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STUDS AND BENT BOLTS

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IFI Note:

1. *IFI-136 is a standard developed through the procedures of Industrial Fasteners Institute. Standards for studs and bent bolts were originally published in Fastener Standards, 5th Edition, 1970. In 1986, these standards were updated, modestly revised and reissued as IFI-136.*

1. **Scope.** This standard covers the general and dimensional requirements for various types of studs and bent bolts in nominal thread diameters 1/2 inches and smaller.

Section A details double end studs (Table 1); Section B details interference-thread double end studs (Table 2); Section C details continuous thread studs; Section D details stud bolts for pressure-temperature piping; and Section E details bent bolts.

2. Section A — Double End Studs.

2.1 **Types.** There are 4 types of double end studs —

Type 1 — Unfinished

Type 2 — Finished, Full or Undersize Body

Type 3 — Finished, Full Body

Type 4 — Finished, Close Body

2.2 **Body Diameter Tolerances.** Type 1 studs shall have an unfinished body with no specified body diameter tolerances. Type 2 studs shall have a maximum body diameter equal to basic major diameter of the thread, and a minimum body diameter equal to the rolled thread blank size. Type 3 studs shall have a maximum body diameter equal to basic major diameter of the thread, and a minimum body diameter equal to the specified minimum major diameter of the thread. Type 4 studs shall have body diameter tolerances as specified by the purchaser (milled or ground body). Tolerances are given in Table 1.

2.3 **Short Studs.** Continuous thread studs shall be supplied for all studs too short to accommodate the standard thread length on each end.

2.4 **Point.** Both ends of the stud shall be pointed. At manufacturer's option, points may

be rounded (oval) or flat and chamfered. When rounded, the stud shall have an oval point with a radius equal to approximately one times the basic stud diameter. When flat and chamfered, the end shall be chamfered from a diameter approximately 0.016 in. below the minor diameter of the thread to produce a length of chamfer or incomplete thread equivalent to 1 to 1.5 times the thread pitch.

2.5 **Length.** The length of stud, measured parallel to the axis, shall be the distance from extreme end to extreme end. The tolerance on length shall be:

Nominal Stud Size	1/4 thru 1/2	9/16 thru 1-1/4	1-3/8 and Over
Nominal Stud Length	Tolerance on Length, in.		
Up to 6 in., incl.	± 0.03	± 0.06	± 0.09
Over 6 in.	± 0.06	± 0.09	± 0.12

2.6 **Full Thread Length, F.** The full thread length is the distance, measured parallel to the axis of stud, from extreme end of the stud to the opposite face of a GO thread ring gage, having the chamfer and/or counterbore removed, which has been assembled by hand as far as the thread will permit.

2.7 **Total Thread Length, G.** The total thread length is the distance, measured parallel to the axis of stud, from the extreme end of the stud to the last scratch on cut threads or to the top of the extrusion angle on rolled threads.

2.8 **Threads.** Threads, when rolled, shall be Unified inch coarse, fine, or 8 thread series (UNRC, UNRF, or 8 UNR series), Class 2A, in accordance with ANSI/ASME B1.1, page A-26. Threads produced by other methods shall preferably be



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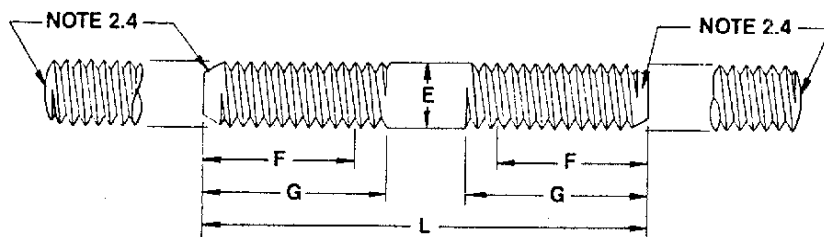


Table 1 Dimensions of Double End Studs

Nominal Size or Basic Stud Diameter	Body Diameter								Nut Ends				
	E								F	G	F	G	G
	Type 1		Type 2		Type 3		Type 4		For Studs Up To And Including 6 in. Length		For Studs Over 6 in. Length		For Short Studs
									Thread Length		Thread Length		Thread Length
	Max	Min	Max	Min	Max	Min	Max	Min	Full Thread	Total Thread	Full Thread	Total Thread	
1/4 0.2500	—	—	0.2500	0.2127	0.2500	0.2408	—	—	0.750	0.875	1.000	1.125	—
5/16 0.3125	—	—	0.3125	0.2712	0.3125	0.3026	—	—	0.875	1.031	1.125	1.281	—
3/8 0.3750	—	—	0.3750	0.3287	0.3750	0.3643	—	—	1.000	1.188	1.250	1.438	—
7/16 0.4375	—	—	0.4375	0.3850	0.4375	0.4258	—	—	1.125	1.344	1.375	1.594	—
1/2 0.5000	—	—	0.5000	0.4435	0.5000	0.4876	—	—	1.250	1.500	1.500	1.750	—
9/16 0.5625	—	—	0.5625	0.5016	0.5625	0.5495	—	—	1.375	1.656	1.625	1.906	—
5/8 0.6250	—	—	0.6250	0.5589	0.6250	0.6113	—	—	1.500	1.812	1.750	2.062	—
3/4 0.7500	—	—	0.7500	0.6773	0.7500	0.7353	—	—	1.750	2.125	2.000	2.375	—
7/8 0.8750	—	—	0.8750	0.7946	0.8750	0.8592	—	—	2.000	2.438	2.250	2.688	—
1 1.0000	—	—	1.0000	0.9100	1.0000	0.9830	—	—	2.250	2.750	2.500	3.000	—
1-1/8 1.1250	—	—	1.1250	1.0228	1.1250	1.1064	—	—	2.500	3.062	2.750	3.312	—
1-1/4 1.2500	—	—	1.2500	1.1476	1.2500	1.2314	—	—	2.750	3.375	3.000	3.625	—
1-3/8 1.3750	—	—	1.3750	1.2563	1.3750	1.3544	—	—	3.000	3.688	3.250	3.928	—
1-1/2 1.5000	—	—	1.5000	1.3812	1.5000	1.4794	—	—	3.250	4.000	3.500	4.250	—
See Notes 2.12	2.1, 2.2								2.6	2.7	2.6	2.7	2.3

UNRC, UNRF, or 8 UNR, but at manufacturer's option, may be Unified inch coarse, fine, or 8 thread series (UNC, UNF, or 8 UN series), Class 2A. Acceptability of screw threads shall be determined based on System 21 of ANSI/ASME B1.3, page A-53.

2.9 Thread Runout. Total runout (eccentricity and angularity) of thread in relation to stud body shall be such that the stud will meet the requirement specified in Appendix I.

2.10 Material. Chemical and mechanical requirements shall be as agreed upon by manufacturer and purchaser. Properties of carbon steel studs are covered in SAE J429, page B-50, ASTM A307, page B-58, ASTM A449, page B-63, and ASTM A354, page B-68. Properties of several grades of stainless steel are covered in ASTM F593, page B-92, and of several nonferrous materials in ASTM F468, page B-100.

2.11 Designation. To avoid possible misunderstanding when specifying the dimensions of

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double end studs, it is recommended that they be designated in the following sequence: product name; nominal size (fractional or decimal equivalent) and threads per inch; stud length (fraction or decimal equivalent); material including grade identification; and protective finish, if required.

Examples:

Type 2 Double End Stud 3/8 - 16x4, SAE Grade 5 Steel

Type 4 Double End Stud .750 - 10x5.50, ASTM A449, Cadmium Plated

2.12 Nominal Size. Where specifying nominal size in decimals, zeros preceding decimal and in fourth decimal place shall be omitted.

3. Section B — Interference-Thread Double End Studs.

3.1 Types. There are 4 types of interference-thread double end studs —

- Type 1 — Unfinished
- Type 2 — Finished, Full or Undersize Body
- Type 3 — Finished, Full Body
- Type 4 — Finished, Close Body

3.2 Body Diameter Tolerances. Type 1 studs shall have an unfinished body with no specified body diameter tolerances. Type 2 studs shall have a maximum body diameter equal to basic major diameter of the thread, and a minimum body diameter equal to the rolled thread blank size. Type 3 studs shall have a maximum body diameter equal to basic major diameter of the thread, and a minimum body diameter equal to the specified minimum major diameter of the thread. Type 4 studs shall have body diameter tolerances as specified by the purchaser (milled or ground body). Tolerances for interference-thread double end studs of the four types are the same as those given in Table 1 for double end studs of the same respective Type number.

3.3 Point. Tap end of studs shall be pointed to dimensions, C and D, Table 2. Unless otherwise specified, nut end of studs shall have an oval point with a radius equal to approximately one times the basic stud diameter. Where chamfer is specified, the nut end shall be chamfered from

a diameter approximately 0.016 in. below the minor diameter of the thread to produce a length of chamfered or partial thread equivalent to 1 to 1.5 times the pitch of the thread and a suitable identification (to distinguish nut end from tap end) shall be provided, such as a conical indent or an annular ring (ring to be a protrusion from flat point of length about 1/32 in. and diameter somewhat smaller than flat point diameter) at option of the manufacturer.

3.4 Length. The length of stud, measured parallel to the axis, shall be the distance from extreme end to extreme end. The tolerance on length shall be:

Nominal Stud Size	1/4 thru 1/2	9/16 thru 1-1/4	1-3/8 and Over
Nominal Stud Length	Tolerance on Length, in.		
Up to 6 in., incl.	± 0.03	± 0.06	± 0.09
Over 6 in.	± 0.06	± 0.09	± 0.12

3.5 Full Thread Length Nut End. The full thread length shall be measured parallel to the axis of stud from the end of the stud to the opposite face of a GO thread ring gage having the chamfer and or counterbore removed which has been assembled by hand as far as the thread will permit.

3.6 Total Thread Length, B&G. The total thread length shall be measured parallel to the axis of stud, from the end of the stud to the end of the thread runout (to last scratch on cut threads or to top of extrusion angle on rolled threads).

3.7 Short Studs. For studs with a length of 3D or less, the thread length on nut end shall be as agreed upon by user and producer.

3.8 Threads.

3.8.1 Nut End. Threads, when rolled, shall be Unified inch coarse, fine, or 8 thread series (UNRC, UNRF, or 8 UNR series), Class 2A, in accordance with ANSI/ASME B1.1, page A-26. Threads produced by other methods shall preferably be UNRC, UNRF, or 8 UNR, but at the manufacturer's option may be Unified inch coarse, fine, or 8 thread series (UNC, UNF, or 8 UN series), Class 2A. Acceptability of screw threads shall be determined based on System 21 of ANSI/ASME B1.3, page A-53.



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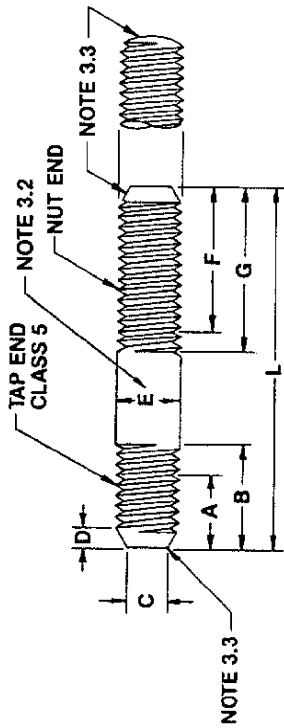


Table 2 Dimensions of Interference-Thread Double End Studs

Nominal Size or Basic Stud Diameter	Tap End						Nut End											
	A	B	Thread Length		C	D	F	G	For Studs of 3D Length or Less		For Studs Less Than 4.75D Length and Over 3D Length		For Studs Over 4.75D and Up To and Including 6 in. Length		For Studs Over 6 in. Length			
			NC 5 HF	NC 5 CSF					Point Diameter	Point Length	Full Thread	Total Thread	Full Thread	Total Thread	Full Thread	Total Thread	Full Thread	Total Thread
1/4	0.2500	0.375	0.500	0.687	0.812	0.150	0.100	—	—	0.375	0.500	0.750	0.875	1.000	1.125	1.250	1.375	
5/16	0.3125	0.469	0.625	0.859	1.015	0.167	0.112	—	—	0.469	0.625	0.875	1.031	1.250	1.438	1.625	1.812	
3/8	0.3750	0.562	0.750	1.032	1.219	0.187	0.125	—	—	0.562	0.750	1.000	1.188	1.500	1.750	2.062	2.375	
7/16	0.4375	0.656	0.875	1.203	1.422	0.214	0.143	—	—	0.656	0.875	1.125	1.344	1.750	2.000	2.375	2.750	
1/2	0.5000	0.750	1.000	1.375	1.625	0.231	0.154	—	—	0.750	1.000	1.250	1.500	1.500	1.500	1.500	1.750	
9/16	0.5625	0.843	1.125	1.547	1.828	0.250	0.167	—	—	0.843	1.125	1.375	1.656	1.625	1.625	1.625	1.906	
5/8	0.6250	0.937	1.250	1.718	2.031	0.273	0.182	—	—	0.937	1.250	1.500	1.812	1.750	1.750	1.750	2.062	
3/4	0.7500	1.125	1.500	2.062	2.438	0.300	0.200	—	—	1.125	1.500	1.750	2.125	2.000	2.000	2.000	2.375	
7/8	0.8750	1.312	1.750	2.406	2.844	0.333	0.222	—	—	1.312	1.750	2.000	2.438	2.250	2.250	2.250	2.688	
1	1.0000	1.500	2.000	2.750	3.250	0.375	0.250	—	—	1.500	2.000	2.250	2.750	2.500	2.500	2.500	3.000	
1-1/8	1.1250	1.687	2.250	3.093	3.655	0.429	0.286	—	—	1.688	2.250	2.500	3.062	2.750	2.750	2.750	3.312	
1-1/4	1.2500	1.875	2.500	3.438	4.062	0.429	0.286	—	—	1.875	2.500	2.750	3.375	3.000	3.000	3.000	3.625	
1-3/8	1.3750	2.062	2.750	3.781	4.469	0.500	0.334	—	—	2.062	2.750	3.000	3.688	3.250	3.250	3.250	3.938	
1-1/2	1.5000	2.250	3.000	4.125	4.875	0.500	0.334	—	—	2.250	3.000	3.250	4.000	3.500	3.500	3.500	4.250	
See Notes 3.12		3.6	3.6	3.6	3.6	3.3	3.7	3.5	3.6	3.5	3.6	3.5	3.6	3.5	3.6	3.5	3.6	

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3.8.2 Tap End. Unless otherwise specified by the purchaser, threads shall be Class 5 interference fit threads, NC5CSF, NC5HF, or NC50NF in accordance with ANSI/ASME B1.12, page A-75.

3.9 Thread Runout. Total runout (eccentricity and angularity) of thread in relation to stud body shall be such that the stud will meet the requirement specified in Appendix I.

3.10 Material. Chemical and mechanical requirements shall be as agreed upon by the manufacturer and purchaser. For guidance, refer to Note 3, Table 1, ANSI/ASME B1.12, page A-78.

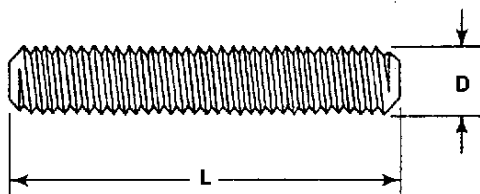
3.11 Designation. To avoid possible misunderstanding when specifying these studs, it is recommended that they be designated in the following sequence. Product name, nominal size (fractional or decimal equivalent) and threads per inch for nut end stud length (fractional or decimal equivalent), series symbol for tap end thread material including grade identification and protective finish, if required.

Examples:

Type 1 Interference Thread Type Double End Stud $\frac{1}{2}$ - 20 x 6 x NC 5 HF SAE Grade 5 Steel.

Type 3 Interference Thread Type Double End Stud .375 - 16 x 3.50 x NC 5 CSF ASTM A449 Steel Cadmium Plated.

3.12 Nominal Size. Where specifying nominal size in decimals, zeros preceding decimal and in the fourth decimal place shall be omitted.



4. Section C — Continuous Thread Studs (General Purpose).

4.1 Length. The length of stud, measured parallel to the axis, is the distance from extreme end

to extreme end. The tolerance on length shall be as tabulated below:

Nominal Stud Size in.	Tolerance on Length, in.	
	For Lengths 6 in. and Shorter	For Lengths Over 6 in.
to 5/16	± 0.03	± 0.06
over 5/16 to 3/4	± 0.06	± 0.12
over 3/4 to 1-1/4	± 0.12	± 0.19
over 1-1/4	± 0.25	± 0.25

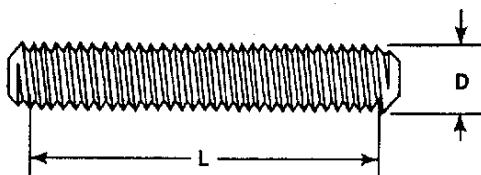
4.2 Point. Both ends of the stud shall be pointed. At manufacturer's option, points may be rounded (oval) or flat and chamfered. When rounded, the stud shall have an oval point with a radius equal to approximately one times the basic stud diameter. When flat and chamfered, the end shall be chamfered from a diameter not exceeding the minor diameter of the thread to produce a length of chamfer or incomplete thread approximately equivalent to 2 times the thread pitch.

4.3 Threads. Threads shall be Unified inch coarse or fine series (UNC or UNF series), Class 2A, in accordance with ANSI/ASME B1.1, page A-26, for stud sizes 1 in. and smaller, and Unified inch coarse or 8 thread series (UNC or 8 UN series) for stud sizes larger than 1 in. Acceptability of screw threads shall be determined based on System 21 of ANSI/ASME B1.3, page A-53.

4.4 Material. Chemical and mechanical requirements shall be as agreed upon by manufacturer and purchaser. Properties of carbon steel studs are covered in SAE J429, page B-50, ASTM A307, page B-58, ASTM A449, page B-63, and ASTM A354, page B-68. Properties of several grades of stainless steel are covered in ASTM F593, page B-92, and of several nonferrous materials in ASTM F468, page B-100.

4.5 Designation. To avoid misunderstanding when specifying continuous thread studs, it is recommended that they be designated in the following sequence: product name, nominal size, threads per inch, stud length, material, and protective finish, if required.

Example: Continuous thread stud, $\frac{1}{2}$ - 13x8, ASTM A307, zinc plated.



5. Section D — Stud Bolts for Pressure-Temperature Piping.

5.1 Reference. Stud bolts for pressure-temperature applications conform to the requirements of ANSI/ASME B16.5, Steel Pipe Flanges and Flanged Fittings.

5.2 Length. The length of stud bolt, measured parallel to the axis, is the distance from first thread to first thread. First thread is defined as the intersection of the major diameter of the thread with the base of the point.

Stud bolts are normally available in $\frac{1}{4}$ in. length increments. Length tolerances, all stud bolt sizes, shall be as tabulated below:

Length, in.	Length Tolerance, in.
to 12	± 0.062
over 12 to 18	± 0.125
over 18	± 0.250

5.3 Point. Both ends of stud bolt shall be pointed. Points shall be flat and chamfered, rounded (oval), or sheared at option of the manufacturer. When points are flat and chamfered, the diameter of the flat shall not exceed the minor diameter of the thread.

5.4 Threads. Threads shall be Unified inch coarse thread series (UNC), Class 2A, for all stud bolt sizes 1 in. and smaller, and Unified inch 8 thread series (8 UN), Class 2A, for all stud bolts larger than 1 in., in accordance with ANSI/ASME B1.1, page A-26. Acceptability of screw threads shall be determined based on System 21 of ANSI/ASME B1.3, page A-53.

5.5 Material. Chemical and mechanical requirements shall be specified by the purchaser and shall be in accordance with applicable ASME, ASTM, and ANSI codes and specifications current at the time of ordering.

5.6 Designation. To avoid misunderstanding when specifying stud bolts for pressure-temperature piping applications, it is recommended that they be designated in the following

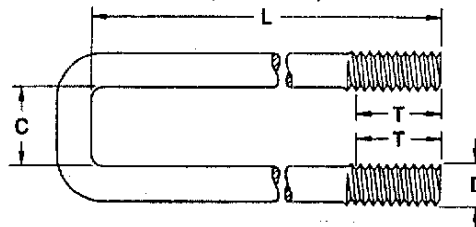
sequence: product name, nominal size, threads per inch, length, material, and protective finish, if required.

Example: ANSI/ASME B16.5 stud bolt,
7/8 – 9x10, ASTM A354, Grade BD.

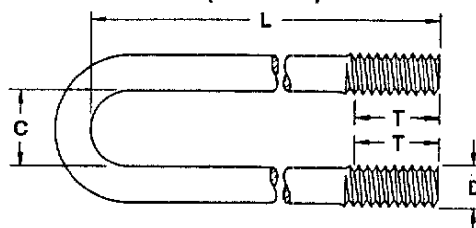
6. Section E — Bent Bolts.

6.1 Types. Bent bolts may be obtained in the basic designs illustrated below. The purchaser is responsible for specifying dimensions, material, and mechanical requirements.

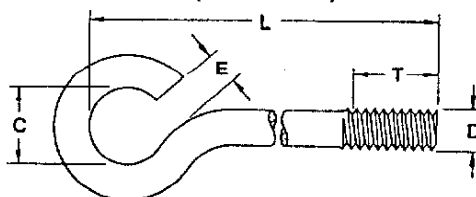
U-Bolt, Square Bend
(DxLxCxT)



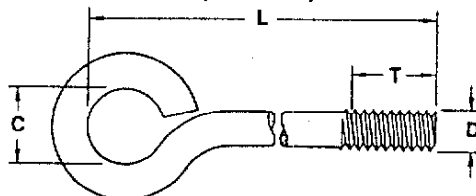
U-Bolt, Round Bend
(DxLxCxT)



Eye Bolt Open
(DxLxCxExT)



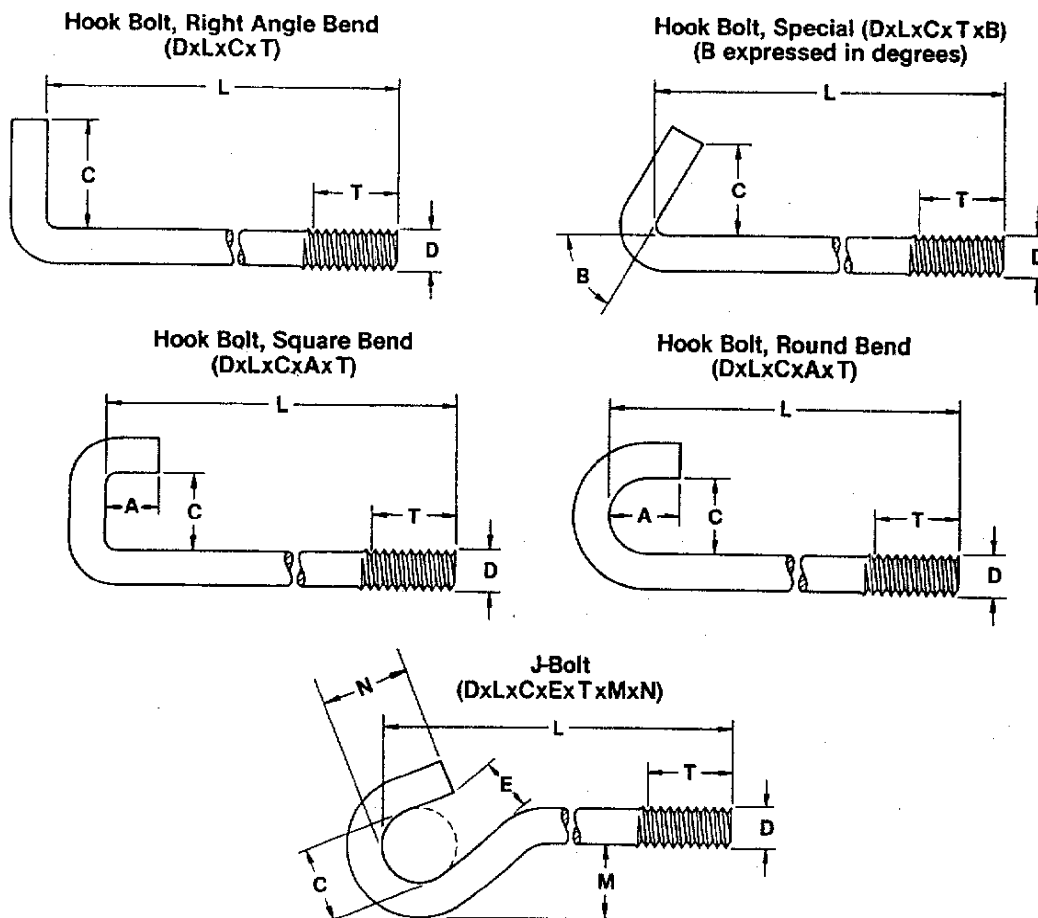
Eye Bolt, Closed
(DxLxCxT)



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6.2 Size. The nominal bolt size is the nominal size (basic major diameter) of the threaded portion.

6.3 Thread Length. The full thread length shall be measured, parallel to the axis of the thread, from the extreme end of the bolt to the last complete (full form) thread.

6.4 Threads. Threads shall be Unified inch coarse, fine, or 8 thread series (UNC, UNF, or 8 UN series), Class 2A, in accordance with ANSI/ASME B1.1, page A-26. Acceptability of screw threads shall be determined based on System 21 ANSI/ASME B1.3, page A-53.

6.5 Material. Chemical and mechanical requirements shall be specified by the purchaser.

For guidance, refer to SAE J429, page B-50, ASTM F593, page B-92, and ASTM F468, page B-100.

6.6 Designation. To avoid possible misunderstanding when specifying bent bolts, it is recommended that dimensional features be given in the sequence shown in brackets adjacent to the bolt type callouts above each illustration; followed by product name, material, and protective finish, if required.

Example: If a medium carbon heat treated steel J-bolt is required with $D = 1/2$ in., UNC threads, $L = 6$ in., $C = 1$ in., $E = 5/8$ in., thread length $T = 1-1/2$ in., $M = 7/8$ in., and $N = 1-1/4$ in., it should be designated —
1/2-13X6x1x5/8x1-1/2x7/8x1-1/4, J-bolt, SAE Grade 5, zinc plated.

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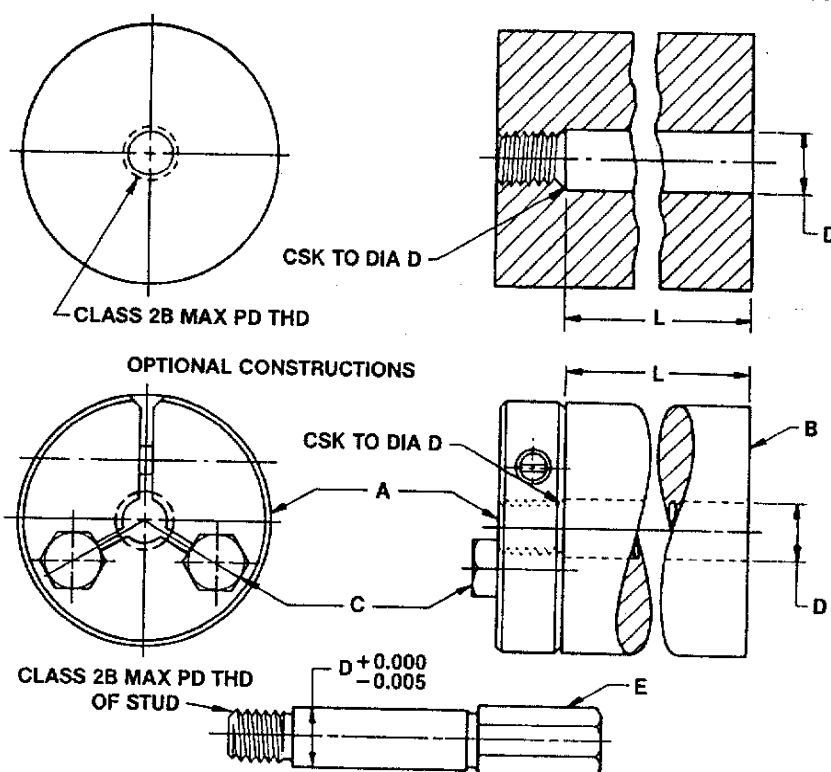
APPENDIX I THREAD RUNOUT SLEEVE GAGE

Gages capable of checking thread eccentricity and angularity respective to the axis of studs are illustrated below.

The lower construction permits use of various length sleeves to accommodate different lengths of studs. Thread ring gage A is centered on the sleeve B by means of positioning plug E and is secured in position by means of attachment screws C. The ring gage is set to Class 2B maximum pitch diameter by use of the positioning plug E.

Diameter D, of counterbore or hole in sleeve, equals the specified maximum diameter of the stud plus the runout allowance. The sleeve length or counterbore depth L should be such that entering face of gage extends beyond the last thread on the stud to be inspected, but for practical purposes should not exceed 3.00 in.

Failure of the stud to enter the threads of the gage for at least two threads, or interference between the sides of hole or counterbore and the stud while engaging threads of gage, indicates excessive thread runout.



- A — Thread ring gage set to Class 2B maximum pitch diameter
- B — Sleeve
- C — Attachment screws
- D — Equals specified maximum stud diameter plus 0.031 in. for $\frac{3}{4}$ in. diameter studs and smaller and 0.062 in. for studs larger than $\frac{3}{4}$ in. diameter
- E — Positioning and setting plug for adjusting ring gage to Class 2B maximum pitch diameter and centering sleeve.
- F — Depth of counterbore or length of sleeve equals the length of stud minus one diameter of stud but for practical purposes should not exceed 3.00 in.

To insure adequate service life, gages shall be suitably hardened.