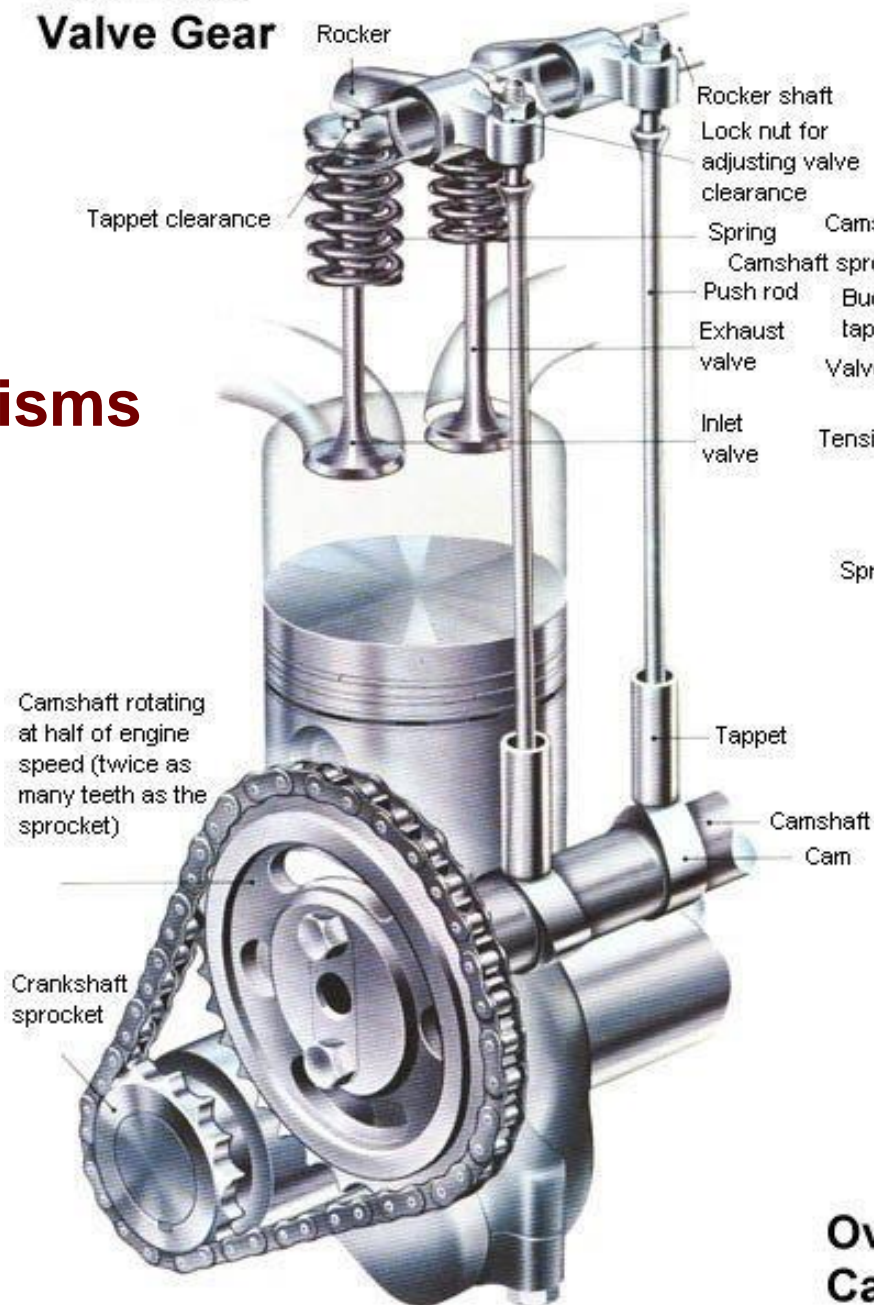
24	SAFETY VALVE - BODY	1	DR. NO. PART 14
23	INLET TUBE	1	
22	SPRING WASHER	1	STAND.
21	BAYONET LUG LOCK SCR.	1	B. A. N°2
20	BAYONET LUGS	3	
19	LOCKING RETAINER	1	
18	FRONT SPACER RING	1	
17	INTAKE VALVE FRAME RING	1	
16	INTAKE VALVE FRAME ELEM.	6	
15	VALVE LEAF RETAINER	1	
14	BEAR SPACER RING	1	
13	INTAKE VALVE LEAF STIFFEN.	6	
12	INTAKE VALVE LEAF	6	
11	NEEDLE	1	
10	FUEL JACKET-CYLINDER	1	
9	FUEL JACKET-CONE	1	
8	VALVE LOCK NUT	1	
7	VALVE BODY	1	
5	INJECTOR	1	DR. N°5 PART 6
5	FRONT RING	1	
4	MOTOR BODY	1	
3	SCREW-ROUND HEAD	3	3/16" DIA.
2	SPARK PLUG	1	STAND. MOD.
1	EXHAUST TUBE	1	

PART N°	NAME	Q	REMARKS
45	LOCK NUT	1	DR. N°5 - PART 6
32	RETAINING RING	2	
31	MELOT NOZZLE	2	
24	SAF. VALVE SPRING RETAIN.	1	
25	SAFETY VALVE PLUG	1	

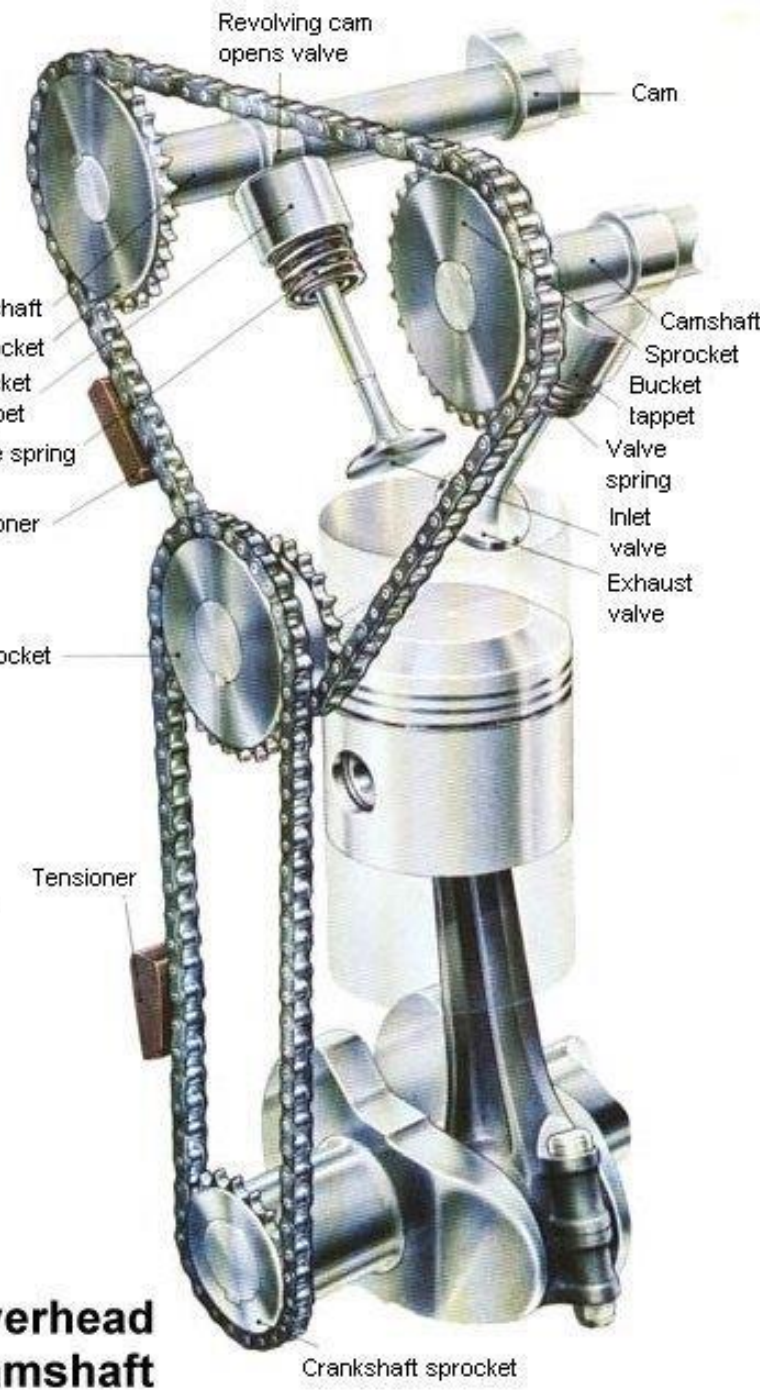
PART N°	NAME	Q	REMARKS
JET MOTOR MODEL Z.M.E.			
DR. BY	CHKD BY	SCALE: FULL	DATE 3/20/45
32	Z.F.		
AIRCRAFT-NET & ROCKET CORP.			DR. N° 1.



Push Rod Valve Gear



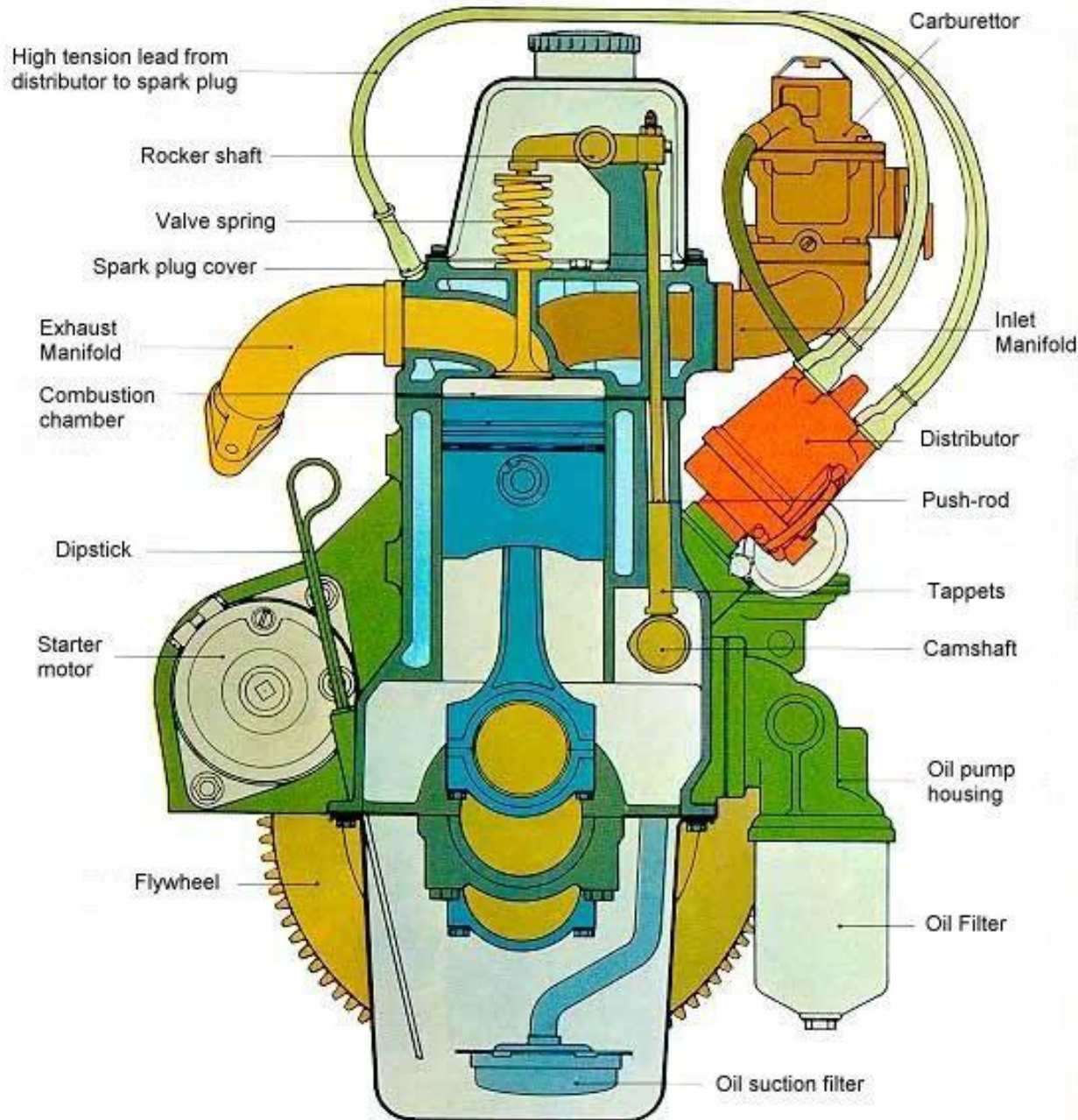
Mechanisms

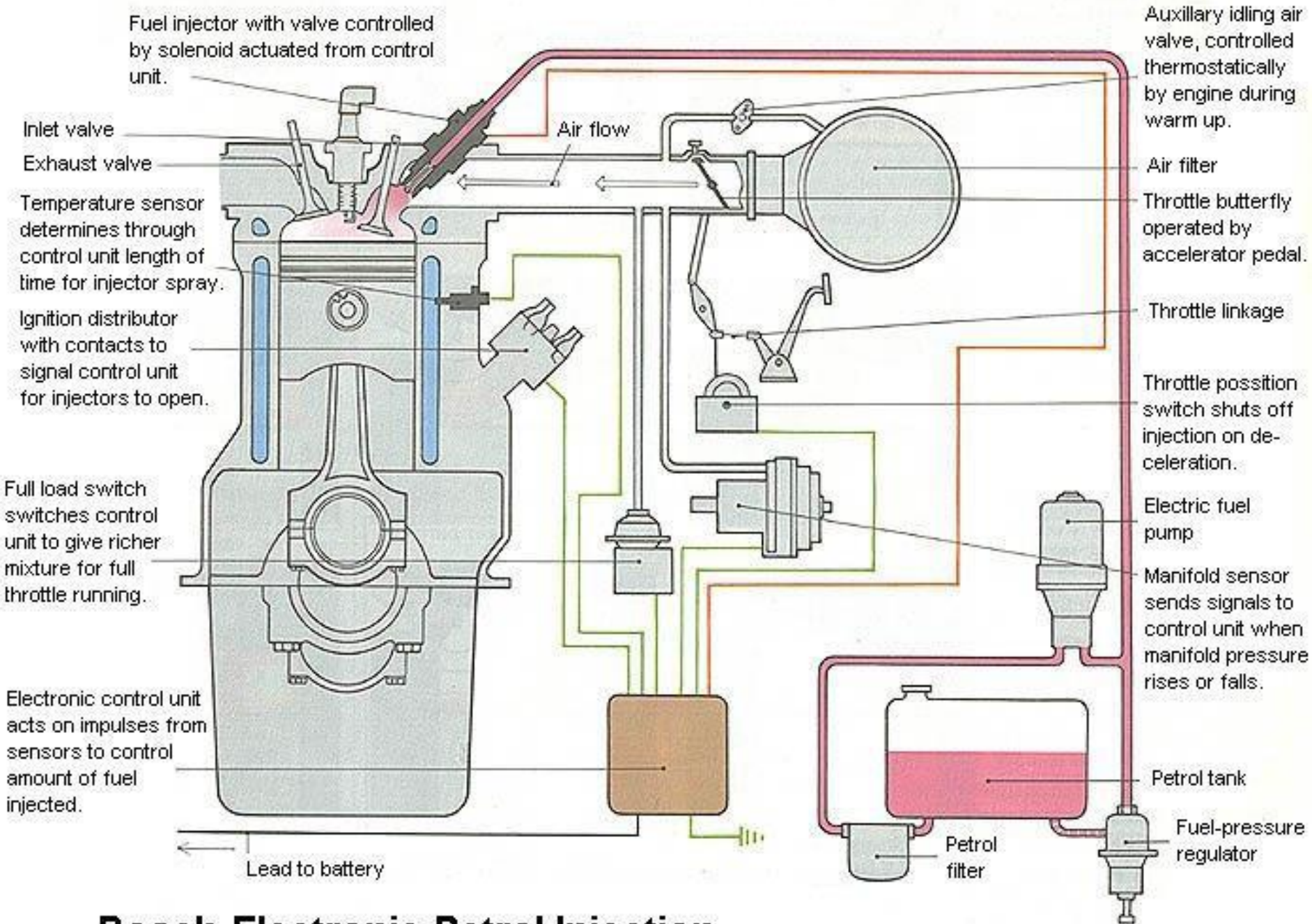


Overhead Camshaft

FRONT SECTION OF A 4-CYLINDER INTERNAL COMBUSTION ENGINE

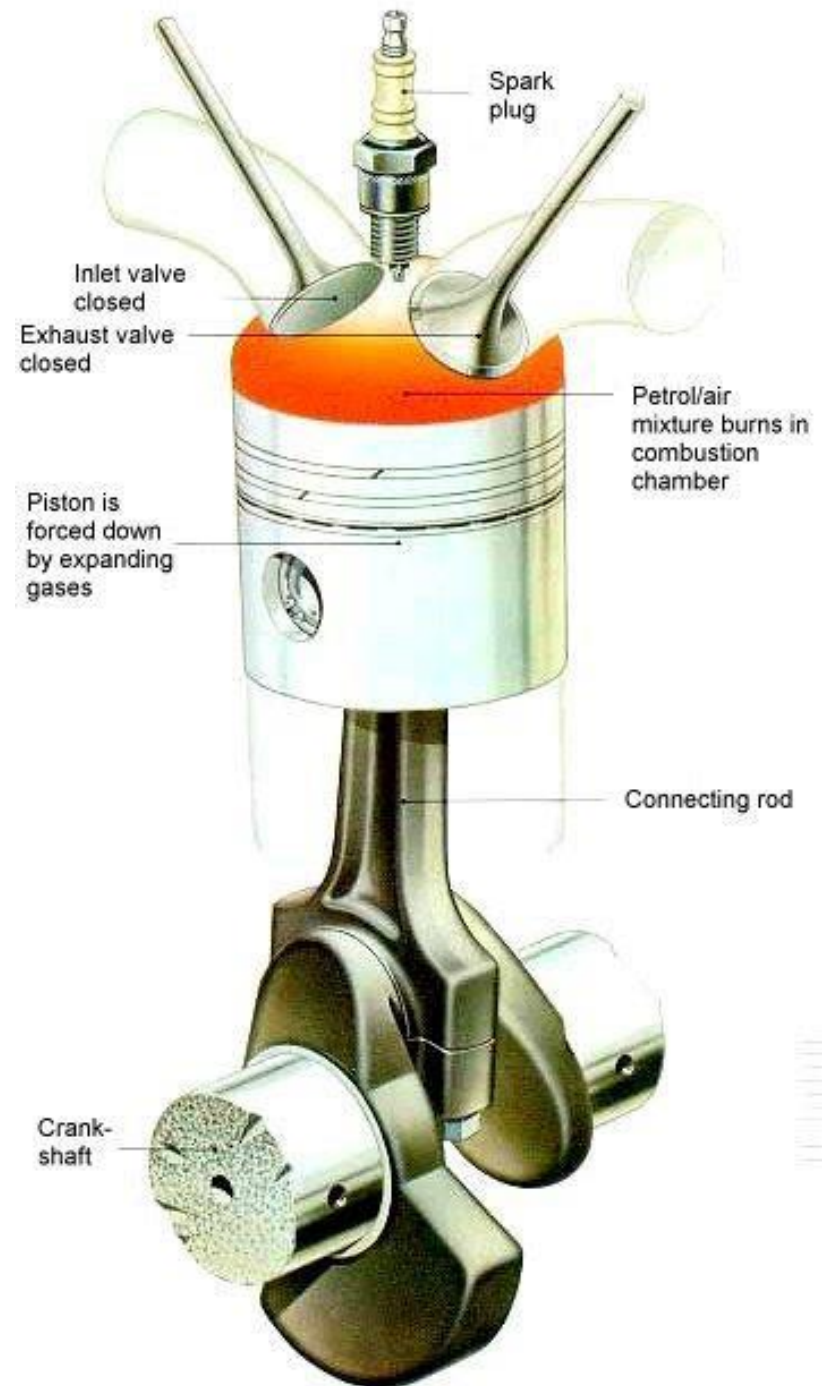
Mechanisms



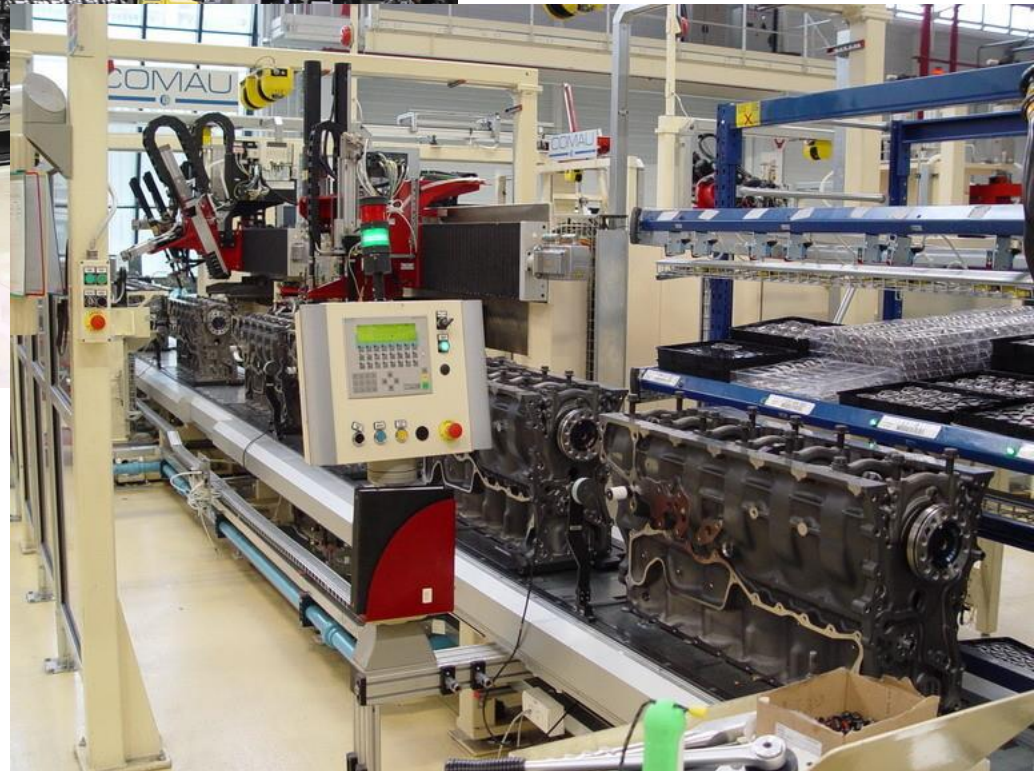
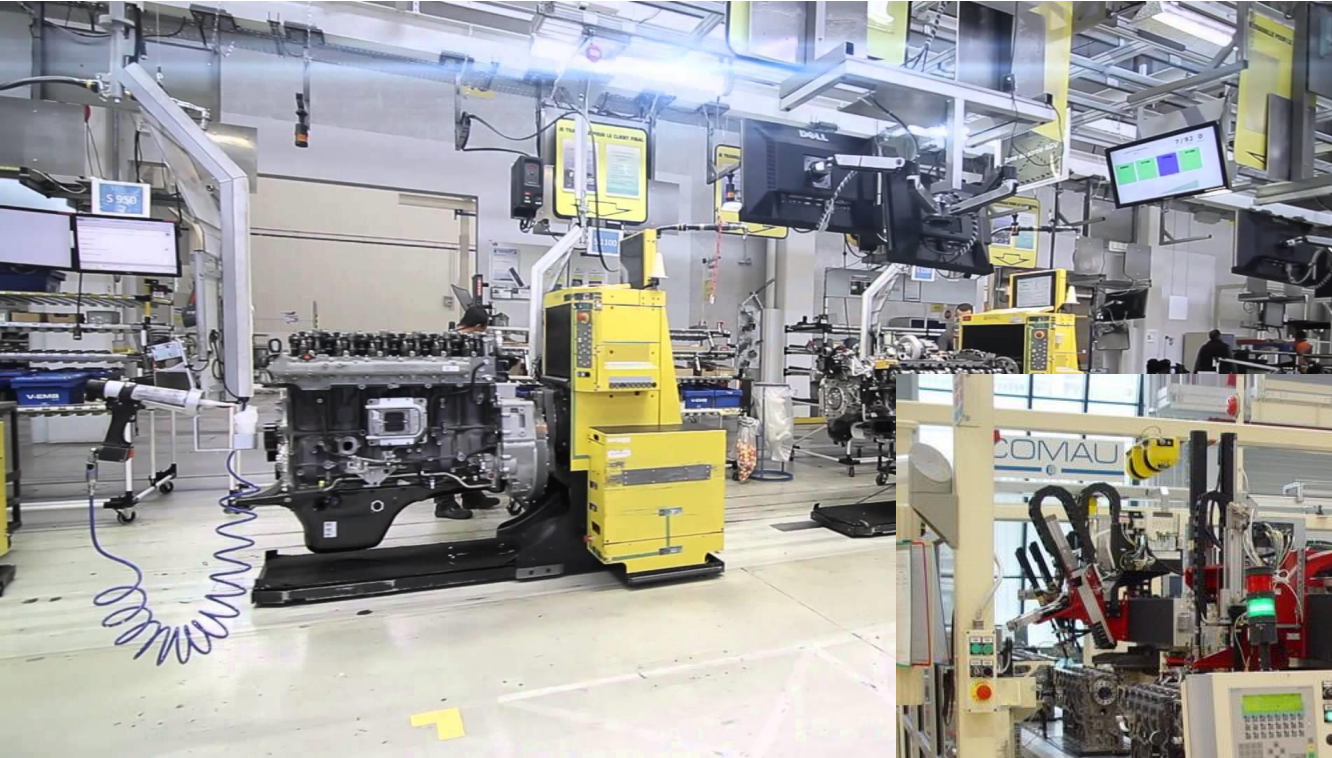


Bosch Electronic Petrol Injection

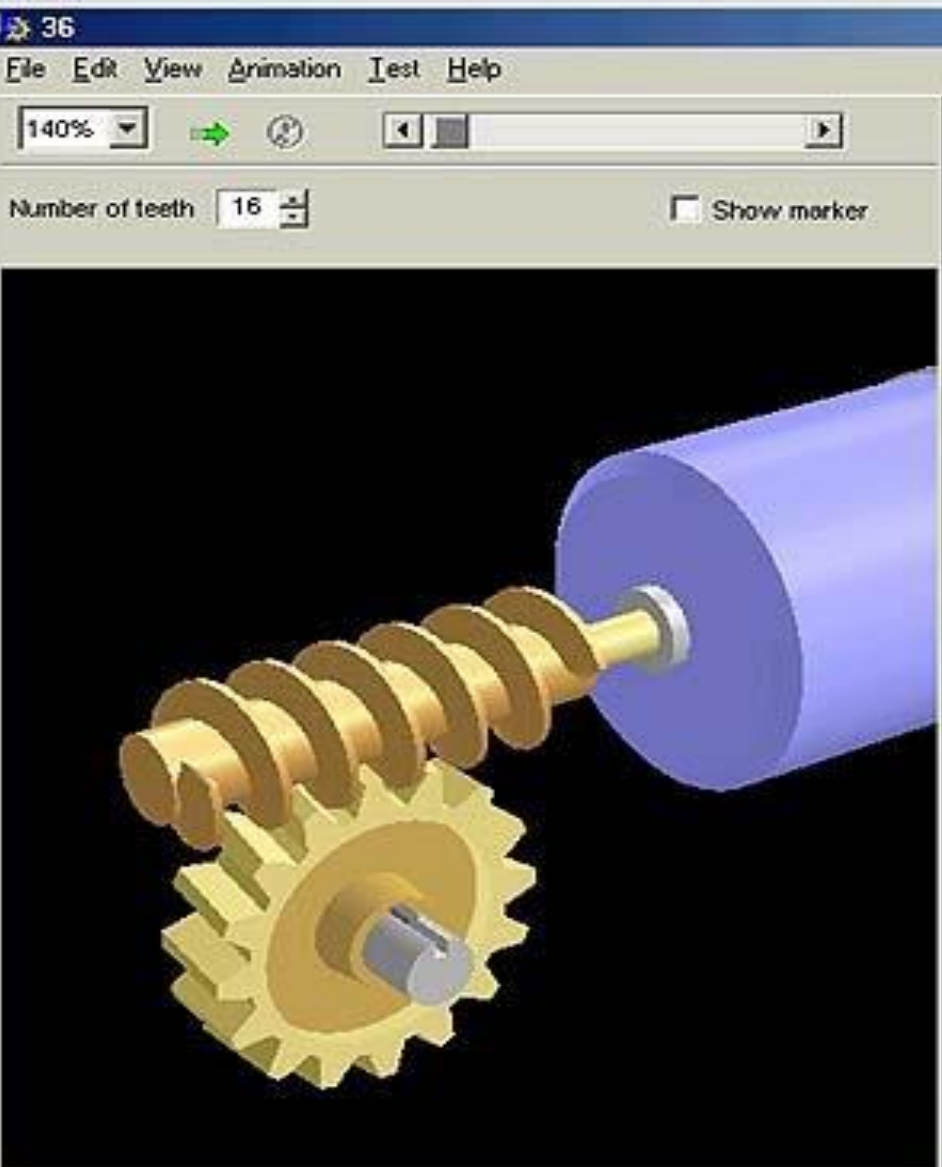
Mechanisms



Renault Trucks (Volvo) Powertrain Factory, Vénissieux France.



Gear – Work Gear



36

File Edit View Animation Test Help


140% [Navigation icons]


Number of teeth 16 [Show marker]

WORM AND WORM WHEEL

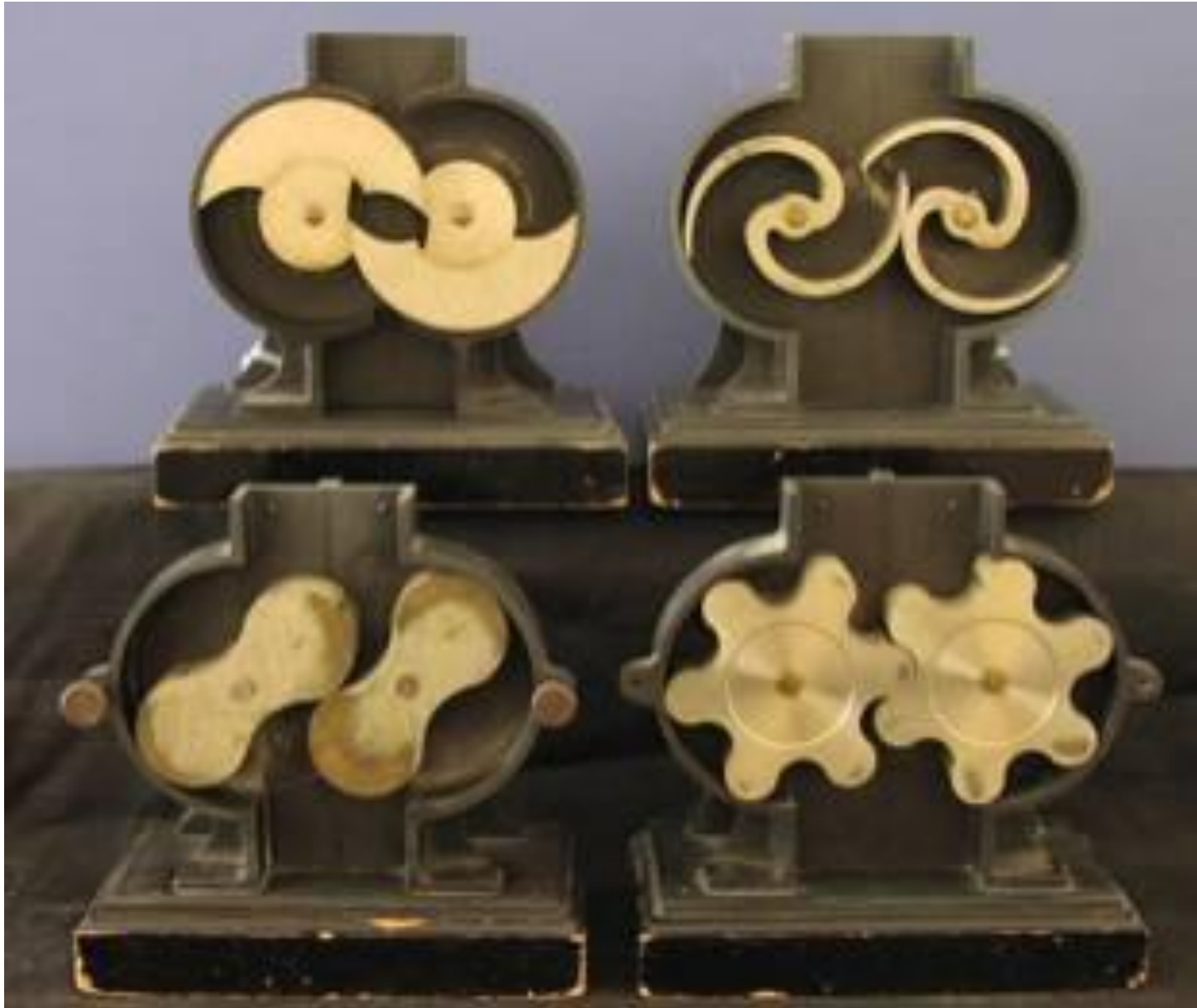
Worm gears are used **when large speed reductions** are required. The worm, which is attached to the driver shaft, has one tooth and takes the form of a screw thread.

Like **bevel gears** a worm and wormwheel transmits torque and rotary motion through 90° .



 [Click here to see a car steering system video](#)

Pressure Pumps



Lifting Equipment



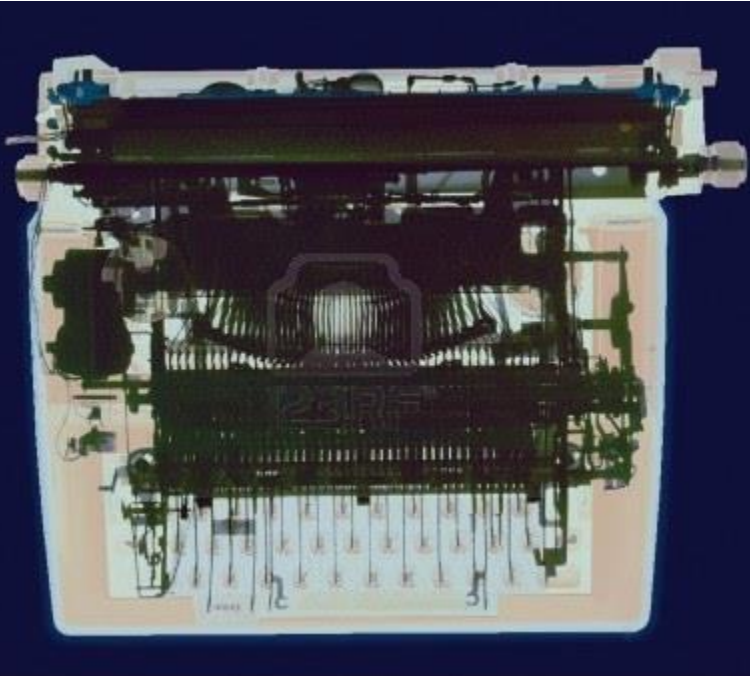
Timekeeping Machines

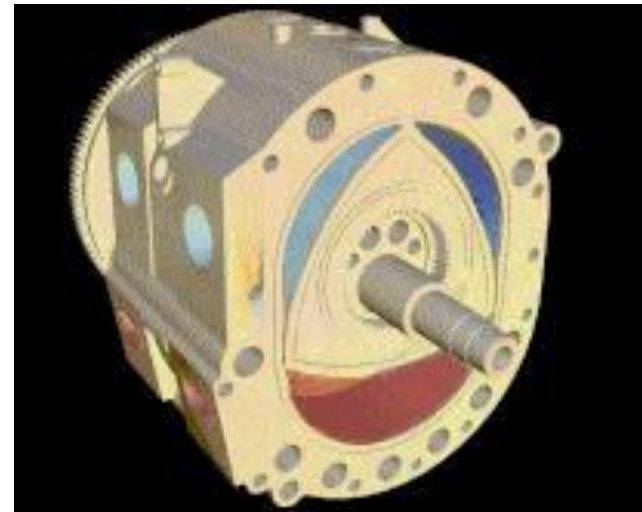
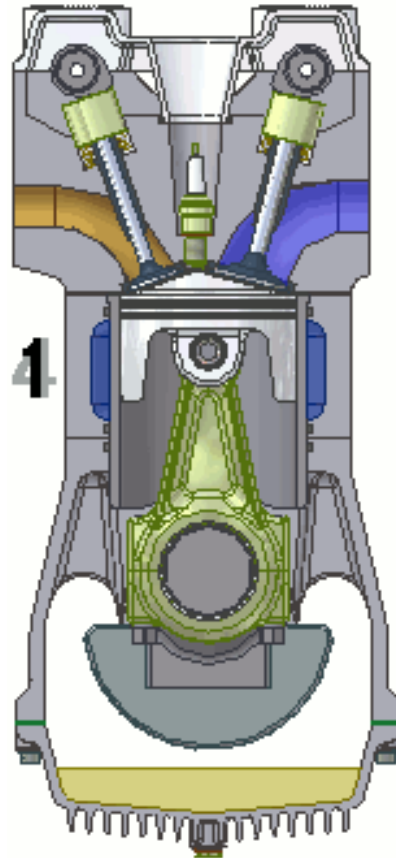
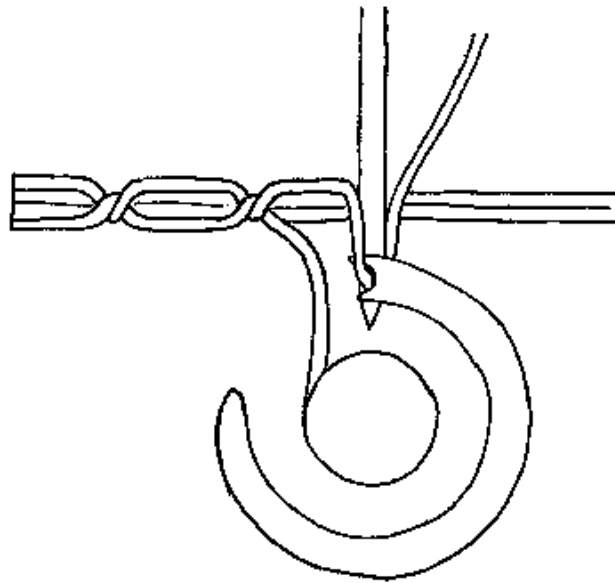
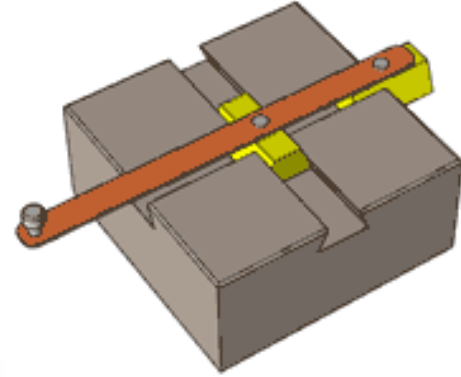
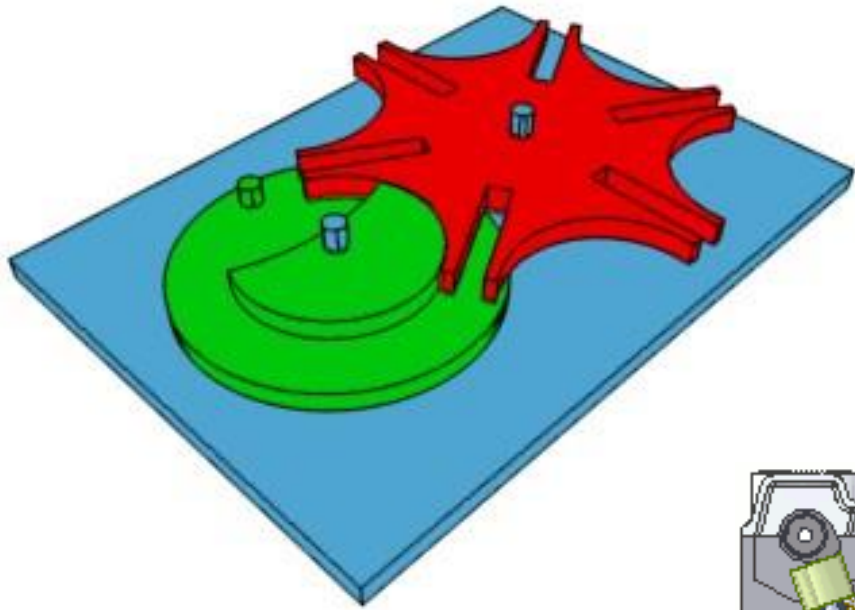


Hard Drive Mechanism



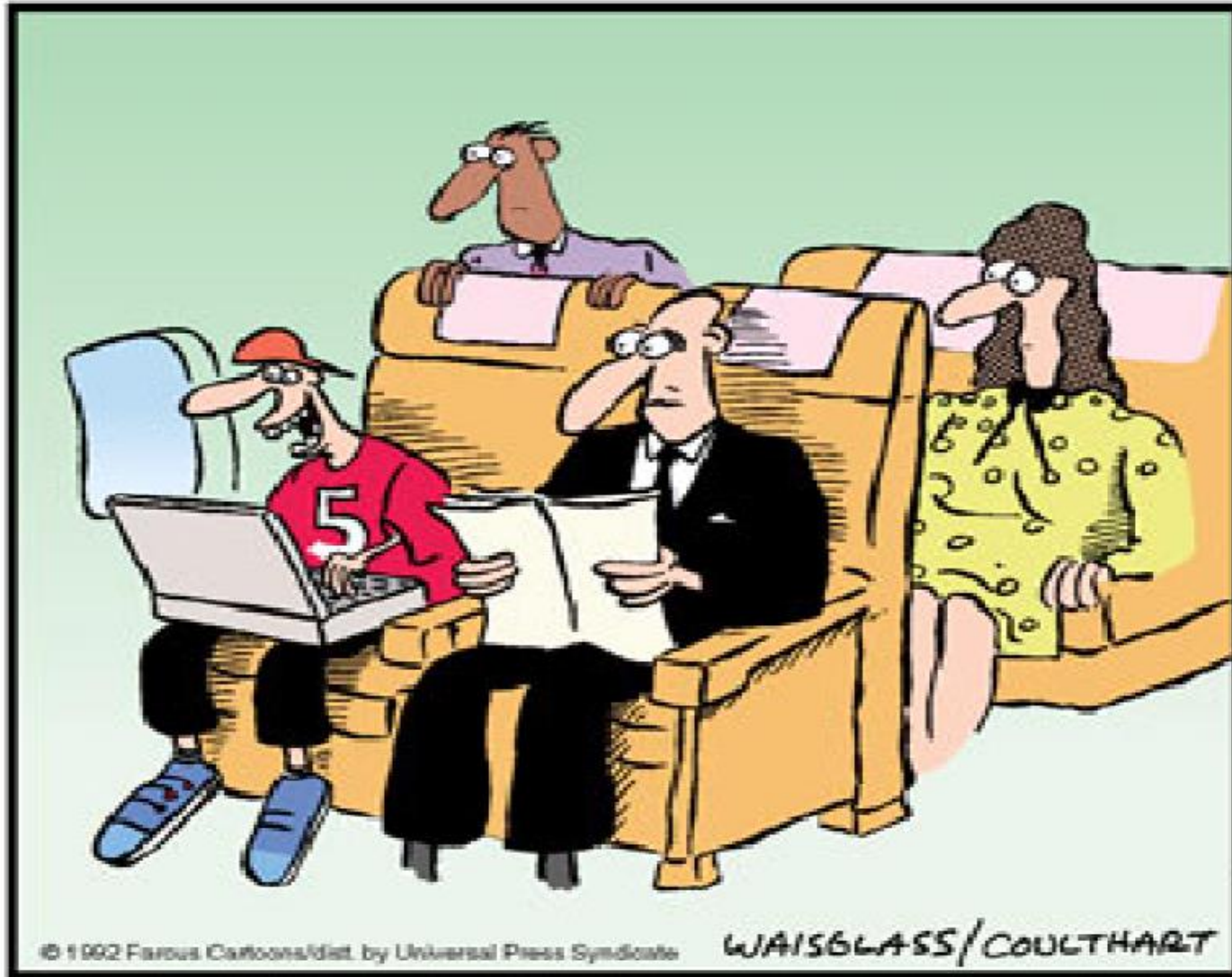
Typewriter Machine





Farcus

by David Waisglass
Gordon Coulthart



**“Cool! I just jammed the air traffic
control tower!”**

Example of Mechanisms

