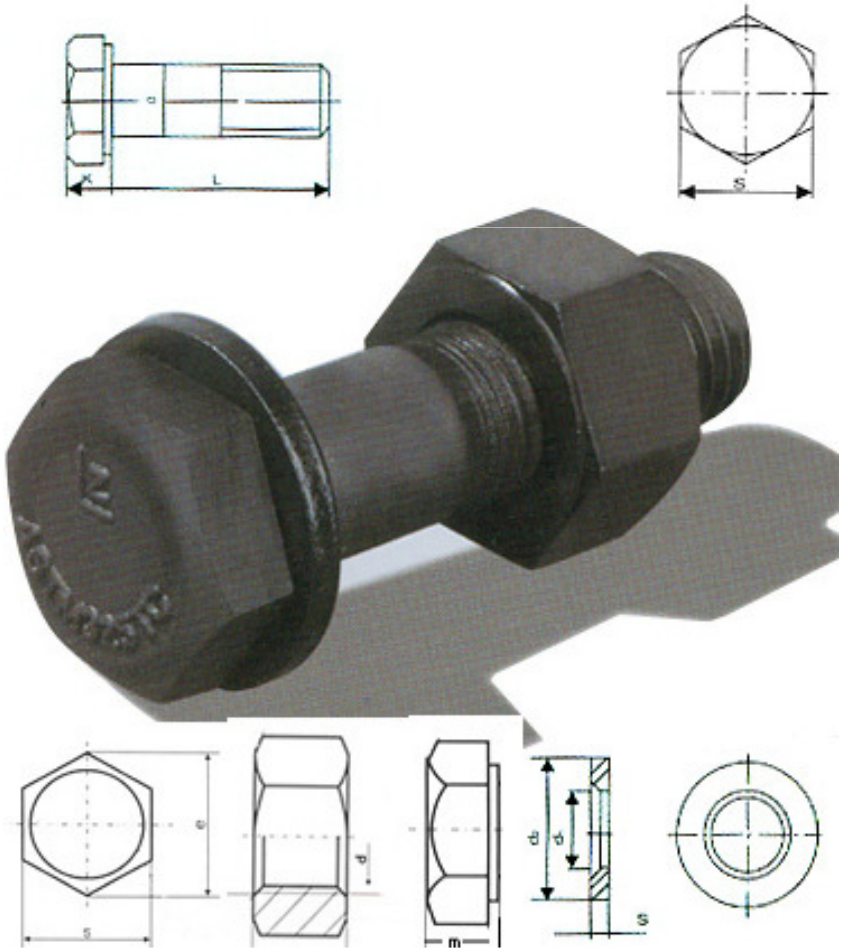
ASSEMBLY ELEMENTS

Screw Threads, Threaded Parts

Fasteners



A thread is a helical ridge of uniform section formed on the inside or outside of a cylinder or a cone. Threads are used for several purposes.

1. For fastening devices such as screws, bolts, studs, and nuts.

2. To provide accurate measurement as in a micrometer.

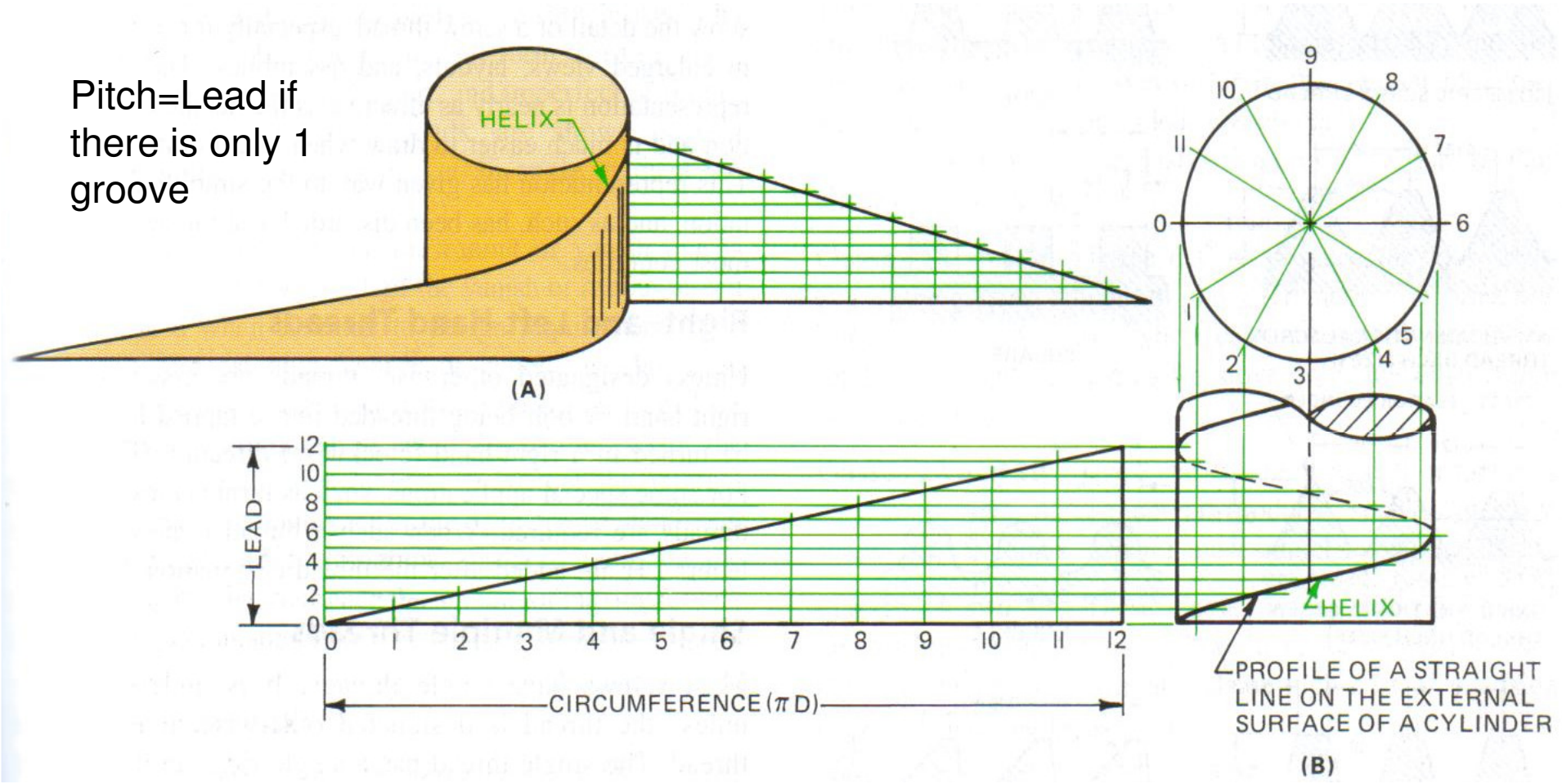
3. To transmit motion. eg. The threaded lead screw on the lathe causes the carriage to move along when threading.

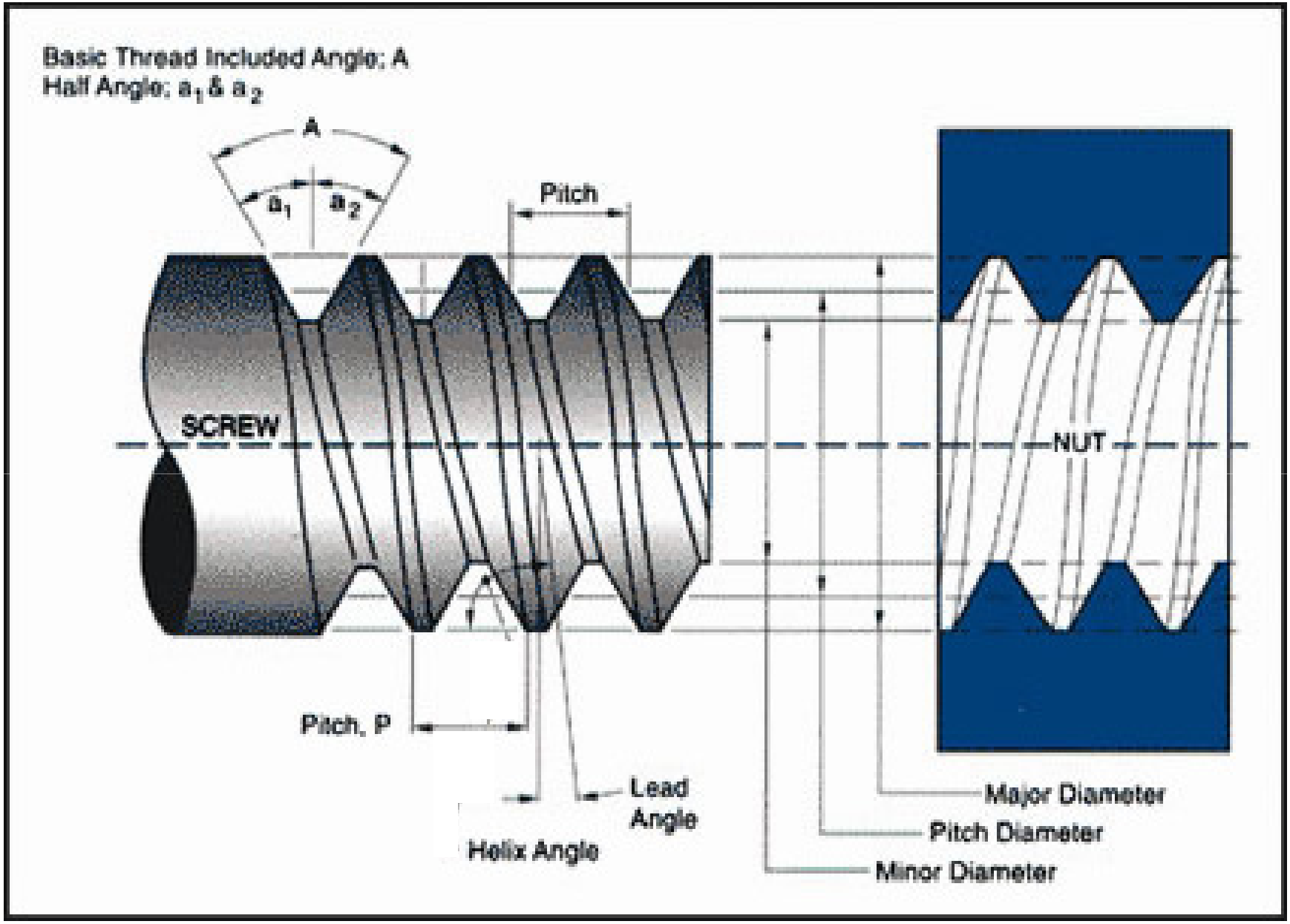
4. To increase force. Heavy work can be raised with a screw jack.

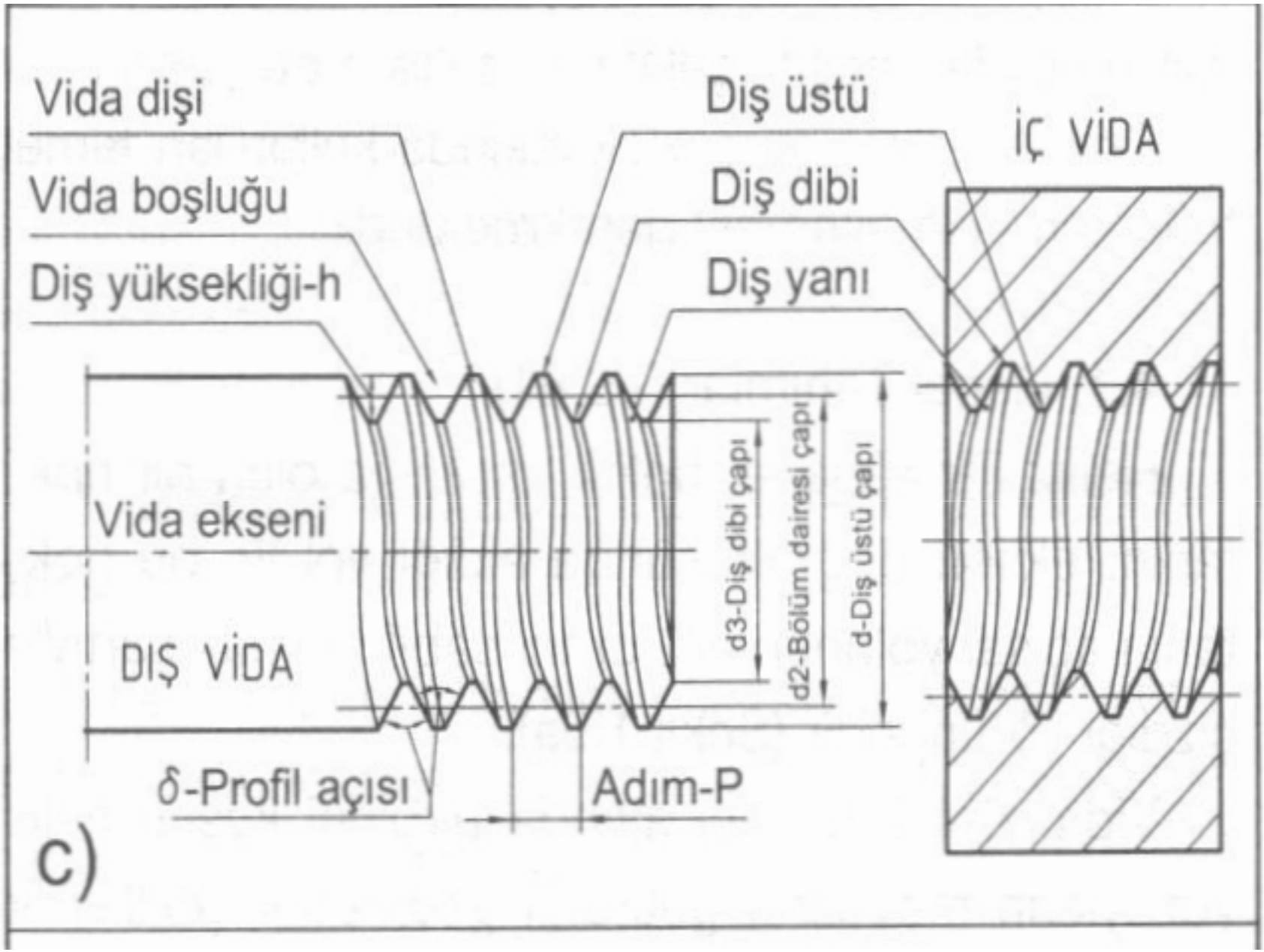
Fasteners

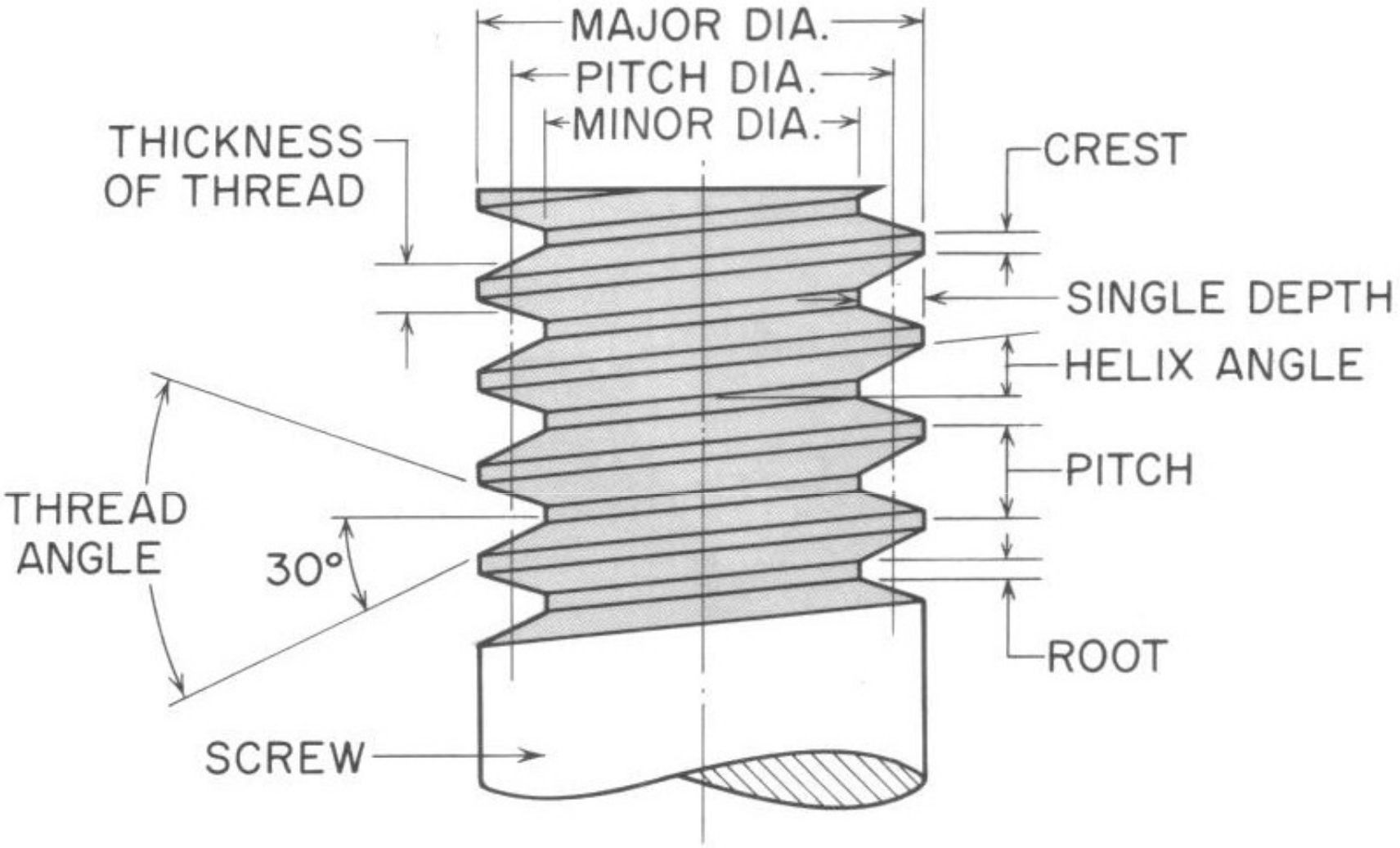
- Permanent
  - Rivets
  - Welds
- Removable
  - Screws
  - Bolts
  - Studs
  - Nuts
  - Pins
  - Keys

Pitch=Lead if there is only 1 groove




Basic Thread Included Angle: A
Half Angle: a_1 & a_2
A
a_1
a_2
Pitch
SCREW
NUT
Pitch, P
Lead Angle
Helix Angle
Major Diameter
Pitch Diameter
Minor Diameter


Vida dişi
Vida boşluğu
Diş yüksekliği-h
Diş üstü
Diş dibi
Diş yanı
İÇ VİDA
Vida ekseni
DIŞ VİDA
d3-Diş dibi çapı
d2-Bölüm dairesi çapı
d-Diş üstü çapı
δ-Profil açısı
Adım-P
c)



The main parts of a screw thread.

Angle of thread—The angle included between the sides of the thread, e.g., the thread angle of the new ISO Metric Thread and that of the American National Form is 60°.

Major diameter—The largest diameter of the thread on the screw or nut.

Minor diameter—The smallest diameter of an external or internal screw thread.

Number of threads—The number of roots or crests per inch of the threaded length. This term does not apply to metric threads.

Pitch—The distance from a point on one thread to the corresponding point on the next thread measured parallel to the axis.

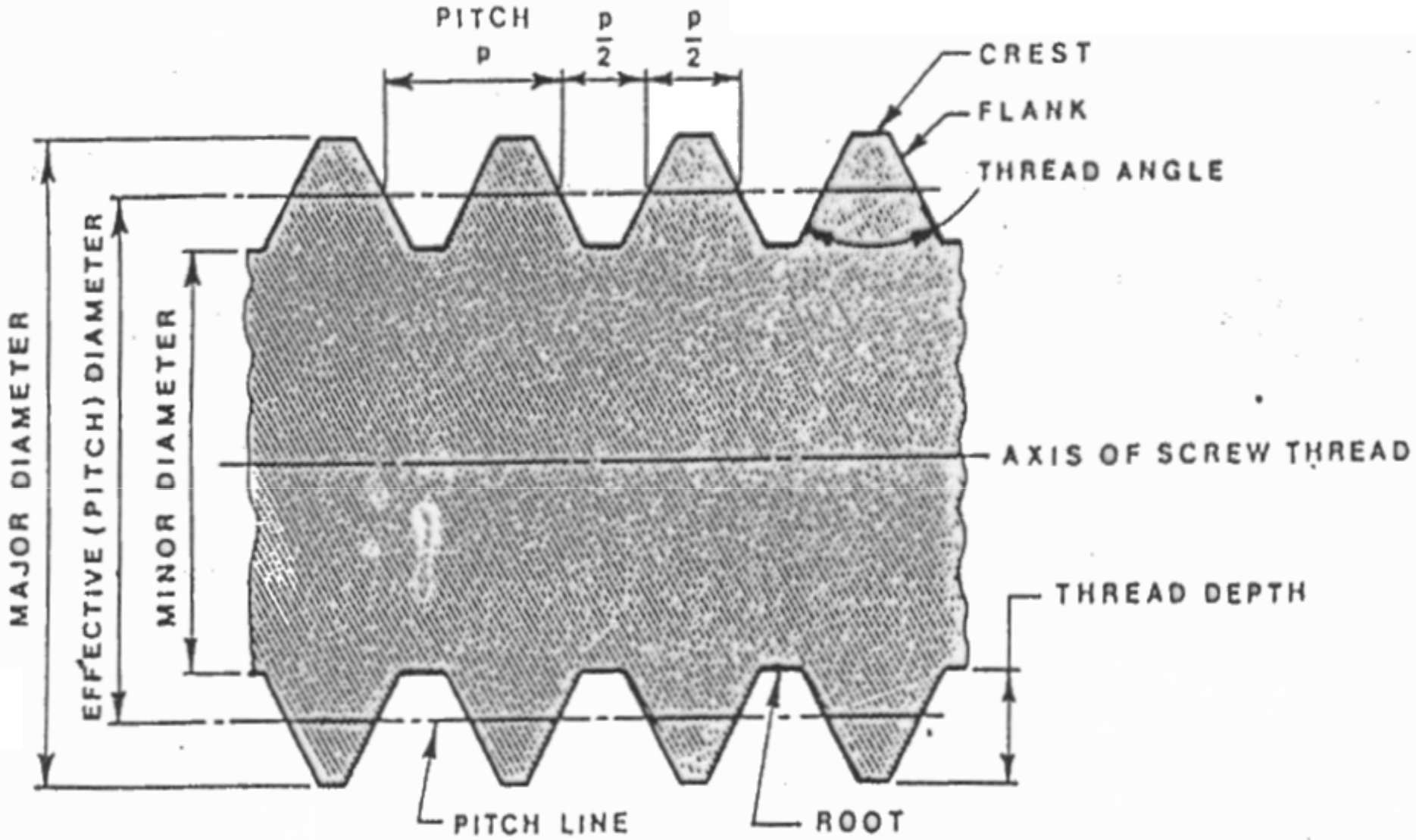
Lead—The distance a screw thread advances axially for one complete revolution.

Crest—The top surface joining the two sides of a thread.

Root—The bottom surface joining the sides of two adjacent threads.

Side—The surface of the thread which connects the crest with the root.

Depth of thread—The distance between the crest and the root of a thread measured perpendicular to the axis.

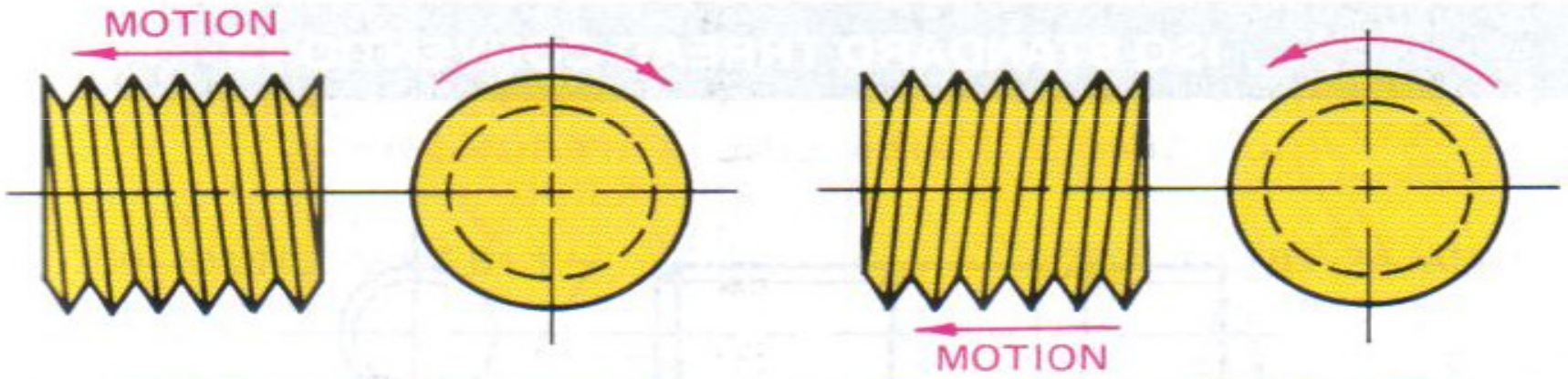


Thread terms

Right- and Left-Hand Threads

Unless designated otherwise, threads are assumed to be right-hand. A bolt being threaded into a tapped hole would be turned in a right-hand (clockwise) direction

For some special applications, such as turnbuckles, left-hand threads are required. When such a thread is necessary, the letters LH are added after the thread designation.

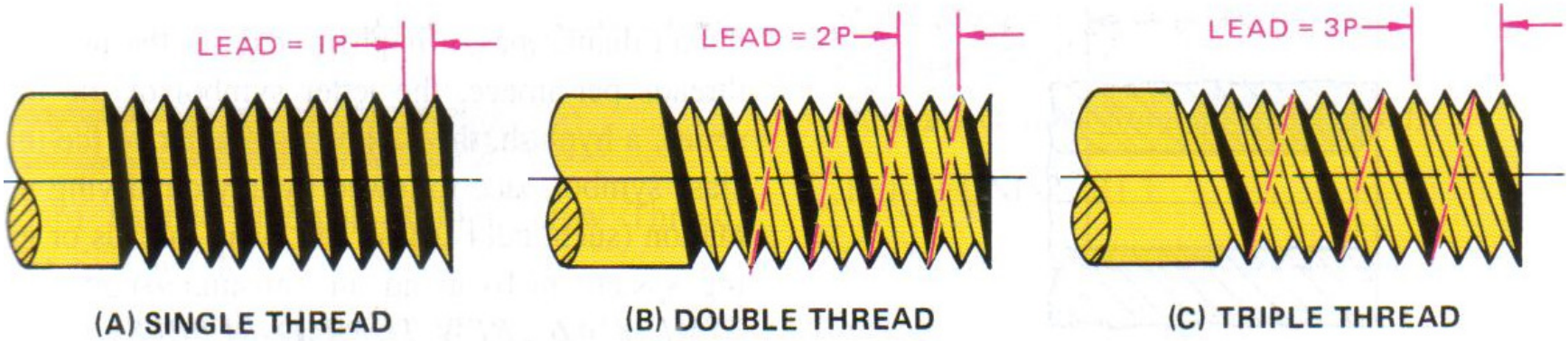


Right- and left-hand threads.

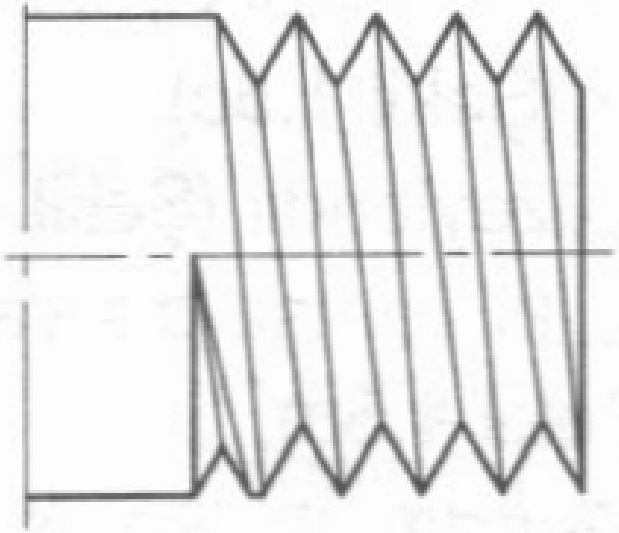
Single and Multiple Threads

Most screws have single threads. It is understood that unless the thread is designated otherwise, it is a single thread. The single thread has a single ridge in the form of a helix The lead of a thread is the distance traveled parallel to the axis in one rotation of a part in relation to a fixed mating part (the distance a nut would travel along the axis of a bolt with one rotation of the nut).

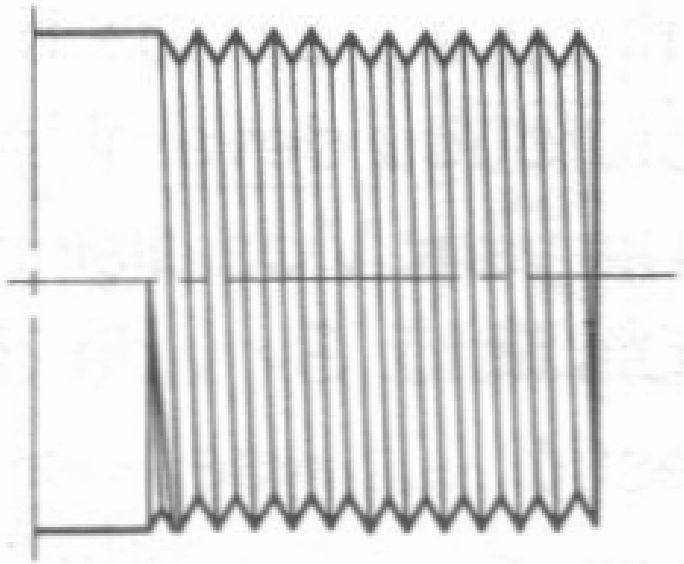
In single threads, the lead is equal to the pitch. A double thread has two ridges, started 180° apart, in the form of helices, and the lead is twice the pitch. A triple thread has three ridges, started 120° apart, in the form of helices, and the lead is three times the pitch. Multiple threads are used when fast movement is desired with a minimum number of rotations, such as on threaded mechanisms for opening and closing windows.



Single and multiple threads.



Normal (coarse) Thread

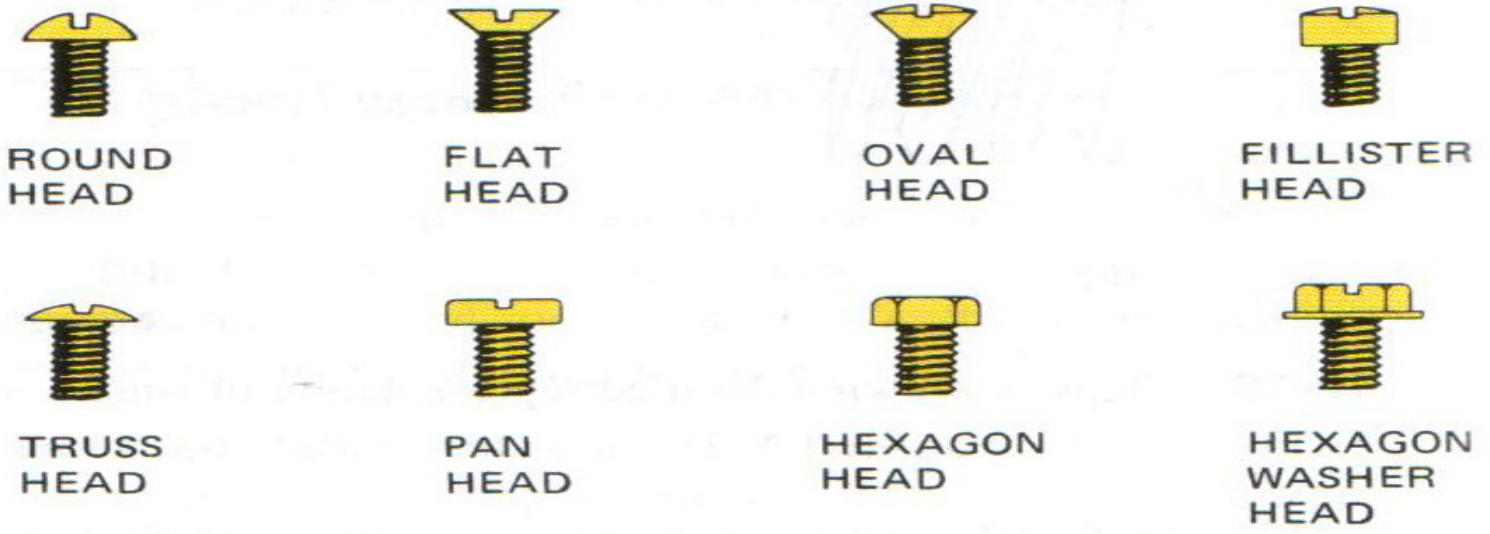


Fine Thread

Coarse-Thread Series This series is intended for use in general engineering work and commercial applications.

Fine-Thread Series The fine-thread series is for general use where a finer thread than the coarse-thread series is desirable. In comparison with a coarse-thread screw, the fine-thread screw is stronger in both tensile and torsional strength and is less likely to loosen under vibration.

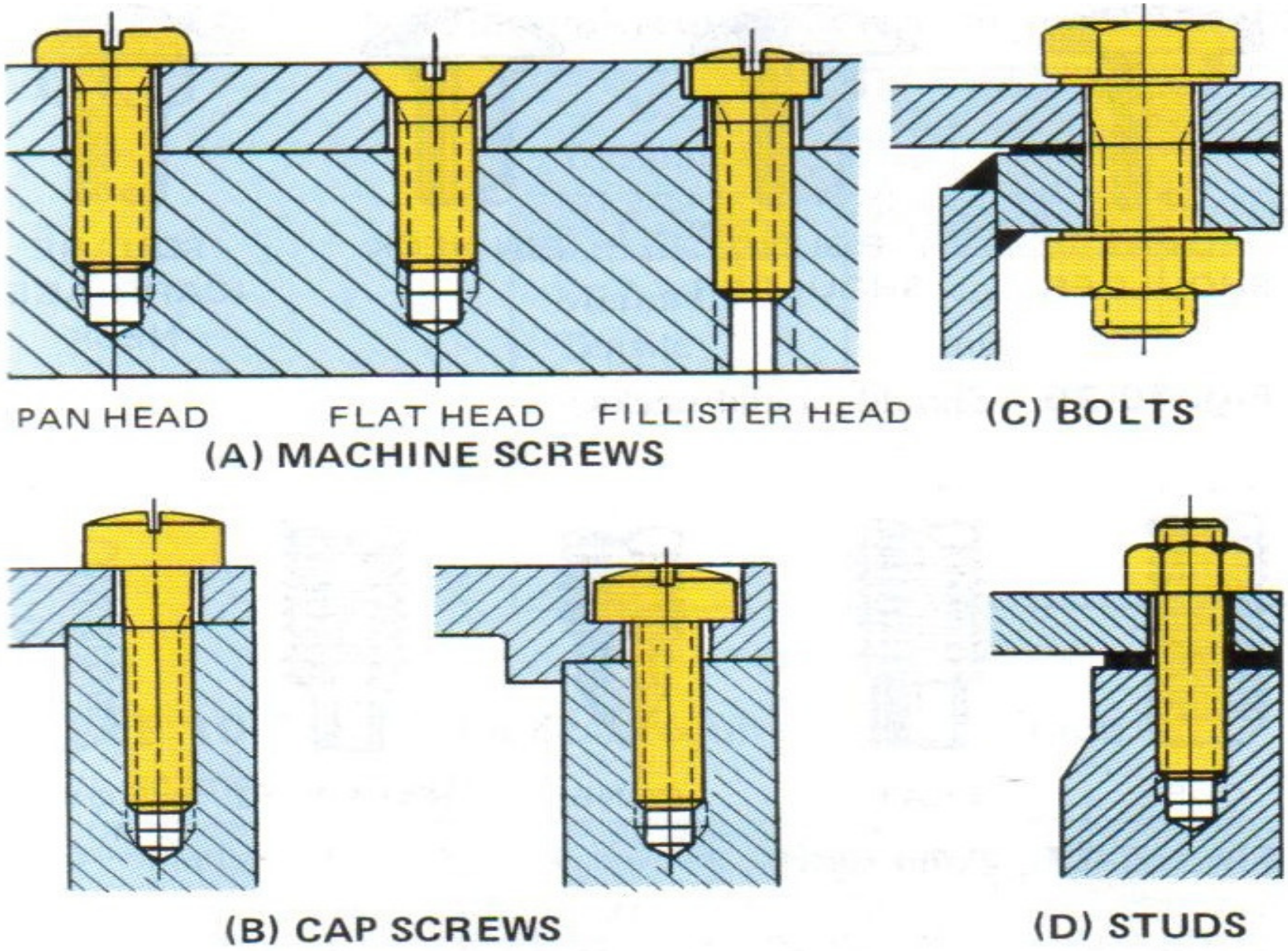
Common threaded fasteners.



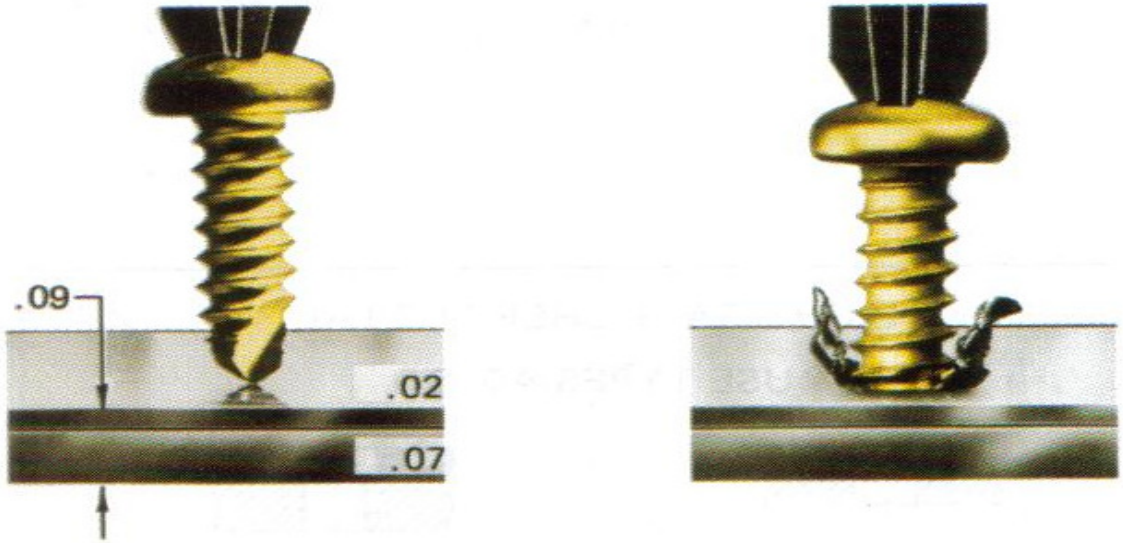
(A) SCREWS

(B) BOLTS

(C) STUDS



Fastener applications.



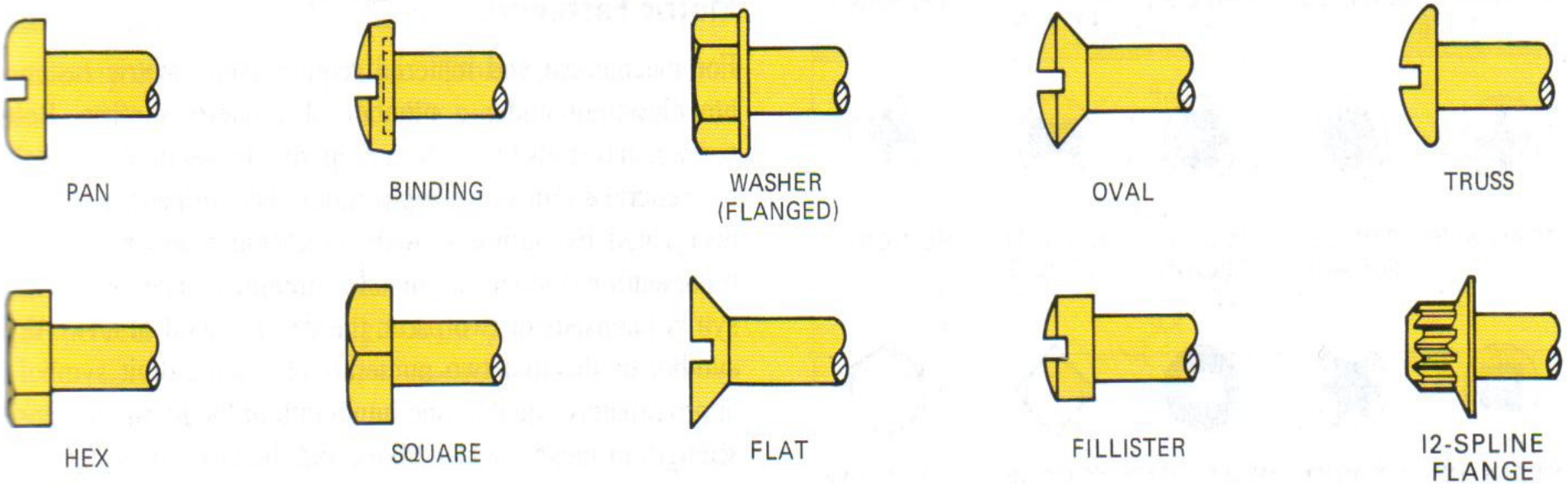
Self-drilling tapping screws.

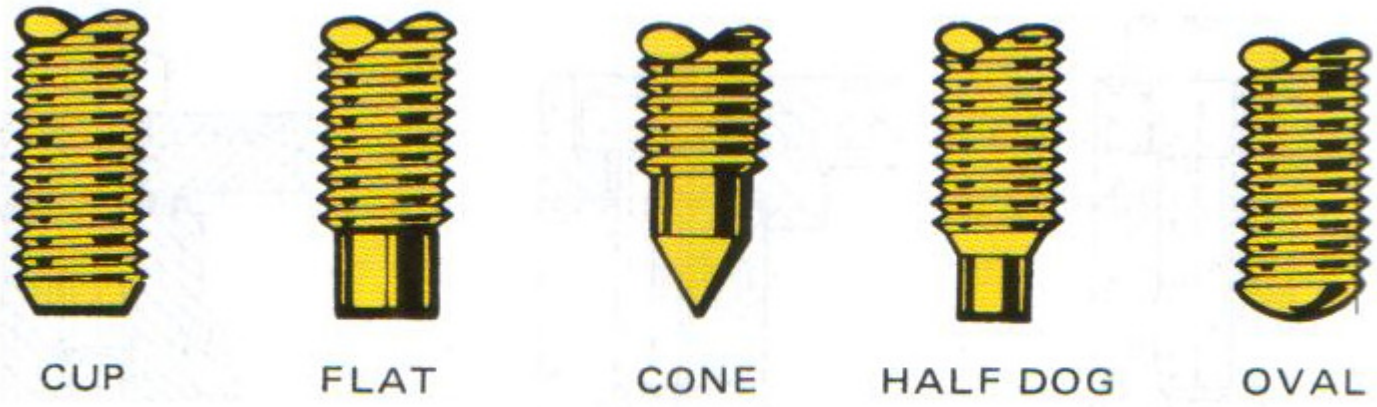
(A) TAPPING SCREWS WITH PREASSEMBLED WASHERS

(B) TAPPING SCREWS WITH PREASSEMBLED SEALING WASHERS OR COMPOUNDS

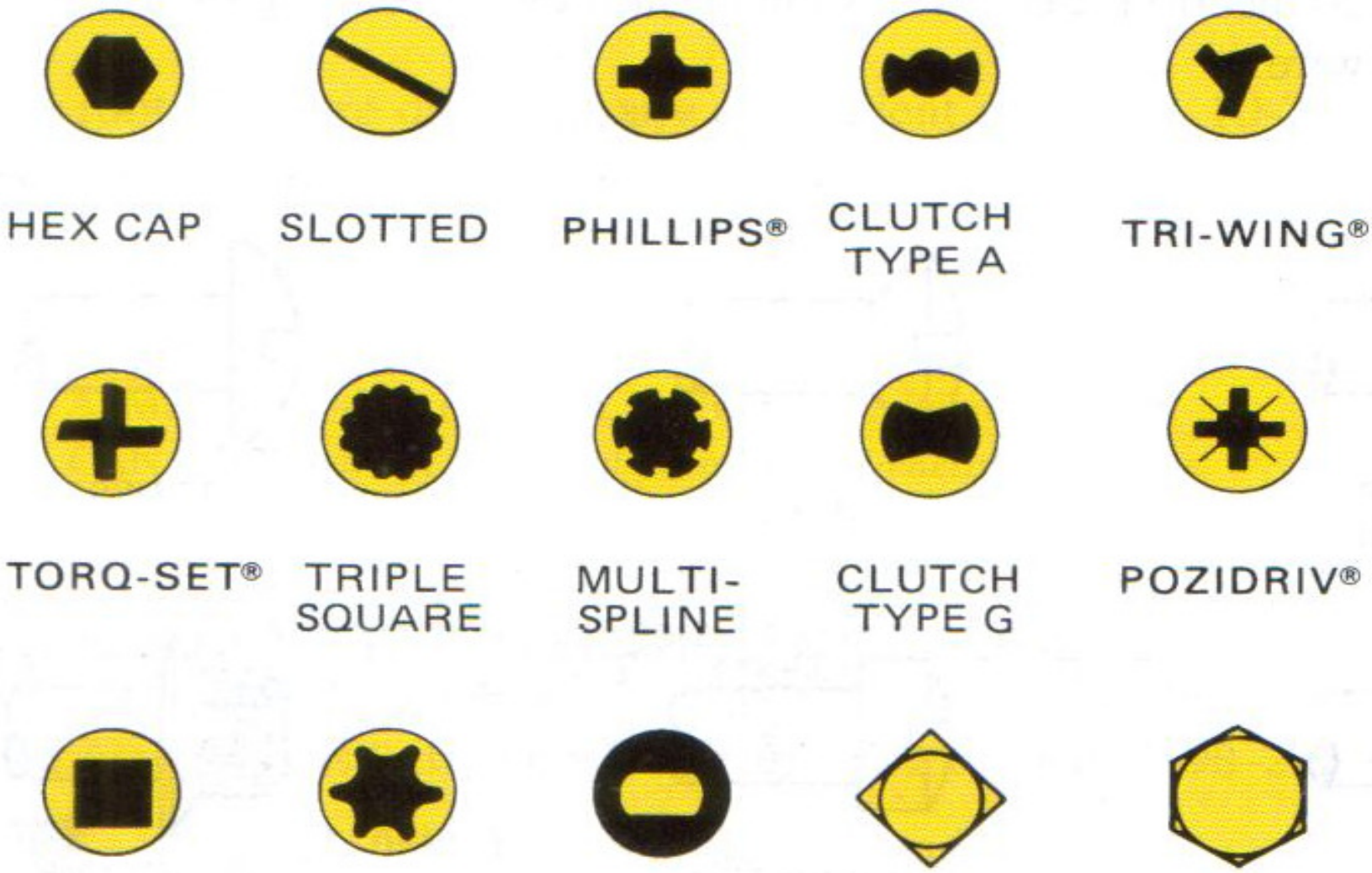
Special tapping screws.

Common Head Styles





Point styles.

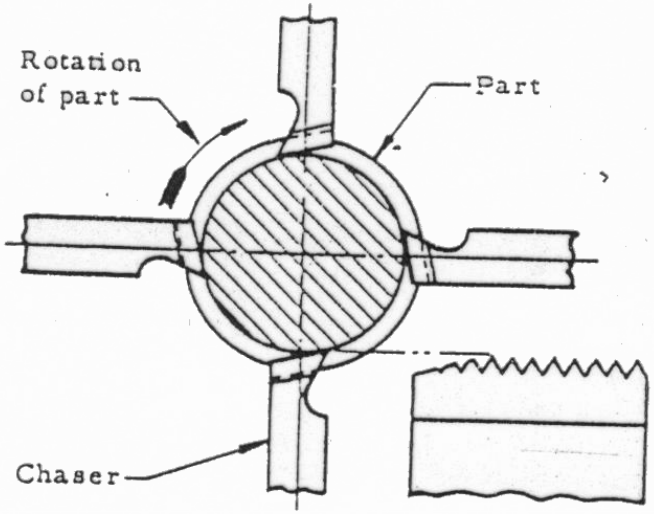


Drive configurations.

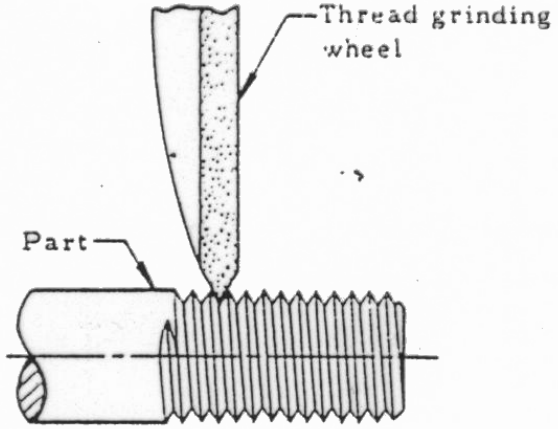
History of Threaded Fasteners

*The earliest records of screws are found in the writings of Archimedes (278-212 B.C.)
*Until 1841 there was no standard thread form, no interchanging of parts. A nut had to be tied to its own bolt!
*In England, Sir Joseph Whitworth made the first attempt to set up a uniform standard in 1841.
* The initial attempt to standardize screw threads in the USA came in 1864. The system was designed by William Sellers. It was known as the "Sellers thread" or the "United States thread". This system fulfilled the need for general-purpose thread for a period; but with the coming of automobile, the airplane, and other modern equipment, it became inadequate.
*In 1935 the American Standard thread with the same 60^0 V form of the old Sellers thread was adopted in the USA. Still there was no standardization among countries.
* In 1948, an agreement was reached on the unification of he American and British screw threads among the Americans, British and Canadians. The new thread was called the "Unified Screw Thread"
*In 1946, an International Organization for Standardization (ISO) committee established a single international system of metric screw threads

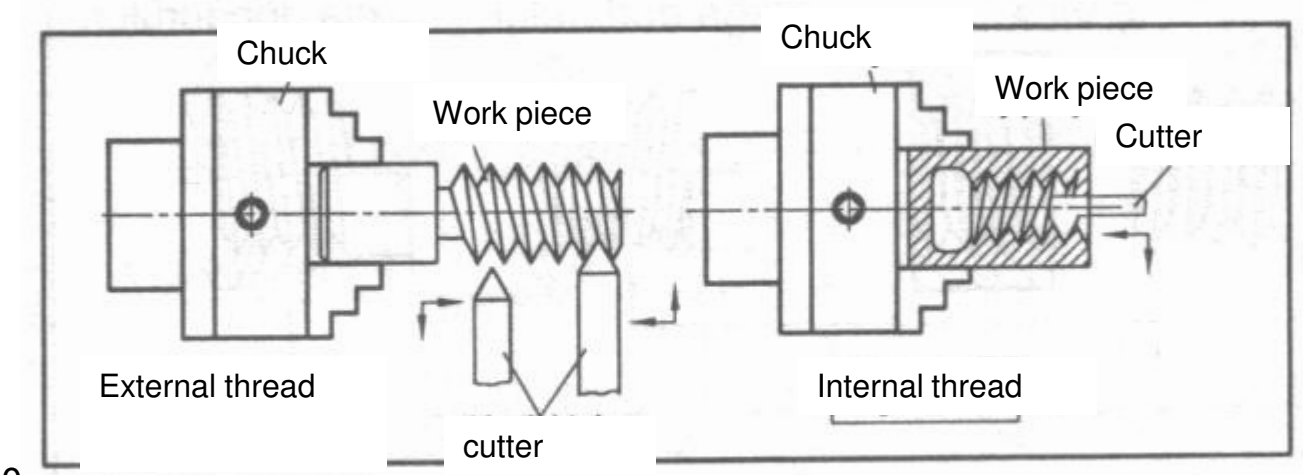
THREAD PRODUCTION



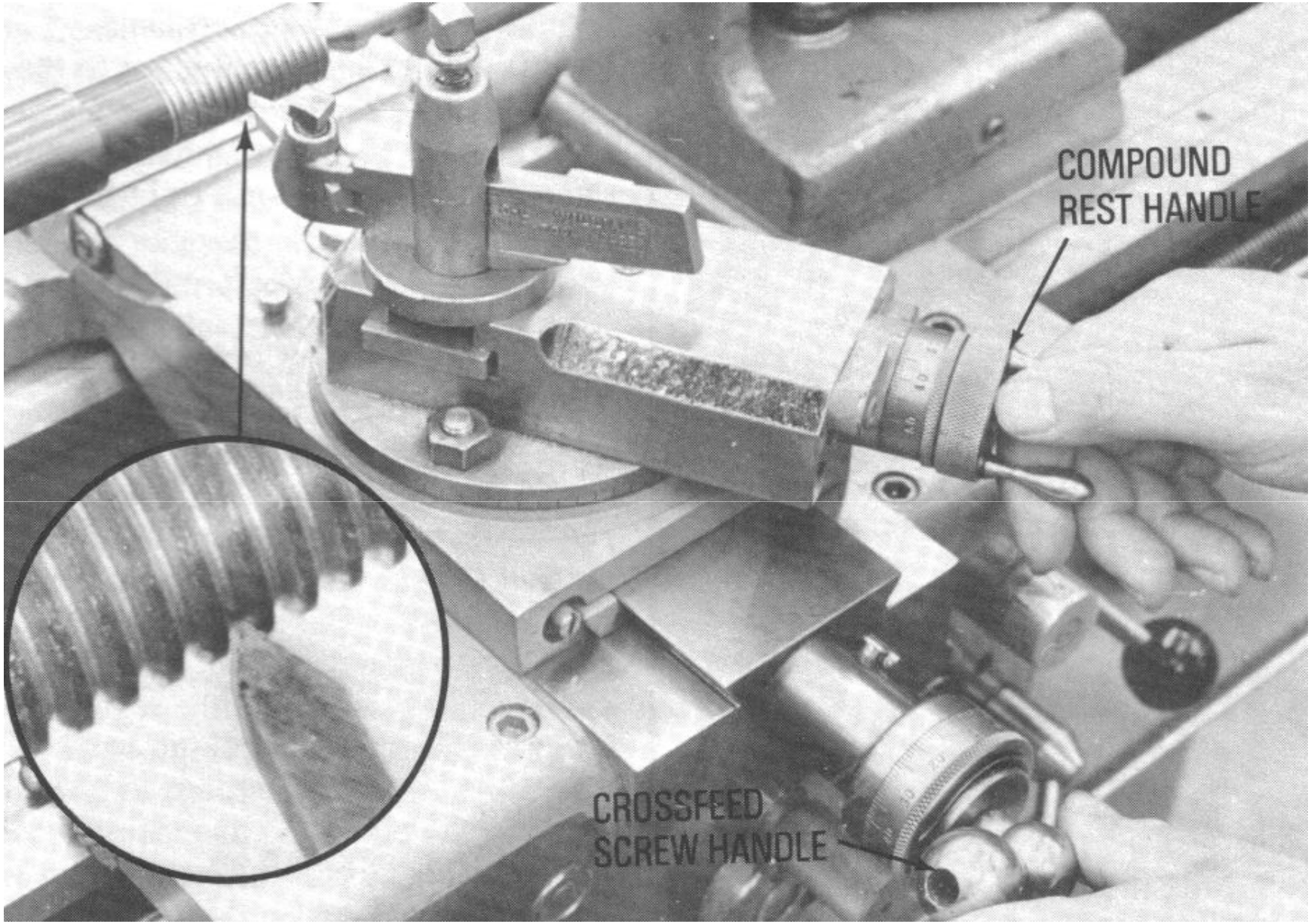
Cutting Threads on a Lathe

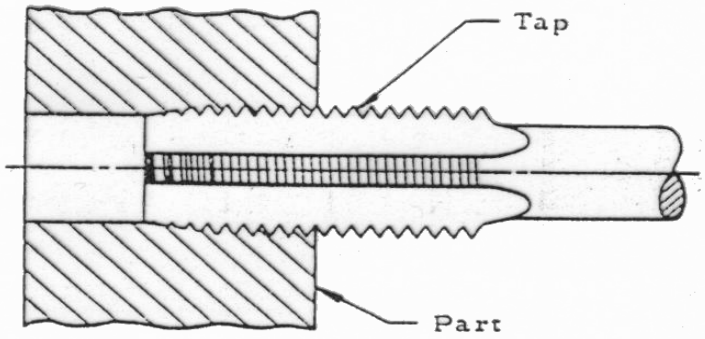


Grinding Threads

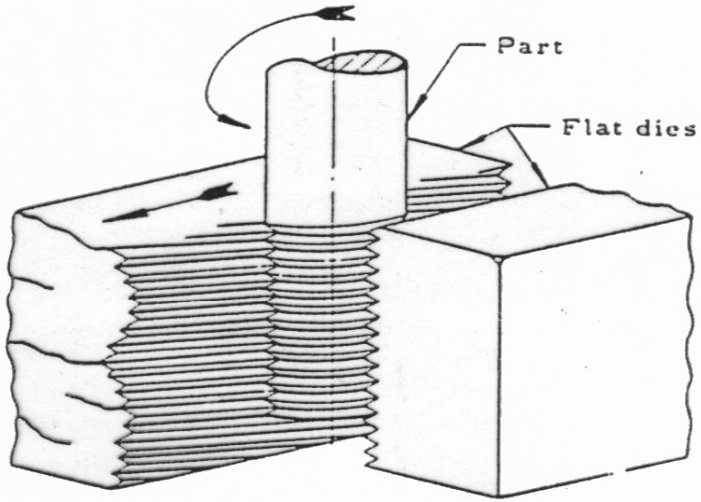


Cutting threads on a lathe

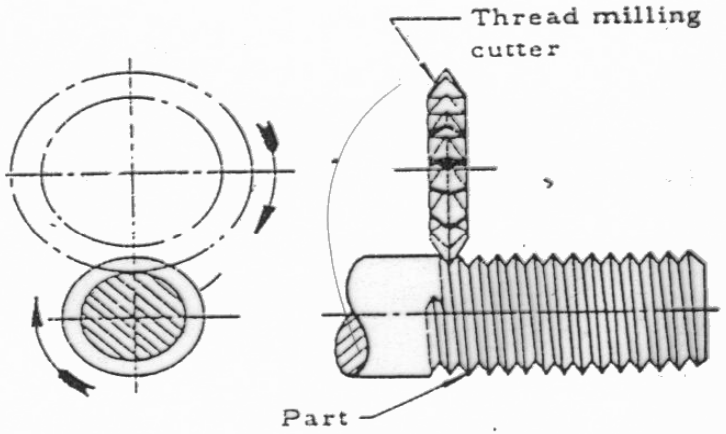

COMPOUND
REST HANDLE
CROSSFEED
SCREW HANDLE



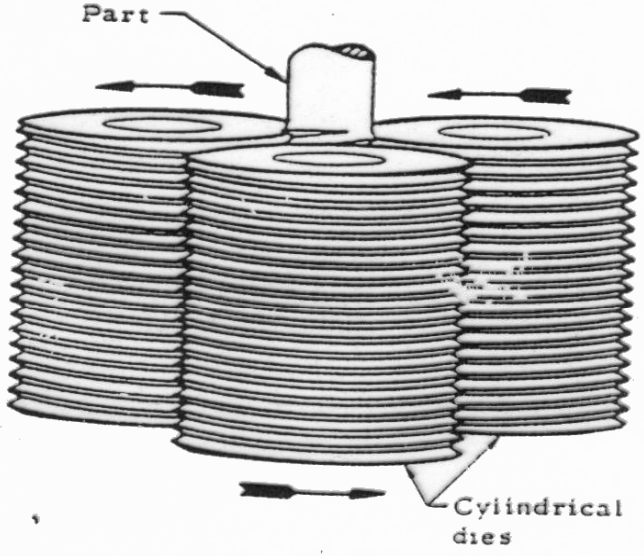
Cutting Threads with a Tap



Rolling Threads with Flat Dies



Cutting Threads with a Milling Cutter

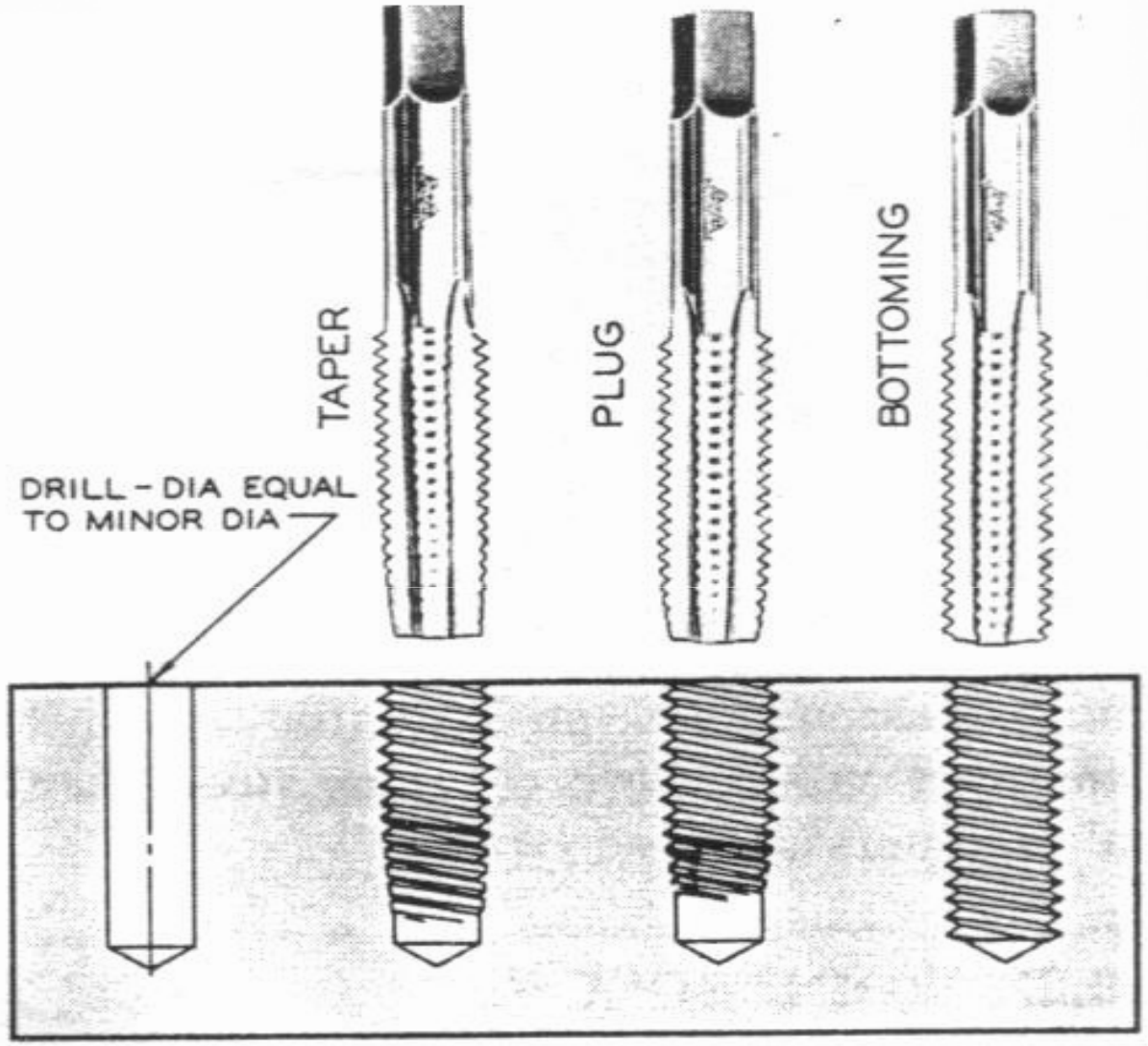


Rolling Threads with Cylindrical Dies

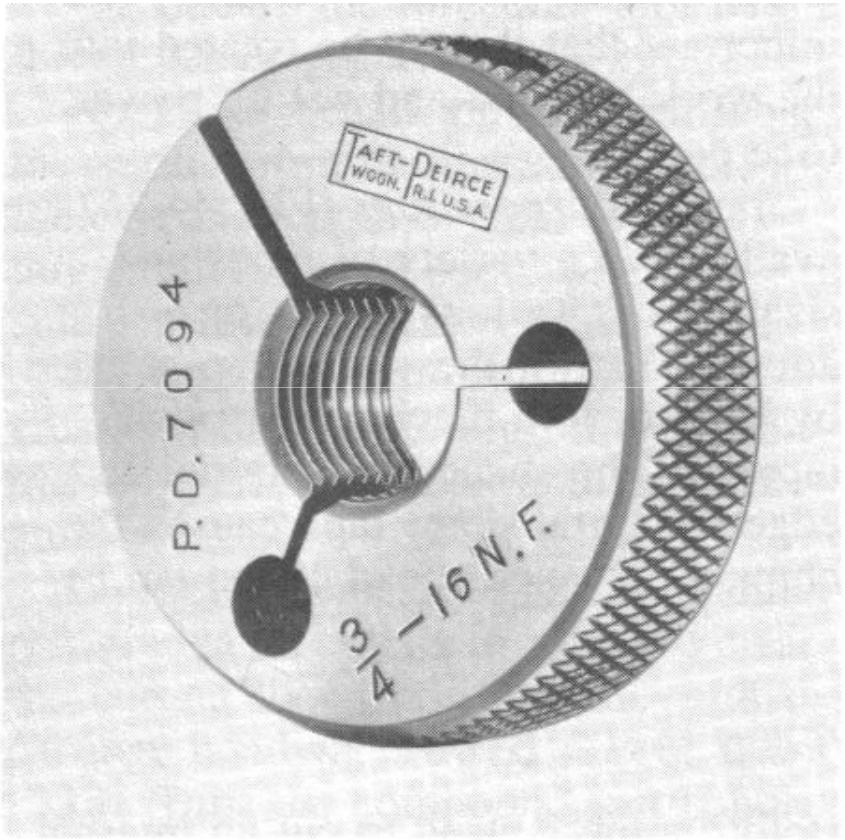
CUTTING INTERNAL THREADS

Most internal threads are cut with taps; however, there are times when a tap of a specific size is not available and the thread must be cut on a lathe. Internal threading, or cutting threads in a hole, is an operation performed on work held in a chuck, collet, or mounted on a faceplate. The threading tool is similar to a boring toolbit, except the shape is ground to the form of the thread to be cut.

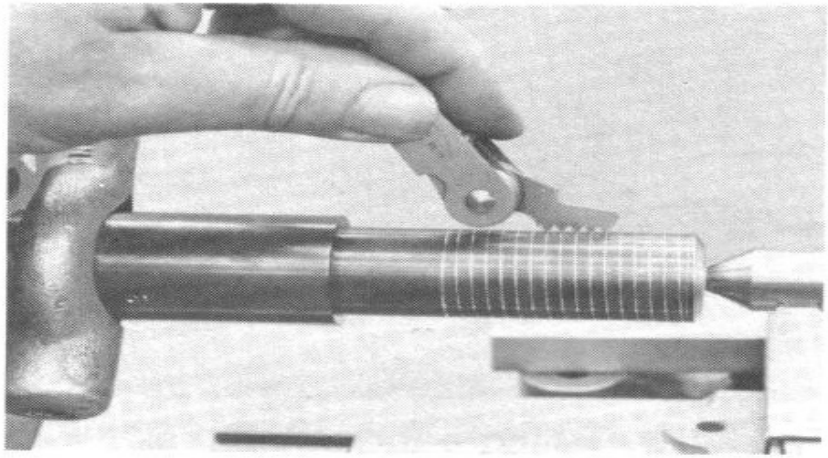
A set of hand taps:
(A) Taper; (B) plug; (C) bottoming.



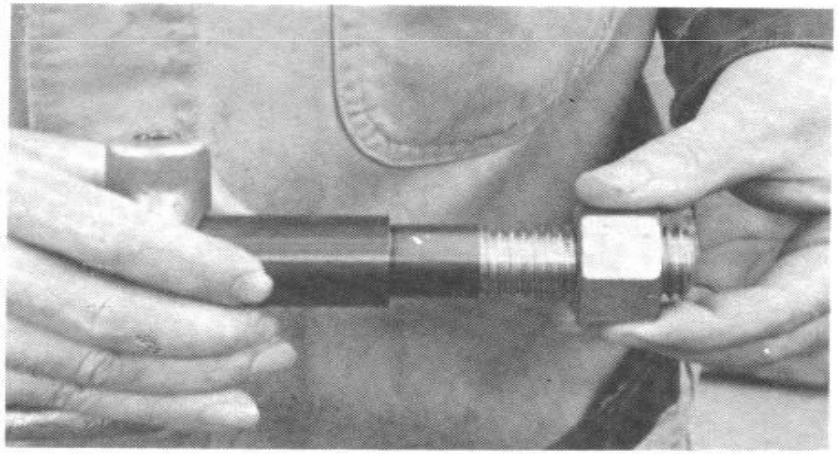
Three types of taps for threading internal holes



A thread ring gage is used for checking threads on production work.

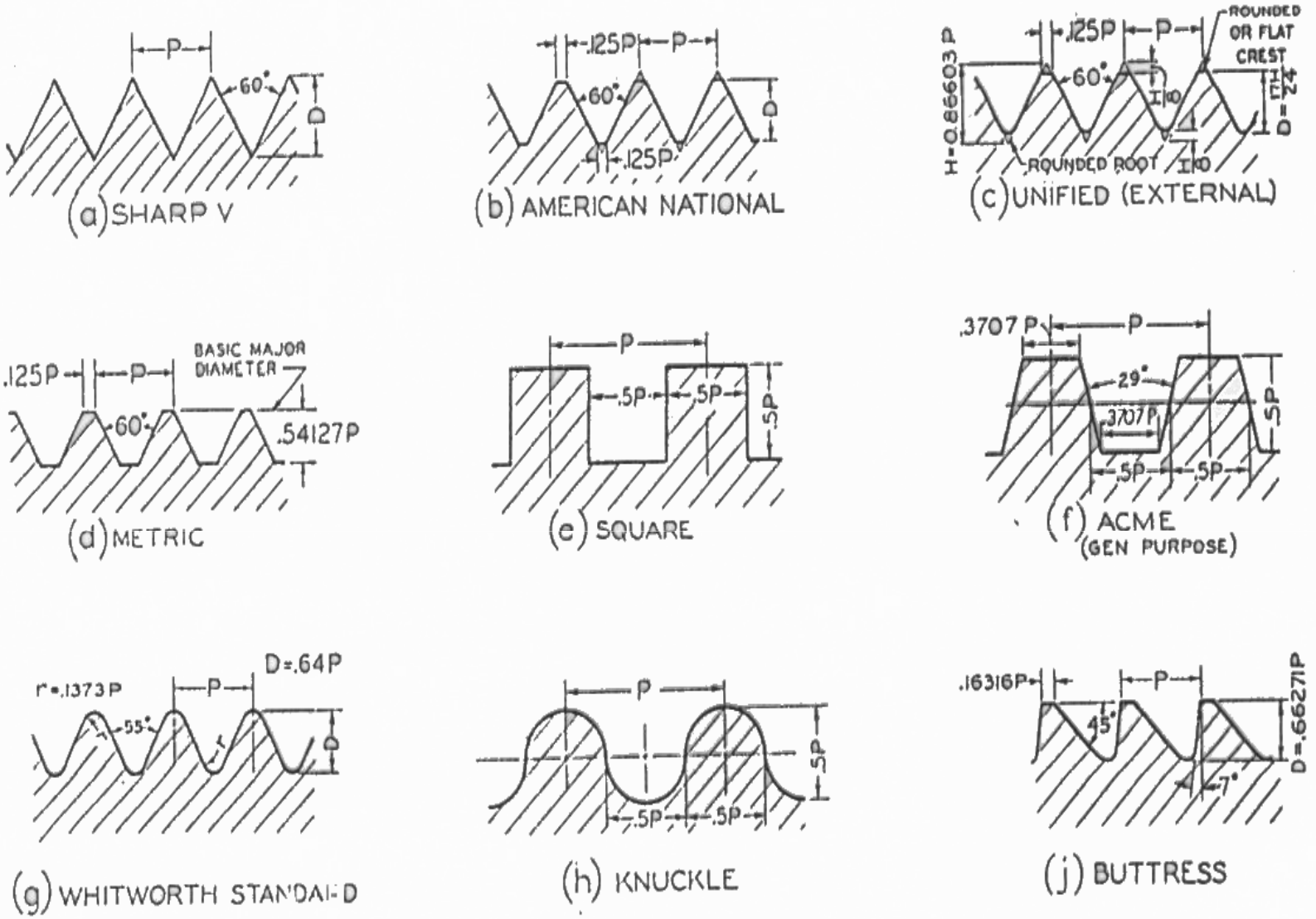


Checking the number of threads per inch with a thread pitch gage.



Checking the accuracy of a thread with a master nut.

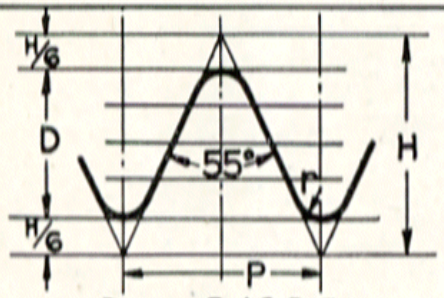
thread with a master nut.



Screw Thread Forms.

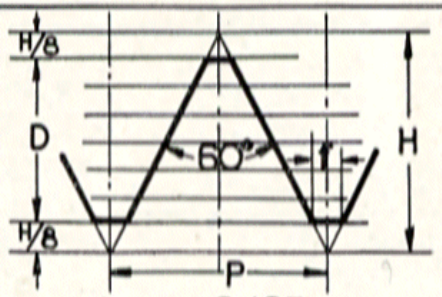
THREAD FORMS.

A. WHITWORTH



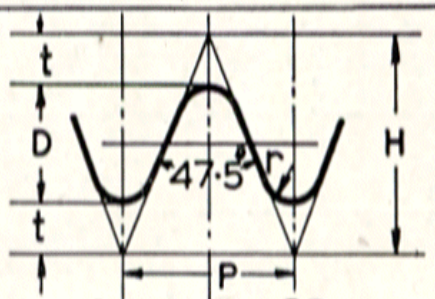
D = ·6403 P
H = ·9605 P
H/6 = ·1600 P
r = ·1373 P

B. SELLERS or U.S.S.



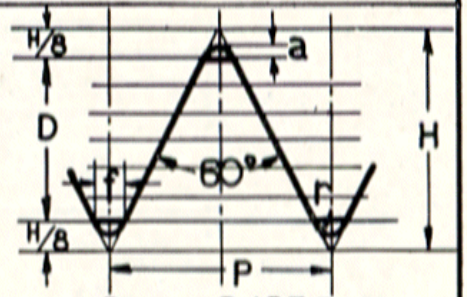
D = ·6495 P
H = ·8660 P
H/8 = ·108 P
f = ·125 P = P/8

C. B.A. British Assn



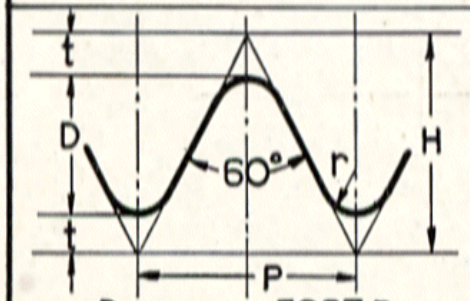
D = ·6 P
H = 1·136 P
t = ·268 P
r = ·182 P

D. S.I. Système International.



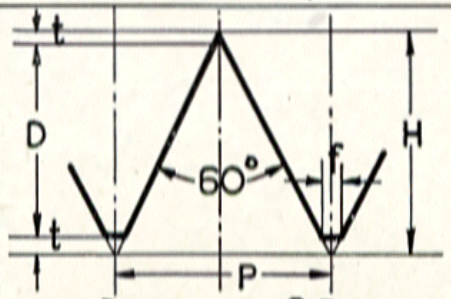
D = ·6495 P
H = ·8660 P
H/8 = ·108 P a = ·05 P
f = ·125 P r = ·058 P

E. C.E.I. Cycle Engrs Institute.



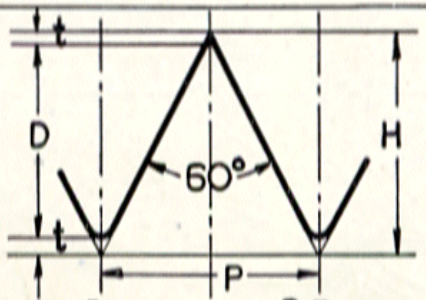
D = ·5327 P
H = ·8660 P
t = P/6 = ·166 P
r = P/6 = ·166 P

F. VEE American Sharp Vee.



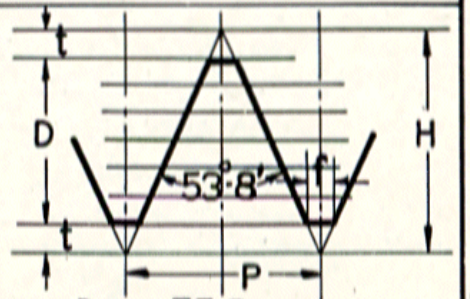
D = ·8 P
H = ·8660 P
t = ·033 P
f = ·04 P

G. BRIGGS PIPE.

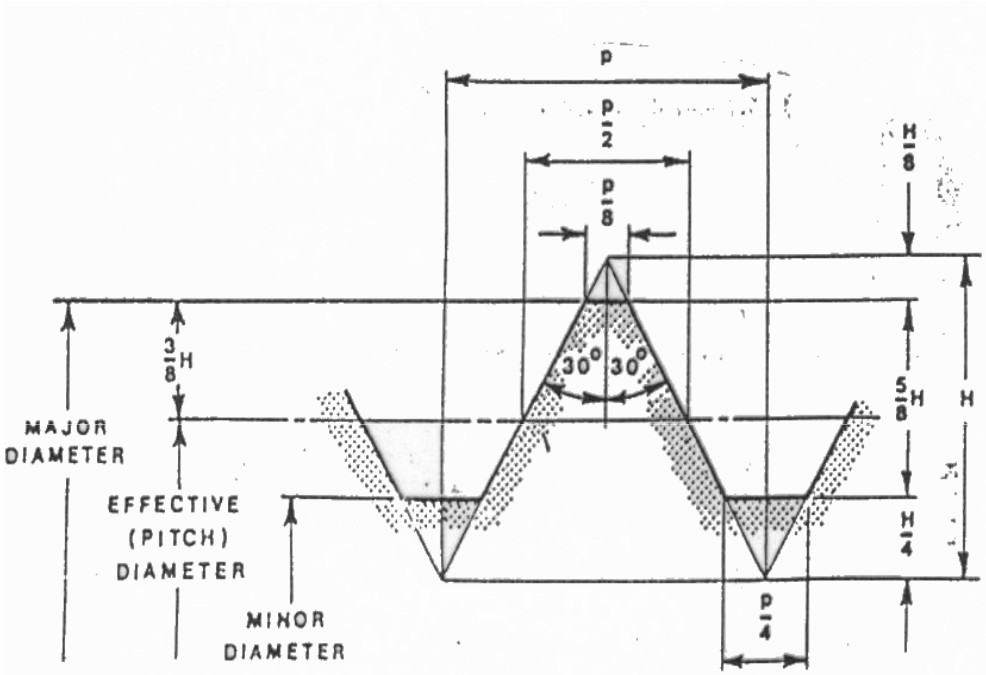


D = ·8 P
H = ·8660 P
t = ·033 P
Taper = 3/4" per foot.

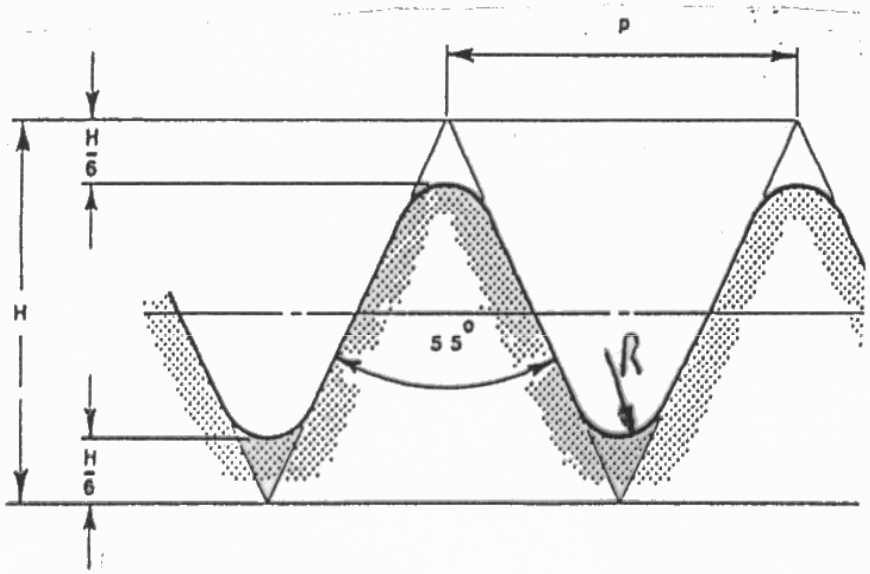
H. LÖWENHERZ.



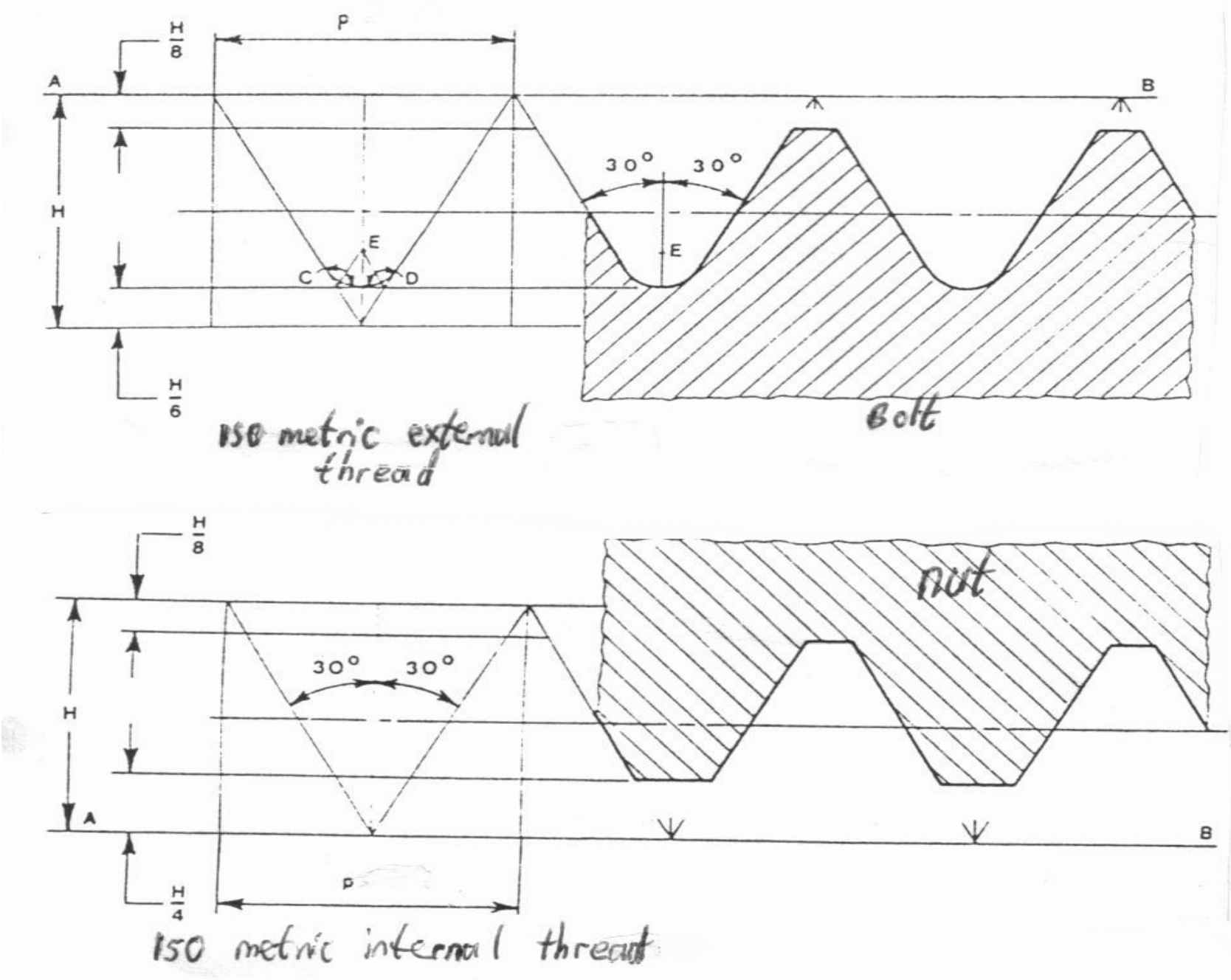
D = ·75 P
H = P
t = P/8 = ·125 P
f = P/8 = ·125 P

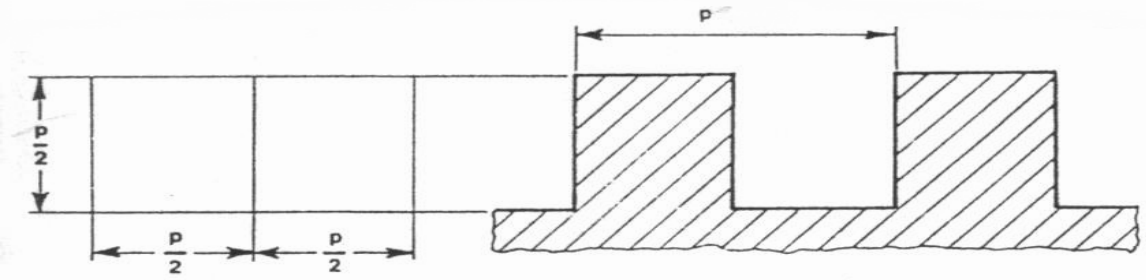


Basic form of ISO metric thread

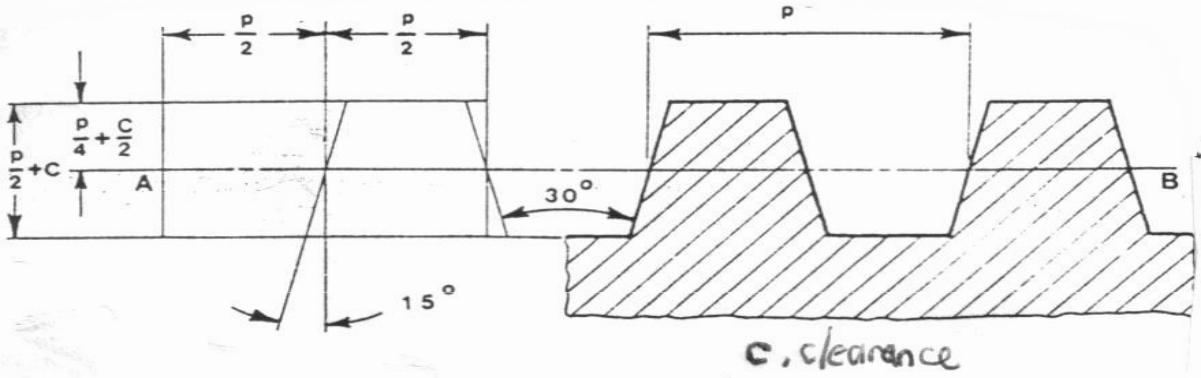


BSP thread


H/8
P
A
B
H
30°
30°
E
C
D
E
H/6
ISO metric external thread
Bolt
H/8
nut
30°
30°
H
A
B
H/4
P
ISO metric internal thread

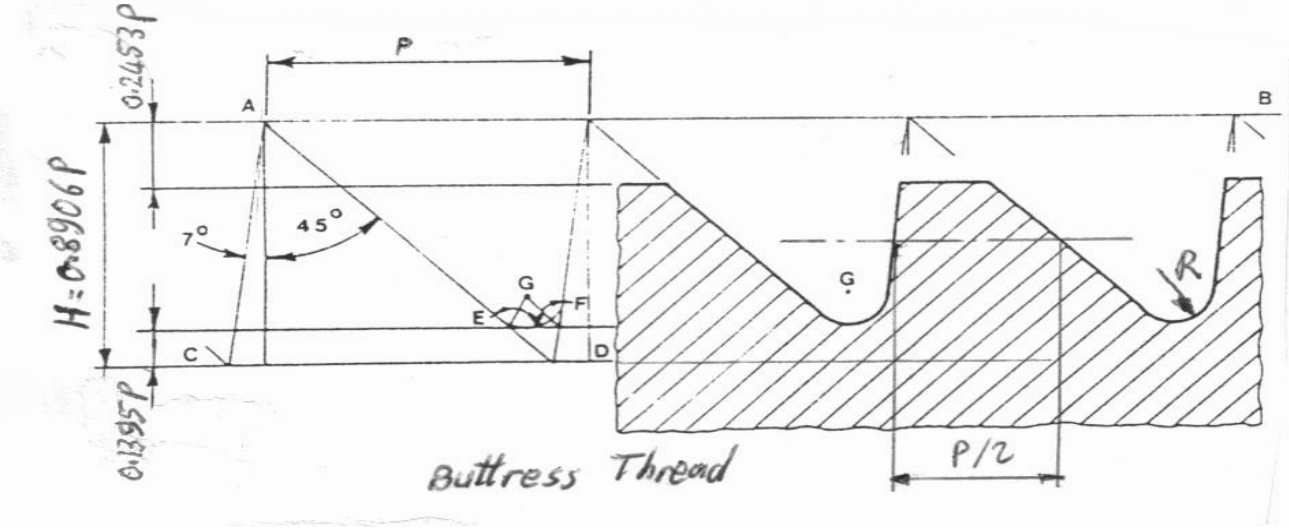


Square thread



P [mm]	C [mm]
2~5	0.25
6~12	0.5
14~44	1

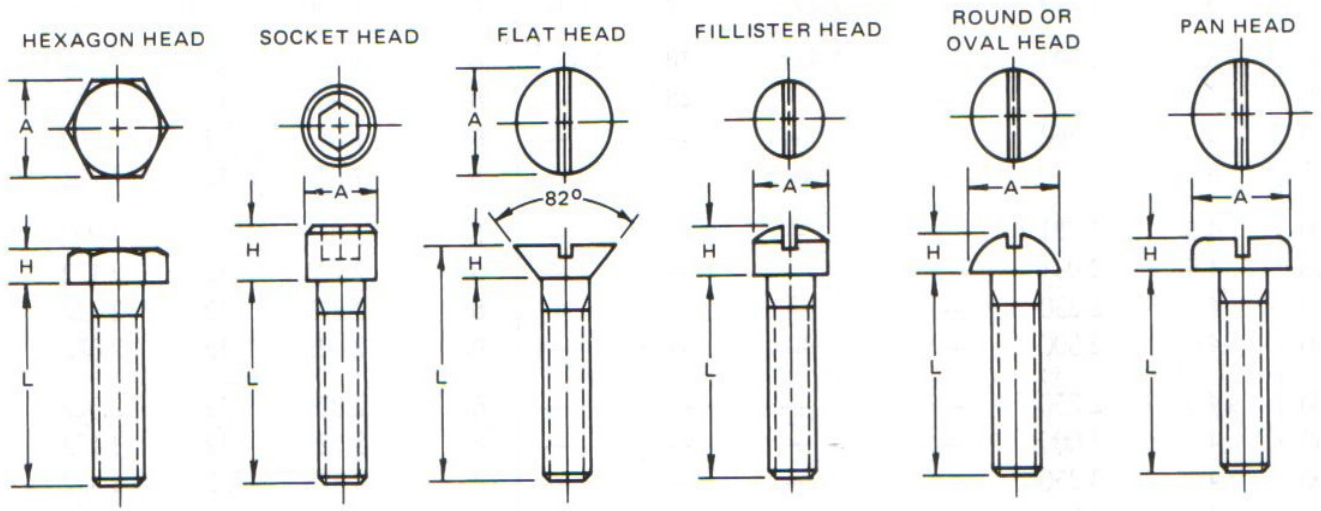
ISO metric trapezoidal thread



Buttress Thread

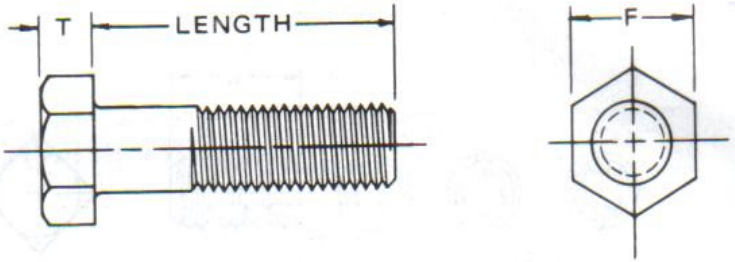
NOMINAL SIZE DIA (mm)	SERIES WITH GRADED PITCHES				SERIES WITH CONSTANT PITCHES															
	COARSE		FINE		4		3		2		1.5		1.25		1		0.75		0.5		0.35	
Preferred	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size	Thread Pitch	Tap Drill Size
1.6	0.35	1.25																				
	1.8	0.35	1.45																			
2		0.4	1.6																			
	2.2	0.45	1.75																			
2.5		0.45	2.05																		0.35	2.15
3		0.5	2.5																		0.35	2.65
	3.5	0.6	2.9																		0.35	3.15
4		0.7	3.3																0.5	3.5		
	4.5	0.75	3.7																0.5	4.0		
5		0.8	4.2																0.5	4.5		
6		1	5.0														0.75	5.2				
8		1.25	6.7	1	7.0										1	7.0	0.75	7.2				
10		1.5	8.5	1.25	8.7								1.25	8.7	1	9.0	0.75	9.2				
12		1.75	10.2	1.25	10.8						1.5	10.5	1.25	10.7	1	11						
	14	2	12	1.5	12.5						1.5	12.5	1.25	12.7	1	13						
16		2	14	1.5	14.5						1.5	14.5			1	15						
	18	2.5	15.5	1.5	16.5					2	16	1.5	16.5			1	17						
20		2.5	17.5	1.5	18.5					2	18	1.5	18.5			1	19						
	22	2.5	19.5	1.5	20.5					2	20	1.5	20.5			1	21						
24		3	21	2	22					2	22	1.5	22.5			1	23						
	27	3	24	2	25					2	25	1.5	25.5			1	26						
30		3.5	26.5	2	28					2	28	1.5	28.5			1	29						
	33	3.5	29.5	2	31					2	31	1.5	31.5										
36		4	32	3	33					2	34	1.5	34.5										
	39	4	35	3	36					2	37	1.5	37.5										
42		4.5	37.5	3	39	4	38	3	39	2	40	1.5	40.5										
	45	4.5	39	3	42	4	41	3	42	2	43	1.5	43.5										
48		5	43	3	45	4	44	3	45	2	46	1.5	46.5										

Metric screw threads.



U.S. CUSTOMARY (INCHES)											METRIC (MILLIMETERS)											
Nominal Size	Hexagon Head		Socket Head		Flat Head		Fillister Head		Round or Oval Head		Nominal Size	Hexagon Head		Socket Head		Flat Head		Fillister Head		Pan Head	
	A	H	A	H	A	H	A	H	A	H		A	H	A	H	A	H	A	H	A	H
.250	.44	.17	.38	.25	.50	.14	.38	.24	.44	.19	M3	5.5	2	5.5	3	5.6	1.6	6	2.4	6	1.9
.312	.50	.22	.47	.31	.62	.18	.44	.30	.56	.25	4	7	2.8	7	4	7.5	2.2	8	3.1	8	2.5
.375	.56	.25	.56	.38	.75	.21	.56	.36	.62	.27	5	8.5	3.5	9	5	9.2	2.5	10	3.8	10	3.1
.438	.62	.30	.66	.44	.81	.21	.62	.37	.75	.33	6	10	4	10	6	11	3	12	4.6	12	3.8
.500	.75	.34	.75	.50	.88	.21	.75	.41	.81	.35	8	13	5.5	13	8	14.5	4	16	6	16	5
.625	.94	.42	.94	.62	1.12	.28	.88	.52	1.00	.44	10	17	7	16	10	18	5	20	7.5	20	6.2
.750	1.12	.50	1.12	.75	1.38	.35	1.00	.61	1.25	.55	12	19	8	18	12	23	6.4				
											16	24	10.5	24	16	29	8				
											20	30	13.1			35	9				

Common machine and cap screws.



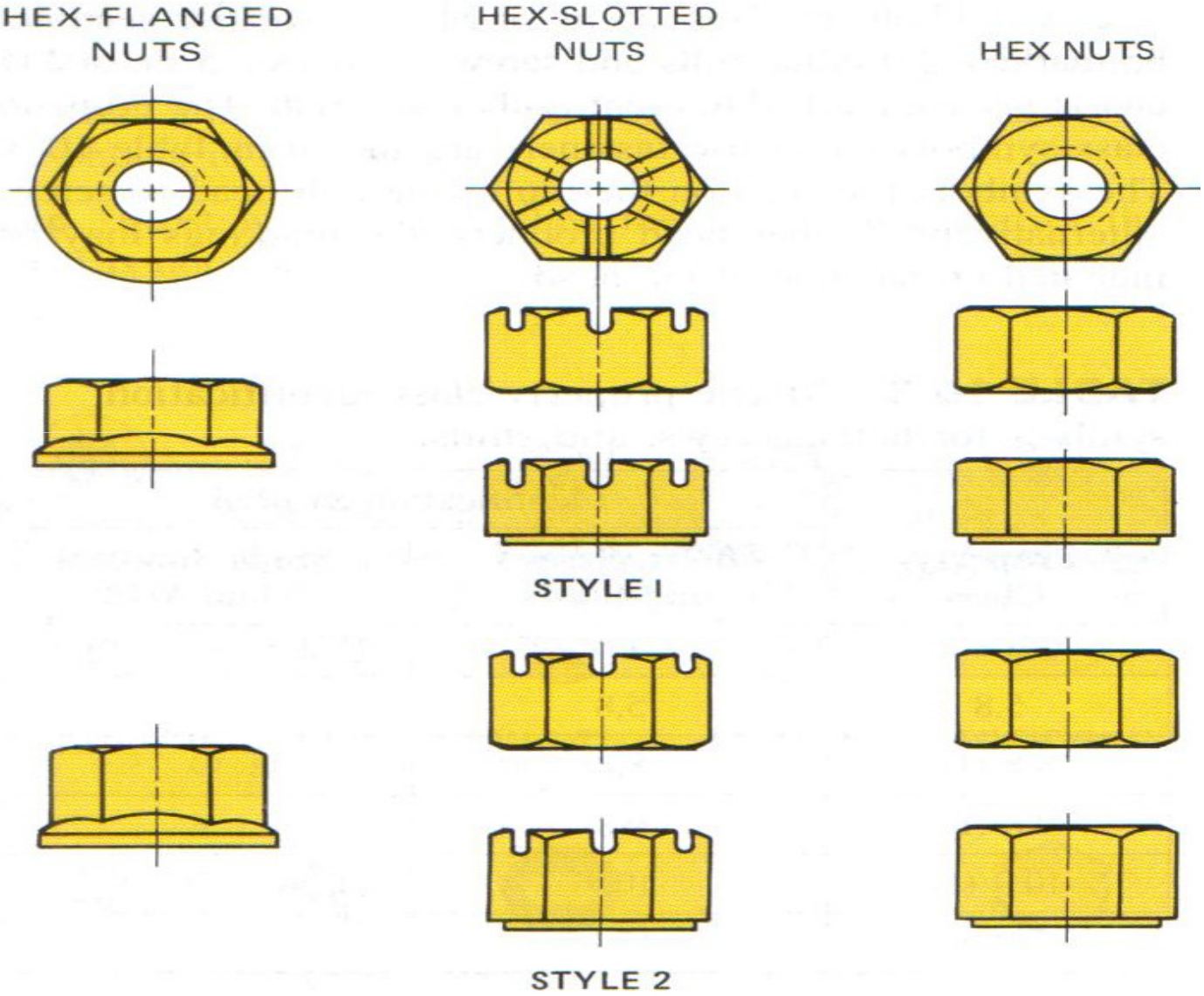
U.S. CUSTOMARY (INCHES)		
Nominal Bolt Size	Width Across Flats F	Thickness T
.250	.438	.172
.312	.500	.219
.375	.562	.250
.438	.625	.297
.500	.750	.344
.625	.938	.422
.750	1.125	.500
.875	1.312	.578
1.000	1.500	.672
1.125	1.688	.750
1.250	1.875	.844
1.375	2.062	.906
1.500	2.250	1.000

METRIC (MILLIMETERS)		
Nominal Bolt Size and Thread Pitch	Width Across Flats F	Thickness T
M5 x 0.8	8	3.9
M6 x 1	10	4.7
M8 x 1.25	13	5.7
M10 x 1.5	15	6.8
M12 x 1.75	18	8
M14 x 2	21	9.3
M16 x 2	24	10.5
M20 x 2.5	30	13.1
M24 x 3	36	15.6
M30 x 3.5	46	19.5
M36 x 4	55	23.4

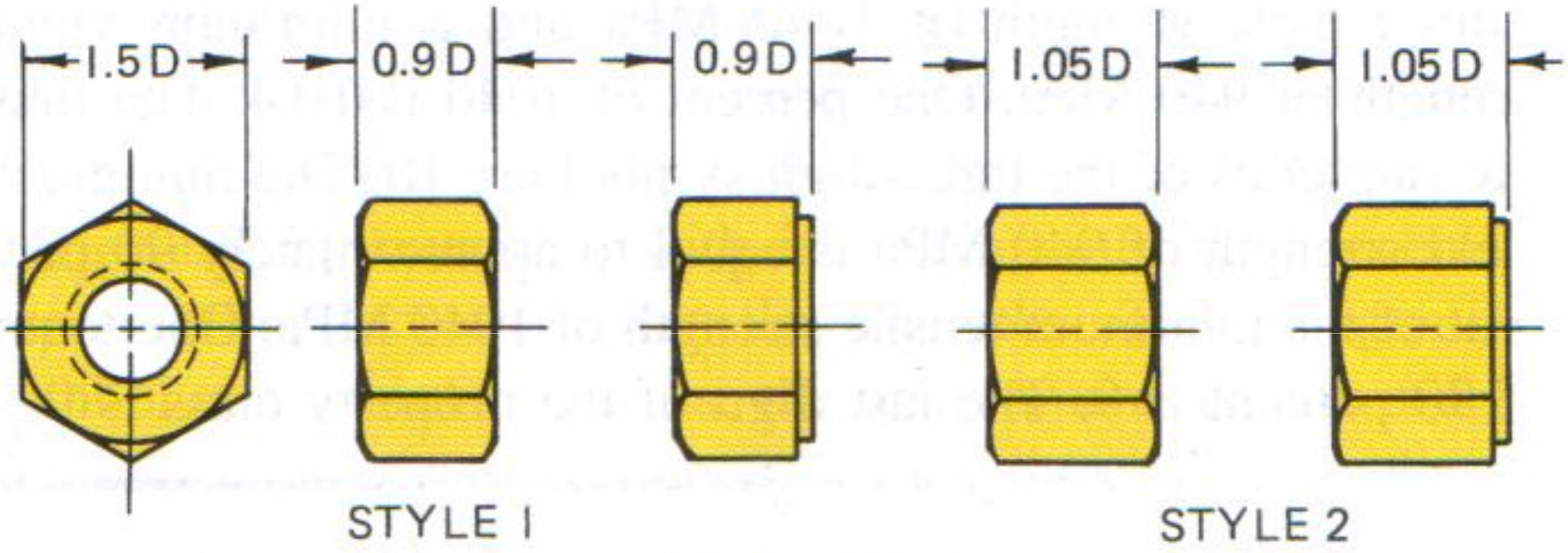
Hexagon-head bolts and cap screws.

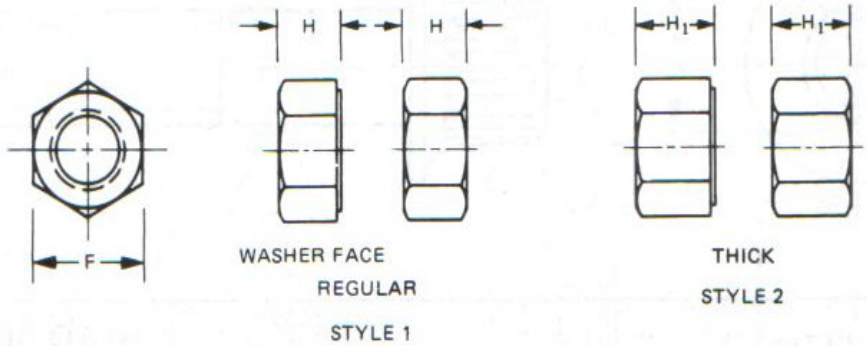
Nuts

The customary terms *regular* and *thick* for describing nut thicknesses have been replaced by the terms *style 1* and *style 2* for metric nuts. The design of style 1 and 2 steel nuts shown in Fig.



Hex-nut styles.


1.5 D
0.9 D
0.9 D
1.05 D
1.05 D
STYLE 1
STYLE 2



U.S. CUSTOMARY (INCHES)			
Nominal Nut Size	Distance Across Flats F	Thickness Max. Style 1 H	Thickness Max. Style 2 H_1
.250	.438	.218	.281
.312	.500	.266	.328
.375	.562	.328	.406
.438	.625	.375	.453
.500	.750	.438	.562
.562	.875	.484	.609
.625	.938	.547	.719
.750	1.125	.641	.812
.875	1.312	.750	.906
1.000	1.500	.859	1.000
1.125	1.688	.969	1.156
1.250	1.875	1.062	1.250
1.375	2.062	1.172	1.375
1.500	2.250	1.281	1.500

METRIC (MILLIMETERS)			
Nominal Nut Size and Thread Pitch	Distance Across Flats F	Thickness Max. Style 1 H	Thickness Max. Style 2 H_1
M4 x 0.7	7	—	3.2
M5 x 0.8	8	4.5	5.3
M6 x 1	10	5.6	6.5
M8 x 1.25	13	6.6	7.8
M10 x 1.5	15	9	10.7
M12 x 1.75	18	10.7	12.8
M14 x 2	21	12.5	14.9
M16 x 2	24	14.5	17.4
M20 x 2.5	30	18.4	21.2
M24 x 3	36	22	25.4
M30 x 3.5	46	26.7	31
M36 x 4	55	32	37.6

Hexagon-head nuts.

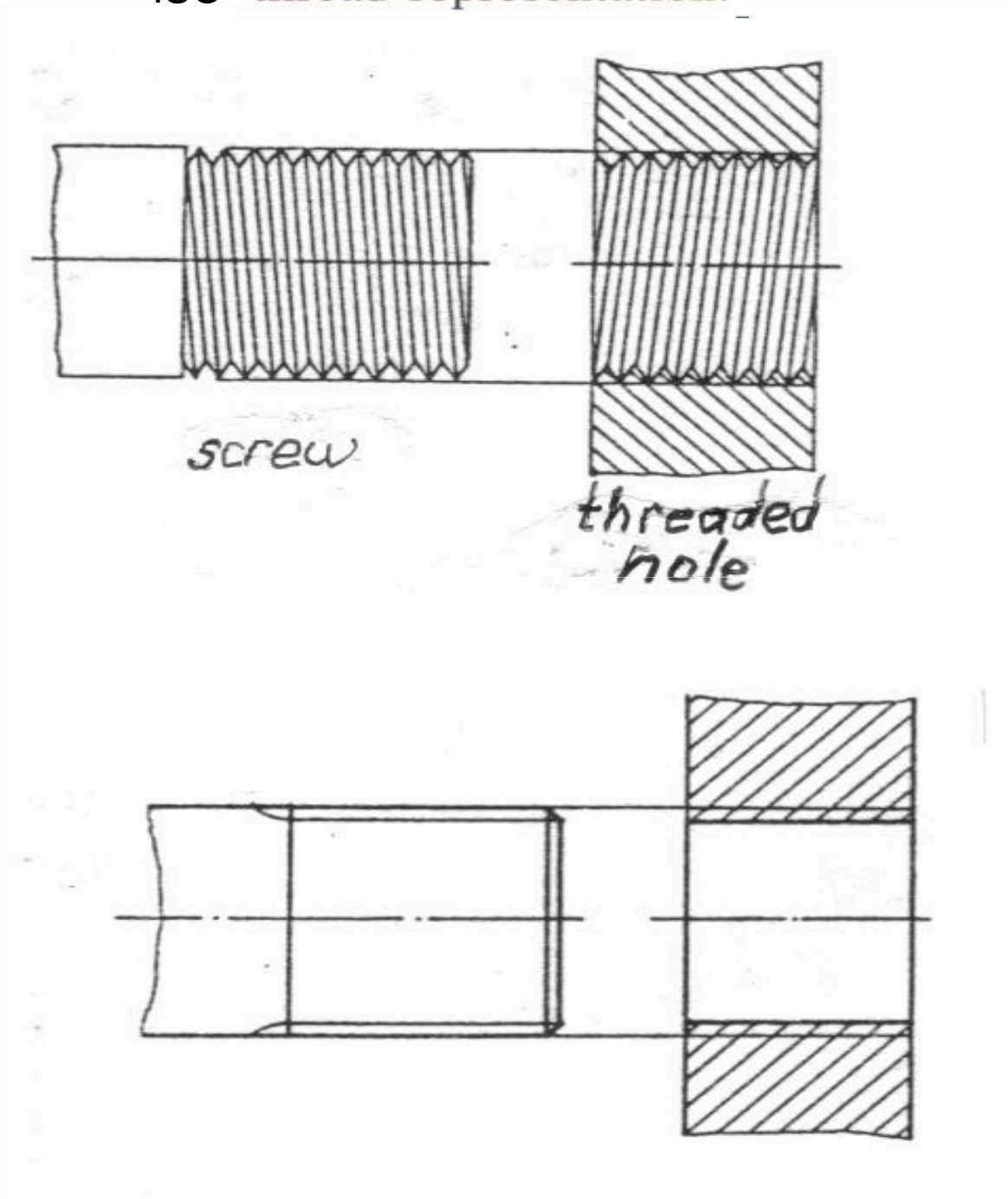
THREADS PER INCH AND TAP DRILL SIZES

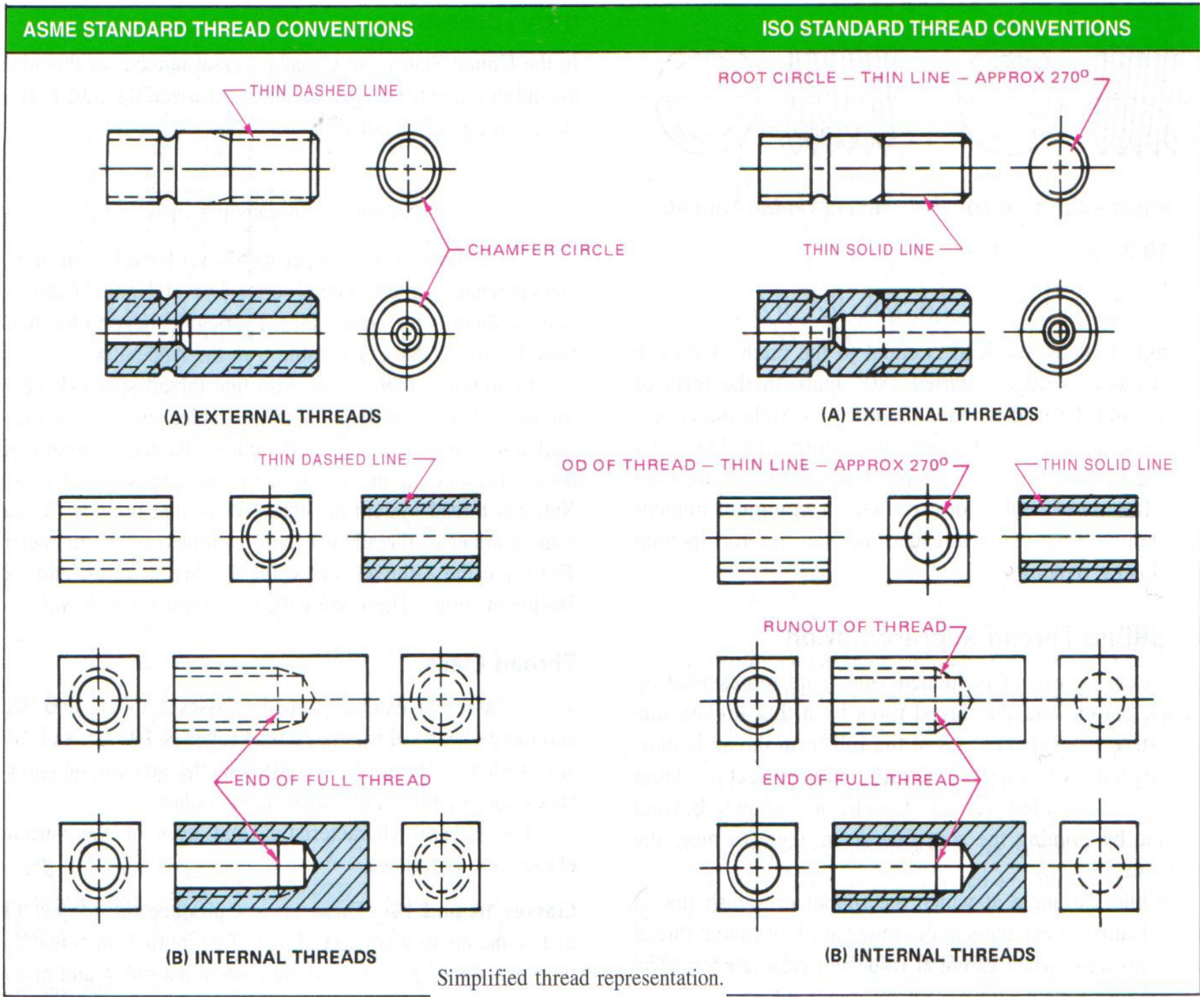
SIZE		Graded Pitch Series						Constant Pitch Series					
INCHES		Coarse UNC		Fine UNF		Extra Fine UNEF		8 UN		12 UN		16 UN	
Number or Fraction	Deci-mal	Threads per Inch	Tap Drill Dia.	Threads per Inch	Tap Drill Dia.	Threads per Inch	Tap Drill Dia.	Threads per Inch	Tap Drill Dia.	Threads per Inch	Tap Drill Dia.	Threads per Inch	Tap Drill Dia.
0	.060	—	—	80	3/64	—	—	—	—	—	—	—	—
2	.086	56	No. 50	64	No. 49	—	—	—	—	—	—	—	—
4	.112	40	No. 43	48	No. 42	—	—	—	—	—	—	—	—
5	.125	40	No. 38	44	No. 37	—	—	—	—	—	—	—	—
6	.138	32	No. 36	40	No. 33	—	—	—	—	—	—	—	—
8	.164	32	No. 29	36	No. 29	—	—	—	—	—	—	—	—
10	.190	24	No. 25	32	No. 21	—	—	—	—	—	—	—	—
1/4	.250	20	7	28	3	32	.219	—	—	—	—	—	—
5/16	.312	18	F	24	1	32	.281	—	—	—	—	—	—
3/8	.375	16	.312	24	Q	32	.344	—	—	—	—	UNC	—
7/16	.438	14	U	20	.391	28	Y	—	—	—	—	16	V
1/2	.500	13	.422	20	.453	28	.469	—	—	—	—	16	.438
9/16	.562	12	.484	18	.516	24	.516	—	—	UNC	—	16	.500
5/8	.625	11	.531	18	.578	24	.578	—	—	12	.547	16	.562
3/4	.750	10	.656	16	.688	20	.703	—	—	12	.672	UNF	—
7/8	.875	9	.766	14	.812	20	.828	—	—	12	.797	16	.812
1	1.000	8	.875	12	.922	20	.953	UNC	—	UNF	—	16	.938
1 1/8	1.125	7	.984	12	1.047	18	1.078	8	1.000	UNF	—	16	1.062
1 1/4	1.250	7	1.109	12	1.172	18	1.188	8	1.125	UNF	—	16	1.188
1 3/8	1.375	6	1.219	12	1.297	18	1.312	8	1.250	UNF	—	16	1.312
1 1/2	1.500	6	1.344	12	1.422	18	1.438	8	1.375	UNF	—	16	1.438
1 5/8	1.625	—	—	—	—	18	—	8	1.500	12	1.547	16	1.562
1 3/4	1.750	5	1.562	—	—	—	—	8	1.625	12	1.672	16	1.688
1 7/8	1.875	—	—	—	—	—	—	8	1.750	12	1.797	16	1.812
2	2.000	4.5	1.781	—	—	—	—	8	1.875	12	1.922	16	1.938
2 1/4	2.250	4.5	2.031	—	—	—	—	8	2.125	12	2.172	16	2.188
2 1/2	2.500	4	2.250	—	—	—	—	8	2.375	12	2.422	16	2.438
2 3/4	2.750	4	2.500	—	—	—	—	8	2.625	12	2.672	16	2.688
3	3.000	4	2.750	—	—	—	—	8	2.875	12	2.922	16	2.938
3 1/4	3.250	4	3.000	—	—	—	—	8	3.125	12	3.172	16	3.188
3 1/2	3.500	4	3.250	—	—	—	—	8	3.375	12	3.422	16	3.438
3 3/4	3.750	4	3.500	—	—	—	—	8	3.625	12	3.668	16	3.688
4	4.000	4	3.750	—	—	—	—	8	3.875	12	3.922	16	3.938

Note: The tap diameter sizes shown are nominal. The class and length of thread will govern he limits on the tapped hole size.

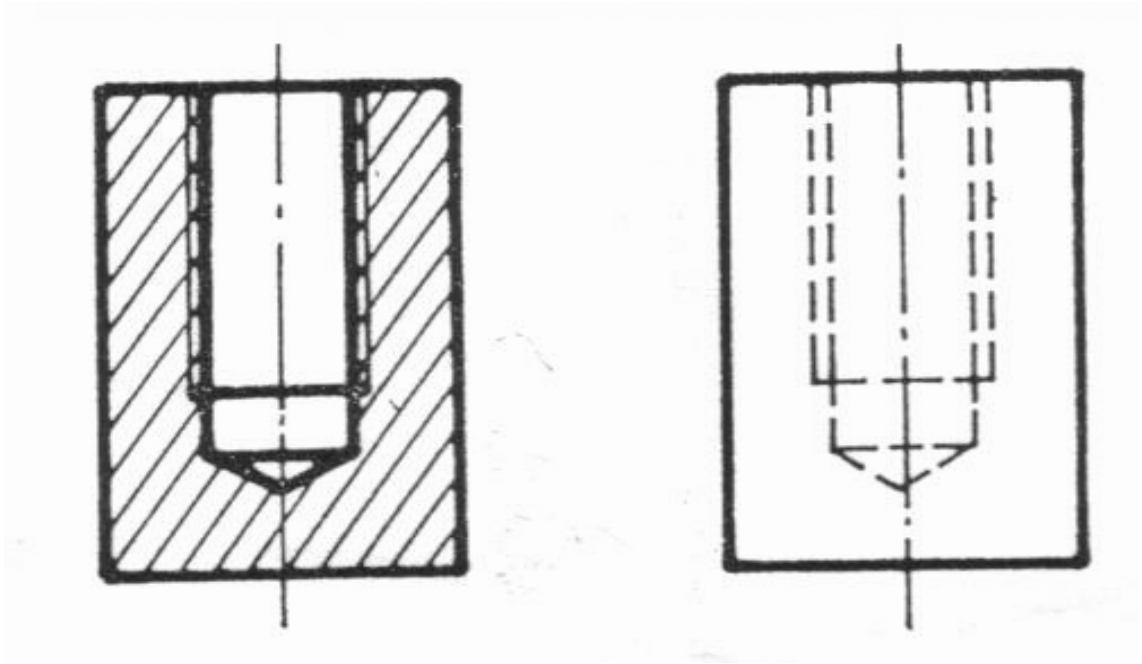
Inch screw threads.

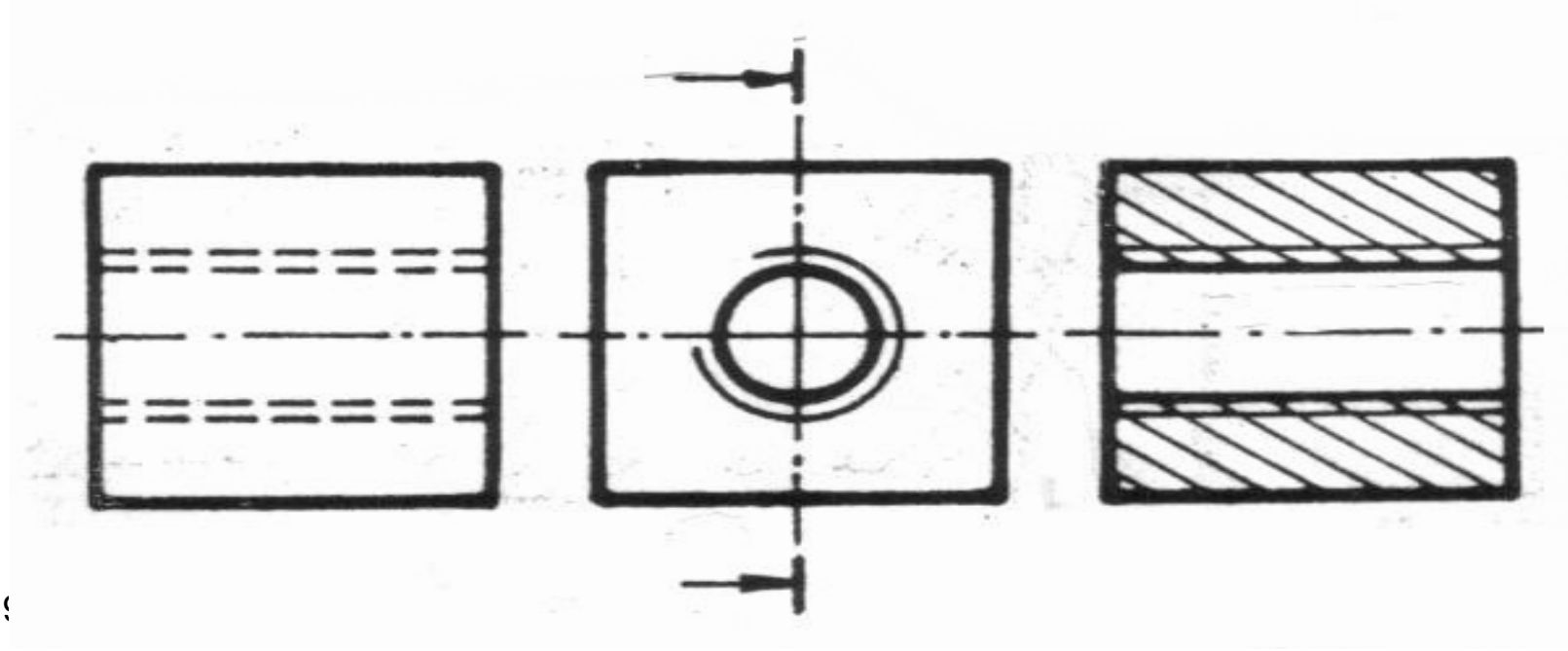
ISO thread representation.

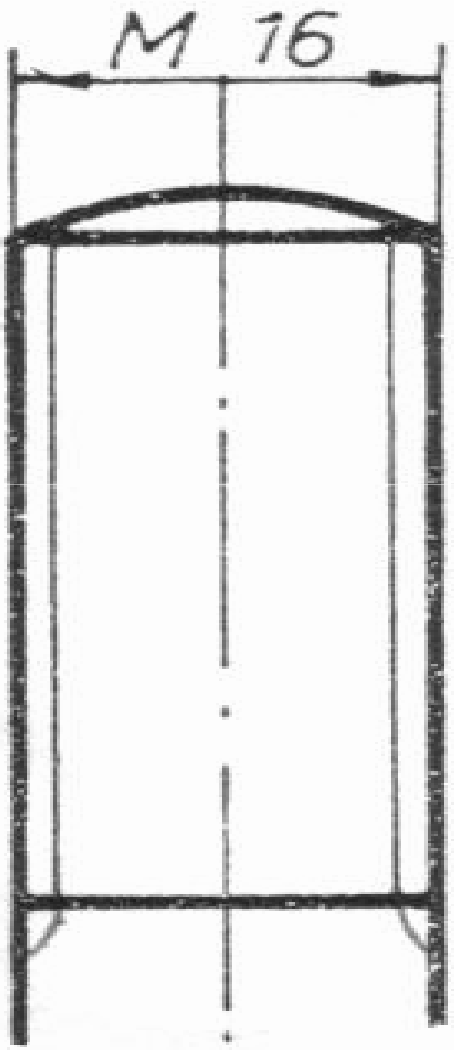


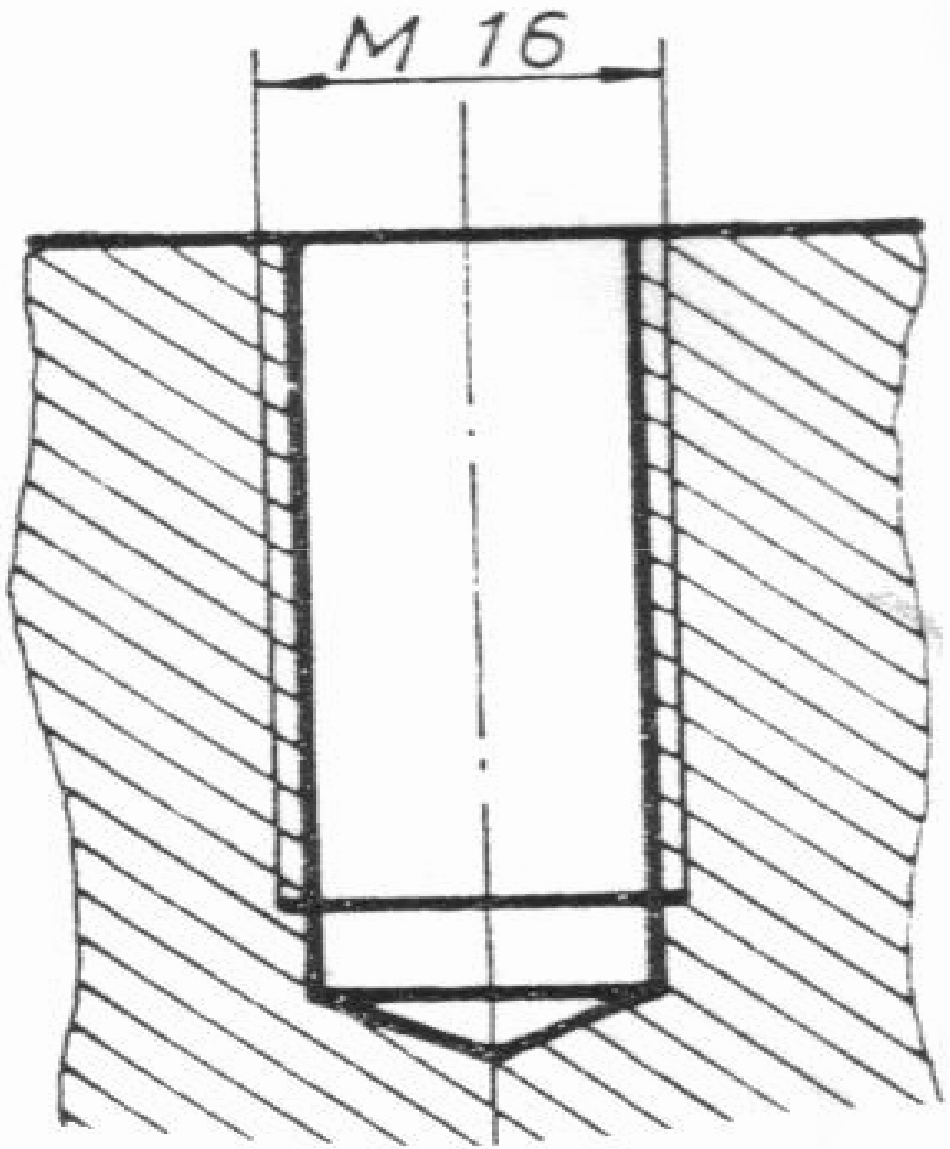


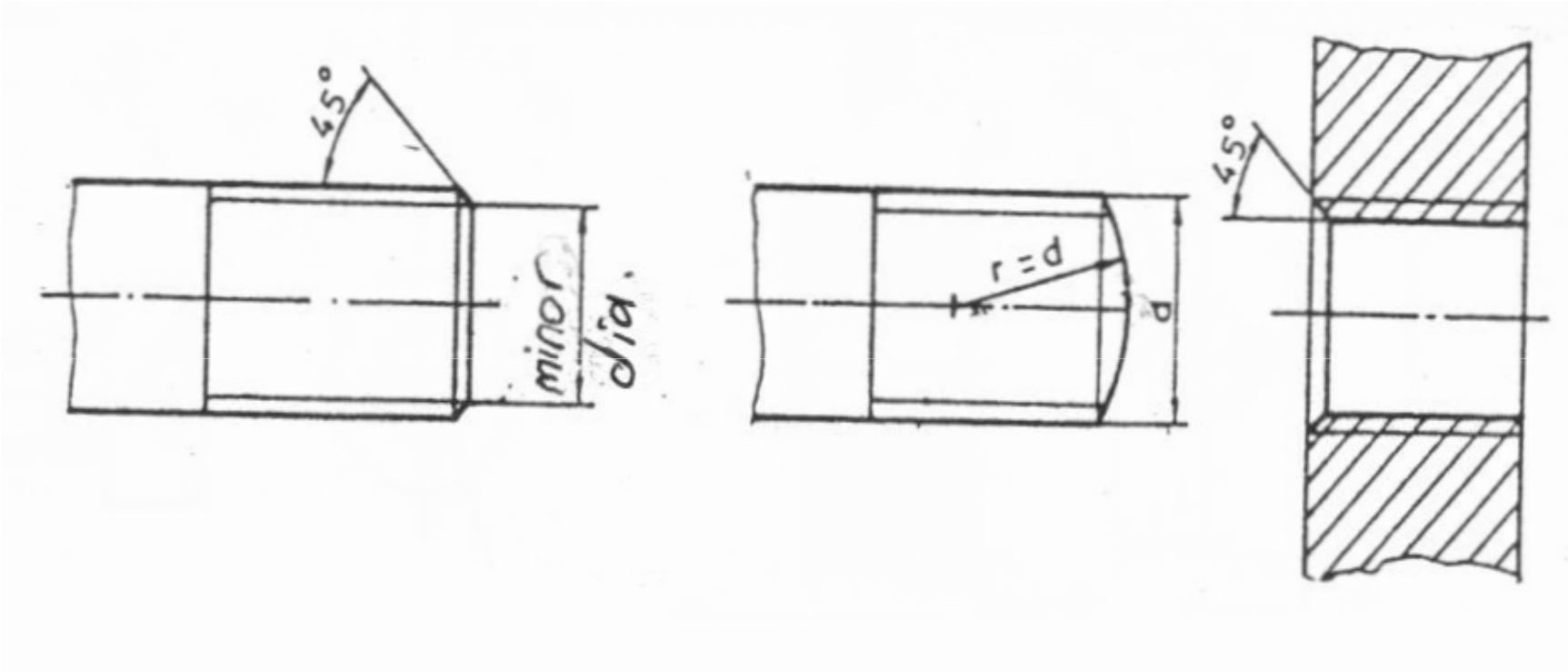
Simplified thread representation.

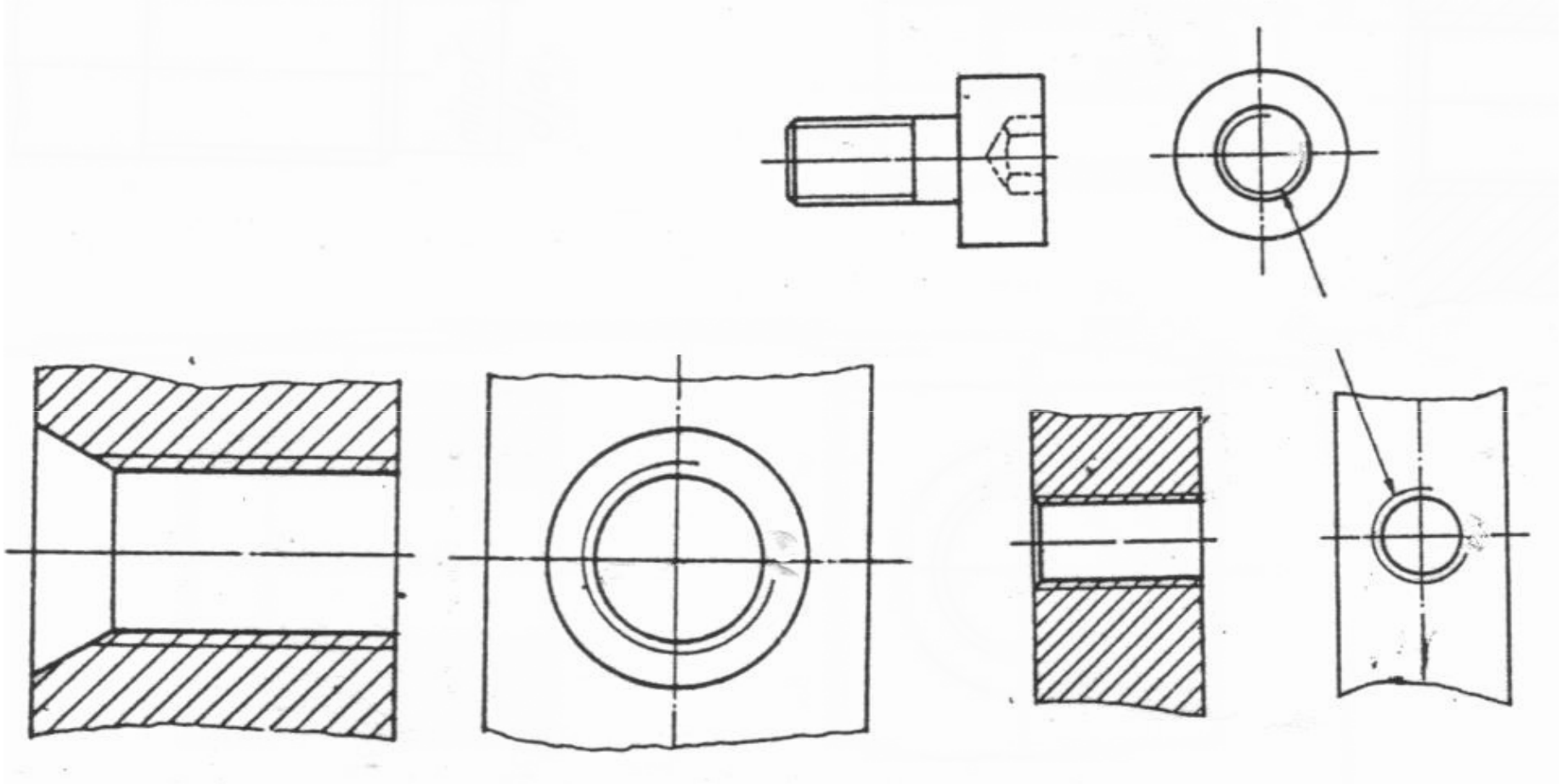


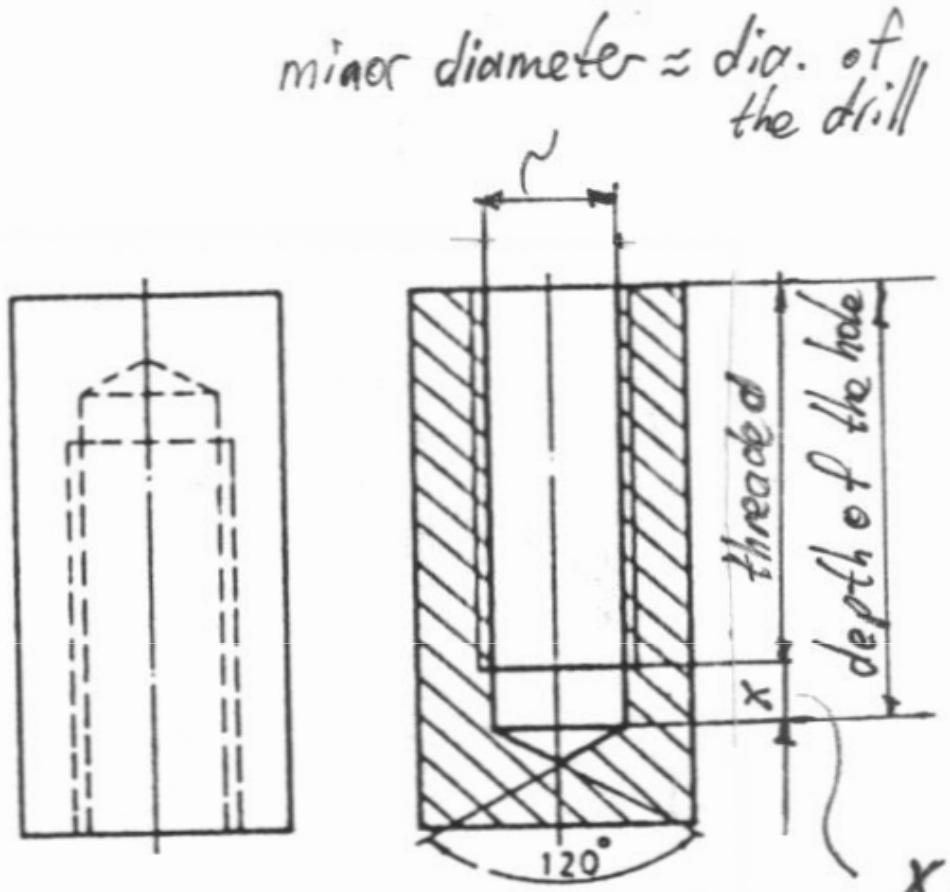



M 16


M 16


45°
minor dia.
r = d
d
45°



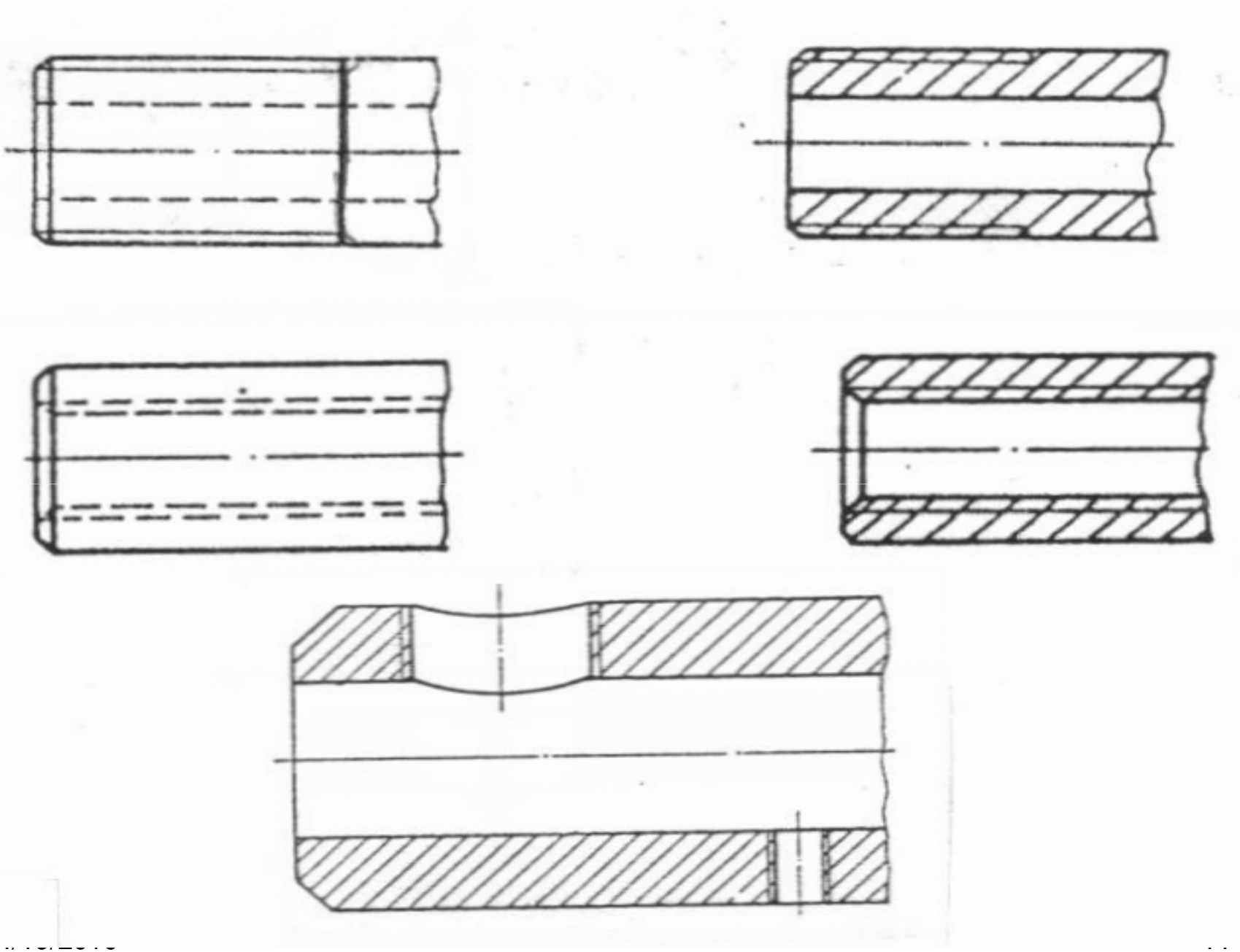


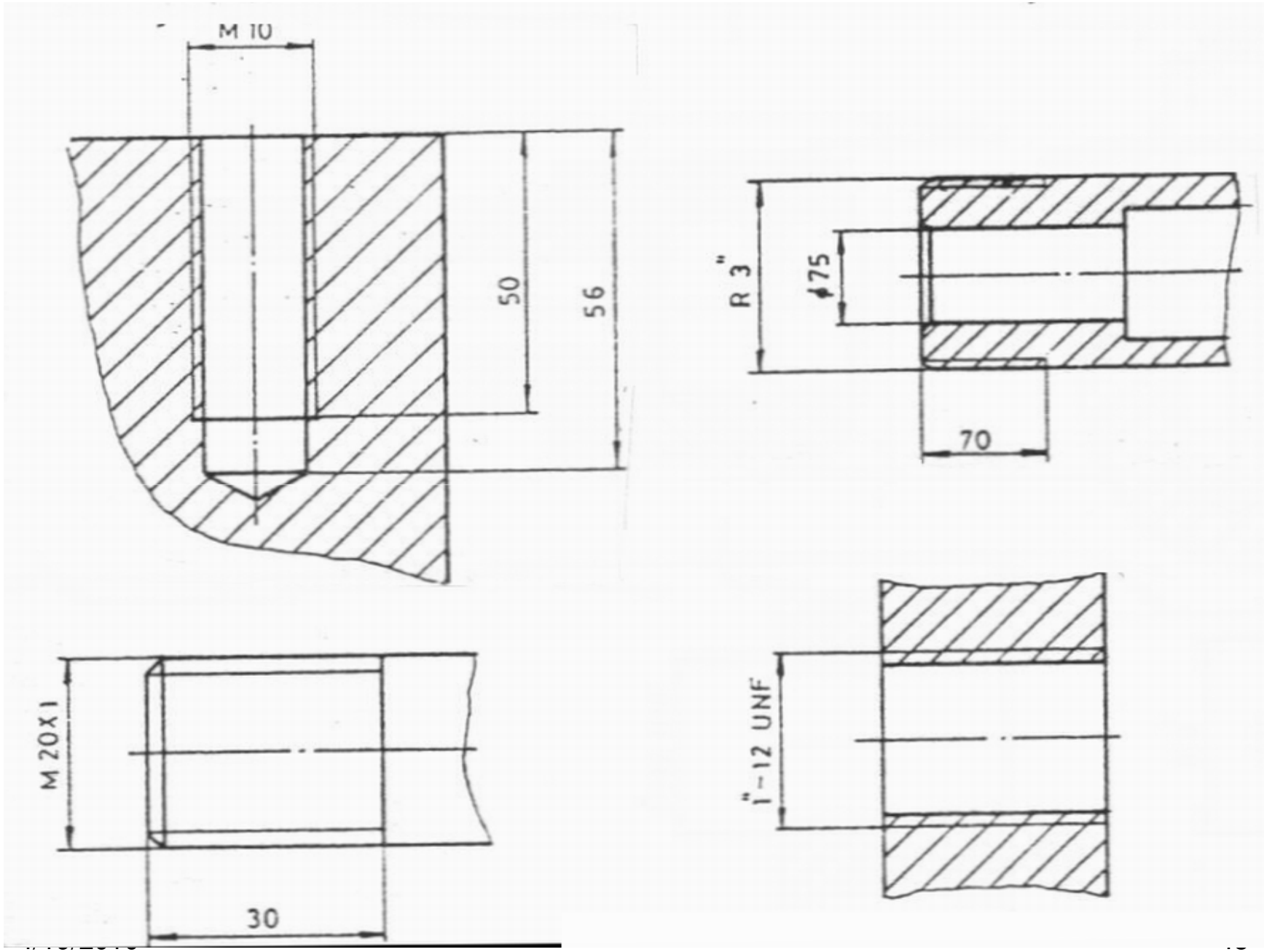
$x \simeq 5p$ (if $d \leq 5$)

$x \simeq 4p$ (if $6 \leq d \leq 10$)

$x \simeq 3p$ (if $12 \leq d \leq 39$)

$x \simeq 2.3p$ (if $40 \leq d \leq 68$)




M 10
50
56
R 3"
ϕ75
70
M 20X1
30
1"-12 UNF

Thread Class (For inch threads)

Three classes of external thread (classes 1A, 2A, and 3A) and three classes of internal thread (classes 1B, 2B, and 3B) are available. These classes differ in the amount of allowances and tolerances provided in each class.

The general characteristics and uses of the various classes are as follows.

Classes 1A and 1B These classes produce the loosest fit, that is, the greatest amount of play (free motion) in assembly. They are useful for work where ease of assembly and disassembly is essential, such as for stove bolts and other rough bolts and nuts.

Classes 2A and 2B These classes are designed for the ordinary good grade of commercial products, such as machine screws and fasteners, and for most interchangeable parts.

Classes 3A and 3B These classes are intended for exceptionally high-grade commercial products, where a particularly close or snug fit is essential and the high cost of precision tools and machines is warranted.

EXAMPLE 1

Standard Unified External Screw Thread:

.250-20 UNC-2A, ASME B1.1

For multiple start threads the number of threads per inch is replaced by the following: pitch in inches *P*, a dash, lead in inches *L*, and the number of starts in inches.

EXAMPLE 2

Standard Unified External Multiple Start Screw Thread:

.750-.0625P-.1875L(3 STARTS)UNF-2A, ASME B1.1

Number-size threads may be shown because of established industrial drafting room practices. When a number-size thread is specified, a three-place decimal inch equivalent, enclosed in parentheses, is placed after the number (see Example).

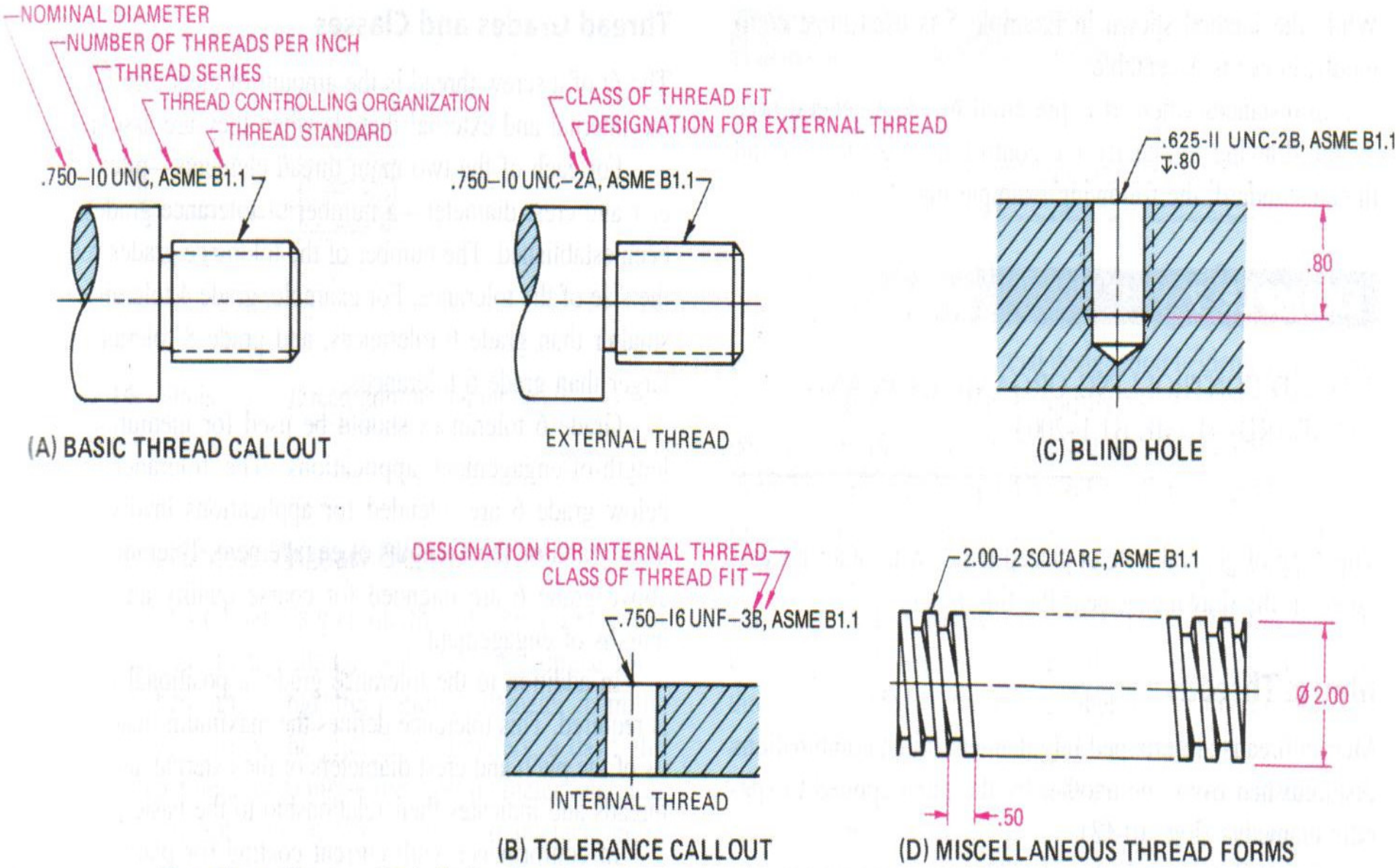
EXAMPLE 3

Standard Unified External Number-Size Thread:

10 (.190)-32 UNF-2A, ASME B1.1

Standard Unified Internal Thread:

5 (.125)-40 UNC-2B, ASME B1.1



Thread specifications for inch-size threads.

Thread Grades and Classes (for Metric Threads)

The *fit* of a screw thread is the amount of clearance between the internal and external threads when they are assembled.

For each of the two main thread elements—pitch diameter and crest diameter—a number of tolerance grades have been established. The number of the tolerance grades reflects the size of the tolerance. For example, grade 4 tolerances are smaller than grade 6 tolerances, and grade 8 tolerances are larger than grade 6 tolerances.

Grade 6 tolerances should be used for medium-quality length-of-engagement applications. The tolerance grades below grade 6 are intended for applications involving fine quality and/or short lengths of engagement. Tolerance grades above grade 6 are intended for coarse quality and/or long lengths of engagement.

In addition to the tolerance grade, a positional tolerance is required. This tolerance defines the maximum-material limits of the pitch and crest diameters of the external and internal threads and indicates their relationship to the basic profile.

In conformance with current coating (or plating) thickness requirements and the demand for ease of assembly, a series of tolerance positions reflecting the application of varying amounts of allowance has been established as follows.

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)

PREFERRED TOLERANCE CLASSES, ISO THREADS*

Quality	External threads (bolts)									Internal threads (nuts)								
	Tolerance position e (large allowance)			Tolerance position g (small allowance)			Tolerance position h (no allowance)			Tolerance position G (small allowance)			Tolerance position H (no allowance)		
	Length of engagement			Length of engagement			Length of engagement			Length of engagement			Length of engagement		
	Group S	Group N	Group L	Group S	Group N	Group L	Group S	Group N	Group L	Group S	Group N	Group L	Group S	Group N	Group L
Fine							3h4h	4h	5h4h				4H	5H	6H
Medium		**6e**	7e6e	5g6g	**6g**	7g6g	5h6h	6h	7h6h	5G	6G	7G	**5H**	**6H**	**7H**
Coarse					8g	9g8g					7G	8G		7H	8H

LENGTH OF THREAD ENGAGEMENT GROUPS

Nominal Size Diam.		Pitch P	Length of Thread Engagement				Nominal Size Diam.		Pitch P	Length of Thread Engagement			
			Group S		Group N	Group L				Group S		Group N	Group L
Over	To and Incl		To and Incl	Over	To and Incl	Over	Over	To and Incl		To and Incl	Over	To and Incl	Over
1.5	2.8	0.2	0.5	0.5	1.5	1.5	22.4	45	1	4	4	12	12
		0.25	0.6	0.6	1.9	1.9			1.5	6.3	6.3	19	19
		0.35	0.8	0.8	2.6	2.6			2	8.5	8.5	25	25
		0.4	1	1	3	3			3	12	12	36	36
		0.45	1.3	1.3	3.8	3.8			3.5	15	15	45	45
									4	18	18	53	53
2.8	5.6	0.35	1	1	3	3			4.5	21	21	63	63
		0.5	1.5	1.5	4.5	4.5							
		0.6	1.7	1.7	5	5	45	90	1.5	7.5	7.5	22	22
		0.7	2	2	6	6			2	9.5	9.5	28	28
		0.75	2.2	2.2	6.7	6.7			3	15	15	45	45
		0.8	2.5	2.5	7.5	7.5			4	19	19	56	56
									5	24	24	71	71
5.6	11.2	0.75	2.4	2.4	7.1	7.1			5.5	28	28	85	85
		1	3	3	9	9			6	32	32	95	95
		1.25	4	4	12	12			2	12	12	36	36
		1.5	5	5	15	15	90	180	3	18	18	53	53
									4	24	24	71	71
11.2	22.4	1	3.8	3.8	11	11			6	36	36	106	106
		1.25	4.5	4.5	13	13			3	20	20	60	60
		1.5	5.6	5.6	16	16	180	355	4	26	26	80	80
		1.75	6	6	18	18			6	40	40	118	118
		2	8	8	24	24							
		2.5	10	10	30	30							

All dimensions are given in millimeters. (Courtesy of ISO Standards.)

ISO Metric Screw Thread Designation

Metric 60° screw thread designation (thread note) is expressed in this order: the metric thread symbol M, the thread form symbol J, where applicable, the nominal diameter in millimeters, a lower case x, the pitch in millimeters, a dash, the pitch diameter tolerance symbol, the crest diameter tolerance symbol (if different from that of the pitch diameter), and a space followed by any qualifying information. For the coarse-thread series only, the pitch is not shown unless the dimension for the length of the thread is required

EXAMPLE 1

Standard Metric M Screw Thread:

M6x1-4h6h, ASME B1.13M

EXAMPLE 2

Standard Metric MJ Thread, Gaging System 21:

MJ6x1-4H (21), ASME B1.21M

The metric thread size or the pitch should include a zero before the decimal if the value is less than one, but should not show a zero as the last number of the value, e.g., M10x1.5 and MJ 2.5x0.45. Notice that there is no space on either side of the x.

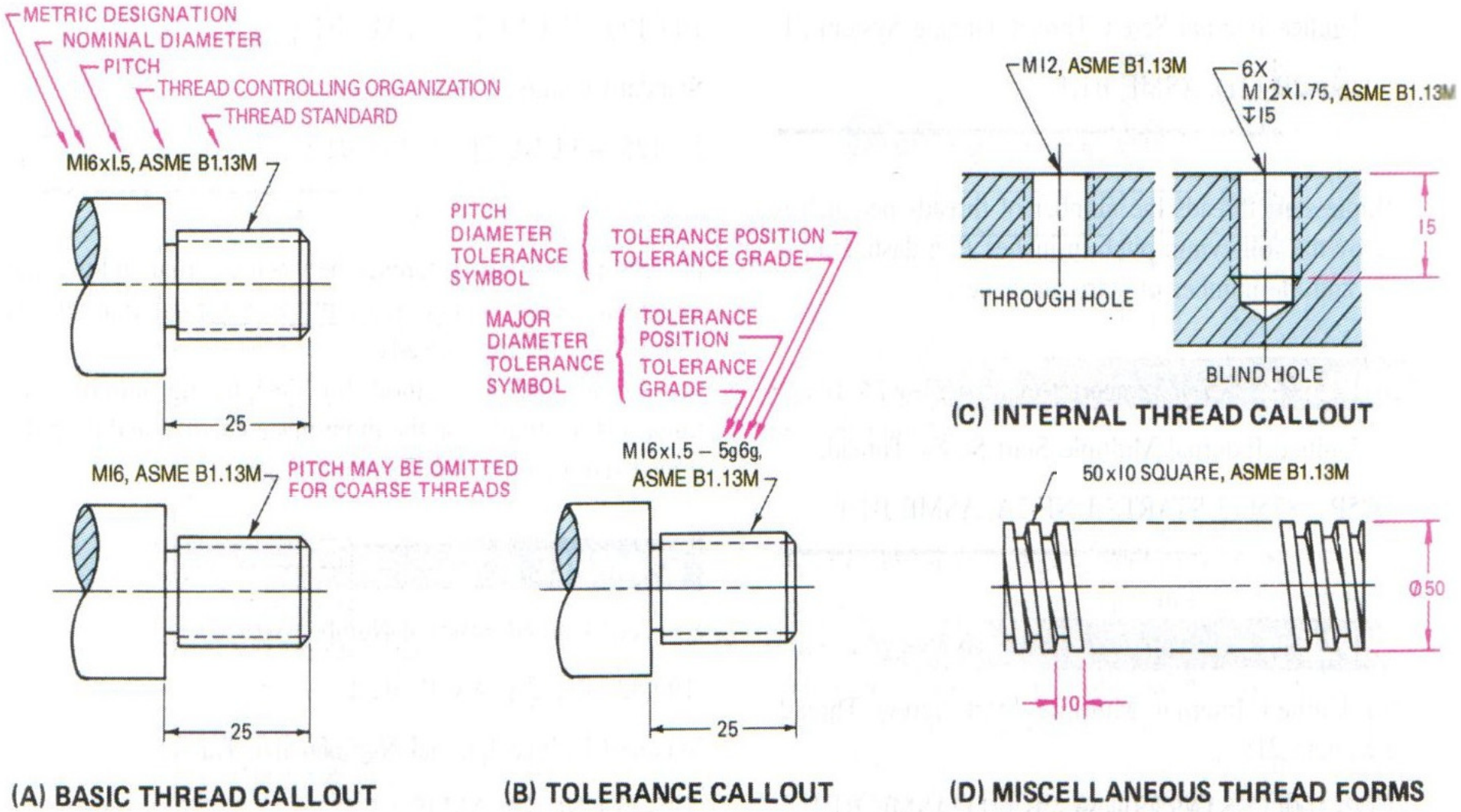
For multiple start threads, the pitch is replaced by the following: *L* (lead in millimeters), *P* (pitch in millimeters), and the number of starts in parentheses.

EXAMPLE 3

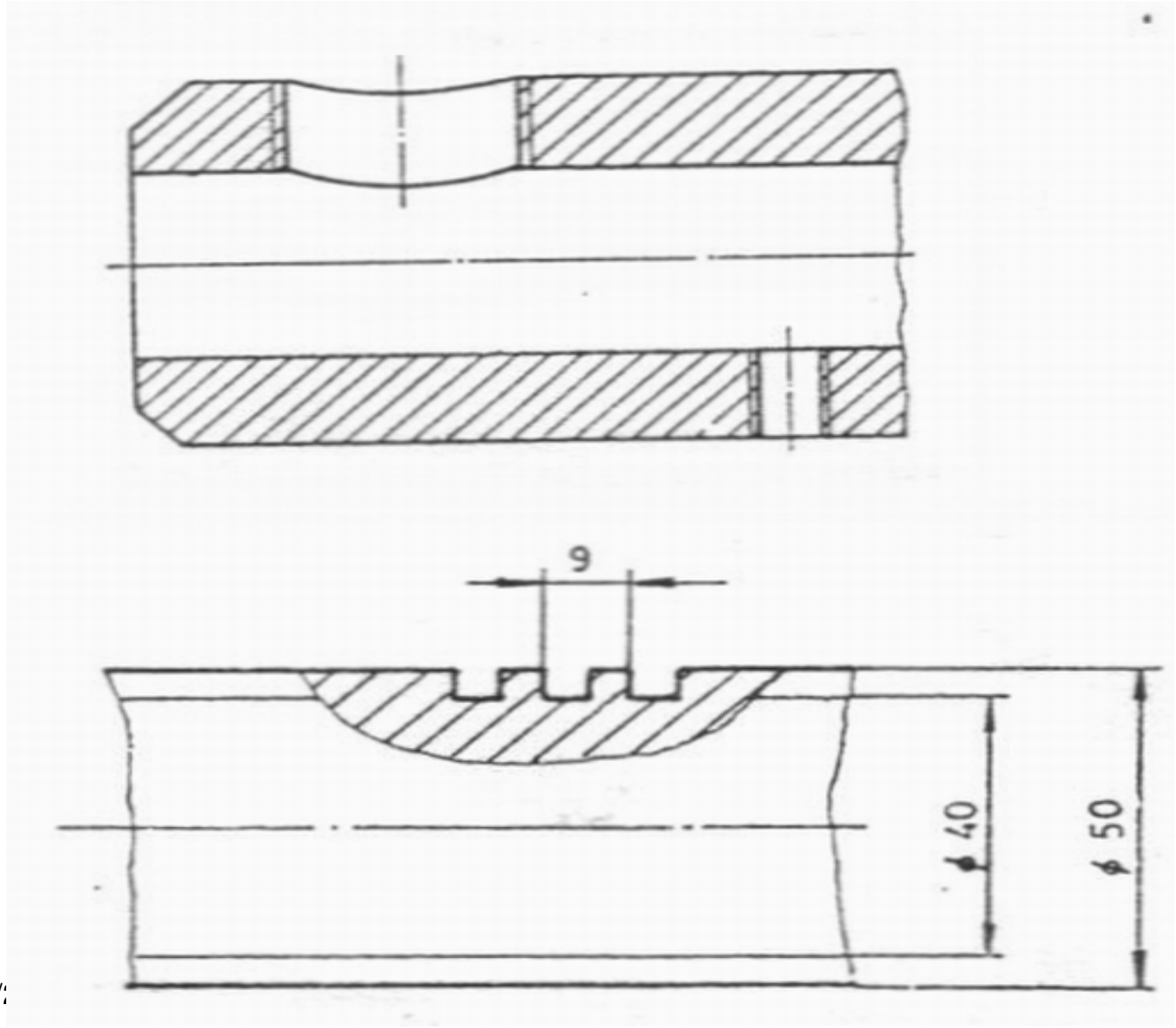
Standard Metric MJ Thread:

MJ20xL7.5P2.5(3 STARTS)-4h6h, ASME B1.21M

The two types of metric 60° screw threads in common use are the M and the MJ forms. The MJ form is similar to the standard metric (M) threads, except the sharp V at the root diameter of the external thread has been replaced with a large radius, which strengthens this stress point, providing extra strength. Since the radius increases the minor diameter of the external thread, the minor diameter of the internal thread is enlarged to clear the radius. All other dimensions are the same as the M threads. The MJ thread form is used predominately in applications requiring high fatigue strength, as found in the aerospace and automotive industries.



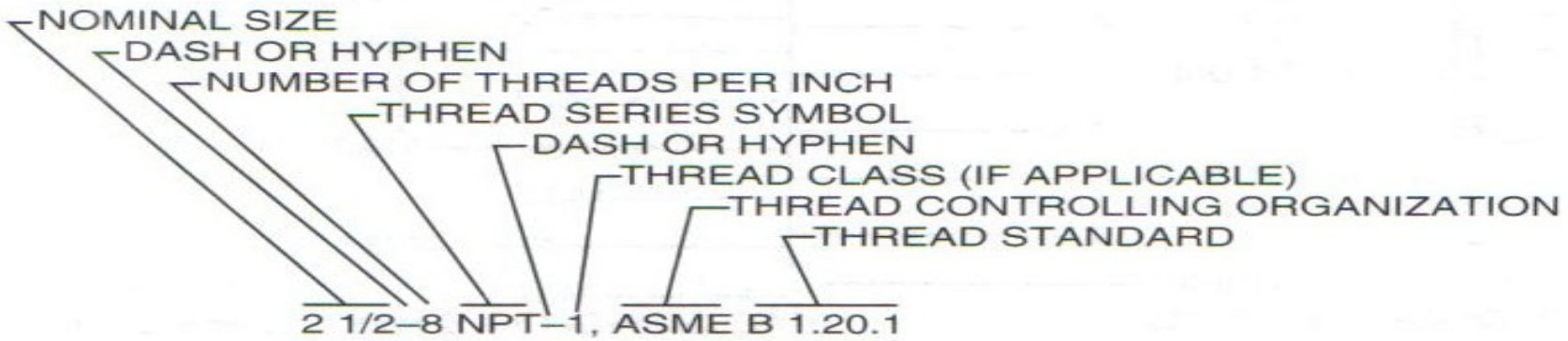
Thread specifications for metric threads.


9
ϕ 40
ϕ 50

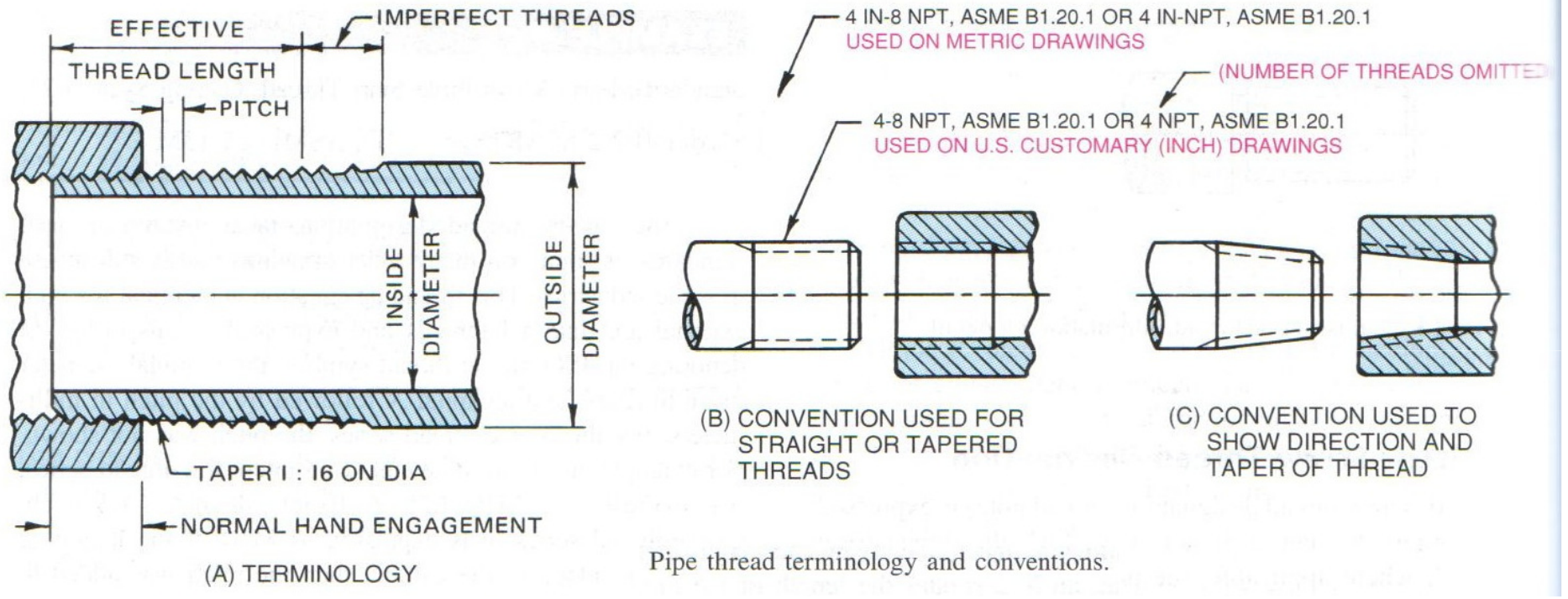
Pipe Threads

The pipe universally used is the inch-sized pipe. When pipe is ordered, the nominal diameter and wall thickness (in inches or millimeters) are given. In calling for the size of thread, the note used is similar to that for screw threads. When calling for a pipe thread on a metric drawing, the abbreviation *IN* follows the pipe size

The designation should cover—in sequence—the nominal size in fractional inches (a decimal inch equivalent may be used only when the computer or other machine cannot handle fractions), the number of threads per inch, the thread series symbol (e.g., NPT or NPS), and the thread class (if applicable), and the thread controlling organization and standard (e.g., ASME B1.20.1).



Pipe thread designation.



Pipe thread terminology and conventions.

British Representation:

0.75-10 UNC-2A x 2.50, LH, DOUBLE, HEXAGON CAP SCREW

0.63- 11 UNC- 2B HEXAGON NUT
SQUARE NUT

½" -11 NPS
NPT

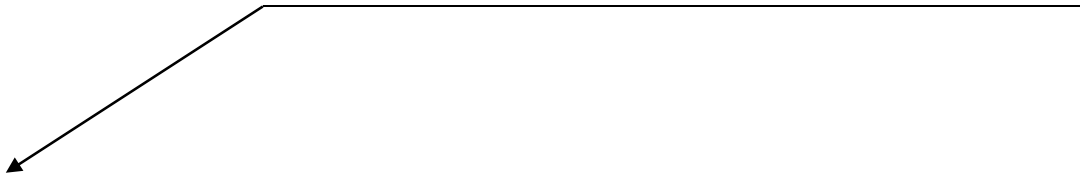
WIDE
NARROW

HELICAL-SPRING LOCK WASHER-1/4" REGULAR-PHOSPHORUS BRONZE

INTERNAL-TOOTH WASHER-1/4" –TYPE A- STEEL

EXTERNAL-TOOTH WASHR-0.562-TYPE B-STEEL

7/8 Drill, 3 Deep, 1-8 UNC- 2B, 2 Deep



ISO Representation:

M18x0.75-40, 5g 6g L-LH-DOUBLE HEX CAP SCR
M8x1.25 HEX NUT

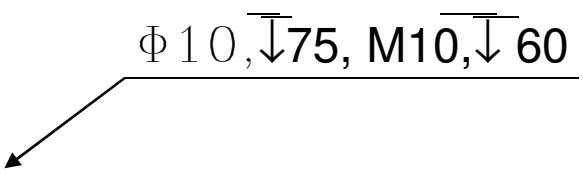
Turkish Rep.:

k
o
Altıköşe Başlı Cıvata M18x0.75 i-40 TS 1021/2, OK, 5D

Altıköşe Somun M8x1.25 i TS 1026/2 K 4D

R ½" TS 61/20 or R ½" DIN 259

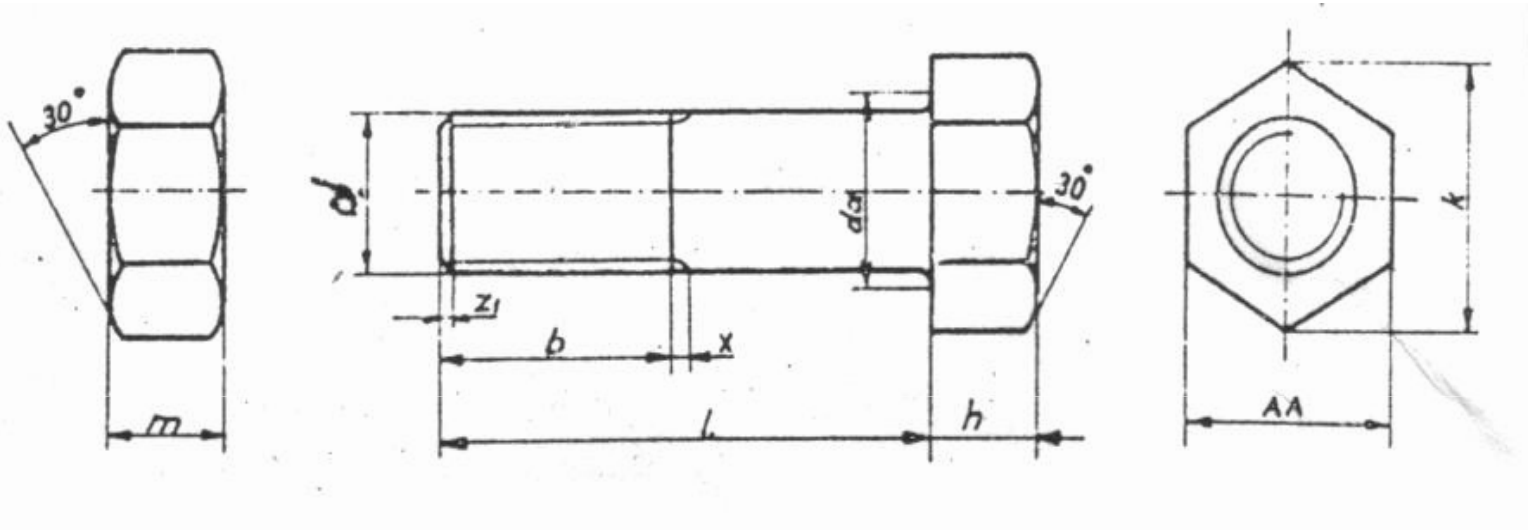
Rondela 15 TS 79/1, St37



$m = 0.8\,d$

$h = 0.7\,d$

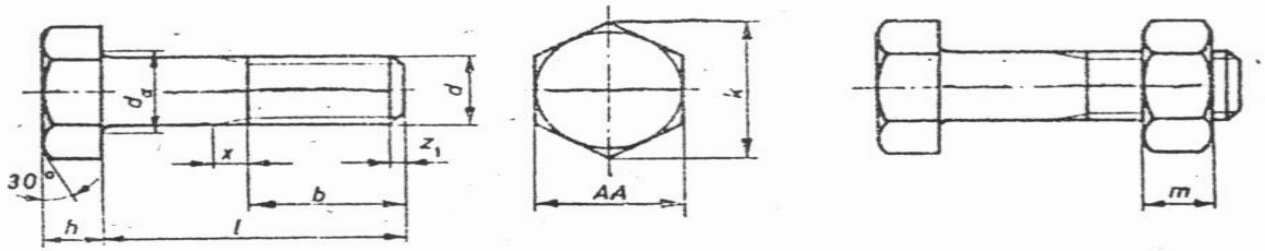
$k = 2d$



ALTIKÖŞE BAŞLI CIVATA

TS 1021/2
DIN 601

Somunsuz — İşleme : (k) — Somunlu



Anma çapı M 12 ve uzunluğu L=100 mm olan altıköşe başlı somunsuz cıvatanın gösterilişi :
Altıköşe başlı cıvata M12—100 TS 1021/2

Anma çapı M12 ve uzunluğu l=100 mm olan altıköşe başlı somunlu cıvatanın gösterilişi :
Altıköşe başlı cıvata M12—100 So TS 1021/2

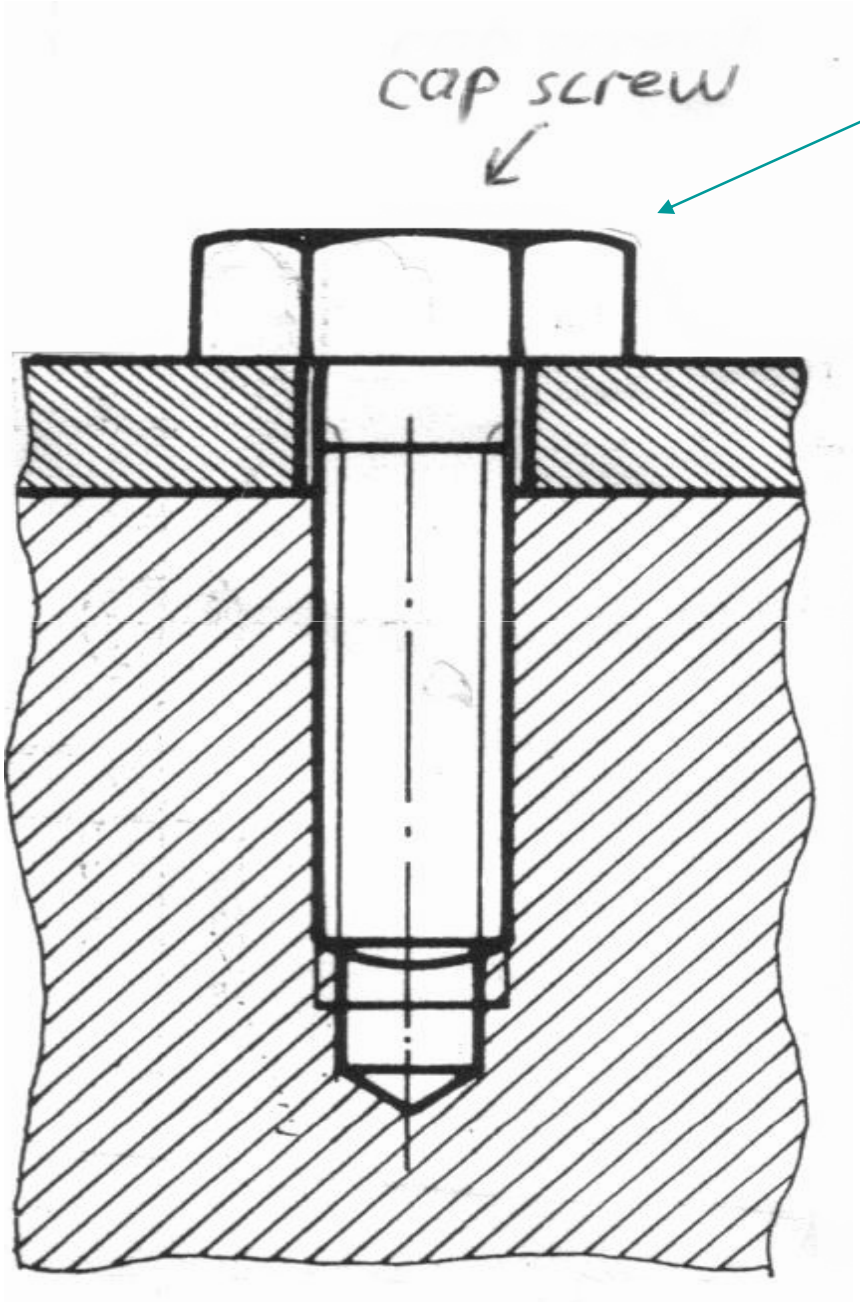
d	M5	M6	M8	M10	M12	M16	M20	M24	(M27)	M30	(M33)	M36	(M39)	M42
b 1)	16	18	22	26	30	38	46	54	60	66	72	78	84	90
b 2)	—	—	28	32	36	44	52	60	66	72	78	84	90	96
b 3)	—	—	—	—	—	57	65	73	79	85	91	97	103	109
d_a max	6	7,2	10,2	12,2	15,2	19,2	24,4	28,4	32,4	35,4	38,4	42,4	45,4	48,6
k min	8,63	10,39	14,20	18,72	20,88	26,17	32,95	39,55	45,20	50,85	55,37	60,79	66,44	72,09
h	3,5	4	5,5	7	8	10	13	15	17	19	21	23	25	26
m	4	5	6,5	8	10	13	16	19	22	24	26	29	31	34
AA	8	10	13	17	19	24	30	36	41	46	50	55	60	65
l	16	16	16	16	20	30	30	40	60	80	80	100	100	120
	50	80	100	200	400	520	520	520	520	520	520	520	520	520

Note:
Standard thread lengths, b, for bolts and for studs may be calculated as follows:

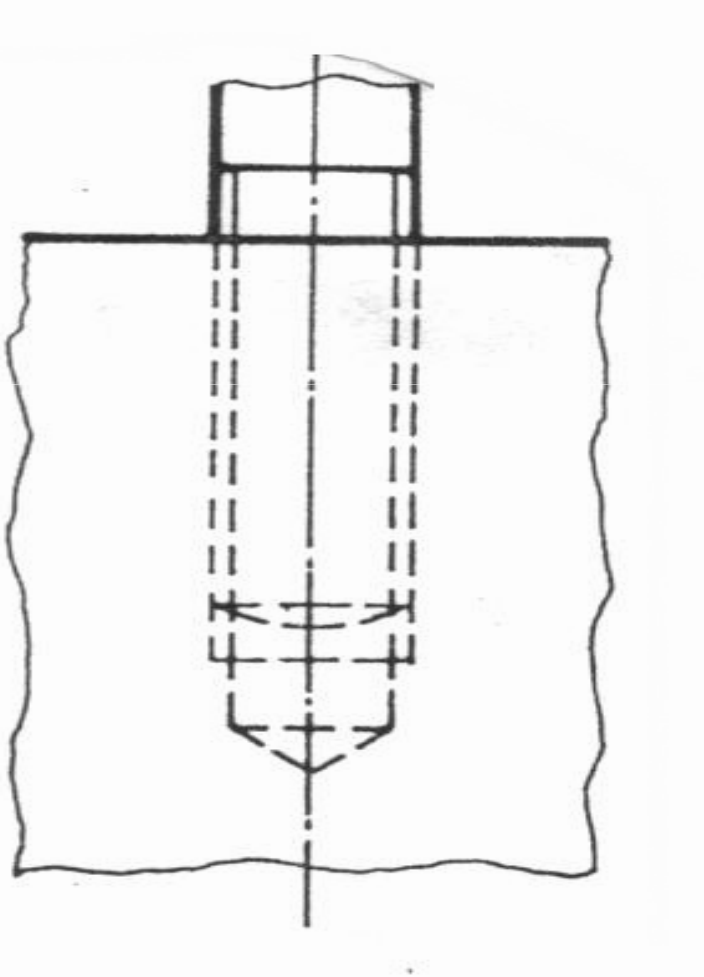
If $l \leq 125$ [mm] $\longrightarrow b = 2d + 6$ [mm]

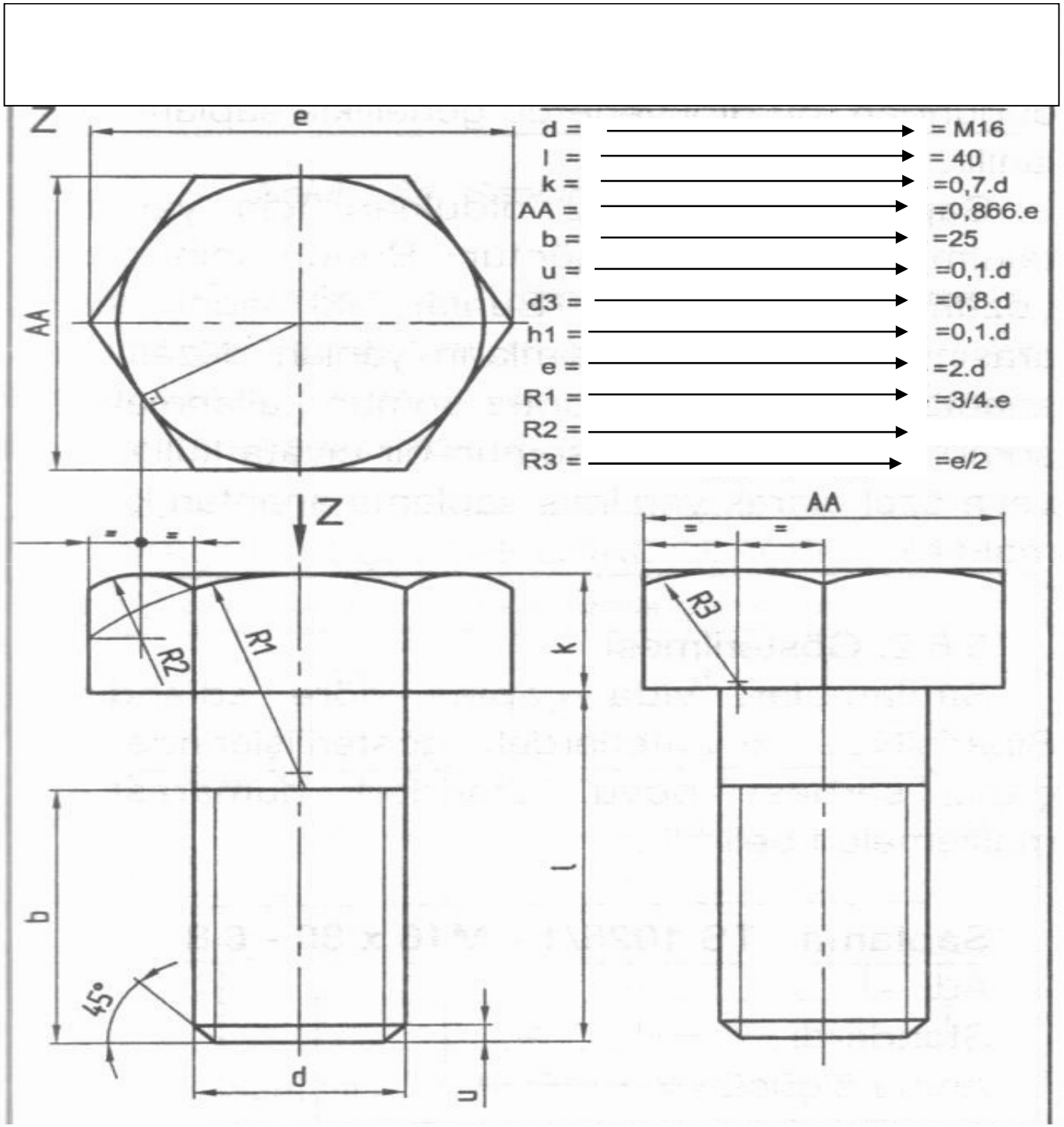
If $125 < l \leq 200$ [mm] $\longrightarrow b = 2d + 12$ [mm]

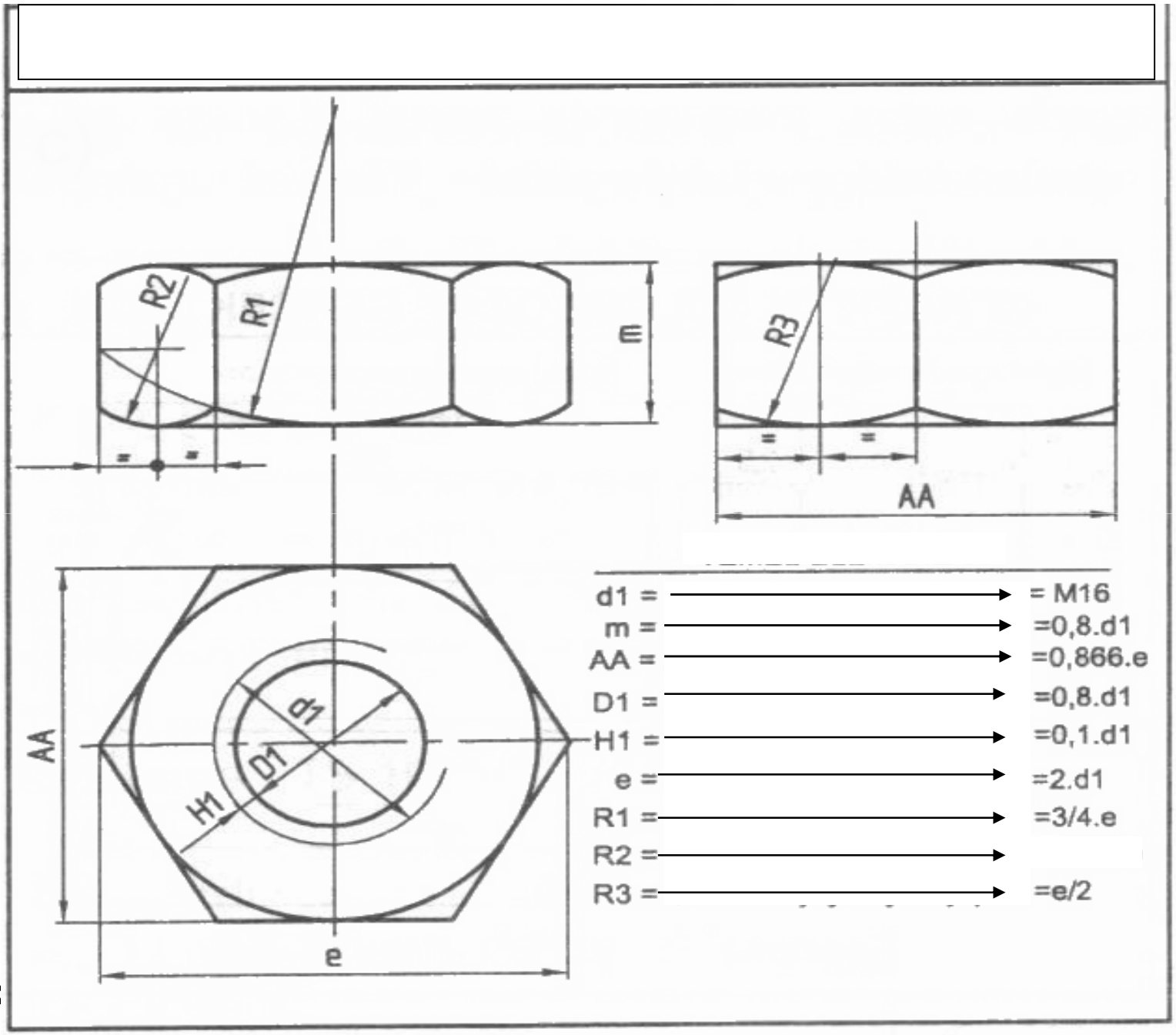
If $l > 200$ [mm] $\longrightarrow b = 2d + 25$ [mm]



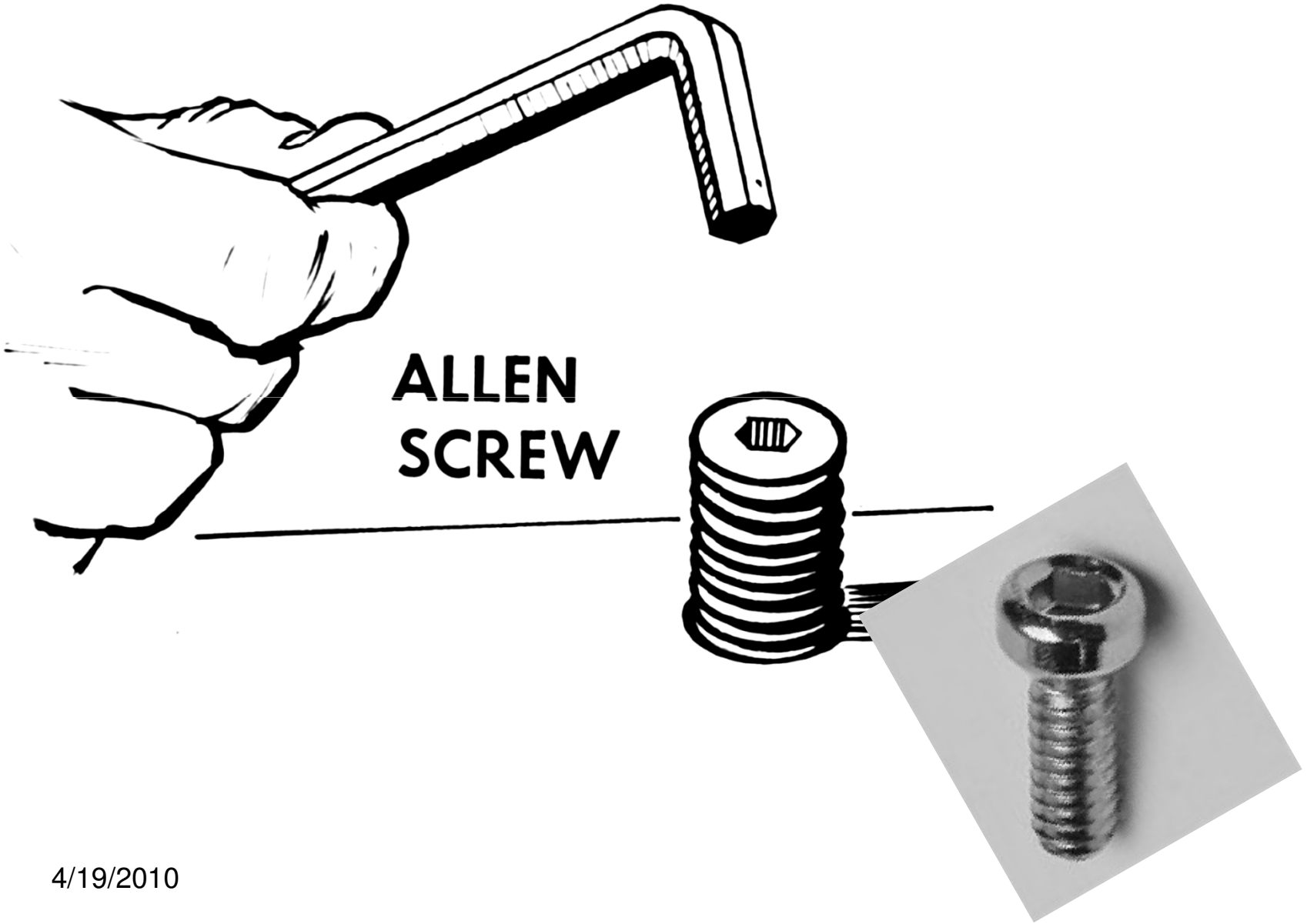
Cıvata

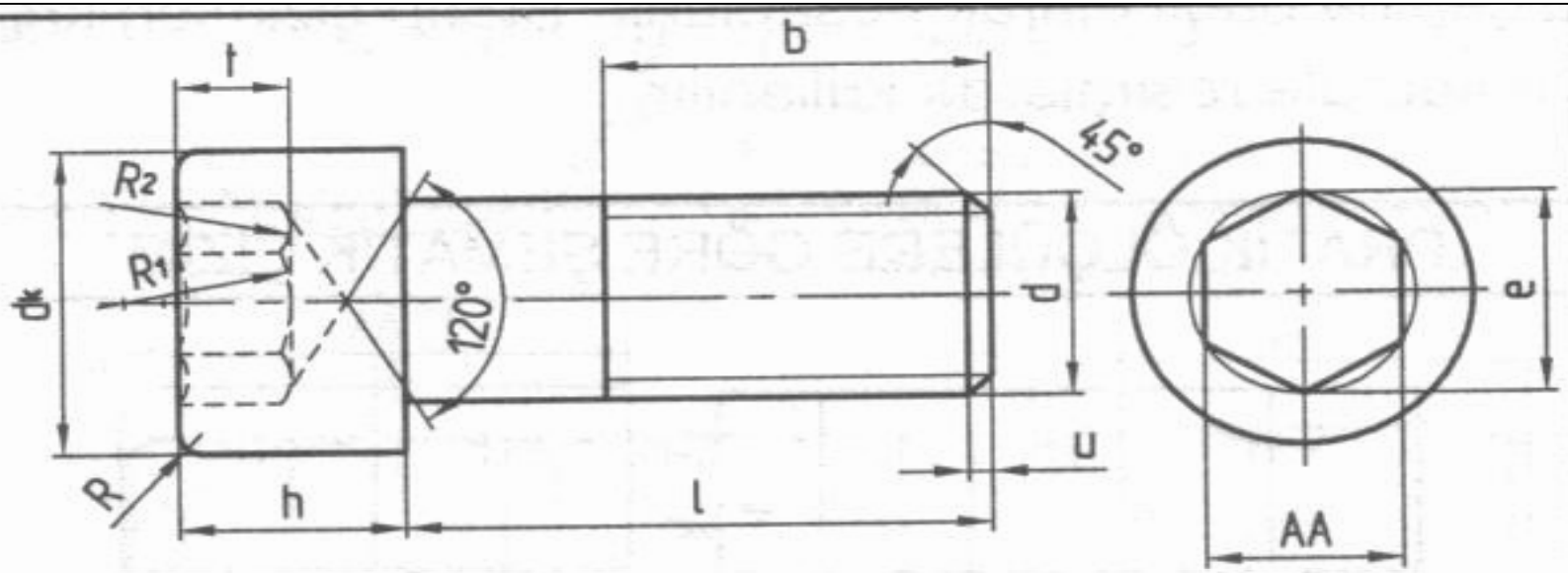



Z
e
AA
d =
l =
k =
AA =
b =
u =
d3 =
h1 =
e =
R1 =
R2 =
R3 =
= M16
= 40
=0,7.d
=0,866.e
=25
=0,1.d
=0,8.d
=0,1.d
=2.d
=3/4.e
=e/2
Z
AA
R1
R2
R3
k
l
b
45°
d
u


R2
R1
e
R3
m
m
AA
AA
D1
d1
H1
e
d1 = → = M16
m = → =0,8.d1
AA = → =0,866.e
D1 = → =0,8.d1
H1 = → =0,1.d1
e = → =2.d1
R1 = → =3/4.e
R2 = →
R3 = → =e/2

ALLEN WRENCH





d =	—— = M16	d3 =	. = 0,8.d
l =	—— = 40	h1 =	. = 0,1.d
h =	—— = 1.d	e =	. = 1.d
dk =	—— =1,5.d	R =	- = 0,1.d
t =	—— = 0,5.d	R1 =	- = 3/4.d
AA =	—— = 0,886.d	R2 =	- = 0,4.d
b =	—— = 25		
u =	—— = 0,1.d		

Inbus **(Alyen)** **ALLEN**

Self-Locking and Back-Driving of Power Screws

Self-locking refers to a condition in which the screw cannot be turned by the application of any magnitude of force applied axially (not as a torque) to the nut. In other words, a self-locking screw will hold the load in place without any application of torque. It does not need a brake to hold the load. This is a very useful situation. For example, if you jacked up your car with a screw jack that was not self-locking, as soon as you let go of the jack handle the car would run the jack back down. You would have to be pretty fast with the lug wrench to change a tire in that case.

The opposite situation to self-locking is a screw that can be back driven, which means that pushing axially on the nut will cause the screw to turn. While of no value for a jack application, this is a useful feature in other situations. One example is a so-called *Yankee screwdriver,* which has a high-lead thread on its barrel that is attached to the blade. The handle is the nut. As you push down axially on the handle, the barrel turns, driving the wood screw into place. Any application in which you want to convert linear motion to rotary motion is a candidate for a back-drivable lead screw.

The condition of self-locking for a power or lead screw is easily predicted if the coefficient of friction in the screw-nut joint is known. The relationship between the friction coefficient and the screw's lead angle determines its self-locking condition. A screw will self-lock if

$$\mu \geq \frac{L}{\pi d_p}\cos\alpha, \qquad \text{or} \qquad \mu \geq \tan\lambda\cos\alpha$$

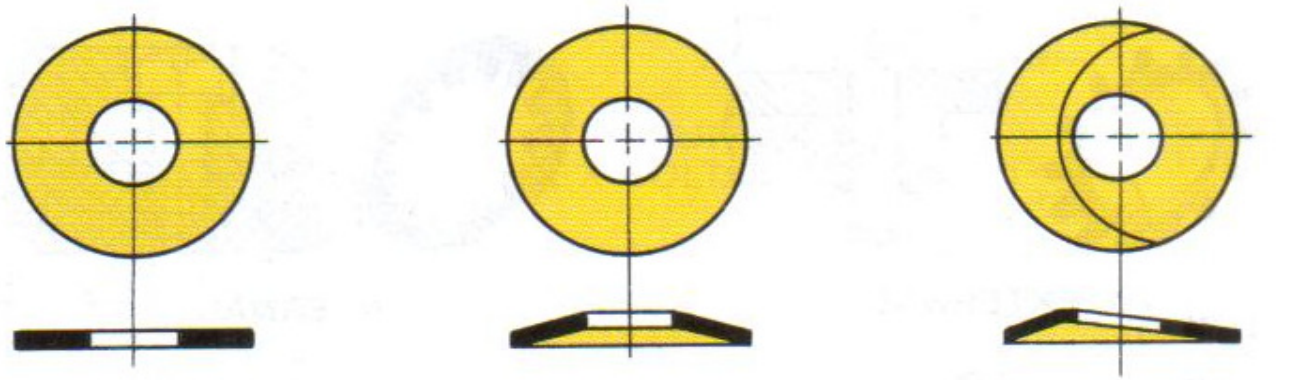
If it is a square thread $\cos\alpha = 1$, and this reduces to

$$\mu \geq \frac{L}{\pi d_p}, \qquad \text{or} \qquad \mu \geq \tan\lambda$$

Note that these relationships presume a static-loading situation. The presence of any vibration from dynamic loading or other sources can cause an otherwise self-locking screw to back down. Any vibrations that cause relative motion between screw and nut will inevitably cause slippage down the thread's incline.

Washers

Washers are one of the most common forms of hardware and perform many varied functions in mechanically fastened assemblies. They may be needed just to span an oversize clearance hole, to give better bearing for nuts or screw faces, or to distribute loads over a greater area. Often, they serve as locking devices for threaded fasteners. They are also used to maintain a spring-resistance pressure, to guard surfaces against marring, and to provide a seal.



Flat and conical washers.

Lock washers prevent a fastener from loosening due to vibration or stress.

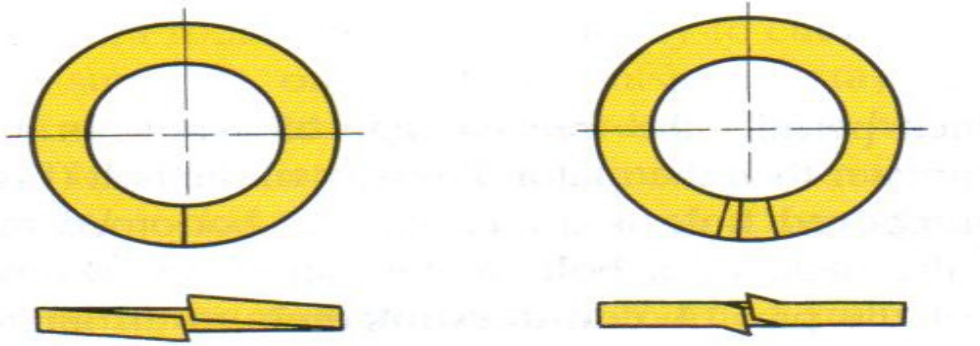
Classification of Washers

Washers are commonly the elements that are added to screw systems to keep them tight, but not all washers are locking types. Many washers serve other functions, such as surface protection, insulation, sealing, electrical connection, and spring-tension take-up devices.

Flat Washers Plain, or flat, washers are used primarily to provide a bearing surface for a nut or a screw head, to cover large clearance holes, and to distribute fastener loads over a large area—particularly on soft materials such as aluminum or wood

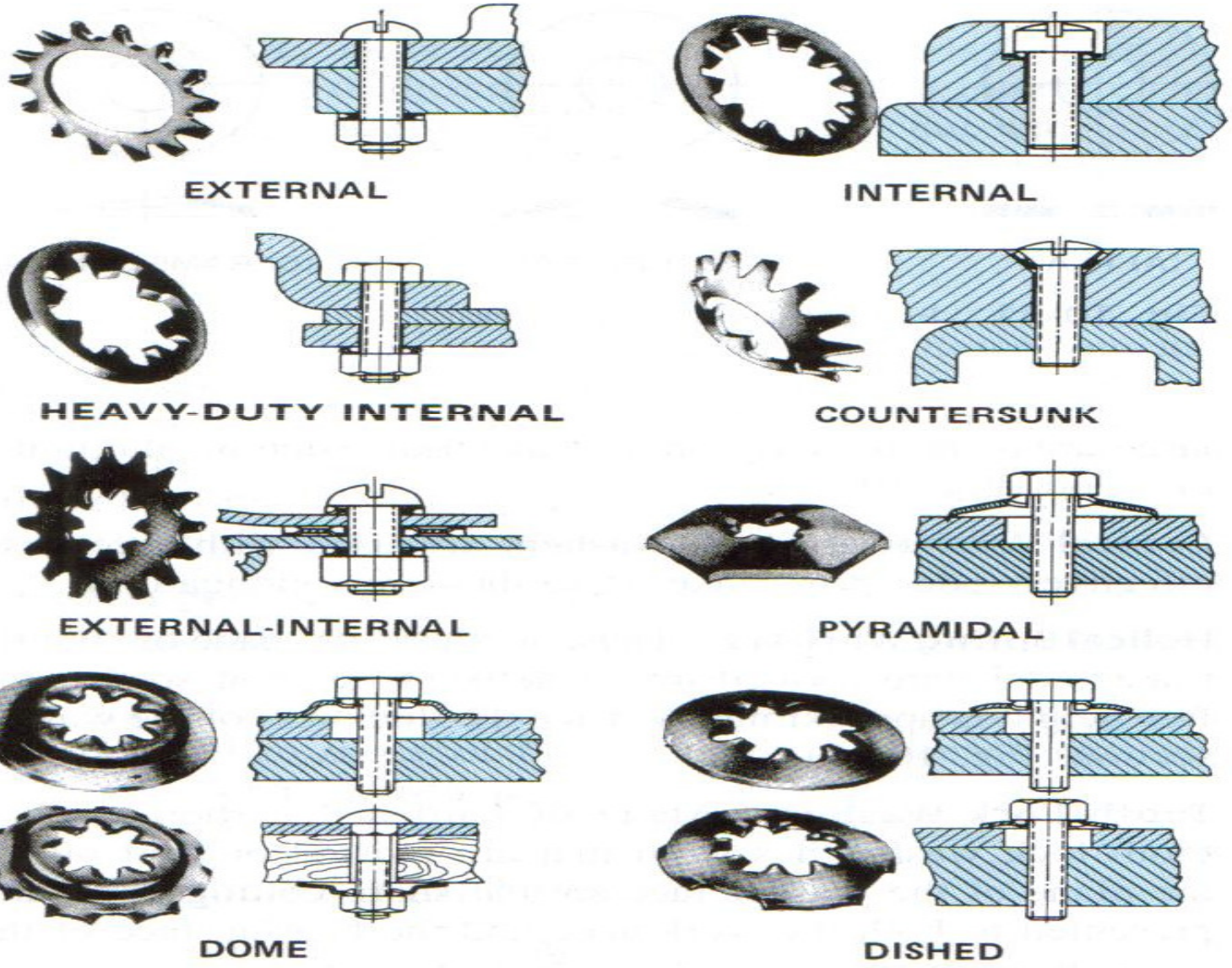
Conical Washers These washers are used with screws to effectively add spring take-up to the screw elongation.

Helical Spring Washers These washers are made of slightly trapezoidal wire formed into a helix of one coil so that the free height is approximately twice the thickness of the washer section



Helical spring washers.

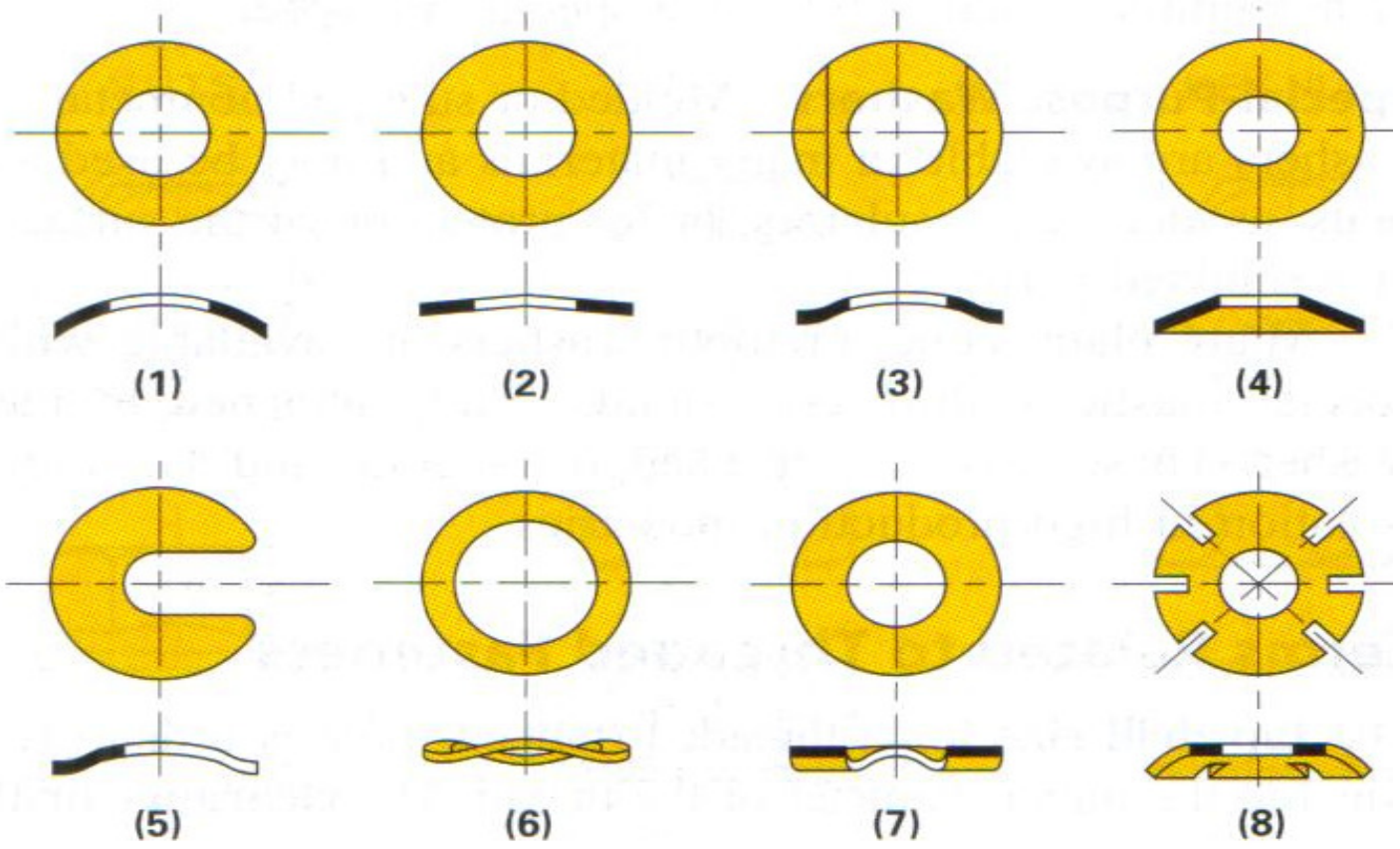
Tooth Lock Washers Made of hardened carbon steel, a tooth lock washer has teeth that are twisted or bent out of the plane of the washer face so that sharp cutting edges are presented to both the workpiece and the bearing face of the screw head or nut



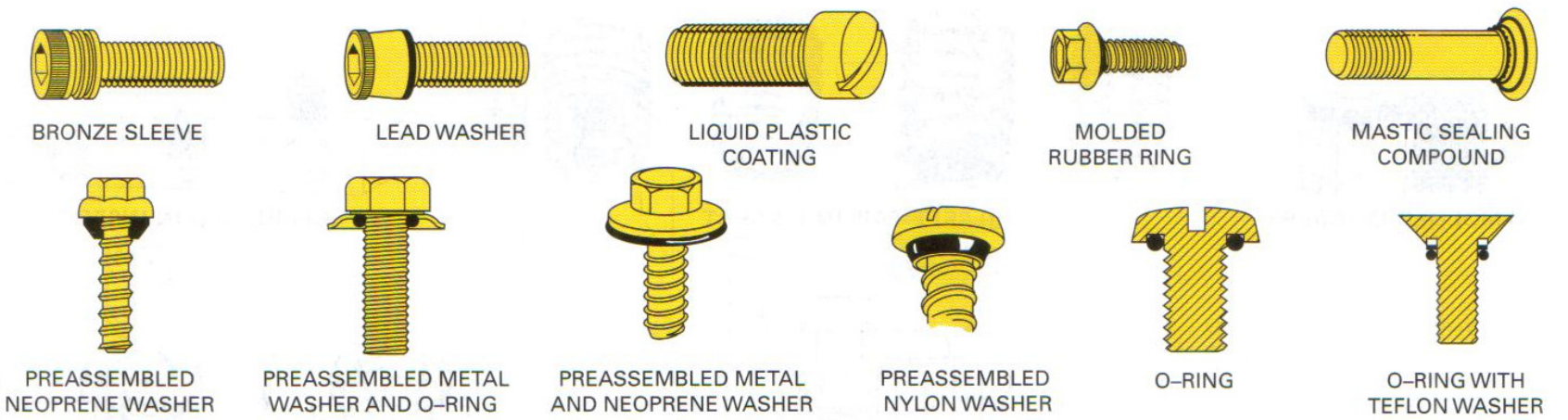
Tooth lock washers.

Spring Washers There are no standard designs for spring washers They are made in a great variety of sizes and shapes and are usually selected from a manufacturer's catalog for some specific purpose.

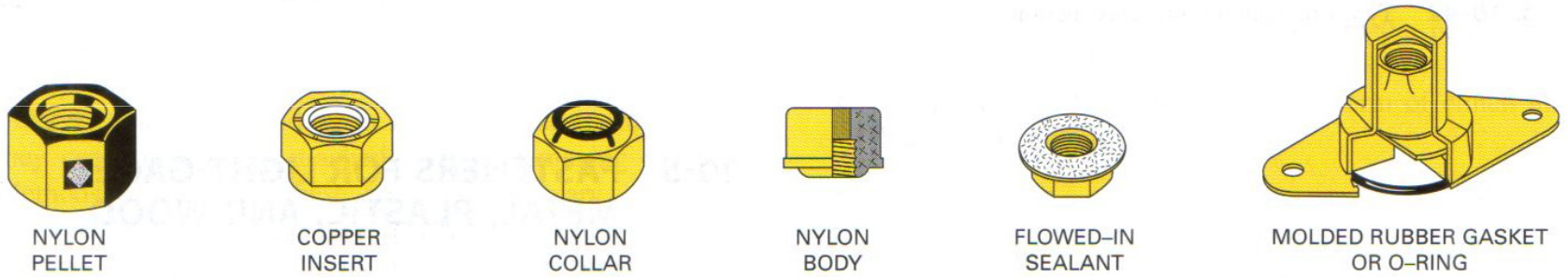
Special-Purpose Washers Molded or stamped nonmetallic washers are available in many materials and may be used as seals, as electrical insulators, or for protection of the surface of assembled parts.



Typical spring washers.



(A) SEALING SCREWS



(C) SEALING NUTS

(D) SEALING WASHERS

FLAT WASHER

LOCKWASHER

SPRING LOCKWASHER

U.S. CUSTOMARY (INCHES)						
Bolt Size	Flat Washers Type A–N			Lockwashers Regular		
	ID	OD	Thick	ID	OD	Thick
#6	.156	.375	.049	.141	.250	.031
#8	.188	.438	.049	.168	.293	.040
#10	.219	.500	.049	.194	.334	.047
#12	.250	.562	.065	.221	.377	.056
.250	.281	.625	.065	.255	.489	.062
.312	.344	.688	.065	.318	.586	.078
.375	.406	.812	.065	.382	.683	.094
.438	.469	.922	.065	.446	.779	.109
.500	.531	1.062	.095	.509	.873	.125
.562	.594	1.156	.095	.572	.971	.141
.625	.656	1.312	.095	.636	1.079	.156
.750	.812	1.469	.134	.766	1.271	.188
.875	.938	1.750	.134	.890	1.464	.219
1.000	1.062	2.000	.134	1.017	1.661	.250
1.125	1.250	2.250	.134	1.144	1.853	.281
1.250	1.375	2.500	.165	1.271	2.045	.312
1.375	1.500	2.750	.165	1.398	2.239	.344
1.500	1.625	3.000	.165	1.525	2.430	.375

METRIC (MILLIMETERS)									
Bolt Size	Flat Washers			Lockwashers			Spring Lockwashers		
	ID	OD	Thick	ID	OD	Thick	ID	OD	Thick
2	2.2	5.5	0.5	2.1	3.3	0.5			
3	3.2	7	0.5	3.1	5.7	0.8			
4	4.3	9	0.8	4.1	7.1	0.9	4.2	8	0.3 0.4
5	5.3	11	1	5.1	8.7	1.2	5.2	10	0.4 0.5
6	6.4	12	1.5	6.1	11.1	1.6	6.2	12.5	0.5 0.7
7	7.4	14	1.5	7.1	12.1	1.6	7.2	14	0.5 0.8
8	8.4	17	2	8.2	14.2	2	8.2	16	0.6 0.9
10	10.5	21	2.5	10.2	17.2	2.2	10.2	20	0.8 1.1
12	13	24	2.5	12.3	20.2	2.5	12.2	25	0.9 1.5
14	15	28	2.5	14.2	23.2	3	14.2	28	1.0 1.5
16	17	30	3	16.2	26.2	3.5	16.3	31.5	1.2 1.7
18	19	34	3	18.2	28.2	3.5	18.3	35.5	1.2 2.0
20	21	36	3	20.2	32.2	4	20.4	40	1.5 2.25
22	23	39	4	22.5	34.5	4	22.4	45	1.75 2.5
24	25	44	4	24.5	38.5	5			
27	28	50	4	27.5	41.5	5			
30	31	56	4	30.5	46.5	6			

American National Standard Metric Plain Washers
(ANSI B18.22M–1981, R1990)

Nominal Washer Size*	Washer Series	Inside Diameter, *A*		Outside Diameter, *B*		Thickness, *C*	
		Max	Min	Max	Min	Max	Min
1.6	Narrow	2.09	1.95	4.00	3.70	0.70	0.50
	Regular	2.09	1.95	5.00	4.70	0.70	0.50
	Wide	2.09	1.95	6.00	5.70	0.90	0.60
2	Narrow	2.64	2.50	5.00	4.70	0.90	0.60
	Regular	2.64	2.50	6.00	5.70	0.90	0.60
	Wide	2.64	2.50	8.00	7.64	0.90	0.60
2.5	Narrow	3.14	3.00	6.00	5.70	0.90	0.60
	Regular	3.14	3.00	8.00	7.64	0.90	0.60
	Wide	3.14	3.00	10.00	9.64	1.20	0.80
3	Narrow	3.68	3.50	7.00	6.64	0.90	0.60
	Regular	3.68	3.50	10.00	9.64	1.20	0.80
	Wide	3.68	3.50	12.00	11.57	1.40	1.00
3.5	Narrow	4.18	4.00	9.00	8.64	1.20	0.80
	Regular	4.18	4.00	10.00	9.64	1.40	1.00
	Wide	4.18	4.00	15.00	14.57	1.75	1.20
4	Narrow	4.88	4.70	10.00	9.64	1.20	0.80
	Regular	4.88	4.70	12.00	11.57	1.40	1.00
	Wide	4.88	4.70	16.00	15.57	2.30	1.60
5	Narrow	5.78	5.50	11.00	10.57	1.40	1.00
	Regular	5.78	5.50	15.00	14.57	1.75	1.20
	Wide	5.78	5.50	20.00	19.48	2.30	1.60
6	Narrow	6.87	6.65	13.00	12.57	1.75	1.20
	Regular	6.87	6.65	18.80	18.37	1.75	1.20
	Wide	6.87	6.65	25.40	24.88	2.30	1.60
8	Narrow	9.12	8.90	18.80†	18.37†	2.30	1.60
	Regular	9.12	8.90	25.40†	24.48†	2.30	1.60
	Wide	9.12	8.90	32.00	31.38	2.80	2.00
10	Narrow	11.12	10.85	20.00	19.48	2.30	1.60
	Regular	11.12	10.85	28.00	27.48	2.80	2.00
	Wide	11.12	10.85	39.00	38.38	3.50	2.50
12	Narrow	13.57	13.30	25.40	24.88	2.80	2.00
	Regular	13.57	13.30	34.00	33.38	3.50	2.50
	Wide	13.57	13.30	44.00	43.38	3.50	2.50
14	Narrow	15.52	15.25	28.00	27.48	2.80	2.00
	Regular	15.52	15.25	39.00	38.38	3.50	2.50
	Wide	15.52	15.25	50.00	49.38	4.00	3.00
16	Narrow	17.52	17.25	32.00	31.38	3.50	2.50
	Regular	17.52	17.25	44.00	43.38	4.00	3.00
	Wide	17.52	17.25	56.00	54.80	4.60	3.50
20	Narrow	22.32	21.80	39.00	38.38	4.00	3.00
	Regular	22.32	21.80	50.00	49.38	4.60	3.50
	Wide	22.32	21.80	66.00	64.80	5.10	4.00
24	Narrow	26.12	25.60	44.00	43.38	4.60	3.50
	Regular	26.12	25.60	56.00	54.80	5.10	4.00
	Wide	26.12	25.60	72.00	70.80	5.60	4.50
30	Narrow	33.02	32.40	56.00	54.80	5.10	4.00
	Regular	33.02	32.40	72.00	70.80	5.60	4.50
	Wide	33.02	32.40	90.00	88.60	6.40	5.00
36	Narrow	38.92	38.30	66.00	64.80	5.60	4.50
	Regular	38.92	38.30	90.00	88.60	6.40	5.00
	Wide	38.92	38.30	110.00	108.60	8.50	7.00

All dimensions are in millimeters.
* Nominal washer sizes are intended for use with comparable screw and bolt sizes.
† The 18.80/18.37 and 25.40/24.48 mm outside diameters avoid washers which could be used in coin-operated devices.

SOURCE: Reprinted courtesy of The American Society of Mechanical Engineers.

American National Standard Type A Plain Washers — Preferred Sizes** (ANSI B18.22.1–1965, R1990)

Nominal Washer Size***		Series	Inside Diameter			Outside Diameter			Thickness		
				Tolerance			Tolerance				
			Basic	Plus	Minus	Basic	Plus	Minus	Basic	Max.	Min.
—	—		0.078	0.000	0.005	0.188	0.000	0.005	0.020	0.025	0.016
—	—		0.094	0.000	0.005	0.250	0.000	0.005	0.020	0.025	0.016
—	—		0.125	0.008	0.005	0.312	0.008	0.005	0.032	0.040	0.025
No. 6	0.138		0.156	0.008	0.005	0.375	0.015	0.005	0.049	0.065	0.036
No. 8	0.164		0.188	0.008	0.005	0.438	0.015	0.005	0.049	0.065	0.036
No. 10	0.190		0.219	0.008	0.005	0.500	0.015	0.005	0.049	0.065	0.036
3/16	0.188		0.250	0.015	0.005	0.562	0.015	0.005	0.049	0.065	0.036
No. 12	0.216		0.250	0.015	0.005	0.562	0.015	0.005	0.065	0.080	0.051
1/4	0.250	N	0.281	0.015	0.005	0.625	0.015	0.005	0.065	0.080	0.051
1/4	0.250	W	0.312	0.015	0.005	0.734*	0.015	0.007	0.065	0.080	0.051
5/16	0.312	N	0.344	0.015	0.005	0.688	0.015	0.007	0.065	0.080	0.051
5/16	0.312	W	0.375	0.015	0.005	0.875	0.030	0.007	0.083	0.104	0.064
3/8	0.375	N	0.406	0.015	0.005	0.812	0.015	0.007	0.065	0.080	0.051
3/8	0.375	W	0.438	0.015	0.005	1.000	0.030	0.007	0.083	0.104	0.064
7/16	0.438	N	0.469	0.015	0.005	0.922	0.015	0.007	0.065	0.080	0.051
7/16	0.438	W	0.500	0.015	0.005	1.250	0.030	0.007	0.083	0.104	0.064
1/2	0.500	N	0.531	0.015	0.005	1.062	0.030	0.007	0.095	0.121	0.074
1/2	0.500	W	0.562	0.015	0.005	1.375	0.030	0.007	0.109	0.132	0.086
9/16	0.562	N	0.594	0.015	0.005	1.156*	0.030	0.007	0.095	0.121	0.074
9/16	0.562	W	0.625	0.015	0.005	1.469*	0.030	0.007	0.109	0.132	0.086
5/8	0.625	N	0.656	0.030	0.007	1.312	0.030	0.007	0.095	0.121	0.074
5/8	0.625	W	0.688	0.030	0.007	1.750	0.030	0.007	0.134	0.160	0.108
3/4	0.750	N	0.812	0.030	0.007	1.469	0.030	0.007	0.134	0.160	0.108
3/4	0.750	W	0.812	0.030	0.007	2.000	0.030	0.007	0,148	0.177	0.122
7/8	0.875	N	0.938	0.030	0.007	1.750	0.030	0.007	0.134	0.160	0.108
7/8	0.875	W	0.938	0.030	0.007	2.250	0.030	0.007	0.165	0.192	0.136
1	1.000	N	1.062	0.030	0.007	2.000	0.030	0.007	0.134	0.160	0.108
1	1.000	W	1.062	0.030	0.007	2.500	0.030	0.007	0.165	0.192	0.136
1 1/8	1.125	N	1.250	0.030	0.007	2.250	0.030	0.007	0.134	0.160	0.108
1 1/8	1.125	W	1.250	0.030	0.007	2.750	0.030	0.007	0.165	0.192	0.136
1 1/4	1.250	N	1.375	0.030	0.007	2.500	0.030	0.007	0.165	0.192	0.136
1 1/4	1.250	W	1.375	0.030	0.007	3.000	0.030	0.007	0.165	0.192	0.136
1 3/8	1.375	N	1.500	0.030	0.007	2.750	0.030	0.007	0.165	0.192	0.136
1 3/8	1.375	W	1.500	0.045	0.010	3.250	0.045	0.010	0.180	0.213	0.153
1 1/2	1.500	N	1.625	0.030	0.007	3.000	0.030	0.007	0.165	0.192	0.136
1 1/2	1.500	W	1.625	0.045	0.010	3.500	0.045	0.010	0.180	0.213	0.153
1 5/8	1.625		1.750	0.045	0.010	3.750	0.045	0.010	0.180	0.213	0.153
1 3/4	1.750		1.875	0.045	0.010	4.000	0.045	0.010	0.180	0.213	0.153
1 7/8	1.875		2.000	0.045	0.010	4.250	0.045	0.010	0.180	0.213	0.153
2	2.000		2.125	0.045	0.010	4.500	0.045	0.010	0.180	0.213	0.153
2 1/4	2.250		2.375	0.045	0.010	4.750	0.045	0.010	0.220	0.248	0.193
2 1/2	2.500		2.625	0.045	0.010	5.000	0.045	0.010	0.238	0.280	0.210
2 3/4	2.750		2.875	0.065	0.010	5.250	0.065	0.010	0.259	0.310	0.228
3	3.000		3.125	0.065	0.010	5.500	0.065	0.010	0.284	0.327	0.249

All dimensions are in inches.

* The 0.734-inch, 1.156-inch, and 1.469-inch outside diameters avoid washers which could be used in coin operated devices.

** Preferred sizes are for the most part from series previously designated "Standard Plate" and "SAE." Where common sizes existed in the two series, the SAE size is designated "N" (narrow) and the Standard Plate "W" (wide). These sizes as well as all other sizes of Type A Plain Washers are to be ordered by ID, OD, and thickness dimensions.

*** Nominal washer sizes are intended for use with comparable nominal screw or bolt sizes.

Additional selected sizes of Type A Plain Washers are shown in Table 1B.

SOURCE: Reprinted courtesy of The American Society of Mechanical Engineers

American National Standard Type A Plain Washers — Additional Selected Sizes (ANSI B18.22.1–1965, R1990)

Inside Diameter			Outside Diameter			Thickness		
	Tolerance			Tolerance				
Basic	Plus	Minus	Basic	Plus	Minus	Basic	Max.	Min.
0.094	0.000	0.005	0.219	0.000	0.005	0.020	0.025	0.016
0.125	0.000	0.005	0.250	0.000	0.005	0.022	0.028	0.017
0.156	0.008	0.005	0.312	0.008	0.005	0.035	0.048	0.027
0.172	0.008	0.005	0.406	0.015	0.005	0.049	0.065	0.036
0.188	0.008	0.005	0.375	0.015	0.005	0.049	0.065	0.036
0.203	0.008	0.005	0.469	0.015	0.005	0.049	0.065	0.036
0.219	0.008	0.005	0.438	0.015	0.005	0.049	0.065	0.036
0.234	0.008	0.005	0.531	0.015	0.005	0.049	0.065	0.036
0.250	0.015	0.005	0.500	0.015	0.005	0.049	0.065	0.036
0.266	0.015	0.005	0.625	0.015	0.005	0.049	0.065	0.036
0.312	0.015	0.005	0.875	0.015	0.007	0.065	0.080	0.051
0.375	0.015	0 005	0.734*	0.015	0.007	0.065	0.080	0.051
0.375	0.015	0.005	1.125	0.015	0.007	0.065	0.080	0.051
0.438	0.015	0.005	0.875	0.030	0.007	0.083	0.104	0.064
0.438	0.015	0.005	1.375	0.030	0.007	0.083	0.104	0.064
0.500	0.015	0.005	1.125	0.030	0.007	0.083	0.104	0.064
0.500	0.015	0.005	1.625	0.030	0.007	0.083	0.104	0.064
0.562	0.015	0.005	1.250	0.030	0.007	0.109	0.132	0.086
0.562	0.015	0.005	1.875	0.030	0.007	0.109	0.132	0.086
0.625	0.015	0.005	1.375	0.030	0.007	0.109	0.132	0.086
0.625	0.015	0.005	2.125	0.030	0.007	0.134	0.160	0.108
0.688	0.030	0.007	1.469*	0.030	0.007	0.134	0.160	0.108
0.688	0.030	0.007	2.375	0.030	0.007	0.165	0.192	0.136
0.812	0.030	0.007	1.750	0.030	0.007	0.148	0.177	0.122
0.812	0.030	0.007	2.875	0.030	0.007	0.165	0.192	0.136
0.938	0.030	0.007	2.000	0.030	0.007	0.165	0.192	0.136
0.938	0.030	0.007	3.375	0.045	0.010	0.180	0.213	0.153
1.062	0.030	0.007	2.250	0.030	0.007	0.165	0.192	0.136
1.062	0.045	0.010	3.875	0.045	0.010	0.238	0.280	0.210
1.250	0.030	0.007	2.500	0.030	0.007	0.165	0.192	0.136
1.375	0.030	0.007	2.750	0.030	0.007	0.165	0.192	0.136
1.500	0.045	0.010	3.000	0.045	0.010	0.180	0.213	0.153
1.625	0.045	0.010	3.250	0.045	0.010	0.180	0.213	0.153
1.688	0.045	0.010	3.500	0.045	0.010	0.180	0.213	0.153
1.812	0.045	0.010	3.750	0.045	0.010	0.180	0.213	0.153
1.938	0.045	0.010	4.000	0.045	0.010	0.180	0.213	0.153
2.062	0.045	0.010	4.250	0.045	0.010	0.180	0.213	0.153

All dimensions are in inches.

* The 0.734-inch and 1.469-inch outside diameters avoid washers which could be used in coin operated devices.

The above sizes are to be ordered by ID, OD, and thickness dimensions.

Preferred Sizes of Type A Plain Washers are shown in Table 1A.

SOURCE: Reprinted courtesy of The American Society of Mechanical Engineers.

American National Standard Type B Plain Washers
(ANSI B18.22.1–1965, R1990)

Nominal Washer Size**		Series†	Inside Diameter			Outside Diameter			Thickness		
				Tolerance			Tolerance				
			Basic	Plus	Minus	Basic	Plus	Minus	Basic	Max.	Min.
No. 0	0.060	N	0.068	0.000	0.005	0.125	0.000	0.005	0.025	0.028	0.022
		R	0.068	0.000	0.005	0.188	0.000	0.005	0.025	0.028	0.022
		W	0.068	0.000	0.005	0.250	0.000	0.005	0.025	0.028	0.022
No. 1	0.073	N	0.084	0.000	0.005	0.156	0.000	0.005	0.025	0.028	0.022
		R	0.084	0.000	0.005	0.219	0.000	0.005	0.025	0.028	0.022
		W	0.084	0.000	0.005	0.281	0.000	0.005	0.032	0.036	0.028
No. 2	0.086	N	0.094	0.000	0.005	0.188	0.000	0.005	0.025	0.028	0.022
		R	0.094	0.000	0.005	0.250	0.000	0.005	0.032	0.036	0.028
		W	0.094	0.000	0.005	0.344	0.000	0.005	0.032	0.036	0.028
No. 3	0.099	N	0.109	0.000	0.005	0.219	0.000	0.005	0.025	0.028	0.022
		R	0.109	0.000	0.005	0.312	0.000	0.005	0.032	0.036	0.028
		W	0.109	0.008	0.005	0.406	0.008	0.005	0.040	0.045	0.036
No. 4	0.112	N	0.125	0.000	0.005	0.250	0.000	0.005	0.032	0.036	0.028
		R	0.125	0.008	0.005	0.375	0.008	0.005	0.040	0.045	0.036
		W	0.125	0.008	0.005	0.438	0.008	0.005	0.040	0.045	0.036
No. 5	0.125	N	0.141	0.000	0.005	0.281	0.000	0.005	0.032	0.036	0.028
		R	0.141	0.008	0.005	0.406	0.008	0.005	0.040	0.045	0.036
		W	0.141	0.008	0.005	0.500	0.008	0.005	0.040	0.045	0.036
No. 6	0.138	N	0.156	0.000	0.005	0.312	0.000	0.005	0.032	0.036	0.028
		R	0.156	0.008	0.005	0.438	0.008	0.005	0.040	0.045	0.036
		W	0.156	0.008	0.005	0.562	0.008	0.005	0.040	0.045	0.036
No. 8	0.164	N	0.188	0.008	0.005	0.375	0.008	0.005	0.040	0.045	0.036
		R	0.188	0.008	0.005	0.500	0.008	0.005	0.040	0.045	0.036
		W	0.188	0.008	0.005	0.625	0.015	0.005	0.063	0.071	0.056
No. 10	0.190	N	0.203	0.008	0.005	0.406	0.008	0.005	0.040	0.045	0.036
		R	0.203	0.008	0.005	0.562	0.008	0.005	0.040	0.045	0.036
		W	0.203	0.008	0.005	0.734*	0.015	0.007	0.063	0.071	0.056
No. 12	0.216	N	0.234	0.008	0.005	0.438	0.008	0.005	0.040	0.045	0.036
		R	0.234	0.008	0.005	0.625	0.015	0.005	0.063	0.071	0.056
		W	0.234	0.008	0.005	0.875	0.015	0.007	0.063	0.071	0.056
1/4	0.250	N	0.281	0.015	0.005	0.500	0.015	0.005	0.063	0.071	0.056
		R	0.281	0.015	0.005	0.734*	0.015	0.007	0.063	0.071	0.056
		W	0.281	0.015	0.005	1.000	0.015	0.007	0.063	0.071	0.056
5/16	0.312	N	0.344	0.015	0.005	0.625	0.015	0.005	0.063	0.071	0.056
		R	0.344	0.015	0.005	0.875	0.015	0.007	0.063	0.071	0.056
		W	0.344	0.015	0.005	1.125	0.015	0.007	0.063	0.071	0.056
3/8	0.375	N	0.406	0.015	0.005	0.734*	0.015	0.007	0.063	0.071	0.056
		R	0.406	0.015	0.005	1.000	0.015	0.007	0.063	0.071	0.056
		W	0.406	0.015	0.005	1.250	0.030	0.007	0.100	0.112	0.090
7/16	0.438	N	0.469	0.015	0.005	0.875	0.015	0.007	0.063	0.071	0.056
		R	0.469	0.015	0.005	1.125	0.015	0.007	0.063	0.071	0.056
		W	0.469	0.015	0.005	1.469*	0.030	0.007	0.100	0.112	0.090

All dimensions are in inches.

* The 0.734-inch and 1.469-inch outside diameters avoid washers which could be used in coin operated devices.

** Nominal washer sizes are intended for use with comparable nominal screw or bolt sizes.

† N indicates Narrow; R, Regular; and W, Wide Series.

Inside and outside diameters shall be concentric within at least the inside diameter tolerance.

Washers shall be flat within 0.005 inch for basic outside diameters up to and including 0.875 inch, and within 0.010 inch for larger outside diameters.

SOURCE: Reprinted courtesy of The American Society of Mechanical Engineers.

Nominal Washer Size**		Series†	Inside Diameter			Outside Diameter			Thickness		
				Tolerance			Tolerance				
			Basic	Plus	Minus	Basic	Plus	Minus	Basic	Max.	Min.
1/2	0.500	N	0.531	0.015	0.005	1.000	0.015	0.007	0.063	0.071	0.056
		R	0.531	0.015	0.005	1.250	0.030	0.007	0.100	0.112	0.090
		W	0.531	0.015	0.005	1.750	0.030	0.007	0.100	0.112	0.090
9/16	0.562	N	0.594	0.015	0.005	1.125	0.015	0.007	0.063	0.071	0.056
		R	0.594	0.015	0.005	1.469*	0.030	0.007	0.100	0.112	0.090
		W	0.594	0.015	0.005	2.000	0.030	0.007	0.100	0.112	0.090
5/8	0.625	N	0.656	0.030	0.007	1.250	0.030	0.007	0.100	0.112	0.090
		R	0.656	0.030	0.007	1.750	0.030	0.007	0.100	0.112	0.090
		W	0.656	0.030	0.007	2.250	0.030	0.007	0.160	0.174	0.146
3/4	0.750	N	0.812	0.030	0.007	1.375	0.030	0.007	0.100	0.112	0.090
		R	0.812	0.030	0.007	2.000	0.030	0.007	0.100	0.112	0.090
		W	0.812	0.030	0.007	2.500	0.030	0.007	0.160	0.174	0.146
7/8	0.875	N	0.938	0.030	0.007	1.469*	0.030	0.007	0.100	0.112	0.090
		R	0.938	0.030	0.007	2.250	0.030	0.007	0.160	0.174	0.146
		W	0.938	0.030	0.007	2.750	0.030	0.007	0.160	0.174	0.146
1	1.000	N	1.062	0.030	0.007	1.750	0.030	0.007	0.100	0.112	0.090
		R	1.062	0.030	0.007	2.500	0.030	0.007	0.160	0.174	0.146
		W	1.062	0.030	0.007	3.000	0.030	0.007	0.160	0.174	0.146
1 1/8	1.125	N	1.188	0.030	0.007	2.000	0.030	0.007	0.100	0.112	0.090
		R	1.188	0.030	0.007	2.750	0.030	0.007	0.160	0.174	0.146
		W	1.188	0.030	0.007	3.250	0.030	0.007	0.160	0.174	0.146
1 1/4	1.250	N	1.312	0.030	0.007	2.250	0.030	0.007	0.160	0.174	0.146
		R	1.312	0.030	0.007	3.000	0.030	0.007	0.160	0.174	0.146
		W	1.312	0.045	0.010	3.500	0.045	0.010	0.250	0.266	0.234
1 3/8	1.375	N	1.438	0.030	0.007	2.500	0.030	0.007	0.160	0.174	0.146
		R	1.438	0.030	0.007	3.250	0.030	0.007	0.160	0.174	0.146
		W	1.438	0.045	0.010	3.750	0.045	0.010	0.250	0.266	0.234
1 1/2	1.500	N	1.562	0.030	0.007	2.750	0.030	0.007	0.160	0.174	0.146
		R	1.562	0.045	0.010	3.500	0.045	0.010	0.250	0.266	0.234
		W	1.562	0.045	0.010	4.000	0.045	0.010	0.250	0.266	0.234
1 5/8	1.625	N	1.750	0.030	0.007	3.000	0.030	0.007	0.160	0.174	0.146
		R	1.750	0.045	0.010	3.750	0.045	0.010	0.250	0.266	0.234
		W	1.750	0.045	0.010	4.250	0.045	0.010	0.250	0.266	0.234
1 3/4	1.750	N	1.875	0.030	0.007	3.250	0.030	0.007	0.160	0.174	0.146
		R	1.875	0.045	0.010	4.000	0.045	0.010	0.250	0.266	0.234
		W	1.875	0.045	0.010	4.500	0.045	0.010	0.250	0.266	0.234
1 7/8	1.875	N	2.000	0.045	0.010	3.500	0.045	0.010	0.250	0.266	0.234
		R	2.000	0.045	0.010	4.250	0.045	0.010	0.250	0.266	0.234
		W	2.000	0.045	0.010	4.750	0.045	0.010	0.250	0.266	0.234
2	2.000	N	2.125	0.045	0.010	3.750	0.045	0.010	0.250	0.266	0.234
		R	2.125	0.045	0.010	4.500	0.045	0.010	0.250	0.266	0.234
		W	2.125	0.045	0.010	5.000	0.045	0.010	0.250	0.266	0.234

All dimensions are in inches.

* The 1.469-inch outside diameter avoids washers which could be used in coin operated devices.

** Nominal washer sizes are intended for use with comparable nominal screw or bolt sizes.

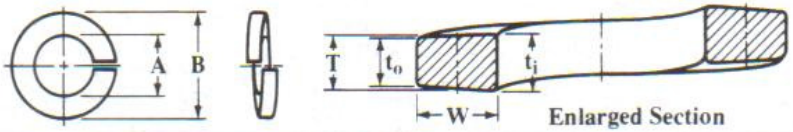
† N indicates Narrow; R, Regular; and W, Wide Series.

Inside and outside diameters shall be concentric within at least the inside diameter tolerance.

Washers shall be flat within 0.005-inch for basic outside diameters up through 0.875-inch and within 0.010 inch for larger outside diameters.

For 2 1/4-, 2 1/2-, 2 3/4-, and 3-inch sizes see ANSI B18.22.1–1965 (R1990).

American National Standard Helical Spring Lock Washers (ANSI-ASME B18.21.1–1990)

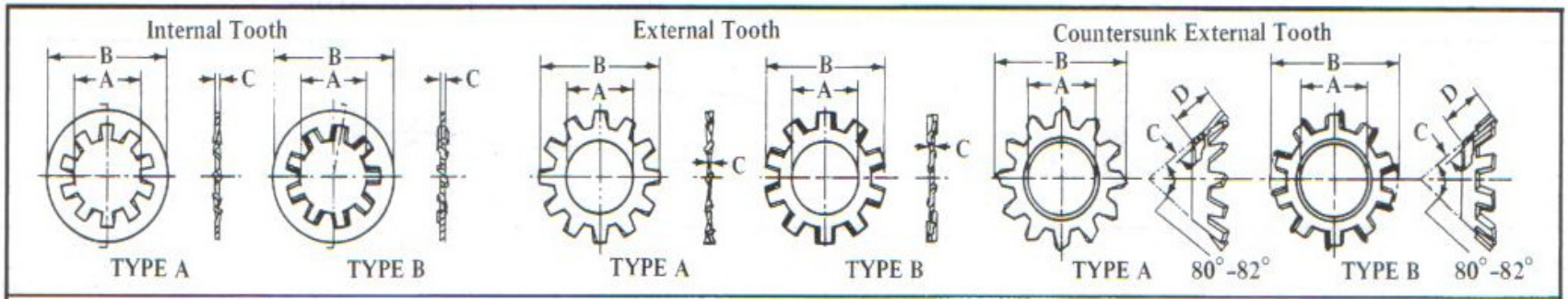


Nominal Washer Size		Inside Diameter, *A*		Regular			Heavy			Extra Duty		
		Max.	Min.	O.D., *B* Max.	Section Width, *W*	Section Thickness, *T*§	O.D., *B* Max.	Section Width, *W*	Section Thickness, *T*§	O.D., *B* Max.	Section Width, *W*	Section Thickness, *T*§
No. 2	0.086	0.094	0.088	0.172	0.035	0.020	0.182	0.040	0.025	0.208	0.053	0.027
No. 3	0.099	0.107	0.101	0.195	0.040	0.025	0.209	0.047	0.031	0.239	0.062	0.034
No. 4	0.112	0.120	0.114	0.209	0.040	0.025	0.223	0.047	0.031	0.253	0.062	0.034
No. 5	0.125	0.133	0.127	0.236	0.047	0.031	0.252	0.055	0.040	0.300	0.079	0.045
No. 6	0.138	0.148	0.141	0.250	0.047	0.031	0.266	0.055	0.040	0.314	0.079	0.045
No. 8	0.164	0.174	0.167	0.293	0.055	0.040	0.307	0.062	0.047	0.375	0.096	0.057
No. 10	0.190	0.200	0.193	0.334	0.062	0.047	0.350	0.070	0.056	0.434	0.112	0.068
No. 12	0.216	0.227	0.220	0.377	0.070	0.056	0.391	0.077	0.063	0.497	0.130	0.080
1/4	0.250	0.260	0.252	0.487	0.109	0.062	0.489	0.110	0.077	0.533	0.132	0.084
5/16	0.3125	0.322	0.314	0.583	0.125	0.078	0.593	0.130	0.097	0.619	0.143	0.108
3/8	0.375	0.385	0.377	0.680	0.141	0.094	0.688	0.145	0.115	0.738	0.170	0.123
7/16	0.4375	0.450	0.440	0.776	0.156	0.109	0.784	0.160	0.133	0.836	0.186	0.143
1/2	0.500	0.512	0.502	0.869	0.171	0.125	0.879	0.176	0.151	0.935	0.204	0.162
9/16	0.5625	0.574	0.564	0.965	0.188	0.141	0.975	0.193	0.170	1.035	0.223	0.182
5/8	0.625	0.640	0.628	1.072	0.203	0.156	1.086	0.210	0.189	1.150	0.242	0.202
11/16	0.6875	0.703	0.691	1.169	0.219	0.172	1.185	0.227	0.207	1.251	0.260	0.221
3/4	0.750	0.765	0.753	1.264	0.234	0.188	1.284	0.244	0.226	1.354	0.279	0.241
13/16	0.8125	0.828	0.816	1.359	0.250	0.203	1.383	0.262	0.246	1.454	0.298	0.261
7/8	0.875	0.890	0.878	1.455	0.266	0.219	1.485	0.281	0.266	1.567	0.322	0.285
15/16	0.9375	0.953	0.941	1.551	0.281	0.234	1.585	0.298	0.284	1.679	0.345	0.308
1	1.000	1.015	1.003	1.647	0.297	0.250	1.691	0.319	0.306	1.785	0.366	0.330
1 1/16	1.0625	1.080	1.066	1.742	0.312	0.266	1.794	0.338	0.326	1.896	0.389	0.352
1 1/8	1.125	1.144	1.129	1.838	0.328	0.281	1.894	0.356	0.345	2.004	0.411	0.375
1 3/16	1.1875	1.208	1.192	1.934	0.344	0.297	1.992	0.373	0.364	2.108	0.431	0.396
1 1/4	1.250	1.272	1.254	2.028	0.359	0.312	2.096	0.393	0.384	2.214	0.452	0.417
1 5/16	1.3125	1.335	1.317	2.124	0.375	0.328	2.194	0.410	0.403	2.318	0.472	0.438
1 3/8	1.375	1.399	1.379	2.210	0.391	0.344	2.292	0.427	0.422	2.420	0.491	0.458
1 7/16	1.4375	1.462	1.442	2.314	0.406	0.359	2.386	0.442	0.440	2.520	0.509	0.478
1 1/2	1.500	1.524	1.504	2.409	0.422	0.375	2.481	0.458	0.458	2.617	0.526	0.496

All dimensions are given in inches. * See Standard for sizes over 1½ to 3, inclusive, for regular and heavy helical spring lock washers and over 1½ to 2, inclusive, for extra-duty helical spring lock washers. § T = mean section thickness = $(t_i + t_o) \div 2$.

SOURCE: Reprinted courtesy of The American Society of Mechanical Engineers.

American National Standard Internal and External Tooth Lock Washers (ANSI/ASME B18.21.1–1990)



Internal Tooth Lock Washers

	Size	#2	#3	#4	#5	#6	#8	#10	#12	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	1	1 1/8	1 1/4
A	Max	0.095	0.109	0.123	0.136	0.150	0.176	0.204	0.231	0.267	0.332	0.398	0.464	0.530	0.596	0.663	0.728	0.795	0.861	0.927	1.060	1.192	1.325
	Min	0.089	0.102	0.115	0.129	0.141	0.168	0.195	0.221	0.256	0.320	0.384	0.448	0.512	0.576	0.640	0.704	0.769	0.832	0.894	1.019	1.144	1.275
B	Max	0.200	0.232	0.270	0.280	0.295	0.340	0.381	0.410	0.478	0.610	0.692	0.789	0.900	0.985	1.071	1.166	1.245	1.315	1.410	1.637	1.830	1.975
	Min	0.175	0.215	0.245	0.255	0.275	0.325	0.365	0.394	0.460	0.594	0.670	0.740	0.867	0.957	1.045	1.130	1.220	1.290	1.364	1.590	1.799	1.921
C	Max	0.015	0.019	0.019	0.021	0.021	0.023	0.025	0.025	0.028	0.034	0.040	0.040	0.045	0.045	0.050	0.050	0.055	0.055	0.060	0.067	0.067	0.067
	Min	0.010	0.012	0.015	0.017	0.017	0.018	0.020	0.020	0.023	0.028	0.032	0.032	0.037	0.037	0.042	0.042	0.047	0.047	0.052	0.059	0.059	0.059

External Tooth Lock Washers

A	Max	...	0.109	0.123	0.136	0.150	0.176	0.204	0.231	0.267	0.332	0.398	0.464	0.530	0.596	0.663	0.728	0.795	0.861	0.927	1.060	...	...
	Min	...	0.102	0.115	0.129	0.141	0.168	0.195	0.221	0.256	0.320	0.384	0.448	0.513	0.576	0.641	0.704	0.768	0.833	0.897	1.025	...	...
B	Max	...	0.235	0.260	0.285	0.320	0.381	0.410	0.475	0.510	0.610	0.694	0.760	0.900	0.985	1.070	1.155	1.260	1.315	1.410	1.620	...	...
	Min	...	0.220	0.245	0.270	0.305	0.365	0.395	0.460	0.494	0.588	0.670	0.740	0.880	0.960	1.045	1.130	1.220	1.290	1.380	1.590	...	...
C	Max	...	0.015	0.019	0.019	0.022	0.023	0.025	0.028	0.028	0.034	0.040	0.040	0.045	0.045	0.050	0.050	0.055	0.055	0.060	0.067	...	...
	Min	...	0.012	0.014	0.015	0.016	0.018	0.020	0.023	0.023	0.028	0.032	0.032	0.037	0.037	0.042	0.042	0.047	0.047	0.052	0.059	...	...

Heavy Internal Tooth Lock Washers

	Size	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8
A	Max	0.267	0.332	0.398	0.464	0.530	0.596	0.663	0.795	0.927
	Min	0.256	0.320	0.384	0.448	0.512	0.576	0.640	0.768	0.894
B	Max	0.536	0.607	0.748	0.858	0.924	1.034	1.135	1.265	1.447
	Min	0.500	0.590	0.700	0.800	0.880	0.990	1.100	1.240	1.400
C	Max	0.045	0.050	0.050	0.067	0.067	0.067	0.067	0.084	0.084
	Min	0.035	0.040	0.042	0.050	0.055	0.055	0.059	0.070	0.075

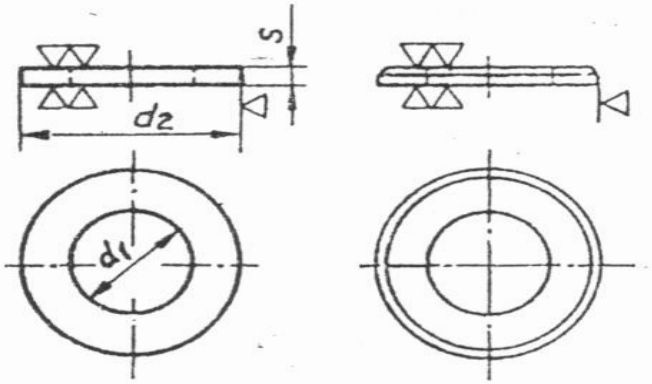
Countersunk External Tooth Lock Washers*

	Size	#4	#6	#8	#10	#12	1/4	#16	5/16	3/8	7/16	1/2
A	Max	0.123	0.150	0.177	0.205	0.231	0.267	0.287	0.333	0.398	0.463	0.529
	Min	0.113	0.140	0.167	0.195	0.220	0.255	0.273	0.318	0.383	0.448	0.512
C	Max	0.019	0.021	0.021	0.025	0.025	0.025	0.028	0.028	0.034	0.045	0.045
	Min	0.015	0.017	0.017	0.020	0.020	0.020	0.023	0.023	0.028	0.037	0.037
D	Max	0.065	0.092	0.105	0.099	0.128	0.128	0.147	0.192	0.255	0.270	0.304
	Min	0.050	0.082	0.088	0.083	0.118	0.113	0.137	0.165	0.242	0.260	0.294

All dimensions are given in inches. * Starting with #4, approx. O.D.'s are: 0.213, 0.289, 0.322, 0.354, 0.421, 0.454, 0.505, 0.599, 0.765, 0.867, and 0.976.

SOURCE: Reprinted courtesy of The American Society of Mechanical Engineers.

Altıköşe başlı cıvata ve somun rondelası	TS 79/1 DIN 125

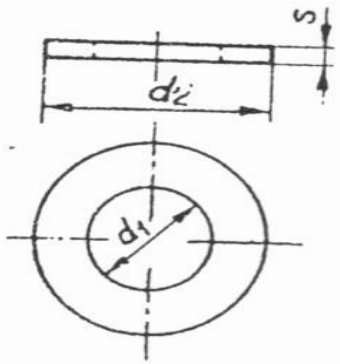


Delik çapı d_1 = 13 mm olan bir rondelanın gösterilişi :

Rondela 13 TS 79/1

d_1	d_2	s	Cıvata
1,8	4,5	0,3	1,7
2,2	5,5	0,5	2
2,5	6	0,5	2,3
2,8	7	0,5	2,6
3,2	7	0,5	3
3,7	8	0,5	3,5
4,3	9	0,8	4
5,3	11	1	5
6,4	12	1,5	6
8,4	17	2	8
10,5	21	2,5	10
13	24	3	12
15	28	3	14
17	30	3	16
19	34	4	18
21	36	4	20
23	40	4	22
25	44	4	24
27	50	5	26
28	50	5	27
29	50	5	28
31	56	5	30
33	60	5	32
34	60	5	33
36	68	6	35
37	68	6	36

Altıköşe başlı cıvata ve somun rondelası	TS 79/2 DIN 126



Delik çapı d_1 = 14 mm olan ham rondelanın gösterilişi :

Rondela 14 TS 79/2

d_1	d_2	s	Cıvata
5,8	11	1	5
7	12	1,5	6
9,5	17	2	8
11,5	21	2,5	10
14	24	3	12
18	30	3	16
23	36	4	20
27	44	4	24
30	50	5	27
33	56	5	30
36	60	5	33
39	68	6	36
42	72	6	39
45	78	7	42
48	85	7	45
52	92	8	48
56	98	8	52
61	105	9	56
65	110	9	60
70	115	9	64
78	125	10	72
86	140	12	80
96	160	12	90
106	175	14	100
116	185	14	110
126	210	16	120

British Representation:

0.75-10 UNC-2A x 2.50, LH, DOUBLE, HEXAGON CAP SCREW

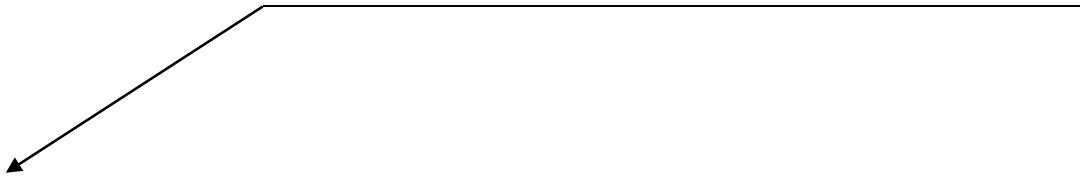
0.63- 11 UNC- 2B HEXAGON NUT
SQUARE NUT

½" -11 NPS
NPT

WIDE
NARROW

HELICAL-SPRING LOCK WASHER-1/4" REGULAR-PHOSPHORUS BRONZE
INTERNAL-TOOTH WASHER-1/4" –TYPE A- STEEL
EXTERNAL-TOOTH WASHR-0.562-TYPE B-STEEL

7/8 Drill, 3 Deep, 1-8 UNC- 2B, 2 Deep



ISO Representation:

M18x0.75-40, 5g 6g L-LH-DOUBLE HEX CAP SCR
M8x1.25 HEX NUT

Turkish Rep.:

k
o
Altıköşe Başlı Cıvata M18x0.75 i-40 TS 1021/2, OK, 5D

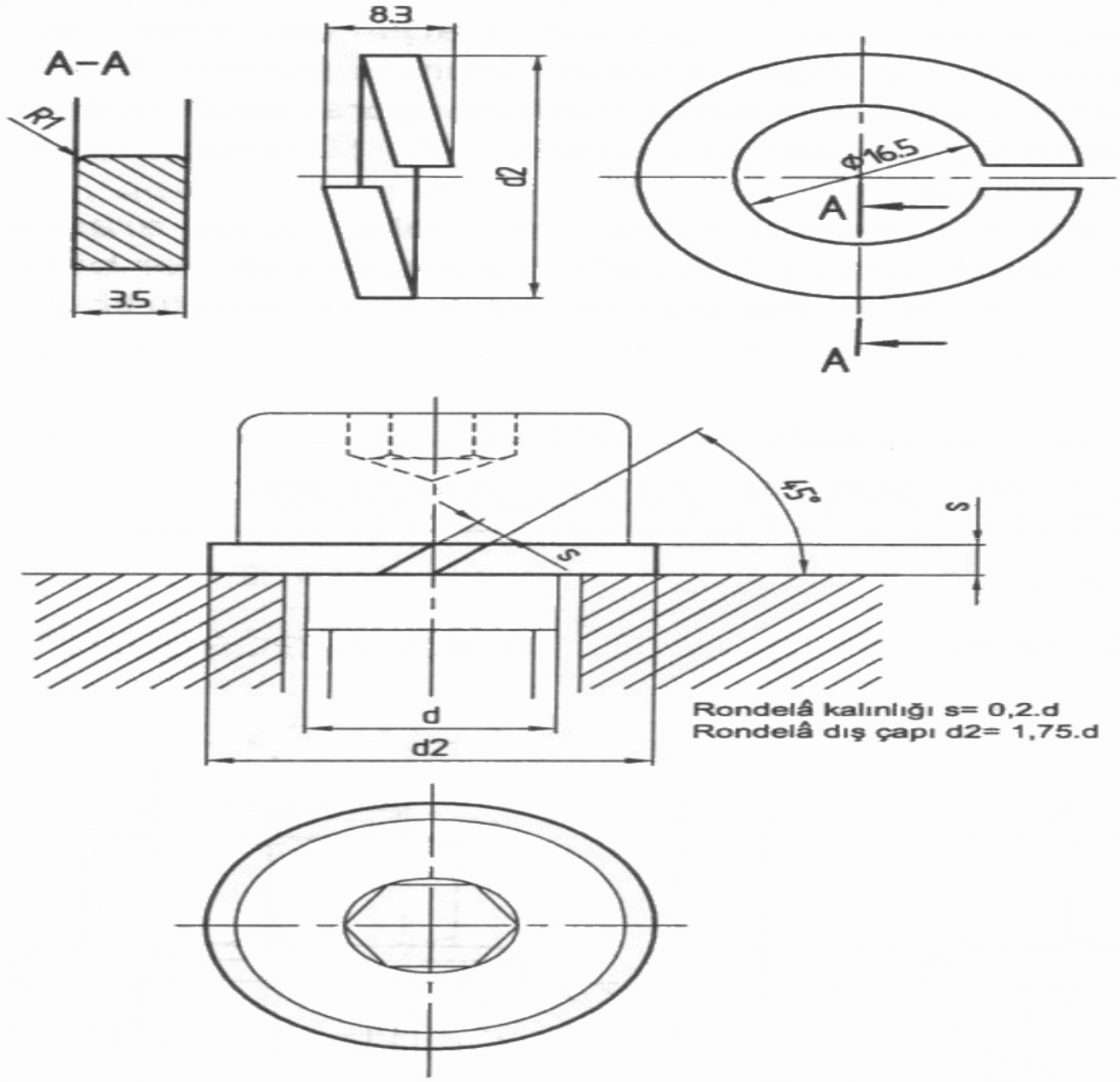
Altıköşe Somun M8x1.25 i TS 1026/2 K 4D

R ½" TS 61/20 or R ½" DIN 259

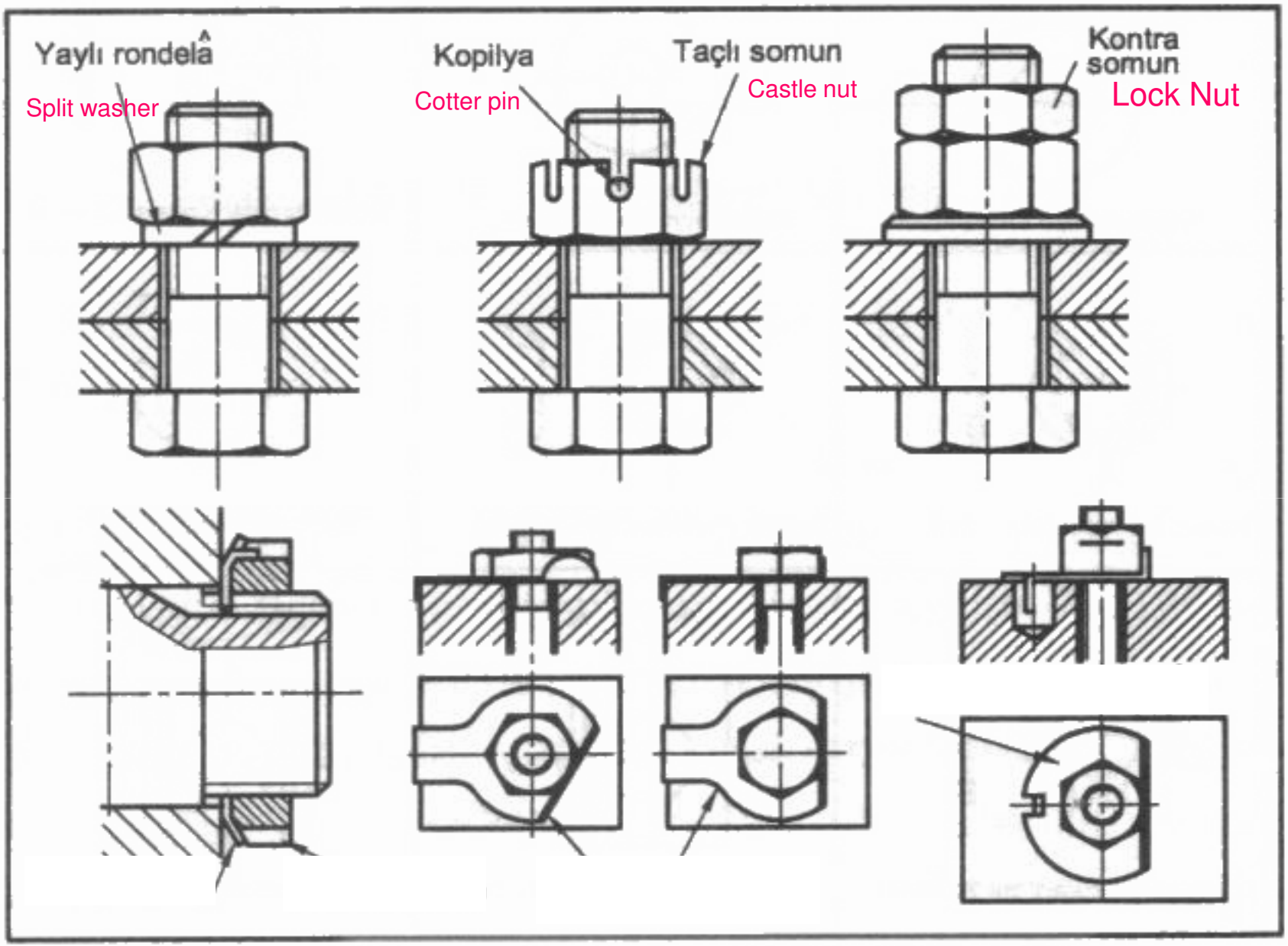
Rondela 15 TS 79/1, St37

$\Phi 10, \overline{\downarrow} 75$, M10, $\overline{\downarrow} 60$

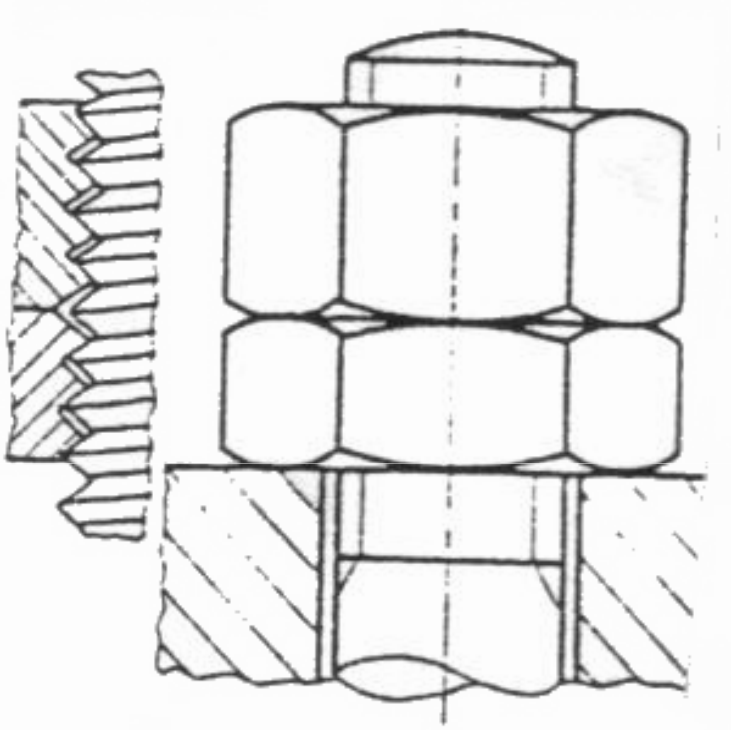
Yaylı rondelâ TS 79/27-B16-Yay çeliği

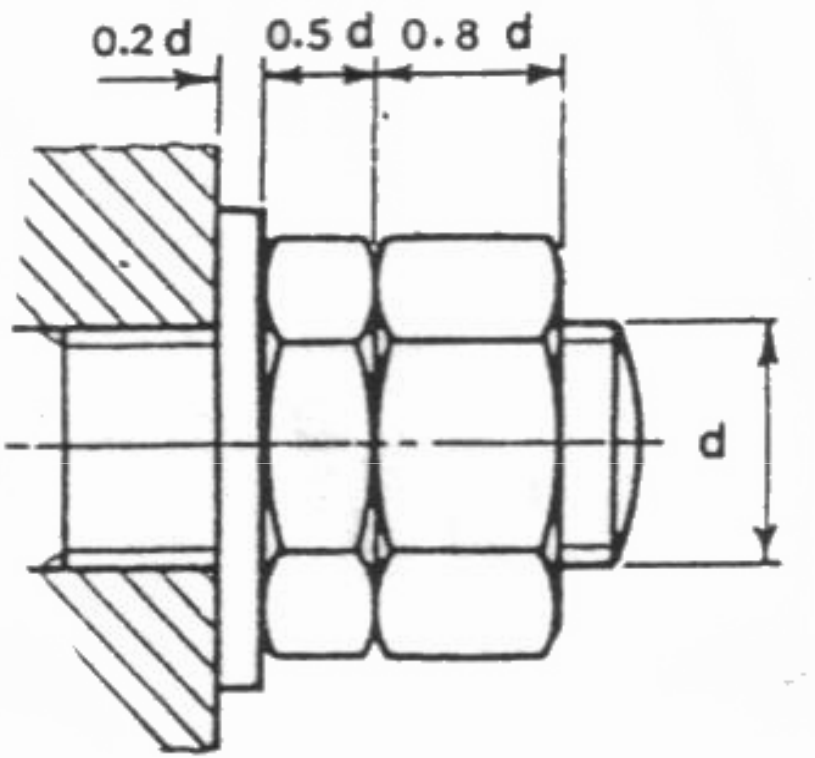


Rondelâ kalınlığı s= 0,2.d
Rondelâ dış çapı d2= 1,75.d



Various Locking Techniques



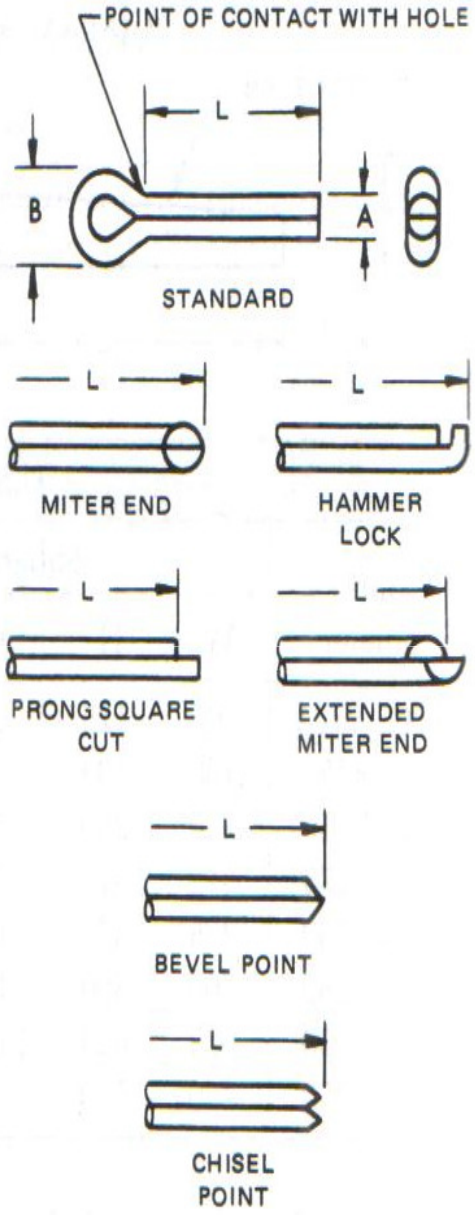


Lock nut

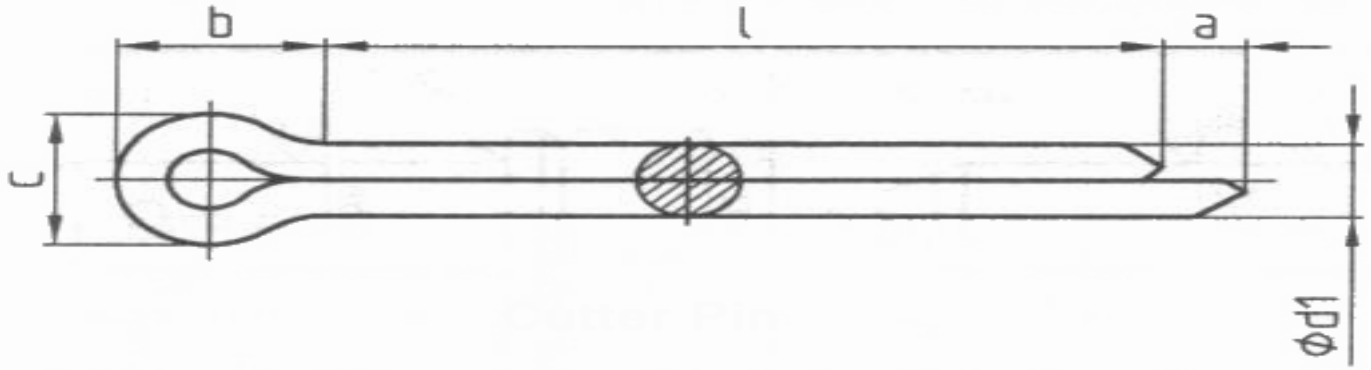
Castle Nuts

U.S. CUSTOMARY (INCHES)				METRIC (MILLIMETERS)			
Nominal Bolt or Thread Size Range	Nominal Cotter-Pin Size (A)	Cotter-Pin Hole	Min. End. Clearance*	Nominal Bolt or Thread-Size Range	Nominal Cotter-Pin Size (A)	Cotter-Pin Hole	Min. End Clearance*
.125	.031	.047	.06	–2.5	0.6	0.8	1.5
.188	.047	.062	.08	2.5–3.5	0.8	1.0	2.0
.250	.062	.078	.11	3.5–4.5	1.0	1.2	2.0
.312	.078	.094	.11	4.5–5.5	1.2	1.4	2.5
.375	.094	.109	.14	5.5–7.0	1.6	1.8	2.5
.438	.109	.125	.14	7.0–9.0	2.0	2.2	3.0
.500	.125	.141	.18	9.0–11	2.5	2.8	3.5
.562	.141	.156	.25	11–14	3.2	3.6	5
.625	.156	.172	.40	14–20	4	4.5	6
1.000–1.125	.188	.203	.40	20–27	5	5.6	7
1.250–1.375	.219	.234	.46	27–39	6.3	6.7	10
1.500–1.625	.250	.266	.46	39–56	8.0	8.5	15
				56–80	10	10.5	20

*End of bolt to center of hole



Cotter pins.

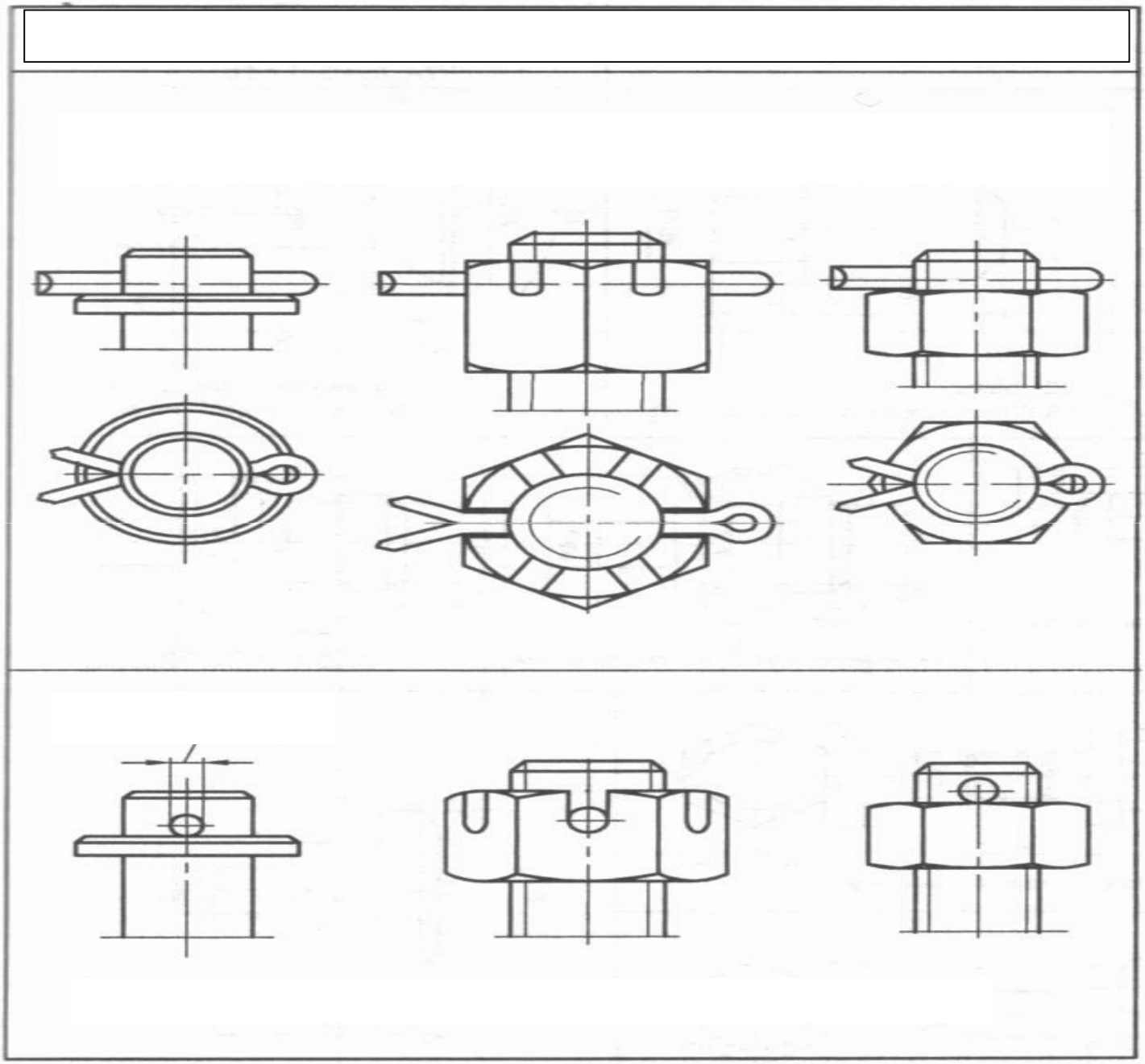


d=5 mm, l= 40 mm olan bir pimin gösterilmesi;

COTTER PIN

KOPILYA TS 2339/1-5x40-Fe

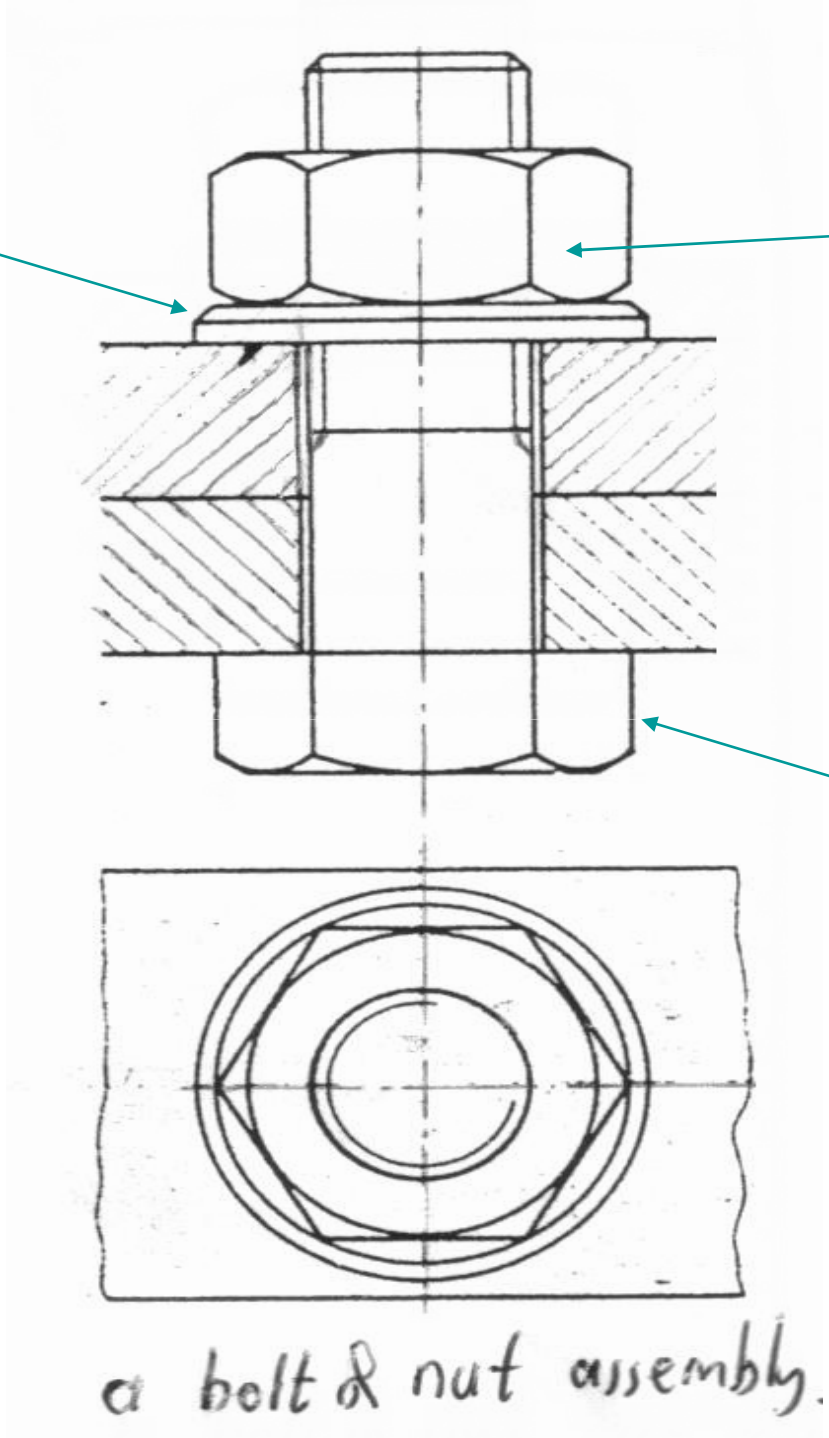
d	1	1,2	1,6	2	2,5	3,2	4	5	6,3
d1	0,9	1	1,4	1,8	2,3	2,9	3,7	4,6	5,9
a	1,6	2,5	2,5	2,5	2,5	3,2	4	4	4
b	3	3	3,2	4	5	6,4	8	10	12,6
c	1,8	2	2,8	3,6	4,6	5,8	7,4	9,2	11,8
v	4	5	5	6	6	8	8	10	12
d2	3-4,5	4-6	5-7	6-9	8-11	9-14	12-20	17-27	23-39
l	6 20	8 25	8 32	10 40	12 50	14 63	14 80	22 100	32 125



Washer

(Rondela,

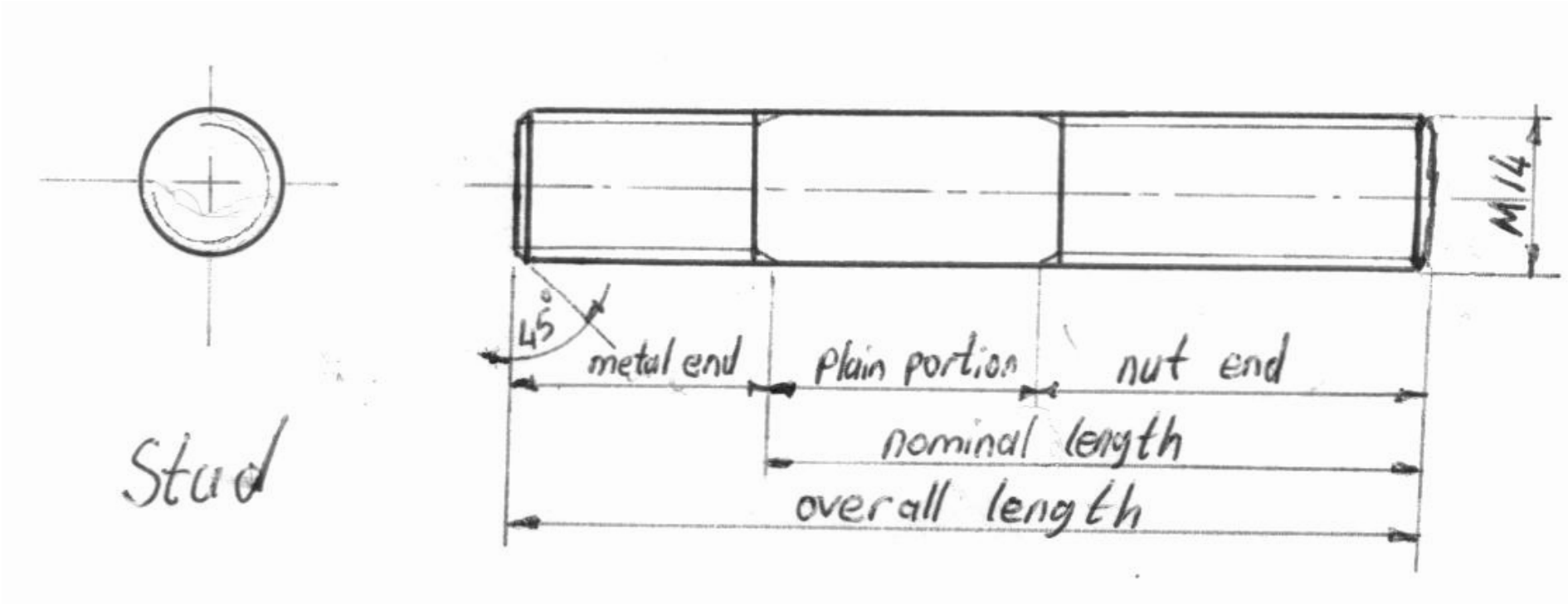
Pul)



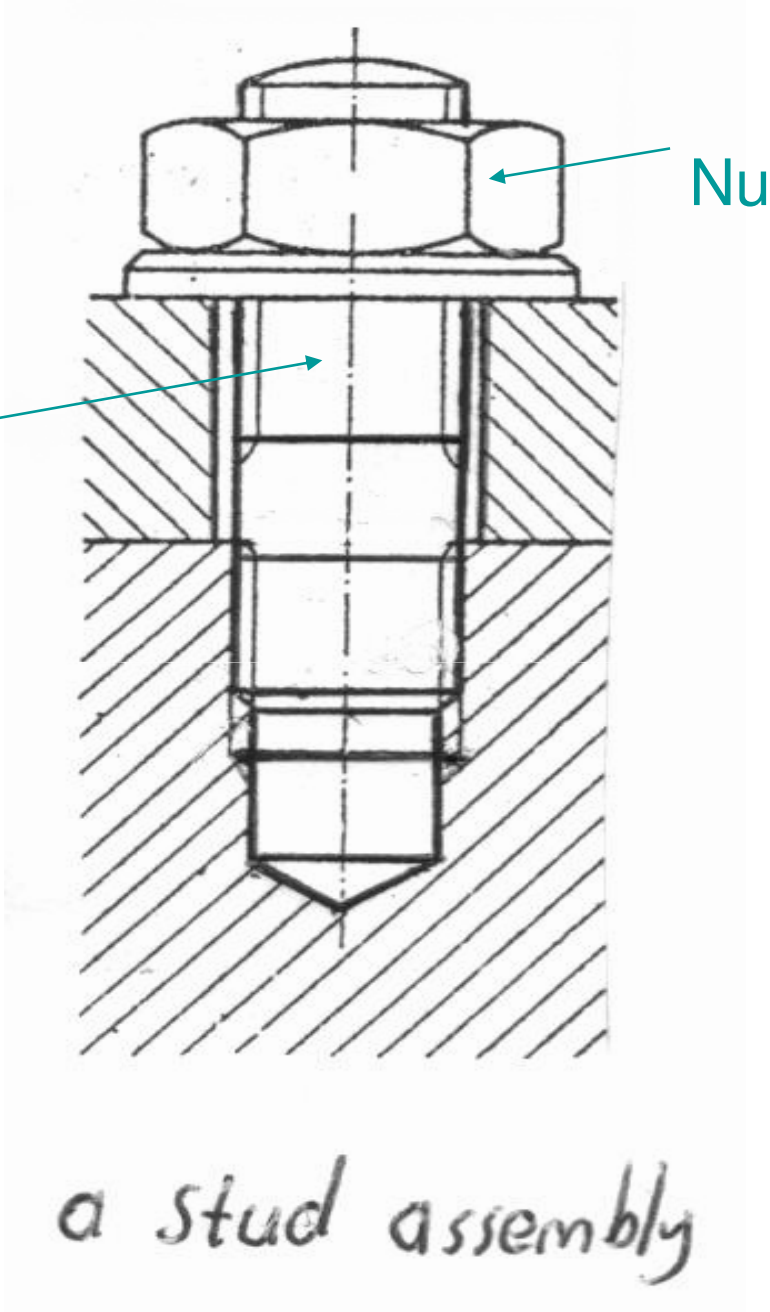
Nut (Somun)

Bolt (Cıvata)

a bolt & nut assembly.

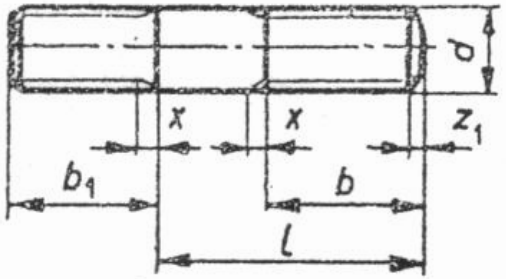

45°
metal end
plain portion
nut end
nominal length
overall length
M14

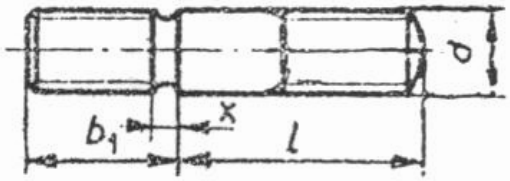
Stud


Nut
Stud
(Saplama)
a stud assembly

(Stud) SAPLAMA $b_1 = 2 . d$ (Özet)

TS 1025/4
DIN 833





Anma çapı M 12 ve uzunluğu l = 70 mm olan saplamanın gösterilişi :

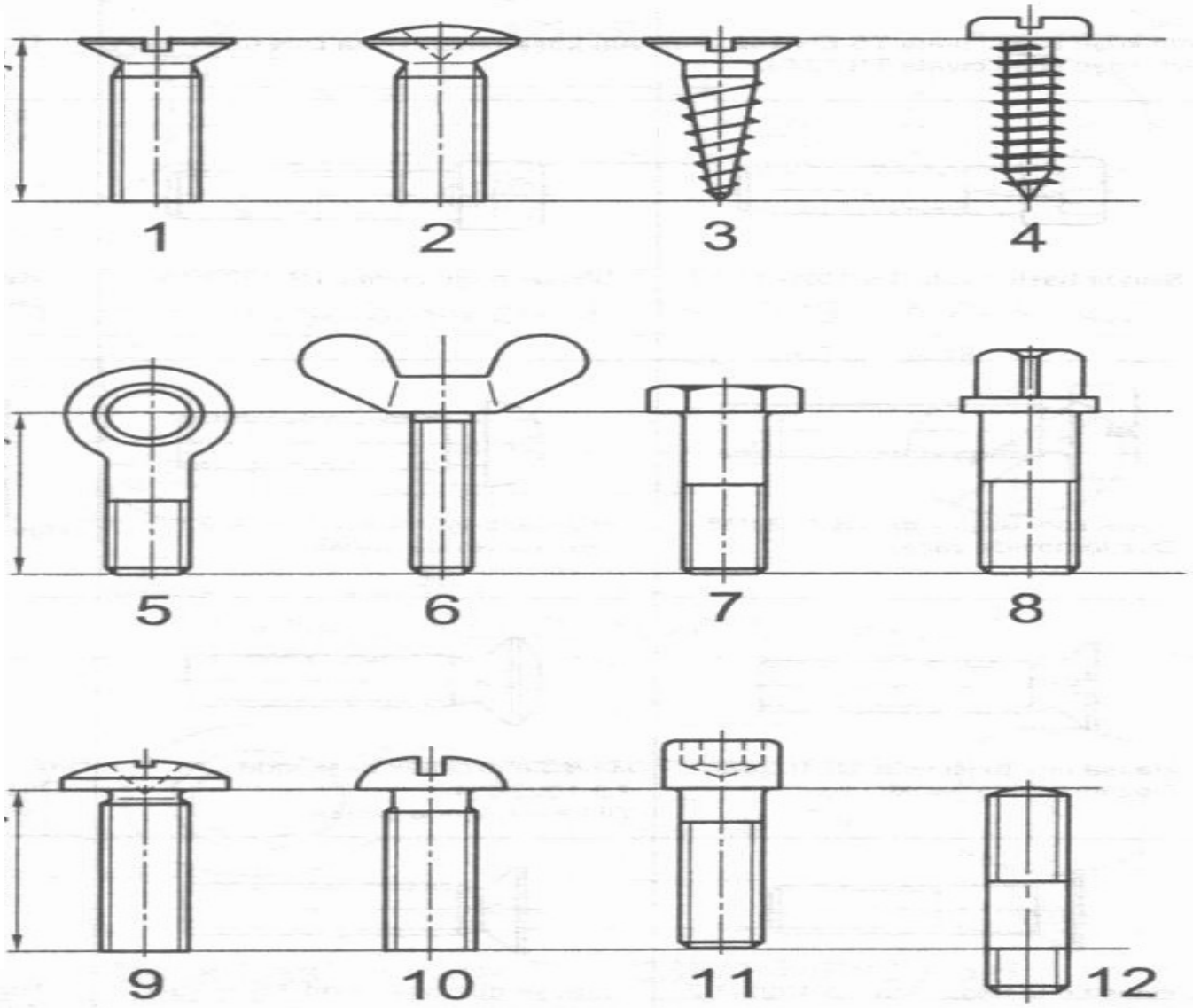
Saplama M 12 — 70 TS 1025/4

Anma çapı M 12 ve l = 70 mm olan oyuklu saplamanın gösterilişi :

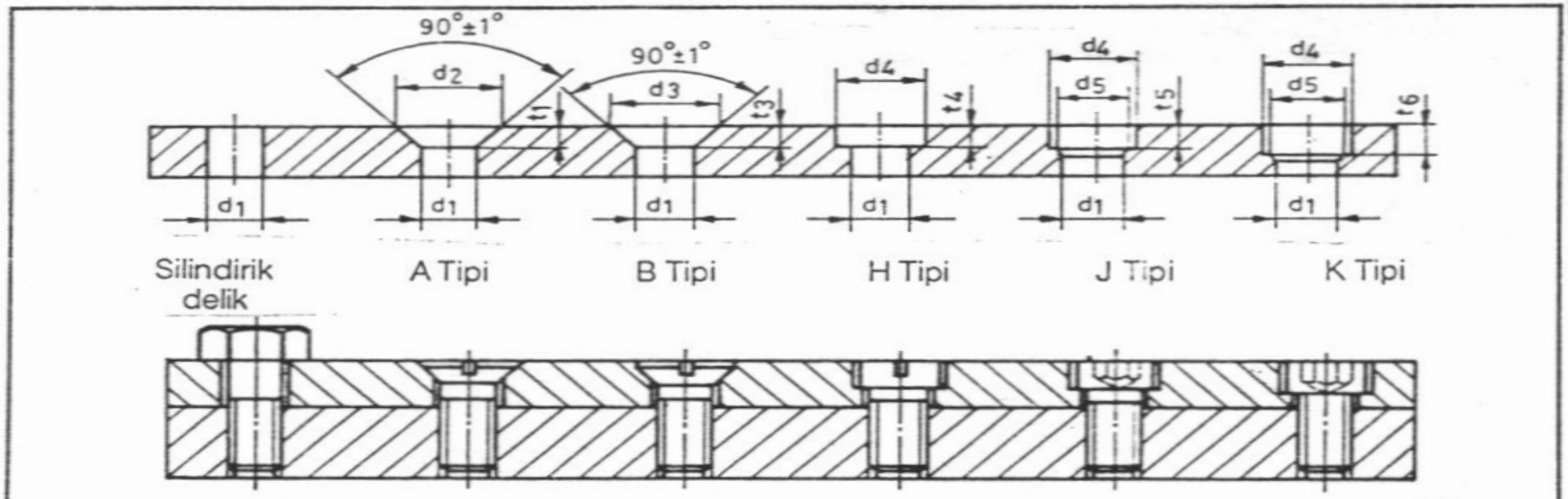
Oy - Saplama M 12 — 70 TS 1025/4

d	M3	(M3,5)	M4	M5	M6	(M7)	M8	M10	M12	(M14)	M16	(M18)	M20	(M22)	M24
	—	—	—	—	—	—	—	—	—	—	—	(M18x2)	M20x2	(M22x2)	M24x2
1)	9	10	10	12	15	15	18	20	22	25	28	30	32	35	38
b 2)	9	10	12	15	18	18	22	25	28	30	35	40	40	45	50
3)	—	—	—	—	—	—	—	—	40	45	50	55	55	60	65
b_1	6	7	8	10	12	14	16	20	24	28	32	36	40	44	48
	12	12	12	15	18	18	18	22	25	28	35	35	40	45	50
l	28	28	70	80	90	100	110	150	180	200	220	220	220	220	220

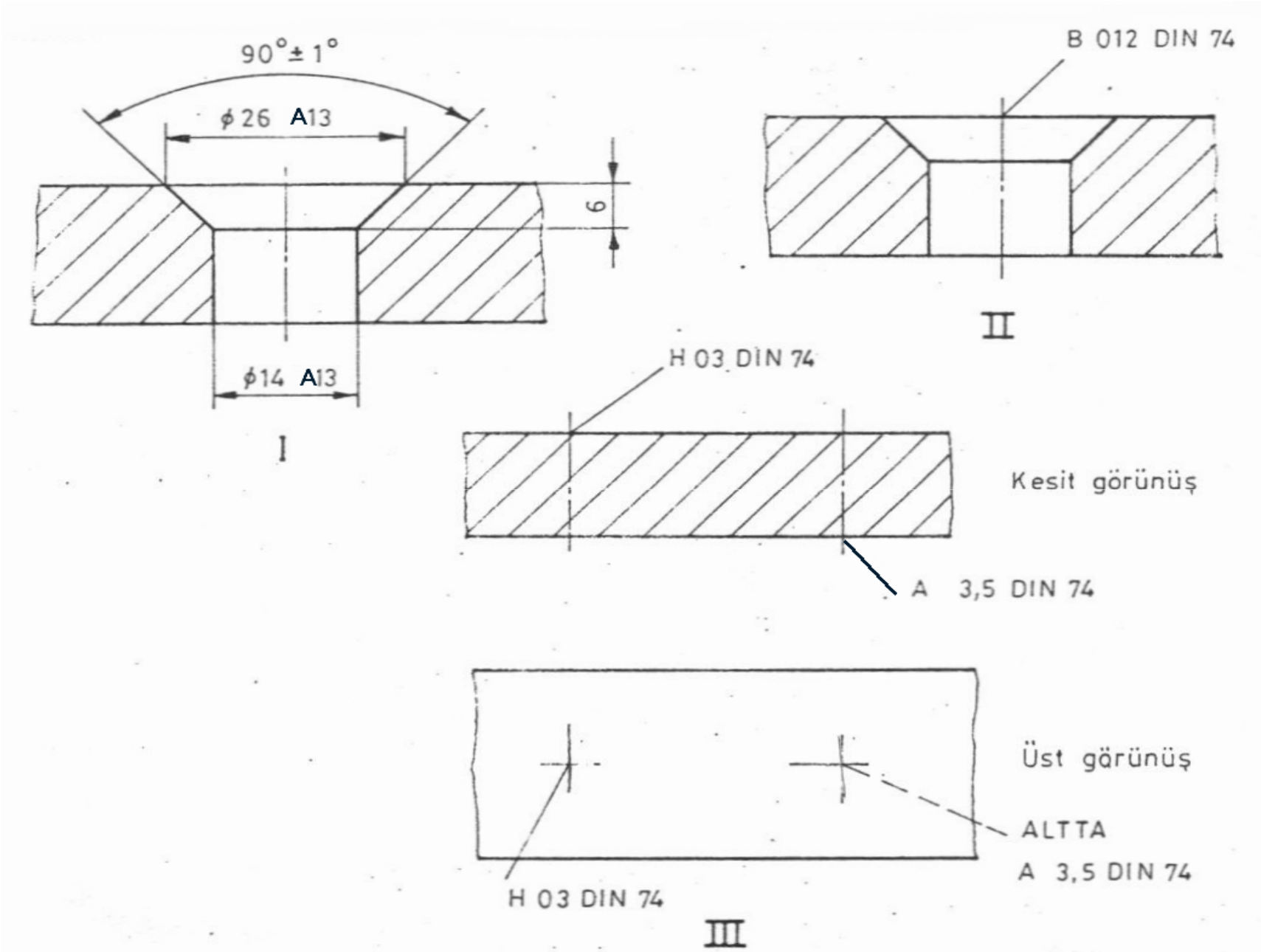
Nominal Length

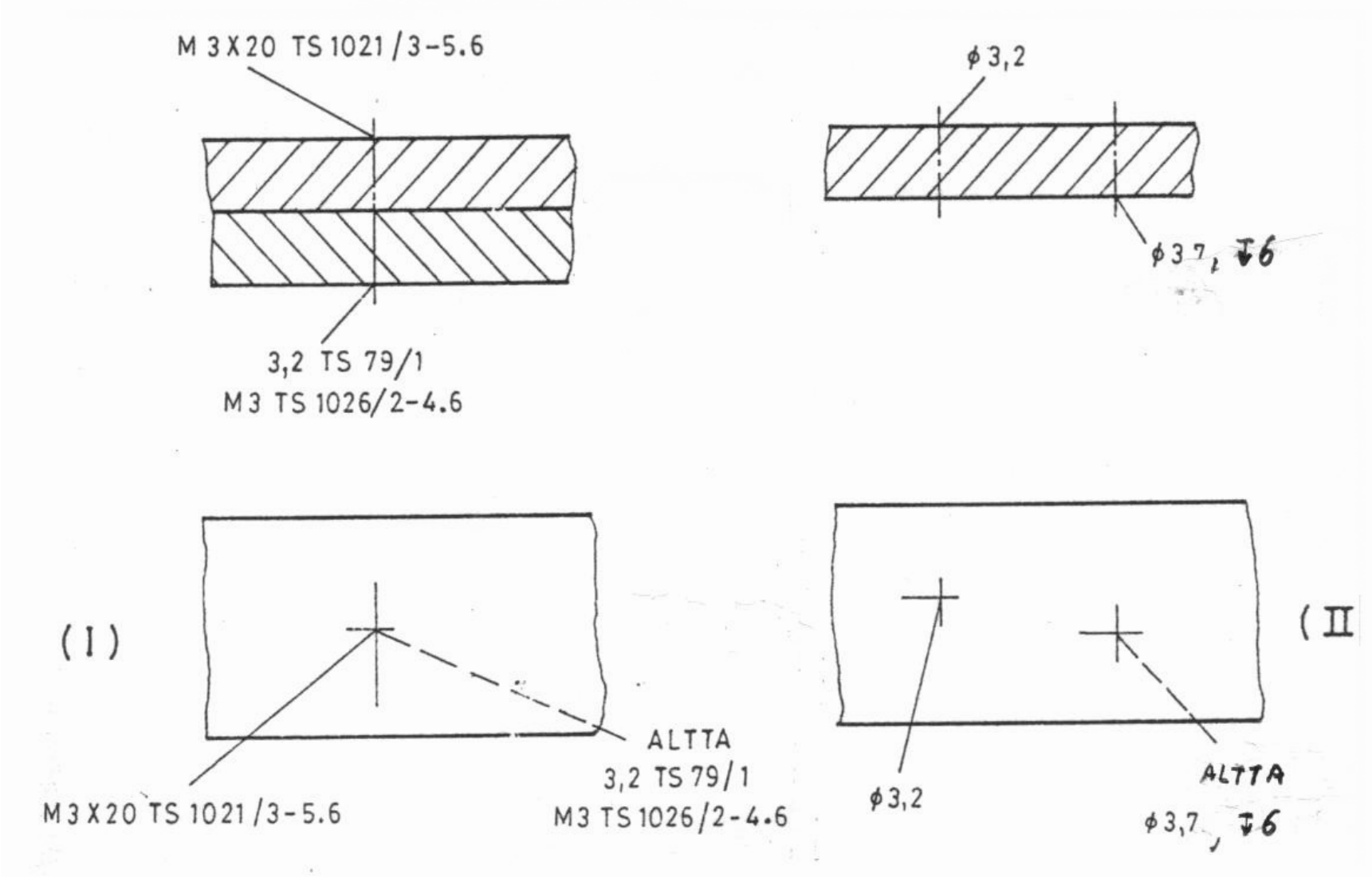


Cıvata Yuvaları TS 1023 , DIN 74



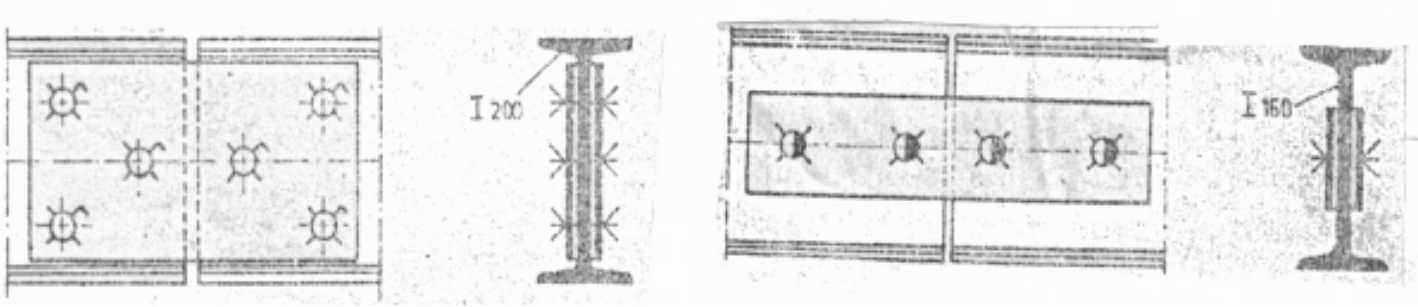
Vida çapı	Delik çapı d_1			Havşa yuva (Orta alıştırma)				Silindirik yuva				
	Bütün tipler			A tipi		B tipi		H, J, K Tipi		Tip H	Tip J	Tip K
	ince H12	orta H13	kaba H14	d_2 H12	$\approx t_1$	d 3	$\approx$ t 3	d 4 H 13	d 5	t 4	t 5	t 6
M 3	3,2	3,4	3,6	6,5	1,6	6,6	1,6	6		2,4		3,4
M 3,5	3,7	3,9	4,1	7,6	1,9			6,5		2,9		–
M 4	4,3	4,5	4,8	8,6	2,1	9	2,3	8		3,2	3,4	4,6
M 5	5,3	5,5	5,8	10,4	2,5	11	2,8	10		4	4,2	4,7
M 6	6,4	6,6	7	12,4	2,9	13	3,2	11		4,7	4,8	6,8
M 8	8,4	9	10	16,4	3,7	17,2	4,1	15		6	6	9
M 10	10,5	11	12	20,4	4,7	21,5	5,3	18		7	7,5	11
M 12	13	14	15	24,4	5,2	26	6	20	16	8	8,5	13
M 14	15	16	17	27,4	5,7	29	6,5	24	18	9	9,5	15
M 16	17	18	19	32,4	7,2	32	7	26	20	10,5	11,5	17,5
M 18	19	20	21	36,4	8,2	35	7,5	30	22	11,5	12,5	19,5
M 20	21	22	24	40,4	9,2	38	8	33	24	12,5	13,5	21,5
M 22	23	24	26			38	12,5	36	26	13,5	14,5	23,5
M 24	25	26	28			41	13,5	40	28	14,5	15,5	25,5


90°±1°
ϕ26 A13
6
ϕ14 A13
I
B 012 DIN 74
II
H 03 DIN 74
Kesit görünüş
A 3,5 DIN 74
Üst görünüş
ALTTA
A 3,5 DIN 74
H 03 DIN 74
III


M 3 X 20 TS 1021 / 3 - 5.6
3,2 TS 79/1
M 3 TS 1026/2-4.6
ϕ 3,2
ϕ 3 7, ∓6
(I)
M 3 X 20 TS 1021 / 3 - 5.6
ALTTA
3,2 TS 79/1
M 3 TS 1026/2-4.6
(II
ϕ 3,2
ALTTA
ϕ 3,7 , ∓6

Cıvata Sembolleri

Cıvata çapı		M8	M10	M12	M14	M16	M16	M20	M22	M24	M27	M30	M33	M36
Gövde çapı		8	10	12	14	16	18	20	22	24	27	30	33	36
Kesit alanı mm^2		31,9	50,9	74,3	102	141	171	220	276	317	419	509	636	745
Delik çapı		8,4	11	13	15	17	19	21	23	25	28	31	34	37
Özel cıvata işareteri	Normal cıvata deliği	8,4			15		19				28	31	34	37
	Diğer cıvata delikleri	Cıvata deliği dairesi üzerine ölçüsü konur. 26												
	Cıvata deliği	Gösterilişten başka ölçüsü konur. M24												
	Havşa başlı cıvata	M20 Üst baş havşalı								Alt baş havşalı M20				
	Montajda takılacak cıvata	8,4			15		19				28	31	34	37
	Montajda delinecek delik	8,4			15		19				28	31	34	37



Property Classes of Fasteners

Inch Fasteners

The strength of customary fasteners for most common uses is determined by the size of the fastener and the material from which it is made. Property classes are defined by the Society of Automotive Engineers (SAE) or the American Society for Testing and Materials (ASTM).

SAE Grade	Bolt Size (IN)	Tensile Strength (KSI)	Yield Strength (KSI)	Proof Strength (KSI)	Material	Head Marking
1	.25-1.5	60	36	33	Low or Medium Carbon Steel	
2	.25-.75	74	57	55	Low or Medium Carbon Steel	
	>.75-1.5	60	36	33	Low or Medium Carbon Steel	
4	.25-1.5	115	100	65	Low or Medium Carbon Steel	
5	.25-1	120	92	85	Medium Carbon Steel, Quenched and Tempered	
	>1-1.5	105	81	74		
5.2	.25-1.5	—	—	—	Low Carbon Martensite Steel, Quenched and Tempered	
7	.25-1.5	133	115	105	Medium Carbon Alloy Steel, Quenched and Tempered, Roll Threaded After Heat Treatment	
8	.25-1.5	150	130	120	Medium Carbon Alloy Steel, Quenched and Tempered	
8.2	.25-1.5	—	—	—	Low Carbon Martensite Steel, Quenched and Tempered	

4

SAE Grades for Fasteners (SAE J429)

The higher the number, the greater the fastener strength.

Metric Fasteners

For mechanical and material requirements, metric fasteners are classified under a number of property classes. Bolts, screws, and studs have seven property classes of steel suitable for general engineering applications. The property classes are designated by numbers, with increasing numbers generally representing increasing tensile strengths. The designation symbol consists of two parts: the first numeral of a two-digit symbol or the first two numerals of a three-digit symbol is approximately equal to one-hundredth of the minimum tensile strength in megapascals (MPa), and the last numeral approximates one-tenth of the ratio expressed as a percentage of minimum yield strength and minimum tensile strength.

Grade	Bolt Size	Tensile Strength (MPa)	Yield Strength (MPa)	Proof Strength (MPa)
4.6	M5-M36	400	240	225
4.8	M1.6-M16	420	340*	310
5.8	M5-M24	520	415*	380
8.8	M17-M36	830	660	600
9.8	M1.6-M16	900	720*	650
10.9	M6-M36	1040	940	830
12.9	M1.6-M36	1220	1100	970

*Yield strengths approximate and not included in standard

SAE Grades for Metric Fasteners

Cıvata ve Somun Gereçleri (Çelik)

Cıvata Gereçleri				Somun Gereçleri			
İşaret	Çekme dayanımı $\geq \sigma c$ Kgf/mm²	Akma Sınırı $\geq \sigma A$ Kgf/mm²	Kopma uzaması δ % Min.	Normal Somun TS 1026/2	Somun m=0,8 d	İnce Somun	TS 1026/3
				d/p < 9	d/p ≥ 9	d/p < 9	d/p ≥ 9
4 A	34	20	30	—	—	4 D	5 D,5 S
4 D	40	24	25				
4 S	40	32	14				
5 D	50	30	22	4 D	5 D,5 S	5 D,5 S	6 G,6 S
5 S	50	40	10				
6 D	60	36	13	5 D,5 S	6 G,6 S	6 G,6 S	8 G
6 S	60	48	8				
6 G	60	54	12				
8 G	80	64	12	6 G,6 S	8 G	8 G	—
10 K	100	90	8	8 G	10 K	—	—
12 K	120	108	8	10 K	10 K	—	—

Yüzey İşleme İşaretleri

Yüzey Kalitesi	İşleme İşaretleri	
	Cıvata	Somun
O Orta	Vida dişi ve bütün yüzeyler ▽▽ Cıvata başı yüzeyleri ve anahtar ağzı yüzeyleri ▽	Vida dişi ve bütün yüzeyler ▽▽
O.K Orta-Kaba	Oturma yüzeyleri, gövde, vida dişi yanları, diş dibi ▽▽ Diğer yüzeyler ~	Vida dişi yanları ve oturma yüzeyleri ▽▽ Anahtar ağzı yüzeyleri ~
K Kaba	Vida dişi yanları, diş dibi ▽ Diş üstü ve bütün diğer yüzeyler ~	Vida dişi yanları, diş üstü ▽ Diş dibi ve bütün diğer yüzeyler ~

Metric nut selection for bolts, screws, and studs.

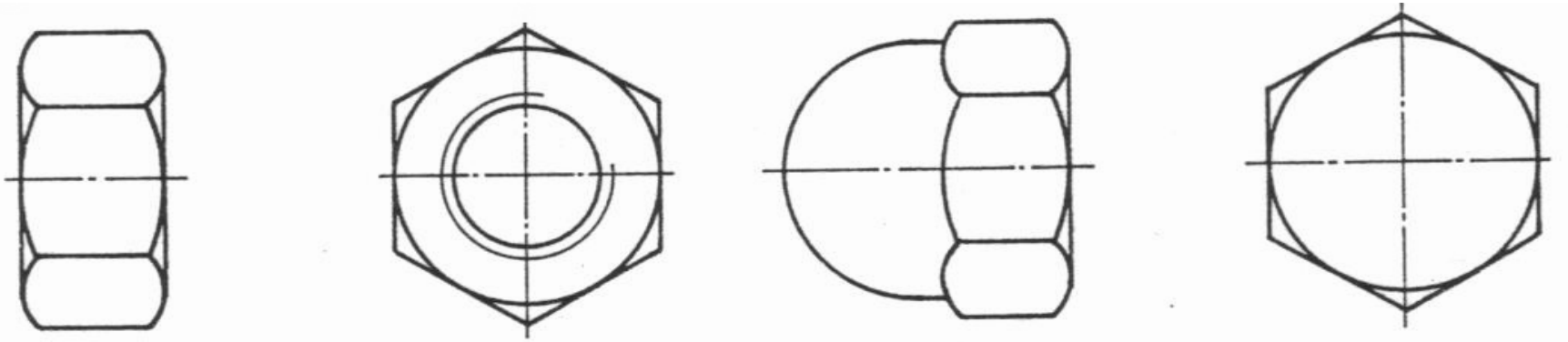
Property Class	Nominal Nut Size	Suggested Property Class of Mating Bolt, Screw, or Stud
5	M5 thru M36	4.6, 4.8, 5.8
9	M5 thru M16 M20 thru M36	5.8, 9.8 5.8, 8.8
10	M6.3 thru M36	10.9

TEK AĞIZLI VE SAĞ HELİS VİDALAR

Vida cinsi	Sembol	Ölçü değerleri	Örnek
Metrik diş	M	Diş üstü çapı d =12 mm	M12
Metrik ince diş	M	Diş üstü çapı x adım d=12 mm P=1.5 mm	M12x1.5
Whitwort diş	"	Diş üstü çapı d=2" (inch)	2"
Whitwort ince diş	W	Diş üstü çapı x 1 inchte diş sayısı d=50 mm P=1" da 6 diş	W50x1"/6
Whitwort boru diş	G	Boru iç çapı d=2 1/2" (inch)	G 2 1/2
Whitwort boru diş-konik	R	Boru iç çapı d=3/4" (inch)	R 3/4
Metrik -konik	M-konik	Referans düzleminde diş üstü çapı d=30 mm P=2 mm	M30x2-konik
Trapez-ISO diş	Tr	Diş üstü çapı x adım d=60 mm P=4 mm	Tr60x4
Testere diş	Te	Diş üstü çapı x adım d=60 mm P=4 mm	Te60x4
Yuvarlak diş	Yv	Diş üstü çapı x 1" ta diş sayısı d=60 mm P=1" da 6 diş	Yv60x1"/6

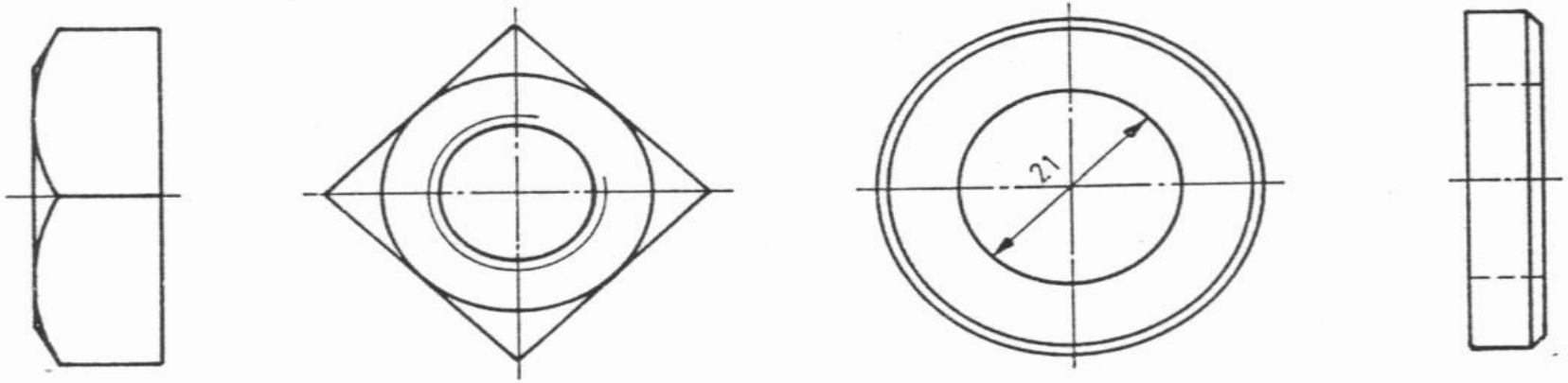
AĞIZ SAYISI ÇOK OLAN VE SOL HELİS VİDALAR

Metrik ISO- sol diş	M - LH	Diş üstü çapı (LH-Left Hand) d=12 mm	M12-LH
Trapez diş-3 ağızlı-sağ	Tr	Diş üstü çapı x İlerleme P_{hatve} d=60 mm h=15 mm Pb=5 mm	Tr60x15P5
Trapez diş-3 ağızlı-sol	Tr-LH	Diş üstü çapı x İlerleme P_{hatve} -sol d=60 mm P=15 mm Pb=5 mm	Tr60x15P5-LH [2)]



ALTIKÖŞE SOMUN
M12 TS 1026/2 OK 4.6

ALTIKÖŞE YÜKSEK ŞAPKALI SOMUN
M10 TS 1026/11 0 4.6

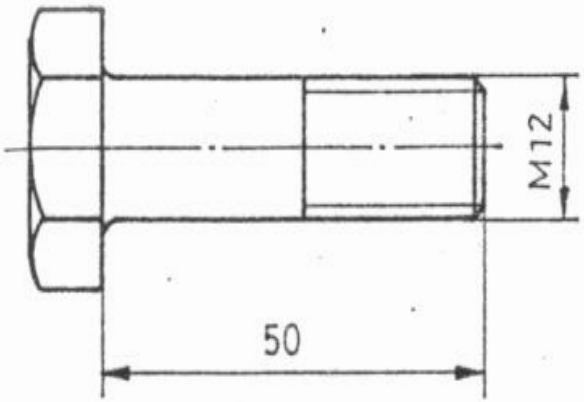


DÖRTKÖŞE PAHLI SOMUN
M8 TS 1026/17 4.6

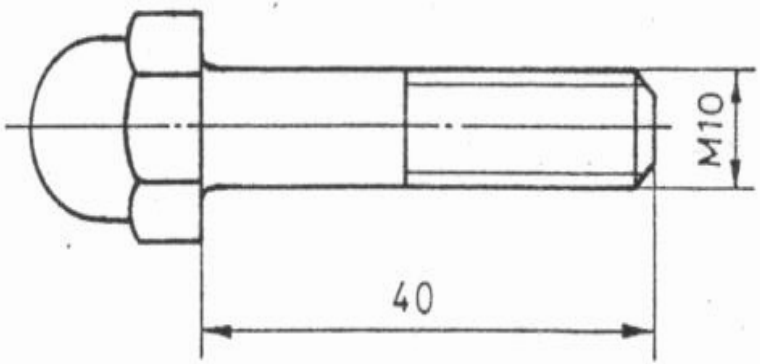
(III)

RONDELA 21 TS 79/1 St 37

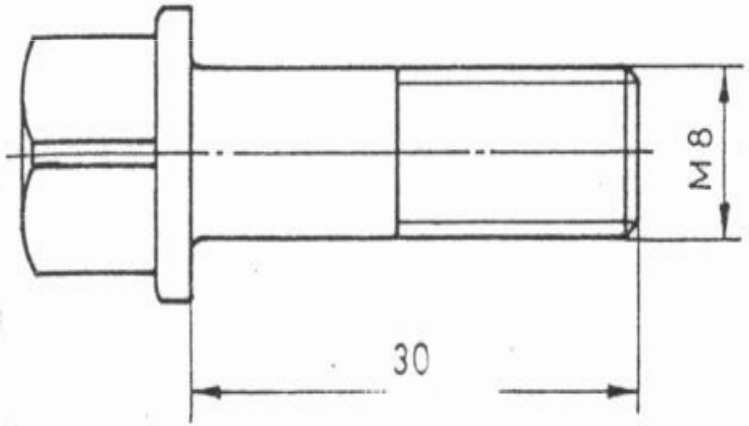
(IV)



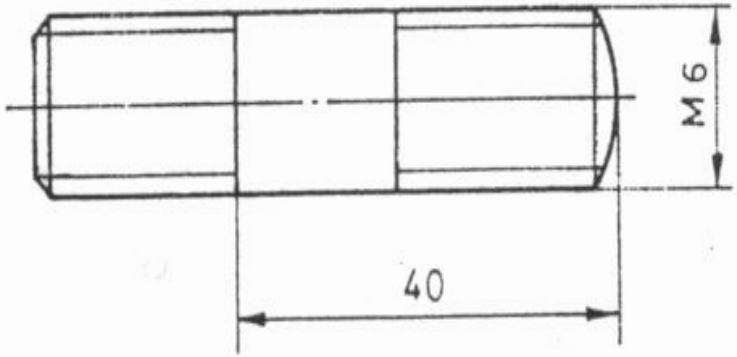
ALTIKÖŞE BAŞLI CIVATA
M12 x 50 TS 1021/2-5.6



ALTIKÖŞE BAŞLI KUBBELİ CIVATA
M10 x 40 TS 1021/2-5.6



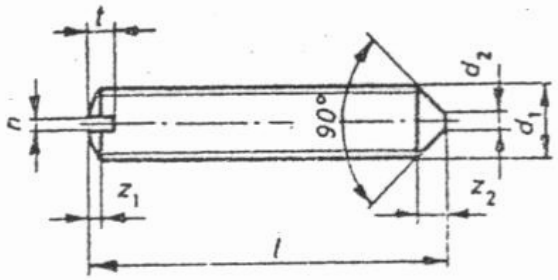
DÖRTKÖŞE BAŞLI CIVATA
M8 x 30 TS 1022/1-4.6



SAPLAMA
M6 x40 TS 1025/3

VİDALI PİM — Tornavida yarıklı

TS 1024/2
DIN 553



Anma çapı M 5 ve uzunluğu l = 12 mm olan başı yarıklı, kesik koni uçlu vidalı pimin gösterilişi :

Vidalı pim M 5 × 12 TS 1024/2

İşleme : (o)

d_1		M2	(M2,3)	M2,5	(M2,6)	M3	(M3,5)	M4	M5	M6	M8	M10	M12	M16	M20
d_2		—	—	—	—	—	—	—	—	1	2	2	2	4	6
n		0,3	0,4	0,4	0,4	0,5	0,5	0,6	0,8	1	1,2	1,6	2	2,5	3
t	min	0,9	0,9	1	1	1,2	1,4	1,5	1,8	2,2	2,7	3,3	3,8	4,5	5,3
	max	1,1	1,1	1,2	1,2	1,45	1,7	1,8	2,1	2,6	3,2	3,9	4,4	5,3	6,3
z_2		1	1,15	1,25	1,3	1,5	1,75	2	2,5	2,5	3	4	5	6	7
l		2,5	2,5	3	3	4	4	5	6	6	8	12	14	18	25
		8	10	10	10	12	12	16	17	22	28	35	45	50	60

British Representation:

0.75-10 UNC-2A x 2.50, LH, DOUBLE, HEXAGON CAP SCREW

0.63- 11 UNC- 2B HEXAGON NUT
SQUARE NUT

½" -11 NPS
NPT

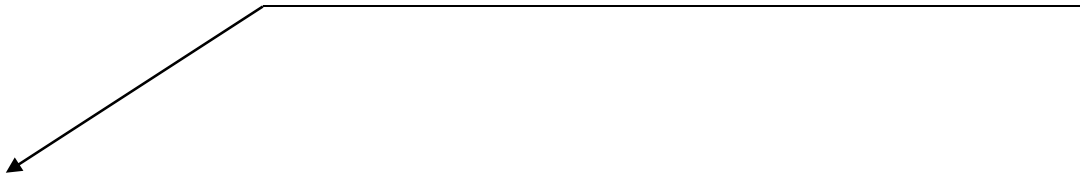
WIDE
NARROW

HELICAL-SPRING LOCK WASHER-1/4" REGULAR-PHOSPHORUS BRONZE

INTERNAL-TOOTH WASHER-1/4" –TYPE A- STEEL

EXTERNAL-TOOTH WASHR-0.562-TYPE B-STEEL

7/8 Drill, 3 Deep, 1-8 UNC- 2B, 2 Deep



ISO Representation:

M18x0.75-40, 5g 6g L-LH-DOUBLE HEX CAP SCR
M8x1.25 HEX NUT

Turkish Rep.:

k
o
Altıköşe Başlı Cıvata M18x0.75 i-40 TS 1021/2, OK, 5D

Altıköşe Somun M8x1.25 i TS 1026/2 K 4D

R ½" TS 61/20 or R ½" DIN 259

Rondela 15 TS 79/1, St37