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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

SCREW-THREAD STANDARDS FOR FEDERAL SERVICES 1942

(Superseding Handbook H25 and the Reports of the National Screw Thread Commission)

NATIONAL BUREAU OF STANDARDS HANDBOOK H28

U. S. DEPARTMENT OF COMMERCE
JESSE H. JONES, Secretary
NATIONAL BUREAU OF STANDARDS
LYMAN J. BRIGGS, Director

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(Superseding Handbook H25 and the Reports of the National Screw Thread Commission)

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FOREWORD

The Interdepartmental Screw Thread Committee has been established by the Departments of War, Navy, and Commerce to promote uniformity in screw-thread standards in the Departments concerned.

The Committee is charged: (1) With the development of standards for screw threads; (2) the standardization of gages, dies, and taps; and (3) the standardization of dimensions of nuts, bolt heads, wrenches and other items associated with the manufacture and use of interchangeable threaded parts. Standards developed by the Committee, when approved by the Departments concerned, are to be published together with a joint order making their use mandatory in the Departments of War, Navy, and Commerce, except where a need for deviations therefrom is shown. Standards thus established are subject to such extension and revision as the Committee may find desirable.

The basis for this handbook is the 1933 report, and preceding reports, of the National Screw Thread Commission, and Handbook H25 which superseded those reports and which this handbook supersedes, together with pertinent standards approved and promulgated by the American Standards Association.

Lyman J. Briggs, *Chairman.*

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APPROVAL BY THE SECRETARIES OF WAR, NAVY, AND COMMERCE

The accompanying report on screw-thread standards for Federal services, as approved on October 3, 1941, by the Interdepartmental Screw Thread Committee, is hereby approved, and the use of these standards by the Departments of War, Navy, and Commerce, except where a need for deviation therefrom is shown, is hereby ordered.

Henry L. Stimson,
Secretary of War.

Frank Knox,
Secretary of the Navy.

Jesse H. Jones,
Secretary of Commerce.

1942 HANDBOOK OF SCREW THREAD STANDARDS FOR FEDERAL SERVICES

As Approved October 3, 1941

SECTION I. INTRODUCTION

1. PURPOSE OF FEDERAL STANDARDS FOR THREADED PRODUCTS

The purpose of this handbook is to present complete dimensional data upon which specifications may be based for threaded products for Government requirements. So far as practicable, these data are intended to conform to generally accepted commercial practice, although certain special requirements of the Government necessitate the inclusion of some standards not generally applicable outside the Government services. References are cited throughout the text to the standards promulgated by the American Standards Association, and to such other published standards as are in agreement with the specifications herein.

There are included in the body of the handbook specifications for threaded products and gages, embodying sufficient information to permit the writing of definite and complete specifications for the purchase of screw-thread products. In the appendixes there is arranged supplementary information of both a general and a technical nature, including such specifications as are not intended to be mandatory.

The specifications in the handbook have been arranged, as far as possible, by products. For example, one section deals with threads for bolts and nuts, etc., another with hose-coupling threads, another with pipe threads, another with wrench-head bolts and nuts, etc.

2. PERSONNEL OF THE COMMITTEE

The personnel of the Interdepartmental Screw Thread Committee is as follows:

Representing the War Department:

Maj. George C. Kenney, Chief, Production Engineering Section, Matériel Division, Wright Field, Dayton, Ohio.

Lt. Col. Mervin E. Gross, Air Corps, Office of the Chief of Air Corps, Washington, D. C. (succeeding Maj. George C. Kenney, November 15, 1939).

Lt. Col. Harry B. Hambleton, Office of Chief of Ordnance, War Department, Washington, D. C.

Maj. Ralph O. Brownfield, Air Corps, Wright Field, Dayton, Ohio (succeeding Lt. Col. Mervin E. Gross, September 19, 1941).

Representing the Navy Department:

Comdr. Harry B. Slocum, U. S. Navy, Naval Gun Factory, U. S. Navy Yard, Washington, D. C.

Lt. Comdr. Guy Chadwick, U. S. Navy, Bureau of Engineering, Navy Department, Washington, D. C.

Lt. Comdr. William K. Mendenhall, Jr., U. S. Navy, Naval Gun Factory, Navy Yard, Washington, D. C. (succeeding Comdr. Harry B. Slocum, December 4, 1939).
Commander E. C. Forsyth, U. S. Navy, Bureau of Ships, Navy Department, Washington, D. C. (succeeding Lt. Comdr. Guy Chadwick, May 1, 1940).
Lt. Comdr. Jesse W. Huckert, U. S. Naval Reserve (succeeding Comdr. William K. Mendenhall, Jr., October 3, 1941).

Representing the Department of Commerce:

Dr. Lyman J. Briggs, Chairman, Director, National Bureau of Standards, Washington, D. C.
Mr. Henry W. Bearce, Secretary, Chief, Division of Weights and Measures, National Bureau of Standards, Washington, D. C.

Liaison Representatives of the American Standards Association:

Mr. Earle Buckingham, Professor, Massachusetts Institute of Technology, Cambridge, Mass.	(Member of the ASME and SAE)
Mr. J. H. Edmonds, General Manager, Lebanon Plant, Bethlehem Steel Co., Lebanon, Pa.	(Member of ASA Committee B18)
Mr. R. E. Flanders, President, Jones & Lamson Machine Co., Springfield, Vt.	(Member of the ASME and SAE)
Mr. A. M. Houser, Engineer of Standardization, Crane Co., 4100 South Kedzie Avenue, Chicago, Ill.	(Member of the ASME)
Mr. Chas. C. Winter, Secretary, Winter Bros. Co., Wrentham, Mass. (succeeding Mr. R. E. Flanders, August 9, 1940).	(Member of ASA Committees B2 and B4).

SECTION II. TERMINOLOGY

In this handbook there are utilized, as far as possible, nontechnical words and terms which best convey alike to the producer and user of screw threads the information presented.

1. DEFINITIONS

The following definitions are given of the more important terms used in the handbook. Definitions of terms which are obviously elementary in character are intentionally omitted.

(*a*) Terms Relating to Screw Threads.—1. *Screw thread.*—A ridge of uniform section in the form of a helix on the external or internal surface of a cylinder, or in the form of a conical spiral on the external or internal surface of a cone.

2. *External and internal threads.*[1]—An external thread is a thread on the outside of a member. Example: A threaded plug.

An internal thread is a thread on the inside of a member. Example: A threaded hole.

3. *Major diameter.*—The largest diameter of the thread of the screw or nut. The term "major diameter" replaces the term "outside diameter" as applied to the thread of a screw and also the term "full diameter" as applied to the thread of a nut.

4. *Minor diameter.*—The smallest diameter of the thread of the screw or nut. The term "minor diameter" replaces the term "core diameter" as applied to the thread of a screw and also the term "inside diameter" as applied to the thread of a nut.

5. *Pitch diameter.*—On a straight screw thread, the diameter of an imaginary cylinder, the surface of which would pass through the

[1] These terms are here defined because of possible confusion arising from the fact that an "internal member" has an "external thread", and vice versa. For the sake of brevity an external thread is hereinafter referred to as a "screw," and an internal thread as a "nut."

threads at such points as to make equal the width of the threads and the width of the spaces cut by the surface of the cylinder. On a taper screw thread, the diameter, at a given distance from a reference plane perpendicular to the axis of an imaginary cone, the surface of which would pass through the threads at such points as to make equal the width of the threads and the width of the spaces cut by the surface of the cone.

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

$$\text{The pitch in inches} = \frac{1}{\text{Number of threads per inch}}$$

7. *Lead.*—The distance a screw thread advances axially in one turn. On a single-thread screw the lead and pitch are identical; on a double-thread screw the lead is twice the pitch; on a triple-thread screw the lead is three times the pitch, etc.

8. *Angle of thread.*—The angle included between the sides of the thread measured in an axial plane.

9. *Half angle of thread.*—The angle included between a side of the thread and the normal to the axis, measured in an axial plane.

10. *Helix angle.*—The angle made by the helix, or conical spiral, of the thread at the pitch diameter with a plane perpendicular to the axis.

11. *Crest.*—The surface of the thread corresponding to the major diameter of the screw and the minor diameter of the nut.

12. *Root.*—The surface of the thread corresponding to the minor diameter of the screw and the major diameter of the nut.

13. *Side or flank.*—The surface of the thread which connects the crest with the root.

14. *Axis of a screw.*—The longitudinal central line through the screw.

15. *Base of thread.*—The bottom section of the thread; the greatest section between the two adjacent roots.

16. *Depth of thread.*—The distance between the crest and the base of the thread measured normal to the axis.

17. *Number of threads.*—Number of threads in 1 inch of length.

18. *Length of engagement.*—The length of contact between two mated parts, measured axially.

19. *Depth of engagement.*—The depth of thread contact of two mated parts, measured radially.

20. *Pitch line.*—An element of the imaginary cylinder or cone specified in definition 5.

21. *Thickness of thread.*—The distance between the adjacent sides of the thread measured along or parallel to the pitch line.

22. *Mean area.*—The term "mean area of a screw," when used in specifications and for other purposes, designates the cross-sectional area computed from the mean of the basic pitch and minor diameters.

(*b*) Terms Relating to Classification and Tolerances.—1. *Allowance.*—An intentional difference in the dimensions of mating parts. It is the minimum clearance or the maximum interference which is intended between mating parts. It represents the condition of the tightest permissible fit, or the largest internal member mated with the smallest external member. Examples:

One half inch, class 1 fit, American National coarse thread series:

Minimum pitch diameter of nut	0.4500
Maximum pitch diameter of screw	.4478
Allowance (positive)	0.0022

One half inch, class 4 fit, American National coarse thread series:

Minimum pitch diameter of nut	.4500
Maximum pitch diameter of screw	.4504
Allowance (negative)	0.0004

2. *Tolerance.*—The amount of variation permitted in the size of a part. Example:

One half inch screw, class 1 fit, American National coarse thread series:

Maximum pitch diameter	0.4478
Minimum pitch diameter	.4404
Tolerance	0.0074

3. *Basic size.*—The theoretical or nominal standard size from which all variations are made.
4. *Crest clearance.*—Defined on a screw form as the space between the crest of a thread and the root of its mating thread.
5. *Finish.*—The character of the surface on a screw thread or other product.
6. *Fit.*—The relation between two mating parts with reference to the conditions of assembly; for example: Wrench fit; close fit; medium fit; free fit; loose fit. The quality of fit is dependent upon both the relative size and the quality of finish of the mating parts.
7. *Neutral zone.*—A positive allowance. (See "Allowance.")
8. *Limits.*—The extreme permissible dimensions of a part. Example:

One half inch screw, class 1 fit, American National coarse thread series:

Maximum pitch diameter	0.4478	These are the limits.
Minimum pitch diameter	.4404	

(c) Terms Relating to Bolt Heads and Nuts.—The following definitions are applicable to certain terms as they are used in sections XI to XIV:

1. *Unfinished.*—Unfinished bolt heads or nuts are not machined or treated on any surface except in the threads.
2. *Semifinished.*—Semifinished bolt heads or nuts are machined or otherwise formed or treated on the bearing surface so as to provide a washer face for bolt heads, and for nuts either a washer face or a circular bearing surface formed by chamfering the edges.
3. *Finished.*—Finished bolt heads and nuts are the same as semifinished except that the surfaces other than the bearing surface have been so treated as to provide a special appearance. The finish desired on all nonbearing surfaces of finished bolt heads and nuts should be specified by the purchaser.
4. *Washer face.*—The washer face is a circular boss turned or otherwise produced on the bearing surface of a bolt head or nut to relieve the corners. A circular bearing surface can also be produced by chamfering the corners of the nut.

5. *Height of head.*—The height of head is the over-all distance from the top to the bearing surface, and includes the thickness of the washer face where such is provided.

6. *Thickness of nut.*—The thickness of the nut is the over-all distance from the top to the bearing surface, and includes the thickness of the washer face where such is provided.

7. *Taper of bolt head or nut.*—The taper of a bolt head or nut is the angle between a side and the axis.

2. ILLUSTRATIONS SHOWING TERMINOLOGY

Figures 1 and 2 illustrate the use of the terms and symbols used in the handbook, as herein defined.

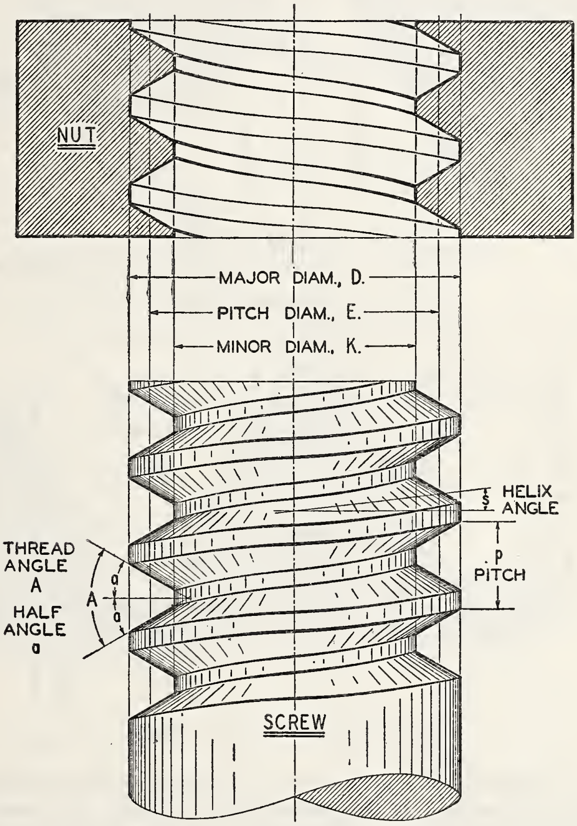

FIGURE 1.—*Screw-thread notation.*

3. SYMBOLS

Symbols for designating screw-thread standards and thread dimensions are a necessity in commercial and engineering practice. The standardization of such symbols yields the usual advantages of standardization. Those listed below have been in customary use for many years, and their general use in standards, specifications, and text-books is recommended.

(a) Identification Symbols.—These are for use on correspondence, drawings, shop and storeroom cards, specifications for parts, taps, dies, gages, etc., and on tools and gages.

The method of designating a screw thread by means of symbols is by the use of the initial letters of the thread series, preceded by the diameter in inches (or the screw number) and number of threads

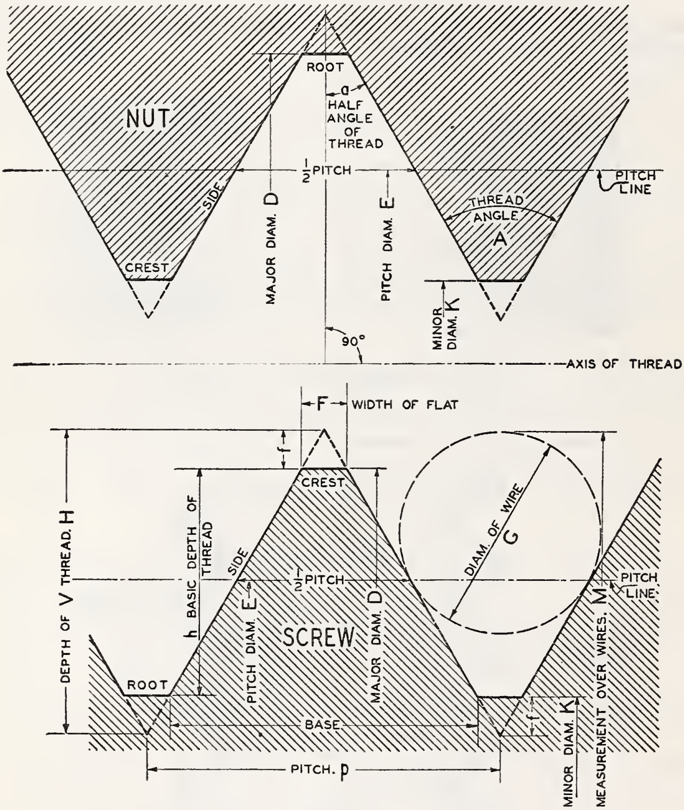

Figure 2.—*Screw-thread notation.*

per inch, all in Arabic characters, and followed by the classification of fit in Arabic numerals. If the thread is left hand, the symbol "LH" shall follow the class of fit. No symbol is used to distinguish right-hand threads. The number of threads per inch shall be indicated in all cases, irrespective of whether it is the standard number of threads for that particular size of threaded part, or special. Tools and gages for standard thread diameters and pitches shall bear standard identification symbols, and special marking of such items shall be avoided.

For screw threads of American National form but of special diameters, pitches, and lengths of engagement, the symbol "NS" shall be used. Examples:

	Mark
American National coarse thread series:	
To specify a threaded part 1 inch diameter, 8 threads per inch, class 1 fit	*1″—8NC—1*
Threaded part 1 inch diameter, 8 threads per inch, class 2 fit, left hand	*1″—8NC—2LH*
American National fine thread series:	
Threaded part 1 inch diameter, 14 threads per inch, class 4 fit	*1″—14NF—4*
Threaded part ⅝ inch diameter, 18 threads per inch, class 5 fit	*⅝″—18NF—5*
American National 8-, 12-, or 16-pitch thread series:	
Threaded part 1 inch diameter, 12 threads per inch, class 3 fit	*1″—12N—3*
Threaded part 1½ inches diameter, 8 threads per inch, class 2 fit, left hand	*1½″—8N—2LH*
American National extra-fine thread series:	
Threaded part 1 inch diameter, 20 threads per inch, class 3 fit	*1″—20NEF—3*
American National form, special pitch:	
Threaded part 1 inch diameter, 18 threads per inch, class 2 fit	*1″—18NS—2*
Threaded part 1¼ inches diameter, 20 threads per inch, class 3 fit, left hand	1¼″—20NS—3LH
American National taper pipe thread:	
Threaded part 1 inch diameter, 11½ threads per inch	*1″—11½NPT*
American National fire-hose coupling threads and American National hose-coupling threads:	
Threaded part 3 inches diameter, 6 threads per inch	*3″—6NH*
Threaded part 1 inch diameter, 11½ threads per inch	*1″—11½NH*
or (see. pp. 122 and 127)	*1″—11½NPSH*

(b) Dimensional Symbols.—For use in formulas for expressing relations of screw threads, and for use on drawings and for similar purposes, the following symbols should be used:

Major diameter	D
Corresponding radius	d
Pitch diameter	E
Corresponding radius	e
Minor diameter	K
Corresponding radius	k
Angle of thread	A (alpha)
Half angle of thread	a or α
Number of turns per inch	N
Number of threads per inch	n
Lead	$L=\frac{1}{N}$
Pitch or thread interval	$p=\frac{1}{n}$
Helix angle	s
Tangent of helix angle	$S=\frac{L}{3.14159\times E}$
Thickness of thread	t
Width of basic flat at top, crest, or root	F
Depth of basic truncation	f
Depth of sharp V thread	H
Basic depth or height of truncated thread	h
Length of engagement	Q
Included angle of taper	B (beta)
One half included angle of taper	β

(c) Symbols for Measurements.—Other symbols, useful for expressing relations in measurements of screw threads and screw-thread gages, are:

Measurement over wires	M
Diameter of wire	G
Corresponding radius	g
Error in pitch	p'
Error in half angle of thread	a'
Pitch diameter increment due to lead error	E'
Pitch diameter increment due to error in half-angle	E''

(d) Symbols for Pipe Threads.—Additional dimensional symbols for American National pipe threads are given in section VII, p. 107. Identification symbols for American National straight pipe threads are given on p. 122.

SECTION III. AMERICAN NATIONAL COARSE- AND FINE-THREAD SERIES FOR BOLTS, MACHINE SCREWS, NUTS, TAPPED HOLES, AND GENERAL APPLICATIONS [2]

1. AMERICAN NATIONAL FORM OF THREAD

The form of thread profile specified herein, known previously as the "United States standard or Sellers' profile," is adopted by the Committee and shall hereafter be known as the "American National form of thread."

The American National form of thread shall be used for all screw-thread work except when otherwise specified for special purposes.

(a) SPECIFICATIONS

1. Angle of Thread.—The basic angle of thread (A) between the sides of the thread measured in an axial plane is 60°. The line bisecting this 60° angle is perpendicular to the axis of the screw thread.

2. Flat at Crest and Root.—The flat at the root and crest of the basic thread form is $\frac{1}{8}\times p$, or $0.125\times p$.

3. Depth of Thread.—The depth of the basic thread form is

$$h=0.649519\times p, \text{ or } h=\frac{0.649519}{n}$$

where

p=pitch in inches
n=number of threads per inch
h=basic depth of thread

4. Clearance at Minor Diameter.—A clearance shall be provided at the minor diameter of the nut by removing from the crest of the basic thread form an amount such as to provide a depth of thread not less than 53 to 75 percent (depending on the size), and not more than 83⅓ percent of the basic thread depth.

5. Clearance at Major Diamater.—A clearance shall be provided at the major diameter of the nut by making the thread form such that the width of flat shall be less than $\frac{1}{8}\times p$, but not less than $\frac{1}{24}\times p$.

(b) ILLUSTRATION

There are indicated in figure 3 the relations as specified herein for the American National form of thread for the minimum nut and maxi-

[2] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published, in part, as ASA B1.1–1935 "Screw Threads," by the A.S.M.E., 29 West 39th St., New York, N. Y.

mum screw, classes 2 and 3 fits. These relations are further shown in figures 7 and 9.

2. THREAD SERIES

It is the aim of the Committee, in establishing thread systems, to eliminate all unnecessary sizes and, in addition, to utilize as far as possible present predominating sizes. The present coarse-thread and fine-thread series, are maintained, the coarse-thread series being the "United States standard" threads, supplemented in the sizes below one-fourth inch by sizes taken from the standard established by the American Society of Mechanical Engineers (A.S.M.E.). The fine-thread series is composed of standards that have been found necessary, and consists of sizes taken from the standards of the Society of Automotive Engineers (S.A.E.) and the fine-thread series of the American Society of Mechanical Engineers (A.S.M.E.).

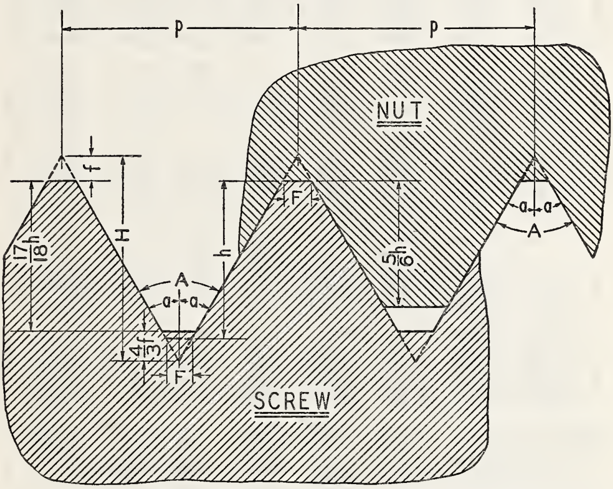

FIGURE 3.—*American National form of thread.*

NOTE.—No allowance is shown. This condition exists in classes 2 and 3 fits, where both the minimum nut and the maximum screw are basic.

NOTATION

$A=60°$
$a=30°$
n=number of threads per inch
$H=0.866025\,p$=depth of 60° sharp V thread
$h=0.649519\,p$=depth of American National form of thread
$\frac{5}{6}h=0.541266\,p$=maximum depth of engagement
$\frac{17}{18}h=0.613435\,p$
$F=0.125000\,p$=width of flat at crest and root of American National form
$f=0.108253\,p$ $=\frac{1}{8}H$ $=\frac{1}{6}h$ } =depth of truncation

(a) AMERICAN NATIONAL COARSE-THREAD SERIES

In table 1 are specified the nominal sizes and basic dimensions of the "American National coarse-thread series."

The American National coarse-thread series is recommended for general use in engineering work, in machine construction where conditions are favorable to the use of bolts, screws, and other threaded components where quick and easy assembly of the parts is desired, and for all work where conditions do not require the use of fine-pitch threads.

400610°—42——2

TABLE 1.—*American National coarse-thread series*

Identification		Basic diameters			Thread data						
Sizes	Threads per inch, n	Major diameter, D	Pitch diameter, E	Minor diameter, K	Metric equivalent of major diameter	Pitch, p	Depth of thread, h	Basic width of flat, $p/8$	Minimum width of flat at major diameter of nut, $p/24$	Helix angle at basic pitch diameter, s	Basic area of section at root of thread, $\frac{\pi K^2}{4}$
1	2	3	4	5	6	7	8	9	10	11	12
		Inches	*Inches*	*Inches*	*mm*	*Inch*	*Inch*	*Inch*	*Inch*	*Deg. Min.*	*Square inches*
1	64	0. 073	0. 0629	0. 0527	1. 854	0. 01562	0. 01015	0. 00195	0. 00065	4 31	0. 0022
2	56	. 086	. 0744	. 0628	2. 184	. 01786	. 01160	. 00223	. 00074	4 22	. 0031
3	48	. 099	. 0855	. 0719	2. 515	. 02083	. 01353	. 00260	. 00087	4 26	. 0041
4	40	. 112	. 0958	. 0795	2. 845	. 02500	. 01624	. 00312	. 00104	4 45	. 0050
5	40	. 125	. 1088	. 0925	3. 175	. 02500	. 01624	. 00312	. 00104	4 11	. 0067
6	32	. 138	. 1177	. 0974	3. 505	. 03125	. 02030	. 00391	. 00130	4 50	. 0075
8	32	. 164	. 1437	. 1234	4. 166	. 03125	. 02030	. 00391	. 00130	3 58	. 0120
10	24	. 190	. 1629	. 1359	4. 826	. 04167	. 02706	. 00521	. 00174	4 39	. 0145
12	24	. 216	. 1889	. 1619	5. 486	. 04167	. 02606	. 00521	. 00174	4 1	. 0206
¼	20	. 2500	. 2175	. 1850	6. 350	. 05000	. 03248	. 00625	. 00208	4 11	. 0269
5/16	18	. 3125	. 2764	. 2403	7. 938	. 05556	. 03608	. 00694	. 00231	3 40	. 0454
⅜	16	. 3750	. 3344	. 2938	9. 525	. 06250	. 04059	. 00781	. 00260	3 24	. 0678
7/16	14	. 4375	. 3911	. 3447	11. 113	. 07143	. 04639	. 00893	. 00298	3 20	. 0933
½	13	. 5000	. 4500	. 4001	12. 700	. 07692	. 04996	. 00962	. 00321	3 7	. 1257
9/16	12	. 5625	. 5084	. 4542	14. 288	. 08333	. 05413	. 01042	. 00347	2 59	. 1620
⅝	11	. 6250	. 5660	. 5069	15. 875	. 09091	. 05905	. 01136	. 00379	2 56	. 2018
¾	10	. 7500	. 6850	. 6201	19. 050	. 10000	. 06495	. 01250	. 00417	2 40	. 3020
⅞	9	. 8750	. 8028	. 7307	22. 225	. 11111	. 07217	. 01389	. 00463	2 31	. 4193
1	8	1. 0000	. 9188	. 8376	25. 400	. 12500	. 08119	. 01562	. 00521	2 29	. 5510
1⅛	7	1. 1250	1. 0322	. 9394	28. 575	. 14286	. 09279	. 01786	. 00595	2 31	. 6931
1¼	7	1. 2500	1. 1572	1. 0644	31. 750	. 14286	. 09279	. 01786	. 00595	2 15	. 8898
1⅜	6	1. 3750	1. 2667	1. 1585	34. 925	. 16667	. 10825	. 02083	. 00694	2 24	1. 0541
1½	6	1. 5000	1. 3917	1. 2835	38. 100	. 16667	. 10825	. 02083	. 00694	2 11	1. 2938
1¾	5	1. 7500	1. 6201	1. 4902	44. 450	. 20000	. 12990	. 02500	. 00833	2 15	1. 7441
2	4½	2. 0000	1. 8557	1. 7113	50. 800	. 22222	. 14434	. 02778	. 00926	2 11	2. 3001
2¼	4½	2. 2500	2. 1057	1. 9613	57. 150	. 22222	. 14434	. 02778	. 00926	1 55	3. 0212
2½	4	2. 5000	2. 3376	2. 1752	63. 500	. 25000	. 16238	. 03125	. 01042	1 57	3. 7161
2¾	4	2. 7500	2. 5876	2. 4252	69. 850	. 25000	. 16238	. 03125	. 01042	1 46	4. 6194
3	4	3. 0000	2. 8376	2. 6752	76. 200	. 25000	. 16238	. 03125	. 01042	1 36	5. 6209
3¼	4	3. 2500	3. 0876	2. 9252	82. 550	. 25000	. 16238	. 03125	. 01042	1 29	6. 7205
3½	4	3. 5000	3. 3376	3. 1752	88. 900	. 25000	. 16238	. 03125	. 01042	1 22	7. 9183
3¾	4	3. 7500	3. 5876	3. 4252	95. 250	. 25000	. 16238	. 03125	. 01042	1 16	9. 2143
4	4	4. 0000	3. 8376	3. 6752	101. 600	. 25000	. 16238	. 03125	. 01042	1 11	10. 6084

(b) AMERICAN NATIONAL FINE-THREAD SERIES

In table 2 are specified the nominal sizes and basic dimensions of the "American National fine-thread series."

The American National fine-thread series is recommended for general use in automotive and aircraft work, and where special conditions require a fine thread.

TABLE 2.—*American National fine-thread series*

Identification		Basic diameters			Thread data						
Sizes	Threads per inch, *n*	Major diameter, *D*	Pitch diameter, *E*	Minor diameter, *K*	Metric equivalent of major diameter	Pitch, *p*	Depth of thread, *h*	Basic width of flat, *p*/8	Minimum width of flat at major diameter of nut, *p*/24	Helix angle at basic pitch diameter, *s*	Basic area of section at root of thread, $\frac{\pi K^2}{4}$
1	2	3	4	5	6	7	8	9	10	11	12
		Inches	*Inches*	*Inches*	*mm*	*Inch*	*Inch*	*Inch*	*Inch*	*Deg. Min.*	*Square inches*
0	80	0.060	0.0519	0.0438	1.524	0.01250	0.00812	0.00156	0.00052	4 23	0.0015
1	72	.073	.0640	.0550	1.854	.01389	.00902	.00174	.00058	3 57	.0024
2	64	.086	.0759	.0657	2.184	.01562	.01015	.00195	.00065	3 45	.0034
3	56	.099	.0874	.0758	2.515	.01786	.01160	.00223	.00074	3 43	.0045
4	48	.112	.0985	.0849	2.845	.02083	.01353	.00260	.00087	3 51	.0057
5	44	.125	.1102	.0955	3.175	.02273	.01476	.00284	.00095	3 45	.0072
6	40	.138	.1218	.1055	3.505	.02500	.01624	.00312	.00104	3 44	.0087
8	36	.164	.1460	.1279	4.166	.02778	.01804	.00347	.00116	3 28	.0128
10	32	.190	.1697	.1494	4.826	.03125	.02030	.00391	.00130	3 21	.0175
12	28	.216	.1928	.1696	5.486	.03571	.02320	.00446	.00149	3 22	.0226
¼	28	.2500	.2268	.2036	6.350	.03571	.02320	.00446	.00149	2 52	.0326
5/16	24	.3125	.2854	.2584	7.938	.04167	.02706	.00521	.00174	2 40	.0524
3/8	24	.3750	.3479	.3209	9.525	.04167	.02706	.00521	.00174	2 11	.0809
7/16	20	.4375	.4050	.3725	11.113	.05000	.03248	.00625	.00208	2 15	.1090
½	20	.5000	.4675	.4350	12.700	.05000	.03248	.00625	.00208	1 57	.1486
9/16	18	.5625	.5264	.4903	14.288	.05556	.03608	.00694	.00231	1 55	.1888
5/8	18	.6250	.5889	.5528	15.875	.05556	.03608	.00694	.00231	1 43	.2400
¾	16	.7500	.7094	.6688	19.050	.06250	.04059	.00781	.00260	1 36	.3513
7/8	14	.8750	.8286	.7822	22.225	.07143	.04639	.00893	.00298	1 34	.4805
1	14	1.0000	.9536	.9072	25.400	.07143	.04639	.00893	.00298	1 22	.6464
1⅛	12	1.1250	1.0709	1.0167	28.575	.08333	.05413	.01042	.00347	1 25	.8118
1¼	12	1.2500	1.1959	1.1417	31.750	.08333	.05413	.01042	.00347	1 16	1.0238
1⅜	12	1.3750	1.3209	1.2667	34.925	.08333	.05413	.01042	.00347	1 9	1.2602
1½	12	1.5000	1.4459	1.3917	38.100	.08333	.05413	.01042	.00347	1 3	1.5212

3. CLASSIFICATION AND TOLERANCES

There are established herein for general use four distinct classes of screw-thread fits as specified in the following brief outline. These four classes of fits, together with the accompanying specifications, are for the purpose of insuring the interchangeable manufacture of screw-thread parts throughout the country.

It is not the intention of the Committee arbitrarily to place a general class or grade of work in a specific class of fit. Each manufacturer and user of screw threads is free to select the class of fit best adapted to his particular needs. The tolerances and dimensions for four classes of fit are given in tables 3 to 14, inclusive, and summarized in tables 15 and 16.

Class 1 fit — Includes screw-thread work in which the threads must assemble readily.

Class 2 fit — Includes the major portion of interchangeable screw-thread work, finished and semifinished bolts and nuts, machine screws, etc.

Class 3 fit — Includes the highest grade of interchangeable screw-thread work.

Class 4 fit — Includes screw-thread work requiring a fine snug fit, somewhat closer than class 3. In this class of fit selective assembly of parts may be necessary.

An examination of the dimensional specifications for the various classes of fit shows that a screw made to tolerances of one class of fit may be used with a nut or tapped hole made to tolerances of some other class of fit. The resulting fit may represent an intermediate class or may approximate one of the classes of fit adopted as standard. The use of different classes of tolerances on the screw and threaded hole may be justified when equipment available is such that one member can be economically produced to a higher accuracy than the other. It should be noted that in the classification of screw thread fits the class number designates the permissible limits of looseness or tightness. It has no connotation of *quality* in any other sense. Class 1 fit provides for the greatest permissible looseness between minimum screw and maximum nut; class 4 fit provides for the smallest permissible looseness. Classes 2 and 3 are between classes 1 and 4 as regards looseness. Each fit has its proper place and none should be regarded as superior or inferior provided that there is compliance with specification requirements under which it is manufactured and sold.

(a) GENERAL SPECIFICATIONS

The following general specifications apply to all classes of fit specified for the American National coarse-thread series and the American National fine-thread series.

1. Uniform Minimum Nut.—The pitch diameter of the minimum threaded hole or nut corresponds to the basic size.

2. Uniform Minor Diameter of Nut.—The minor diameter of the threaded hole or nut, of any given size and pitch, is the same for fits of classes 1 to 4, inclusive.

3. Length of Engagement.—A length of engagement equal to the basic major diameter is the basis of the tolerances specified herein for screw-thread products.

4. Tolerances.[3]—(*a*) The tolerances specified represent the extreme variations permitted on the product.

(*b*) The tolerance on the nut is plus, and is applied from the basic size to above basic size.

(*c*) The tolerance on the screw is minus, and is applied from the maximum screw size to below the maximum screw size.

(*d*) The pitch diameter tolerances for a screw and nut of a given class of fit are the same.

(*e*) Pitch diameter tolerances include lead and angle variations. (See footnote 1, tables 3, 4, 5, and 6.)

(*f*) The tolerances on the major diameters of class 1 fit or class 2 fit screws are twice the tolerance values allowed on the pitch diameters of the same respective classes and pitches with the following exception: On class 2 fit, American National coarse-thread series, externally threaded parts of unfinished, hot-rolled material, the same tolerances on major diameter are applied as on class 1 fit screws.

The tolerances on the major diameters of classes 3 and 4 screws, American National coarse-thread series, are the same as those on class 2 finished screws of the same thread series; and for the American National fine-thread series are the same as those on class 2 of that series.

[3] Recommendations and explanations regarding the applications of tolerances are given in appendix 1.

(*g*) The minimum minor diameter of a screw of a given pitch is such as to result in a basic flat ($\frac{1}{8} \times p$) at the root when the pitch diameter of the screw is at its minimum value. When the maximum

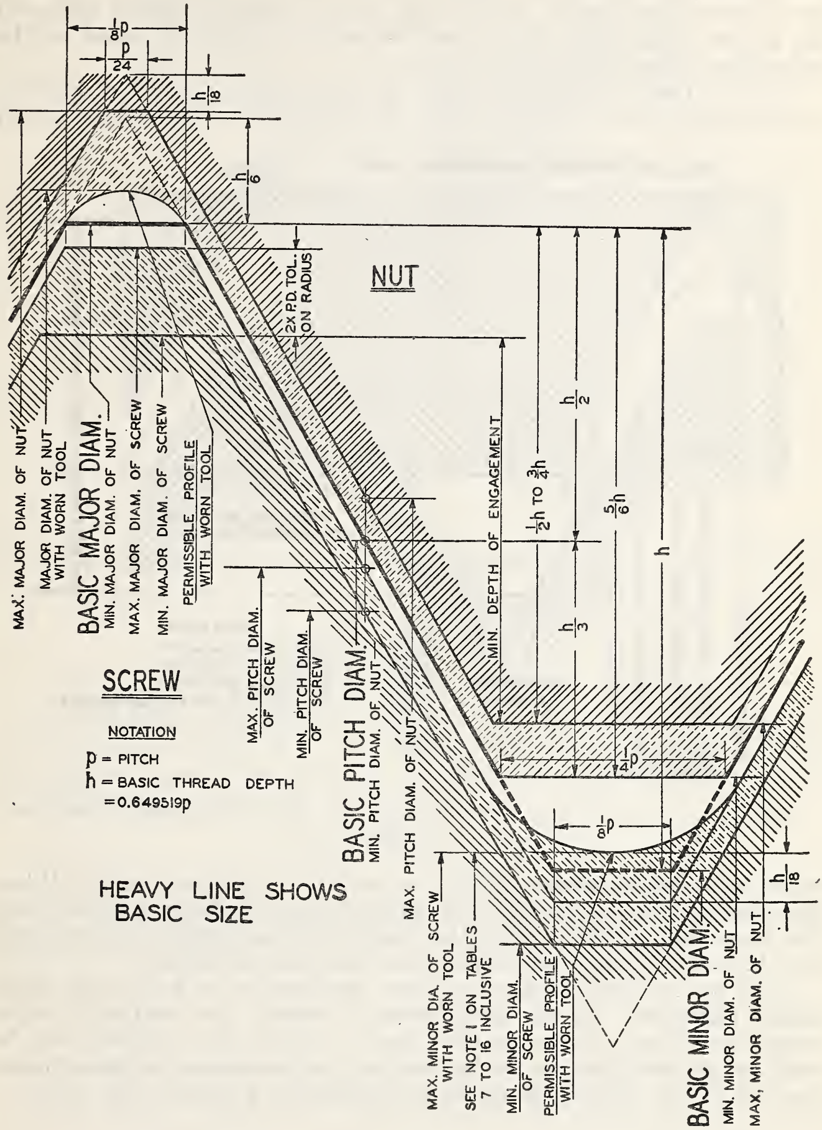

FIGURE 4.—*Illustration of tolerances, allowance (neutral space), and crest clearances for class 1 fit.*

screw is basic, the minimum minor diameter of the screw will be below the basic minor diameter by the amount of the specified pitch diameter tolerance.

(*h*) The maximum minor diameter of a screw of a given pitch may be such as results from the use of a worn or rounded threading tool, when the pitch diameter is at its maximum value. In no case, however, should the form of a thread, as results from tool wear, be such as to cause the screw to be rejected on the maximum minor diameter by a "go" ring gage, the minor diameter of which is equal to the minimum minor diameter of the nut.

(*i*) The maximum major diameter of the nut of a given pitch is such as to result in a flat equal to one-third of the basic flat ($1/24 \times p$)

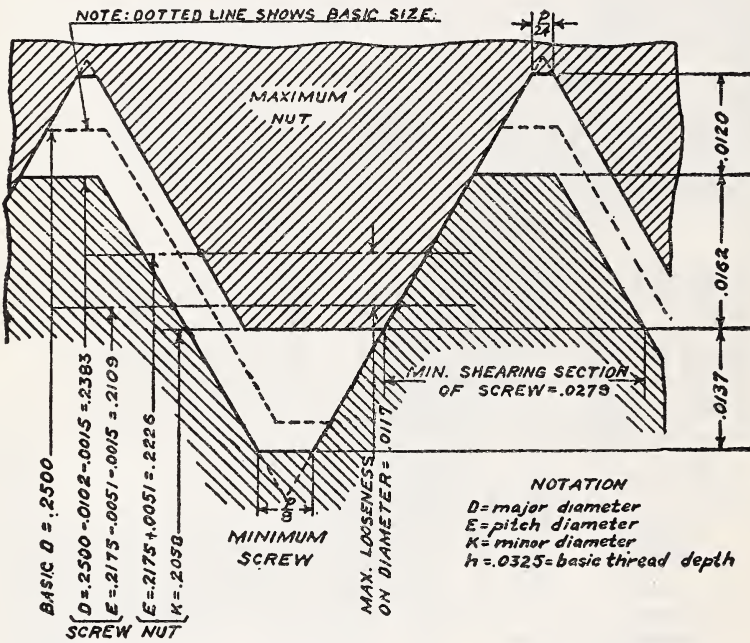

FIGURE 5.—*Illustration of loosest condition for class 1 fit, one-fourth inch, 20 threads.*

when the pitch diameter of the nut is at its maximum value. When the minimum nut is basic, its maximum major diameter will be above the basic major diameter by the amount of the specified pitch diameter tolerance plus two-ninths of the basic thread depth.

(*j*) The nominal minimum major diameter of a nut is the basic major diameter. In no case, however, should the minimum major diameter of the nut, as results from a worn tap or cutting tool, be such as to cause the nut to be rejected on the minimum major diameter by a "go" plug gage made to the standard form at the crest.

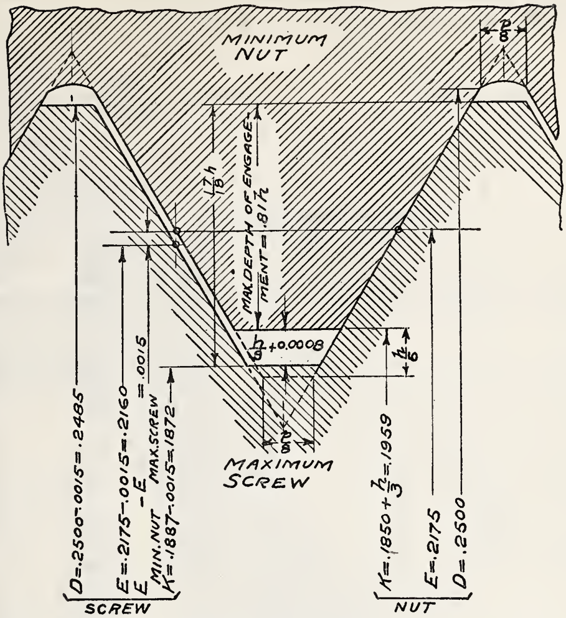

FIGURE 6.—*Illustration of tightest condition for class 1 fit, one-fourth inch, 20 threads.*

NOTATION

D=major diameter
E=pitch diameter
K=minor diameter
h=0.0325=basic thread depth

(*k*) Tolerances are based on the pitch of the thread and a length of engagement equal to the basic major diameter, but may be used for lengths of engagement up to 1½ diameters. (For longer lengths of engagement see section VI, p. 86.)

(b) CLASSIFICATION OF FITS

1. CLASS 1 FIT.—(*a*) *Definition.*—The class 1 fit is intended to cover the manufacture of threaded parts where quick and easy assembly is necessary, and where an allowance is required.

TABLE 3.—*Class 1 fit, allowances and tolerances for screws and nuts*

Threads per inch	Allowances	Pitch-diameter tolerances [1]	Lead errors consuming one half of pitch-diameter tolerances [2]	Errors in half-angle consuming one half of pitch-diameter tolerances	
1	2	3	4	5	
	Inch	*Inch*	*Inch*	*Deg.*	*Min.*
80	0.0007	0.0024	0.0007	3	40
72	.0007	.0025	.0007	3	26
64	.0007	.0026	.0008	3	10
56	.0008	.0028	.0008	3	0
48	.0009	.0031	.0009	2	50
44	.0009	.0032	.0009	2	41
40	.0010	.0034	.0010	2	36
36	.0011	.0036	.0010	2	28
32	.0011	.0038	.0011	2	19
28	.0012	.0043	.0012	2	18
24	.0013	.0046	.0013	2	6
20	.0015	.0051	.0015	1	57
18	.0016	.0057	.0016	1	58
16	.0018	.0063	.0018	1	55
14	.0021	.0070	.0020	1	52
13	.0022	.0074	.0021	1	50
12	.0024	.0079	.0023	1	49
11	.0026	.0085	.0025	1	47
10	.0028	.0092	.0027	1	45
9	.0031	.0100	.0029	1	43
8	.0034	.0111	.0032	1	42
7	.0039	.0124	.0036	1	39
6	.0044	.0145	.0042	1	40
5	.0052	.0169	.0049	1	37
4½	.0057	.0184	.0053	1	35
4	.0064	.0204	.0059	1	33

[1] The tolerances specified for pitch diameter include all errors of pitch diameter, lead, and angle. The full tolerance cannot, therefore, be used on pitch diameter unless the lead and angle of the thread are perfect. Columns 4 and 5 give, for information, the errors in lead (per length of thread engaged) and in angle, each of which can be compensated for by half the tolerance on the pitch diameter given in column 3. If lead and angle errors both exist to the amounts tabulated, the pitch diameter of a bolt, for example, must be reduced by the full tolerance or it will not enter the "go" gage.

[2] Between any 2 threads not farther apart than the length of engagement.

This class has an allowance on the screw to permit ready assembly even when the threads are slightly bruised or dirty.

(*b*) *Minimum nut basic.*—The pitch diameter of the minimum nut of a given diameter and pitch corresponds to the basic pitch diameter, as specified in the tables of thread series given herein, which is computed from the basic major diameter of the thread. The pitch diameter of the minimum nut is the theoretical pitch diameter for that size.

(*c*) *Maximum screw below basic.*[4]—The dimensions of the maximum screw of a given pitch and diameter are below the basic dimensions as specified in the tables of thread series given herein, which are computed from the basic major diameter of the threads, by the amount of the allowance given in table 3.

(*d*) *Allowance and tolerance values.*—Allowances and tolerances are specified in table 3.

[4] The maximum minor diameter of the screw is above the basic minor diameter as shown in fig. 4.

2. Class 2 Fit—(*a*) *Definition.*—The class 2 fit is intended to apply to the major portion of threaded work in interchangeable manufacture, where no allowance is required.

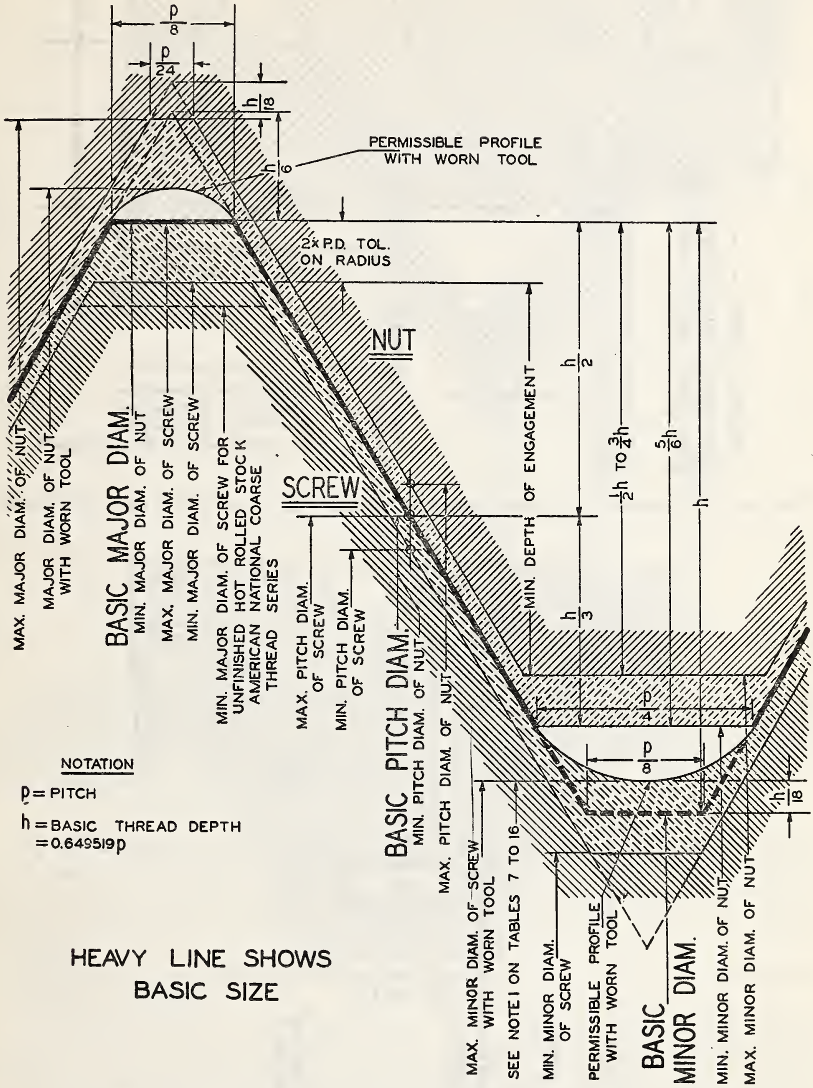

Figure 7.—*Illustration of tolerances and crest clearances for class 2 fit.*

(*b*) *Minimum nut basic.*—The pitch diameter of the minimum nut of a given diameter and pitch corresponds to the basic pitch diameter, as specified in tables of thread series given herein, which is computed from the basic major diameter of the thread.

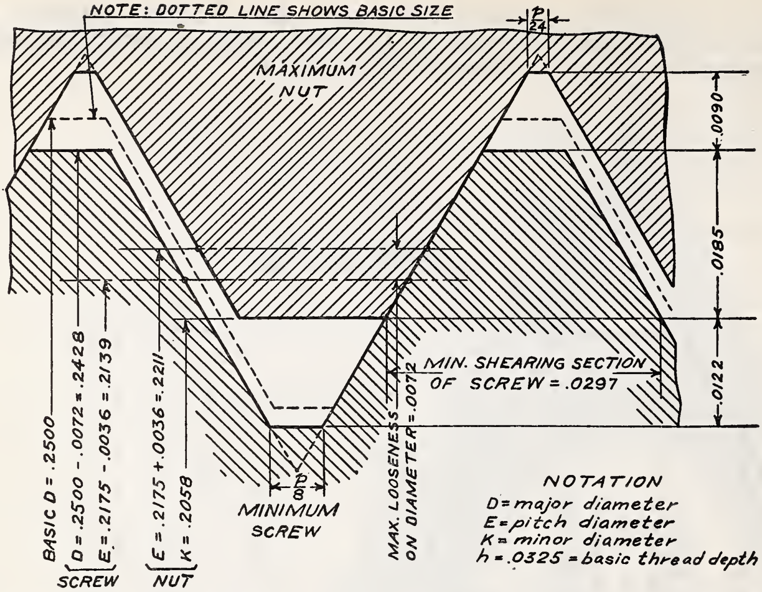

FIGURE 8.—*Illustration of loosest condition for class 2 fit, one-fourth inch, 20 threads.*

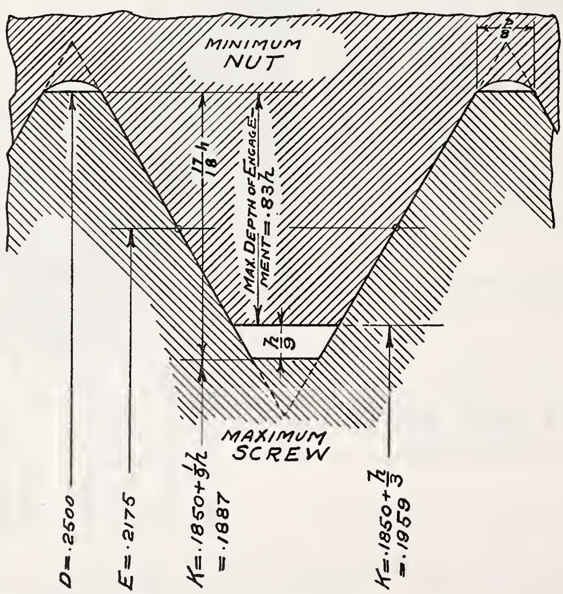

FIGURE 9.—*Illustration of tigthest condition for class 2 fit, one-fourth inch, 20 threads.*

NOTATION

D=major diameter
E=pitch diameter
K=minor diameter
h=0.0325=basic thread depth

Table 4.—*Class 2 fit, tolerances for screws and nuts (no allowances)*

Threads per inch	Allowances	Pitch-diameter tolerances[1]	Lead errors consuming one-half of pitch-diameter tolerances[2]	Errors in half-angle consuming one-half of pitch-diameter tolerances	
1	2	3	4	5	
	Inch	*Inch*	*Inch*	*Deg.*	*Min.*
80	0.0000	0.0017	0.0005	2	36
72	.0000	.0018	.0005	2	28
64	.0000	.0019	.0005	2	19
56	.0000	.0020	.0006	2	8
48	.0000	.0022	.0006	2	1
44	.0000	.0023	.0007	1	56
40	.0000	.0024	.0007	1	50
36	.0000	.0025	.0007	1	43
32	.0000	.0027	.0008	1	39
28	.0000	.0031	.0009	1	39
24	.0000	.0033	.0010	1	31
20	.0000	.0036	.0010	1	22
18	.0000	.0041	.0012	1	25
16	.0000	.0045	.0013	1	22
14	.0000	.0049	.0014	1	19
13	.0000	.0052	.0015	1	17
12	.0000	.0056	.0016	1	17
11	.0000	.0059	.0017	1	14
10	.0000	.0064	.0018	1	13
9	.0000	.0070	.0020	1	12
8	.0000	.0076	.0022	1	10
7	.0000	.0085	.0025	1	8
6	.0000	.0101	.0029	1	9
5	.0000	.0116	.0033	1	6
4½	.0000	.0127	.0037	1	5
4	.0000	.0140	.0040	1	4

[1] The tolerances specified for pitch diameter include all errors of pitch diameter, lead, and angle. The full tolerance cannot, therefore, be used on pitch diameter unless the lead and angle of the thread are perfect. Columns 4 and 5 give, for information, the errors in lead (per length of thread engaged) and in angle, each of which can be compensated for by half the tolerance on the pitch diameter given in column 3. If lead and angle errors both exist to the amounts tabulated, the pitch diameter of a bolt, for example, must be reduced by the full tolerance or it will not enter a basic nut or gage.

[2] Between any two threads not farther apart than the length of engagement.

(*c*) *Maximum screw basic.*[5]—The major diameter and pitch diameter of the maximum screw of a given pitch and diameter correspond to the basic dimensions, as specified in tables of thread series given herein, which are computed from the basic major diameter of the thread.

(*d*) *Allowance and tolerance values.*—Allowances and tolerances are specified in table 4.

3. Class 3 Fit.—(*a*) *Definition.*—The class 3 fit is intended to apply to the highest grade of interchangeable screw thread work. It is the same in every particular as class 2 fit, except that the tolerances are smaller. Tapped holes within class 3 tolerances are difficult and expensive to produce commercially.

[5] The maximum minor diameter of the screw is above the basic minor diameter, as shown in fig. 7.

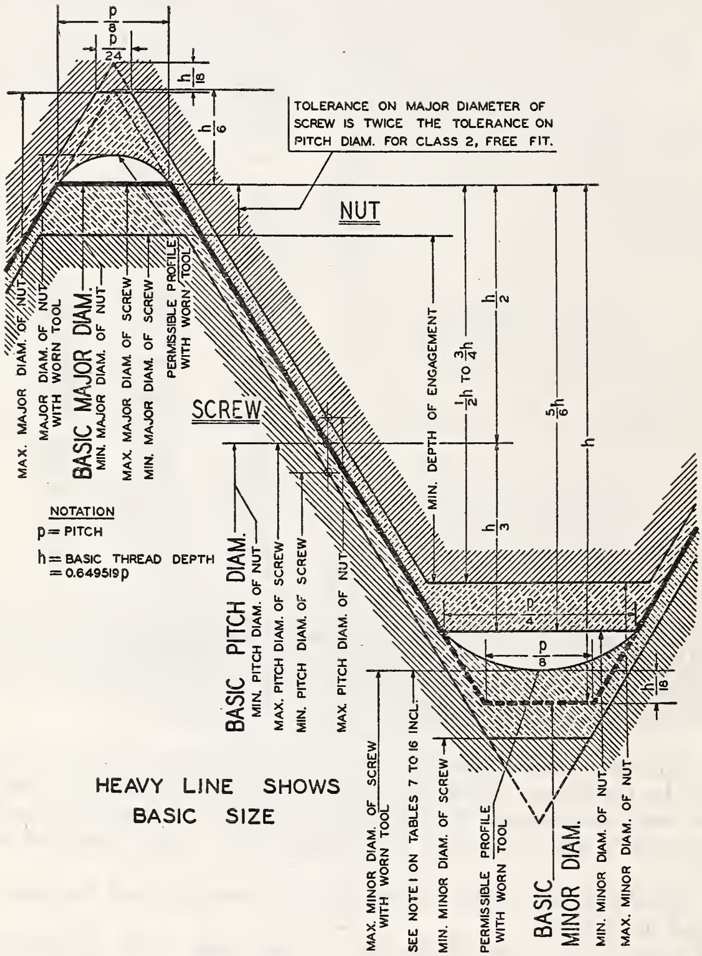

Figure 10.—*Illustration of tolerances and crest clearances for class 3 fit.*

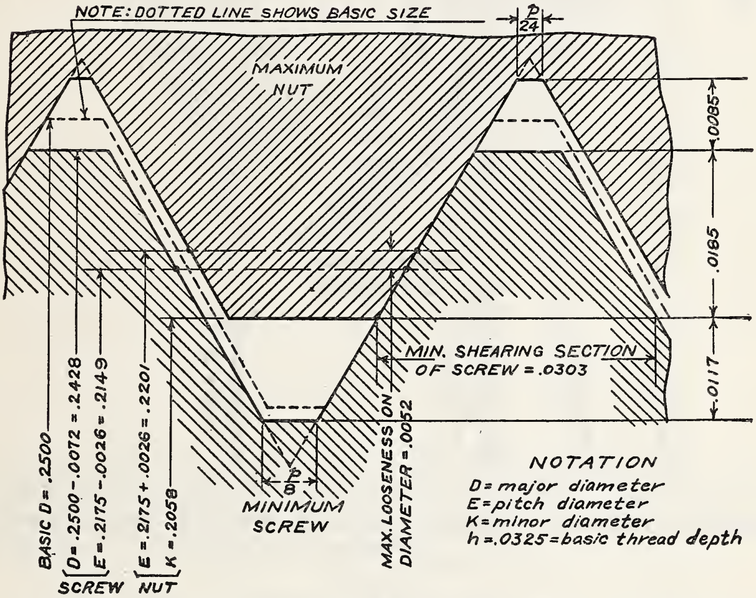

Figure 11.—*Illustration of loosest condition for class 3 fit, one-fourth inch, 20 threads.*

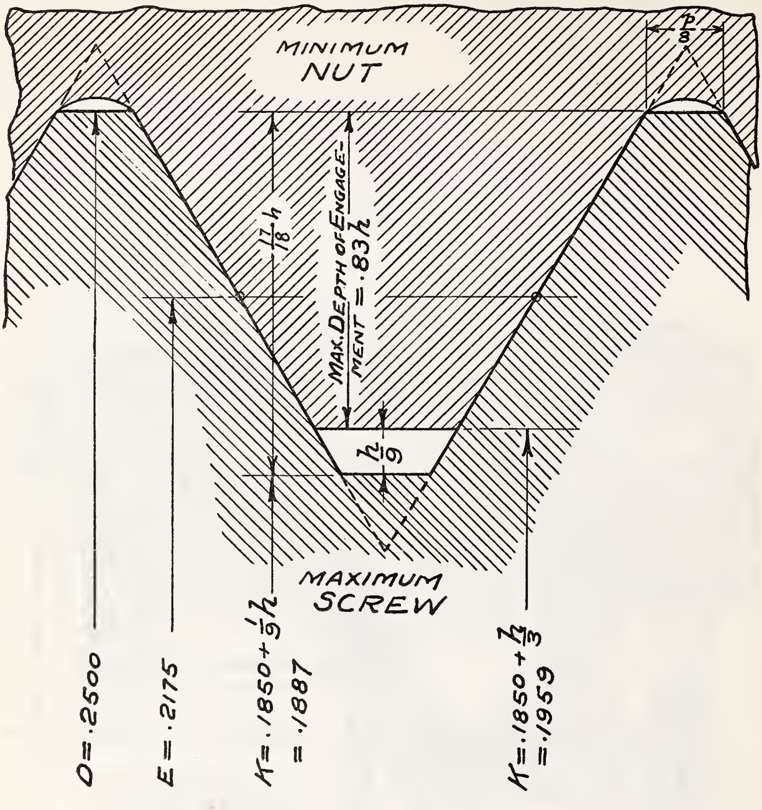

FIGURE 12.—*Illustration of tightest condition for class 3 fit, one-fourth inch, 20 threads.*

NOTATION

D=major diameter
E=pitch diameter
K=minor diameter
h=0.0325=basic thread depth

(*b*) *Minimum nut basic.*—The pitch diameter of the minimum nut of a given diameter and pitch corresponds to the basic pitch diameter, as specified in tables of thread series given herein, which is computed from the basic major diameter of the thread.

(*c*) *Maximum screw basic.*[6]—The major diameter and pitch diameter of the maximum screw of a given pitch and diameter correspond to the basic dimensions, as specified in tables of thread series given herein, which are computed from the basic major diameter of the thread.

(*d*) *Allowance and tolerance values.*—Allowances and tolerances are specified in table 5.

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[6] The maximum minor diameter of the screw is above the basic minor diameter, as shown in fig. 10.

Table 5.—*Class 3 fit, tolerances for screws and nuts (no allowances)*

Threads per inch	Allowances	Pitch-diameter tolerances[1]	Lead errors consuming one half of pitch-diameter tolerances[2]	Errors in half-angle consuming one half of pitch-diameter tolerances	
1	2	3	4	5	
	Inch	*Inch*	*Inch*	*Deg.*	*Min.*
80	0.0000	0.0013	0.0004	1	59
72	.0000	.0013	.0004	1	47
64	.0000	.0014	.0004	1	43
56	.0000	.0015	.0004	1	36
48	.0000	.0016	.0005	1	28
44	.0000	.0016	.0005	1	21
40	.0000	.0017	0005	1	18
36	.0000	.0018	.0005	1	14
32	.0000	.0019	.0005	1	10
28	.0000	.0022	.0006	1	11
24	.0000	.0024	.0007	1	6
20	.0000	.0026	.0008	1	0
18	.0000	.0030	.0009	1	2
16	.0000	.0032	.0009	0	59
14	.0000	.0036	.0010	0	58
13	.0000	.0037	.0011	0	55
12	.0000	.0040	.0012	0	55
11	.0000	.0042	.0012	0	53
10	.0000	.0045	.0013	0	52
9	.0000	.0049	.0014	0	51
8	.0000	.0054	.0016	0	50
7	.0000	.0059	.0017	0	47
6	.0000	.0071	.0020	0	49
5	.0000	.0082	.0024	0	47
4½	.0000	.0089	.0026	0	46
4	.0000	.0097	.0028	0	44

[1] The tolerances specified for pitch diameter include all errors of pitch diameter, lead, and angle. The full tolerance cannot, therefore, be used on pitch diameter unless the lead and angle of the thread are perfect. Columns 4 and 5 give, for information, the errors in lead (per length of thread engaged) and in angle, each of which can be compensated for by half the tolerance on the pitch diameter given in column 3. If lead and angle errors both exist to the amounts tabulated, the pitch diameter of a bolt, for example, must be reduced by the full tolerance or it will not enter a basic nut or gage.

[2] Between any 2 threads not farther apart than the length of engagement.

4. Class 4 Fit.—(*a*) *Definition.*—The class 4 fit is intended for threaded work requiring a fine snug fit, and where a screw driver or wrench may be necessary for assembly. In the manufacture of screw-thread products belonging in this class it will be necessary to use precision tools,[7] gages made to special tolerances for this class (see table 18, p. 52), and other refinements. This class should, therefore, be used only in cases where requirements of the mechanism being produced are exacting, or where special conditions require screws having a precision fit. In order to secure the fit desired it may be necessary in some cases to select the parts when the product is being assembled.

(*b*) *Minimum nut basic.*—The pitch diameter of the minimum nut of a given diameter and pitch corresponds to the basic pitch diameter, as specified in tables of thread series given herein, which is computed from the basic major diameter of the thread.

[7] Including positive control of taps and dies by means of a lead screw. See p. 210.

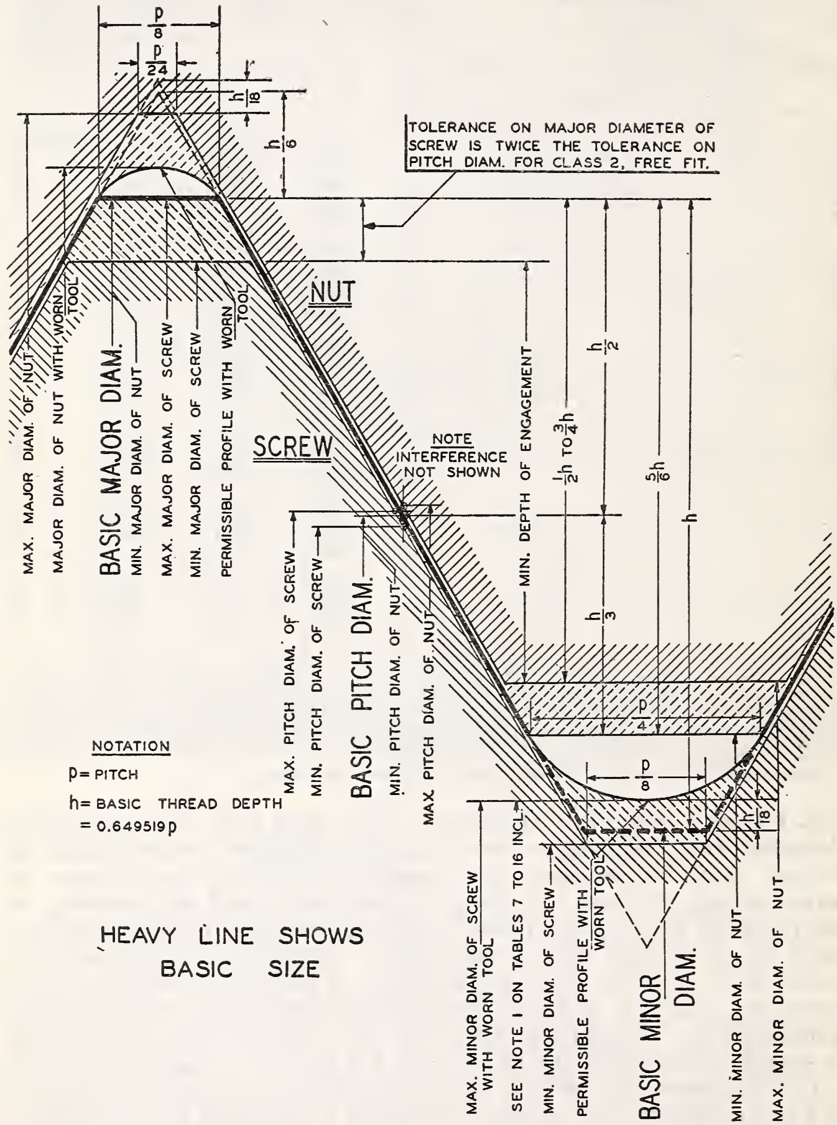

FIGURE 13.—*Illustration of tolerances, allowance (interference), and crest clearances for class 4 fit.*

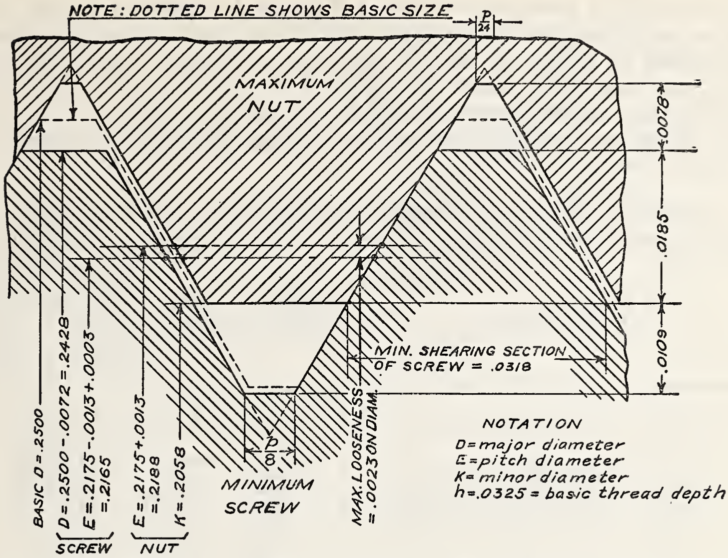

FIGURE 14.—*Illustration of loosest condition for class 4 fit, one-fourth inch, 20 threads.*

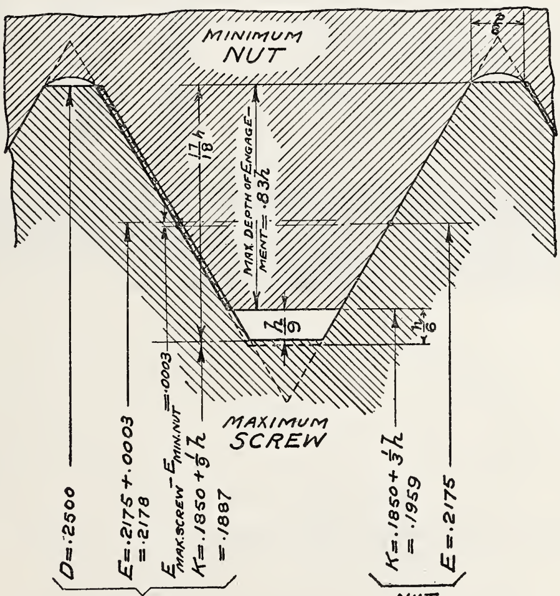

FIGURE 15.—*Illustration of tightest condition for class 4 fit, one-fourth inch, 20 threads.*

NOTATIONS

D=major diameter
E=pitch diameter
K=minor diameter
h=0.0325=basic thread depth

400610°—42——3

(*c*) *Maximum screw above basic.*—The pitch diameter of the maximum screw of a given diameter and pitch is above the basic dimensions as specified in tables of thread series given herein, which are computed from the basic major diameter of the thread, by the amount of the allowance (interference) specified in table 6.

(*d*) *Allowance and tolerance values.*—Allowances and tolerances are specified in table 6.

TABLE 6.—*Class 4 fit, allowances and tolerances for screws and nuts*

Threads per inch	Interferences or negative allowances	Pitch-diameter tolerances [1]	Lead errors consuming one-half of pitch-diameter tolerances [2]	Errors in half-angle consuming one-half of pitch-diameter tolerances	
1	2	3	4	5	
	Inch	*Inch*	*Inch*	*Deg.*	*Min.*
28	0.0002	0.0011	0.0003	0	35
24	.0003	.0012	.0003	0	33
20	.0003	.0013	.0004	0	30
18	.0003	.0015	.0004	0	31
16	.0004	.0016	.0005	0	29
14	.0004	.0018	.0005	0	29
13	.0004	.0019	.0005	0	28
12	.0005	.0020	.0006	0	28
11	.0005	.0021	.0006	0	26
10	.0006	.0023	.0007	0	26
9	.0006	.0024	.0007	0	25
8	.0007	.0027	.0008	0	25
7	.0008	.0030	.0009	0	24
6	.0009	.0036	.0010	0	25
5	.0010	.0041	.0012	0	23
4½	.0011	.0044	.0013	0	23
4	.0013	.0048	.0014	0	22

[1] The tolerances specified for pitch diameter include all errors of pitch diamter, lead, and angle. The full tolerance cannot, therefore, be used on pitch diameter unless the lead and angle of the thread are perfect. Columns 4 and 5 give, for information, the errors in lead (per length of thread engaged) and in angle, each of which can be compensated for by half the tolerance on the pitch diameter given in column 3. If lead and angle errors both exist to the amounts tabulated, the pitch diameter of a bolt, for example, must be reduced by the full tolerance or it will not enter the "go" gage.

[2] Between any 2 threads not farther apart than the length of engagement.

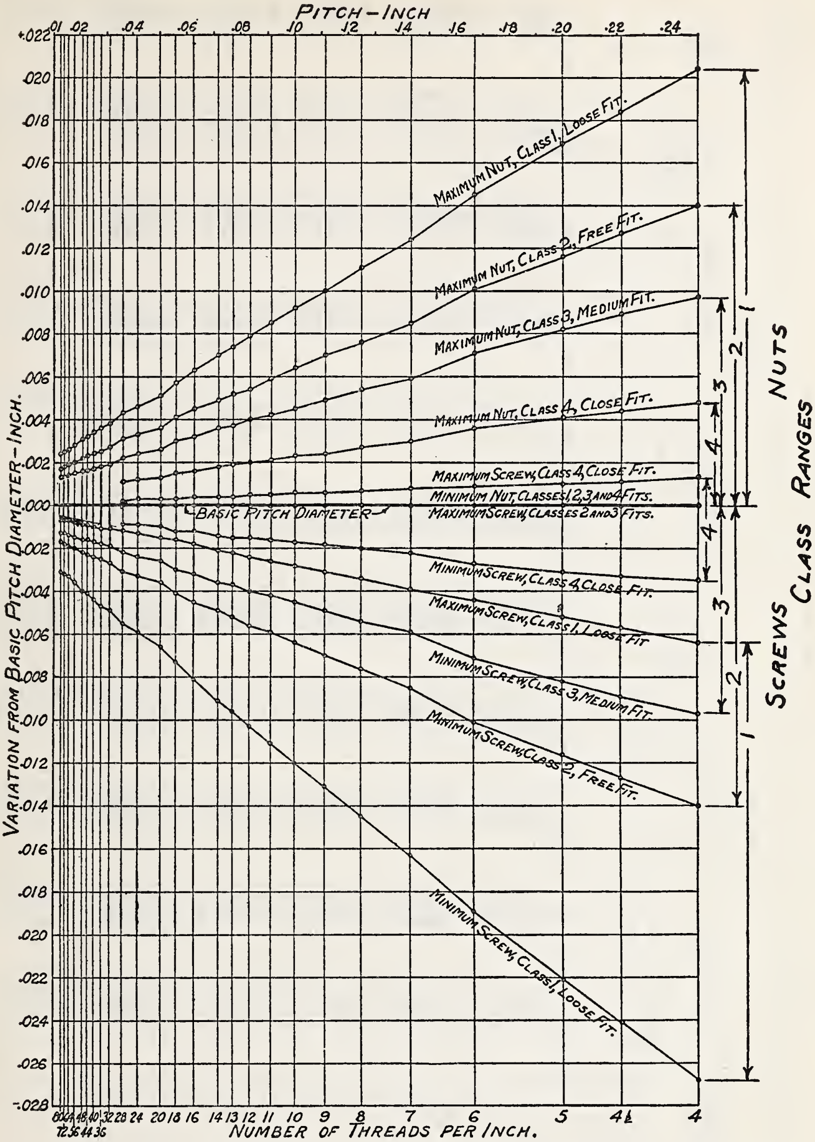

FIGURE 16.—*Relation of maximum and minimum pitch diameters of classes 1, 2, 3, and 4 fits to basic pitch diameters.*

4. TABLES OF LIMITING DIMENSIONS

The limiting dimensions of American National coarse and American National fine threads, to be made to the tolerances and allowances determining the various classes of fit, as herein established, are here tabulated.

TABLE 7.—*Class 1 fit, American National coarse-thread series*

Sizes	Threads per inch	Screw sizes: Major diameter, Max.	Screw sizes: Major diameter, Min.	Screw sizes: Pitch diameter, Max.	Screw sizes: Pitch diameter, Min.	Screw sizes: Minor diameter, maximum [1]	Nut sizes: Minor diameter, Min.	Nut sizes: Minor diameter, Max.	Nut sizes: Pitch diameter, Min.	Nut sizes: Pitch diameter, Max.	Nut sizes: Major diameter, minimum [2]	Basic major diameter
1	2	3	4	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1	64	0.0723	0.0671	0.0622	0.0596	0.0531	0.0561	0.0623	0.0629	0.0655	0.0730	0.0730
2	56	.0852	.0796	.0736	.0708	.0633	.0667	.0737	.0744	.0772	.0860	.0860
3	48	.0981	.0919	.0846	.0815	.0725	.0764	.0841	.0855	.0886	.0990	.0990
4	40	.1110	.1042	.0948	.0914	.0803	.0849	.0938	.0958	.0992	.1120	.1120
5	40	.1240	.1172	.1078	.1044	.0933	.0979	.1062	.1088	.1122	.1250	.1250
6	32	.1369	.1293	.1166	.1128	.0986	.1042	.1145	.1177	.1215	.1380	.1380
8	32	.1629	.1553	.1426	.1388	.1246	.1302	.1384	.1437	.1475	.1640	.1640
10	24	.1887	.1795	.1616	.1570	.1376	.1449	.1559	.1629	.1675	.1900	.1900
12	24	.2147	.2055	.1876	.1830	.1636	.1709	.1801	.1889	.1935	.2160	.2160
¼	20	.2485	.2383	.2160	.2109	.1872	.1959	.2060	.2175	.2226	.2500	.2500
5⁄16	18	.3109	.2995	.2748	.2691	.2427	.2524	.2630	.2764	.2821	.3125	.3125
⅜	16	.3732	.3606	.3326	.3263	.2965	.3073	.3184	.3344	.3407	.3750	.3750
7⁄16	14	.4354	.4214	.3890	.3820	.3478	.3602	.3721	.3911	.3981	.4375	.4375
½	13	.4978	.4830	.4478	.4404	.4034	.4167	.4290	.4500	.4574	.5000	.5000
9⁄16	12	.5601	.5443	.5060	.4981	.4579	.4723	.4850	.5084	.5163	.5625	.5625
⅝	11	.6224	.6054	.5634	.5549	.5109	.5266	.5397	.5660	.5745	.6250	.6250
¾	10	.7472	.7288	.6822	.6730	.6245	.6417	.6553	.6850	.6942	.7500	.7500
⅞	9	.8719	.8519	.7997	.7897	.7356	.7547	.7689	.8028	.8128	.8750	.8750
1	8	.9966	.9744	.9154	.9043	.8432	.8647	.8795	.9188	.9299	1.0000	1.0000
1⅛	7	1.1211	1.0963	1.0283	1.0159	.9458	.9704	.9858	1.0322	1.0446	1.1250	1.1250
1¼	7	1.2461	1.2213	1.1533	1.1409	1.0708	1.0954	1.1108	1.1572	1.1696	1.2500	1.2500
1⅜	6	1.3706	1.3416	1.2623	1.2478	1.1661	1.1946	1.2126	1.2667	1.2812	1.3750	1.3750
1½	6	1.4956	1.4666	1.3873	1.3728	1.2911	1.3196	1.3376	1.3917	1.4062	1.5000	1.5000
1¾	5	1.7448	1.7110	1.6149	1.5980	1.4994	1.5335	1.5551	1.6201	1.6370	1.7500	1.7500
2	4½	1.9943	1.9575	1.8500	1.8316	1.7217	1.7594	1.7835	1.8557	1.8741	2.0000	2.0000

2¼	4½	2.2443	2.2075	2.1000	2.0816	1.9717	2.0094	2.0335	2.1057	2.1241	2.2500	2.2500
2½	4	2.4936	2.4528	2.3312	2.3108	2.1869	2.2294	2.2564	2.3376	2.3580	2.5000	2.5000
2¾	4	2.7436	2.7028	2.5812	2.5608	2.4369	2.4794	2.5064	2.5876	2.6080	2.7500	2.7500
3	4	2.9936	2.9528	2.8312	2.8108	2.6869	2.7294	2.7564	2.8376	2.8580	3.0000	3.0000
3¼	4	3.2436	3.2028	3.0812	3.0608	2.9369	2.9794	3.0064	3.0876	3.1080	3.2500	3.2500
3½	4	3.4936	3.4528	3.3312	3.3108	3.1869	3.2294	3.2564	3.3376	3.3580	3.5000	3.5000
3¾	4	3.7436	3.7028	3.5812	3.5608	3.4369	3.4794	3.5064	3.5876	3.6080	3.7500	3.7500
4	4	3.9936	3.9528	3.8312	3.8108	3.6869	3.7294	3.7564	3.8376	3.8580	4.0000	4.0000

[1] [2] See footnotes on p. 37.

TABLE 8.—*Class 2 fit, American National coarse-thread series*

Sizes	Threads per inch	Screw sizes: Major diameter, Maximum	Screw sizes: Major diameter, Semifinished and finished bolts and screws, Min.	Screw sizes: Major diameter, Threaded parts of unfinished, hot-rolled material, Min.	Screw sizes: Pitch diameter, Max.	Screw sizes: Pitch diameter, Min.	Screw sizes: Minor diameter, maximum [1]	Nut sizes [3]: Minor diameter, Min.	Nut sizes: Minor diameter, Max.	Nut sizes: Pitch diameter, Min	Nut sizes: Pitch diameter, Max.	Nut sizes: Major diameter, minimum [2]	Basic major diameter
1	2	3	4	4a	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1	64	0.0730	0.0692	0.0678	0.0629	0.0610	0.0538	0.0561	0.0623	0.0629	0.0648	0.0730	0.0730
2	56	.0860	.0820	.0804	.0744	.0724	.0641	.0667	.0737	.0744	.0764	.0860	.0860
3	48	.0990	.0946	.0928	.0855	.0833	.0734	.0764	.0841	.0855	.0877	.0990	.0990
4	40	.1120	.1072	.1052	.0958	.0934	.0813	.0849	.0938	.0958	.0982	.1120	.1120
5	40	.1250	.1202	.1182	.1088	.1064	.0943	.0979	.1062	.1088	.1112	.1250	.1250
6	32	.1380	.1326	.1304	.1177	.1150	.0997	.1042	.1145	.1177	.1204	.1380	.1380
8	32	.1640	.1586	.1564	.1437	.1410	.1257	.1302	.1384	.1437	.1464	.1640	.1640
10	24	.1900	.1834	.1808	.1629	.1596	.1389	.1449	.1559	.1629	.1662	.1900	.1900
12	24	.2160	.2094	.2068	.1889	.1856	.1649	.1709	.1801	.1889	.1922	.2160	.2160
¼	20	.2500	.2428	.2398	.2175	.2139	.1887	.1959	.2060	.2175	.2211	.2500	.2500
5⁄16	18	.3125	.3043	.3011	.2764	.2723	.2443	.2524	.2630	.2764	.2805	.3125	.3125
⅜	16	.3750	.3660	.3624	.3344	.3299	.2983	.3073	.3184	.3344	.3389	.3750	.3750
7⁄16	14	.4375	.4277	.4235	.3911	.3862	.3499	.3602	.3721	.3911	.3960	.4375	.4375
½	13	.5000	.4896	.4852	.4500	.4448	.4056	.4167	.4290	.4500	.4552	.5000	.5000
9⁄16	12	.5625	.5513	.5467	.5084	.5028	.4603	.4723	.4850	.5084	.5140	.5625	.5625
⅝	11	.6250	6132	.6080	.5660	.5601	.5135	.5266	.5397	.5660	.5719	.6250	.6250
¾	10	.7500	.7372	.7316	.6850	.6786	.6273	.6417	.6553	.6850	.6914	.7500	.7500
⅞	9	.8750	.8610	.8550	.8028	.7958	.7387	.7547	.7689	.8028	.8098	.8750	.8750
1	8	1.0000	.9848	.9778	.9188	.9112	.8466	.8647	.8795	.9188	.9264	1.0000	1.0000
1⅛	7	1.1250	1.1080	1.1002	1.0322	1.0237	.9497	.9704	.9858	1.0322	1.0407	1.1250	1.1250
1¼	7	1.2500	1.2330	1.2252	1.1572	1.1487	1.0747	1.0954	1.1108	1.1572	1.1657	1.2500	1.2500
1⅜	6	1.3750	1.3548	1.3460	1.2667	1.2566	1.1705	1.1946	1.2126	1.2667	1.2768	1.3750	1.3750
1½	6	1.5000	1.4798	1.4710	1.3917	1.3816	1.2955	1.3196	1.3376	1.3917	1.4018	1.5000	1.5000
1¾	5	1.7500	1.7268	1.7162	1.6201	1.6085	1.5046	1.5335	1.5551	1.6201	1.6317	1.7500	1.7500
2	4½	2.0000	1.9746	1.9632	1.8557	1.8430	1.7274	1.7594	1.7835	1.8557	1.8684	2.0000	2.0000

2¼	4½	2.2500	2.2246	2.2132	2.1057	2.0930	1.9774	2.0094	2.0335	2.1057	2.1184	2.2500	2.2500
2½	4	2.5000	2.4720	2.4592	2.3376	2.3236	2.1933	2.2294	2.2564	2.3376	2.3516	2.5000	2.5000
2¾	4	2.7500	2.7220	2.7092	2.5876	2.5736	2.4433	2.4794	2.5064	2.5876	2.6016	2.7500	2.7500
3	4	3.0000	2.9720	2.9592	2.8376	2.8236	2.6933	2.7294	2.7564	2.8376	2.8516	3.0000	3.0000
3¼	4	3.2500	3.2220	3.2092	3.0876	3.0736	2.9433	2.9794	3.0064	3.0876	3.1016	3.2500	3.2500
3½	4	3.5000	3.4720	3.4592	3.3376	3.3236	3.1933	3.2294	3.2564	3.3376	3.3516	3.5000	3.5000
3¾	4	3.7500	3.7220	3.7092	3.5876	3.5736	3.4433	3.4794	3.5064	3.5876	3.6016	3.7500	3.7500
4	4	4.0000	3.9720	3.9592	3.8376	3.8236	3.6933	3.7294	3.7564	3.8376	3.8516	4.0000	4.0000

[1] [2] See footnotes on p. 37.
[3] The use, where practicable, of class 1 tolerances for nuts in the numbered sizes, instead of class 2, is recommended.

TABLE 9.—*Class 3 fit, American National coarse-thread series*

Sizes	Threads per inch	Screw sizes					Nut sizes [3]					Basic major diameter
		Major diameter		Pitch diameter		Minor diameter, maximum [1]	Minor diameter		Pitch diameter		Major diameter, minimum [2]	
		Max.	Min.	Max.	Min.		Min.	Max.	Min.	Max.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1	64	0.0730	0.0692	0.0629	0.0615	0.0538	0.0561	0.0623	0.0629	0.0643	0.0730	0.0730
2	56	.0860	.0820	.0744	.0729	.0641	.0667	.0737	.0744	.0759	.0860	.0860
3	48	.0990	.0946	.0855	.0839	.0734	.0764	.0841	.0855	.0871	.0990	.0990
4	40	.1120	.1072	.0958	.0941	.0813	.0849	.0938	.0958	.0975	.1120	.1120
5	40	.1250	.1202	.1088	.1071	.0943	.0979	.1062	.1088	.1105	.1250	.1250
6	32	.1380	.1326	.1177	.1158	.0997	.1042	.1145	.1177	.1196	.1380	.1380
8	32	.1640	.1586	.1437	.1418	.1257	.1302	.1384	.1437	.1456	.1640	.1640
10	24	.1900	.1834	.1629	.1605	.1389	.1449	.1559	.1629	.1653	.1900	.1900
12	24	.2160	.2094	.1889	.1865	.1649	.1709	.1801	.1889	.1913	.2160	.2160
1/4	20	.2500	.2428	.2175	.2149	.1887	.1959	.2060	.2175	.2201	.2500	.2500
5/16	18	.3125	.3043	.2764	.2734	.2443	.2524	.2630	.2764	.2794	.3125	.3125
3/8	16	.3750	.3660	.3344	.3312	.2983	.3073	.3184	.3344	.3376	.3750	.3750
7/16	14	.4375	.4277	.3911	.3875	.3499	.3602	.3721	.3911	.3947	.4375	.4375
1/2	13	.5000	.4896	.4500	.4463	.4056	.4167	.4290	.4500	.4537	.5000	.5000
9/16	12	.5625	.5513	.5084	.5044	.4603	.4723	.4850	.5084	.5124	.5625	.5625
5/8	11	.6250	.6132	.5660	.5618	.5135	.5266	.5397	.5660	.5702	.6250	.6250
3/4	10	.7500	.7372	.6850	.6805	.6273	.6417	.6553	.6850	.6895	.7500	.7500
7/8	9	.8750	.8610	.8028	.7979	.7387	.7547	.7689	.8028	.8077	.8750	.8750
1	8	1.0000	.9848	.9188	.9134	.8466	.8647	.8795	.9188	.9242	1.0000	1.0000
1 1/8	7	1.1250	1.1080	1.0322	1.0263	.9497	.9704	.9858	1.0322	1.0381	1.1250	1.1250
1 1/4	7	1.2500	1.2330	1.1572	1.1513	1.0747	1.0954	1.1108	1.1572	1.1631	1.2500	1.2500
1 3/8	6	1.3750	1.3548	1.2667	1.2596	1.1705	1.1946	1.2126	1.2667	1.2738	1.3750	1.3750
1 1/2	6	1.5000	1.4798	1.3917	1.3846	1.2955	1.3196	1.3376	1.3917	1.3988	1.5000	1.5000
1 3/4	5	1.7500	1.7268	1.6201	1.6119	1.5046	1.5335	1.5551	1.6201	1.6283	1.7500	1.7500
2	4 1/2	2.0000	1.9746	1.8557	1.8468	1.7274	1.7594	1.7835	1.8557	1.8646	2.0000	2.0000
2 1/4	4 1/2	2.2500	2.2246	2.1057	2.0968	1.9774	2.0094	2.0335	2.1057	2.1146	2.2500	2.2500
2 1/2	4	2.5000	2.4720	2.3376	2.3279	2.1933	2.2294	2.2564	2.3376	2.3473	2.5000	2.5000
2 3/4	4	2.7500	2.7220	2.5876	2.5779	2.4433	2.4794	2.5064	2.5876	2.5973	2.7500	2.7500
3	4	3.0000	2.9720	2.8376	2.8279	2.6933	2.7294	2.7564	2.8376	2.8473	3.0000	3.0000
3 1/4	4	3.2500	3.2220	3.0876	3.0779	2.9433	2.9794	3.0064	3.0876	3.0973	3.2500	3.2500
3 1/2	4	3.5000	3.4720	3.3376	3.3279	3.1933	3.2294	3.2564	3.3376	3.3473	3.5000	3.5000
3 3/4	4	3.7500	3.7220	3.5876	3.5779	3.4433	3.4794	3.5064	3.5876	3.5973	3.7500	3.7500
4	4	4.0000	3.9720	3.8376	3.8279	3.6933	3.7294	3.7564	3.8376	3.8473	4.0000	4.0000

[1] [2] See footnotes on p. 37.

[3] The use, where practicable, of class 2 tolerances for nuts, instead of class 3, is recommended.

TABLE 10.—*Class 4 fit, American National coarse-thread series*

Sizes	Threads per inch	Screw sizes: Major diameter, Max.	Screw sizes: Major diameter, Min.	Screw sizes: Pitch diameter, Max.	Screw sizes: Pitch diameter, Min.	Screw sizes: Minor diameter, maximum [1]	Nut sizes: Minor diameter, Min.	Nut sizes: Minor diameter, Max.	Nut sizes: Pitch diameter, Min.	Nut sizes: Pitch diameter, Max.	Nut sizes: Major diameter, minimum [2]	Basic major diameter
1	2	3	4	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
¼	20	0.2500	0.2428	0.2178	0.2165	0.1887	0.1959	0.2060	0.2175	0.2188	0.2500	0.2500
5/16	18	.3125	.3043	.2767	.2752	.2443	.2524	.2630	.2764	.2779	.3125	.3125
⅜	16	.3750	.3660	.3348	.3332	.2983	.3073	.3184	.3344	.3360	.3750	.3750
7/16	14	.4375	.4277	.3915	.3897	.3499	.3602	.3721	.3911	.3929	.4375	.4375
½	13	.5000	.4896	.4504	.4485	.4056	.4167	.4290	.4500	.4519	.5000	.5000
9/16	12	.5625	.5513	.5089	.5069	.4603	.4723	.4850	.5084	.5104	.5625	.5625
⅝	11	.6250	.6132	.5665	.5644	.5135	.5266	.5397	.5660	.5681	.6250	.6250
¾	10	.7500	.7372	.6856	.6833	.6273	.6417	.6553	.6850	.6873	.7500	.7500
⅞	9	.8750	.8610	.8034	.8010	.7387	.7547	.7689	.8028	.8052	.8750	.8750
1	8	1.0000	.9848	.9195	.9168	.8466	.8647	.8795	.9188	.9215	1.0000	1.0000
1⅛	7	1.1250	1.1080	1.0330	1.0300	.9497	.9704	.9858	1.0322	1.0352	1.1250	1.1250
1¼	7	1.2500	1.2330	1.1580	1.1550	1.0747	1.0954	1.1108	1.1572	1.1602	1.2500	1.2500
1⅜	6	1.3750	1.3548	1.2676	1.2640	1.1705	1.1946	1.2126	1.2667	1.2703	1.3750	1.3750
1½	6	1.5000	1.4798	1.3926	1.3890	1.2955	1.3196	1.3376	1.3917	1.3953	1.5000	1.5000
1¾	5	1.7500	1.7268	1.6211	1.6170	1.5046	1.5335	1.5551	1.6201	1.6242	1.7500	1.7500
2	4½	2.0000	1.9746	1.8568	1.8524	1.7274	1.7594	1.7835	1.8557	1.8601	2.0000	2.0000
2¼	4½	2.2500	2.2246	2.1068	2.1024	1.9774	2.0094	2.0335	2.1057	2.1101	2.2500	2.2500
2½	4	2.5000	2.4720	2.3389	2.3341	2.1933	2.2294	2.2564	2.3376	2.3424	2.5000	2.5000
2¾	4	2.7500	2.7220	2.5889	2.5841	2.4433	2.4794	2.5064	2.5876	2.5924	2.7500	2.7500
3	4	3.0000	2.9720	2.8389	2.8341	2.6933	2.7294	2.7564	2.8376	2.8424	3.0000	3.0000
3¼	4	3.2500	3.2220	3.0889	3.0841	2.9433	2.9794	3.0064	3.0876	3.0924	3.2500	3.2500
3½	4	3.5000	3.4720	3.3389	3.3341	3.1933	3.2294	3.2564	3.3376	3.3424	3.5000	3.5000
3¾	4	3.7500	3.7220	3.5889	3.5841	3.4433	3.4794	3.5064	3.5876	3.5924	3.7500	3.7500
4	4	4.0000	3.9720	3.8389	3.8341	3.6933	3.7294	3.7564	3.8376	3.8424	4.0000	4.0000

[1] [2] See footnotes on p. 37.

TABLE 11.—*Class 1 fit, American National fine-thread series*

Sizes	Threads per inch	Screw sizes					Nut sizes					Basic major diameter
		Major diameter		Pitch diameter		Minor diameter, maximum [1]	Minor diameter		Pitch diameter		Major diameter, minimum [2]	
		Max.	Min.	Max.	Min.		Min.	Max.	Min.	Max.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
0	80	0.0593	0.0545	0.0512	0.0488	0.0440	0.0465	0.0514	0.0519	0.0543	0.0600	0.0600
1	72	.0723	.0673	.0633	.0608	.0553	.0580	.0634	.0640	.0665	.0730	.0730
2	64	.0853	.0801	.0752	.0726	.0661	.0691	.0746	.0759	.0785	.0860	.0860
3	56	.0982	.0926	.0866	.0838	.0763	.0797	.0856	.0874	.0902	.0990	.0990
4	48	.1111	.1049	.0976	.0945	.0855	.0894	.0960	.0985	.1016	.1120	.1120
5	44	.1241	.1177	.1093	.1061	.0962	.1004	.1068	.1102	.1134	.1250	.1250
6	40	.1370	.1302	.1208	.1174	.1063	.1109	.1179	.1218	.1252	.1380	.1380
8	36	.1629	.1557	.1449	.1413	.1288	.1339	.1402	.1460	.1496	.1640	.1640
10	32	.1889	.1813	.1686	.1648	.1506	.1562	.1624	.1697	.1735	.1900	.1900
12	28	.2148	.2062	.1916	.1873	.1710	.1773	.1835	.1928	.1971	.2160	.2160
1/4	28	.2488	.2402	.2256	.2213	.2050	.2113	.2173	.2268	.2311	.2500	.2500
5/16	24	.3112	.3020	.2841	.2795	.2601	.2674	.2739	.2854	.2900	.3125	.3125
3/8	24	.3737	.3645	.3466	.3420	.3226	.3299	.3364	.3479	.3525	.3750	.3750
7/16	20	.4360	.4258	.4035	.3984	.3747	.3834	.3906	.4050	.4101	.4375	.4375
1/2	20	.4985	.4883	.4660	.4609	.4372	.4459	.4531	.4675	.4726	.5000	.5000
9/16	18	.5609	.5495	.5248	.5191	.4927	.5024	.5100	.5264	.5321	.5625	.5625
5/8	18	.6234	.6120	.5873	.5816	.5552	.5649	.5725	.5889	.5946	.6250	.6250
3/4	16	.7482	.7356	.7076	.7013	.6715	.6823	.6903	.7094	.7157	.7500	.7500
7/8	14	.8729	.8589	.8265	.8195	.7853	.7977	.8062	.8286	.8356	.8750	.8750
1	14	.9979	.9839	.9515	.9445	.9103	.9227	.9312	.9536	.9606	1.0000	1.0000
1 1/8	12	1.1226	1.1068	1.0685	1.0606	1.0204	1.0348	1.0438	1.0709	1.0788	1.1250	1.1250
1 1/4	12	1.2476	1.2318	1.1935	1.1856	1.1454	1.1598	1.1688	1.1959	1.2038	1.2500	1.2500
1 3/8	12	1.3726	1.3568	1.3185	1.3106	1.2704	1.2848	1.2938	1.3209	1.3288	1.3750	1.3750
1 1/2	12	1.4976	1.4818	1.4435	1.4356	1.3954	1.4098	1.4188	1.4459	1.4538	1.5000	1.5000

[1] [2] See footnotes on p. 37.

TABLE 12.—*Class 2 fit, American National fine-thread series*

Sizes	Threads per inch	Screw sizes: Major diameter, Max.	Screw sizes: Major diameter, Min.	Screw sizes: Pitch diameter, Max.	Screw sizes: Pitch diameter, Min.	Screw sizes: Minor diameter, maximum [1]	Nut sizes [3]: Minor diameter, Min.	Nut sizes [3]: Minor diameter, Max.	Nut sizes [3]: Pitch diameter, Min.	Nut sizes [3]: Pitch diameter, Max.	Nut sizes [3]: Major diameter, minimum [2]	Basic major diameter
1	2	3	4	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
0	80	0.0600	0.0566	0.0519	0.0502	0.0447	0.0465	0.0514	0.0519	0.0536	0.0600	0.0600
1	72	.0730	.0694	.0640	.0622	.0560	.0580	.0634	.0640	.0658	.0730	.0730
2	64	.0860	.0822	.0759	.0740	.0668	.0691	.0746	.0759	.0778	.0860	.0860
3	56	.0990	.0950	.0874	.0854	.0771	.0797	.0856	.0874	.0894	.0990	.0990
4	48	.1120	.1076	.0985	.0963	.0864	.0894	.0960	.0985	.1007	.1120	.1120
5	44	.1250	.1204	.1102	.1079	.0971	.1004	.1068	.1102	.1125	.1250	.1250
6	40	.1380	.1332	.1218	.1194	.1073	.1109	.1179	.1218	.1242	.1380	.1380
8	36	.1640	.1590	.1460	.1435	.1299	.1339	.1402	.1460	.1485	.1640	.1640
10	32	.1900	.1846	.1697	.1670	.1517	.1562	.1624	.1697	.1724	.1900	.1900
12	28	.2160	.2098	.1928	.1897	.1722	.1773	.1835	.1928	.1959	.2160	.2160
1/4	28	.2500	.2438	.2268	.2237	.2062	.2113	.2173	.2268	.2299	.2500	.2500
5/16	24	.3125	.3059	.2854	.2821	.2614	.2674	.2739	.2854	.2887	.3125	.3125
3/8	24	.3750	.3684	.3479	.3446	.3239	.3299	.3364	.3479	.3512	.3750	.3750
7/16	20	.4375	.4303	.4050	.4014	.3762	.3834	.3906	.4050	.4086	.4375	.4375
1/2	20	.5000	.4928	.4675	.4639	.4387	.4459	.4531	.4675	.4711	.5000	.5000
9/16	18	.5625	.5543	.5264	.5223	.4943	.5024	.5100	.5264	.5305	.5625	.5625
5/8	18	.6250	.6168	.5889	.5848	.5568	.5649	.5725	.5889	.5930	.6250	.6250
3/4	16	.7500	.7410	.7094	.7049	.6733	.6823	.6903	.7094	.7139	.7500	.7500
7/8	14	.8750	.8652	.8286	.8237	.7874	.7977	.8062	.8286	.8335	.8750	.8750
1	14	1.0000	.9902	.9536	.9487	.9124	.9227	.9312	.9536	.9585	1.0000	1.0000
1 1/8	12	1.1250	1.1138	1.0709	1.0653	1.0228	1.0348	1.0438	1.0709	1.0765	1.1250	1.1250
1 1/4	12	1.2500	1.2388	1.1959	1.1903	1.1478	1.1598	1.1688	1.1959	1.2015	1.2500	1.2500
1 3/8	12	1.3750	1.3638	1.3209	1.3153	1.2728	1.2848	1.2938	1.3209	1.3265	1.3750	1.3750
1 1/2	12	1.5000	1.4888	1.4459	1.4403	1.3978	1.4098	1.4188	1.4459	1.4515	1.5000	1.5000

[1] [2] See footnotes on p. 37.
[3] The use, where practicable, of class 1 tolerances for nuts in the numbered sizes, instead of class 2, is recommended.

TABLE 13.—*Class 3 fit, American National fine-thread series*

Sizes	Threads per inch	Screw sizes: Major diameter, Max.	Screw sizes: Major diameter, Min.	Screw sizes: Pitch diameter, Max.	Screw sizes: Pitch diameter, Min.	Screw sizes: Minor diameter, maximum [1]	Nut sizes [3]: Minor diameter, Min.	Nut sizes [3]: Minor diameter, Max.	Nut sizes [3]: Pitch diameter, Min.	Nut sizes [3]: Pitch diameter, Max.	Nut sizes [3]: Major diameter, minimum [2]	Basic major diameter
1	2	3	4	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
0	80	0.0600	0.0566	0.0519	0.0506	0.0447	0.0465	0.0514	0.0519	0.0532	0.0600	0.0600
1	72	.0730	.0694	.0640	.0627	.0560	.0580	.0634	.0640	.0653	.0730	.0730
2	64	.0860	.0822	.0759	.0745	.0668	.0691	.0746	.0759	.0773	.0860	.0860
3	56	.0990	.0950	.0874	.0859	.0771	.0797	.0856	.0874	.0889	.0990	.0990
4	48	.1120	.1076	.0985	.0969	.0864	.0894	.0960	.0985	.1001	.1120	.1120
5	44	.1250	.1204	.1102	.1086	.0971	.1004	.1068	.1102	.1118	.1250	.1250
6	40	.1380	.1332	.1218	.1201	.1073	.1109	.1179	.1218	.1235	.1380	.1380
8	36	.1640	.1590	.1460	.1442	.1299	.1339	.1402	.1460	.1478	.1640	.1640
10	32	.1900	.1846	.1697	.1678	.1517	.1562	.1624	.1697	.1716	.1900	.1900
12	28	.2160	.2098	.1928	.1906	.1722	.1773	.1835	.1928	.1950	.2160	.2160
¼	28	.2500	.2438	.2268	.2246	.2062	.2113	.2173	.2268	.2290	.2500	.2500
5/16	24	.3125	.3059	.2854	.2830	.2614	.2674	.2739	.2854	.2878	.3125	.3125
⅜	24	.3750	.3684	.3479	.3455	.3239	.3299	.3364	.3479	.3503	.3750	.3750
7/16	20	.4375	.4303	.4050	.4024	.3762	.3834	.3906	.4050	.4076	.4375	.4375
½	20	.5000	.4928	.4675	.4649	.4387	.4459	.4531	.4675	.4701	.5000	.5000
9/16	18	.5625	.5543	.5264	.5234	.4943	.5024	.5100	.5264	.5294	.5625	.5625
⅝	18	.6250	.6168	.5889	.5859	.5568	.5649	.5725	.5889	.5919	.6250	.6250
¾	16	.7500	.7410	.7094	.7062	.6733	.6823	.6903	.7094	.7126	.7500	.7550
⅞	14	.8750	.8652	.8286	.8250	.7874	.7977	.8062	.8286	.8322	.8750	.8750
1	14	1.0000	.9902	.9536	.9500	.9124	.9227	.9312	.9536	.9572	1.0000	1.0000
1⅛	12	1.1250	1.1138	1.0709	1.0669	1.0228	1.0348	1.0438	1.0709	1.0749	1.1250	1.1250
1¼	12	1.2500	1.2388	1.1959	1.1919	1.1478	1.1598	1.1688	1.1959	1.9999	1.2500	1.2500
1⅜	12	1.3750	1.3638	1.3209	1.3169	1.2728	1.2848	1.2938	1.3209	1.3249	1.3750	1.3750
1½	12	1.5000	1.4888	1.4459	1.4419	1.3978	1.4098	1.4188	1.4459	1.4499	1.5000	1.5000

[1] [2] See footnotes on p. 37.
[3] The use, where practicable, of class 2 tolerances for nuts, instead of class 3, is recommended.

TABLE 14.—*Class 4 fit, American National fine-thread series*

Sizes	Threads per inch	Screw sizes					Nut sizes					Basic major diameter
		Major diameter		Pitch diameter		Minor diameter, maximum [1]	Minor diameter		Pitch diameter		Major diameter, minimum [2]	
		Max.	Min.	Max.	Min.		Min.	Max.	Min.	Max.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/4	28	0.2500	0.2438	0.2270	0.2259	0.2062	0.2113	0.2173	0.2268	0.2279	0.2500	0.2500
5/16	24	.3125	.3059	.2857	.2845	.2614	.2674	.2739	.2854	.2866	.3125	.3125
3/8	24	.3750	.3684	.3482	.3470	.3239	.3299	.3364	.3479	.3491	.3750	.3750
7/16	20	.4375	.4303	.4053	.4040	.3762	.3834	.3906	.4050	.4063	.4375	.4375
1/2	20	.5000	.4928	.4678	.4665	.4387	.4459	.4531	.4675	.4688	.5000	.5000
9/16	18	.5625	.5543	.5267	.5252	.4943	.5024	.5100	.5264	.5279	.5625	.5625
5/8	18	.6250	.6168	.5892	.5877	.5568	.5649	.5725	.5889	.5904	.6250	.6250
3/4	16	.7500	.7410	.7098	.7082	.6733	.6823	.6903	.7094	.7110	.7500	.7500
7/8	14	.8750	.8652	.8290	.8272	.7874	.7977	.8062	.8286	.8304	.8750	.8750
1	14	1.0000	.9902	.9540	.9522	.9124	.9227	.9312	.9536	.9554	1.0000	1.0000
1 1/8	12	1.1250	1.1138	1.0714	1.0694	1.0228	1.0348	1.0438	1.0709	1.0729	1.1250	1.1250
1 1/4	12	1.2500	1.2388	1.1964	1.1944	1.1478	1.1598	1.1688	1.1959	1.1979	1.2500	1.2500
1 3/8	12	1.3750	1.3638	1.3214	1.3194	1.2728	1.2848	1.2938	1.3209	1.3229	1.3750	1.3750
1 1/2	12	1.5000	1.4888	1.4464	1.4444	1.3978	1.4098	1.4188	1.4459	1.4479	1.5000	1.5000

[1] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the minimum screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h (or $0.6495p$), from the minimum pitch diameter of the screw.

[2] Dimensions for the minimum major diameter of the nut correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the nut shall be that corresponding to a flat at the major diameter of the maximum nut equal to $\frac{1}{24} \times p$, andmay be determined by adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the nut.

TABLE 15.—*Limiting dimensions and tolerances, classes 1, 2, 3, and 4 fits, American National coarse-thread series*

Dimensions and tolerances		Machine screw number or nominal size															
		1	2	3	4	5	6	8	10	12	1/4	5/16	3/8	7/16	1/2	9/16	5/8
		Threads per inch															
		64	56	48	40	40	32	32	24	24	20	18	16	14	13	12	11
BOLTS AND SCREWS		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Class 1, major diameter	Max	0.0723	0.0852	0.0981	0.1110	0.1240	0.1369	0.1629	0.1887	0.2147	0.2485	0.3109	0.3732	0.4354	0.4978	0.5601	0.6224
	Min	.0671	.0796	.0919	.1042	.1172	.1293	.1553	.1795	.2055	.2383	.2995	.3606	.4214	.4830	.5443	.6054
	Tol	.0052	.0056	.0062	.0068	.0068	.0076	.0076	.0092	.0092	.0102	.0114	.0126	.0140	.0148	.0158	.0170
Classes 2, 3, and 4, major diameter	Max	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125	.3750	.4375	.5000	.5625	.6250
	Min	.0692	.0820	.0946	.1072	.1202	.1326	.1586	.1834	.2094	.2428	.3043	.3660	.4277	.4896	.5513	.6132
	Tol	.0038	.0040	.0044	.0048	.0048	.0054	.0054	.0066	.0066	.0072	.0082	.0090	.0098	.0104	.0112	.0118
Class 2, major diameter (threaded parts of unfinished, hot-rolled material)	Max	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125	.3750	.4375	.5000	.5625	.6250
	Min	.0678	.0804	.0928	.1052	.1182	.1304	.1564	.1808	.2068	.2398	.3011	.3624	.4235	.4852	.5467	.6080
	Tol	.0052	.0056	.0062	.0068	.0068	.0076	.0076	.0092	.0092	.0102	.0114	.0126	.0140	.0148	.0158	.0170
Class 1, minor diameter	Max.[1]	.0531	.0633	.0725	.0803	.0933	.0986	.1246	.1376	.1636	.1872	.2427	.2965	.3478	.4034	.4579	.5109
Classes 2, 3, and 4, minor diameter	Max.[1]	.0538	.0641	.0734	.0813	.0943	.0997	.1257	.1389	.1649	.1887	.2443	.2983	.3499	.4056	.4603	.5135
Class 1, pitch diameter	Max	.0622	.0736	.0846	.0948	.1078	.1166	.1426	.1616	.1876	.2160	.2748	.3326	.3890	.4478	.5060	.5634
	Min	.0596	.0708	.0815	.0914	.1044	.1128	.1388	.1570	.1830	.2109	.2691	.3263	.3820	.4404	.4981	.5549
	Tol	.0026	.0028	.0031	.0034	.0034	.0038	.0038	.0046	.0046	.0051	.0057	.0063	.0070	.0074	.0079	.0085
Class 2, pitch diameter	Max	.0629	.0744	.0855	.0958	.1088	.1177	.1437	.1629	.1889	.2175	.2764	.3344	.3911	.4500	.5084	.5660
	Min	.0610	.0724	.0833	.0934	.1064	.1150	.1410	.1596	.1856	.2139	.2723	.3299	.3862	.4448	.5028	.5601
	Tol	.0019	.0020	.0022	.0024	.0024	.0027	.0027	.0033	.0033	.0036	.0041	.0045	.0049	.0052	.0056	.0059
Class 3, pitch diameter	Max	.0629	.0744	.0855	.0958	.1088	.1177	.1437	.1629	.1889	.2175	.2764	.3344	.3911	.4500	.5084	.5660
	Min	.0615	.0729	.0839	.0941	.1071	.1158	.1418	.1605	.1865	.2149	.2734	.3312	.3875	.4463	.5044	.5618
	Tol	.0014	.0015	.0016	.0017	.0017	.0019	.0019	.0024	.0024	.0026	.0030	.0032	.0036	.0037	.0040	.0042
Class 4, pitch diameter	Max	--------	--------	--------	--------	--------	--------	--------	--------	--------	.2178	.2767	.3348	.3915	.4504	.5089	.5665
	Min	--------	--------	--------	--------	--------	--------	--------	--------	--------	.2165	.2752	.3332	.3897	.4485	.5069	.5644
	Tol	--------	--------	--------	--------	--------	--------	--------	--------	--------	.0013	.0015	.0016	.0018	.0019	.0020	.0021

NUTS AND TAPPED HOLES																	
Classes 1, 2, 3, and 4, major diameter	Min.[2]	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125	.3750	.4375	.5000	.5625	.6250
Classes 1, 2, 3, and 4, minor diameter	Max.	.0623	.0737	.0841	.0938	.1062	.1145	.1384	.1559	.1801	.2060	.2630	.3184	.3721	.4290	.4850	.5397
	Min.	.0561	.0667	.0764	.0849	.0979	.1042	.1302	.1449	.1709	.1959	.2524	.3073	.3602	.4167	.4723	.5266
	Tol.	.0062	.0070	.0077	.0089	.0083	.0103	.0082	.0110	.0092	.0101	.0106	.0111	.0119	.0123	.0127	.0131
Classes 1, 2, 3, and 4, pitch diameter	Min.	.0629	.0744	.0855	.0958	.1088	.1177	.1437	.1629	.1889	.2175	.2764	.3344	.3911	.4500	.5084	.5660
Class 1, pitch diameter	Max.[3]	.0655	.0772	.0886	.0992	.1122	.1215	.1475	.1675	.1935	.2226	.2821	.3407	.3981	.4574	.5163	.5745
	Tol.	.0026	.0028	.0031	.0034	.0034	.0038	.0038	.0046	.0046	.0051	.0057	.0063	.0070	.0074	.0079	.0085
Class 2, pitch diameter	Max.[3]	.0648	.0764	.0877	.0982	.1112	.1204	.1464	.1662	.1922	.2211	.2805	.3389	.3960	.4552	.5140	.5719
	Tol.	.0019	.0020	.0022	.0024	.0024	.0027	.0027	.0033	.0033	.0036	.0041	.0045	.0049	.0052	.0056	.0059
Class 3, pitch diameter	Max.[3]	.0643	.0759	.0871	.0975	.1105	.1196	.1456	.1653	.1913	.2201	.2794	.3376	.3947	.4537	.5124	.5702
	Tol.	.0014	.0015	.0016	.0017	.0017	.0019	.0019	.0024	.0024	.0026	.0030	.0032	.0036	.0037	.0040	.0042
Class 4, pitch diameter	Max.[3]										.2188	.2779	.3360	.3929	.4519	.5104	.5681
	Tol.										.0013	.0015	.0016	.0018	.0019	.0020	.0021

[1] See footnote 1 on p. 45.
[2] See footnote 2 on p. 45.
[3] See footnote 3 on p. 45.

TABLE 15.—*Limiting dimensions and tolerances, classes 1, 2, 3, and 4 fits, American National coarse-thread series*—Continued

Dimensions and tolerances		Size ¾	Size ⅞	Size 1	Size 1⅛	Size 1¼	Size 1⅜	Size 1½	Size 1¾	Size 2	Size 2¼	Size 2½	Size 2¾	Size 3	Size 3¼	Size 3½	Size 3¾	Size 4
	Threads per inch	10	9	8	7	7	6	6	5	4½	4½	4	4	4	4	4	4	4
BOLTS AND SCREWS		Inch	Inch	Inch	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
Class 1, major diameter	Max	0.7472	0.8719	0.9966	1.1211	1.2461	1.3706	1.4956	1.7448	1.9943	2.2443	2.4936	2.7436	2.9936	3.2436	3.4936	3.7436	3.9936
	Min	.7288	.8519	.9744	1.0963	1.2213	1.3416	1.4666	1.7110	1.9575	2.2075	2.4528	2.7028	2.9528	3.2028	3.4528	3.7028	3.9528
	Tol	.0184	.0200	.0222	.0248	.0248	.0290	.0290	.0338	.0368	.0368	.0408	.0408	.0408	.0408	.0408	.0408	.0408
Classes 2, 3, and 4, major diameter	Max	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000	1.7500	2.0000	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
	Min	.7372	.8610	.9848	1.1080	1.2330	1.3548	1.4798	1.7268	1.9746	2.2246	2.4720	2.7220	2.9720	3.2220	3.4720	3.7220	3.9720
	Tol	.0128	.0140	.0152	.0170	.0170	.0202	.0202	.0232	.0254	.0254	.0280	.0280	.0280	.0280	.0280	.0280	.0280
Class 2, major diameter (threaded parts of unfinished, hot-rolled material)	Max	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000	1.7500	2.0000	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
	Min	.7316	.8550	.9778	1.1002	1.2252	1.3460	1.4710	1.7162	1.9632	2.2132	2.4592	2.7092	2.9592	3.2092	3.4592	3.7092	3.9592
	Tol	.0184	.0200	.0222	.0248	.0248	.0290	.0290	.0338	.0368	.0368	.0408	.0408	.0408	.0408	.0408	.0408	.0408
Class 1, minor diameter	Max.[1]	.6245	.7356	.8432	.9458	1.0708	1.1661	1.2911	1.4994	1.7217	1.9717	2.1869	2.4369	2.6869	2.9369	3.1869	3.4369	3.6869
Classes 2, 3, and 4, minor diameter	Max.[1]	.6273	.7387	.8466	.9497	1.0747	1.1705	1.2955	1.5046	1.7274	1.9774	2.1933	2.4433	2.6933	2.9433	3.1933	3.4433	3.6933
Class 1, pitch diameter	Max	.6822	.7997	.9154	1.0283	1.1533	1.2623	1.3873	1.6149	1.8500	2.1000	2.3312	2.5812	2.8312	3.0812	3.3312	3.5812	3.8312
	Min	.6730	.7897	.9043	1.0159	1.1409	1.2478	1.3728	1.5980	1.8316	2.0816	2.3108	2.5608	2.8108	3.0608	3.3108	3.5608	3.8108
	Tol	.0092	.0100	.0111	.0124	.0124	.0145	.0145	.0169	.0184	.0184	.0204	.0204	.0204	.0204	.0204	.0204	.0204
Class 2, pitch diameter	Max	.6850	.8028	.9188	1.0322	1.1572	1.2667	1.3917	1.6201	1.8557	2.1057	2.3376	2.5876	2.8376	3.0876	3.3376	3.5876	3.8376
	Min	.6786	.7958	.9112	1.0237	1.1487	1.2566	1.3816	1.6085	1.8430	2.0930	2.3236	2.5736	2.8236	3.0736	3.3236	3.5736	3.8236
	Tol	.0064	.0070	.0076	.0085	.0085	.0101	.0101	.0116	.0127	.0127	.0140	.0140	.0140	.0140	.0140	.0140	.0140
Class 3, pitch diameter	Max	.6850	.8028	.9188	1.0322	1.1572	1.2667	1.3917	1.6201	1.8557	2.1057	2.3376	2.5876	2.8376	3.0876	3.3376	3.5876	3.8376
	Min	.6805	.7979	.9134	1.0263	1.1513	1.2596	1.3846	1.6119	1.8468	2.0968	2.3279	2.5779	2.8279	3.0779	3.3279	3.5779	3.8279
	Tol	.0045	.0049	.0054	.0059	.0059	.0071	.0071	.0082	.0089	.0089	.0097	.0097	.0097	.0097	.0097	.0097	.0097
Class 4, pitch diameter	Max	.6856	.8034	.9195	1.0330	1.1580	1.2676	1.3926	1.6211	1.8568	2.1068	2.3389	2.5889	2.8389	3.0889	3.3389	3.5889	3.8389
	Min	.6833	.8010	.9168	1.0300	1.1550	1.2640	1.3890	1.6170	1.8524	2.1024	2.3341	2.5841	2.8341	3.0841	3.3341	3.5841	3.8341
	Tol	.0023	.0024	.0027	.0030	.0030	.0036	.0036	.0041	.0044	.0044	.0048	.0048	.0048	.0048	.0048	.0048	.0048

NUTS AND TAPPED HOLES																	
Classes 1, 2, 3, and 4, major diameter Min.[2]	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000	1.7500	2.0000	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
Classes 1, 2, 3, and 4, minor diameter Max.	.6553	.7689	.8795	.9858	1.1108	1.2126	1.3376	1.5551	1.7835	2.0335	2.2564	2.5064	2.7564	3.0064	3.2564	3.5064	3.7564
Min.	.6417	.7547	.8647	.9704	1.0954	1.1946	1.3196	1.5335	1.7594	2.0094	2.2294	2.4794	2.7294	2.9794	3.2294	3.4794	3.7294
Tol.	.0136	.0142	.0148	.0154	.0154	.0180	.0180	.0216	.0241	.0241	.0270	.0270	.0270	.0270	.0270	.0270	.0270
Classes 1, 2, 3, and 4, pitch diameter Min.	.6850	.8028	.9188	1.0322	1.1572	1.2667	1.3917	1.6201	1.8557	2.1057	2.3376	2.5876	2.8376	3.0876	3.3376	3.5876	3.8376
Class 1, pitch diameter Max.[3]	.6942	.8128	.9299	1.0446	1.1696	1.2812	1.4062	1.6370	1.8741	2.1241	2.3580	2.6080	2.8580	3.1080	3.3580	3.6080	3.8580
Tol.	.0092	.0100	.0111	.0124	.0124	.0145	.0145	.0169	.0184	.0184	.0204	.0204	.0204	.0204	.0204	.0204	.0204
Class 2, pitch diameter Max.[3]	.6914	.8098	.9264	1.0407	1.1657	1.2768	1.4018	1.6317	1.8684	2.1184	2.3516	2.6016	2.8516	3.1016	3.3516	3.6016	3.8516
Tol.	.0064	.0070	.0076	.0085	.0085	.0101	.0101	.0116	.0127	.0127	.0140	.0140	.0140	.0140	.0140	.0140	.0140
Class 3, pitch diameter Max.[3]	.6895	.8077	.9242	1.0381	1.1631	1.2738	1.3988	1.6283	1.8646	2.1146	2.3473	2.5973	2.8473	3.0973	3.3473	3.5973	3.8473
Tol.	.0045	.0049	.0054	.0059	.0059	.0071	.0071	.0082	.0089	.0089	.0097	.0097	.0097	.0097	.0097	.0097	.0097
Class 4, pitch diameter Max.[3]	.6873	.8052	.9215	1.0352	1.1602	1.2703	1.3953	1.6242	1.8601	2.1101	2.3424	2.5924	2.8424	3.0924	3.3424	3.5924	3.8424
Tol.	.0023	.0024	.0027	.0030	.0030	.0036	.0036	.0041	.0044	.0044	.0048	.0048	.0048	.0048	.0048	.0048	.0048

[1] See footnote 1 on p. 45

[2] See footnote 2 on p. 45

[3] See footnote 3 on p. 45.

400610°—42——4

TABLE 16.—*Limiting dimensions and tolerances, classes 1, 2, 3, and 4 fits, American National fine-thread series*

Dimensions and tolerances		0	1	3	3	4	5	6	8	10	12	¼	5/16	⅜	7/16
		Machine screw number or nominal size													
	Threads per inch	80	72	64	56	48	44	40	36	32	28	28	24	24	20
BOLTS AND SCREWS		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Class 1, major diameter	Max.	0.0593	0.0723	0.0853	0.0982	0.1111	0.1241	0.1370	0.1629	0.1889	0.2148	0.2488	0.3112	0.3737	0.4360
	Min.	.0545	.0673	.0801	.0926	.1049	.1177	.1302	.1557	.1813	.2062	.2402	.3020	.3645	.4258
	Tol.	.0048	.0050	.0052	.0056	.0062	.0064	.0068	.0072	.0076	.0086	.0086	.0092	.0092	.0102
Classes 2, 3, and 4, major diameter	Max.	.0600	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125	.3750	.4375
	Min.	.0566	.0694	.0822	.0950	.1076	.1204	.1332	.1590	.1846	.2098	.2438	.3059	.3684	.4303
	Tol.	.0034	.0036	.0038	.0040	.0044	.0046	.0048	.0050	.0054	.0062	.0062	.0066	.0066	.0072
Class 1, minor diameter	Max.[1]	.0440	.0553	.0661	.0763	.0855	.0962	.1063	.1288	.1506	.1710	.2050	.2601	.3226	.3747
Classes 2, 3, and 4, minor diameter	Max.[1]	.0447	.0560	.0668	.0771	.0864	.0971	.1073	.1299	.1517	.1722	.2062	.2614	.3239	.3762
Class 1, pitch diameter	Max.	.0512	.0633	.0752	.0866	.0976	.1093	.1208	.1449	.1686	.1916	.2256	.2841	.3466	.4035
	Min.	.0488	.0608	.0726	.0838	.0945	.1061	.1174	.1413	.1648	.1873	.2213	.2795	.3420	.3984
	Tol.	.0024	.0025	.0026	.0028	.0031	.0032	.0034	.0036	.0038	.0043	.0043	.0046	.0046	.0051
Class 2, pitch diameter	Max.	.0519	.0640	.0759	.0874	.0985	.1102	.1218	.1460	.1697	.1928	.2268	.2854	.3479	.4050
	Min.	.0502	.0622	.0740	.0854	.0963	.1079	.1194	.1435	.1670	.1897	.2237	.2821	.3446	.4014
	Tol.	.0017	.0018	.0019	.0020	.0022	.0023	.0024	.0025	.0027	.0031	.0031	.0033	.0033	.0036
Class 3, pitch diameter	Max.	.0519	.0640	.0759	.0874	.0985	.1102	.1218	.1460	.1697	.1928	.2268	.2854	.3479	.4050
	Min.	.0506	.0627	.0745	.0859	.0969	.1086	.1201	.1442	.1678	.1906	.2246	.2830	.3455	.4024
	Tol.	.0013	.0013	.0014	.0015	.0016	.0016	.0017	.0018	.0019	.0022	.0022	.0024	.0024	.0026
Class 4, pitch diameter	Max.											.2270	.2857	.3482	.4053
	Min.											.2259	.2845	.3470	.4040
	Tol.											.0011	.0012	.0012	.0013
NUTS AND TAPPED HOLES															
Classes 1, 2, 3, and 4, major diameter	Min.[2]	.0600	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125	.3750	.4375
Classes 1, 2, 3, and 4, minor diameter	Max.	.0514	.0634	.0746	.0856	.0960	.1068	.1179	.1402	.1624	.1835	.2173	.2739	.3364	.3906
	Min.	.0465	.0580	.0691	.0797	.0894	.1004	.1109	.1339	.1562	.1773	.2113	.2674	.3299	.3834
	Tol.	.0049	.0054	.0055	.0059	.0066	.0064	.0070	.0063	.0062	.0062	.0060	.0065	.0065	.0072

Classes 1, 2, 3, and 4, pitch diameter	Min.	.0519	.0640	.0759	.0874	.0985	.1102	.1218	.1460	.1697	.1928	.2268	.2854	.3479	.4050
Class 1, pitch diameter	Max.[3]	.0543	.0665	.0785	.0902	.1016	.1134	.1252	.1496	.1735	.1971	.2311	.2900	.3525	.4101
	Tol.	.0024	.0025	.0026	.0028	.0031	.0032	.0034	.0036	.0038	.0043	.0043	.0046	.0046	.0051
Class 2, pitch diameter	Max.[3]	.0536	.0658	.0778	.0894	.1007	.1125	.1242	.1485	.1724	.1959	.2299	.2887	.3512	.4086
	Tol.	.0017	.0018	.0019	.0020	.0022	.0023	.0024	.0025	.0027	.0031	.0031	.0033	.0033	.0036
Class 3, pitch diameter	Max.[3]	.0532	.0653	.0773	.0889	.1001	.1118	.1235	.1478	.1716	.1950	.2290	.2878	.3503	.4076
	Tol.	.0013	.0013	.0014	.0015	.0016	.0016	.0017	.0018	.0019	.0022	.0022	.0024	.0024	.0026
Class 4, pitch diameter	Max.[3]											.2279	.2866	.3491	.4063
	Tol.											.0011	.0012	.0012	.0013

1 See footnote 1 on p. 45.
2 See footnote 2 on p. 45.
3 See footnote 3 on p. 45.

TABLE 16.—*Limiting dimensions and tolerances, classes 1, 2, 3, and 4 fits, American National fine-thread series*—Continued

Dimensions and tolerances		Size ½	9/16	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
	Threads per inch	20	18	18	16	14	14	12	12	12	12
BOLTS AND SCREWS		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*
Class 1, major diameter	Max	0.4985	0.5609	0.6234	0.7482	0.8729	0.9979	1.1226	1.2476	1.3726	1.4976
	Min	.4883	.5495	.6120	.7356	.8589	.9839	1.1068	1.2318	1.3568	1.4818
	Tol	.0102	.0114	.0114	.0126	.0140	.0140	.0158	.0158	.0158	.0158
Classes 2, 3, and 4, major diameter	Max	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000
	Min	.4928	.5543	.6168	.7410	.8652	.9902	1.1138	1.2388	1.3638	1.4888
	Tol	.0072	.0082	.0082	.0090	.0098	.0098	.0112	.0112	.0112	.0112
Class 1, minor diameter	Max.[1]	.4372	.4927	.5552	.6715	.7853	.9103	1.0204	1.1454	1.2704	1.3954
Classes 2, 3, and 4, minor diameter	Max.[1]	.4387	.4943	.5568	.6733	.7874	.9124	1.0228	1.1478	1.2728	1.3978
Class 1, pitch diameter	Max	.4660	.5248	.5873	.7076	.8265	.9515	1.0685	1.1935	1.3185	1.4435
	Min	.4609	.5191	.5816	.7013	.8195	.9445	1.0606	1.1856	1.3106	1.4356
	Tol	.0051	.0057	.0057	.0063	.0070	.0070	.0079	.0079	.0079	.0079
Class 2, pitch diameter	Max	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
	Min	.4639	.5223	.5848	.7049	.8237	.9487	1.0653	1.1903	1.3153	1.4403
	Tol	.0036	.0041	.0041	.0045	.0049	.0049	.0056	.0056	.0056	.0056
Class 3, pitch diameter	Max	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
	Min	.4649	.5234	.5859	.7062	.8250	.9500	1.0669	1.1919	1.3169	1.4419
	Tol	.0026	.0030	.0030	.0032	.0036	.0036	.0040	.0040	.0040	.0040
Class 4, pitch diameter	Max	.4678	.5267	.5892	.7098	.8290	.9540	1.0714	1.1964	1.3214	1.4464
	Min	.4665	.5252	.5877	.7082	.8272	.9522	1.0694	1.1944	1.3194	1.4444
	Tol	.0013	.0015	.0015	.0016	.0018	.0018	.0020	.0020	.0020	.0020
NUTS AND TAPPED HOLES											
Classes 1, 2, 3, and 4, major diameter	Min.[2]	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000
Classes 1, 2, 3, and 4, minor diameter	Max	.4531	.5100	.5725	.6903	.8062	.9312	1.0438	1.1688	1.2938	1.4188
	Min	.4459	.5024	.5649	.6823	.7977	.9227	1.0348	1.1598	1.2848	1.4098
	Tol	.0072	.0076	.0076	.0080	.0085	.0085	.0090	.0090	.0090	.0090

Classes 1, 2, 3, and 4, pitch diameter	Min.	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
Class 1, pitch diameter	Max.[3]	.4726	.5321	.5946	.7157	.8356	.9606	1.0788	1.2038	1.3288	1.4538
	Tol.	.0051	.0057	.0057	.0063	.0070	.0070	.0079	.0079	.0079	.0079
Class 2, pitch diameter	Max.[3]	.4711	.5305	.5930	.7139	.8335	.9585	1.0765	1.2015	1.3265	1.4515
	Tol.	.0036	.0041	.0041	.0045	.0049	.0049	.0056	.0056	.0056	.0056
Class 3, pitch diameter	Max.[3]	.4701	.5294	.5919	.7126	.8322	.9572	1.0749	1.1999	1.3249	1.4499
	Tol.	.0026	.0030	.0030	.0032	.0036	.0036	.0040	.0040	.0040	.0040
Class 4, pitch diameter	Max.[3]	.4688	.5279	.5904	.7110	.8304	.9554	1.0729	1.1979	1.3229	1.4479
	Tol.	.0013	.0015	.0015	.0016	.0018	.0018	.0020	.0020	.0020	.0020

[1] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the minimum screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h (or 0.6495 p), from the minimum pitch diameter of the screw.

[2] Dimensions for the minimum major diameter of the nut correspond to the basic flat ($\frac{1}{8} \times p$) and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the nut shall be that corresponding to a flat at the major diameter of the maximum nut equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or 0.7939 p) to the maximum pitch diameter of the nut.

[3] These dimensions are the minimum metal or "not go" size. The "go" or basic size is the one that should be placed on the component drawing with the tolerance.

5. GAGES [8]

The manufacture and gaging of threaded products has progressed to the point where standardized methods of inspection can be formulated. From the standpoint of economy of effort, and to assure that users of screw-threaded products will apply the same methods of inspection as the manufacturers, it is considered of great importance that the fundamental principles be laid down for future use. The gaging methods herein described are those which have been tested by producers and consumers of screw-thread products with mutual satisfaction.

(a) FUNDAMENTALS

1. Object of Gaging.—The final results sought by gaging are to secure interchangeability, that is, the assembly of mating parts without selection or fitting of one part to another, and to insure that the product conforms to the specified dimensions within the limits of variation establishing the closest and loosest conditions of fit permissible in any given case, as provided for in the foregoing specifications. This requires the use of gages representing the limit of maximum metal, known as "go" gages, which control the minimum looseness or maximum tightness in the fit of mating parts, and which accordingly control interchangeability; and the use of gages representing the limit of minimum metal, known as "not go" gages, which limit the amount of looseness between mating parts, and thus control in large measure the proper functioning of the parts.

Gages should be used to assure production of satisfactory parts. After manufacture gages may be used to cull out unsatisfactory parts.

2. Purpose of "Go" and "Not Go" Gages.—The "go" gages control the extent of the tolerance in the direction of the limit of maximum metal, and represent the maximum limit of the internal member and the minimum limit of the external member. To pass inspection, parts must be acceptable to proper "go" gages, and such mating parts will always assemble. Successful interchangeable manufacturing has been carried on for many years with the use of "go" gages only.

"Not go" gages control the extent of the tolerance in the direction of the limit of minimum metal, and represent the minimum limit of the internal member and the maximum limit of the external member. The "not go" thread gage shall be permitted to enter or to be entered a distance equal to the length of the standard "not go" gage, without shake or play. Therefore, it will be permissible to accept threaded parts when the "not go" thread gage enters or is entered a distance equal to or less than the length of the standard "not go" thread gage, without shake or play, provided that the snug fit of the "not go" thread gage in or on the component is *not* obtained by the "not go" thread plug gage bottoming in the hole, or the "not go" thread ring gage abutting a shoulder on the component. The requirements of extreme applications such as exceptionally thin or ductile material, small number of threads, etc., may necessitate modification of this practice. The length of the "not go" thread gages as used for the above inspection will be that prescribed in Commercial Standard

[8] This standard, in substantially the same form, is in process of approval by the American Standards Association. It will be published as ASA B1.2—1941 "Screw Thread Gages and Gaging," by the A. S. M.E., 29 West 39th St., New York, N. Y.

CS8–41, Gage Blanks (see footnote 9, below). In the event that "not go" thread gages on hand do not conform to the length specified in CS8–41, the functioning will be based on a scale measurement to the length prescribed in CS8–41.

There is a broad, general principle in regard to limit gages which should be kept in mind; a "go" gage should check simultaneously as many elements as possible, a "not go" gage, to be effective, can check but one element. By "effective inspection" is meant assurance that specified requirements in regard to size are not exceeded. A "not go" thread gage made to check the pitch diameter is usually sufficient for practical purposes. In order that the "not go" gage may check pitch diameter only, it is necessary that the crest of the thread be removed so that the major diameter of the plug gage shall be less than that specified for the "go" plug gage and the minor diameter of the ring gage shall be greater than that specified for the "go" ring gage. A correspondingly greater relief should be provided at the root of the thread of the "not go" gage than of the "go" gage.

The truncation of the major diameter of the thread of the "not go" thread-plug gage, shall be such that the width of flat will be equal to $p/4$, and the truncation of the minor diameter of the thread of the "not go" thread-ring gage shall be such that the width of flat will be $3p/8$. (See "thread form of thread plug and ring gages," p. 50.) On account of manufacturing conditions incidental to the production of general purpose nuts it may be necessary, upon agreement between the manufacturer and the user, to modify this practice.

3. Gage Classification.—The limiting dimensions of the threaded parts to be produced should be represented in: (*a*) Gages used in checking the product as it is machined, known as "working gages"; (*b*) gages for use in the acceptance of the product, known as "inspection gages"; and (*c*) gages used to determine the accuracy of the two preceding classes of gages, known as "master gages".

4. Gages Used To Measure the Product.—The gages used to check the product may be divided into two general types: "Mechanical" and "optical." Both types, however, are controlled by the master gages. Most of the product accepted by one type of gaging with a correct gage will be accepted by the other. It should be pointed out, however, that those parts which are near either rejection point may be accepted by one system and rejected by the other.

(*a*) *Mechanical gages.*—Mechanical gages ordinarily comprise the inspection and working gages as above defined, and these two classes are generally of the same design. The dimensions of inspection gages are such that they represent very nearly the extreme limits of the part. It is recommended that, when successive inspections are required, the working gages, either by design or selection, be of such dimensions that they are inside the limits of the gages used in succeeding inspections.

Standard designs for certain types of mechanical gages are available in the report of the American Gage Design Committee, U S. Department of Commerce Commercial Standard No. CS8–41, "Gage Blanks." [9]

(*b*) *Optical gages.*—When gages of the optical type are employed the elements of wear and "feel" are not involved, but there may be observational errors.

[9] For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. 15¢.

5. Gages for Reference.—(*a*) *Master gage.*—The master gage is a thread-plug gage which represents the physical dimensions of the nominal or basic size of the part. It clearly establishes the minimum size of the threaded hole and the maximum size of the screw at the point at which interference between mating parts begins. A master gage shall be accompanied by a record of its measurement.

(*b*) *Setting gage* (*check gage*).—A setting gage is a thread-plug gage to which adjustable thread-ring gages, thread-snap gages, and other thread comparators are adjusted for size. Setting plugs of standard design are provided with a portion which is truncated at the major diameter and with a full portion, as specified in par. 2 (c), p. 50. In adjusting thread-ring gages to size, the setting plug gage controls the pitch diameter, and also assures that proper clearance is provided at the major diameter of the ring gage. The ring gage should be given further inspection to determine whether or not the minor diameter is within the specified limits. The minor diameter may be inspected by means of "go" and "not go" plain plug gages, and, if desired, the major diameter by optical examination of a sulphur-graphite, plaster-of-paris, copper amalgam, or other suitable cast of the thread.

6. Direction of Tolerances on Gages.—All gages used for the *production* of screw threads and "go" gages used for inspection are to be within the extreme limits of the product. The limiting dimensions specified for screw threads represent the extreme limitation of an acceptable product. The tolerances are those necessary to include all errors or variations in the sizes of *production* tools, gages, and all other manufacturing variations. However, in order to avoid needless controversy on parts close to the minimum metal sizes or "not go" limits, because of possible small differences in sizes of the gages used, the pitch diameter tolerances on all "not go" gages used for *final inspection* and for inspection of purchased product may be outside the product limits *if specifically authorized.* The Government is the authorizing agent when items such as bolts, nuts, gages, etc., are purchased on specified dimensional requirements. In the case of assembled machines purchased on a performance basis, such as automobiles, trucks, tanks, etc., the manufacturer or contractor is the authorizing agent, and, as such, is free to use such gages and gaging methods as he has found applicable and satisfactory.

7. Temperature at Which Gages Shall be Standard. — *The nominal dimensions of gages and product shall be correct at a temperature of 68° F (20° C).*—As gages and products are ordinarily checked at room temperature, whatever it may happen to be, it is desirable that the thermal coefficient of expansion of gages be the same as that of the product on which they are used. Inasmuch as the majority of threaded products consist of iron and steel, and as screw-thread gages are ordinarily made of hardened steel, because of its high wear-resisting qualities, this condition is ordinarily fulfilled without giving it special attention.

8. Measuring Pressure for Three-Wire Measurements.[10]—In measuring the pitch diameter of hardened screw-thread gages by means of wires, and in measuring the wires themselves, the same contact pressure should be used. A contact pressure of 1 pound is

[10] Methods of measuring pitch diameter of screw-thread gages are described and specifications for wires are given in appendix 2, p. 197.

recommended for pitches finer than 20 threads per inch and of 2½ pounds for 20 threads per inch and coarser. It is also recommended as standard practice that wires be measured between a flat contact and a cylindrical contact 0.750 inch in diameter. The contacts shall be of hardened steel, accurately ground and lapped.

(b) SPECIFICATIONS FOR GAGES

The following specifications are for the purpose of establishing definite limits for thread gages rather than for the purpose of specifying the gages required for the various inspection operations:

1. Classification of Gages, and Gage Tolerances.—Screw-thread gages for classes 1, 2, 3, and 4 are classified according to accuracy as W, X, and Y, the W gages being the most accurate. The tolerance limits on W and X gages coincide with the extreme product limits. The tolerance limits on Y "go" gages are placed inside of the extreme product limits to provide allowance for wear of the gages. The tolerances on all "not go" gages, however, are applied from the extreme product limit. The selection of gages from among these designations for use in the inspection of threaded product depends entirely upon the specifications for the product.

(*a*) *Master gages.*—These shall be plug gages made to the basic dimensions as accurately as possible. The variations from basic diameters shall be plus. Each master gage shall be marked with an identification number or symbol, and be accompanied by a record of its measurement, on major diameter, pitch diameter, lead, and angle. In case of question, the deviations of such gages from the exact standard shall be ascertained by the National Bureau of Standards, at Washington, D. C.

(*b*) *W gages.*—For the inspection of class 4 product, gages made within especially close limits are necessary. The tolerances for such gages, designated as W, are given in table 18.

(*c*) *X gages.*—X gages should be suitable for inspection and setting gages for classes 1, 2, and 3, except that in some cases W gages may be desirable for class 3 setting plugs. The tolerances on these gages are given in table 19. In all cases the tolerances for "go" gages shall be such that the gage does not fall outside of the component tolerances. When a thread-plug gage is used as the "go" gage for checking a tapped hole, it may be larger, but not smaller than the minimum size specified. On the other hand, when a thread-plug gage is used as the "go" setting plug for thread-ring gages or for optical or other comparators, it may be smaller, but never larger than the maximum size of the screw.

X tolerances, as given in table 19, are specified for all "not go" gages for classes 1, 2, and 3.

(*d*) *Y gages.*—Y "go" gages should be suitable for inspection and working gages for classes 1 and 2 fits, ¼ in. diameter and larger. For diameters less than ¼ in. X gages should be used. They may also be desired as working gages for classes 2 and 3 fits. The tolerances on these gages are given in table 20.

(*e*) *Tolerances on lead.*—The tolerances on lead given in tables 18 to 20, inclusive, are specified as an allowable variation between any two threads not farther apart than the length of engagement of the assembled threaded product.

(*f*) *Tolerances on angle of thread.*—The tolerances on angle of thread, as specified in tables 18 to 20, inclusive, for the various pitches, are tolerances on one half of the included angle. This insures that the bisector of the included angle will be perpendicular to the axis of the thread within proper limits. The equivalent deviation from the true thread form caused by such irregularities as convex or concave sides of thread, rounded crests, or slight projections on the thread form, should not exceed the tolerances permitted on angle of thread.

2. Thread Form of Thread Plug and Ring Gages.—(*a*) *"Go" thread gages.*—The major diameter of the "go" thread plug gage is the same as the basic major diameter, with a plus gage tolerance. The minor diameter of the "go" thread ring gage is the same as the minimum minor diameter of the nut or tapped hole with a minus gage tolerance.

A relief (which may be a sharp "V") is provided at the root of the "go" thread plug or ring gage, the width of which is not greater than one-eighth of the pitch.

(*b*) *"Not go" thread gages.*—The crest of the thread of the "not go" plug gage is truncated below its basic major diameter such an amount that the width of the flat at the crest will be equal to one fourth of the pitch, with a minus gage tolerance.

The crest of the thread of the "not go" ring gage is truncated above the basic minor diameter such an amount that the width of the flat at the crest will be equal to three eighths of the pitch, with a plus gage tolerance.

A relief (which in small diameters and fine pitches may be a sharp "V") is provided at the root of the "not go" thread plug or ring gage, the width of which is approximately one fourth of the pitch. Thus contact of the "not go" thread gage on the sides of the threads, rather than at the corners of the crest and root, is assured. Also the effect of angle error on the fit of the "not go" gage with the product is minimized. The above requirements are illustrated in figure 17.

(*c*) *Specifications for major diameter of truncated setting plugs.*—(1) The major diameter of the full portion of the "go" setting plug is basic American National form (one-eighth pitch flat) with plus tolerance.

(2) The major diameter of the truncated portion of the "go" setting plug is full American National form minus one third the basic thread depth with tolerance taken minus.

(3) The major diameter of the full portion of the "not go" setting plug shall be the same as that of the "go" thread setting plug of the same nominal size and having American National form with the exception that in no case shall the amount of truncation from theoretical V be less than 0.058 p. This latter condition might arise in the case of fine pitches and especially wide tolerances. Tolerance shall be taken minus.

(4) The major diameter of the truncated portion of the "not go" setting plug shall be full American National form minus one third the basic thread depth with the tolerance taken minus.

3. Recommended Gage Practice.—There are given in table 17 the recommended uses for the foregoing thread plug and ring gages. Tables 22, 23, 24, and 25 give limiting dimensions of gages of the several classifications for the American National coarse and American National fine thread series.

It is suggested that, in case of question between the manufacturer and purchaser of threaded products in regard to their size, if the manufacturer produces limit gages which do not measure outside of the specified limits for the threaded components and which pass the parts in question, they be accepted as meeting the specifications for size. In case the dimensions of the gages are questioned, their sizes

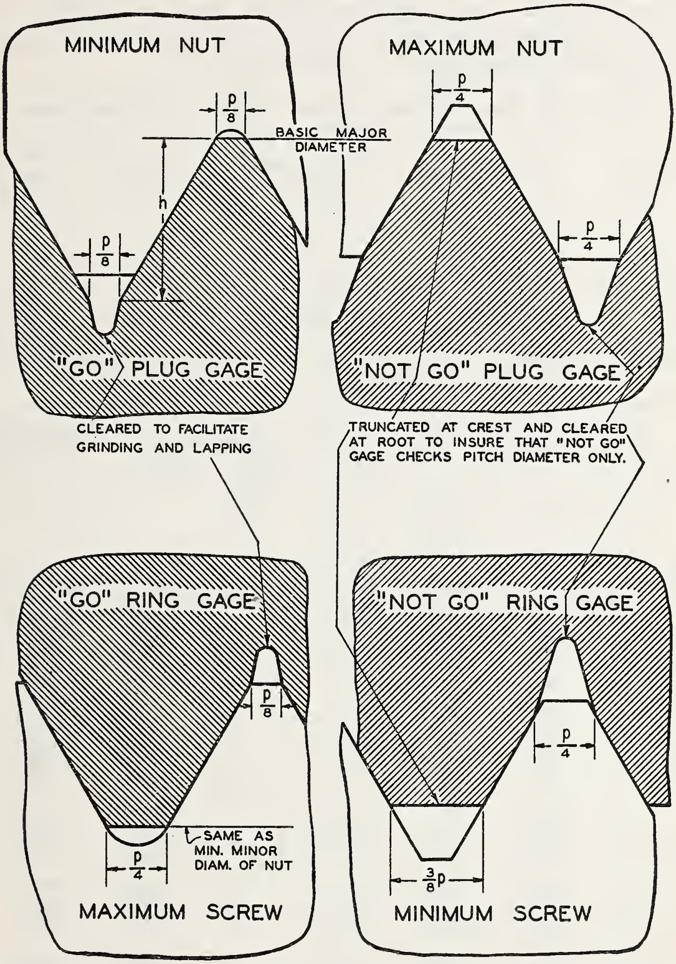

FIGURE 17.—*Thread form of "go" and "not go" thread plug and ring gages.*

shall be determined by a disinterested third party, preferably the National Bureau of Standards at Washington, D. C., which maintains a department for this service.

4. TOLERANCES FOR PLAIN GAGES.—For plain plug gages, plain ring gages, and plain adjustable snap gages required for measuring diameters of screw-thread work, the gage tolerances specified in table 21 should be used. These tolerances are designated X, Y, and Z.

Y and Z plain gages are suitable for working gages for gaging major and minor diameters of all classes of threaded product. For inspection gages Y tolerances are recommended.

5. Marking of Gages.—Each gage shall be plainly and permanently marked, for identification, with the diameter, pitch, thread series, and class of fit. See section II, division 3, "Symbols."

For example: A 1-inch, 8-pitch, gage of the American National coarse-thread series, class 2 fit, shall be marked 1″—8NC—2.

A 1-inch, 14-pitch gage of the American National fine-thread series, class 3 fit, shall be marked 1″—14NF—3.

Table 17.—*Recommended uses for W, X, and Y, thread gages*

Class of fit	All setting gages	"Go" inspection gage	"Go" working gage	All "not go" inspection and working gages
1	2	3	4	5
Class 1 fit	X, table 19	Y, table 20	Y, table 20	X, table 19.
Class 2 fit	do	do	do	Do.
Class 3 fit	W or X, tables 18, 19	X, table 19	X, table 19	Do.
Class 4 fit	W, table 18	W, table 18	W, table 18	W, table 18.

Table 18.—*Tolerances for W "go" and "not go" thread gages for class 4, and for W "go" setting plugs for class 3*

Threads per inch	Tolerance on pitch diameter [1]		Tolerance in lead [2]	Tolerance on half angle of thread		Total cumulative tolerance [3]	Tolerance on major or minor diameters	
	From—	To—					From—	To—
1	2	3	4	5		6	7	8
	Inch	*Inch*	*Inch* ±	*Deg.* ±	*Min.*	*Inch*	*Inch*	*Inch*
80	0.0000	0.0001	0.0001	0	20	0.00038	0.0000	0.0003
72	.0000	.0001	.0001	0	20	.00039	.0000	.0003
64	.0000	.0001	.0001	0	20	.00041	.0000	.0003
56	.0000	.0001	.0001	0	20	.00043	.0000	.0003
48	.0000	.0001	.0001	0	18	.00043	.0000	.0003
44	.0000	.0001	.0010	0	15	.00042	.0000	.0003
40	.0000	.0001	.0001	0	15	.00043	.0000	.0003
36	.0000	.0001	.0001	0	12	.00042	.0000	.0003
32	.0000	.0001	.0001	0	12	.00043	.0000	.0003
28	.0000	.0001	.00015	0	8	.00048	.0000	.0005
24	.0000	.0001	.00015	0	8	.00051	.0000	.0005
20	.0000	.0001	.00015	0	8	.00053	.0000	.0005
18	.0000	.0001	.00015	0	8	.00055	.0000	.0005
16	.0000	.0001	.00015	0	8	.00058	.0000	.0006
14	.0000	.00015	.0002	0	6	.00068	.0000	.0006
13	.0000	.00015	.0002	0	6	.00070	.0000	.0006
12	.0000	.00015	.0002	0	6	.00071	.0000	.0006
11	.0000	.00015	.0002	0	6	.00073	.0000	.0006
10	.0000	.0002	.00025	0	5	.00085	.0000	.0006
9	.0000	.0002	.00025	0	5	.00088	.0000	.0007
8	.0000	.0002	.00025	0	5	.00091	.0000	.0007
7	.0000	.00025	.0003	0	4	.00102	.0000	.0007
6	.0000	.00025	.0003	0	4	.00106	.0000	.0008
5	.0000	.00025	.0003	0	4	.00112	.0000	.0008
4½	.0000	.0003	.0003	0	4	.00121	.0000	.0008
4	.0000	.0003	.0003	0	4	.00126	.0000	.0009

[1] On "go" plugsthe tolerance is plus, and on "go" rings the tolerance is minus. On "not go" plugs the tolerance is minus but may be plus, and on "not go" rings the tolerance is plus but may be minus. See par. 6, p.48.

[2] Allowable variation in lead between any two threads not farther apart than the standard length of engagement, which is equal to the basic major diameter.

[3] The tolerance for one element, namely, pitch diameter, lead, or angle, as given above, may be exceeded provided that the errors in the other 2 elements are sufficiently small so that the total cumulative tolerance shown in column 6 is not exceeded.

TABLE 19.—*Tolerances for X "go" and "not go" thread gages for classes 1, 2, and 3*

Threads per inch	Tolerance on pitch diameter [1]		Tolerance in lead [2]	Tolerance on half angle of thread		Tolerance on major or minor diameters [1]	
	From—	To—				From—	To—
1	2	3	4	5		6	7
	Inch	*Inch*	*Inch* ±	*Deg.* ±	*Min.*	*Inch*	*Inch*
80	0.0000	0.0002	0.0002	0	30	0.0000	0.0003
72	.0000	.0002	.0002	0	30	.0000	.0003
64	.0000	.0002	.0002	0	30	.0000	.0004
56	.0000	.0002	.0002	0	30	.0000	.0004
48	.0000	.0002	.0002	0	30	.0000	.0004
44	.0000	.0002	.0002	0	20	.0000	.0004
40	.0000	.0002	.0002	0	20	.0000	.0004
36	.0000	.0002	.0002	0	20	.0000	.0004
32	.0000	.0003	.0003	0	15	.0000	.0004
28	.0000	.0003	.0003	0	15	.0000	.0005
24	.0000	.0003	.0003	0	15	.0000	.0005
20	.0000	.0003	.0003	0	15	.0000	.0005
18	.0000	.0003	.0003	0	10	.0000	.0005
16	.0000	.0003	.0003	0	10	.0000	.0006
14	.0000	.0003	.0003	0	10	.0000	.0006
13	.0000	.0003	.0003	0	10	.0000	.0006
12	.0000	.0003	.0003	0	10	.0000	.0006
11	.0000	.0003	.0003	0	10	.0000	.0006
10	.0000	.0003	.0003	0	10	.0000	.0006
9	.0000	.0003	.0003	0	10	.0000	.0007
8	.0000	.0004	.0004	0	5	.0000	.0007
7	.0000	.0004	.0004	0	5	.0000	.0007
6	.0000	.0004	.0004	0	5	.0000	.0008
5	.0000	.0004	.0004	0	5	.0000	.0008
4½	.0000	.0004	.0004	0	5	.0000	.0008
4	.0000	.0004	.0004	0	5	.0000	.0009

[1] On "go" plugs the tolerance is plus, and on "go" rings the tolerance is minus. On "not go" plugs the tolerance is minus, but may be plus, and on "not go" rings the tolerance is plus but may be minus. See par. 6, p. 48.

[2] Allowable variation in lead between any two threads not farther apart than the standard length of engagement, which is equal to the basic major diameter.

Table 20.—*Tolerances for Y "go" thread gages*

Threads per inch	Tolerance on pitch diameter [1]		Tolerance in lead [2]	Tolerance on half angle of thread	Tolerance on major or minor diameters [1]	
	From—	To—			From—	To—
1	2	3	4	5	6	7
	Inch	*Inch*	*Inch* ±	*Deg. Min.* ±	*Inch*	*Inch*
80	0.0001	0.0003	0.0002	0 45	0.0000	0.0003
72	.0001	.0003	.0002	0 45	.0000	.0003
64	.0001	.0004	.0002	0 45	.0000	.0004
56	.0001	.0004	.0002	0 45	.0000	.0004
48	.0001	.0004	.0002	0 45	.0000	.0004
44	.0001	.0004	.0002	0 30	.0000	.0004
40	.0001	.0004	.0002	0 30	.0000	.0004
36	.0001	.0004	.0002	0 30	.0000	.0004
32	.0001	.0004	0003	0 20	.0000	.0004
28	.0002	.0005	.0003	0 20	.0000	.0005
24	.0002	.0005	.0003	0 20	.0000	.0005
20	.0002	.0005	.0003	0 20	.0000	.0005
18	.0002	.0005	.0003	0 15	.0000	.0005
16	.0002	.0006	.0003	0 15	.0000	.0006
14	.0002	.0006	.0003	0 15	.0000	.0006
13	.0002	.0006	.0003	0 15	.0000	.0006
12	.0002	.0006	.0003	0 10	.0000	.0006
11	.0002	.0006	.0003	0 10	.0000	.0006
10	.0002	.0006	.0003	0 10	.0000	.0006
9	.0002	.0007	.0003	0 10	.0000	.0007
8	.0002	.0007	.0004	0 5	.0000	.0007
7	.0002	.0007	.0004	0 5	.0000	.0007
6	.0003	.0008	.0004	0 5	.0000	.0008
5	.0003	.0008	.0004	0 5	.0000	.0008
4½	.0003	.0008	.0004	0 5	.0000	.0008
4	.0003	.0009	.0004	0 5	.0000	.0009

1 On "go" plugs the tolerance is plus and on "go" rings the tolerance is minus.

2 Allowable variation in lead between any two threads not farther apart than the standard length of engagement, which is equal to the basic major diameter.

Table 21.—*Tolerances for plain gages* [1]

Size range		X	Y	Z
Above—	To and including—			
1	2	3	4	5
Inches	*Inches*	*Inch*	*Inch*	*Inch*
0.029	0.825	0.00004	0.00007	0.00010
.825	1.510	.00006	.00009	.00012
1.510	2.510	.00008	.00012	.00016
2.510	4.510	.00010	.00015	.00020
4.510	6.510	.00013	.00019	.00025
6.510	9.010	.00016	.00024	.00032
9.010	12.010	.00020	.00030	.00040

1 On "go" plugs the tolerance is plus, and on "go" rings the tolerance is minus.

TABLE 22.—*Limiting dimensions of setting plug and thread ring gages for screws of classes 1, 2, 3, and 4 fits, American National coarse-thread series*

Limiting dimensions			Machine screw number or nominal size: 1	2	3	4	5	6	8	10	12	¼	5⁄16
			Threads per inch: 64	56	48	40	40	32	32	24	24	20	18
"GO" GAGES FOR SCREWS			*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Major diameter of full-form setting plug	Class 1	Max	0.0727	0.0856	0.0985	0.1114	0.1244	0.1373	0.1633	0.1892	0.2152	0.2490	0.3114
		Min	.0723	.0852	.0981	.1110	.1240	.1369	.1629	.1887	.2147	.2485	.3109
	Classes 2 and 3.	Max	.0734	.0864	.0994	.1124	.1254	.1384	.1644	.1905	.2165	.2505	.3130
		Min	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
	Class 4	Max										.2508	.3133
		Min										.2503	.3128
Major diameter of truncated setting plug	Class 1	Max	.0689	.0813	.0936	.1056	.1186	.1301	.1561	.1797	.2057	.2377	.2989
		Min	.0685	.0809	.0932	.1052	.1182	.1297	.1557	.1792	.2052	.2372	.2984
	Classes 2 and 3.	Max	.0697	.0821	.0945	.1066	.1196	.1312	.1572	.1809	.2069	.2392	.3005
		Min	.0693	.0817	.0941	.1062	.1192	.1308	.1568	.1804	.2064	.2387	.3000
	Class 4	Max										.2395	.3008
		Min										.2390	.3003
Pitch diameter of setting plug or ring gage	Class 1	Max. X	.0622	.0736	.0846	.0948	.1078	.1166	.1426	.1616	.1876	.2160	.2748
		Min. X	.0620	.0734	.0844	.0946	.1076	.1163	.1423	.1613	.1873	.2157	.2745
		Max. Y										.2158	.2746
		Min. Y										.2155	.2743
	Classes 2 and 3.	Max. X	.0629	.0744	.0855	.0958	.1088	.1177	.1437	.1629	.1889	.2175	.2764
		Min. X	.0627	.0742	.0853	.0956	.1086	.1174	.1434	.1626	.1886	.2172	.2761
		Max. Y										.2173	.2762
		Min. Y										.2170	.2759
	Class 3	Max. W										.2175	.2764
		Min. W										.2174	.2763
	Class 4	Max. W										.2178	.2767
		Min. W										.2177	.2766
Minor diameter of ring gage	Classes 1, 2, 3, and 4.	Max	.0561	.0667	.0764	.0849	.0979	.1042	.1302	.1449	.1709	.1959	.2524
		Min	.0557	.0663	.0760	.0845	.0975	.1038	.1298	.1444	.1704	.1954	.2519

"Not Go" Gages for Screws

Major diameter of full-form setting plug	Class 1	Min	.0719	.0848	.0977	.1106	.1236	.1365	.1625	.1882	.2142	.2480	.3104
		Max	.0723	.0852	.0981	.1110	.1240	.1369	.1629	.1887	.2147	.2485	.3109
	Classes 2 and 3	Min	.0726	.0856	.0986	.1116	.1246	.1376	.1636	.1895	.2155	.2495	.3120
		Max	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
	Class 4	Min	----	----	----	----	----	----	----	----	----	.2498	.3123
		Max	----	----	----	----	----	----	----	----	----	.2503	.3128
Major diameter of truncated setting plug	Class 1	Min	.0660	.0781	.0901	.1018	.1148	.1259	.1519	.1745	.2005	.2321	.2927
		Max	.0664	.0785	.0905	.1022	.1152	.1263	.1523	.1750	.2010	.2326	.2932
	Class 2	Min	.0674	.0797	.0919	.1038	.1168	.1281	.1541	.1771	.2031	.2351	.2959
		Max	.0678	.0801	.0923	.1042	.1172	.1285	.1545	.1776	.2036	.2356	.2964
	Class 3	Min	.0679	.0802	.0925	.1045	.1175	.1289	.1549	.1780	.2040	.2361	.2970
		Max	.0683	.0806	.0929	.1049	.1179	.1293	.1553	.1785	.2045	.2366	.2975
	Class 4	Min	----	----	----	----	----	----	----	----	----	.2377	.2988
		Max	----	----	----	----	----	----	----	----	----	.2382	.2993
Pitch diameter of setting plug or ring gages for production and inspection.	Class 1	Min	.0596	.0708	.0815	.0914	.1044	.1128	.1388	.1570	.1830	.2109	.2691
		Max	.0598	.0710	.0817	.0916	.1046	.1131	.1391	.1573	.1833	.2112	.2694
	Class 2	Min	.0610	.0724	.0833	.0934	.1064	.1150	.1410	.1596	.1856	.2139	.2723
		Max	.0612	.0726	.0835	.0936	.1066	.1153	.1413	.1599	.1859	.2142	.2726
	Class 3	Min	.0615	.0729	.0839	.0941	.1071	.1158	.1418	.1605	.1865	.2149	.2734
		Max	.0617	.0731	.0841	.0943	.1073	.1161	.1421	.1608	.1868	.2152	.2737
	Class 4	Min	----	----	----	----	----	----	----	----	----	.2165	.2752
		Max	----	----	----	----	----	----	----	----	----	.2166	.2753
(OPTIONAL) Pitch diameter of setting plug or ring gages for inspection (see par. 6, p. 48).	Class 1	Min	.0594	.0706	.0813	.0912	.1042	.1125	.1385	.1567	.1827	.2106	.2688
		Max	.0596	.0708	.0815	.0914	.1044	.1128	.1388	.1570	.1830	.2109	.2691
	Class 2	Min	.0608	.0722	.0831	.0932	.1062	.1147	.1407	.1593	.1853	.2136	.2720
		Max	.0610	.0724	.0833	.0934	.1064	.1150	.1410	.1596	.1856	.2139	.2723
	Class 3	Min	.0613	.0727	.0837	.0939	.1069	.1155	.1415	.1602	.1862	.2146	.2731
		Max	.0615	.0729	.0839	.0941	.1071	.1158	.1418	.1605	.1865	.2149	.2734
	Class 4	Min	----	----	----	----	----	----	----	----	----	.2164	.2751
		Max	----	----	----	----	----	----	----	----	----	.2165	.2752
Minor diameter of ring gage	Class 1	Min	.0562	.0669	.0770	.0860	.0990	.1060	.1320	.1480	.1740	.2001	.2571
		Max	.0566	.0673	.0774	.0864	.0994	.1064	.1324	.1485	.1745	.2006	.2576
	Class 2	Min	.0576	.0685	.0788	.0880	.1010	.1082	.1342	.1506	.1766	.2031	.2603
		Max	.0580	.0689	.0792	.0884	.1014	.1086	.1346	.1511	.1771	.2036	.2608
	Class 3	Min	.0581	.0690	.0794	.0887	.1017	.1090	.1350	.1515	.1775	.2041	.2614
		Max	.0585	.0694	.0798	.0891	.1021	.1094	.1354	.1520	.1780	.2046	.2619
	Class 4	Min	----	----	----	----	----	----	----	----	----	.2057	.2632
		Max	----	----	----	----	----	----	----	----	----	.2062	.2637

TABLE 22.—*Limiting dimensions of setting plug and thread ring gages for screws of classes 1, 2, 3, and 4 fits, American National coarse-thread series*—Continued

Limiting dimensions			Size: 3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8
		Threads per inch	16	14	13	12	11	10	9	8	7	7	6
"GO" GAGES FOR SCREWS			*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*
Major diameter of full-form setting plug	Class 1	Max.	0.3738	0.4360	0.4984	0.5507	0.6230	0.7478	0.8726	0.9973	1.1218	1.2468	1.3714
		Min.	.3732	.4354	.4978	.5601	.6224	.7472	.8719	.9966	1.1211	1.2461	1.3706
	Classes 2 and 3.	Max.	.3756	.4381	.5006	.5631	.6256	.7506	.8757	1.0007	1.1257	1.2507	1.3758
		Min.	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750
	Class 4	Max.	.3760	.4385	.5010	.5636	.6261	.7512	.8763	1.0014	1.1265	1.2515	1.3767
		Min.	.3754	.4379	.5004	.5630	.6255	.7506	.8756	1.0007	1.1258	1.2508	1.3759
Major diameter of truncated setting plug	Class 1	Max.	.3597	.4199	.4811	.5421	.6027	.7255	.8478	0.9695	1.0902	1.2152	1.3345
		Min.	.3591	.4193	.4805	.5415	.6021	.7249	.8471	.9688	1.0895	1.2145	1.3337
	Classes 2 and 3.	Max.	.3615	.4220	.4833	.5445	.6054	.7283	.8509	.9729	1.0941	1.2191	1.3389
		Min.	.3609	.4214	.4827	.5439	.6048	.7277	.8502	.9722	1.0934	1.2184	1.3381
	Class 4	Max.	.3619	.4224	.4837	.5450	.6058	.7289	.8515	.9736	1.0949	1.2199	1.3398
		Min.	.3613	.4218	.4831	.5444	.6052	.7283	.8508	.9729	1.0942	1.2192	1.3390
Pitch diameter of setting plug or ring gage.	Class 1	Max X	.3326	.3890	.4478	.5060	.5634	.6822	.7997	.9154	1.0283	1.1533	1.2623
		Min. X	.3323	.3887	.4475	.5057	.5631	.6819	.7994	.9150	1.0279	1.1529	1.2619
		Max. Y	.3324	.3388	.4476	.5058	.5632	.6820	.7995	.9152	1.0281	1.1531	1.2620
		Min. Y	.3320	.3884	.4472	.5054	.5628	.6816	.7990	.9147	1.0276	1.1526	1.2615
	Classes 2 and 3.	Max. X	.3344	.3911	.4500	.5084	.5660	.6850	.8028	.9188	1.0322	1.1572	1.2667
		Min. X	.3341	.3908	.4497	.5081	.5657	.6847	.8025	.9184	1.0318	1.1568	1.2663
		Max. Y	.3342	.3909	.4498	.5082	.5658	.6848	.8026	.9186	1.0320	1.1570	1.2664
		Min. Y	.3338	.3905	.4494	.5078	.5654	.6844	.8021	.9181	1.0315	1.1565	1.2659
	Class 3	Max. W	.3344	.3911	.4500	.5084	.5660	.6850	.8028	.9188	1.0322	1.1572	1.2667
		Min. W	.3343	.39095	.44985	.50825	.56585	.6848	.8026	.9186	1.03195	1.15695	1.26645
	Class 4	Max. W	.3348	.3915	.4504	.5089	.5665	.6856	.8034	.9195	1.0330	1.1580	1.2676
		Min. W	.3347	.39135	.45025	.50875	.56635	.6854	.8032	.9193	1.03275	1.15775	1.26735
Minor diameter of ring gage	Classes 1, 2, 3, and 4.	Max.	.3073	.3602	.4167	.4723	.5266	.6417	.7547	.8647	0.9704	1.0954	1.1946
		Min.	.3067	.3596	.4161	.4717	.5260	.6411	.7540	.8640	.9697	1.0947	1.1938

"NOT GO" GAGES FOR SCREWS

Gage	Class	Limit											
Major diameter of full-form setting plug	Class 1	Min	.3726	.4348	.4972	.5595	.6218	.7466	.8712	.9959	1.1204	1.2454	1.3698
		Max	.3732	.4354	.4978	.5601	.6224	.7472	.8719	.9966	1.1211	1.2461	1.3706
	Classes 2 and 3	Min	.3744	.4369	.4994	.5619	.6244	.7494	.8743	.9993	1.1243	1.2493	1.3742
		Max	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750
	Class 4	Min	.3748	.4373	.4998	.5624	.6249	.7500	.8749	1.0000	1.1251	1.2501	1.3751
		Max	.3754	.4379	.5004	.5630	.6255	.7506	.8756	1.0007	1.1258	1.2508	1.3759
Major diameter of truncated setting plug	Class 1	Min	.3528	.4123	.4731	.5336	.5937	.7157	.8371	0.9577	1.0771	1.2021	1.3192
		Max	.3534	.4129	.4737	.5342	.5943	.7163	.8378	.9584	1.0778	1.2028	1.3200
	Class 2	Min	.3564	.4165	.4775	.5383	.5989	.7213	.8432	.9646	1.0849	1.2099	1.3280
		Max	.3570	.4171	.4781	.5389	.5995	.7219	.8439	.9653	1.0856	1.2106	1.3288
	Class 3	Min	.3577	.4178	.4790	.5399	.6006	.7232	.8453	.9668	1.0875	1.2125	1.3310
		Max	.3583	.4184	.4796	.5405	.6012	.7238	.8460	.9675	1.0882	1.2132	1.3318
	Class 4	Min	.3597	.4200	.4812	.5424	.6032	.7260	.8484	.9702	1.0912	1.2162	1.3354
		Max	.3603	.4206	.4818	.5430	.6038	.7266	.8491	.9709	1.0919	1.2169	1.3362
Pitch diameter of setting plug or ring gages for production and inspection.	Class 1	Min	.3263	.3820	.4404	.4981	.5549	.6730	.7897	.9043	1.0159	1.1409	1.2478
		Max	.3266	.3823	.4407	.4984	.5552	.6733	.7900	.9047	1.0163	1.1413	1.2482
	Class 2	Min	.3299	.3862	.4448	.5028	.5601	.6786	.7958	.9112	1.0237	1.1487	1.2566
		Max	.3302	.3865	.4451	.5031	.5604	.6789	.7961	.9116	1.0241	1.1491	1.2570
	Class 3	Min	.3312	.3875	.4463	.5044	.5618	.6805	.7979	.9134	1.0263	1.1513	1.2596
		Max	.3315	.3878	.4466	.5047	.5621	.6808	.7982	.9138	1.0267	1.1517	1.2690
	Class 4	Min	.3332	.3897	.4485	.5069	.5644	.6833	.8010	.9168	1.0300	1.1550	1.2640
		Max	.3333	.38985	.44865	.50705	.56455	.6835	.8012	.9170	1.03025	1.15525	1.26425
(OPTIONAL) Pitch diameter of setting plug or ring gages for inspection (see par. 6, p. 48)	Class 1	Min	.3260	.3817	.4401	.4978	.5546	.6727	.7894	.9039	1.0155	1.1405	1.2474
		Max	.3263	.3820	.4404	.4981	.5549	.6730	.7897	.9043	1.0159	1.1409	1.2478
	Class 2	Min	.3296	.3859	.4445	.5025	.5598	.6783	.7955	.9108	1.0233	1.1483	1.2562
		Max	.3299	.3862	.4448	.5028	.5601	.6786	.7958	.9112	1.0237	1.1487	1.2566
	Class 3	Min	.3309	.3872	.4460	.5041	.5615	.6802	.7976	.9130	1.0259	1.1509	1.2592
		Max	.3312	.3875	.4463	.5044	.5618	.6805	.7979	.9134	1.0263	1.1513	1.2596
	Class 4	Min	.3331	.38955	.44835	.50675	.56425	.6831	.8008	.9166	1.02975	1.15475	1.26375
		Max	.3332	.3897	.4485	.5069	.5644	.6833	.8010	.9168	1.0300	1.1550	1.2640
Minor diameter of ring gage	Class 1	Min	.3128	.3665	.4238	.4801	.5352	.6514	.7656	.8772	0.9850	1.1100	1.2117
		Max	.3134	.3671	.4244	.4807	.5358	.6520	.7663	.8779	.9857	1.1107	1.2125
	Class 2	Min	.3164	.3707	.4282	.4848	.5404	.6570	.7717	.8841	.9928	1.1178	1.2205
		Max	.3170	.3713	.4288	.4854	.5410	.6576	.7724	.8848	.9935	1.1185	1.2213
	Class 3	Min	.3177	.3720	.4297	.4864	.5421	.6589	.7738	.8863	.9954	1.1204	1.2235
		Max	.3183	.3726	.4303	.4870	.5427	.6595	.7745	.8870	.9961	1.1211	1.2243
	Class 4	Min	.3197	.3742	.4319	.4889	.5447	.6617	.7769	.8897	.9991	1.1241	1.2279
		Max	.3203	.3748	.4325	.4895	.5453	.6623	.7776	.8904	.9998	1.1248	1.2287

Table 22.—*Limiting dimensions of setting plug and thread ring gages for screws of classes 1, 2, 3, and 4 fits, American National coarse-thread series*—Continued

Limiting dimensions			Size 1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4
			Threads per inch										
			6	5	4½	4½	4	4	4	4	4	4	4
"Go" Gages for Screws			*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter of full-form setting plug	Class 1	Max	1.4964	1.7456	1.9951	2.2451	2.4945	2.7445	2.9945	3.2445	3.4945	3.7445	3.9945
		Min	1.4956	1.7448	1.9943	2.2443	2.4936	2.7436	2.9936	3.2436	3.4936	3.7436	3.9936
	Classes 2 and 3	Max	1.5008	1.7508	2.0008	2.2508	2.5009	2.7509	3.0009	3.2509	3.5009	3.7509	4.0009
		Min	1.5000	1.7500	2.0000	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
	Class 4	Max	1.5017	1.7518	2.0019	2.2519	2.5022	2.7522	3.0022	3.2522	3.5022	3.7522	4.0022
		Min	1.5009	1.7510	2.0011	2.2511	2.5013	2.7513	3.0013	3.2513	3.5013	3.7513	4.0013
Major diameter of truncated setting plug.	Class 1	Max	1.4595	1.7015	1.9462	2.1962	2.4395	2.6895	2.9395	3.1895	3.4395	3.6895	3.9395
		Min	1.4587	1.7007	1.9454	2.1954	2.4386	2.6886	2.9386	3.1886	3.4386	3.6886	3.9386
	Classes 2 and 3	Max	1.4639	1.7067	1.9519	2.2019	2.4459	2.6959	2.9459	3.1959	3.4459	3.6959	3.9459
		Min	1.4631	1.7059	1.9511	2.2011	2.4450	2.6950	2.9450	3.1950	3.4450	3.6950	3.9450
	Class 4	Max	1.4648	1.7077	1.9530	2.2030	2.4472	2.6972	2.9472	3.1972	3.4472	3.6972	3.9472
		Min	1.4640	1.7069	1.9522	2.2022	2.4463	2.6963	2.9463	3.1963	3.4463	3.6963	3.9463
Pitch diameter of setting plug or ring gage	Class 1	Max. X	1.3873	1.6149	1.8500	2.1000	2.3312	2.5812	2.8312	3.0812	3.3312	3.5812	3.8312
		Min. X	1.3869	1.6145	1.8496	2.0996	2.3308	2.5808	2.8308	3.0808	3.3308	3.5808	3.8308
		Max. Y	1.3870	1.6146	1.8497	2.0997	2.3309	2.5809	2.8309	3.0809	3.3309	3.5809	3.8309
		Min. Y	1.3865	1.6141	1.8492	2.0992	2.3303	2.5803	2.8303	3.0803	3.3303	3.5803	3.8303
	Classes 2 and 3	Max. X	1.3917	1.6201	1.8557	2.1057	2.3376	2.5876	2.8376	3.0876	3.3376	3.5876	3.8376
		Min. X	1.3913	1.6197	1.8553	2.1053	2.3372	2.5872	2.8372	3.0872	3.3372	3.5872	3.8372
		Max. Y	1.3914	1.6198	1.8554	2.1054	2.3373	2.5873	2.8373	3.0873	3.3373	3.5873	3.8373
		Min. Y	1.3909	1.6193	1.8549	2.1049	2.3367	2.5867	2.8367	3.0867	3.3367	3.5867	3.8367
	Class 3	Max. W	1.3917	1.6201	1.8557	2.1057	2.3376	2.5876	2.8376	3.0876	3.3376	3.5876	3.8376
		Min. W	1.39145	1.61985	1.8554	2.1054	2.3373	2.5873	2.8373	3.0873	3.3373	3.5873	3.8373
	Class 4	Max. W	1.3926	1.6211	1.8568	2.1068	2.3389	2.5889	2.8389	3.0889	3.3389	3.5889	3.8389
		Min. W	1.39235	1.62085	1.8565	2.1065	2.3386	2.5886	2.8386	3.0886	3.3386	3.5886	3.8386
Minor diameter of ring gage	Classes 1, 2, 3, and 4	Max	1.3196	1.5335	1.7594	2.0094	2.2294	2.4794	2.7294	2.9794	3.2294	3.4794	3.7294
		Min	1.3188	1.5327	1.7586	2.0086	2.2285	2.4785	2.7285	2.9785	3.2285	3.4785	3.7285

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Major diameter of full-form setting plug	Class 1	Min	1. 4948	1. 7440	1. 9935	2. 2435	2. 4927	2. 7427	2. 9927	3. 2427	3. 4927	3. 7427	3. 9927
		Max	1. 4956	1. 7448	1. 9943	2. 2443	2. 4936	2. 7436	2. 9936	3. 2436	3. 4936	3. 7436	3. 9936
	Classes 2 and 3	Min	1. 4992	1. 7492	1. 9992	2. 2492	2. 4991	2. 7491	2. 9991	3. 2491	3. 4991	3. 7491	3. 9991
		Max	1. 5000	1. 7500	2. 0000	2. 2500	2. 5000	2. 7500	3. 0000	3. 2500	3. 5000	3. 7500	4. 0000
	Class 4	Min	1. 5001	1. 7502	2. 0003	2. 2503	2. 5004	2. 7504	3. 0004	3. 2504	3. 5004	3. 7504	4. 0004
		Max	1. 5009	1. 7510	2. 0011	2. 2511	2. 5013	2. 7513	3. 0013	3. 2513	3. 5013	3. 7513	4. 0013
Major diameter of truncated setting plug	Class 1	Min	1. 4442	1. 6838	1. 9270	2. 1770	2. 4182	2. 6682	2. 9182	3. 1682	3. 4182	3. 6682	3. 9182
		Max	1. 4450	1. 6846	1. 9278	2. 1778	2. 4191	2. 6691	2. 9191	3. 1691	3. 4191	3. 6691	3. 9191
	Class 2	Min	1. 4530	1. 6943	1. 9384	2. 1884	2. 4310	2. 6810	2. 9310	3. 1810	3. 4310	3. 6810	3. 9310
		Max	1. 4538	1. 6951	1. 9392	2. 1892	2. 4319	2. 6819	2. 9319	3. 1819	3. 4319	3. 6819	3. 9319
	Class 3	Min	1. 4560	1. 6977	1. 9422	2. 1922	2. 4353	2. 6853	2. 9353	3. 1853	3. 4353	3. 6853	3. 9353
		Max	1. 4568	1. 6985	1. 9430	2. 1930	2. 4362	2. 6862	2. 9362	3. 1862	3. 4362	3. 6862	3. 9362
	Class 4	Min	1. 4604	1. 7028	1. 9478	2. 1978	2. 4415	2. 6915	2. 9415	3. 1915	3. 4415	3. 6915	3. 9415
		Max	1. 4612	1. 7036	1. 9486	2. 1986	2. 4424	2. 6924	2. 9424	3. 1924	3. 4424	3. 6924	3. 9424
Pitch diameter of setting plug or ring gages for production and inspection.	Class 1	Min	1. 3728	1. 5980	1. 8316	2. 0816	2. 3108	2. 5608	2. 8108	3. 0608	3. 3108	3. 5608	3. 8108
		Max	1. 3732	1. 5984	1. 8320	2. 0820	2. 3112	2. 5612	2. 8112	3. 0612	3. 3112	3. 5612	3. 8112
	Class 2	Min	1. 3816	1. 6085	1. 8430	2. 0930	2. 3236	2. 5736	2. 8236	3. 0736	3. 3236	3. 5736	3. 8236
		Max	1. 3820	1. 6089	1. 8434	2. 0934	2. 3240	2. 5740	2. 8240	3. 0740	3. 3240	3. 5740	3. 8240
	Class 3	Min	1. 3846	1. 6119	1. 8468	2. 0968	2. 3279	2. 5779	2. 8279	3. 0779	3. 3279	3. 5779	3. 8279
		Max	1. 3850	1. 6123	1. 8472	2. 0972	2. 3283	2. 5783	2. 8283	3. 0783	3. 3283	3. 5783	3. 8283
	Class 4	Min	1. 3890	1. 6170	1. 8524	2. 1024	2. 3341	2. 5841	2. 8341	3. 0841	3. 3341	3. 5841	3. 8341
		Max	1. 38925	1. 61725	1. 8527	2. 1027	2. 3344	2. 5844	2. 8344	3. 0844	3. 3344	3. 5844	3. 8344
(OPTIONAL) Pitch diameter of setting plug or ring gages for inspection. (See par. 6, p. 48.)	Class 1	Min	1. 3724	1. 5976	1. 8312	2. 0812	2. 3104	2. 5604	2. 8104	3. 0604	3. 3104	3. 5604	3. 8104
		Max	1. 3728	1. 5980	1. 8316	2. 0816	2. 3108	2. 5608	2. 8108	3. 0608	3. 3108	3. 5608	3. 8108
	Class 2	Min	1. 3812	1. 6081	1. 8426	2. 0926	2. 3232	2. 5732	2. 8232	3. 0732	3. 3232	3. 5732	3. 8232
		Max	1. 3816	1. 6085	1. 8430	2. 0930	2. 3236	2. 5736	2. 8236	3. 0736	3. 3236	3. 5736	3. 8236
	Class 3	Min	1. 3842	1. 6115	1. 8464	2. 0964	2. 3275	2. 5775	2. 8275	3. 0775	3. 3275	3. 5775	3. 8275
		Max	1. 3846	1. 6119	1. 8468	2. 0968	2. 3279	2. 5779	2. 8279	3. 0779	3. 3279	3. 5779	3. 8279
	Class 4	Min	1. 38875	1. 61675	1. 8521	2. 1021	2. 3338	2. 5838	2. 8338	3. 0838	3. 3338	3. 5838	3. 8338
		Max	1. 3890	1. 6170	1. 8524	2. 1024	2. 3341	2. 5841	2. 8341	3. 0841	3. 3341	3. 5841	3. 8341
Minor diameter of ring gage	Class 1	Min	1. 3367	1. 5547	1. 7835	2. 0335	2. 2567	2. 5067	2. 7567	3. 0067	3. 2567	3. 5067	3. 7567
		Max	1. 3375	1. 5555	1. 7843	2. 0343	2. 2576	2. 5076	2. 7576	3. 0076	3. 2576	3. 5076	3. 7576
	Class 2	Min	1. 3455	1. 5652	1. 7949	2. 0449	2. 2695	2. 5195	2. 7695	3. 0195	3. 2695	3. 5195	3. 7695
		Max	1. 3463	1. 5660	1. 7957	2. 0457	2. 2704	2. 5204	2. 7704	3. 0204	3. 2704	3. 5204	3. 7704
	Class 3	Min	1. 3485	1. 5686	1. 7987	2. 0487	2. 2738	2. 5238	2. 7738	3. 0238	3. 2738	3. 5238	3. 7738
		Max	1. 3493	1. 5694	1. 7995	2. 0495	2. 2747	2. 5247	2. 7747	3. 0247	3. 2747	3. 5247	3. 7747
	Class 4	Min	1. 3529	1. 5737	1. 8043	2. 0543	2. 2800	2. 5300	2. 7800	3. 0300	3. 2800	3. 5300	3. 7800
		Max	1. 3537	1. 5745	1. 8051	2. 0551	2. 2809	2. 5309	2. 7809	3. 0309	3. 2809	3. 5309	3. 7809

TABLE 23.—*Limiting dimensions of setting plug and thread ring gages for screws of classes 1, 2, 3, and 4 fits, American National fine-thread series*

Limiting dimensions			0	1	2	3	4	5	6	8	10	12	¼	5/16
		Threads per inch	80	72	64	56	48	44	40	36	32	28	28	24
"GO" GAGES FOR SCREWS			*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Major diameter of full-form setting plug.	Class 1	Max	0.0596	0.0726	0.0857	0.0986	0.1115	0.1245	0.1374	0.1633	0.1893	0.2153	0.2493	0.3117
		Min	.0593	.0723	.0853	.0982	.1111	.1241	.1370	.1629	.1889	.2148	.2488	.3112
	Classes 2 and 3.	Max	.0603	.0733	.0864	.0994	.1124	.1254	.1384	.1644	.1904	.2165	.2505	.3130
		Min	.0600	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
	Class 4	Max											.2507	.3133
		Min											.2502	.3128
Major diameter of truncated setting plug.	Class 1	Max	.0566	.0693	.0820	.0943	.1066	.1191	.1316	.1569	.1821	.2071	.2411	.3021
		Min	.0563	.0690	.0816	.0939	.1062	.1187	.1312	.1565	.1817	.2066	.2406	.3016
	Classes 2 and 3.	Max	.0573	.0700	.0827	.0951	.1075	.1200	.1326	.1580	.1832	.2083	.2423	.3034
		Min	.0570	.0697	.0823	.0947	.1071	.1196	.1322	.1576	.1828	.2078	.2418	.3029
	Class 4	Max											.2425	.3037
		Min											.2420	.3032
Pitch diameter of setting plug or ring gage.	Class 1	Max. X	.0512	.0633	.0752	.0866	.0976	.1093	.1208	.1449	.1686	.1916	.2256	.2841
		Min. X	.0510	.0631	.0750	.0864	.0974	.1091	.1206	.1447	.1683	.1913	.2253	.2838
		Max. Y											.2254	.2839
		Min. Y											.2251	.2836
	Classes 2 and 3.	Max. X	.0519	.0640	.0759	.0874	.0985	.1102	.1218	.1460	.1697	.1928	.2268	.2854
		Min. X	.0517	.0638	.0757	.0872	.0983	.1100	.1216	.1458	.1694	.1925	.2265	.2851
		Max. Y											.2266	.2852
		Min. Y											.2263	.2849
	Class 3	Max. W											.2268	.2854
		Min. W											.2267	.2853
	Class 4	Max. W											.2270	.2857
		Min. W											.2269	.2856
Minor diameter of ring gage	Classes 1, 2, 3, and	Max	.0465	.0580	.0691	.0797	.0894	.1004	.1109	.1339	.1562	.1773	.2113	.2674
		Min	.0462	.0577	.0687	.0793	.0890	.1000	.1105	.1335	.1558	.1768	.2108	.2669

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Major diameter of full-form setting plug.	Class 1	Min	.0590	.0720	.0849	.0978	.1107	.1237	.1366	.1625	.1885	.2143	.2483	.3107
		Max	.0593	.0723	.0853	.0982	.1111	.1241	.1370	.1629	.1889	.2148	.2488	.3112
	Classes 2 and 3.	Min	.0597	.0727	.0856	.0986	.1116	.1246	.1376	.1636	.1896	.2155	.2495	.3120
		Max	.0600	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
	Class 4	Min											.2497	.3123
		Max											.2502	.3128
Major diameter of truncated setting plug.	Class 1	Min	.0539	.0665	.0790	.0911	.1031	.1155	.1278	.1529	.1779	.2023	.2363	.2970
		Max	.0542	.0668	.0794	.0915	.1035	.1159	.1282	.1533	.1783	.2028	.2368	.2975
	Class 2	Min	.0553	.0679	.0804	.0927	.1049	.1173	.1298	.1551	.1801	.2047	.2387	.2996
		Max	.0556	.0682	.0808	.0931	.1053	.1177	.1302	.1555	.1805	.2052	.2392	.3001
	Class 3	Min	.0557	.0684	.0809	.0932	.1055	.1180	.1305	.1558	.1809	.2056	.2396	.3005
		Max	.0560	.0687	.0813	.0936	.1059	.1184	.1309	.1562	.1813	.2061	.2401	.3010
	Class 4	Min											.2409	.3020
		Max											.2414	.3025
Pitch diameter of setting plug and ring gages for production and inspection.	Class 1	Min	.0488	.0608	.0726	.0838	.0945	.1061	.1174	.1413	.1648	.1873	.2213	.2795
		Max	.0490	.0610	.0728	.0840	.0947	.1063	.1176	.1415	.1651	.1876	.2216	.2798
	Class 2	Min	.0502	.0622	.0740	.0854	.0963	.1079	.1194	.1435	.1670	.1897	.2237	.2821
		Max	.0504	.0624	.0742	.0856	.0965	.1081	.1196	.1437	.1673	.1900	.2240	.2824
	Class 3	Min	.0506	.0627	.0745	.0859	.0969	.1086	.1201	.1442	.1678	.1906	.2246	.2830
		Max	.0508	.0629	.0747	.0861	.0971	.1088	.1203	.1444	.1681	.1909	.2249	.2833
	Class 4	Min											.2259	.2845
		Max											.2260	.2846
(OPTIONAL) Pitch diameter of setting plug and ring gages for inspection. (See par. 6, p. 48.)	Class 1	Min	.0486	.0606	.0724	.0836	.0943	.1059	.1172	.1411	.1645	.1870	.2210	.2792
		Max	.0488	.0608	.0726	.0838	.0945	.1061	.1174	.1413	.1648	.1873	.2213	.2795
	Class 2	Min	.0500	.0620	.0738	.0852	.0961	.1077	.1192	.1433	.1667	.1894	.2234	.2818
		Max	.0502	.0622	.0740	.0854	.0963	.1079	.1194	.1435	.1670	.1897	.2237	.2821
	Class 3	Min	.0504	.0625	.0743	.0857	.0967	.1084	.1199	.1440	.1675	.1903	.2243	.2327
		Max	.0506	.0627	.0745	.0859	.0969	.1086	.1201	.1442	.1678	.1906	.2246	.2830
	Class 4	Min											.2258	.2844
		Max											.2259	.2845
Minor diameter of ring gage	Class 1	Min	.0466	.0581	.0692	.0799	.0900	.1012	.1120	.1353	.1580	.1796	.2136	.2705
		Max	.0469	.0584	.0696	.0803	.0904	.1016	.1124	.1357	.1584	.1801	.2141	.2710
	Class 2	Min	.0475	.0592	.0706	.0815	.0918	.1030	.1140	.1375	.1602	.1820	.2160	.2731
		Max	.0478	.0595	.0710	.0819	.0922	.1034	.1144	.1379	.1606	.1825	.2165	.2736
	Class 3	Min	.0479	.0597	.0711	.0820	.0924	.1037	.1147	.1382	.1610	.1829	.2169	.2740
		Max	.0482	.0600	.0715	.0824	.0928	.1041	.1151	.1386	.1614	.1834	.2174	.2745
	Class 4	Min											.2182	.2755
		Max											.2187	.2760

TABLE 23.—*Limiting dimensions of setting plug and thread ring gages for screws of classes 1, 2, 3, and 4 fits, American National fine-thread series*—Continued

Limiting dimensions			3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
		Threads per inch	24	20	20	18	18	16	14	14	12	12	12	12
"GO" GAGES FOR SCREWS			*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter of full-form setting plug.	Class 1	Max	0.3742	0.4365	0.4990	0.5614	0.6239	0.7488	0.8735	0.9985	1.1232	1.2482	1.3732	1.4982
		Min	.3737	.4360	.4985	.5609	.6234	.7482	.8729	.9979	1.1226	1.2476	1.3726	1.4976
	Classes 2 and 3.	Max	.3755	.4380	.5005	.5630	.6255	.7506	.8756	1.0006	1.1256	1.2506	1.3756	1.5006
		Min	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000
	Class 4	Max	.3758	.4383	.5008	.5633	.6258	.7510	.8760	1.0010	1.1261	1.2511	1.3761	1.5011
		Min	.3753	.4378	.5003	.5628	.6253	.7504	.8754	1.0004	1.1255	1.2505	1.3755	1.5005
Major diameter of truncated setting plug.	Class 1	Max	.3646	.4252	.4877	.5489	.6114	.7347	.8574	0.9824	1.1046	1.2296	1.3546	1.4796
		Min	.3641	.4247	.4872	.5484	.6109	.7341	.8568	.9818	1.1040	1.2290	1.3540	1.4790
	Classes 2 and 3.	Max	.3659	.4267	.4892	.5505	.6130	.7365	.8595	.9845	1.1070	1.2320	1.3570	1.4820
		Min	.3654	.4262	.4887	.5500	.6125	.7359	.8589	.9839	1.1064	1.2314	1.3564	1.4814
	Class 4	Max	.3662	.4270	.4895	.5508	.6133	.7369	.8599	.9849	1.1075	1.2325	1.3575	1.4825
		Min	.3657	.4265	.4890	.5503	.6128	.7363	.8593	.9843	1.1069	1.2319	1.3569	1.4819
Pitch diameter of setting plug or ring gage.	Class 1	Max. X	.3466	.4035	.4660	.5248	.5873	.7076	.8265	.9515	1.0685	1.1935	1.3185	1.4435
		Min. X	.3463	.4032	.4657	.5245	.5870	.7073	.8262	.9512	1.0682	1.1932	1.3182	1.4432
		Max. Y	.3464	.4033	.4658	.5246	.5871	.7074	.8263	.9513	1.0683	1.1933	1.3183	1.4433
		Min. Y	.3461	.4030	.4655	.5243	.5868	.7070	.8259	.9509	1.0679	1.1929	1.3179	1.4429
	Classes 2 and 3.	Max. X	.3479	.4050	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
		Min. X	.3476	.4047	.4672	.5261	.5886	.7091	.8283	.9533	1.0706	1.1956	1.3206	1.4456
		Max. Y	.3477	.4048	.4673	.5262	.5887	.7092	.8284	.9534	1.0707	1.1957	1.3207	1.4457
		Min. Y	.3474	.4045	.4670	.5259	.5884	.7088	.8280	.9530	1.0703	1.1953	1.3203	1.4453
	Class 3	Max. W	.3479	.4050	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
		Min. W	.3478	.4049	.4674	.5263	.5888	.7093	.82845	.95345	1.07075	1.19575	1.32075	1.44575
	Class 4	Max. W	.3482	.4053	.4678	.5267	.5892	.7098	.8290	.9540	1.0714	1.1964	1.3214	1.4464
		Min. W	.3481	.4052	.4677	.5266	.5891	.7097	.82885	.95385	1.07125	1.19625	1.32125	1.44625
Minor diameter of ring gage	Classes 1, 2, 3, and 4.	Max	.3299	.3834	.4459	.5024	.5649	.6823	.7977	.9227	1.0348	1.1598	1.2848	1.4098
		Min	.3294	.3829	.4454	.5019	.5644	.6817	.7971	.9221	1.0342	1.1592	1.2842	1.4092

"NOT GO" GAGES FOR SCREWS

Major diameter of full-form setting plug.	Class 1	Min	.3732	.4355	.4980	.5604	.6229	.7476	.8723	.9973	1.1220	1.2470	1.3720	1.4970
		Max	.3737	.4360	.4985	.5609	.6234	.7482	.8729	.9979	1.1226	1.2476	1.3726	1.4976
	Classes 2 and 3.	Min	.3745	.4370	.4995	.5620	.6245	.7494	.8744	.9994	1.1244	1.2494	1.3744	1.4994
		Max	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000
	Class 4	Min	.3748	.4373	.4998	.5623	.6247	.7498	.8748	0.9998	1.1249	1.2499	1.3749	1.4999
		Max	.3753	.4378	.5003	.5628	.6253	.7504	.8754	1.0004	1.1255	1.2505	1.3755	1.5005
Major diameter of truncated setting plug.	Class 1	Min	.3595	.4196	.4821	.5427	.6052	.7278	.8498	0.9748	1.0961	1.2211	1.3461	1.4711
		Max	.3600	.4201	.4826	.5432	.6057	.7284	.8504	.9754	1.0967	1.2217	1.3467	1.4717
	Class 2	Min	.3621	.4226	.4851	.5459	.6084	.7314	.8540	.9790	1.1008	1.2258	1.3508	1.4758
		Max	.3626	.4231	.4856	.5464	.6089	.7320	.8546	.9796	1.1014	1.2264	1.3514	1.4764
	Class 3	Min	.3630	.4236	.4861	.5470	.6095	.7327	.8553	.9803	1.1024	1.2274	1.3524	1.4774
		Max	.3635	.4241	.4866	.5475	.6100	.7333	.8559	.9809	1.1030	1.2280	1.3530	1.4780
	Class 4	Min	.3645	.4252	.4877	.5488	.6113	.7347	.8575	.9825	1.1049	1.2299	1.3549	1.4799
		Max	.3650	.4257	.4882	.5493	.6118	.7353	.8581	.9831	1.1055	1.2305	1.3555	1.4805
Pitch diameter of setting plug and ring gages for production and inspection.	Class 1	Min	.3420	.3984	.4609	.5191	.5816	.7013	.8195	.9445	1.0606	1.1856	1.3106	1.4356
		Max	.3423	.3987	.4612	.5194	.5819	.7016	.8198	.9448	1.0609	1.1859	1.3109	1.4359
	Class 2	Min	.3446	.4014	.4639	.5223	.5848	.7049	.8237	.9487	1.0653	1.1903	1.3153	1.4403
		Max	.3449	.4017	.4642	.5226	.5851	.7052	.8240	.9490	1.0656	1.1906	1.3156	1.4406
	Class 3	Min	.3455	.4024	.4649	.5234	.5859	.7062	.8250	.9500	1.0669	1.1919	1.3169	1.4419
		Max	.3458	.4027	.4652	.5237	.5862	.7065	.8253	.9503	1.0672	1.1922	1.3172	1.4422
	Class 4	Min	.3470	.4040	.4665	.5252	.5877	.7082	.8272	.9522	1.0694	1.1944	1.3194	1.4444
		Max	.3471	.4041	.4666	.5253	.5878	.7083	.82735	.95235	1.06955	1.19455	1.31955	1.4445
(OPTIONAL) Pitch diameter of setting plug and ring gages for inspection. See par. 6, p. 48.)	Class 1	Min	.3417	.3981	.4606	.5188	.5813	.7010	.8192	.9442	1.0603	1.1853	1.3103	1.4353
		Max	.3420	.3984	.4609	.5191	.5816	.7013	.8195	.9445	1.0606	1.1856	1.3106	1.4356
	Class 2	Min	.3443	.4011	.4636	.5220	.5845	.7046	.8234	.9484	1.0650	1.1900	1.3150	1.4400
		Max	.3446	.4014	.4639	.5223	.5848	.7049	.8237	.9487	1.0653	1.1903	1.3153	1.4403
	Class 3	Min	.3452	.4021	.4646	.5231	.5856	.7059	.8247	.9497	1.0666	1.1916	1.3166	1.4416
		Max	.3455	.4024	.4649	.5234	.5859	.7062	.8250	.9500	1.0669	1.1919	1.3169	1.4419
	Class 4	Min	.3469	.4039	.4664	.5251	.5876	.7081	.82705	.95205	1.06925	1.19425	1.31925	1.44425
		Max	.3470	.4040	.4665	.5252	.5877	.7082	.8272	.9522	1.0694	1.1944	1.3194	1.4444
Minor diameter of ring gage	Class 1	Min	.3330	.3876	.4501	.5071	.5696	.6878	.8040	.9290	1.0426	1.1676	1.2926	1.4176
		Max	.3335	.3881	.4506	.5076	.5701	.6884	.8046	.9296	1.0432	1.1682	1.2932	1.4182
	Class 2	Min	.3356	.3906	.4531	.5103	.5728	.6914	.8082	.9332	1.0473	1.1723	1.2973	1.4223
		Max	.3361	.3911	.4536	.5108	.5733	.6920	.8088	.9338	1.0479	1.1729	1.2979	1.4229
	Class 3	Min	.3365	.3916	.4541	.5114	.5739	.6927	.8095	.9345	1.0489	1.1739	1.2989	1.4239
		Max	.3370	.3921	.4546	.5119	.5744	.6933	.8101	.9351	1.0495	1.1745	1.2995	1.4245
	Class 4	Min	.3380	.3932	.4557	.5132	.5757	.6947	.8117	.9367	1.0514	1.1764	1.3014	1.4264
		Max	.3385	.3937	.4562	.5137	.5762	.6953	.8123	.9373	1.0520	1.1770	1.3020	1.4270

TABLE 24.—*Limiting dimensions o) thread plug gages for nuts of classes 1, 2, 3, and 4 fits, American National coarse-thread series*

Limiting dimensions			1	2	3	4	5	6	8	10	12	¼	5/16	⅜	7/16	½	9/16	⅝	¾	⅞
		Threads per inch	64	56	48	40	40	32	32	24	24	20	18	16	14	13	12	11	10	9
"Go" Gages for Nuts			*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Major diameter of plug gage.	Classes 1, 2, 3, and 4.	Min	0.0730	0.0860	0.0990	0.1120	0.1250	0.1380	0.1640	0.1900	0.2160	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625	0.6250	0.7500	0.8750
		Max	.0734	.0864	.0994	.1124	.1254	.1384	.1644	.1905	.2165	.2505	.3130	.3756	.4381	.5006	.5631	.6256	.7506	.8757
Pitch diameter of plug gage.	Classes 1, 2, and 3.	Min X	.0629	.0744	.0855	.0958	.1088	.1177	.1437	.1629	.1889	.2175	.2764	.3344	.3911	.4500	.5084	.5660	.6850	.8028
		Max X	.0631	.0746	.0857	.0960	.1090	.1180	.1440	.1632	.1892	.2178	.2767	.3347	.3914	.4503	.5087	.5663	.6853	.8031
		Min Y	.0630	.0745	.0856	.0959	.1089	.1178	.1438	.1631	.1891	.2177	.2766	.3346	.3913	.4502	.5086	.5662	.6852	.8030
		Max Y	.0633	.0748	.0859	.0962	.1092	.1181	.1441	.1634	.1894	.2180	.2769	.3350	.3917	.4506	.5090	.5666	.6856	.8035
	Class 4	Min W	------	------	------	------	------	------	------	------	------	.2175	.2764	.3344	.3911	.4500	.5084	.5660	.6850	.8028
		Max W	------	------	------	------	------	------	------	------	------	.2176	.2765	.3345	.39125	.45015	.50855	.56615	.6852	.8030
"Not Go" Gages for Nuts																				
Major diameter of plug gage.	Class 1	Max	.0723	.0849	.0976	.1100	.1230	.1350	.1610	.1855	.2115	.2443	.3062	.3678	.4290	.4907	.5524	.6139	.7375	.8609
		Min	.0719	.0845	.0972	.1096	.1226	.1346	.1606	.1850	.2110	.2438	.3057	.3672	.4284	.4901	.5518	.6133	.7369	.8602
	Class 2	Max	.0716	.0841	.0967	.1090	.1220	.1339	.1599	.1842	.2102	.2428	.3046	.3660	.4269	.4885	.5501	.6113	.7347	.8579
		Min	.0712	.0837	.0963	.1086	.1216	.1335	.1595	.1837	.2097	.2423	.3041	.3654	.4263	.4879	.5495	.6107	.7341	.8572
	Class 3	Max	.0711	.0836	.0961	.1083	.1213	.1331	.1591	.1833	.2093	.2418	.3035	.3647	.4256	.4870	.5485	.6096	.7328	.8558
		Min	.0707	.0832	.0957	.1079	.1209	.1327	.1587	.1828	.2088	.2413	.3030	.3641	.4250	.4864	.5479	.6090	.7322	.8551
	Class 4	Max	------	------	------	------	------	------	------	------	------	.2405	.3020	.3631	.4238	.4852	.5465	.6075	.7306	.8533
		Min	------	------	------	------	------	------	------	------	------	.2400	.3015	.3625	.4232	.4846	.5459	.6069	.7300	.8526
Pitch diameter of thread plug gages for production and inspection.	Class 1	Max	.0655	.0772	.0886	.0992	.1122	.1215	.1475	.1675	.1935	.2226	.2821	.3407	.3981	.4574	.5163	.5745	.6942	.8128
		Min	.0653	.0770	.0884	.0990	.1120	.1212	.1472	.1672	.1932	.2223	.2818	.3404	.3978	.4571	.5160	.5742	.6939	.8125
	Class 2	Max	.0648	.0764	.0877	.0982	.1112	.1204	.1464	.1662	.1922	.2211	.2805	.3389	.3960	.4552	.5140	.5719	.6914	.8098
		Min	.0646	.0762	.0875	.0980	.1110	.1201	.1461	.1659	.1919	.2208	.2802	.3386	.3957	.4549	.5137	.5716	.6911	.8095
	Class 3	Max	.0643	.0759	.0871	.0975	.1105	.1196	.1456	.1653	.1913	.2201	.2794	.3376	.3947	.4537	.5124	.5702	.6895	.8077
		Min	.0641	.0757	.0869	.0973	.1103	.1193	.1453	.1650	.1910	.2198	.2791	.3373	.3944	.4534	.5121	.5699	.6892	.8074
	Class 4	Max	------	------	------	------	------	------	------	------	------	.2188	.2779	.3360	.3929	.4519	.5104	.5681	.6873	.8052
		Min	------	------	------	------	------	------	------	------	------	.2187	.2778	.3359	.39275	.45175	.51025	.56795	.6871	.8050
(optional)																				
Pitch diameter of thread plug gages for inspection (see par. 6, p. 48).	Class 1	Max	.0657	.0774	.0888	.0994	.1124	.1218	.1478	.1678	.1938	.2229	.2824	.3410	.3984	.4577	.5166	.5748	.6945	.8131
		Min	.0655	.0772	.0886	.0992	.1122	.1215	.1475	.1675	.1935	.2226	.2821	.3407	.3981	.4574	.5163	.5745	.6942	.8128
	Class 2	Max	.0650	.0766	.0879	.0984	.1114	.1207	.1467	.1665	.1925	.2214	.2808	.3392	.3963	.4555	.5143	.5722	.6917	.8101
		Min	.0648	.0764	.0877	.0982	.1112	.1204	.1464	.1662	.1922	.2211	.2805	.3389	.3960	.4552	.5140	.5719	.6914	.8098
	Class 3	Max	.0645	.0761	.0873	.0977	.1107	.1199	.1459	.1656	.1916	.2204	.2797	.3379	.3950	.4540	.5127	.5705	.6898	.8080
		Min	.0643	.0759	.0871	.0975	.1105	.1196	.1456	.1653	.1913	.2201	.2794	.3376	.3947	.4537	.5124	.5702	.6895	.8077
	Class 4	Max	------	------	------	------	------	------	------	------	------	.2189	.2780	.3361	.39305	.45205	.51055	.56825	.6875	.8054
		Min	------	------	------	------	------	------	------	------	------	.2188	.2779	.3360	.3929	.4519	.5104	.5681	.6873	.8052

Limiting dimensions			1	1⅛	1¼	1⅜	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	3¾	4
			Threads per inch														
			8	7	7	6	6	5	4½	4½	4	4	4	4	4	4	4
"Go" Gages for Nuts			*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter of plug gage	Classes 1, 2, 3, and 4	Min	1.0000	1.1250	1.2500	1.3750	1.5000	1.7500	2.0000	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
		Max	1.0007	1.1257	1.2507	1.3758	1.5008	1.7508	2.0008	2.2508	2.5009	2.7509	3.0009	3.2509	3.5009	3.7509	4.0009
Pitch diameter of plug gage	Classes 1, 2, and 3	Min. X	.9188	1.0322	1.1572	1.2667	1.3917	1.6201	1.8557	2.1057	2.3376	2.5876	2.8376	3.0876	3.3376	3.5876	3.8376
		Max. X	.9192	1.0326	1.1576	1.2671	1.3921	1.6205	1.8561	2.1061	2.3380	2.5880	2.8380	3.0880	3.3380	3.5880	3.8380
		Min. Y	.9190	1.0324	1.1574	1.2670	1.3920	1.6204	1.8560	2.1060	2.3379	2.5879	2.8379	3.0879	3.3379	3.5879	3.8379
		Max. Y	.9195	1.0329	1.1579	1.2675	1.3925	1.6209	1.8565	2.1065	2.3385	2.5885	2.8385	3.0885	3.3385	3.5885	3.8385
	Class 4	Min. W	.9188	1.0322	1.1572	1.2667	1.3917	1.6201	1.8557	2.1057	2.3376	2.5876	2.8376	3.0876	3.3376	3.5876	3.8376
		Max. W	.9190	1.03245	1.15745	1.26695	1.39195	1.62035	1.8560	2.1060	2.3379	2.5879	2.8379	3.0879	3.3379	3.5879	3.8379
"Not Go" Gages for Nuts																	
Major diameter of plug gage	Class 1	Max	.9840	1.1065	1.2315	1.3534	1.4784	1.7236	1.9703	2.2203	2.4663	2.7163	2.9663	3.2163	3.4663	3.7163	3.9663
		Min	.9833	1.1058	1.2308	1.3526	1.4776	1.7228	1.9695	2.2195	2.4654	2.7154	2.9654	3.2154	3.4654	3.7154	3.9654
	Class 2	Max	.9805	1.1026	1.2276	1.3490	1.4740	1.7183	1.9646	2.2146	2.4599	2.7099	2.9599	3.2099	3.4599	3.7099	3.9599
		Min	.9798	1.1019	1.2269	1.3482	1.4732	1.7175	1.9638	2.2138	2.4590	2.7090	2.9590	3.2090	3.4590	3.7090	3.9590
	Class 3	Max	.9783	1.1000	1.2250	1.3460	1.4710	1.7149	1.9608	2.2108	2.4556	2.7056	2.9556	3.2056	3.4556	3.7056	3.9556
		Min	.9776	1.0993	1.2243	1.3452	1.4702	1.7141	1.9600	2.2100	2.4547	2.7047	2.9547	3.2047	3.4547	3.7047	3.9547
	Class 4	Max	.9756	1.0971	1.2221	1.3425	1.4675	1.7108	1.9563	2.2063	2.4507	2.7007	2.9507	3.2007	3.4507	3.7007	3.9507
		Min	.9749	1.0964	1.2214	1.3417	1.4667	1.7100	1.9555	2.2055	2.4498	2.6998	2.9498	3.1998	3.4498	3.6998	3.9498
Pitch diameter of thread plug gages for production and inspection.	Class 1	Max	.9299	1.0446	1.1696	1.2812	1.4062	1.6370	1.8741	2.1241	2.3580	2.6080	2.8580	3.1080	3.3580	3.6080	3.8580
		Min	.9295	1.0442	1.1692	1.2808	1.4058	1.6366	1.8737	2.1237	2.3576	2.6076	2.8576	3.1076	3.3576	3.6076	3.8576
	Class 2	Max	.9264	1.0407	1.1657	1.2768	1.4018	1.6317	1.8684	2.1184	2.3516	2.6016	2.8516	3.1016	3.3516	3.6016	3.8516
		Min	.9260	1.0403	1.1653	1.2764	1.4014	1.6313	1.8680	2.1180	2.3512	2.6012	2.8512	3.1012	3.3512	3.6012	3.8512
	Class 3	Max	.9242	1.0381	1.1631	1.2738	1.3988	1.6283	1.8646	2.1146	2.3473	2.5973	2.8473	3.0973	3.3473	3.5973	3.8473
		Min	.9238	1.0377	1.1627	1.2734	1.3984	1.6279	1.8642	2.1142	2.3469	2.5969	2.8469	3.0969	3.3469	3.5969	3.8469
	Class 4	Max	.9215	1.0352	1.1602	1.2703	1.3953	1.6242	1.8601	2.1101	2.3424	2.5924	2.8424	3.0924	3.3424	3.5924	3.8424
		Min	.9213	1.03495	1.15995	1.27005	1.39505	1.62395	1.8598	2.1098	2.3421	2.5921	2.8421	3.0921	3.3421	3.5921	3.8421
(OPTIONAL) Pitch diameter of thread plug gages for inspection (see par. 6, p. 48).	Class 1	Max	.9303	1.0450	1.1700	1.2816	1.4066	1.6374	1.8745	2.1245	2.3584	2.6084	2.8584	3.1084	3.3584	3.6084	3.8584
		Min	.9299	1.0446	1.1696	1.2812	1.4062	1.6370	1.8741	2.1241	2.3580	2.6080	2.8580	3.1080	3.3580	3.6080	3.8580
	Class 2	Max	.9268	1.0411	1.1661	1.2772	1.4022	1.6321	1.8688	2.1188	2.3520	2.6020	2.8520	3.1020	3.3520	3.6020	3.8520
		Min	.9264	1.0407	1.1657	1.2768	1.4018	1.6317	1.8684	2.1184	2.3516	2.6016	2.8516	3.1016	3.3516	3.6016	3.8516
	Class 3	Max	.9246	1.0385	1.1635	1.2742	1.3992	1.6287	1.8650	2.1150	2.3477	2.5977	2.8477	3.0977	3.3477	3.5977	3.8477
		Min	.9242	1.0381	1.1631	1.2738	1.3988	1.6283	1.8646	2.1146	2.3473	2.5973	2.8473	3.0973	3.3473	3.5973	3.8473
	Class 4	Max	.9217	1.03545	1.16045	1.27055	1.39555	1.62445	1.8604	2.1104	2.3427	2.5927	2.8427	3.0927	3.3427	3.5927	3.8427
		Min	.9215	1.0352	1.1602	1.2703	1.3953	1.6242	1.8601	2.1101	2.3424	2.5924	2.8424	3.0924	3.3424	3.5924	3.8424

Table 25.—*Limiting dimensions of thread plug gages for nuts of classes 1, 2, 3, and 4 fits, American National fine-thread series*

Limiting dimensions		Machine screw number or nominal size: 0	1	2	3	4	5	6	8	10	12	1/4	5/16
	Threads per inch	80	72	64	56	48	44	40	36	32	28	28	24
"Go" Gages for Nuts		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Major diameter of plug gage: Classes 1, 2, 3, and 4	Min	0.0600	0.0730	0.0860	0.0990	0.1120	0.1250	0.1380	0.1640	0.1900	0.2160	0.2500	0.3125
	Max	.0603	.0733	.0864	.0994	.1124	.1254	.1384	.1644	.1904	.2165	.2505	.3130
Pitch diameter of plug gage: Classes 1, 2, and 3	Min. X	.0519	.0640	.0759	.0874	.0985	.1102	.1213	.1460	.1697	.1928	.2268	.2854
	Max. X	.0521	.0642	.0761	.0876	.0987	.1104	.1220	.1462	.1700	.1931	.2271	.2857
	Min. Y											.2270	.2856
	Max. Y											.2273	.2859
Class 4	Min. W											.2268	.2854
	Max. W											.2269	.2855
"Not Go" Gages for Nuts													
Major diameter of plug gage: Class 1	Max	.0597	.0725	.0853	.0979	.1106	.1232	.1360	.1616	.1870	.2126	.2466	.3080
	Min	.0594	.0722	.0849	.0975	.1102	.1228	.1356	.1612	.1866	.2121	.2461	.3075
Class 2	Max	.0590	.0718	.0846	.0971	.1097	.1223	.1350	.1605	.1859	.2114	.2454	.3067
	Min	.0587	.0715	.0842	.0967	.1093	.1219	.1346	.1601	.1855	.2109	.2449	.3062
Class 3	Max	.0586	.0713	.0841	.0966	.1091	.1216	.1343	.1598	.1851	.2105	.2445	.3058
	Min	.0583	.0710	.0837	.0962	.1087	.1212	.1339	.1594	.1847	.2100	.2440	.3053
Class 4	Max											.2434	.3046
	Min											.2429	.3041
Pitch diameter of thread plug gages for production and inspection: Class 1	Max	.0543	.0665	.0785	.0902	.1016	.1134	.1252	.1496	.1735	.1971	.2311	.2900
	Min	.0541	.0663	.0783	.0900	.1014	.1132	.1250	.1494	.1732	.1968	.2308	.2897
Class 2	Max	.0536	.0658	.0778	.0894	.1007	.1125	.1242	.1485	.1724	.1959	.2299	.2887
	Min	.0534	.0656	.0776	.0892	.1005	.1123	.1240	.1483	.1721	.1956	.2296	.2884
Class 3	Max	.0532	.0653	.0773	.0889	.1001	.1118	.1235	.1478	.1716	.1950	.2290	.2878
	Min	.0530	.0651	.0771	.0887	.0999	.1116	.1233	.1476	.1713	.1947	.2287	.2875
Class 4	Max											.2279	.2866
	Min											.2278	.2865
(optional) Pitch diameter of thread plug gages for inspection (see par. 6, p. 48): Class 1	Max	.0545	.0667	.0787	.0904	.1018	.1136	.1254	.1498	.1738	.1974	.2314	.2903
	Min	.0543	.0665	.0785	.0902	.1016	.1134	.1252	.1496	.1735	.1971	.2311	.2900
Class 2	Max	.0538	.0660	.0780	.0896	.1009	.1127	.1244	.1487	.1727	.1962	.2302	.2890
	Min	.0536	.0658	.0778	.0894	.1007	.1125	.1242	.1485	.1724	.1959	.2299	.2887
Class 3	Max	.0534	.0655	.0775	.0891	.1003	.1120	.1237	.1480	.1719	.1953	.2293	.2881
	Min	.0532	.0653	.0773	.0889	.1001	.1118	.1235	.1478	.1716	.1950	.2290	.2878
Class 4	Max											.2280	.2867
	Min											.2279	.2866

Limiting dimensions			3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
		Threads per inch	24	20	20	18	18	16	14	14	12	12	12	12
"Go" Gages for Nuts														
			Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter of plug gage	Classes 1, 2, 3, and 4.	Min	0.3750	0.4375	0.5000	0.5625	0.6250	0.7500	0.8750	1.0000	1.1250	1.2500	1.3750	1.5000
		Max	.3755	.4380	.5005	.5630	.6255	.7506	.8756	1.0006	1.1256	1.2506	1.3756	1.5006
Pitch diameter of plug gage	Classes 1, 2, and 3.	Min. X	.3479	.4050	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
		Max. X	.3482	.4053	.4678	.5267	.5892	.7097	.8289	.9539	1.0712	1.1962	1.3212	1.4462
		Min. Y	.3481	.4052	.4677	.5266	.5891	.7096	.8288	.9538	1.0711	1.1961	1.3211	1.4461
		Max. Y	.3484	.4055	.4680	.5269	.5894	.7100	.8292	.9542	1.0715	1.1965	1.3215	1.4465
	Class 4	Min. W	.3479	.4050	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
		Max. W	.3480	.4051	.4676	.5265	.5890	.7095	.82875	.95375	1.07105	1.19605	1.32105	1.44605
"Not Go" Gages for Nuts														
Major diameter of plug gage	Class 1	Max	.3705	.4318	.4943	.5562	.6187	.7428	.8665	.9915	1.1149	1.2399	1.3649	1.4899
		Min	.3700	.4313	.4938	.5557	.6182	.7422	.8659	.9909	1.1143	1.2393	1.3643	1.4893
	Class 2	Max	.3692	.4303	.4928	.5546	.6171	.7410	.8644	.9894	1.1126	1.2376	1.3626	1.4876
		Min	.3687	.4298	.4923	.5541	.6166	.7404	.8638	.9888	1.1120	1.2370	1.3620	1.4870
	Class 3	Max	.3683	.4293	.4918	.5535	.6160	.7397	.8631	.9881	1.1110	1.2360	1.3610	1.4860
		Min	.3678	.4288	.4913	.5530	.6155	.7391	.8625	.9875	1.1104	1.2354	1.3604	1.4854
	Class 4	Max	.3671	.4280	.4905	.5520	.6145	.7381	.8613	.9863	1.1090	1.2340	1.3590	1.4840
		Min	.3666	.4275	.4900	.5515	.6140	.7375	.8607	.9857	1.1084	1.2334	1.3584	1.4834
Pitch diameter of thread plug gages for production and inspection.	Class 1	Max	.3525	.4101	.4726	.5321	.5946	.7157	.8356	.9606	1.0788	1.2038	1.3288	1.4538
		Min	.3522	.4098	.4723	.5318	.5943	.7154	.8353	.9603	1.0785	1.2035	1.3285	1.4535
	Class 2	Max	.3512	.4086	.4711	.5305	.5930	.7139	.8335	.9585	1.0765	1.2015	1.3265	1.4515
		Min	.3509	.4083	.4708	.5302	.5927	.7136	.8332	.9582	1.0762	1.2012	1.3262	1.4512
	Class 3	Max	.3503	.4076	.4701	.5294	.5919	.7126	.8322	.9572	1.0749	1.1999	1.3249	1.4499
		Min	.3500	.4073	.4698	.5291	.5916	.7123	.8319	.9569	1.0746	1.1996	1.3246	1.4496
	Class 4	Max	.3491	.4063	.4683	.5279	.5904	.7110	.8304	.9554	1.0729	1.1979	1.3229	1.4479
		Min	.3490	.4062	.4687	.5278	.5903	.7109	.83025	.95525	1.07275	1.19775	1.32275	1.44775
(OPTIONAL)														
Pitch diameter of thread plug gages for inspection (see par. 6, p. 48).	Class 1	Max	.3528	.4104	.4729	.5324	.5949	.7160	.8359	.9609	1.0791	1.2041	1.3291	1.4541
		Min	.3525	.4101	.4726	.5321	.5946	.7157	.8356	.9606	1.0788	1.2038	1.3288	1.4538
	Class 2	Max	.3515	.4089	.4714	.5308	.5933	.7142	.8338	.9588	1.0768	1.2018	1.3268	1.4518
		Min	.3512	.4086	.4711	.5305	.5930	.7139	.8335	.9585	1.0765	1.2015	1.3265	1.4515
	Class 3	Max	.3506	.4079	.4704	.5297	.5922	.7129	.8325	.9575	1.0752	1.2002	1.3252	1.4502
		Min	.3503	.4076	.4701	.5294	.5919	.7126	.8322	.9572	1.0749	1.1999	1.3249	1.4499
	Class 4	Max	.3492	.4064	.4689	.5280	.5905	.7111	.83055	.95555	1.07305	1.19805	1.32305	1.44805
		Min	.3491	.4063	.4688	.5279	.5904	.7110	.8304	.9554	1.0729	1.1979	1.3229	1.4479

SECTION IV. UNIFORM PITCH SCREW-THREAD SERIES FOR HIGH-PRESSURE FASTENINGS, BOILER APPLICATIONS, MACHINERY COMPONENTS, ETC.[11]

1. FORM OF THREAD

The American National form of thread profile as specified in section III shall be used.

2. THREAD SERIES

Where special threads are required, it is sometimes essential to select a certain pitch as standard for a range of sizes. Also, in general practice, where the pitch of a special thread is optional, the uniform use of a selected pitch is advantageous. For such applications 8, 12, and 16 threads per inch are widely used.

(a) AMERICAN NATIONAL 8-PITCH THREAD SERIES

In table 26 are specified the nominal sizes and basic dimensions of the "American National 8-pitch thread series."

Bolts for high-pressure pipe flanges, cylinder-head studs, and similar fastenings against pressure require that an initial tension be set up in the fastening, by elastic deformation of the fastening and the components held together, such that the joint will not open up when the steam or other pressure is applied. To secure a proper initial tension it is not practicable that the pitch should increase with the diameter of the thread, as the torque required to assemble the fastening would be excessive. Accordingly, for such purposes the 8-pitch thread has come into general use.

(b) AMERICAN NATIONAL 12-PITCH THREAD SERIES

The nominal sizes and basic dimensions of the "American National 12-pitch thread series" are specified in table 27.

Sizes of 12-pitch threads from one half inch to and including one and three fourths inches are used in boiler practice, which requires that worn stud holes be retapped with a tap of the next larger size, the increment being one sixteenth inch throughout most of the range. Die-head chasers for sizes up to 3 inches are stocked by manufacturers.[12]

The 12-pitch threads are also widely used in machine construction, as for thin nuts on shafts and sleeves. From the standpoints of good design and simplification of practice, it is desirable to limit shoulder diameters to one-eighth-inch steps. The 12 pitch is the coarsest in general use, which will permit a threaded collar which screws onto a threaded shoulder to slip over a shaft, the difference in diameter between shoulder and shaft being one-eighth inch.

(c) AMERICAN NATIONAL 16-PITCH THREAD SERIES

The nominal sizes and basic dimensions of the "American National 16-pitch thread series" are specified in table 28.

The 16-pitch series is a uniform pitch series for such applications as require a relatively fine thread. It is intended primarily for use on threaded adjusting collars and bearing retaining nuts.

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[11] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published as ASA B1.1—1935 "Screw Threads" by the A. S. M. E., 29 West 39th St., New York, N. Y.

[12] See U. S. Department of Commerce Simplified Practice Recommendation R51–29, Die Head Chasers.

3. CLASSIFICATION, TOLERANCES, AND LIMITING DIMENSIONS

The general specifications and classification of fits given in section VI herein, are applicable to the American National 8-pitch, 12-pitch, and 16-pitch thread series. The dimensions and tolerances for two classes of fit derived from tables 37 and 116 are given in tables 29, 30, and 31.

TABLE 26.—*American National 8-pitch thread series*

Identification		Basic diameters			Thread data		
Sizes	Threads per inch	Major diameter, *D*	Pitch diameter, *E*	Minor diameter, *K*	Metric equivalent of major diameter	Helix angle at basic pitch diameter, *s*	Basic area of section at root of thread, $\frac{\pi K^2}{4}$
1	2	3	4	5	6	7	8
Inches		*Inches*	*Inches*	*Inches*	*mm.*	*Deg. Min.*	*Square inches*
1 [1]	8	1.0000	0.9188	0.8376	25.400	2 29	0.5510
1⅛	8	1.1250	1.0438	.9626	28.575	2 11	.7277
1¼	8	1.2500	1.1688	1.0876	31.750	1 57	.9290
1⅜	8	1.3750	1.2938	1.2126	34.925	1 46	1.1548
1½	8	1.5000	1.4188	1.3376	38.100	1 36	1.4052
1⅝	8	1.6250	1.5438	1.4626	41.275	1 29	1.6801
1¾	8	1.7500	1.6688	1.5876	44.450	1 22	1.9796
1⅞	8	1.8750	1.7938	1.7126	47.625	1 16	2.3036
2	8	2.0000	1.9188	1.8376	50.800	1 11	2.6521
2⅛	8	2.1250	2.0438	1.9626	53.975	1 7	3.0252
2¼	8	2.2500	2.1688	2.0876	57.150	1 3	3.4228
2½	8	2.5000	2.4188	2.3376	63.500	0 57	4.2917
2¾	8	2.7500	2.6688	2.5876	69.850	0 51	5.2588
3	8	3.0000	2.9188	2.8376	76.200	0 47	6.3240
3¼	8	3.2500	3.1688	3.0876	82.550	0 43	7.4874
3½	8	3.5000	3.4188	3.3376	88.900	0 40	8.7490
3¾	8	3.7500	3.6688	3.5876	95.250	0 37	10.1088
4	8	4.0000	3.9188	3.8376	101.600	0 35	11.5667
4¼	8	4.2500	4.1688	4.0876	107.950	0 33	13.1228
4½	8	4.5000	4.4188	4.3376	114.300	0 31	14.7771
4¾	8	4.7500	4.6688	4.5876	120.650	0 29	16.5295
5	8	5.0000	4.9188	4.8376	127.000	0 28	18.3802
5¼	8	5.2500	5.1688	5.0876	133.350	0 26	20.3290
5½	8	5.5000	5.4188	5.3376	139.700	0 25	22.3760
5¾	8	5.7500	5.6688	5.5876	146.050	0 24	24.5211
6	8	6.0000	5.9188	5.8376	152.400	0 23	26.7645

[1] Standard size of the American National coarse-thread series.

NOTE.—Pitch, p=0.12500 inch; depth of thread, h=0.08119 inch; basic width of flat, $p/8$=0.01562 inch; minimum width of flat at major diameter of nut, $p/24$=0.00521 inch.

TABLE 27.—*American National 12-pitch thread series*

Identification		Basic diameters			Thread data		
Sizes	Threads per inch	Major diameter, *D*	Pitch diameter, *E*	Minor diameter, *K*	Metric equivalent of major diameter	Helix angle at basic pitch diameter, *s*	Basic area of section at root of thread, $\frac{\pi K^2}{4}$
1	2	3	4	5	6	7	8
Inches		*Inches*	*Inches*	*Inches*	*mm.*	*Deg. Min.*	*Square inches*
½	12	0.5000	0.4459	0.3917	12.700	3 24	0.1205
9/16 [1]	12	.5625	.5084	.4542	14.288	2 59	.1620
⅝	12	.6250	.5709	.5167	15.875	2 40	.2097
11/16	12	.6875	.6334	.5792	17.463	2 24	.2635
¾	12	.7500	.6959	.6417	19.050	2 11	.3234
13/16	12	.8125	.7584	.7042	20.638	2 0	.3895
⅞	12	.8750	.8209	.7667	22.225	1 51	.4617
15/16	12	.9375	.8834	.8292	23.813	1 43	.5400
1	12	1.0000	.9459	.8917	25.400	1 36	.6245
1 1/16	12	1.0625	1.0084	.9542	26.988	1 30	.7151
1⅛ [2]	12	1.1250	1.0709	1.0167	28.575	1 25	.8118
1 3/16	12	1.1875	1.1334	1.0792	30.163	1 20	.9147
1¼ [2]	12	1.2500	1.1959	1.1417	31.750	1 16	1.0237
1 5/16	12	1.3125	1.2584	1.2042	33.338	1 12	1.1389
1⅜ [2]	12	1.3750	1.3209	1.2667	34.925	1 9	1.2602
1 7/16	12	1.4375	1.3834	1.3292	36.513	1 6	1.3876
1½ [2]	12	1.5000	1.4459	1.3917	38.100	1 3	1.5212
1⅝	12	1.6250	1.5709	1.5167	41.275	0 58	1.8067
1¾	12	1.7500	1.6959	1.6417	44.450	0 54	2.1168
1⅞	12	1.8750	1.8209	1.7667	47.625	0 50	2.4514
2	12	2.0000	1.9459	1.8917	50.800	0 47	2.8106
2⅛	12	2.1250	2.0709	2.0167	53.975	0 44	3.1943
2¼	12	2.2500	2.1959	2.1417	57.150	0 42	3.6025
2⅜	12	2.3750	2.3209	2.2667	60.325	0 39	4.0353
2½	12	2.5000	2.4459	2.3917	63.500	0 37	4.4927
2⅝	12	2.6250	2.5709	2.5167	66.675	0 35	4.9745
2¾	12	2.7500	2.6959	2.6417	69.850	0 34	5.4810
2⅞	12	2.8750	2.8209	2.7667	73.025	0 32	6.0119
3	12	3.0000	2.9459	2.8917	76.200	0 31	6.5674
3⅛	12	3.1250	3.0709	3.0167	79.375	0 30	7.1475
3¼	12	3.2500	3.1959	3.1417	82.550	0 29	7.7521
3⅜	12	3.3750	3.3209	3.2667	85.725	0 27	8.3812
3½	12	3.5000	3.4459	3.3917	88.900	0 26	9.0349
3⅝	12	3.6250	3.5709	3.5167	92.075	0 26	9.7132
3¾	12	3.7500	3.6959	3.6417	95.250	0 25	10.4159
3⅞	12	3.8750	3.8209	3.7667	98.425	0 24	11.1433
4	12	4.0000	3.9459	3.8917	101.600	0 23	11.8951
4¼	12	4.2500	4.1959	4.1417	107.950	0 22	13.4725
4½	12	4.5000	4.4459	4.3917	114.300	0 21	15.1480
4¾	12	4.7500	4.6959	4.6417	120.650	0 19	16.9217
5	12	5.0000	4.9459	4.8917	127.000	0 18	18.7936
5¼	12	5.2500	5.1959	5.1417	133.350	0 18	20.7636
5½	12	5.5000	5.4459	5.3917	139.700	0 17	22.8319
5¾	12	5.7500	5.6959	5.6417	146.050	0 16	24.9983
6	12	6.0000	5.9459	5.8917	152.400	0 15	27.2628

[1] Standard size of the American National coarse-thread series.
[2] Standard size of the American National fine-thread series.

NOTE.—Pitch, p=0.08333 inch; depth of thread, h=0.05413 inch; basic width of flat, $p/8$=0.01042 inch; minimum width of flat at major diameter of nut, $p/24$=0.00347 inch.

TABLE 28.—*American National 16-pitch thread series*

Identification		Basic diameters			Thread data		
Sizes	Threads per inch	Major diameter, D	Pitch diameter, E	Minor diameter, K	Metric equivalent of major diameter	Helix angle at basic pitch diameter, s	Basic area of section at root of thread, $\frac{\pi K^2}{4}$
1	2	3	4	5	6	7	8
Inches		*Inches*	*Inches*	*Inches*	*mm*	*Deg. Min.*	*Square inches*
3/4 [1]	16	0.7500	0.7094	0.6688	19.050	1 36	0.3513
13/16	16	.8125	.7719	.7313	20.638	1 29	.4200
7/8	16	.8750	.8344	.7938	22.225	1 22	.4949
15/16	16	.9375	.8969	.8563	23.813	1 16	.5759
1	16	1.0000	.9594	.9188	25.400	1 11	.6630
1 1/16	16	1.0625	1.0219	.9813	26,988	1 7	.7563
1 1/8	16	1.1250	1.0844	1.0438	28.575	1 3	.8557
1 3/16	16	1.1875	1.1469	1.1063	30.163	1 0	.9612
1 1/4	16	1.2500	1.2094	1.1688	31.750	0 57	1.0729
1 5/16	16	1.3125	1.2719	1.2313	33.338	0 54	1.1907
1 3/8	16	1.3750	1.3344	1.2938	34.925	0 51	1.3147
1 7/16	16	1.4375	1.3969	1.3563	36.513	0 49	1.4448
1 1/2	16	1.5000	1.4594	1.4188	38.100	0 47	1.5810
1 9/16	16	1.5625	1.5219	1.4813	39.688	0 45	1.7234
1 5/8	16	1.6250	1.5844	1.5438	41.275	0 43	1.8719
1 11/16	16	1.6875	1.6469	1.6063	42.863	0 42	2.0265
1 3/4	16	1.7500	1.7094	1.6688	44.450	0 40	2.1873
1 13/16	16	1.8125	1.7719	1.7313	46.038	0 39	2.3542
1 7/8	16	1.8750	1.8344	1.7938	47.625	0 37	2.5272
1 15/16	16	1.9375	1.8969	1.8563	49.213	0 36	2.7064
2	16	2.0000	1.9594	1.9188	50.800	0 35	2.8917
2 1/16	16	2.0625	2.0219	1.9813	52.388	0 34	3.0831
2 1/8	16	2.1250	2.0844	2.0438	53.975	0 33	3.2807
2 3/16	16	2.1875	2.1469	2.1063	55.563	0 32	3.4844
2 1/4	16	2.2500	2.2094	2.1688	57.150	0 31	3.6943
2 5/16	16	2.3125	2.2719	2.2313	58.738	0 30	3.9103
2 3/8	16	2.3750	2.3344	2.2938	60.325	0 29	4.1324
2 7/16	16	2.4375	2.3969	2.3563	61.913	0 29	4.3606
2 1/2	16	2.5000	2.4594	2.4188	63.500	0 28	4.5950
2 5/8	16	2.6250	2.5844	2.5438	66.675	0 26	5.0822
2 3/4	16	2.7500	2.7094	2.6688	69.850	0 25	5.5940
2 7/8	16	2.8750	2.8344	2.7938	73.025	0 24	6.1303
3	16	3.0000	2.9594	2.9188	76.200	0 23	6.6911
3 1/8	16	3.1250	3.0844	3.0438	79.375	0 22	7.2765
3 1/4	16	3.2500	3.2094	3.1688	82.550	0 21	7.8864
3 3/8	16	3.3750	3.3344	3.2938	85.725	0 21	8.5209
3 1/2	16	3.5000	3.4594	3.4188	88.900	0 20	9.1799
3 5/8	16	3.6250	3.5844	3.5438	92.075	0 19	9.8634
3 3/4	16	3.7500	3.7094	3.6688	95.250	0 18	10.5715
3 7/8	16	3.8750	3.8344	3.7938	98.425	0 18	11.3042
4	16	4.0000	3.9594	3.9188	101.600	0 17	12.0614

[1] Standard size of the American National fine-thread series.

NOTE.—Pitch, p=0.06250 inch; depth of thread, h=0.04059 inch; basic width of flat, $p/8$=0.00781 inch; minimum width of flat at major diameter of nut, $p/24$=0.00260 inch.

Table 29.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National 8-pitch thread series*

Dimensions and tolerances [1]		Size (inches) 1 [2]	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2
Bolts and Screws		*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max	1.0000	1.1250	1.2500	1.3750	1.5000	1.6250	1.7500	1.8750	2.0000
	Min	.9848	1.1098	1.2348	1.3598	1.4848	1.6098	1.7348	1.8598	1.9848
	Tol	.0152	.0152	.0152	.0152	.0152	.0152	.0152	.0152	.0152
Classes 2 and 3, minor diameter	Max. [3]	.8466	.9716	1.0966	1.2216	1.3466	1.4716	1.5966	1.7216	1.8466
Class 2, pitch diameter (for general use)	Max	.9188	1.0438	1.1688	1.2938	1.4188	1.5438	1.6688	1.7938	1.9188
	Min	.9112	1.0359	1.1605	1.2852	1.4098	1.5345	1.6591	1.7838	1.9084
	Tol	.0076	.0079	.0083	.0086	.0090	.0093	.0097	.0100	.0104
Class 3, pitch diameter	Max	.9188	1.0438	1.1688	1.2938	1.4188	1.5438	1.6688	1.7938	1.9188
	Min	.9134	1.0383	1.1630	1.2877	1.4125	1.5373	1.6620	1.7868	1.9115
	Tol	.0054	.0055	.0058	.0061	.0063	.0065	.0068	.0070	.0073
Nuts and Tapped Holes										
Classes 2 and 3, major diameter	Min. [4]	1.0000	1.1250	1.2500	1.3750	1.5000	1.6250	1.7500	1.8750	2.0000
Classes 2 and 3, minor diameter	Min	.8647	.9897	1.1147	1.2397	1.3647	1.4897	1.6147	1.7397	1.8647
	Max	.8795	1.0045	1.1295	1.2545	1.3795	1.5045	1.6295	1.7545	1.8795
	Tol	.0148	.0148	.0148	.0148	.0148	.0148	.0148	.0148	.0148
Classes 2 and 3, pitch diameter	Min	.9188	1.0438	1.1688	1.2938	1.4188	1.5438	1.6688	1.7938	1.9188
Class 2, pitch diameter (for general use)	Max. [5]	.9264	1.0517	1.1771	1.3024	1.4278	1.5531	1.6785	1.8038	1.9292
	Tol	.0076	.0079	.0083	.0086	.0090	.0093	.0097	.0100	.0104
Class 3, pitch diameter	Max. [5]	.9242	1.0493	1.1746	1.2999	1.4251	1.5503	1.6756	1.8008	1.9261
	Tol	.0054	.0055	.0058	.0061	.0063	.0065	.0068	.0070	.0073

Dimensions and tolerances [1]		Size (inches) 2⅛	2¼	2½	2¾	3	3¼	3½	3¾	4
Bolts and Screws		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max	2.1250	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
	Min	2.1098	2.2348	2.4848	2.7348	2.9848	3.2348	3.4848	3.7348	3.9848
	Tol	.0152	.0152	.0152	.0152	.0152	.0152	.0152	.0152	.0152
Classes 2 and 3, minor diameter	Max. [3]	1.9716	2.0966	2.3466	2.5966	2.8466	3.0966	3.3466	3.5966	3.8466
Class 2, pitch diameter (for general use)	Max	2.0438	2.1688	2.4188	2.6688	2.9188	3.1688	3.4188	3.6688	3.9188
	Min	2.0331	2.1578	2.4071	2.6564	2.9058	3.1556	3.4055	3.6554	3.9053
	Tol	.0107	.0110	.0117	.0124	.0130	.0132	.0133	.0134	.0135
Class 3, pitch diameter	Max	2.0438	2.1688	2.4188	2.6688	2.9188	3.1688	3.4188	3.6688	3.9188
	Min	2.0363	2.1611	2.4106	2.6601	2.9096	3.1595	3.4095	3.6594	3.9093
	Tol	.0075	.0077	.0082	.0087	.0092	.0093	.0093	.0094	.0095
Nuts and Tapped Holes										
Classes 2 and 3, major diameter	Min. [4]	2.1250	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
Classes 2 and 3, minor diameter	Min	1.9897	2.1147	2.3647	2.6147	2.8647	3.1147	3.3647	3.6147	3.8647
	Max	2.0045	2.1295	2.3795	2.6295	2.8795	3.1295	3.3795	3.6295	3.8795
	Tol	.0148	.0148	.0148	.0148	.0148	.0148	.0148	.0148	.0148
Classes 2 and 3, pitch diameter	Min	2.0438	2.1688	2.4188	2.6688	2.9188	3.1688	3.4188	3.6688	3.9188
Class 2, pitch diameter (for general use)	Max. [5]	2.0545	2.1798	2.4305	2.6812	2.9318	3.1820	3.4321	3.6822	3.9323
	Tol	.0107	.0110	.0117	.0124	.0130	.0132	.0133	.0134	.0135
Class 3, pitch diameter	Max. [5]	2.0513	2.1765	2.4270	2.6775	2.9280	3.1781	3.4281	3.6782	3.9283
	Tol	.0075	.0077	.0082	.0087	.0092	.0093	.0093	.0094	.0095

See footnotes at end of table.

TABLE 29.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National 8-pitch thread series*—Continued

Dimensions and tolerances		Size (inches)							
		4¼	4½	4¾	5	5¼	5½	5¾	6
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max	4. 2500	4. 5000	4. 7500	5. 0000	5. 2500	5. 5000	5. 7500	6. 0000
	Min	4. 2348	4. 4848	4. 7348	4. 9848	5. 2348	5. 4848	5. 7348	5. 9848
	Tol	. 0152	. 0152	. 0152	. 0152	. 0152	. 0152	. 0152	. 0152
Classes 2 and 3, minor diameter	Max.[3]	4. 0966	4. 3466	4. 5966	4. 8466	5. 0966	5. 3466	5. 5966	5. 8466
Class 2, pitch diameter (for general use)	Max	4. 1688	4. 4188	4. 6688	4. 9188	5. 1688	5. 4188	5. 6688	5. 9188
	Min	4. 1551	4. 4050	4. 6549	4. 9048	5. 1547	5. 4046	5. 6545	5. 9044
	Tol	. 0137	. 0138	. 0139	. 0140	. 0141	. 0142	. 0143	. 0144
Class 3, pitch diameter	Max	4. 1688	4. 4188	4. 6688	4. 9188	5. 1688	5. 4188	5. 6688	5. 9188
	Min	4. 1592	4. 4091	4. 6590	4. 9089	5. 1589	5. 4088	5. 6587	5. 9086
	Tol	. 0096	. 0097	. 0098	. 0099	. 0099	. 0100	. 0101	. 0102
NUTS AND TAPPED HOLES									
Classes 2 and 3, major diameter	Min.[4]	4. 2500	4. 5000	4. 7500	5. 0000	5. 2500	5. 5000	5. 7500	6. 0000
Classes 2 and 3, minor diameter	Min	4. 1147	4. 3647	4. 6147	4. 8647	5. 1147	5. 3647	5. 6147	5. 8647
	Max	4. 1295	4. 3795	4. 6295	4. 8795	5. 1295	5. 3795	5. 6295	5. 8795
	Tol	. 0148	. 0148	. 0148	. 0148	. 0148	. 0148	. 0148	. 0148
Classes 2 and 3, pitch diameter	Min	4. 1688	4. 4188	4. 6688	4. 9188	5. 1688	5. 4188	5. 6688	5. 9188
Class 2, pitch diameter (for general use)	Max.[5]	4. 1825	4. 4326	4. 6827	4. 9328	5. 1829	5. 4330	5. 6831	5. 9332
	Tol	. 0137	. 0138	. 0139	. 0140	. 0141	. 0142	. 0143	. 0144
Class 3, pitch diameter	Max.[5]	4. 1784	4. 4285	4. 6786	4. 9287	5. 1787	5. 4288	5. 6789	5. 9290
	Tol	. 0096	. 0097	. 0098	. 0099	. 0099	. 0100	. 0101	. 0102

[1] Pitch diameter tolerances include errors of lead and angle. The class 2 tolerances are based on the formulas in table 116 and a length of engagement equal to the basic major diameter for sizes from 1⅛ to 3 inches, inclusive, and a length of engagement of 3 inches for sizes over the 3-inch. The class 3 tolerances are 70 percent of the class 2 tolerances. The 1-inch size being in the American National coarse-thread series, the tolerances for this size correspond to that series.

[2] Standard size screw and nut of the American National coarse-thread series.

[3] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the minimum screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting 0.0812 inch from the minimum pitch diameter of the screw.

[4] Dimensions for the minimum major diameter of the nut correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the nut shall be that corresponding to a flat at the major diameter of the maximum nut equal to $\frac{1}{24} \times p$, and may be determined by adding 0.0992 inch to the maximum pitch diameter of the nut.

[5] These dimensions are the minimum metal or "not go" size. The "go" or basic size is the one that should be placed on the component drawing with the tolerance.

TABLE 30.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National 12-pitch thread series*

Dimensions and tolerances [1]		Size (inches)								
		½	9/16 [2]	⅝	11/16	¾	13/16	⅞	15/16	1
BOLTS AND SCREWS		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Classes 2 and 3, major diameter	Max	0.5000	0.5625	0.6250	0.6875	0.7500	0.8125	0.8750	0.9375	1.0000
	Min	.4888	.5513	.6138	.6763	.7388	.8013	.8638	.9263	.9888
	Tol	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112
Classes 2 and 3, minor diameter	Max.[4]	.3978	.4603	.5228	.5853	.6478	.7103	.7728	.8353	.8978
Class 2, pitch diameter (for general use)	Max	.4459	.5084	.5709	.6334	.6959	.7584	.8209	.8834	.9459
	Min	.4403	.5028	.5653	.6278	.6903	.7528	.8153	.8778	.9403
	Tol	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056
Class 3, pitch diameter	Max	.4459	.5084	.5709	.6334	.6959	.7584	.8209	.8834	.9459
	Min	.4419	.5044	.5669	.6294	.6919	.7544	.8169	.8794	.9419
	Tol	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040
NUTS AND TAPPED HOLES										
Classes 2 and 3, major diameter	Min.[5]	.5000	.5625	.6250	.6875	.7500	.8125	.8750	.9375	1.0000
Classes 2 and 3, minor diameter	Min	.4098	.4723	.5348	.5973	.6598	.7223	.7848	.8473	.9098
	Max	.4225	.4850	.5438	.6063	.6688	.7313	.7938	.8563	.9188
	Tol	.0127	.0127	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Classes 2 and 3, pitch diameter	Min	.4459	.5084	.5709	.6334	.6959	.7584	.8209	.8834	.9459
Class 2, pitch diameter (for general use)	Max.[6]	.4515	.5140	.5765	.6390	.7015	.7640	.8265	.8890	.9515
	Tol	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056
Class 3, pitch diameter	Max.[6]	.4499	.5124	.5749	.6374	.6999	.7624	.8249	.8874	.9499
	Tol	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040

Dimensions and tolerances [1]		Size (inches)								
		1 1/16	1⅛ [3]	1 3/16	1¼ [3]	1 5/16	1⅜ [3]	1 7/16	1½ [3]	1⅝
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max	1.0625	1.1250	1.1875	1.2500	1.3125	1.3750	1.4375	1.5000	1.6250
	Min	1.0513	1.1138	1.1763	1.2388	1.3013	1.3638	1.4263	1.4888	1.6138
	Tol	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112
Classes 2 and 3, minor diameter	Max.[4]	.9603	1.0228	1.0853	1.1478	1.2103	1.2728	1.3353	1.3978	1.5228
Class 2, pitch diameter (for general use)	Max	1.0084	1.0709	1.1334	1.1959	1.2584	1.3209	1.3834	1.4459	1.5709
	Min	1.0028	1.0653	1.1278	1.1903	1.2528	1.3153	1.3778	1.4403	1.5645
	Tol	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0064
Class 3, pitch diameter	Max	1.0084	1.0709	1.1334	1.1959	1.2584	1.3209	1.3834	1.4459	1.5709
	Min	1.0044	1.0669	1.1294	1.1919	1.2544	1.3169	1.3794	1.4419	1.5664
	Tol	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0045
NUTS AND TAPPED HOLES										
Classes 2 and 3, major diameter	Min.[5]	1.0625	1.1250	1.1875	1.2500	1.3125	1.3750	1.4375	1.5000	1.6250
Classes 2 and 3, minor diameter	Min	.9723	1.0348	1.0973	1.1598	1.2223	1.2848	1.3473	1.4098	1.5348
	Max	.9813	1.0438	1.1063	1.1688	1.2313	1.2938	1.3563	1.4188	1.5438
	Tol	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Classes 2 and 3, pitch diameter	Min	1.0084	1.0709	1.1334	1.1959	1.2584	1.3209	1.3834	1.4459	1.5709
Class 2, pitch diameter (for general use)	Max.[6]	1.0140	1.0765	1.1390	1.2015	1.2640	1.3265	1.3890	1.4515	1.5773
	Tol	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0064
Class 3, pitch diameter	Max.[6]	1.0124	1.0749	1.1374	1.1999	1.2624	1.3249	1.3874	1.4499	1.5754
	Tol	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0045

See footnotes at end of table.

TABLE 30.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National 12-pitch thread series*—Continued

Dimensions and tolerances [1]		Size (inches)								
		1¾	1⅞	2	2⅛	2¼	2⅜	2½	2⅝	2¾
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max.	1.7500	1.8750	2.0000	2.1250	2.2500	2.3750	2.5000	2.6250	2.7500
	Min.	1.7388	1.8638	1.9888	2.1138	2.2388	2.3638	2.4888	2.6138	2.7388
	Tol.	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112
Classes 2 and 3, minor diameter	Max.[4]	1.6478	1.7728	1.8978	2.0228	2.1478	2.2728	2.3978	2.5228	2.6478
Class 2, pitch diameter (for general use)	Max.	1.6959	1.8209	1.9459	2.0709	2.1959	2.3209	2.4459	2.5709	2.6959
	Min.	1.6894	1.8143	1.9392	2.0641	2.1890	2.3139	2.4388	2.5638	2.6887
	Tol.	.0065	.0066	.0067	.0068	.0069	.0070	.0071	.0071	.0072
Class 3, pitch diameter	Max.	1.6959	1.8209	1.9459	2.0709	2.1959	2.3209	2.4459	2.5709	2.6959
	Min.	1.6913	1.8163	1.9412	2.0661	2.1911	2.3160	2.4410	2.5659	2.6909
	Tol.	.0046	.0046	.0047	.0048	.0048	.0049	.0049	.0050	.0050
NUTS AND TAPPED HOLES										
Classes 2 and 3, major diameter	Min.[5]	1.7500	1.8750	2.0000	2.1250	2.2500	2.3750	2.5000	2.6250	2.7500
Classes 2 and 3, minor diameter	Min.	1.6598	1.7848	1.9098	2.0348	2.1598	2.2848	2.4098	2.5348	2.6598
	Max.	1.6688	1.7938	1.9188	2.0438	2.1688	2.2938	2.4188	2.5438	2.6688
	Tol.	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Classes 2 and 3, pitch diameter	Min.	1.6959	1.8209	1.9459	2.0709	2.1959	2.3209	2.4459	2.5709	2.6959
Class 2, pitch diameter (for general use)	Max.[6]	1.7024	1.8275	1.9526	2.0777	2.2028	2.3279	2.4530	2.5780	2.7031
	Tol.	.0065	.0066	.0067	.0068	.0069	.0070	.0071	.0071	.0072
Class 3, pitch diameter	Max.[6]	1.7005	1.8255	1.9506	2.0757	2.2007	2.3258	2.4508	2.5759	2.7009
	Tol.	.0046	.0046	.0047	.0048	.0048	.0049	.0049	.0050	.0050

Dimensions and tolerances [1]		Size (inches)								
		2⅞	3	3⅛	3¼	3⅜	3½	3⅝	3¾	3⅞
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max.	2.8750	3.0000	3.1250	3.2500	3.3750	3.5000	3.6250	3.7500	3.8750
	Min.	2.8638	2.9888	3.1138	3.2388	3.3638	3.4888	3.6138	3.7388	3.8638
	Tol.	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112
Classes 2 and 3, minor diameter	Max.[4]	2.7728	2.8978	3.0228	3.1478	3.2728	3.3978	3.5228	3.6478	3.7728
Class 2, pitch diameter (for general use)	Max.	2.8209	2.9459	3.0709	3.1959	3.3209	3.4459	3.5709	3.6959	3.8209
	Min.	2.8136	2.9385	3.0635	3.1884	3.3133	3.4383	3.5632	3.6881	3.8131
	Tol.	.0073	.0074	.0074	.0075	.0076	.0076	.0077	.0078	.0078
Class 3, pitch diameter	Max.	2.8209	2.9459	3.0709	3.1959	3.3209	3.4459	3.5709	3.6959	3.8209
	Min.	2.8158	2.9408	3.0657	3.1907	3.3156	3.4406	3.5655	3.6905	3.8154
	Tol.	.0051	.0051	.0052	.0052	.0053	.0053	.0054	.0054	.0055
NUTS AND TAPPED HOLES										
Classes 2 and 3, major diameter	Min.[5]	2.8750	3.0000	3.1250	3.2500	3.3750	3.5000	3.6250	3.7500	3.8750
Classes 2 and 3, minor diameter	Min.	2.7848	2.9098	3.0348	3.1598	3.2848	3.4098	3.5348	3.6598	3.7848
	Max.	2.7938	2.9188	3.0438	3.1688	3.2938	3.4188	3.5438	3.6688	3.7938
	Tol.	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Classes 2 and 3, pitch diameter	Min.	2.8209	2.9459	3.0709	3.1959	3.3209	3.4459	3.5709	3.6959	3.8209
Class 2, pitch diameter (for general use)	Max.[6]	2.8282	2.9533	3.0783	3.2034	3.3285	3.4535	3.5786	3.7037	3.8287
	Tol.	.0073	.0074	.0074	.0075	.0076	.0076	.0077	.0078	.0078
Class 3, pitch diameter	Max.[6]	2.8260	2.9510	3.0761	3.2011	3.3262	3.4512	3.5763	3.7013	3.8264
	Tol.	.0051	.0051	.0052	.0052	.0053	.0053	.0054	.0054	.0055

See footnotes at end of table.

TABLE 30.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National 12-pitch thread series*—Continued

Dimensions and tolerances [1]		Size (inches)								
		4	4¼	4½	4¾	5	5¼	5½	5¾	6
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max	4.0000	4.2500	4.5000	4.7500	5.0000	5.2500	5.5000	5.7500	6.0000
	Min	3.9888	4.2388	4.4888	4.7388	4.9888	5.2388	5.4888	5.7388	5.9888
	Tol	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112	.0112
Classes 2 and 3, minor diameter	Max.[4]	3.8978	4.1478	4.3978	4.6478	4.8978	5.1478	5.3978	5.6478	5.8978
Class 2, pitch diameter (for general use)	Max	3.9459	4.1959	4.4459	4.6959	4.9459	5.1959	5.4459	5.6959	5.9459
	Min	3.9380	4.1879	4.4378	4.6876	4.9375	5.1874	5.4373	5.6872	5.9371
	Tol	.0079	.0080	.0081	.0083	.0084	.0085	.0086	.0087	.0088
Class 3, pitch diameter	Max	3.9459	4.1959	4.4459	4.6959	4.9459	5.1959	5.4459	5.6959	5.9459
	Min	3.9404	4.1903	4.4402	4.6901	4.9400	5.1900	5.4399	5.6898	5.9397
	Tol	.0055	.0056	.0057	.0058	.0059	.0059	.0060	.0061	.0062
NUTS AND TAPPED HOLES										
Classes 2 and 3, major diameter	Min.[5]	4.0000	4.2500	4.5000	4.7500	5.0000	5.2500	5.5000	5.7500	6.0000
Classes 2 and 3, minor diameter	Min	3.9098	4.1598	4.4098	4.6598	4.9098	5.1598	5.4098	5.6598	5.9098
	Max	3.9188	4.1688	4.4188	4.6688	4.9188	5.1688	5.4188	5.6688	5.9188
	Tol	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Classes 2 and 3, pitch diameter	Min	3.9459	4.1959	4.4459	4.6959	4.9459	5.1959	5.4459	5.6959	5.9459
Class 2, pitch diameter (for general use)	Max.[6]	3.9538	4.2039	4.4540	4.7042	4.9543	5.2044	5.4545	5.7046	5.9547
	Tol	.0079	.0080	.0081	.0083	.0084	.0085	.0086	.0087	.0088
Class 3, pitch diameter	Max.[6]	3.9514	4.2015	4.4516	4.7017	4.9518	5.2018	5.4519	5.7020	5.9521
	Tol	.0055	.0056	.0057	.0058	.0059	.0059	.0060	.0061	.0062

[1] Pitch diameter tolerances include errors of lead and angle. The class 2 tolerances for sizes above 1½ inches are based on the formulas in table 116 and a length of engagement of 6 threads or ½ inch. The class 3 tolerances are 70 percent of the class 2 tolerances. For lengths of engagement of 1 inch, 0.0010 inch may be added to these tolerances. As certain sizes up to 1½ inches are included in the American National coarse or fine thread series, the tolerances to and including 1½ inches correspond to those series.

[2] Standard size screw and nut of the American National coarse thread series.

[3] Standard size screw and nut of the American National fine thread series.

[4] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the minimum screw equal to $\frac{1}{8}\times p$, and may be determined by subtracting 0.0541 inch from the minimum pitch diameter of the screw.

[5] Dimensions for the minimum major diameter of the nut correspond to the basic flat ($\frac{1}{8}\times p$) and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the nut shall be that corresponding to a flat at the major diameter of the maximum nut equal to $\frac{1}{24}\times p$, and may be determined by adding 0.0662 inch to the maximum pitch diameter of the nut.

[6] These dimensions are the minimum metal or "not go" size. The "go" or basic size is the one that should be placed on the component drawing with the tolerance.

TABLE 31.—*Limiting dimensions and tolerances, class 3 fit, American National 16-pitch thread series*

Dimensions and tolerances [1]		Size (inches)									
		3/4 [2]	13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16
BOLTS AND SCREWS		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter	Max.	0.7500	0.8125	0.8750	0.9375	1.0000	1.0625	1.1250	1.1875	1.2500	1.3125
	Min.	.7410	.8035	.8660	.9285	.9910	1.0535	1.1160	1.1785	1.2410	1.3035
	Tol.	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Minor diameter	Max.[3]	.6733	.7358	.7983	.8608	.9233	.9858	1.0483	1.1108	1.1733	1.2358
Pitch diameter	Max.	.7094	.7719	.8344	.8969	.9594	1.0219	1.0844	1.1469	1.2094	1.2719
	Min.	.7062	.7684	.8308	.8933	.9557	1.0182	1.0806	1.1431	1.2056	1.2680
	Tol.	.0032	.0035	.0036	.0036	.0037	.0037	.0038	.0038	.0038	.0039
NUTS AND TAPPED HOLES											
Major diameter	Min.[4]	.7500	.8125	.8750	.9375	1.0000	1.0625	1.1250	1.1875	1.2500	1.3125
Minor diameter	Min.	.6823	.7448	.8073	.8698	.9323	.9948	1.0573	1.1198	1.1823	1.2448
	Max.	.6903	.7528	.8153	.8778	.9403	1.0028	1.0653	1.1278	1.1903	1.2528
	Tol.	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
Pitch diameter	Min.	.7094	.7719	.8344	.8969	.9594	1.0219	1.0844	1.1469	1.2094	1.2719
	Max.	.7126	.7754	.8380	.9005	.9631	1.0256	1.0882	1.1507	1.2132	1.2758
	Tol.	.0032	.0035	.0036	.0036	.0037	.0037	.0038	.0038	.0038	.0039

Dimensions and tolerances [1]		Size (inches)									
		1 3/8	1 7/16	1 1/2	1 9/16	1 5/8	1 11/16	1 3/4	1 13/16	1 7/8	1 15/16
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter	Max.	1.3750	1.4375	1.5000	1.5625	1.6250	1.6875	1.7500	1.8125	1.8750	1.9375
	Min.	1.3660	1.4285	1.4910	1.5535	1.6160	1.6785	1.7410	1.8035	1.8660	1.9235
	Tol.	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Minor diameter	Max.[3]	1.2983	1.3608	1.4233	1.4858	1.5483	1.6108	1.6733	1.7358	1.7983	1.8608
Pitch diameter	Max.	1.3344	1.3969	1.4594	1.5219	1.5844	1.6469	1.7094	1.7719	1.8344	1.8969
	Min.	1.3305	1.3929	1.4554	1.5179	1.5803	1.6428	1.7053	1.7677	1.8302	1.8927
	Tol.	.0039	.0040	.0040	.0040	.0041	.0041	.0041	.0042	.0042	.0042
NUTS AND TAPPED HOLES											
Major diameter	Min.[4]	1.3750	1.4375	1.5000	1.5625	1.6250	1.6875	1.7500	1.8125	1.8750	1.9375
Minor diameter	Min.	1.3073	1.3698	1.4323	1.4948	1.5573	1.6198	1.6823	1.7448	1.8073	1.8698
	Max.	1.3153	1.3778	1.4403	1.5028	1.5653	1.6278	1.6903	1.7528	1.8153	1.8778
	Tol.	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
Pitch diameter	Min.	1.3344	1.3969	1.4594	1.5219	1.5844	1.6469	1.7094	1.7719	1.8344	1.8969
	Max.	1.3383	1.4009	1.4634	1.5259	1.5885	1.6510	1.7135	1.7761	1.8386	1.9011
	Tol.	.0039	.0040	.0040	.0040	.0041	.0041	.0041	.0042	.0042	.0042

See footnotes at end of table.

TABLE 31.—*Limiting dimensions and tolerances, class 3 fit, American National 16-pitch thread series*—Continued

Dimensions and tolerances [1]		Size (inches)									
		2	2 1/16	2 1/8	2 3/16	2 1/4	2 5/16	2 3/8	2 7/16	2 1/2	2 5/8
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter	Max	2.0000	2.0625	2.1250	2.1875	2.2500	2.3125	2.3750	2.4375	2.5000	2 6250
	Min	1.9910	2.0535	2.1160	2.1785	2.2410	2.3035	2.3660	2.4285	2.4910	2.6160
	Tol	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Minor diameter	Max. [3]	1.9233	1.9858	2.0483	2.1108	2.1733	2.2358	2.2983	2.3608	2.4233	2.5483
Pitch diameter	Max	1.9594	2.0219	2.0844	2.1469	2.2094	2.2719	2.3344	2.3969	2.4594	2.5844
	Min	1.9551	2.0176	2.0801	2.1426	2.2050	2.2675	2.3300	2.3924	2.4549	2.5799
	Tol	.0043	.0043	.0043	.0043	.0044	.0044	.0044	.0045	.0045	.0045
NUTS AND TAPPED HOLES											
Major diameter	Min. [4]	2.0000	2.0625	2.1250	2.1875	2.2500	2.3125	2.3750	2.4375	2.5000	2.6250
Minor diameter	Min	1.9323	1.9948	2.0573	2.1198	2.1823	2.2448	2.3073	2.3698	2.4323	2.5573
	Max	1.9403	2.0028	2.0653	2.1278	2.1903	2.2528	2.3153	2.3778	2.4403	2.5653
	Tol	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
Pitch diameter	Min	1.9594	2.0219	2.0844	2.1469	2.2094	2.2719	2.3344	2.3969	2.4594	2.5844
	Max	1.9637	2.0262	2.0887	2.1512	2.2138	2.2763	2.3388	2.4014	2.4639	2 5889
	Tol	.0043	.0043	.0043	.0043	.0044	.0044	.0044	.0045	.0045	.0045

Dimensions and tolerances [1]		Size (inches)										
		2 3/4	2 7/8	3	3 1/8	3 1/4	3 3/8	3 1/2	3 5/8	3 3/4	3 7/8	4
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Major diameter	Max	2.7500	2.8750	3.0000	3.1250	3.2500	3.3750	3.5000	3.6250	3.7500	3.8750	4.0000
	Min	2.7410	2.8660	2.9910	3.1160	3.2410	3.3660	3.4910	3.6160	3.7410	3.8660	3.9910
	Tol	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090
Minor diameter	Max. [3]	2.6733	2.7983	2.9233	3.0483	3.1733	3.2983	3.4233	3.5483	3.6733	3.7983	3.9233
Pitch diameter	Max	2.7094	2.8344	2.9594	3.0844	3.2094	3.3344	3.4594	3.5844	3.7094	3.8344	3.9594
	Min	2.7048	2.8298	2.9547	3.0797	3.2046	3.3296	3.4545	3, 5795	3.7044	3.8294	3.9543
	Tol	.0046	.0046	.0047	.0047	.0048	.0048	.0049	.0049	.0050	.0050	.0051
NUTS AND TAPPED HOLES												
Major diameter	Min. [4]	2.7500	2.8750	3.0000	3.1250	3.2500	3.3750	3.5000	3.6250	3.7500	3.8750	4.0000
Minor diameter	Min	2.6823	2.8073	2.9323	3.0573	3.1823	3.3073	3.4323	3.5573	3.6823	3.8073	3.9323
	Max	2.6903	2.8153	2.9403	3.0653	3.1903	3.3153	3.4403	3.5653	3.6903	3.8153	3.9403
	Tol	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080
Pitch diameter	Min	2.7094	2.8344	2.9594	3.0844	3.2094	3.3344	3.4594	3.5844	3.7094	3.8344	3.9594
	Max	2.7140	2.8390	2.9641	3.0891	3.2142	3.3392	3.4643	3.5893	3.7144	3.8394	3.9645
	Tol	.0046	.0046	.0047	.0047	.0048	.0048	.0049	.0049	.0050	.0050	.0051

[1] Pitch diameter tolerances include errors of lead and angle, and are 70 percent of the tolerances for class 2 based on the formulas in table 116 and a length of engagement of 6 threads or 3/8 inch. The 3/4-inch size being in the American National fine-thread series, the tolerance for this size corresponds to that series.

[2] Standard size screw and nut of the American National fine-thread series.

[3] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn-tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the minimum screw equal to $\frac{1}{8}\times p$, and may be determined by subtracting 0.0406 inch from the minimum pitch diameter of the screw.

[4] Dimensions for the minimum major diameter of the nut correspond to the basic flat ($\frac{1}{8}\times p$) and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the nut shall be that corresponding to a flat at the major diameter of the maximum nut equal to $\frac{1}{24}\times p$, and may be determined by adding 0.0496 inch to the maximum pitch diameter of the nut.

4. GAGES

The specifications for gages given in section III are applicable to the American National 8-, 12- and 16-pitch thread series. Tolerances on diameter, lead, and angle for *W*, *X*, and *Y* gages, as specified in section III, are given in table 32.

Each gage shall be marked for identification, with the diameter, pitch, and class of fit as specified in Section II, division 3, "Symbols," p. 5.

TABLE 32.—*Tolerances for thread gages, American National 8-, 12-, and 16-pitch thread series*

Class of gage	Tolerance on pitch diameter [1]		Tolerance on lead [2]	Tolerance on half ange of thread		Tolerance on major or minor diameters [1]	
	From—	To—				From—	To—
8-PITCH							
	Inch	*Inch*	*Inch*	*Deg.*	*Min.*	*Inch*	*Inch*
W	0.0000	0.0002	0.00025	0	5	0.0000	0.0007
X	.0000	.0004	.0004	0	5	.0000	.0007
Y	.0002	.0007	.0004	0	5	.0000	.0007
12-PITCH							
W	0.0000	0.00015	0.0002	0	6	0.0000	0.0006
X	.0000	.0003	.0003	0	10	.0000	.0006
Y	.0002	.0006	.0003	0	10	.0000	.0006
16.PITCH							
W	0.0000	0.0001	0.00015	0	8	0.0000	0.0006
X	.0000	.0003	.0003	0	10	.0000	.0006
Y	.0002	.0006	.0003	0	15	.0000	.0006

[1] On "go" plugs the tolerance is plus, and on "go" rings the tolerance is minus. On "not go" plugs the tolerance is minus, and on "not go" rings the tolerance is plus.
[2] Allowable variation in lead between any 2 threads not farther apart than the standard length of engagement.

SECTION V. AERONAUTICAL SCREW-THREAD SERIES, INCLUDING AMERICAN NATIONAL EXTRA-FINE THREAD SERIES

1. FORM OF THREAD

The American National form of thread profile as specified in section III shall be used.

2. THREAD SERIES

The thread sizes listed in table 33, which include selections from the standard thread series specified in sections III and IV herein, and in addition the American National extra-fine thread series specified in this section, shall be used in aircraft and aeronautical equipment. When the nature of the design requires thread sizes not included in table 33, threads of American National form, and preferably conforming to the specifications in section VI herein, shall be used when specifically authorized.

The American National extra-fine thread series is intended for special uses where (1) thin-walled material is to be threaded, (2) thread depth of nuts clearing ferrules, coupling flanges, etc., must be held to a minimum, and (3) a maximum practicable number of threads are required within a given thread length. This thread series is the same as the SAE extra-fine thread series, but it includes additional sizes. The nominal sizes and basic dimensions are specified in table 34.

3. CLASSIFICATION, TOLERANCES, AND LIMITING DIMENSIONS, AMERICAN NATIONAL EXTRA-FINE THREAD SERIES

The general specifications and classification of fits given in section VI, herein, are applicable to the American National extra-fine thread series. The dimensions and tolerances for two classes of fit derived from tables 37 and 116 are given in table 35.

4. GAGES

The specifications for gages given in section III are applicable to the American National extra-fine thread series. Each gage shall be marked for identification with the diameter, pitch, and class of fit as specified in section II, division 3, "Symbols", p. 5.

TABLE 33.—*Aeronautic screw thread series, recommended selections from standard thread series*

Size	Basic major diameter	Thread series (Threads per inch) NC	NF	NEF	8N	12N
1	2	3	4	5	6	7
	Inches					
0	0.0600		80			
1	.0730	64	72			
2	.0860	56	64			
3	.0990	48	56			
4	.1120	40	48			
5	.1250	40	44			
6	.1380	32	40			
8	.1640	32	36			
10	.1900	24	32			
¼	.2500	20	28	32		
5/16	.3125	18	24	32		
⅜	.3750	16	24	32		
7/16	.4375	14	20	28		
½	.5000	13	20	28		
9/16	.5625	12	18	24		
⅝	.6250	11	18	24		
11/16	.6875			24		
¾	.7500	10	16	20		
13/16	.8125			20		
⅞	.8750	9	14	20		
15/16	.9375			20		
1	1.0000	8	14	20		
1 1/16	1.0625			18		12
1⅛	1.1250			18	8	12
1 3/16	1.1875			18		12
1¼	1.2500			18	8	12
1 5/16	1.3125			18		12
1⅜	1.3750			18	8	12
1 7/16	1.4375			18		12

Size	Basic major diameter	Thread series (Threads per inch) NEF	8N	12N	16N
1	2	5	6	7	8
	Inches				
1½	1.5000	18	8	12	
1 9/16	1.5625	18			
1⅝	1.6250	18	8	12	
1 11/16	1.6875	18			
1¾	1.7500	16	8	12	16
1 13/16	1.8125				16
1⅞	1.8750		8	12	16
1 15/16	1.9375				16
2	2.0000	16	8	12	16
2 1/16	2.0625				16
2⅛	2.1250		8	12	16
2 3/16	2.1875				16
2¼	2.2500		8	12	16
2 5/16	2.3125				16
2⅜	2.3750			12	16
2 7/16	2.4375				16
2½	2.5000		8	12	16
2⅝	2.6250			12	16
3¾	2.7500		8	12	16
2⅞	2.8750			12	16
3	3.0000		8	12	16
3⅛	3.1250			12	16
3¼	3.2500		8	12	16
3⅜	3.3750			12	16
3½	3.5000		8	12	16
3⅝	3.6250			12	16
3¾	3.7500		8	12	16
3⅞	3.8750			12	16
4	4.0000		8	12	16

TABLE 34.—*American National extra-fine thread series*

Identification		Basic diameters			Thread data						
Size	Threads per inch	Major diameter, D	Pitch diameter, E	Minor diameter, K	Metric equivalent of major diameter	Pitch, p	Depth of thread, h	Basic width of flat, $p/8$	Minimum width of flat at major diameter of nut, $p/24$	Helix angle at basic pitch diameter, s	Basic area of section at root of thread, $\pi K^2/4$
1	2	3	4	5	6	7	8	9	10	11	12
Inches		*Inches*	*Inches*	*Inches*	*mm*	*Inch*	*Inch*	*Inch*	*Inch*	*Deg. Min.*	*Square inches*
1/4	32	0.2500	0.2297	0.2094	6.350	0.03125	0.02030	0.00391	0.00130	2 29	0.0344
5/16	32	.3125	.2922	.2719	7.938	.03125	.02030	.00391	.00130	1 57	.0581
3/8	32	.3750	.3547	.3344	9.525	.03125	.02030	.00391	.00130	1 36	.0878
7/16	28	.4375	.4143	.3911	11.113	.03571	.02320	.00446	.00149	1 34	.1201
1/2	28	.5000	.4768	.4536	12.700	.03571	.02320	.00446	.00149	1 22	.1616
9/16	24	.5625	.5354	.5084	14.288	.04167	.02706	.00521	.00174	1 25	.2030
5/8	24	.6250	.5979	.5709	15.875	.04167	.02706	.00521	.00174	1 16	.2560
11/16	24	.6875	.6604	.6334	17.463	.04167	.02706	.00521	.00174	1 9	.3151
3/4	20	.7500	.7175	.6850	19.050	.05000	.03248	.00625	.00208	1 16	.3685
13/16	20	.8125	.7800	.7475	20.638	.05000	.03248	.00625	.00208	1 10	.4388
7/8	20	.8750	.8425	.8100	22.225	.05000	.03248	.00625	.00208	1 4	.5153
15/16	20	.9375	.9050	.8725	23.813	.05000	.03248	.00625	.00208	1 0	.5979
1	20	1.0000	.9675	.9350	25.400	.05000	.03248	.00625	.00208	0 57	.6866
1 1/16	18	1.0625	1.0264	.9903	26.988	.05556	.03608	.00694	.00231	0 59	.7702
1 1/8	18	1.1250	1.0889	1.0528	28.575	.05556	.03608	.00694	.00231	0 56	.8705
1 3/16	18	1.1875	1.1514	1.1153	30.163	.05556	.03608	.00694	.00231	0 53	.9770
1 1/4	18	1.2500	1.2139	1.1778	31.750	.05556	.03608	.00694	.00231	0 50	1.0895
1 5/16	18	1.3125	1.2764	1.2403	33.338	.05556	.03608	.00694	.00231	0 48	1.2082
1 3/8	18	1.3750	1.3389	1.3028	34.925	.05556	.03608	.00694	.00231	0 45	1.3330
1 7/16	18	1.4375	1.4014	1.3653	36.513	.05556	.03608	.00694	.00231	0 43	1.4640
1 1/2	18	1.5000	1.4639	1.4278	38.100	.05556	.03608	.00694	.00231	0 42	1.6011
1 9/16	18	1.5625	1.5264	1.4903	39.688	.05556	.03608	.00694	.00231	0 40	1.7444
1 5/8	18	1.6250	1.5889	1.5528	41.275	.05556	.03608	.00694	.00231	0 38	1.8937
1 11/16	18	1.6875	1.6514	1.6153	42.863	.05556	.03608	.00694	.00231	0 37	2.0493
1 3/4	16	1.7500	1.7094	1.6688	44.450	.06250	.04059	.00781	.00260	0 40	2.1873
2	16	2.0000	1.9594	1.9188	50.800	.06250	.04059	.00781	.00260	0 35	2.8917

TABLE 35.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National extra-fine thread series*

Dimensions and tolerances [1]		Size (inch)								
		¼	5/16	⅜	7/16	½	9/16	⅝	11/16	¾
		Threads per inch								
		32	32	32	28	28	24	24	24	20
BOLTS AND SCREWS		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Classes 2 and 3 major diameter	Max	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625	0.6250	0.6875	0.7500
	Min	.2446	.3071	.3696	.4313	.4938	.5559	.6184	.6809	.7428
	Tol	.0054	.0054	.0054	.0062	.0062	.0066	.0066	.0066	.0072
Classes 2 and 3, minor diameter	Max.[2]	.2117	.2742	.3367	.3937	.4562	.5114	.5739	.6364	.6887
Class 2, pitch diameter	Max	.2297	.2922	.3547	.4143	.4768	.5354	.5979	.6604	.7175
	Min.[4]	.2265	.2889	.3513	.4107	.4731	.5314	.5938	.6563	.7129
	Tol	.0032	.0033	.0034	.0036	.0037	.0040	.0041	.0041	.0046
Class 3, pitch diameter	Max	.2297	.2922	.3547	.4143	.4768	.5354	.5979	.6604	.7175
	Min.[4]	.2275	.2899	.3523	.4118	.4742	.5326	.5950	.6575	.7143
	Tol	.0022	.0023	.0024	.0025	.0026	.0028	.0029	.0029	.0032
NUTS AND TAPPED HOLES										
Classes 2 and 3, major diameter	Min.[3]	.2500	.3125	.3750	.4375	.5000	.5625	.6250	.6875	.7500
Classes 2 and 3, minor diameter	Min	.2162	.2787	.3412	.3988	.4613	.5174	.5799	.6424	.6959
	Max	.2208	.2833	.3458	.4041	.4666	.5235	.5860	.6485	.7027
	Tol	.0046	.0046	.0046	.0053	.0053	.0061	.0061	.0061	.0068
Class 2, pitch diameter	Min	.2297	.2922	.3547	.4143	.4768	.5354	.5979	.6604	.7175
	Max.[4]	.2329	.2955	.3581	.4179	.4805	.5394	.6020	.6645	.7221
	Tol	.0032	.0033	.0034	.0036	.0037	.0040	.0041	.0041	.0046
Class 3, pitch diameter	Min	.2297	.2922	.3547	.4143	.4768	.5354	.5979	.6604	.7175
	Max.[4]	.2319	.2945	.3571	.4168	.4794	.5382	.6008	.6633	.7207
	Tol	.0022	.0023	.0024	.0025	.0026	.0028	.0029	.0029	.0032

See footnotes at end of table.

TABLE 35.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National extra-fine thread series*—Continued

Dimensions and tolerances [1]		Size (inches)								
		13/16	7/8	15/16	1	1 1/16	1 1/8	1 3/16	1 1/4	1 5/16
		Threads per inch								
		20	20	20	20	18	18	18	18	18
BOLTS AND SCREWS		*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max	0.8125	0.8750	0.9375	1.0000	1.0625	1.1250	1.1875	1.2500	1.3125
	Min	.8053	.8678	.9303	.9928	1.0543	1.1168	1.1793	1.2418	1.3043
	Tol	.0072	.0072	.0072	.0072	.0082	.0082	.0082	.0082	.0082
Classes 2 and 3, minor diameter	Max. [2]	.7512	.8137	.8762	.9387	.9943	1.0568	1.1193	1.1818	1.2443
Class 2, pitch diameter	Max	.7800	.8425	.9050	.9675	1.0264	1.0889	1.1514	1.2139	1.2764
	Min. [4]	.7754	.8378	.9003	.9627	1.0216	1.0837	1.1462	1.2086	1.2711
	Tol	.0046	.0047	.0047	.0048	.0048	.0052	.0052	.0053	.0053
Class 3, pitch diameter	Max	.7800	.8425	.9050	.9675	1.0264	1.0889	1.1514	1.2139	1.2764
	Min. [4]	.7768	.8392	.9017	.9641	1.0228	1.0853	1.1478	1.2102	1.2727
	Tol	.0032	.0033	.0033	.0034	.0036	.0036	.0036	.0037	.0037
NUTS AND TAPPED HOLES										
Classes 2 and 3, major diameter	Min. [3]	.8125	.8750	.9370	1.0000	1.0625	1.1250	1.1875	1.2500	1.3125
Classes 2 and 3, minor diameter	Min	.7584	.8209	.8834	.9459	1.0024	1.0649	1.1274	1.1899	1.2524
	Max	.7652	.8277	.8902	.9527	1.0099	1.0724	1.1349	1.1974	1.2599
	Tol	.0068	.0068	.0068	.0068	.0075	.0075	.0075	.0075	.0075
Class 2, pitch diameter	Min	.7800	.8425	.9050	.9675	1.0264	1.0889	1.1514	1.2139	1.2764
	Max. [4]	.7846	.8472	.9097	.9723	1.0312	1.0941	1.1566	1.2192	1.2817
	Tol	.0046	.0047	.0047	.0048	.0048	.0052	.0052	.0053	.0053
Class 3, pitch diameter	Min	.7800	.8425	.9050	.9675	1.0264	1.0889	1.1514	1.2139	1.2764
	Max. [4]	.7832	.8458	.9083	.9709	1.0300	1.0925	1.1550	1.2176	1.2801
	Tol	.0032	.0033	.0033	.0034	.0036	.0036	.0036	.0037	.0037

See footnotes at end of table.

TABLE 35.—*Limiting dimensions and tolerances, classes 2 and 3 fits, American National extra-fine thread series*—Continued

Dimensions and tolerances [1]		Size (inches)							
		1⅜	1⁷⁄₁₆	1½	1⁹⁄₁₆	1⅝	1¹¹⁄₁₆	1¾	2
		Threads per inch							
		18	18	18	18	18	18	16	16
BOLTS AND SCREWS		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Classes 2 and 3, major diameter	Max	1.3750	1.4375	1.5000	1.5625	1.6250	1.6875	1.7500	2.0000
	Min	1.3668	1.4293	1.4918	1.5543	1.6168	1.6793	1.7410	1.9910
	Tol	.0082	.0082	.0082	.0082	.0082	.0082	.0090	.0090
Classes 2 and 3, minor diameter	Max.[2]	1.3068	1.3693	1.4318	1.4943	1.5568	1.6193	1.6733	1.9233
Class 2, pitch diameter	Max	1.3389	1.4014	1.4639	1.5264	1.5889	1.6514	1.7094	1.9594
	Min.[4]	1.3335	1.3960	1.4584	1.5209	1.5833	1.6458	1.7035	1.9533
	Tol	.0054	.0054	.0055	.0055	.0056	.0056	.0059	.0061
Class 3, pitch diameter	Max	1.3389	1.4014	1.4639	1.5264	1.5889	1.6514	1.7094	1.9594
	Min.[4]	1.3351	1.3976	1.4601	1.5225	1.5850	1.6475	1.7053	1.9551
	Tol	.0038	.0038	.0038	.0039	.0039	.0039	.0041	.0043
NUTS AND TAPPED HOLES									
Classes 2 and 3, major diameter	Min.[3]	1.3750	1.4375	1.5000	1.5625	1.6250	1.6875	1.7500	2.0000
Classes 2 and 3, minor diameter	Min	1.3149	1.3774	1.4399	1.5024	1.5649	1.6274	1.6823	1.9323
	Max	1.3224	1.3849	1.4474	1.5099	1.5724	1.6349	1.6903	1.9403
	Tol	.0075	.0075	.0075	.0075	.0075	.0075	.0080	.0080
Class 2, pitch diameter	Min	1.3389	1.4014	1.4639	1.5264	1.5889	1.6514	1.7094	1.9594
	Max.[4]	1.3443	1.4068	1.4694	1.5319	1.5945	1.6570	1.7153	1.9655
	Tol	.0054	.0054	.0055	.0055	.0056	.0056	.0059	.0061
Class 3, pitch diameter	Min	1.3389	1.4014	1.4639	1.5264	1.5889	1.6514	1.7094	1.9594
	Max.[4]	1.3427	1.4052	1.4677	1.5303	1.5928	1.6553	1.7135	1.9637
	Tol	.0038	.0038	.0038	.0039	.0039	.0039	.0041	.0043

[1] Pitch diameter tolerances include errors of lead and angle. The class 2 tolerances are based on the formulas in table 116 and a length of engagement of 6 threads. The class 3 tolerances are 70 percent of the class 2 tolerances.

[2] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the minimum screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h (or 0.6495 p), from the minimum pitch diameter of the screw.

[3] Dimensions for the minimum major diameter of the nut correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the nut shall be that corresponding to a flat at the major diameter of the maximum nut equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or 0.7939 p) to the maximum pitch diameter of the nut.

[4] These dimensions are the minimum metal or "not go" size. The "go" or basic size is the one that should be placed on the component drawing with the tolerance.

SECTION VI. SCREW THREADS OF SPECIAL DIAMETERS, PITCHES, AND LENGTHS OF ENGAGEMENT

The tolerances specified in section III of this report apply in general to bolts, nuts, and tapped holes of standard pitches and diameters. They are based on the pitch of the thread and a length of engagement equal to the basic major diameter, but are used for lengths of engagement up to 1½ diameters.

In addition to the foregoing threaded components, there are large quantities of threaded parts produced, such as hub and radiator caps in the automotive industry, threaded collars on machine tools, etc., where the diameters are larger, the pitches finer, and the lengths of engagement shorter than for bolt and nut practice. The following specifications have been adopted for such threaded parts, and the tolerances are based on the diameter, pitch, and length of engagement of the components.

1. FORM OF THREAD

The American National form of thread profile as specified in section III shall be used.

2. THREAD SERIES

In sections III, IV, and V there are given the limiting dimensions for standard thread series. The use of these series, wherever possible, is recommended for all applications.

Whenever sizes and pitches in the American National coarse, fine, or extra-fine, or the 8-, 12-, or 16-pitch thread series are not suitable, it is recommended that one of the following pitches be selected: 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 28, 32, 36, 40, 48, 56, 64 threads per inch.

Basic thread data for these pitches are given in table 36.

3. CLASSIFICATION AND TOLERANCES

There are established herein for general use four classes of screw-thread fits, which are named and numbered to correspond to the regular classification of fits given in section III. These four classes, together with the accompanying specifications, are intended to insure a uniform practice for screw threads not included in the American National coarse, fine, or extra-fine thread series, nor in the 8-, 12-, or 16-pitch thread series.

TABLE 36.—*Thread data for recommended pitches for special threads*

Threads per inch, *n*	Pitch, *p*	Depth of thread, *h*	Basic width of flat, *p*/8	Minimum width of flat at major diameter of nut, *p*/24
1	2	3	4	5
	Inch	*Inch*	*Inch*	*Inch*
64	0.01562	0.01015	0.00195	0.00065
56	.01786	.01160	.00223	.00074
48	.02083	.01353	.00260	.00087
40	.02500	.01624	.00312	.00104
36	.02778	.01804	.00347	.00116
32	.03125	.02030	.00391	.00130
28	.03571	.02320	.00446	.00149
24	.04167	.02706	.00521	.00174
20	.05000	.03248	.00625	.00208
18	.05556	.03608	.00694	.00231
16	.06250	.04059	.00781	.00260
14	.07143	.04639	.00893	.00298
12	.08333	.05413	.01042	.00347
10	.10000	.06495	.01250	.00417
8	.12500	.08119	.01562	.00521
6	.16667	.10825	.02083	.00694
4	.25000	.16238	.03125	.01042

It is not the intention of the Committee arbitrarily to place a general class or grade of work in a specific class of fit. Each manufacturer and user of screw threads is free to select the class of fit best adapted to his particular needs.

(a) GENERAL SPECIFICATIONS

The following general specifications apply to all classes of fit specified for screw threads of special diameters, pitches, and lengths of engagement.

1. UNIFORM MINIMUM NUT.—The pitch diameter of the minimum threaded hole or nut corresponds to the basic size.[13]

2. TOLERANCES.[14]—(*a*) The tolerances specified represent the extreme variations allowed on the product.

(*b*) The tolerance on the nut is plus, and is applied from the basic size to above basic size.

(*c*) The tolerance on the screw is minus, and is applied from the maximum screw size to below the maximum screw size.

(*d*) The pitch diameter tolerances for a screw and nut of a given class of fit are the same.

(*e*) Pitch diameter tolerances include all errors of pitch diameter, lead, and angle. The full tolerance cannot, therefore, be used on pitch diameter unless the lead and angle of the thread are perfect.

(*f*) The pitch diameter tolerances are obtained by adding three values, or increments; one dependent upon the basic major diameter, another upon the length of engagement, and the third upon the pitch of the thread. These increments are based on formulas given in appendix 1. However, where tolerance values so obtained exceed those given in section III for corresponding pitches of the American National coarse or fine thread series, and for any diameters equal to or less than these standard sizes and lengths of engagement equal to or less than one diameter, the tolerances given in section III are used. (See rules for using tolerance tables on p. 90.)

(*g*) The tolerances on the major diameters of the screws and minor diameters of the nuts are based on the pitch of the thread, as these control the depth of engagement; they are, therefore, based on the pitch alone.

(*h*) The minimum minor diameter of a screw of a given pitch is such as to result in a basic flat ($\frac{1}{8} \times p$) at the root when the pitch diameter of the screw is at its minimum value. When the maximum screw is basic, the minimum minor diameter of the screw will be below the basic minor diameter by the amount of the specified pitch diameter tolerance.

(*i*) The maximum minor diameter of a screw of a given pitch may be such as results from the use of a worn or rounded threading tool, when the pitch diameter is at its maximum value. In no case, however, should the form of the screw, as results from tool wear, be such as to cause the screw to be rejected on the maximum minor diameter by a "go" ring gage, the minor diameter of which is equal to the minimum minor diameter of the nut.

(*j*) The maximum major diameter of the nut of a given pitch is such as to result in a flat equal to one third of the basic flat ($\frac{1}{24} \times p$) when the pitch diameter of the nut is at its maximum value. When the minimum nut is basic, its maximum major diameter will be above the basic major diameter by the amount of the specified pitch diameter tolerance plus two-ninths of the basic thread depth.

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[13] Special cases will arise, however, when a class 1 thread is required on finished drawn tubing with thin walls, and in such cases the allowance should be made on the nut.

[14] Recommendations and explanations regarding the application of tolerances are given in appendix 1, p. 194.

(*k*) The nominal minimum major diameter of a nut is the basic major diameter. In no case, however, should the minimum major diameter of the nut, as results from a worn tap or cutting tool, be such as to cause the nut to be rejected on the minimum major diameter by a "go" plug gage made to the standard form at the crest.

(*l*) The tolerance on minor diameter of a nut of a given pitch is one-sixth of the basic thread depth regardless of the class of fit.[15]

(b) CLASSIFICATION OF FITS

1. Class 1 Fit.—This class is intended to cover the manufacture of threaded parts where quick and easy assembly is necessary and where an allowance is required.

This class is made with an allowance on the screw, so as to permit ready assembly, even when the threads are slightly bruised or dirty, in conformity with the practice in section III.[16]

Tables 37 and 38 give the limiting dimensions and tolerances for major, pitch, and minor diameters of threads of special diameters, pitches, and lengths of engagement.

2. Class 2 Fit.—This class is intended to apply to the major portion of threaded work in interchangeable manufacture, where no allowance is required. It is the same in every particular as class 1 except that it has no allowance and the tolerances are smaller.

Tables 37 and 39 give the limiting dimensions and tolerances for major, pitch, and minor diameters of threads of special diameters, pitches, and lengths of engagement.

3. Class 3 Fit.—This class is intended to apply to the higher grade of interchangeable screw-thread work. It is the same as class 2 in every particular except that the tolerances are smaller.

Tables 37 and 40 give the limiting dimensions and tolerances for major, pitch, and minor diameters of threads of special diameters, pitches, and lengths of engagement.

4. Class 4 Fit.—This class is intended for threaded work requiring a fine, snug fit, and where a screw driver or wrench may be necessary for assembly.

In the manufacture of screw-thread products belonging to this class it may be necessary to use precision tools, gages made to special tolerances for this class (see table 42, p. 102), and other refinements. This quality of work should, therefore, be used only in cases where requirements of the mechanism being produced are exacting. In order to secure the fit desired, it may be necessary in some cases to select the parts when the product is being assembled.

The maximum pitch diameters of the screws are slightly larger than the minimum pitch diameters of the nuts determined from table 37.

Tables 37 and 41 give the limiting dimensions and tolerances for major, pitch, and minor diameters of threads of special diameters, pitches, and lengths of engagement.

[15] Special threads having a length of engagement considerably less than one diameter will not develop the full strength of the screw. The minimum minor diameter of the nut of the American National form of thread is such as to provide a minimum clearance on diameter at the minor diameter equal to two-ninths of the basic thread depth. If this clearance is reduced by providing a greater percentage of thread depth in the nut, the strength of such a fastening is increased. In such cases when the screw is subject to considerable tension, it is permissible to make the minor diameter of the nut less than the minimum specified in order to give the necessary depth of engagement.

On the other hand, when the length of engagement is exceptionally long the minor diameter of the nut may be greater than the maximum specified without impairing the strength of the fastening.

[16] See footnote 13, p. 88.

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4. TABLES OF DIMENSIONS

In order to simplify the specification of dimensions of special fastening screw threads, tables 37, 38, 39, 40, and 41 are arranged herein, and are intended to cover all practical combinations of diameter, pitch, length of engagement, and class of fit. The use of these tables instead of the application of formulas to determine limiting dimensions of a special thread facilitates placing dimensions on drawings. Also, in cases of special threads of the same diameter, pitch, and class of fit, but slightly different lengths of engagement, the threads may be gaged by a single set of gages, as identical pitch diameter tolerances will be applied.

(*a*) Arrangement of Tables.—The arrangement of dimensions and tolerances given in these tables has the following features:

All thread dimensions of threads of special diameters, pitches, and lengths of engagement, except pitch diameter tolerances are derived from table 37.

Pitch diameter tolerances are taken from tables 38, 39, 40, or 41, depending upon the class of fit required. These pitch diameter tolerances were obtained by adding increments[17] corresponding to the major diameters at the top, the threads per inch at the side of the table, and mean lengths of engagement of ¼, 1, and 2¼ inches for pitches from 64 to 12 threads per inch, inclusive, and ½, 2, and 4½ inches for pitches from 10 to 4 threads per inch, inclusive. Thus, the increments of the pitch diameter tolerances based on length of engagement and on diameter vary by definite steps instead of continuously. However, in order that the tolerances given in these tables might be wholly consistent with those given in section III, certain values as listed are greater or less than those yielded by the above method. This modification was made by inserting in the tables, in the positions corresponding to standard sizes, pitches, and lengths of engagement of the American National coarse- and fine-thread series, the pitch diameter tolerances listed in section III. Then, wherever necessary, all values above and to the left of these inserted values were reduced so that none of them should exceed these standard values, and those below and to the right were increased so that none should be less than the standard values. This has the important advantage that in a series of sizes, frequently occurring in practice, consisting partly of standard sizes and partly of special sizes, there will be no undue irregularity in the progression of the pitch diameter tolerance, with consequent difficulties in securing gages, etc.

The maximum pitch diameter tolerances listed are equal to the tolerances on the major diameter of the screws of the same pitch, as given in table 37.

(*b*) Rules for Use of Tables.—For consistent application of these pitch diameter tolerance tables to all cases, adherence to the following rules relative to the use of the tables is necessary:

1. Tolerances on pitch diameter corresponding to major diameters between those for which values are given in the tables shall be those of the next larger diameter.

2. Tolerances on pitch diameter for pitches between those for which values are given in the tables shall be those of the next coarser

[17] The formulas for determining such increments are listed on p. 195.

pitch, except that for screws having 80, 72, 44, 13, 11, 9, 7, 5, or 4½ threads per inch, lengths of engagement of one and one half diameters or less, and diameters less than the standard diameters for the respective pitches as given in section III, the tolerances given in section III shall be used.

3. Tolerances on pitch diameter for pitches coarser than 4 threads per inch shall be the same as those for 4 threads per inch.

4. Tolerances on pitch diameter when the length of engagement is exactly ½, or 1½, inches for 12 threads per inch and finer, or 1, or 3, inches for pitches coarser than 12 threads per inch, shall correspond to the interval of which these are the upper limits.

5. Tolerances on pitch diameter for lengths of engagement greater than those for which values are given shall be the maximum values listed for the pitch concerned.

(c) Examples.—The following examples illustrate the use of these tables:

Example: 3¼-inch, 16-thread, class 1, with allowance on screw, one half inch length of engagement:

From table 38:
Pitch diameter tolerance .... =0. 0095
Also from table 37, for the screw:
Maximum major diameter=3. 2500−0. 0018=3. 2482
Minimum major diameter =3. 2482− . 0126=3. 2356
Maximum minor diameter=3. 2500− . 0785=3. 1715
Maximum pitch diameter =3. 2500− . 0424=3. 2076
Minimum pitch diameter =3. 2076− . 0095=3. 1981
And for the nut:
Minimum major diameter .... =3. 2500
Minimum minor diameter =3. 2500− . 0677=3. 1823
Maximum minor diameter=3. 1823+ . 0068=3. 1891
Minimum pitch diameter =3. 2500− . 0406=3. 2094
Maximum pitch diameter =3. 2094+ . 0095=3. 2189

Example: 3-inch, 24-thread, class 2 fit, five eighths inch length of engagement:

From table 39:
Pitch diameter tolerance .... =0. 0066

In this instance the pitch diameter tolerance is printed in italics. In accordance with the footnote under table 37 it is desirable to avoid the use of tolerances set in italics as the combination of class of fit, length of engagement, pitch, and diameter is disproportionate. If it is decided to use a closer fit, class 3 fit or class 4 fit may be chosen. Assuming the choice of class 3 fit, the following dimensions are obtained:

From table 40:
Pitch diameter tolerance .... =0. 0065
From table 37 for the screw:
Maximum major diameter .... =3. 0000
Minimum major diameter =3. 0000−0. 0066=2. 9934
Maximum minor diameter =3. 0000− . 0511=2. 9489
Maximum pitch diameter =3. 0000− . 0271=2. 9729
Minimum pitch diameter =2. 9729− . 0065=2. 9664
And for the nut:
Minimum major diameter .... =3. 0000
Minimum minor diameter =3. 0000− . 0451=2. 9549
Maximum minor diameter =2. 9549+ . 0045=2. 9594
Minimum pitch diameter =3. 0000− . 0271=2. 9729
Maximum pitch diameter =2. 9729+ . 0065=2. 9794

If, instead, it is decided to reduce the length of engagement to one half inch, the following dimensions are obtained:

From table 39:

Pitch diameter tolerance ------------------ =0. 0060

From table 37 for the screw:

Maximum major diameter ------------------ =3. 0000
Minimum major diameter =3. 0000−0. 0066=2. 9934
Maximum minor diameter =3. 0000− . 0511=2. 9489
Maximum pitch diameter =3. 0000− . 0271=2. 9729
Minimum pitch diameter =2. 9729− . 0060=2. 9669

And for the nut:

Minimum major diameter ------------------ =3. 0000
Minimum minor diameter =3. 0000− . 0451=2. 9549
Maximum minor diameter =2. 9549+ . 0045=2. 9594
Minimum pitch diameter =3. 0000− . 0271=2. 9729
Maximum pitch diameter =2. 9729+ . 0060=2. 9789

TABLE 37.—*Values for obtaining thread dimensions of special screw threads, classes 1, 2, 3, and 4 fits*

Threads per inch	SCREW SIZES: To obtain maximum dimensions for major, pitch, and minor diameters, subtract the values in the "maximum" columns from the basic major diameter. Apply tolerances minus. See tables 38, 39, 40, and 41 for pitch diameter tolerances.									NUT SIZES: To obtain minimum dimensions for minor, pitch, and major diameters, subtract the values in the "minimum" columns from the basic major diameter. Apply tolerances plus. See tables 38, 39, 40, and 41 for pitch diameter tolerances.			
	Major diameter				Pitch diameter, maximum			Minor diameter [1] maximum		Minor diameter		Pitch diameter, minimum	Major diameter [2] minimum
	Maximum		Tolerance							Minimum	Tolerance		
	Class 1	Classes 2, 3, 4	Class 1	Classes 2, 3, 4	Class 1	Classes 2, 3	Class 4	Class 1	Classes 2, 3, 4	Classes 1, 2, 3, and 4			
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
64	0.0007	0.0000	0.0052	0.0038	0.0108	0.0101	0.0100	0.0199	0.0192	0.0169	0.0017	0.0101	0.0000
56	.0008	.0000	.0056	.0040	.0124	.0116	.0114	.0227	.0219	.0193	.0019	.0116	.0000
48	.0009	.0000	.0062	.0044	.0144	.0135	.0133	.0265	.0256	.0226	.0023	.0135	.0000
40	.0010	.0000	.0068	.0048	.0172	.0162	.0160	.0317	.0307	.0271	.0027	.0162	.0000
36	.0011	.0000	.0072	.0050	.0191	.0180	.0178	.0352	.0341	.0301	.0030	.0180	.0000
32	.0011	.0000	.0076	.0054	.0214	.0203	.0201	.0394	.0383	.0338	.0034	.0203	.0000
28	.0012	.0000	.0086	.0062	.0244	.0232	.0230	.0450	.0438	.0387	.0039	.0232	.0000
24	.0013	.0000	.0092	.0066	.0284	.0271	.0268	.0524	.0511	.0451	.0045	.0271	.0000
20	.0015	.0000	.0102	.0072	.0340	.0325	.0322	.0628	.0613	.0541	.0054	.0325	.0000
18	.0016	.0000	.0114	.0082	.0377	.0361	.0358	.0698	.0682	.0601	.0060	.0361	.0000
16	.0018	.0000	.0126	.0090	.0424	.0406	.0402	.0785	.0767	.0677	.0068	.0406	.0000
14	.0021	.0000	.0140	.0098	.0485	.0464	.0460	.0897	.0876	.0773	.0077	.0464	.0000
12	.0024	.0000	.0158	.0112	.0565	.0541	.0536	.1046	.1022	.0902	.0090	.0541	.0000
10	.0028	.0000	.0184	.0128	.0678	.0650	.0644	.1255	.1227	.1083	.0109	.0650	.0000
8	.0034	.0000	.0222	.0152	.0846	.0812	.0805	.1568	.1534	.1353	.0135	.0812	.0000
6	.0044	.0000	.0290	.0202	.1127	.1083	.1074	.2089	.2045	.1804	.0180	.1083	.0000
4	.0064	.0000	.0408	.0280	.1688	.1624	.1611	.3131	.3067	.2706	.0270	.1624	.0000

[1] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the minimum screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h (or $0.6495p$) from the minimum pitch diameter of the screw.

[2] Dimensions for the minimum major diameter of the nut correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the nut shall be that corresponding to a flat at the major diameter of the maximum nut equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the nut.

TABLE 38.—*Pitch diameter tolerances for special screw threads, class 1 fit*

Threads per inch	Lengths of engagement		Pitch diameter tolerances for diameters up to and including—																				
	From—	To and including—	1/16 inch	1/8 inch	3/16 inch	1/4 inch	3/8 inch	1/2 inch	3/4 inch	1 inch	1½ inches	2 inches	3 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches	24 inches
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
64		½	0.0026	0.0026	0.0034	0.0038	0.0042	0.0044	0.0047	0.0050	0.0052												
56		½	.0028	.0028	.0034	.0038	.0044	.0046	.0049	.0052	.0056												
	½	1½	.0052	.0054	.0055	.0056	*.0056*	*.0056*	*.0056*	*.0056*	*.0056*												
48		½	.0031	.0031	.0034	.0038	.0046	.0048	.0051	.0054	.0058	0.0062											
	½	1½	.0054	.0056	.0057	.0057	.0057	.0057	.0057	.0062	*.0062*	*.0062*											
40		½	.0034	[1].0034	.0034	.0038	.0046	.0051	.0054	.0057	.0061	.0065											
	½	1½	.0057	.0057	.0057	.0057	.0057	.0057	.0057	.0068	*.0068*	*.0068*											
36		½		.0036	.0036	.0038	.0046	.0051	.0056	.0058	.0063	.0067	0.0072										
	½	1½		.0057	.0057	.0057	.0057	.0057	.0057	.0070	.0072	*.0072*	*.0072*										
32		½		.0038	.0038	.0038	.0046	.0051	.0057	.0060	.0065	.0069	.0075										
	½	1½		.0057	.0057	.0057	.0057	.0057	.0057	.0070	.0076	*.0076*	*.0076*										
28		½			.0043	[2].0043	.0046	.0051	.0057	.0063	.0067	.0071	.0077	0.0083									
	½	1½			.0057	.0057	.0057	.0057	.0057	.0070	.0079	.0086	*.0086*	*.0086*									
24		½			.0046	.0046	[2].0046	.0051	.0057	.0066	.0070	.0074	.0080	.0086									
	½	1½			.0057	.0057	.0057	.0057	.0057	.0070	.0079	.0089	.0092	*.0092*									
20		½			.0051	[1].0051	.0051	[2].0051	.0057	.0070	.0074	.0078	.0084	.0090	0.0099								
	½	1½			.0057	.0057	.0057	.0057	.0057	.0070	.0079	.0093	.0099	.0102	*.0102*								
	1½	3			.0098	.0100	.0102	*.0102*	*.0102*	*.0102*	*.0102*	*.0102*	*.0102*	*.0102*	*.0102*								
18		½				.0057	.0057	.0057	.0057	.0070	.0077	.0080	.0087	.0092	.0101	0.0109	0.0114						
	½	1½				.0057	.0057	.0057	.0057	.0070	.0079	.0095	.0102	.0107	.0114	*.0114*	*.0114*						
	1½	3				.0102	.0104	.0106	.0109	.0112	.0114	*.0114*	*.0114*	*.0114*	*.0114*	*.0114*	*.0114*						
16		½				.0063	[1].0063	.0063	.0063	.0070	.0079	.0083	.0090	.0095	.0104	.0112	.0118	0.0124					
	½	1½				.0063	.0063	.0063	[2].0063	.0070	.0079	.0098	.0105	.0110	.0119	.0126	*.0126*	*.0126*					
	1½	3				.0105	.0107	.0109	.0112	.0115	.0120	.0123	.0126	*.0126*	*.0126*	*.0126*	*.0126*	*.0126*					

	------	½	------	------	------	------	.0070	.0070	.0070	.0070	.0079	.0087	.0093	.0099	.0108	.0115	.0122	.0128	0.0133	0.0138	------	------	------
14	½	1½	------	------	------	------	.0070	.0070	.0070	[2].0070	.0079	.0102	.0108	.0114	.0123	.0130	.0137	.0140	*.0140*	*.0140*	------	------	------
	1½	3	------	------	------	------	.0111	.0113	.0116	.0119	.0123	.0127	.0133	.0139	.0140	*.0140*	*.0140*	*.0140*	*.0140*	*.0140*	------	------	------
	------	½	------	------	------	------	.0075	.0077	.0079	.0079	.0079	.0091	.0097	.0103	.0112	.0119	.0126	.0132	.0138	.0143	0.0148	0.0152	------
12	½	1½	------	------	------	------	.0079	.0079	.0079	.0079	[2].0079	.0106	.0112	.0118	.0127	.0134	.0141	.0147	.0153	.0158	*.0158*	*.0158*	------
	1½	3	------	------	------	------	.0115	.0117	.0120	.0123	.0127	.0131	.0137	.0143	.0152	.0158	*.0158*	*.0153*	*.0158*	*.0158*	*.0158*	*.0158*	------
	------	1	------	------	------	------	------	.0087	[1].0092	.0098	.0102	.0106	.0112	.0118	.0127	.0134	.0141	.0147	.0153	.0158	.0158	.0163	0.0171
10	1	3	------	------	------	------	------	.0117	.0120	.0123	.0128	.0132	.0138	.0143	.0152	.0160	.0166	.0172	.0178	.0183	*.0184*	*.0184*	*.0184*
	3	6	------	------	------	------	------	.0167	.0171	.0173	.0178	.0181	.0184	*.0184*	*.0184*	*.0184*	*.0184*	*.0184*	*.0184*	*.0184*	*.0184*	*.0184*	*.0184*
	------	1	------	------	------	------	------	.0095	.0098	[1].0111	.0111	.0111	.0115	.0121	.0130	.0137	.0144	.0150	.0156	.0161	.0166	.0170	.0179
8	1	3	------	------	------	------	------	.0125	.0128	.0131	.0135	.0139	.0145	.0151	.0160	.0167	.0174	.0180	.0186	.0191	.0196	.0200	.0209
	3	6	------	------	------	------	------	.0175	.0178	.0181	.0185	.0189	.0195	.0201	.0210	.0217	.0222	*.0222*	*.0222*	*.0222*	*.0222*	*.0222*	*.0222*
	------	1	------	------	------	------	------	------	.0109	.0112	.0116	.0120	.0126	.0132	.0141	.0148	.0155	.0161	.0166	.0172	.0176	.0181	.0190
6	1	3	------	------	------	------	------	------	.0139	.0142	[1].0145	.0150	.0156	.0162	.0171	.0178	.0185	.0191	.0196	.0202	.0206	.0211	.0220
	3	6	------	------	------	------	------	------	.0189	.0192	.0196	.0200	.0206	.0212	.0221	.0228	.0235	.0241	.0246	.0252	.0256	.0261	.0270
	------	1	------	------	------	------	------	------	------	.0130	.0134	.0138	.0145	.0150	.0159	.0167	.0173	.0179	.0185	.0190	.0195	.0199	.0208
4	1	3	------	------	------	------	------	------	------	.0160	.0164	.0168	[1].0204	.0204	.0204	.0204	.0204	.0209	.0215	.0220	.0225	.0229	.0238
	3	6	------	------	------	------	------	------	------	.0210	.0215	.0218	.0225	.0230	.0239	.0247	.0253	.0259	.0265	.0270	.0275	.0279	.0288

[1] Standard size of the American National coarse-thread series.
[2] Standard size of the American National fine-thread series.

NOTE.—It is preferable to avoid the use of tolerances set in italics by choosing a closer fit, shorter length of engagement, coarser pitch, or smaller diameter.

TABLE 39.—*Pitch diameter tolerances for special screw threads, class 2 fit*

Threads per inch	Lengths of engagement		Pitch diameter tolerances for diameters up to and including—																					
	From—	To and including—	1/16 inch	1/8 inch	3/16 inch	1/4 inch	3/8 inch	1/2 inch	3/4 inch	1 inch	1½ inches	2 inches	3 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches	24 inches
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
64		½	0.0019	0.0019	0.0024	0.0027	0.0030	0.0032	0.0035	0.0038													
56		½	.0020	.0020	.0024	.0027	.0031	.0033	.0036	.0038	0.0040												
	½	1½	.0038	.0040	*.0040*	*.0040*	*.0040*	*.0040*	*.0040*	*.0040*	*.0040*												
48		½	.0022	.0022	.0024	.0027	.0032	.0034	.0037	.0039	.0044												
	½	1½	.0039	.0041	.0041	.0041	.0041	.0041	.0041	.0044	*.0044*												
40		½	.0024	[1] .0024	.0024	.0027	.0033	.0035	.0038	.0041	.0045	0.0048											
	½	1½	.0041	.0041	.0041	.0041	.0041	.0041	.0041	.0048	*.0048*	*.0048*											
36		½		.0025	.0025	.0027	.0033	.0036	.0039	.0042	.0046	.0050											
	½	1½		.0041	.0041	.0041	.0041	.0041	.0041	.0049	.0050	*.0050*											
32		½		.0027	.0027	.0027	.0033	.0036	.0040	.0043	.0047	.0051	0.0054										
	½	1½		.0041	.0041	.0041	.0041	.0041	.0041	.0049	.0054	*.0054*	*.0054*										
28		½			.0031	[2] .0031	.0033	.0036	.0041	.0044	.0048	.0052	.0058	0.0062									
	½	1½			.0041	.0041	.0041	.0041	.0041	.0049	.0056	.0062	*.0062*	*.0062*									
24		½			.0033	.0033	[2] .0033	.0036	.0041	.0045	.0050	.0054	.0060	.0065									
	½	1½			.0041	.0041	.0041	.0041	.0041	.0049	.0056	.0066	*.0066*	*.0066*									
20		½			.0036	[1] .0036	.0036	[2] .0036	.0041	.0047	.0052	.0056	.0062	.0067	0.0072								
	½	1½			.0041	.0041	.0041	.0041	.0041	.0049	.0056	.0071	.0072	*.0072*	*.0072*								
18		½				.0039	.0041	.0041	.0041	.0049	.0053	.0057	.0063	.0069	.0078	0.0082							
	½	1½				.0041	.0041	.0041	.0041	.0049	.0056	.0072	.0078	.0082	*.0082*	*.0082*							
	1½	3				.0079	.0081	.0082	*.0082*	*.0082*	*.0082*	*.0082*	*.0082*	*.0082*	*.0082*	*.0082*							
16		½				.0040	[1] .0045	.0045	.0045	.0049	.0054	.0058	.0065	.0070	.0079	.0087	0.0090						
	½	1½				.0045	.0045	.0045	[2] .0045	.0049	.0056	.0073	.0080	.0085	.0090	*.0090*	*.0090*						
	1½	3				.0080	.0082	.0084	.0087	.0090	*.0090*	*.0090*	*.0090*	*.0090*	*.0090*	*.0090*	*.0090*						
14		½					.0045	.0048	.0049	.0049	.0056	.0060	.0066	.0072	.0081	.0088	.0095	0.0098					
	½	1½					.0049	.0049	.0049	[2] .0049	.0056	.0075	.0081	.0087	.0096	.0098	*.0098*	*.0098*					
	1½	3					.0084	.0086	.0089	.0092	.0096	.0098	*.0098*	*.0098*	*.0098*	*.0098*	*.0098*	*.0098*					

	------	½	------	------	------	------	.0046	.0048	.0051	.0054	.0056	.0062	.0068	.0074	.0083	.0090	.0097	.0103	0.0109	0.0112	------	------	------
12	½	1½	------	------	------	------	.0056	.0056	.0056	.0056	[2].0056	.0077	.0083	.0089	.0098	.0105	.0112	*.0112*	*.0112*	*.0112*	------	------	------
	1½	3	------	------	------	------	.0086	.0088	.0091	.0094	.0098	.0100	.0108	.0112	*.0112*	*.0112*	*.0112*	*.0112*	*.0112*	*.0112*	------	------	------
	------	1	------	------	------	------	------	.0056	[1].0064	.0069	.0073	.0077	.0083	.0089	.0098	.0105	.0112	.0112	.0116	.0122	.0126	0.0128	------
10	1	3	------	------	------	------	------	.0088	.0091	.0094	.0098	.0100	.0108	.0112	.0121	.0128	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	------
	3	6	------	------	------	------	------	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	------
	------	1	------	------	------	------	------	.0060	.0064	[1].0076	.0076	.0077	.0083	.0089	.0098	.0105	.0112	.0115	.0120	.0125	.0130	.0135	0.0143
8	1	3	------	------	------	------	------	.0090	.0093	.0095	.0100	.0104	.0110	.0115	.0124	.0132	.0139	.0145	.0150	.0152	*.0152*	*.0152*	*.0152*
	3	6	------	------	------	------	------	.0140	.0143	.0145	.0150	.0152	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*
	------	1	------	------	------	------	------	------	.0068	.0071	.0075	.0079	.0085	.0091	.0100	.0107	.0114	.0120	.0126	.0131	.0136	.0140	.0149
6	1	3	------	------	------	------	------	------	.0098	.0101	[1].0101	.0109	.0115	.0121	.0130	.0137	.0144	.0150	.0156	.0161	.0166	.0170	.0179
	3	6	------	------	------	------	------	------	.0148	.0151	.0155	.0159	.0165	.0171	.0180	.0187	.0194	.0200	.0202	*.0202*	*.0202*	*.0202*	*.0202*
	------	1	------	------	------	------	------	------	------	.0080	.0084	.0088	.0095	.0100	.0109	.0117	.0123	.0129	.0135	.0140	.0145	.0149	.0158
4	1	3	------	------	------	------	------	------	------	.0110	.0114	.0118	[1].0140	.0140	.0140	.0147	.0153	.0159	.0165	.0170	.0175	.0179	.0188
	3	6	------	------	------	------	------	------	------	.0160	.0164	.0168	.0175	.0180	.0189	.0197	.0203	.0209	.0215	.0220	.0225	.0229	.0238

[1] Standard size of the American National coarse-thread series. [2] Standard size of the American National fine-thread series.

NOTE.—It is preferable to avoid the use of tolerances set in italics by choosing a closer fit, shorter length of engagement, coarser pitch, or smaller diameter. Attention is directed to table 28 in the 1941 SAE Handbook, which is to be studied by the Committee as a substitute for the above table.

TABLE 40.—*Pitch diameter tolerances for special screw threads, class 3 fit*

Threads per inch	Lengths of engagement		Pitch diameter tolerances for diameters up to and including—																				
	From—	To and including—	1/16 inch	1/8 inch	3/16 inch	1/4 inch	3/8 inch	1/2 inch	3/4 inch	1 inch	1½ inches	2 inches	3 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches	24 inches
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
64		½	0.0014	0.0014	0.0017	0.0019	0.0023	0.0025	0.0028	0.0031	0.0036	0.0038											
	½	1½	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0036	.0038	*.0038*											
56		½	.0015	.0015	.0017	.0019	.0024	.0026	.0029	.0032	.0036	.0040											
	½	1½	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0036	.0040	*.0040*											
48		½	.0016	.0016	.0017	.0019	.0024	.0026	.0029	.0032	.0037	.0041	0.0044										
	½	1½	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0036	.0040	.0044	*.0044*										
40		½	.0017	[1].0017	.0017	.0019	.0024	.0026	.0030	.0033	.0037	.0041	.0048										
	½	1½	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0036	.0040	.0048	*.0048*										
36		½		.0018	.0018	.0019	.0024	.0026	.0030	.0033	.0038	.0042	.0048	0.0050									
	½	1½		.0030	.0030	.0030	.0030	.0030	.0030	.0036	.0040	.0050	*.0050*	*.0050*									
32		½		.0019	.0019	.0019	.0024	.0026	.0030	.0034	.0038	.0042	.0048	.0054									
	½	1½		.0030	.0030	.0030	.0030	.0030	.0030	.0036	.0040	.0054	*.0054*	*.0054*									
28		½			.0022	[2].0022	.0024	.0026	.0030	.0034	.0039	.0043	.0049	.0054	0.0062								
	½	1½			.0030	.0030	.0030	.0030	.0030	.0036	.0040	.0058	.0062	*.0062*	*.0062*								
24		½			.0024	.0024	[2].0024	.0026	.0030	.0035	.0040	.0044	.0050	.0055	.0064								
	½	1½			.0030	.0030	.0030	.0030	.0030	.0036	.0040	.0059	.0065	.0066	*.0066*								
20		½			.0025	[1].0026	.0026	[2].0026	.0030	.0036	.0040	.0045	.0051	.0056	.0065	0.0072							
	½	1½			.0030	.0030	.0030	.0030	.0030	.0036	.0040	.0060	.0066	.0071	.0072	*.0072*							
	1½	3			.0065	.0066	.0068	.0070	.0071	*.0071*	*.0071*	*.0072*	*.0072*	*.0072*	*.0072*	*.0072*							
18		½				.0027	.0030	.0030	.0030	.0036	.0010	.0045	.0051	.0057	.0066	.0073	0.0080						
	½	1½				.0030	.0030	.0030	.0030	.0036	.0040	.0060	.0066	.0072	.0081	.0082	*.0082*						
	1½	3				.0067	.0069	.0071	.0071	.0071	.0071	.0082	*.0082*	*.0082*	*.0082*	*.0082*	*.0082*						
16		½				.0028	[1].0032	.0032	.0032	.0036	.0040	.0046	.0052	.0058	.0066	.0074	.0081	0.0087					
	½	1½				.0032	.0032	.0032	[2].0032	.0036	.0040	.0061	.0067	.0073	.0081	.0089	.0090	*.0090*					
	1½	3				.0068	.0070	.0071	.0071	.0071	.0071	.0084	.0090	*.0090*	*.0090*	*.0090*	*.0090*	*.0090*					

	-------	½	------	------	------	------	.0032	.0036	.0036	.0036	.0040	.0047	.0053	.0058	.0067	.0075	.0082	.0088	0.0093	0.0098	-------	-------	-------
14	½	1½	------	------	------	------	.0036	.0036	.0036	[2].0036	.0040	.0062	.0068	.0073	.0082	.0090	.0097	.0098	*.0098*	*.0098*	-------	-------	-------
	1½	3	------	------	------	------	.0071	.0071	.0071	.0071	.0071	.0084	.0092	.0098	*.0098*	*.0098*	*.0098*	*.0098*	*.0098*	*.0098*	-------	-------	-------
	-------	½	------	------	------	------	.0032	.0036	.0040	.0040	.0040	.0048	.0054	.0059	.0068	.0076	.0083	.0089	.0094	.0099	0.0104	0.0109	-------
12	½	1½	------	------	------	------	.0040	.0040	.0040	.0040	[2].0040	.0063	.0069	.0074	.0083	.0091	.0098	.0104	.0109	.0112	*.0112*	*.0112*	-------
	1½	3	------	------	------	------	.0071	.0071	.0071	.0071	.0071	.0084	.0092	.0099	.0108	.0112	*.0112*	*.0112*	*.0112*	*.0112*	*.0112*	*.0112*	-------
	-------	1	------	------	------	------	------	.0040	[1].0045	.0054	.0059	.0063	.0069	.0074	.0083	.0091	.0098	.0104	.0109	.0112	.0112	.0115	0.0124
10	1	3	------	------	------	------	------	.0071	.0071	.0071	.0071	.0084	.0092	.0099	.0108	.0112	.0119	.0125	.0128	*.0128*	*.0128*	*.0128*	*.0128*
	3	6	------	------	------	------	------	.0120	.0123	.0126	.0128	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*	*.0128*
	-------	1	------	------	------	------	------	.0042	.0045	[1].0054	.0059	.0063	.0069	.0074	.0083	.0091	.0098	.0104	.0109	.0112	.0113	.0117	.0126
8	1	3	------	------	------	------	------	.0071	.0071	.0071	.0071	.0086	.0092	.0099	.0108	.0114	.0121	.0127	.0132	.0138	.0143	.0147	.0152
	3	6	------	------	------	------	------	.0128	.0125	.0128	.0132	.0136	.0142	.0148	.0152	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*	*.0152*
	-------	1	------	------	------	------	------	------	.0048	.0054	.0059	.0063	.0069	.0074	.0083	.0091	.0098	.0104	.0109	.0112	.0115	.0120	.0128
6	1	3	------	------	------	------	------	------	.0071	.0071	[1].0071	.0089	.0095	.0100	.0109	.0117	.0124	.0130	.0135	.0140	.0145	.0150	.0158
	3	6	------	------	------	------	------	------	.0122	.0130	.0135	.0139	.0145	.0150	.0159	.0167	.0174	.0180	.0185	.0190	.0195	.0200	.0202
	-------	1	------	------	------	------	------	------	------	.0055	.0059	.0063	.0070	.0075	.0084	.0092	.0098	.0104	.0110	.0115	.0120	.0124	.0133
4	1	3	------	------	------	------	------	------	------	.0085	.0089	.0093	[1].0097	.0105	.0114	.0122	.0128	.0134	.0140	.0145	.0150	.0154	.0163
	3	6	------	------	------	------	------	------	------	.0135	.0139	.0143	.0150	.0155	.0164	.0172	.0178	.0184	.0190	.0195	.0200	.0204	.0213

[1] Standard size of the American National coarse-thread series.
[2] Standard size of the American National fine-thread series.

NOTE.—It is preferable to avoid the use of tolerances set in italics by choosing a closer fit, shorter length of engagement, coarser pitch, or smaller diameter. Attention is directed to table 29 in the 1941 SAE Handbook, which is to be studied by the Committee as a substitute for the above table.

TABLE 41.—*Pitch diameter tolerances for special screw threads, class 4 fit*

Threads per inch	Lengths of engagement		Pitch diameter tolerances for diameters up to and including—																	
	From—	To and including—	¼ inch	⅜ inch	½ inch	¾ inch	1 inch	1½ inches	2 inches	3 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches	24 inches
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
	------	½	[1]0.0011	0.0012	0.0013	0.0015	0.0017	0.0019	0.0021	0.0024	0.0027	0.0032	0.0036	0.0039	0.0042	0.0045	0.0047	0.0050	0.0052	0.0056
28	½	1½	.0015	.0015	.0015	.0015	.0018	.0020	.0029	.0032	.0035	.0039	.0043	.0046	.0049	.0052	.0055	.0057	.0059	.0062
	1½	3	.0032	.0033	.0034	.0036	.0036	.0036	.0041	.0044	.0047	.0052	.0056	.0059	*.0062*	*.0062*	*.0062*	*.0062*	*.0062*	*.0062*
	------	½	.0012	[1].0012	.0013	.0015	.0018	.0020	.0022	.0025	.0028	.0032	.0036	.0039	.0042	.0045	.0048	.0050	.0052	.0057
24	½	1½	.0015	.0015	.0015	.0015	.0018	.0020	.0029	.0032	.0035	.0040	.0043	.0047	.0050	.0052	.0055	.0057	.0060	.0064
	1½	3	.0033	.0034	.0035	.0036	.0036	.0036	.0042	.0045	.0048	.0052	.0056	.0059	.0062	.0065	.0066	*.0066*	*.0066*	*.0066*
	------	½	[2].0013	.0013	[1].0013	.0015	.0018	.0020	.0022	.0025	.0028	.0033	.0036	.0040	.0043	.0046	.0048	.0050	.0053	.0057
20	½	1½	.0015	.0015	.0015	.0015	.0018	.0020	.0030	.0033	.0036	.0040	.0044	.0047	.0050	.0053	.0056	.0058	.0060	.0065
	1½	3	.0033	.0034	.0035	.0036	.0036	.0036	.0042	.0045	.0048	.0053	.0056	.0060	.0063	.0066	.0068	.0070	.0072	.0072
	------	½	.0013	.0015	.0015	.0015	.0018	.0020	.0023	.0026	.0028	.0033	.0037	.0040	.0043	.0046	.0048	.0051	.0053	.0057
18	½	1½	.0015	.0015	.0015	.0015	.0018	.0020	.0030	.0033	.0036	.0040	.0044	.0047	.0050	.0053	.0056	.0058	.0061	.0065
	1½	3	.0033	.0034	.0035	.0036	.0036	.0036	.0042	.0046	.0048	.0053	.0057	.0060	.0063	.0066	.0068	.0071	.0073	.0077
	------	½	.0014	[2].0016	.0016	.0016	.0018	.0020	.0023	.0026	.0029	.0033	.0037	.0040	.0043	.0046	.0049	.0051	.0053	.0058
16	½	1½	.0016	.0016	.0016	[1].0016	.0018	.0020	.0030	.0033	.0036	.0041	.0044	.0048	.0051	.0054	.0056	.0059	.0061	.0065
	1½	3	.0034	.0035	.0036	.0036	.0036	.0036	.0042	.0046	.0049	.0053	.0057	.0060	.0063	.0066	.0069	.0071	.0073	.0078
	------	½	------	.0016	.0018	.0018	.0018	.0020	.0023	.0026	.0029	.0034	.0038	.0041	.0044	.0047	.0049	.0052	.0054	.0058
14	½	1½	------	.0018	.0018	.0018	[1].0018	.0020	.0031	.0034	.0037	.0041	.0045	.0048	.0051	.0054	.0057	.0059	.0061	.0066
	1½	3	------	.0035	.0036	.0036	.0036	.0036	.0042	.0046	.0049	.0054	.0058	.0061	.0064	.0067	.0069	.0072	.0074	.0078
	------	½	------	.0016	.0018	.0020	.0020	.0020	.0024	.0027	.0030	.0034	.0038	.0041	.0044	.0047	.0050	.0052	.0054	.0059
12	½	1½	------	.0020	.0020	.0020	.0020	[1].0020	.0031	.0034	.0037	.0042	.0046	.0049	.0052	.0055	.0057	.0060	.0062	.0066
	1½	3	------	.0036	.0036	.0036	.0036	.0036	.0042	.0046	.0050	.0054	.0058	.0061	.0064	.0067	.0070	.0072	.0074	.0079
	------	1	------	------	.0020	[2].0023	.0023	.0023	.0031	.0034	.0037	.0042	.0046	.0049	.0052	.0055	.0057	.0060	.0062	.0066
10	1	3	------	------	.0036	.0036	.0036	.0036	.0042	.0046	.0050	.0054	.0058	.0061	.0064	.0067	.0070	.0072	.0074	.0079
	3	6	------	------	.0060	.0062	.0063	.0065	.0067	.0070	.0073	.0077	.0081	.0084	.0088	.0090	.0093	.0095	.0098	.0102
	------	1	------	------	.0021	.0023	[2].0027	.0027	.0031	.0034	.0037	.0042	.0046	.0049	.0052	.0055	.0057	.0060	.0062	.0066
8	1	3	------	------	.0036	.0036	.0036	.0036	.0043	.0046	.0050	.0054	.0058	.0061	.0064	.0067	.0070	.0072	.0074	.0079
	3	6	------	------	.0061	.0062	.0064	.0066	.0068	.0071	.0074	.0078	.0082	.0085	.0088	.0091	.0094	.0096	.0099	.0103
	------	1	------	------	------	.0024	.0027	.0027	.0031	.0034	.0037	.0042	.0046	.0049	.0052	.0055	.0057	.0060	.0062	.0066
6	1	3	------	------	------	.0036	.0036	[2].0036	.0044	.0047	.0050	.0055	.0058	.0062	.0065	.0068	.0070	.0073	.0075	.0079
	3	6	------	------	------	.0064	.0065	.0067	.0069	.0072	.0075	.0080	.0083	.0087	.0090	.0093	.0095	.0098	.0100	.0104
	------	1	------	------	------	------	.0028	.0030	.0032	.0035	.0038	.0042	.0046	.0049	.0052	.0055	.0058	.0060	.0062	.0066
4	1	3	------	------	------	------	.0043	.0045	.0047	[2].0048	.0053	.0057	.0061	.0064	.0067	.0070	.0073	.0075	.0077	.0082
	3	6	------	------	------	------	.0068	.0070	.0072	.0075	.0078	.0082	.0086	.0089	.0092	.0095	.0098	.0100	.0102	.0106

[1] Standard size of the American National fine-thread series.

[2] Standard size of the American National coarse-thread series.

NOTE.—It is preferable to avoid the use of tolerances set in italics by choosing a shorter length of engagement, coarser pitch, or smaller diameter.

5. GAGES

The classification of gages as presented in section III, division 5, "Gages", applies also to gages for special threads. Gage tolerances are the same except for diameters above 1½ inches. The thread form of plug and ring gages is the same as in section III, except:

(1) The major diameter of the "not go" plug gage shall equal the basic pitch diameter (minimum pitch diameter of internal thread) plus two-thirds basic thread depth plus gage tolerance, with a minus gage tolerance, or

Max. major diameter "not go" plug

$$=\text{basic pitch diameter}+2/3h+\text{gage tolerance.}$$

(2) The minor diameter of the "not go" ring gage shall be midway between the pitch diameter of the "not go" ring (minimum pitch diameter of external thread) and the minor diameter of the "go" ring, with a plus gage tolerance, or

Min. minor diameter of "not go" ring

$$=\text{basic pitch diameter}-h/3-\frac{\text{allowance}+\text{product tolerance.}}{2}$$

(3) The major diameter of the "not go" setting plug shall equal the minimum major diameter of the external thread with a plus tolerance. However, a setting plug with full and truncated portions, as specified in section III, will be accepted.

(4) A relief at the minor diameter, the width of which is approximately one-fourth the pitch, shall be provided for "not go" plug gages for class 1.

In ordering gages for a special thread, the length of engagement of the component thread (as distinct from the length of the gage), and the diameter, pitch, and class of fit, should be stated.

With regard to the marking of gages, each gage shall be plainly marked, for identification, with the diameter, pitch, thread series—that is, "NS" to indicate a special thread of American National form—and class of fit. See section II, division 3, "Symbols." For example, a 1-inch, 18-pitch gage of American National form of thread, class 3 fit, shall be marked: 1″—18NS—3.

Tolerances for W, X, and Y gages for special threads are given in tables 42, 43, and 43A.

TABLE 42.—*Tolerances for W "go" and "not go" thread gages for special threads*

Threads per inch	Tolerance in lead [1]	Tolerance on half angle of thread	Tolerance on major or minor diameters [2]		Tolerance on pitch diameter[3]			
			To and including 4-in. diam.	Above 4-in. diam.	To and including 1½-in. diam.	Above 1½- to 4-in. diam.	Above 4- to 8-in. diam.	Above 8- to 12-in. diam.[3]
1	2	3	4	5	6	7	8	9
	Inch ±	*Deg. Min.* ±	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
80	0.00015	0 20	0.0004	----------	0.00015	----------	----------	----------
72	.00015	0 20	.0004	----------	.00015	----------	----------	----------
64	.00015	0 20	.0004	----------	.00015	----------	----------	----------
56	.00015	0 20	.0004	----------	.00015	----------	----------	----------
48	.00015	0 18	.0004	----------	.00015	----------	----------	----------
44	.00015	0 15	.0004	----------	.00015	----------	----------	----------
40	.00015	0 15	.0004	----------	.00015	----------	----------	----------
36	.00015	0 12	.0004	----------	.00015	----------	----------	----------
32	.00015	0 12	.0005	0.0007	.00015	0.0002	0.00025	0.0003
28	.00015	0 8	.0005	.0007	.00015	.0002	.00025	.0003
24	.00015	0 8	.0005	.0007	.00015	.0002	.00025	.0003
20	.00015	0 8	.0005	.0007	.00015	.0002	.00025	.0003
18	.00015	0 8	.0005	.0007	.00015	.0002	.00025	.0003
16	.00015	0 8	.0006	.0009	.0002	.00025	.0003	.0004
14	.0002	0 6	.0006	.0009	.0002	.00025	.0003	.0004
13	.0002	0 6	.0006	.0009	.0002	.00025	.0003	.0004
12	.0002	0 6	.0006	.0009	.0002	.00025	.0003	.0004
11	.0002	0 6	.0006	.0009	.0002	.00025	.0003	.0004
10	.00025	0 6	.0006	.0009	.0002	.00025	.0003	.0004
9	.00025	0 6	.0007	.0011	.0002	.00025	.0003	.0004
8	.00025	0 5	.0007	.0011	.0002	.00025	.0003	.0004
7	.0003	0 5	.0007	.0011	.0002	.00025	.0003	.0004
6	.0003	0 5	.0008	.0013	.0002	.00025	.0003	.0004
5	.0003	0 4	.0008	.0013	----------	.00025	.0003	.0004
4½	.0003	0 4	.0008	.0013	----------	.00025	.0003	.0004
4	.0003	0 4	.0009	.0015	----------	.00025	.0003	.0004

[1] Allowable variation in lead between any two threads not farther apart than the length of the standard gage, shown in CS8-41, omitting one full thread at each end of the gage.
[2] On "go" plugs the tolerance is plus and on "go" rings the tolerance is minus. (See par. 6, p. 48.)
[3] Above 12 inches the tolerance is directly proportional to the tolerance in this column, in the ratio of the diameter to 12 inches.

TABLE 43.—*Tolerances for X "go" and "not go" thread gages for special threads*

Threads per inch	Tolerance in lead [1]	Tolerance on half angle of thread		Tolerance on major or minor diameters [2]		Tolerance on pitch diameter [2]			
				To and including 4-in. diam.	Above 4-in. diam.	To and including 1½-in. diam.	Above 1½- to 4-in. diam.	Above 4- to 8-in. diam.	Above 8- to 12-in. diam.[3]
1	2	3		4	5	6	7	8	9
	Inch ±	*Deg.* ±	*Min.*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
80	0.0002	0	30	0.0004	----------	0.0002	----------	----------	----------
72	.0002	0	30	.0004	----------	.0002	----------	----------	----------
64	.0002	0	30	.0004	----------	.0002	----------	----------	----------
56	.0002	0	30	.0004	----------	.0002	----------	----------	----------
48	.0002	0	30	.0004	----------	.0002	----------	----------	----------
44	.0002	0	20	.0004	----------	.0002	----------	----------	----------
40	.0002	0	20	.0004	----------	.0002	----------	----------	----------
36	.0002	0	20	.0004	----------	.0002	----------	----------	----------
32	.0003	0	15	.0005	0.0007	.0003	0.0004	0.0005	0.0006
28	.0003	0	15	.0005	.0007	.0003	.0004	.0005	.0006
24	.0003	0	15	.0005	.0007	.0003	.0004	.0005	.0006
20	.0003	0	15	.0005	.0007	.0003	.0004	.0005	.0006
18	.0003	0	10	.0005	.0007	.0003	.0004	.0005	.0006
16	.0003	0	10	.0006	.0009	.0003	.0004	.0006	.0008
14	.0003	0	10	.0006	.0009	.0003	.0004	.0006	.0008
13	.0003	0	10	.0006	.0009	.0003	.0004	.0006	.0008
12	.0003	0	10	.0006	.0009	.0003	.0004	.0006	.0008
11	.0003	0	10	.0006	.0009	.0003	.0004	.0006	.0008
10	.0003	0	10	.0006	.0009	.0003	.0004	.0006	.0008
9	.0003	0	10	.0007	.0011	.0003	.0004	.0006	.0008
8	.0004	0	5	.0007	.0011	.0004	.0005	.0006	.0008
7	.0004	0	5	.0007	.0011	.0004	.0005	.0006	.0008
6	.0004	0	5	.0008	.0013	.0004	.0005	.0006	.0008
5	.0004	0	5	.0008	.0013	----------	.0005	.0006	.0008
4½	.0004	0	5	.0008	.0013	----------	.0005	.0006	.0008
4	.0004	0	5	.0009	.0015	----------	.0005	.0006	.0008

[1] Allowable variation in lead between any two threads not farther apart than the length of the standard gage, shown in CS8–41, omitting one full thread at each end of the gage.
[2] On "go" plugs the tolerance is plus and on "go" rings the tolerance is minus. (See par. 6, p. 48.)
[3] Above 12 inches the tolerance is directly proportional to the tolerance in this column, in the ratio of the diameter to 12 inches.

TABLE 43A.—*Tolerances for Y "go" thread gages for special threads*

Threads per inch	Tolerance in lead [1]	Tolerance on half angle of thread	Tolerance on major or minor diameters[2]		Limits on pitch diameter [2]							
			To and including 4 in. diam.	Above 4 in. diam.	To and including 1½ in. diam.		Above 1½ in. to 4 in. diam.		Above 4 in. to 8 in. diam.		Above 8 in. to 12 in. diam.	
					From–	To–	From–	To–	From–	To–	From–	To–
1	2	3	4	5	6	7	8	9	10	11	12	13
	Inch ±	*Deg. Min.* ±	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
80	0.0002	0 45	0.0004		0.0001	0.0003						
72	.0002	0 45	.0004		.0001	.0003						
64	.0002	0 45	.0004		.0001	.0004						
56	.0002	0 45	.0004		.0001	.0004						
48	.0002	0 45	.0004		.0001	.0004						
44	.0002	0 30	.0004		.0001	.0004						
40	.0002	0 30	.0004		.0001	.0004						
36	.0002	0 30	.0004		.0001	.0004						
32	.0003	0 20	.0005	0.0007	.0002	.0005	0.0001	0.0006	0.0001	0.0008	0.0001	0.0010
28	.0003	0 20	.0005	.0007	.0002	.0005	.0002	.0007	.0002	.0009	.0002	.0011
24	.0003	0 20	.0005	.0007	.0002	.0005	.0002	.0007	.0002	.0009	.0002	.0011
20	.0003	0 20	.0005	.0007	.0002	.0005	.0002	.0007	.0002	.0009	.0002	.0011
18	.0003	0 15	.0005	.0007	.0002	.0005	.0002	.0007	.0002	.0009	.0002	.0011
16	.0003	0 15	.0006	.0009	.0002	.0006	.0002	.0008	.0002	.0010	.0002	.0011
14	.0003	0 15	.0006	.0009	.0002	.0006	.0002	.0008	.0002	.0010	.0002	.0012
13	.0003	0 15	.0006	.0009	.0002	.0006	.0002	.0008	.0002	.0010	.0002	.0012
12	.0003	0 10	.0006	.0009	.0002	.0006	.0002	.0008	.0002	.0010	.0002	.0012
11	.0003	0 10	.0006	.0009	.0002	.0006	.0002	.0008	.0002	.0010	.0002	.0012
10	.0003	0 10	.0006	.0009	.0002	.0006	.0002	.0008	.0002	.0010	.0002	.0012
9	.0003	0 10	.0007	.0011	.0002	.0007	.0002	.0009	.0002	.0011	.0002	.0013
8	.0004	0 5	.0007	.0011	.0002	.0007	.0002	.0009	.0002	.0011	.0002	.0013
7	.0004	0 5	.0007	.0011	.0002	.0007	.0002	.0009	.0002	.0011	.0002	.0013
6	.0004	0 5	.0008	.0013	.0003	.0008	.0002	.0010	.0002	.0012	.0002	.0014
5	.0004	0 5	.0008	.0013			.0002	.0010	.0002	.0012	.0002	.0014
4½	.0004	0 5	.0008	.0013			.0002	.0010	.0002	.0012	.0002	.0014
4	.0004	0 5	.0009	.0015			.0003	.0011	.0003	.0013	.0003	.0015

[1] Allowable variation in lead between any two threads not farther apart than the length of the standard gage, shown in CS8–41, omitting one full thread at each end of the gage.
[2] On "go" plugs the tolerance is plus and on "go" rings the tolerance is minus.

SECTION VII. AMERICAN NATIONAL PIPE THREADS [18]

The original American pipe-thread standard for taper threaded pipe joints was formulated prior to the year 1882 by Robert Briggs, of Philadelphia, Pa. After his death, a paper by Mr. Briggs containing detailed information regarding American pipe and pipe thread practice was read before the Institution of Civil Engineers of Great Britain. This is recorded in the Excerpt Minutes, Volume LXXI, Session 1882–1883, Part 1 of that society.

In 1886 the large majority of American manufacturers were threading pipe to practically the Briggs Standard, so acting jointly with The American Society of Mechanical Engineers they formally adopted it as a standard practice in that year and master gages were made.

Later at various conferences representatives of the manufacturers and The American Society of Mechanical Engineers established addi-

[18] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published as ASA B2–1941 "American Standard Pipe Threads" by the A. S. M. E., 29 West 39th St., New York, N. Y.

tional sizes, certain details of gaging, tolerances, special applications of the standard, and in addition tabulated the formulas and dimensions more completely than was originally done by Mr. Briggs.

In 1913 a Committee on the Standardization of Pipe Threads was organized for the purpose of reediting and expanding the Briggs Standard, with the American Gas Association and The American Society of Mechanical Engineers as joint sponsors. After six years of work this committee completed the revised standard for taper pipe thread which was published in the A. S. M. E. "Transactions" of 1919, and was approved by the American Standards Association in December 1919. This standard was adopted by, and appeared in the various reports of, the National Screw Thread Commission.

In the years which followed, the need for a further revision of this American Standards pamphlet was felt and the necessity of adding to it the recent developments in pipe threading practice. Accordingly, the Sectional Committee on the Standardization of Pipe Threads was organized in 1927. The specifications in this section are in agreement with the standard developed by that Committee.

Substantially the same standard for taper pipe threads, but with various additional refinements in gaging, is issued as Army-Navy Aeronautical Specification AN–GGG–P–363.

1. AMERICAN NATIONAL TAPER PIPE THREADS

The normal type of joint made with American National pipe threads is that employing an external taper and an internal taper thread. Other types of joints made with standard pipe threads are discussed in subsequent divisions of this section.

(a) FORM OF THREAD

1. Angle of Thread.—The angle between the sides of the thread is 60° when measured in an axial plane, and the line bisecting this angle is perpendicular to the axis for either taper or straight threads.

2. Depth of Thread.—The depth of the truncated thread, h, is based on factors entering into the manufacture of cutting tools and the making of tight joints. The crest and root of thread are truncated a minimum amount equal to $0.033p$ except for 8 threads per inch which are truncated $0.045p$ at the crest and $0.033p$ at the root. The (basic) maximum depth of the truncated thread, h, is $0.80p$ except for 8 threads per inch which is $0.788p$. For the allowable limits on crest and root truncation see table 45.

This standard shows flat surfaces for root and crest of the thread. When examined, the crests and roots of commercially manufactured threads appear rounded, and it is intended that threads of product will be acceptable when crest and root lie within the tolerance zones shown in figure 20.

400610°—42——8

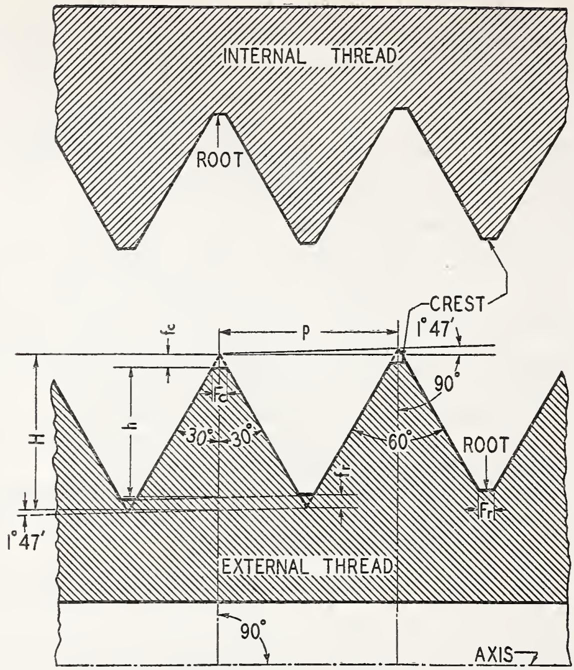


FIGURE 18.—*American National taper pipe thread form and notation.*

NOTATION

H=0.866025p=depth of 60° sharp V thread [19]
h {=0.800000p=depth of thread on work, 11½ threads and finer.
{=0.788000p=depth of thread on work, 8 threads
p=1/n-pitch (measured parallel to axis)
n=number of threads per inch
fc=depth of truncation at crest
fr=depth of truncation at root
Fc=Width of flat at crest
Fr=Width of flat at root

3. TAPER OF THREAD.—The taper of the taper pipe thread is 1 in 16, or 0.75 inch per foot, measured on the diameter and along the axis.

(b) ILLUSTRATIONS

There are shown in figure 18 the relations as specified herein for form of thread, and general notation. Special notation is given in figure 19.

(c) SYMBOLS

The list of symbols given in section II, 3, together with additional symbols given below, should be used in formulas for expressing relations of pipe threads, on drawings, etc. Symbols such as L1 and E1 may either be written as shown, or with the second character as a subscript.

[19] For a symmetrical straight screw thread, $H=\frac{p}{2}\cot a$. For a symmetrical taper screw thread $H=\frac{p}{2}(\cot a-\tan^2 y \tan a)$, so that the exact value for an American National taper pipe thread is H=0.865743p as against H=0.866025p, the value given above. For an 8-pitch thread, which is the coarsest standard taper pipe thread pitch, the corresponding values of H are 0.108218 inch and 0.108253 inch, respectively, the difference being 0.000035 inch. This difference being too small to be significant, the value of H=0.866025p continues in use for threads of three fourths inch, or less, taper per foot.

American National taper pipe thread .... NPT
Outside diameter of pipe = maximum major diameter of pipe thread .... D
Internal diameter of pipe .... d
Distance from gaging notch to end of pipe = normal engagement by hand between external and internal threads .... L_1
Length, L3—2 threads (= length to A. P. I. gage point) .... L_2
Length of effective thread, external thread .... L_3
Total length of external thread to last scratch .... L_4
Normal wrench take-up .... L_5
Pitch diameter of thread at end of pipe .... E_o
Pitch diameter of thread at gaging notch or large end of internal thread .... E_1
Pitch diameter of external thread at L_2 from end of pipe .... E_2
Pitch diameter of external thread at L_3 from end of pipe .... E_3
Major diameter at end of pipe .... D_o
Minor diameter at end of pipe .... K_o

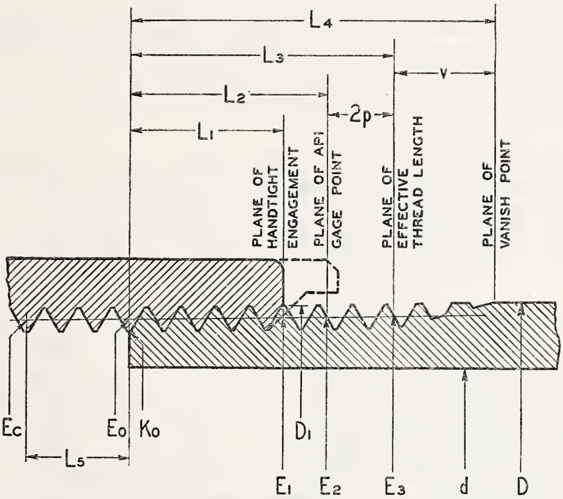


FIGURE 19.—*American National taper pipe thread notation.*

NOTATION

$$E_o = D - (0.05D + 1.1)p$$
$$E_1 = E_o + 0.0625\ L_1$$
$$L_3 = p(0.8D + 6.8)$$

(d) BASIC DIMENSIONS

1. OUTSIDE DIAMETER OF PIPE.—The outside diameters of pipe are given in column 5 of table 44.

2. DIAMETER OF THREADS.—The pitch diameters of the taper threads are determined by formulas based on the outside diameter of pipe and the pitch of thread:

$$E_o = D - (0.05D + 1.1)p$$
$$E1 = E_o + 0.0625\ L1$$

3. LENGTH OF THREAD.—The effective length of the taper external thread is determined by a formula based on the outside diameter of pipe and the pitch of the thread:

$$L3 = (0.8D + 6.8)p$$

This formula determines directly the length of effective thread, which includes approximately two usable threads slightly imperfect at the crest.

4. Length of Engagement.—The normal length of engagement between taper external and internal threads, when screwed together by hand, is shown in column 9 of table 44. This length is controlled by the construction and use of taper thread gages. It is recognized that in special applications, such as flanges for high pressure work, longer thread engagement is used, in which case the pitch diameter E_1, is maintained and the pitch diameter at the end of pipe is proportionately smaller.

(e) MANUFACTURING TOLERANCES OF THREADED PRODUCT

The variation in thread elements on steel products and all pipe made of steel, wrought iron, or brass, should not exceed the limits stated below.

On pipe fittings and valves (not steel) for steam pressures 300 lb and below, it is intended that plug and ring gage practice, as set up in this standard, provides for a satisfactory check on accumulated variations in such product. Therefore no tolerances on thread elements have been established.

For service conditions, where more exact check is required, a procedure developed by industry and found practical, other than use of the regulation plug and ring gages, may be followed.

For steel products and all pipe made of steel, wrought iron, or brass, the variations in thread elements shall not exceed the following limits:

1. Taper.—Sizes ⅛ to ⅜ in., inclusive: Maximum taper, ⅞ in. per ft, minimum taper, 11/16 in. per ft. Sizes ½ to 2 in., inclusive: Maximum taper, 27/32 in. per ft, minimum taper, 11/16 in. per ft. Sizes 2½ in. and larger: Maximum taper, 13/16 in. per ft, minimum taper, 23/32 in. per ft. The tolerance on the 2-in. line pipe shall be the same as that shown for sizes 2½ in. and larger.

2. Lead.—27, 18, and 14 threads per inch: ± 0.003 in. in length of effective thread. 11½ and 8 threads per inch: ± 0.003 in. per inch, ± 0.006 in. cumulative.

3. Angle.—27 threads per inch: ±2½ deg, included angle. 18 and 14 threads per inch: ±2 deg, included angle. 11½ and 8 threads per inch: ±1½ deg, included angle.

4. Depth of Thread.—The depth of thread shall conform to the limits on crest and root truncations stated in table 45 and shown in figure 20.

5. Pitch Diameter.—The maximum allowable variation in the commercial product is one turn large or one turn small from the gaging notch on plug and gaging face of ring when using working gages. (See figs. 24 and 25.) This is equivalent to a maximum allowable variation of one and one-half turns from the basic dimensions, on account of the wear allowance of one-half turn on working gages.

Table 44.—*Dimensions of American National taper pipe threads* [1]

[For notation, see fig. 19]

Nominal size of pipe	Number of threads per inch, n	Pitch, p	Depth of thread, h	Outside diameter of pipe,[1] D	Pitch diameters: At end of pipe, or at length L_1 from end of coupling $E_0=D-\frac{0.05D+1.1}{n}$	Pitch diameters: At length L_1 on pipe, or at end of coupling,[2] $E_1=E_0+\frac{L_1}{16}$	Basic minor diameter at small end of pipe,[3] K_0	Length of normal engagement by hand,[4] L_1	Length of effective thread,[5] L_3	Increase in diameter per thread, $\frac{0.0625}{n}$
1	2	3	4	5	6	7	8	9	10	11
Inches		*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*
⅛	27	0.03704	0.02963	0.405	0.36351	0.37476	0.33388	0.180	0.2638	0.00231
¼	18	.05556	.04444	.540	.47739	.48989	.43294	.200	.4018	.00347
⅜	18	.05556	.04444	.675	.61201	.62701	.56757	.240	.4078	.00347
½	14	.07143	.05714	.840	.75843	.77843	.70129	.320	.5337	.00446
¾	14	.07143	.05714	1.050	.96768	.98887	.91054	.339	.5457	.00446
1	11½	.08696	.06957	1.315	1.21363	1.23863	1.14407	.400	.6828	.00543
1¼	11½	.08696	.06957	1.660	1.55713	1.58338	1.48757	.420	.7068	.00543
1½	11½	.08696	.06957	1.900	1.79609	1.82234	1.72652	.420	.7235	.00543
2	11½	.08696	.06957	2.375	2.26902	2.29627	2.19946	.436	.7565	.00543
2 [6]	11½	.08696	.06957	2.375	2.25453	2.29627	2.18497	.668	.9884	.00543
2½	8	.12500	.09850	2.875	2.71953	2.76216	2.61953	.682	1.1375	.00781
3	8	.12500	.09850	3.500	3.34062	3.38850	3.24063	.766	1.2000	.00781
3½	8	.12500	.09850	4.000	3.83750	3.88881	3.73750	.821	1.2500	.00781
4	8	.12500	.09850	4.500	4.33438	4.38712	4.23438	.844	1.3000	.00781
5	8	.12500	.09850	5.563	5.39073	5.44929	5.29073	.937	1.4063	.00781
6	8	.12500	.09850	6.625	6.44609	6.50597	6.34609	.958	1.5125	.00781
8	8	.12500	.09850	8.625	8.43359	8.50003	8.33359	1.063	1.7125	.00781
10	8	.12500	.09850	10.750	10.54531	10.62094	10.44531	1.210	1.9250	.00781
12	8	.12500	.09850	12.750	12.53281	12.61781	12.43281	1.360	2.1250	.00781
14 OD	8	.12500	.09850	14.000	13.77500	13.87262	13.67500	1.562	2.2500	.00781
16 OD	8	.12500	.09850	16.000	15.76250	15.87575	15.66250	1.812	2.4500	.00781
18 OD	8	.12500	.09850	18.000	17.75000	17.87500	17.65000	2.000	2.6500	.00781
20 OD	8	.12500	.09850	20.000	19.73750	19.87031	19.63750	2.125	2.8500	.00781
24 OD	8	.12500	.09850	24.000	23.71250	23.86094	23.61250	2.375	3.2500	.00781

[1] The basic dimensions of the American National taper pipe thread are given to five decimal places. While this implies a greater degree of precision than is ordinarily attained, these dimensions are so expressed for the purpose of eliminating errors in computations.

[2] Also pitch diameter at gaging notch.

[3] Given as information for use in selecting tap drills.

[4] Also length of ring gage and length from gaging notch to small end of plug gage.

[5] Also length of plug gage.

[6] A. P. I. line pipe. This is the only size of line pipe that differs in length of thread from the American National standard. The standard thread chambers in the lower pressure fittings and valves do not accommodate this longer line pipe thread.

TABLE 45.—*Limits on crest and root truncation on product, American National taper pipe threads*

[See fig. 20]

Threads per Inch	Truncation				Width of Flat			
	Minimum		Maximum		Minimum		Maximum	
1	2	3	4	5	6	7	8	9
	Formula	*Inch*	*Formula*	*Inch*	*Formula*	*Inch*	*Formula*	*Inch*
27	0.033p	0.0012	0.096p	0.0036	0.038p	0.0014	0.111p	0.0041
18	.033p	.0018	.088p	.0049	.038p	.0021	.102p	.0057
14	.033p	.0024	.078p	.0056	.038p	.0027	.090p	.0064
11½	.033p	.0029	.073p	.0064	.038p	.0033	.084p	.0073
8 crest	.045p	.0056	.083p	.0104	.052p	.0065	.096p	.0120
8 root	.033p	.0041	.073p	.0091	.038p	.0048	.084p	.0105

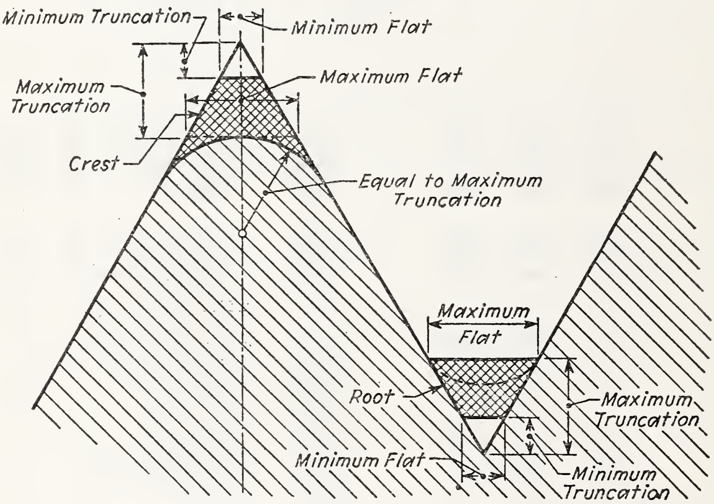


FIGURE 20.—*Crest and root truncations of American National taper pipe threads*

(f) GAGES AND GAGE TOLERANCES

1. Classification of Gages.—Gages properly to maintain interchangeability of product should consist of:

1, Master gages used to check reference gages
2, Reference gages used to check working gages
3, Working and inspection gages used to check product.

(*a*) *Master gages.*—The set of master gages consists of taper threaded plug and ring gages. (See figs. 21, 22, and 23.) The plug gages are made to dimensions given in table 44 except for depth of threads. They are constructed of hardened steel with a gaging notch located a distance L_1 (table 44) from the small end. The ring gages have a

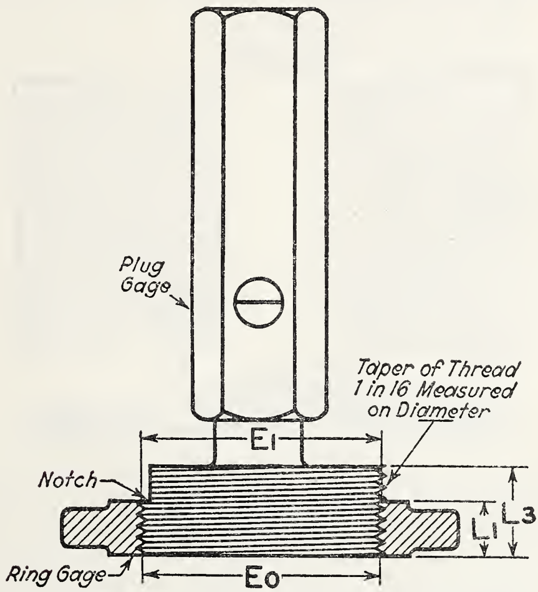


Figure 21.—*Standard taper pipe thread plug and ring gages.*

length equal to dimension L_1. These rings are fitted to the plugs coming flush at the notch. The roots of the threads on these gages should not be less than a sharp "V". Preferably they may be undercut beyond the sharp "V" to facilitate grinding, and the crests are truncated an amount equal to 0.10 p as illustrated in figure 22. The set of master gages is primarily for the use of gage and tool manufacturers and for accurate comparison in checking references gages.

(*b*) *Reference gages.*—The set of reference gages consists of taper threaded plug and ring gages. (See figs. 21, 22, and 23.) They are identical in design and have the same thread form as the set of master gages. They are made of hardened steel to dimensions given in table 44 except for the depth of threads. The reference gages are used primarily for checking working gages.

(*c*) *Working and inspection gages.*—The sets of working and inspection gages consist of taper threaded plug and ring gages. (See figs. 21, 22, and 23.) They are identical in design and have the same thread form as the set of master gages. The center of the gaging notch shall intersect the thread at or near the pitch line on the flank of the thread toward the large end of the gage. They are made of hardened steel

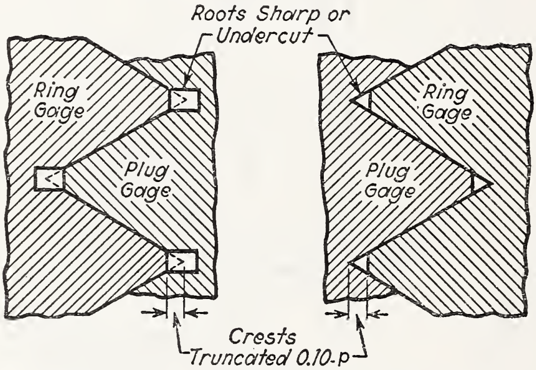


FIGURE 22.—*Recommended forms of gage threads.*

to dimensions given in table 44 except for the depth of threads. The working and inspection gages are used for checking the product.

Basic dimensions of taper pipe thread gages are given in table 46A.

(d) *Limit gages.*—There are occasions when it is desirable to check the maximum and minimum limits of taper threaded product directly with a limit working gage rather than with a standard basic working gage which necessitates counting the turns by which the gage overtravels or fails to come up to the basic surface on the product. To meet this requirement the design of limit gage shown in figure 23 has been developed as an alternative to the recognized standard basic plug and ring working gages covered by Par. (c). These gages retain the basic notch on the plug together with the basic surface of the ring and in addition include two notches or steps on both plug and ring, one the maximum and one the minimum. The retention of the basic step or notch facilitates checking against the present master and reference gages and also provides a convenient means of checking the maximum and minimum steps. The limit gage thread form, tolerances, etc., shall be as specified in this standard for the corresponding basic working gages.

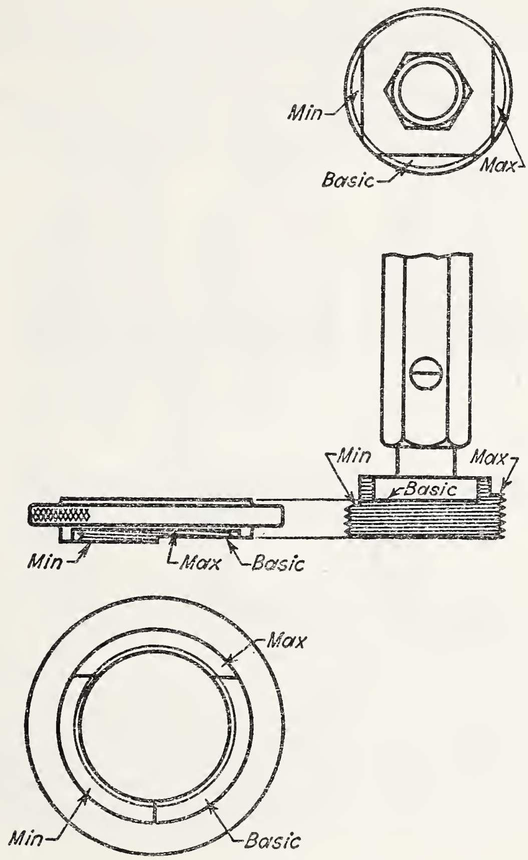


FIGURE 23.—*Alternative form of taper pipe thread plug and ring gages, limit type.*

2. GAGE TOLERANCES.—In the manufacture of gages, variations from basic dimensions are unavoidable. Furthermore, gages will wear in use. In order to fix the maximum allowable variations of gages, tolerances have been established.

(a) *Master gage tolerances.*—The set of master gages should be made to the basic dimensions as accurately as possible. Each master gage should in addition be accompanied by a record of the measurements of all elements of the thread.

(b) *Reference, inspection, and working gage tolerances.*—These gages should be made to the basic dimensions and should be within the tolerances for individual elements as specified in table 46. Columns 3 to 7 of table 46 are used when checking gages by measurement.

Each reference gage should be accompanied by a record of the decimal part of a turn that it varies plus or minus from the basic dimensions, determined by the method stated below.

Caution: In checking other gages by assembling with such reference gage and determining standoff, such correction cannot be applied reliably as a correction to the measured standoff to give a theoretically correct standoff.

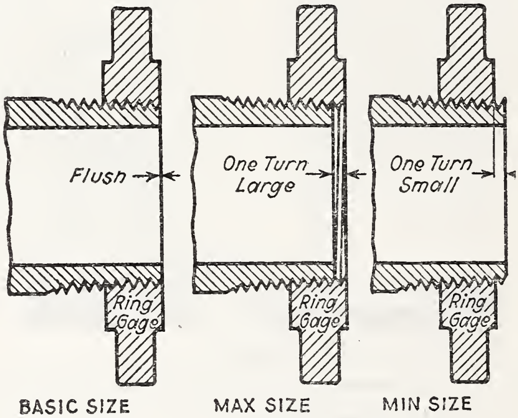


FIGURE 24.—*Gaging of external American National taper pipe threads.*

(c) *Relation of lead and angle errors to pitch diameter tolerances.*—When it is necessary to compute from measurements the decimal part of a turn that a gage varies from the basic dimensions which is required for master and reference gages, tables 47 and 48 should be used. Table 48 gives the correction in diameter for angle errors and table 47 gives the correction in diameter for lead errors.

The correction in diameter for lead and angle errors plus the pitch diameter errors, multiplied by 16, gives the longitudinal variation from basic at the gaging notch. This longitudinal variation divided by the pitch equals the decimal part of a turn that the gage varies from basic at the gaging notch.

(d) *Worn working-gage tolerances.*—The maximum wear on working gages must not be more than the equivalent of one half turn from the basic dimensions.

3. Gaging Practices.—(a) *Gaging external taper threads.*—In gaging external taper threads, the ring gage, figures 21 and 23, should

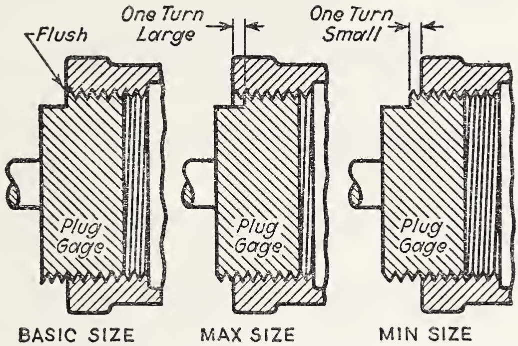


Figure 25.—*Gaging of internal American National taper pipe threads.*

screw tightly by hand on the pipe or external thread, the small end of the gage coming flush with the end of the thread. (See fig. 24.) For tolerance see p. 109.

(b) *Gaging internal taper threads.*—In gaging internal taper threads, the plug gage, fig. 21, and fig. 23 should screw tightly by hand into the fitting or coupling, the notch coming flush with the face. (See fig. 25.) When the thread is chamfered, the notch should be flush with the intersection of the chamfer cone and the pitch line of the thread.

4. Marking of Gages.—Each gage shall be plainly and permanently marked so as to indicate clearly the nominal size of pipe, number of threads per inch, and the proper symbol to identify the thread form. Example: 3—8NPT.

TABLE 46.—*Tolerances for American National reference, inspection, and working taper pipe thread plug and ring gages*

Nominal pipe size	Number of threads per inch	Tolerance on pitch diameter [1]	Tolerance on lead [2 4]		Tolerance on half angle [3]		Tolerance on taper [4 5]		Tolerance on major diameter [6]	Tolerance on minor diameter [6]	Total cumulative tolerances on pitch diameter		Stand-off between plug and ring gages at gaging notch	
			Plugs	Rings	Plugs	Rings	Plugs	Rings	Plugs	Rings	Plugs	Rings	Dimensions at opposite extreme tolerance limits [7]	Dimensions midway between opposite tolerance limits [8]
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inches		*Inch* ±	*Inch*	*Inch*	*Min.* ±	*Min.* ±	*Inch* +	*Inch* −	*Inch* −	*Inch* +	*Inch*	*Inch*	*Inch*	*Inch*
1/8	27	0.0002	0.0002	0.0003	15	20	0.0003	0.0006	0.0015	0.0015	0.00080	0.00118	0.032	0.009
1/4	18	.0002	.0002	.0003	15	20	.0004	.0007	.002	.002	.00092	.00134	.036	.009
3/8	18	.0002	.0002	.0003	15	20	.0004	.0007	.002	.002	.00092	.00134	.036	.009
1/2	14	.0003	.0002	.0003	10	15	.0006	.0009	.003	.003	.00097	.00142	.038	.007
3/4	14	.0003	.0002	.0003	10	15	.0006	.0009	.003	.003	.00097	.00142	.038	.007
1	11½	.0003	.0003	.0004	10	15	.0008	.0012	.0035	.0035	.00121	.00170	.047	.007
1¼	11½	.0003	.0003	.0004	10	15	.0008	.0012	.0035	.0035	.00121	.00170	.047	.007
1½	11½	.0003	.0003	.0004	10	15	.0008	.0012	.0035	.0035	.00121	.00170	.047	.007
2	11½	.0003	.0003	.0004	10	15	.0008	.0012	.0035	.0035	.00121	.00170	.047	.007
2½	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
3	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
3½	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
4	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
5	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
6	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
8	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
10	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
12	8	.0005	.0004	.0005	7	10	.0010	.0014	.005	.005	.00158	.00211	.059	.010
14 OD	8	.0008	.0005	.0006	7	10	.0010	.0014	.005	.005	.00206	.00271	.076	.019
16 OD	8	.0008	.0005	.0006	7	10	.0010	.0014	.005	.005	.00206	.00271	.076	.019
18 OD	8	.0008	.0005	.0006	7	10	.0010	.0014	.005	.005	.00206	.00271	.076	.019
20 OD	8	.0008	.0005	.0006	7	10	.0010	.0014	.005	.005	.00206	.00271	.076	.019
24 OD	8	.0008	.0005	.0006	7	10	.0010	.0014	.005	.005	.00206	.00271	.076	.019

[1] To be measured at the gaging notch of plug gage.

[2] Allowable variation in lead between any two threads in L1 length of gage (fig. 21).

[3] In solving for the correction in diameter for angle errors, the average error in half angle for the two sides of thread regardless of their signs should be taken.

[4] The lead and taper on plug and ring gages shall be measured along the pitch line omitting the imperfect threads at each end.

[5] Allowable variation in taper, from basic taper in L1 length of gage (fig. 21).

[6] Tolerances on major diameter of plug and minor diameter of ring are $0.04p$ to the nearest 0.0005 in. This means that the crest truncation of the gage threads may vary from $0.10p$ to $0.12p$.

[7] Maximum possible interchange stand-off, any ring against any plug other than its master plug, may occur when taper errors are zero and all other dimensions are at opposite extreme tolerance limits.

[8] Interchange stand-off, any ring against any plug other than its master plug, may occur when all dimensions including taper are midway between opposite tolerance limits.

NOTE.—The large end of the ring gage shall be flush with the gaging notch of its master plug gage when assembled hand tight within ±0.002 in. for sizes ⅛ to 2 in. inclusive, within ±0.003 in. for sizes 2½ to 12 in, inclusive, and within ±0.005 in. for sizes 14 in. and larger.

The tolerances for the height L1 from small end to gaging notch of the plug gage (fig. 21) shall be +0.000 and −0.001 for sizes ⅛ to 2 in. inclusive, and +0.000 and −0.002 for sizes 2½ in. and larger.

The tolerances for the over-all thread length L3 of the plug gage (fig. 21) shall be −0.000 and +0.005 for sizes ⅛ in. to 2 in. inclusive, and +0.010 and −0.000 for sizes 2½ in. and larger. Tolerances for the thickness L1 of the ring gage (fig. 21) shall be −0.000 and +0.001 for sizes ⅛ to 2 in. incl., and +0.002 and −0.000 for sizes 2½ in. and larger.

Table 46A.—*Basic dimensions of threaded plug and ring gages for American National taper pipe threads*

Nominal size of pipe (in inches)	Number of threads per inch, n	Pitch, p	Major diameters of plug gages [1]: At small end, $E_0+\frac{0.666025}{n}$	Major diameters of plug gages [1]: At gaging notch, $E_1+\frac{0.666025}{n}$	Major diameters of plug gages [1]: At large end, full ring, $E_3+\frac{0.666025}{n}$	Pitch diameters of plug and ring gages: At small end, E_0	Pitch diameters of plug and ring gages: At gaging notch, E_1	Pitch diameters of plug and ring gages: At large end, full ring, E_3	Minor diameters of ring gages [1]: At small end, $E_0-\frac{0.666025}{n}$	Minor diameters of ring gages [1]: At gaging notch, $E_1-\frac{0.666025}{n}$	Minor diameters of ring gages [1]: At large end, full ring, $E_3-\frac{0.666025}{n}$	Increase in diameter per thread $\frac{0.0625}{n}$	Thickness of thin ring, L_1	Thickness of full ring, L_3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Inch	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inches*	*Inches*
1/8	27	0.03704	0.38818	0.39943	0.40467	0.36351	0.37476	0.38000	0.33884	0.35009	0.35533	0.00231	0.180	0.26385
1/4	18	.05556	.51439	.52689	.53950	.47739	.48989	.50250	.44039	.45289	.46550	.00347	.200	.40178
3/8	18	.05556	.64902	.66402	.67450	.61201	.62701	.63750	.57501	.59001	.60050	.00347	.240	.40778
1/2	14	.07143	.80600	.82600	.83936	.75843	.77843	.79179	.71086	.73086	.74421	.00446	.320	.53371
3/4	14	.07143	1.01525	1.03644	1.04936	.96768	.98887	1.00179	.92011	.94129	.95421	.00446	.339	.54571
1	11½	.08696	1.27155	1.29655	1.31422	1.21363	1.23863	1.25630	1.15571	1.18072	1.19839	.00543	.400	.68278
1¼	11½	.08696	1.61505	1.64130	1.65922	1.55713	1.58338	1.60130	1.49921	1.52547	1.54339	.00543	.420	.70678
1½	11½	.08696	1.85400	1.88025	1.89922	1.79609	1.82234	1.84130	1.73817	1.76442	1.78339	.00543	.420	.72348
2	11½	.08696	2.32694	2.35419	2.37422	2.26902	2.29627	2.31630	2.21111	2.23836	2.25839	.00543	.436	.75652
2½	8	.12500	2.80278	2.84541	2.87388	2.71953	2.76216	2.79062	2.63628	2.67890	2.70737	.00781	.682	1.13750
3	8	.12500	3.42388	3.47175	3.49888	3.34062	3.38850	3.41562	3.25737	3.30525	3.33237	.00781	.766	1.20000
3½	8	.12500	3.92075	3.97207	3.99888	3.83750	3.88881	3.91562	3.75425	3.80556	3.83237	.00781	.821	1.25000
4	8	.12500	4.41763	4.47038	4.49888	4.33438	4.38712	4.41562	4.25112	4.30387	4.33237	.00781	.844	1.30000
4½	8	.12500	4.91450	4.96919	4.99888	4.83125	4.88594	4.91562	4.74800	4.80268	4.83237	.00781	.875	1.35000
5	8	.12500	5.47398	5.53255	5.56188	5.39073	5.44929	5.47862	5.30748	5.36604	5.39537	.00781	.937	1.40630
6	8	.12500	6.52935	6.58922	6.62388	6.44609	6.50597	6.54062	6.36284	6.42272	6.45737	.00781	.958	1.51250
7	8	.12500	7.52310	7.58560	7.62388	7.43984	7.50234	7.54062	7.35659	7.41909	7.45737	.00781	1.000	1.61250
8	8	.12500	8.51685	8.58328	8.62388	8.43359	8.50003	8.54062	8.35034	8.41678	8.45737	.00781	1.063	1.71250
9	8	.12500	9.51060	9.58122	9.62388	9.42734	9.49797	9.54062	9.34409	9.41472	9.45737	.00781	1.130	1.81250
10	8	.12500	10.62857	10.70419	10.74888	10.54531	10.62094	10.66562	10.46206	10.53768	10.58237	.00781	1.210	1.92500
11	8	.12500	11.62232	11.70263	11.74888	11.53906	11.61938	11.66562	11.45581	11.53612	11.58237	.00781	1.285	2.02500
12	8	.12500	12.61607	12.70107	12.74888	12.53281	12.61781	12.66562	12.44956	12.53456	12.58237	.00781	1.360	2.12500
14 OD	8	.12500	13.85825	13.95588	13.99888	13.77500	13.87262	13.91562	13.69175	13.78937	13.83237	.00781	1.562	2.25000
15 OD	8	.12500	14.85200	14.95744	14.99888	14.76875	14.87419	14.91562	14.68550	14.79093	14.83237	.00781	1.687	2.35000
16 OD	8	.12500	15.84575	15.95900	15.99888	15.76250	15.87575	15.91562	15.67925	15.79250	15.83237	.00781	1.812	2.45000
17 OD	8	.12500	16.83950	16.95825	16.99888	16.75625	16.87500	16.91562	16.67300	16.79175	16.83237	.00781	1.900	2.55000
18 OD	8	.12500	17.83325	17.95825	17.99888	17.75000	17.87500	17.91562	17.66675	17.79175	17.83237	.00781	2.000	2.65000
20 OD	8	.12500	19.82075	19.95357	19.99888	19.73750	19.87031	19.91562	19.65425	19.78706	19.83237	.00781	2.125	2.85000
22 OD	8	.12500	21.80825	21.94888	21.99888	21.72500	21.86562	21.91562	21.64175	21.78237	21.83237	.00781	2.250	3.05000
24 OD	8	.12500	23.79575	23.94419	23.99888	23.71250	23.86094	23.91562	23.62925	23.77768	23.83237	.00781	2.375	3.25000
26 OD	8	.12500	25.78325	25.93950	25.99888	25.70000	25.85625	25.91562	25.61675	25.77300	25.83237	.00781	2.500	3.45000
28 OD	8	.12500	27.77075	27.93482	27.99888	27.68750	27.85156	27.91562	27.60425	27.76831	27.83237	.00781	2.625	3.65000
30 OD	8	.12500	29.75825	29.93013	29.99888	29.67500	29.84688	29.91562	29.59175	29.76362	29.83237	.00781	2.750	3.85000

[1] These dimensions are based on a crest truncation of $0.1p$ for pipe thread gages, which insures bearing of the gage on the sides of the thread, when cut with a slightly dull tool, instead of at the roots of the thread.

Table 47. *Corrections in diameter for errors in lead, 60° threads*

Error in lead in inches, p'	Correction in diameter, $E'=1.732\ p'$									
	0.00000	0.00001	0.00002	0.00003	0.00004	0.00005	0.00006	0.00007	0.00008	0.00009
1	2	3	4	5	6	7	8	9	10	11
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
0.00000	0.00000	0.00002	0.00003	0.00005	0.00007	0.00009	0.00010	0.00012	0.00014	0.00016
0.00010	.00017	.00019	.00021	.00023	.00024	.00026	.00028	.00029	.00031	.00033
0.00020	.00035	.00036	.00038	.00040	.00042	.00043	.00045	.00047	.00048	.00050
0.00030	.00052	.00054	.00055	.00057	.00059	.00061	.00062	.00064	.00066	.00068
0.00040	.00069	.00071	.00073	.00074	.00076	.00078	.00080	.00081	.00083	.00085
0.00050	.00087	.00088	.00090	.00092	.00094	.00095	.00097	.00099	.00100	.00102
0.00060	.00104	.00106	.00107	.00109	.00111	.00113	.00114	.00116	.00118	.00120
0.00070	.00121	.00123	.00125	.00126	.00128	.00130	.00132	.00133	.00135	.00137
0.00080	.00139	.00140	.00142	.00144	.00145	.00147	.00149	.00151	.00152	.00154
0.00090	.00156	.00158	.00159	.00161	.00163	.00165	.00166	.00168	.00170	.00171
0.00100	.00173	.00175	.00177	.00178	.00180	.00182	.00184	.00185	.00187	.00189
0.00110	.00191	.00192	.00194	.00196	.00197	.00199	.00201	.00203	.00204	.00206
0.00120	.00208	.00210	.00211	.00213	.00215	.00217	.00218	.00220	.00222	.00223
0.00130	.00225	.00227	.00229	.00230	.00232	.00234	.00236	.00237	.00239	.00241
0.00140	.00242	.00244	.00246	.00248	.00249	.00251	.00253	.00255	.00256	.00258
0.00150	.00260	.00262	.00263	.00265	.00267	.00268	.00270	.00272	.00274	.00275
0.00160	.00277	.00279	.00281	.00282	.00284	.00286	00288	.00289	.00291	.00293
0.00170	.00294	.00296	.00298	.00300	.00301	.00303	.00305	.00307	.00308	.00310
0.00180	.00312	.00313	.00315	.00317	.00319	.00320	.00322	.00324	.00326	.00327
0.00190	.00329	.00331	.00333	.00334	.00336	.00338	.00339	.00341	.00343	.00345
0.00200	.00346	.00348	.00350	.00352	.00353	.00355	.00357	.00359	.00360	.00362

Table 48.—*Corrections in diameter for errors in half angle, American National taper pipe thread gages*

Error in half angle of thread in minutes, a'	Correction in diameter, $E''=\frac{1.53812}{n}\times\tan a'$.				
	8 threads per inch	11½ threads per inch	14 threads per inch	18 threads per inch	27 threads per inch
1	2	3	4	5	6
	Inch	*Inch*	*Inch*	*Inch*	*Inch*
1	0.00006	0.00004	0.00003	0.00002	0.00002
2	.00011	.00008	.00006	.00005	.00003
3	.00017	.00012	.00010	.00007	.00005
4	.00022	.00016	.00013	.00010	.00007
5	.00028	.00019	.00016	.00012	.00008
6	.00034	.00023	.00019	.00015	.00010
7	.00039	.00027	.00022	.00017	.00012
8	.00045	.00031	.00026	.00020	.00013
9	.00050	.00035	.00029	.00022	.00015
10	.00056	.00039	.00032	.00025	.00017
11	.00062	.00043	.00035	.00027	.00018
12	.00067	.00047	.00038	.00030	.00020
13	.00073	.00051	.00042	.00032	.00022
14	.00078	.00054	.00045	.00035	.00023
15	.00084	.00058	.00048	.00037	.00025
16	.00089	.00062	.00051	.00040	.00027
17	.00095	.00066	.00054	.00042	.00028
18	.00101	.00070	.00058	.00045	.00030
19	.00106	.00074	.00061	.00047	.00031
20	.00112	.00078	.00064	.00050	.00033
21	.00117	.00082	.00067	.00052	.00035
22	.00123	.00086	.00070	.00055	.00036
23	.00129	.00089	.00074	.00057	.00038
24	.00134	.00093	.00077	.00060	.00040
25	.00140	.00097	.00080	.00062	.00041
26	.00145	.00101	.00083	.00065	.00043
27	.00151	.00105	.00086	.00067	.00045
28	.00157	.00109	.00089	.00070	.00046
29	.00162	.00113	.00093	.00072	.00048
30	.00168	.00117	.00096	.00075	.00050
45	.00252	.00175	.00144	.00112	.00075
60	.00336	.00233	.00192	.00149	.00099

2. SPECIAL TAPER PIPE THREADS

(a) RAILING FITTINGS

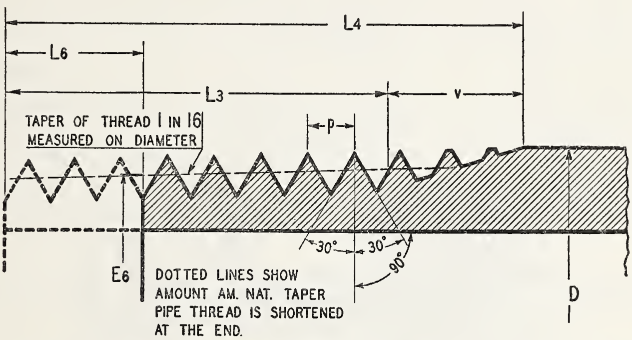
Railing fittings require a rigid mechanical thread joint with external and internal taper threads.

The external thread is basically the same as the American National taper pipe thread, except that it is shortened to permit the use of the larger end of the pipe thread. (See the figure over table 49.) The dimensions of these external and internal threads are shown in tables 49 and 50. A recess in the fitting provides a covering for the last scratch or imperfect threads on the pipe.

The form of thread is the same as the form of the American National taper pipe thread shown in Fig. 18.

The gaging of these threads is specified in tables 49 and 50.

TABLE 49.—*Dimensions of external taper pipe threads for railing fittings, (mechanical joints)*

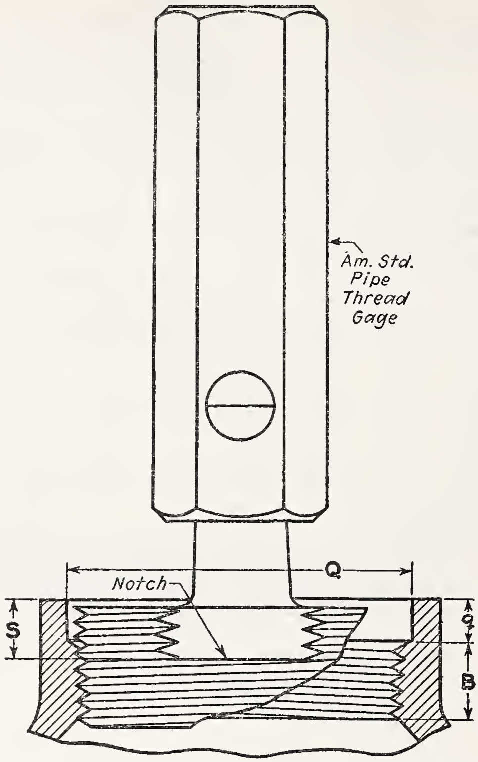


Nominal pipe size	Outside diameter of pipe D	Number of threads per inch	Depth of thread	Pitch diameter at end of external thread E6	Length of effective thread of Am. Nat. pipe thds. L3	Total length of external thread, max L4–L6	Shortening of Am. Nat. taper pipe thread L6		Imperfect threads due to lead of die, max. *V*	
1	2	3	4	5	6	7	8	9	10	11
Inches	*Inches*		*Inch*	*Inches*	*Inches*	*Inches*	*Threads*	*Inch*	*Threads*	*Inch*
½	0.840	14	0.0571	0.7718	0.534	0.498	3	0.214	2½	0.179
¾	1.050	14	.0571	.9811	.546	.510	3	.214	2½	.179
1	1.315	11½	.0696	1.2299	.683	.639	3	.261	2½	.217
1¼	1.660	11½	.0696	1.5734	.707	.707	3	.261	3	.261
1½	1.900	11½	.0696	1.8124	.724	.724	3	.261	3	.261
2	2.375	11½	.0696	2.2853	.757	.757	3	.261	3	.261
2½	2.875	8	.0985	2.7508	1.138	1.013	4	.500	3	.375
3	3.500	8	.0985	3.3719	1.200	1.075	4	.500	3	.375
3½	4.000	8	.0985	3.8688	1.250	1.125	4	.500	3	.375
4	4.500	8	.0985	4.3656	1.300	1.175	4	.500	3	.375

NOTE.—These dimensions agree with those developed by the Manufacturers Standardization Society of the Valve and Fittings Industry as of June 30, 1936.

The symbol NPTR should be used on tools and gages to indicate the American National taper pipe thread for rail fittings.

TABLE 50.—*Dimensions, internal taper pipe thread for railing fittings, (mechanical joints)*



Nominal pipe size	Depth of recess in fitting, *q* Min.	Diameter of recess in fitting, *Q* Min.	Thread length *B* Min.	Distance gage[1] notch comes below face of fitting *S*	
1	2	3	4	5	6
Inches	*Inch*	*Inches*	*Inch*	*Threads*	*Inch*
½	0.18	0.86	0.25	4	0.286
¾	.18	1.07	.25	4	.286
1	.22	1.34	.30	4	.348
1¼	.26	1.68	.39	4	.348
1½	.26	1.92	.43	4	.348
2	.26	2.40	.43	4	.348
2½	.38	2.90	.63	5	.625
3	.38	3.53	.63	5	.625
3½	.38	4.04	.63	5	.625
4	.38	4.54	.63	5	.625

[1] American National taper pipe thread plug gage.

NOTE.—These dimensions agree with those developed by the Manufacturers Standardization Society of the Valve and Fittings Industry as of June 30, 1936.

(b) THREADING OF PIPE FOR AMERICAN STANDARD THREADED STEEL FLANGES

The length of the effective external taper thread of the American National pipe thread provides a sufficient number of threads on the pipe to insure a satisfactorily joint with the ordinary weight of fitting or flange. The American Standard Steel Flanges for high pressure-temperature service (ASA B16e–1939) calls for thread lengths in the flanges in proportion to the thickness of the flange. This means that the thread lengths in the flanges intended for higher pressures in a given size are longer than the thread lengths in the flanges intended for the lower pressures.

Table 51 provides for a length of effective thread on pipe for sizes and weights of flanges where the regular American National length of effective thread is too short to bring the end of the pipe reasonably close to the face of the flange when both parts are assembled by power. As the threads in all flanges as well as on the pipe are gaged with a tolerance of one thread large and one thread small there will naturally be some difference in distance between the end of the pipe and face of the flange in the various assemblies for the different sizes and weights of flanges.

In the following table the additional number of threads are added to the small end of the standard pipe thread and the pitch diameter at the end of the external thread, Eo, is, therefore, smaller than that of the regular standard pipe. In other words, the small end of the ring gage will pass over the end of the pipe the number of turns or the length in inches equal to the values given in table 51.

TABLE 51.—*Projection of threaded end through ring gage, steel flanges*

Nominal pipe size	150, 300 lb.	400 lb.	600 lb.		900 lb.		1500 lb.		2500 lb.	
	Number of turns	Number of turns	Number of turns	Inches	Number of turns	Inches	Number of turns	Inches	Number of turns	Inches
½	(1)	--------	(1)	(1)	--------	--------	3½	0.25	7	0.50
¾	(1)	--------	(1)	(1)	--------	--------	5	.36	7	.50
1	(1)	--------	(1)	(1)	--------	--------	5	.43	7½	.65
1¼	(1)	--------	(1)	(1)	--------	--------	5	.43	7½	.65
1½	(1)	--------	(1)	(1)	--------	--------	5	.43	7½	.65
2	(1)	--------	(1)	(1)	--------	--------	5	.43	7½	.65
2½	(1)	--------	(1)	(1)	--------	--------	5	.625	8	1.00
3	(1)	--------	1	0.125	3	0.375	6	.75	10	1.25
3½	(1)	--------	1	.125	--------	--------	--------	--------	--------	--------
4	(1)	(1)	1½	.187	3½	.437	6½	.81	10½	1.31
5	(1)	(1)	1½	.187	3½	.437	6½	.81	10½	1.31
6	(1)	(1)	1½	.187	3½	.437	7½	.94	11½	1.44
8	(1)	(1)	2	.250	4	.500	8	1.00	14	1.75
10	(1)	(1)	3	.375	5	.625	9	1.125	16	2.00
12	(1)	(1)	3	.375	5	.625	10	1.250	19	2.375
14 OD	(1)	(1)	3	.375	6	.750	--------	--------	--------	--------
16 OD	(1)	(1)	3	.375	6	.750	--------	--------	--------	--------
18 OD	(1)	(1)	3	.375	6	.750	--------	--------	--------	--------
20 OD	(1)	(1)	3	.375	6	.750	--------	--------	--------	--------
24 OD	(1)	(1)	3	.375	6	.750	--------	--------	--------	--------

1 Regular American National pipe thread is used for this size.

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3. AMERICAN NATIONAL STRAIGHT PIPE THREADS

While external and internal taper screw threads are recommended for pipe joints in practically every service, there are certain types of joints where straight pipe threads are used to advantage. Five of these straight pipe thread joints are covered by this standard, all of which are based on the pitch diameter of the American National taper pipe thread at the gaging notch (dimension E1 of tables 44 and 45).

(a) FORM OF THREAD

The pitch, angle, and depth of thread are the same as the corresponding dimensions of the American National taper pipe thread. (See exceptions in pars. (d) 3 and (g) below).

(b) SYMBOLS

These five types of joints are listed below, together with the symbols by which they are designated:

American National straight pipe threads for pressure-tight joints in pipe couplings -- NPSC
American National straight pipe threads for pressure-tight joints in grease cup, and fuel and oil tubing ---------------------- NPSG
American National straight pipe threads for free fitting mechanical joints for fixtures ------------------------------------- NPSM
American National straight pipe threads for loose fitting mechanical joints with locknuts --------------------------------- NPSL
American National straight pipe threads for hose couplings and nipples -- NPSH

(c) DIAMETER OF THREAD

The basic pitch diameter for both the external and internal straight pipe thread is equal to the pitch diameter of the thread "E1" at the gaging notch, and is the same as the large end of the internal taper pipe thread. The variations from this diameter are covered in footnotes under the following tables.

(d) PRESSURE-TIGHT JOINTS

1.—Pipe Couplings.—Pressure tight joints are sometimes made with *straight* internal threads and the American National *taper* external threads. One or both members are considered to be sufficiently ductile to adjust themselves to the taper of the external thread but are recommended for low pressures only. The dimensions of these internal coupling threads are given in table 52.

TABLE 52.—*Dimensions of American National internal straight pipe threads in pipe couplings (pressure-tight joints)*

Nominal pipe size	Number of threads per inch	Pitch diameter [4]		Minor [1] diameter
		Max.[2]	Min.[3]	Min.
1	2	3	4	5
Inches	*Inches*	*Inches*	*Inches*	*Inches*
1/8	27	0.3782	0.3713	0.342
1/4	18	.4951	.4847	.440
3/8	18	.6322	.6218	.577
1/2	14	.7851	.7717	.715
3/4	14	.9956	.9822	.925
1	11½	1.2468	1.2305	1.161
1¼	11½	1.5915	1.5752	1.506
1½	11½	1.8305	1.8142	1.745
2	11½	2.3044	2.2881	2.219
2½	8	2.7739	2.7504	2.652
3	8	3.4002	3.3768	3.278
3½	8	3.9005	3.8771	3.779
4	8	4.3988	4.3754	4.277

[1] As the American National pipe thread form is maintained the major and the minor diameters of the internal thread vary with the pitch diameter.
[2] Column 3 is the same as the pitch diameter at the end of internal thread E1, Table 44, increased by 1½ turns.
[3] Column 4 is equal to column 3 reduced by 3 turns.
[4] Attention is called to the fact that the actual pitch diameter of the straight tapped hole will be slightly smaller than the values given when gaged with a taper plug gage as specified below under (h).

2. OIL OR GREASE CUP AND OTHER LUBRICATION FITTINGS.—These fittings are attached to machine parts (1) by a joint consisting of two taper pipe threads (external and internal), (2) by a taper external pipe thread and a straight internal pipe thread, or (3) by two straight machine screw threads (external and internal) drawing up to a shoulder. The dimensions of the taper threads for the first type of joint are given in table 44. The dimensions of the straight internal pipe thread referred to in the second type of joint are given in table 53. As the threads of the third type of joint are not pipe threads they are not detailed here. The dimensions for these threads shall be in accordance with section III.

TABLE 53.—*Dimensions of American National internal straight pipe threads for oil or grease cup and other lubrication fittings (pressure tight joints)*

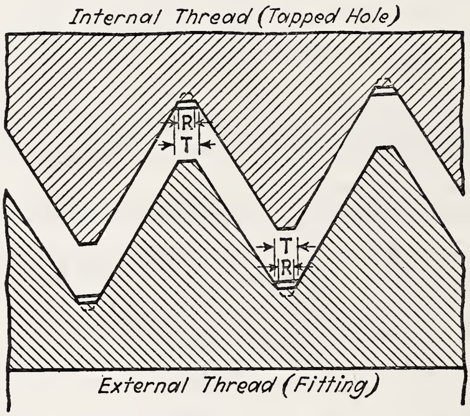
Nominal pipe size	Number of threads per inch	Pitch diameter [4]		Minor [1] diameter
		Max.[2]	Min.[3]	Min.
1	2	3	4	5
Inch		*Inches*	*Inches*	*Inches*
1/8	27	0.3713	0.3678	0.338
1/4	18	.4847	.4795	.435
3/8	18	.6218	.6166	.572
1/2	14	.7717	.7650	.708
3/4	14	.9822	.9755	.918
1	11½	1.2305	1.2224	1.153

[1] As the American National pipe thread form is maintained the major and the minor diameters of the internal thread vary with the pitch diameter.
[2].Column 3 is the same as equal to column 4, table 52.
[3] Column 4 is equal to column 3 reduced by 1½ turns.
[4] Attention is called to the fact that the actual pitch diameter of the straight tapped hole will be slightly smaller than the values given when gaged with a taper plug gage as specified below under (h).

3. Refrigerant, SAE Fuel and Oil Tube Fittings.—The thread joints of the refrigerant, S. A. E. fuel and oil tube fittings are of the same type and dimensions as those of the oil or grease cup and other lubrication fittings covered in paragraph 2 except that the form of thread is modified. This modification of the American National pipe thread form consists of truncating the minor diameter of the external and the major diameter of the internal threads to insure contact at these points as specified in table 54 and illustrated in the figure over that table.

This modified form of thread can be produced by reducing the major diameter of American National pipe thread taps and increasing the minor diameter of American National pipe thread dies.

Table 54.—*Thread modification limits for refrigerant, S. A. E. fuel and oil tube fittings (pressure tight joints)*



Nominal pipe size	Number of threads per inch	Limits for truncation of roots of threads	
		R	*T*
1	2	3	4
Inch		*Inch*	*Inch*
⅛	27	0.004	0.005
¼	18	.005	.006
⅜	18	.005	.006
½	14	.005	.006
¾	14	.005	.006
1	11½	.006	.008

Note.—For pitch diameters see table 53.

(e) FREE-FITTING MECHANICAL JOINTS

Standard wrought-iron, wrought-steel, and brass pipe are often used for special applications where there are no internal pressures but where straight pipe thread joints are required for mechanical assemblies for strength, adjustments, etc. The dimensions of these threads are given in table 55.

TABLE 55.—*Dimensions of American National external and internal straight pipe threads for mechanical joints*

Nominal pipe size	Number of threads per inch	External thread			Internal thread		
		Major [1] diameter	Pitch diameter		Pitch diameter		Minor [1] diameter
		Max.	Max.[2]	Min.[3]	Max.[4]	Min.[5]	Min.
1	2	3	4	5	6	7	8
Inches		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/8	27	0.404	0.3748	0.3713	0.3783	0.3748	0.345
1/4	18	.534	.4899	.4847	.4951	.4899	.446
3/8	18	.671	.6270	.6218	.6322	.6270	.583
1/2	14	.836	.7784	.7717	.7851	.7784	.721
3/4	14	1.046	.9889	.9822	.9956	.9889	.932
1	11½	1.308	1.2386	1.2305	1.2467	1.2386	1.169
1¼	11½	1.653	1.5834	1.5753	1.5915	1.5834	1.514
1½	11½	1.892	1.8223	1.8142	1.8304	1.8223	1.753
2	11½	2.366	2.2963	2.2882	2.3044	2.2963	2.227
2½	8	2.861	2.7622	2.7505	2.7739	2.7622	2.664
3	8	3.487	3.3885	3.3768	3.4002	3.3885	3.290
3½	8	3.987	3.8888	3.8771	3.9005	3.8888	3.790
4	8	4.486	4.3871	4.3754	4.3988	4.3871	4.289
5	8	5.548	5.4493	5.4376	5.4610	5.4493	5.351
6	8	6.605	6.5060	6.4943	6.5177	6.5060	6.408

[1] As the American National pipe thread form is maintained the major and the minor diameters of the internal thread and the minor and major diameters of the external thread vary with the pitch diameter.
[2] Column 4 is the same as the pitch diameter at the end of internal thread E_1, table 44.
[3] Column 5 is equal to column 4 reduced by 1½ turns.
[4] Column 6 is equal to column 7 increased by 1½ turns.
[5] Column 7 is the same as column 4.

(f) LOCKNUT THREADS

Occasional requirements make it advisable to have a straight thread of the largest diameter it is possible to cut on a standard pipe. This practice has been standardized and is known as American National external and internal straight pipe threads for locknut connections. Limiting dimensions are given in table 56. Ordinarily straight internal threads are used with straight external threads providing a loose fit which makes it necessary to use packing to seal the joint as in the tank nipple thread joint shown in figure 26. In this application an American National standard taper pipe thread is cut on the end of the pipe after having first cut the "external locknut thread."

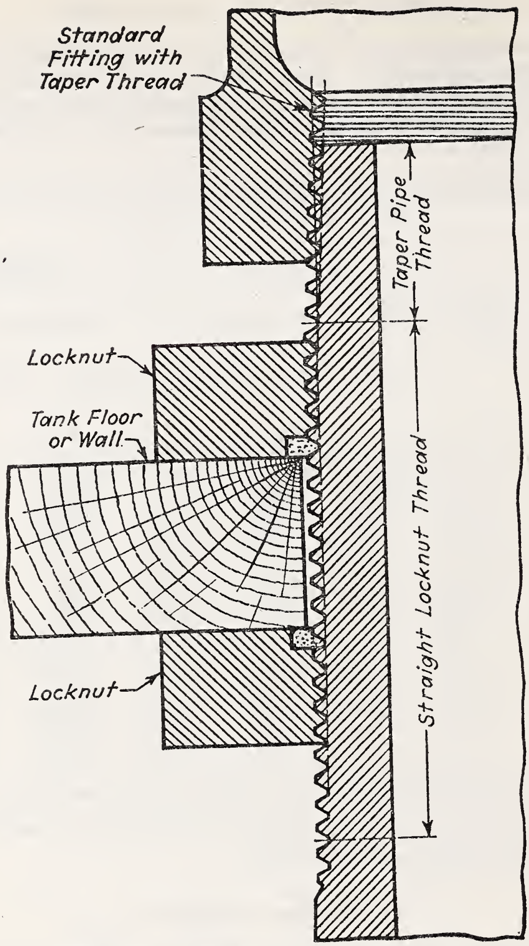


FIGURE 26.—*Illustration of "tank nipple" thread.*

Table 56.—*Dimensions, external and internal straight pipe threads for locknut connections (mechanical joints)*

Nominal pipe size	Number of threads per inch	External threads			Internal threads		
		Maximum[1] major diameter	Pitch diameter		Pitch diameter		Minimum[1] minor diameter
			Max.[2]	Min.[3]	Max.[4]	Min.[5]	
1	2	3	4	5	6	7	8
Inches		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/8	27	0.414	0.3840	0.3805	0.3898	0.3863	0.357
1/4	18	.548	.5038	.4986	.5125	.5073	.463
3/8	18	.685	.6409	.6357	.6496	.6444	.600
1/2	14	.853	.7963	.7896	.8075	.8008	.744
3/4	14	1.064	1.0067	1.0000	1.0179	1.0112	.954
1	11½	1.330	1.2604	1.2523	1.2739	1.2658	1.196
1¼	11½	1.675	1.6051	1.5970	1.6187	1.6106	1.541
1½	11½	1.914	1.8441	1.8360	1.8576	1.8495	1.780
2	11½	2.388	2.3180	2.3099	2.3315	2.3234	2.254
2½	8	2.892	2.7934	2.7817	2.8129	2.8012	2.703
3	8	3.519	3.4198	3.4081	3.4393	3.4276	3.329
3½	8	4.019	3.9201	3.9084	3.9396	3.9279	3.829
4	8	4.517	4.4184	4.4067	4.4379	4.4262	4.328
5	8	5.579	5.4805	5.4688	5.5001	5.4884	5.390
6	8	6.636	6.5372	6.5255	6.5567	6.5450	6.447
8	8	8.630	8.5313	8.5196	8.5508	8.5391	8.441
10	8	10.751	10.6522	10.6405	10.6717	10.6600	10.562
12	8	12.748	12.6491	12.6374	12.6686	12.6569	12.558

1 As the American National pipe thread form of thread is maintained the major and the minor diameters of the internal thread and the minor and the major diameters of the external thread vary with the pitch diameter.

2 Column 4 is the same as the pitch diameter at the end of internal thread E_1, table 44, increased by 4 turns.

3 Column 5 is equal to column 4 reduced by 1½ turns.

4 Column 6 is equal to column 7 increased by 1½ turns.

5 Column 7 is the same as the pitch diameter at the end of internal thread E_1, table 44, increased by 5 turns.

(g) HOSE NIPPLES AND COUPLINGS

Hose coupling joints are ordinarily made with straight internal and external loose fitting threads. There are several standards of hose threads having various diameters and pitches, one of which is based on the American National pipe thread. By the use of this thread series, dimensions of which are given in table 60, section VIII, p. 134, opposite the designation "Steam, air, water, and all other hose connections," it is possible to join small hose sizes ½ to 2 in. inclusive to ends of standard pipe having American National external taper pipe threads using a gasket to seal the joint. The American National screw thread form is used for the hose nipples and couplings specified in table 60.

(h) GAGES FOR STRAIGHT PIPE THREADS

Gages to control properly the production of these straight threads should be either straight "go" and "not go" thread gages or the regular American National taper pipe thread gages, as indicated below.

1. Use of Straight "go" and "not go" Thread Gages.—(a) Straight "go" and "not go" thread gages should be used for all types

of threaded joints where both the external and internal threads are straight. Taper thread gages may be used for the internal threads of all types of mechanical thread joints where the external thread is taper and the internal thread is straight.

(b) The straight "go" and "not go" gages used for checking mechanical joint threads, tables 55 and 56, should be made to the pitch diameters specified in the tables. The depth and profile of the threads for "go" gages should be the same as specified for taper pipe thread gages. (See fig. 23.)

All "not go" gages should be truncated according to practice for American National screw-thread form gages.

2. Use of Taper Gages.—Taper thread gages should be used for all types of pressure tight joints where the external thread is taper and the internal thread is straight.

The gaging notch on American National taper pipe thread plug gages should come flush with the end of American National straight pipe threaded couplings or, if chamfered, the notch should be flush with the intersection of the chamfer cone and the pitch line of the thread, allowing a tolerance of one and one-half turns large or small to gage.

Internal straight threads to receive grease cup, refrigerant, fuel, and oil fittings should be between one and one-half and three turns small to the American National taper pipe thread plug gage at the end of the tapping or the bottom of the chamfer, if chamfered.

However, when the modified form of thread for grease cup, fuel, and oil fittings (par. (d) 3) is used it is necessary to reduce the major diameter of the plug gage and increase the minor diameter of the ring gage to clear the additional root truncation of the internal and external threads. It is suggested that the truncation on the gages be such that the flat is twice the minimum flat specified for the threads in table 54, dimension *R*.

3. Tolerances on Gages.—The tolerances on all gages should be in accordance with the gage tolerances specified for American National taper pipe thread gages in table 46.

SECTION VIII. AMERICAN NATIONAL HOSE-COUPLING AND FIRE-HOSE COUPLING THREADS [20]

Several years ago specifications for American National standard fire-hose coupling threads were approved by the National Board of Fire Underwriters, National Fire Protection Association, American Society of Mechanical Engineers, American Society of Municipal Improvements, New England Water Works Association, American Water Works Association, the National Bureau of Standards, and other interested organizations. These specifications were published in 1911 as the Specifications of the National Board of Fire Underwriters, recommended by the National Fire Protection Association and approved

[20] These standards, in substantially the same form, have been adopted by the American Standards Association. They are published as ASA B26–1925 "Fire Hose Coupling Screw Thread" and ASA B33.1–1935 "Hose Coupling Screw Threads" by the A. S. M. E., 29 West 39th St., New York, N. Y.

by the various other organizations. They were also published in 1914 as Circular C50 of the National Bureau of Standards. This circular was revised and republished in 1917.

When the National Screw Thread Commission took up its work on the standardization of screw threads, the specifications for fire-hose coupling threads above referred to were accepted as the basis of its work on fire-hose coupling threads. It was found, however, that the specifications as originally drawn were inadequate in that they specified nominal dimensions only, with no maximum and minimum limits. The limiting dimensions herein specified have met with general approval. State-wide adoption of the American National fire-hose coupling threads is completed in 16 States and the District of Columbia, and is under effective headway in 20 States. Their use has been made compulsory by State legislative acts in California, Massachusetts, Oregon, and Texas.

With regard to the American National hose-coupling threads, the purpose of this specification is to provide a standard which will be recognized and adopted at once by a majority of manufacturers and consumers and toward which the minority may be brought, thus eliminating many threads which have been in use and the confusion and misunderstandings that have prevailed.

As in other lines of work, current practice in use and manufacture must be recognized as well as the specific advantages of certain thread proportions for specific uses. This prevents the adoption of a single specification for each one of the nominal sizes.

These standards apply to the threaded parts of hose couplings, valves, nozzles, and all other fittings used in direct connection with hose intended for fire protection or for domestic, industrial, and general service in nominal sizes of ½, ⅝, ¾, 1, 1¼, 1½, and 2 inches.

In ordering threading tools [21] for producing American National hose-coupling and fire-hose coupling threads, it should be pointed out that new taps should be near the maximum permissible size of the coupling, and new dies near the minimum permissible size of the nipple, in order that reasonable wear may be provided. As the threading tools wear by use, the couplings will become smaller and the nipples larger until the limiting dimensions are reached. These must not be exceeded. When the product reaches, or comes dangerously close to the limiting size, the threading tools should be readjusted or replaced.

1. FORM OF THREAD

1. Angle of Thread.—The basic angle of thread (A) between the sides of the thread measured in an axial plane is 60°. The line biescting this 60° angle, is perpendicular to the axis of the screw thread.

[21] In the interest of the universal adoption of the American National fire-hose threads throughout the United States, attention is directed to the fact that sets of tools for rethreading existing hydrants and hose couplings are commerically available. Such sets comprise roughing and finishing taps, roughing and finishing dies, expanders for expanding undersize externally threaded fittings preparatory to rethreading, gages, and various accessories. The tools are applicable where existing threaded fittings do not differ so widely from the American National standards as to leave insufficient stock for the new thread. By the use of such tools a considerable number of municipalities have at small expense converted their existing equipment and thus availed themselves of the important advantages which standardization affords.

2. Flat at Crest and Root.—The flat at the root and crest of the basic thread form is $\frac{1}{8}\times p$, or $0.125\times p$.

3. Depth of Thread.—The depth of the basic thread form is

$$h=0.649519\times p, \text{ or } h=\frac{0.649519}{n},$$

where

p=pitch in inches
n=number of threads per inch
h=basic depth of thread.

2. THREAD SERIES

(*a*) American National Hose-Coupling Threads.—There are specified in table 57 a thread series and basic dimensions for hose-coupling threads which apply to the threaded parts of hose couplings, valves, nozzles, and all other fittings used in direct connection with hose intended for fire protection or for domestic, industrial, and general service in nominal sizes of ½, ⅝, ¾, 1, 1¼, 1½, and 2 inches. Symbols for designating these threads are given on p. 7.

Table 57.—*American National hose-coupling threads*

MINIMUM (BASIC) COUPLING DIMENSIONS

Nominal size of hose	Service	Number of threads per inch	Pitch	Depth of thread	Major diameter	Pitch diameter	Minor diameter	Allowance
1	2	3	4	5	6	7	8	9
Inches			*Inches*	*Inch*	*Inches*	*Inches*	*Inches*	*Inch*
½, ⅝, ¾	Garden hose	11½	0.08696	0.05648	1.0725	1.0160	0.9595	------
¾, 1	Chemical engine and booster hose	8	.12500	.08119	1.3870	1.3058	1.2246	------
1½	Fire-protection hose	9	.11111	.07217	2.0020	1.9298	1.8577	------
½	Steam, air, water, and all other hose connections.	14	.07143	.04639	.8323	.7859	.7395	------
¾		14	.07143	.04639	1.0428	.9964	.9500	------
1		11½	.08696	.05648	1.3051	1.2486	1.1921	------
1¼		11½	.08696	.05648	1.6499	1.5934	1.5369	------
1½		11½	.08696	.05648	1.8888	1.8323	1.7758	------
2		11½	.08696	.05648	2.3628	2.3063	2.2498	------

MAXIMUM (BASIC) NIPPLE DIMENSIONS

½, ⅝, ¾	Garden hose	11½	0.08696	0.05648	1.0625	1.0060	0.9495	0.0100
¾, 1	Chemical-engine and booster hose	8	.12500	.08119	1.3750	1.2938	1.2126	.0120
1½	Fire-protection hose	9	.11111	.07217	1.9900	1.9178	1.8457	.0120
½	Steam, air, water, and all other hose connections.	14	.07143	.04639	.8248	.7784	.7320	.0075
¾		14	.07143	.04639	1.0353	.9889	.9425	.0075
1		11½	.08696	.05648	1.2951	1.2386	1.1821	.0100
1¼		11½	.08696	.05648	1.6399	1.5834	1.5269	.0100
1½		11½	.08696	.05648	1.8788	1.8223	1.7658	.0100
2		11½	.08696	.05648	2.3528	2.2963	2.2398	.0100

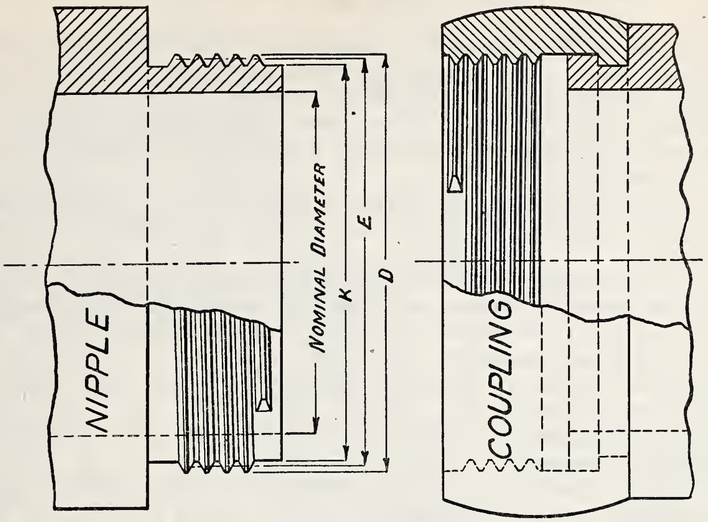


FIGURE 27.—*American National hose-coupling and American National fire-hose coupling threads.*

See tables 59, 60, 61, and 62 for dimensions and tolerances.

(*b*) AMERICAN NATIONAL FIRE-HOSE COUPLING THREADS.—There are specified in table 58 a thread series and basic dimensions for fire-hose couplings from 2½ to 4½ inches in diameter which will be known as the "American National fire-hose threads." These basic sizes and dimensions correspond in all details to those recommended by the National Fire Protection Association and by the National Bureau of Standards.

The American National fire-hose coupling thread is recommended for use on all couplings and hydrant connections for fire-protection systems, and for all other purposes where hose couplings and connections are required in sizes between 2½ and 4½ inches in diameter. Symbols for designating these threads are given on p. 7.

TABLE 58.—*American National fire-hose coupling threads*

MINIMUM (BASIC) COUPLING DIMENSIONS

Nominal size of hose	Number of threads per inch	Pitch	Depth of thread	Major diameter	Pitch diameter	Minor diameter	Allowance
1	2	3	4	5	6	7	8
Inches		*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inch*
2½	7½	0.13333	0.08660	3.0836	2.9970	2.9104	----------
3	6	.16667	.10825	3.6389	3.5306	3.4223	----------
3½	6	.16667	.10825	4.2639	4.1556	4.0473	----------
4½	4	.25000	.16238	5.7859	5.6235	5.4611	----------
MAXIMUM (BASIC) NIPPLE DIMENSIONS							
2½	7½	0.13333	0.08660	3.0686	2.9820	2.8954	0.0150
3	6	.16667	.10825	3.6239	3.5156	3.4073	.0150
3½	6	.16667	.10825	4.2439	4.1356	4.0273	.0200
4½	4	.25000	.16238	5.7609	5.5985	5.4361	.0250

3. ALLOWANCES AND TOLERANCES

(*a*) Specified allowances and tolerances, given in table 59, apply to American National hose coupling and American National fire-hose coupling threads. The tolerances represent extreme variations permitted on the product. There are shown, in figure 28, the relations between nipple and coupling dimensions and thread form as specified herein.

(*b*) The tolerance on the coupling is plus, and is applied from the minimum coupling dimension to above the minimum coupling dimension.

(*c*) The tolerance on the nipple is minus, and is applied from the maximum nipple dimension to below the maximum nipple dimension.

(*d*) The pitch diameter tolerances provided for a mating nipple and coupling are the same.

(*e*) Pitch diameter tolerances include lead and angle variations. (See footnote 1, table 59.)

(*f*) The tolerance on the major diameter is twice the tolerance on the pitch diameter.

(*g*) The tolerance on the minor diameter of the nipple is equal to the tolerance on pitch diameter plus two ninths of the basic thread depth. The minimum minor diameter of a nipple is such as to result in a flat equal to one third of the basic flat ($1/24 \times p$) at the root when the pitch diameter of the nipple is at its minimum value. The maximum minor diameter is basic, but may be such as results from the use of a worn or rounded threading tool.

(*h*) The tolerance on major diameter of the coupling is equal to the tolerance on pitch diameter plus two ninths of the basic thread depth. The minimum major diameter of the coupling is such as to result in a basic flat ($1/8 \times p$) when the pitch diameter of the coupling is at its minimum value. The maximum major diameter of the coupling is that corresponding to a flat equal to one third the basic flat ($1/24 \times p$).

(*i*) The tolerance on the minor diameter of the coupling is twice the tolerance on pitch diameter of the coupling. The minimum minor diameter of a coupling is such as to result in a basic flat ($1/8 \times p$) at the crest when the pitch diameter of the coupling is at its minimum value.

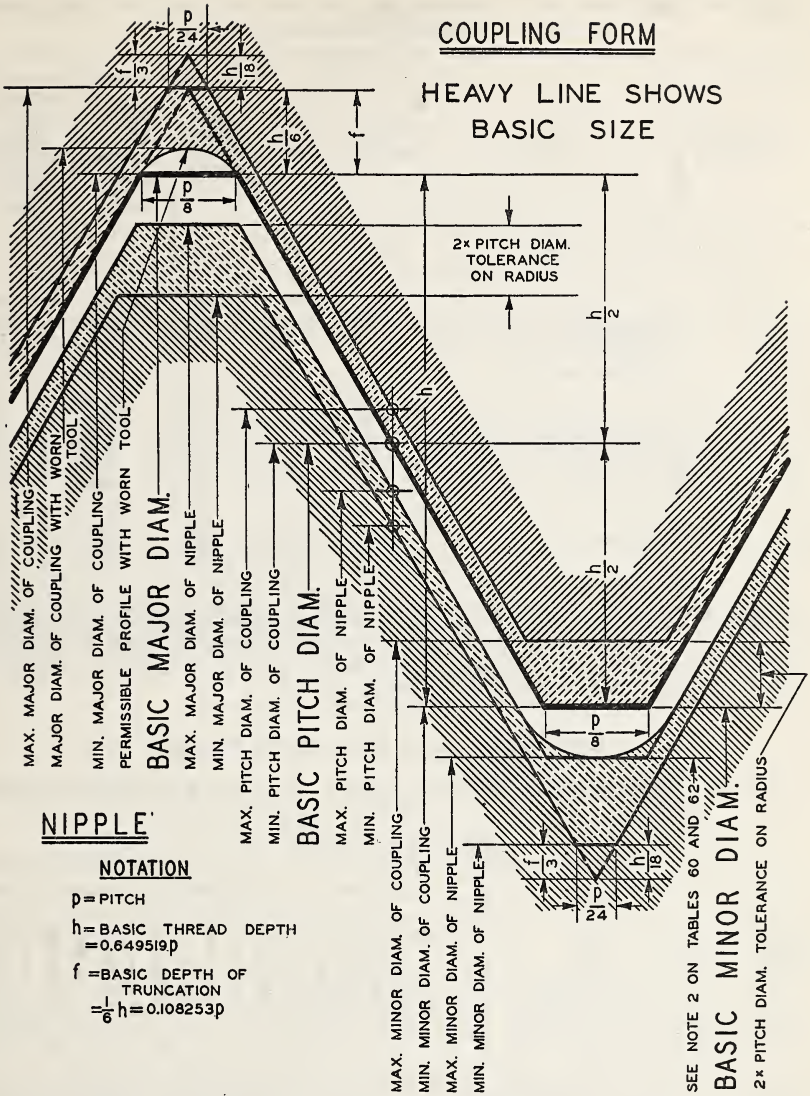


FIGURE 28.—*American National hose-coupling and American National fire-hose coupling threads.*

TABLE 59.—*Tolerances and allowances for American National hose-coupling and American National fire-hose coupling threads*

Nominal size of hose	Service	Threads per inch	Allowances	Tolerances on pitch diameter [1]	Lead errors consuming one half of pitch-diameter tolerances [2]	Errors in half angle consuming one half of pitch-diameter tolerances	
1	2	3	4	5	6	7	
Inches			*Inch*	*Inch*	*Inch*	*Deg.*	*Min.*
½, ⅝, ¾	Garden hose	11½	0.0100	0.0085	0.0025	1	52
¾, 1	Chemical engine and booster hose.	8	.0120	.0111	.0032	1	42
1½	Fire protection hose	9	.0120	.0111	.0032	1	54
½	Steam, air, water, and all other hose connections.	14	.0075	.0070	.0020	1	52
¾		14	.0075	.0070	.0020	1	52
1		11½	.0100	.0085	.0025	1	52
1¼		11½	.0100	.0085	.0025	1	52
1½		11½	.0100	.0085	.0025	1	52
2		11½	.0100	.0085	.0025	1	52
2½	Fire hose	7½	.0150	.0160	.0046	2	17
3		6	.0150	.0180	.0052	2	4
3½		6	.0200	.0180	.0052	2	4
4½		4	.0250	.0250	.0072	1	55

[1] The tolerances specified for pitch diameter include all errors of pitch diameter, lead, and angle. The full tolerance cannot, therefore, be used on pitch diameter unless the lead and angle of the thread are perfect. Columns 6 and 7 give, for information, the errors in lead (per length of thread engaged) and in angle, each of which can be compensated for by half the tolerance on the pitch diameter given in column 5. If lead and angle errors both exist to the amount tabulated, the pitch diameter of a nipple, for example, must be reduced by the full tolerance or it will not enter the "go" gage.

[2] Between any two threads not farther apart than the length of engagement.

4. TABLES OF LIMITING DIMENSIONS

TABLE 60.—*Limiting dimensions and tolerances, American National hose-coupling threads*

COUPLING THREAD

Nominal size of hose	Service	Threads per inch	Pitch	Depth of thread	Major diameter: Maximum	Major diameter: Tolerance	Major diameter: Minimum	Pitch diameter: Maximum	Pitch diameter: Tolerance	Pitch diameter: Minimum	Minor diameter: Maximum	Minor diameter: Tolerance	Minor diameter: Minimum
1	2	3	4	5	6	7	8	9	10	11	12	13	14
In.			*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
½, ⅝, ¾	Garden hose	11½	0.08696	0.05648	------	------	[1] 1.0725	1.0245	0.0085	1.0160	0.9765	0.0170	0.9595
¾, 1	Chemical engine and booster hose.	8	.12500	.08119	------	------	[1] 1.3870	1.3169	.0111	1.3058	1.2468	.0222	1.2246
1½	Fire protection hose.	9	.11111	.07217	------	------	[1] 2.0020	1.9409	.0111	1.9298	1.8799	.0222	1.8577
½	Steam, air, water and all other hose connections.	14	.07143	.04639	------	------	[1] .8323	.7929	.0070	.7859	.7535	.0140	.7395
¾		14	.07143	.04639	------	------	[1] 1.0428	1.0034	.0070	.9964	.9640	.0140	.9500
1		11½	.08696	.05648	------	------	[1] 1.3051	1.2571	.0085	1.2486	1.2091	.0170	1.1921
1¼		11½	.08696	.05648	------	------	[1] 1.6499	1.6019	.0085	1.5934	1.5539	.0170	1.5369
1½		11½	.08696	.05648	------	------	[1] 1.8888	1.8408	.0085	1.8323	1.7928	.0170	1.7758
2		11½	.08696	.05648	------	------	[1] 2.3628	2.3148	.0085	2.3063	2.2668	.0170	2.2498

[1] Dimensions for the minimum major diameter of the coupling correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the coupling shall be that corresponding to a flat at the major diameter of the maximum coupling equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{1}{6} \times h$ (or $0.7939p$) to the maximum pitch diameter of the coupling.

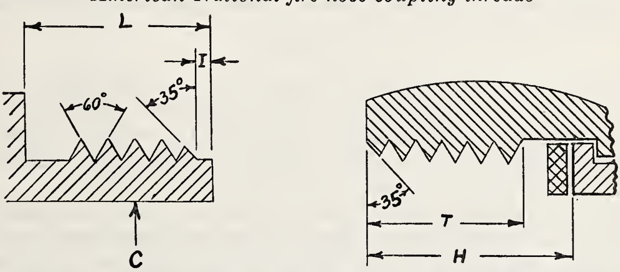
TABLE 60.—*Limiting dimensions and tolerances, American National hose-coupling threads*—Continued

NIPPLE THREAD

Nominal size of hose	Service	Threads per inch	Pitch	Depth of thread	Major diameter: Maximum	Major diameter: Tolerance	Major diameter: Minimum	Pitch diameter: Maximum	Pitch diameter: Tolerance	Pitch diameter: Minimum	Minor diameter: Maximum	Minor diameter: Tolerance	Minor diameter: Minimum
1	2	3	4	5	6	7	8	9	10	11	12	13	14
In.			*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
½, ⅝, ¾	Garden hose	11½	0.08696	0.05648	1.0625	0.0170	1.0455	1.0060	0.0085	0.9975	[2] 0.9495	------	------
¾, 1	Chemical engine and booster hose.	8	.12500	.08119	1.3750	.0222	1.3528	1.2938	.0111	1.2827	[2] 1.2126	------	------
1½	Fire protection hose.	9	.11111	.07217	1.9900	.0222	1.9678	1.9178	.0111	1.9067	[2] 1.8457	------	------
½	Steam, air, water and all other hose connections.	14	.07143	.04639	.8248	.0140	.8108	.7784	.0070	.7714	[2] .7320	------	------
¾		14	.07143	.04639	1.0353	.0140	1.0213	.9889	.0070	.9819	[2] .9425	------	------
1		11½	.08696	.05648	1.2951	.0170	1.2781	1.2386	.0085	1.2301	[2] 1.1821	------	------
1¼		11½	.08696	.05648	1.6399	.0170	1.6229	1.5834	.0085	1.5749	[2] 1.5269	------	------
1½		11½	.08696	.05648	1.8788	.0170	1.8618	1.8223	.0085	1.8138	[2] 1.7658	------	------
2		11½	.08696	.05648	2.3528	.0170	2.3358	2.2963	.0085	2.2878	[2] 2.2398	------	------

[2] Dimensions given for the maximum minor diameter of the nipple are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the nipple shall be that corresponding to a flat at the minor diameter of the minimum nipple equal to $\frac{1}{24} \times p$, and may be determined by subtracting $1\frac{2}{9} \times h$ (or $0.7939p$) from the minimum pitch diameter of the nipple.

TABLE 61.—*Lengths of threads for American National hose-coupling threads and American National fire-hose coupling threads*



Nominal size of hose	Service	Threads per inch, n	Length of nipple, L	Depth of coupling, H	Thread length for coupling, T	Length of pilot, I	Inside diameter of nipple, C Maximum	Approximate number of threads in length T
1	2	3	4	5	6	7	8	9
Inches			*Inches*	*Inches*	*Inch*	*Inch*	*Inches*	
½, ⅝, ¾	Garden hose	11½	9/16	17/32	⅜	⅛	25/32	4¼
¾, 1	Chemical engine and booster hose.	8	⅝	19/32	15/32	5/32	1 1/32	3¾
1½	Fire protection hose	9	⅝	19/32	15/32	5/32	1 17/32	4¼
½	Steam, air, water, and all other hose connections.	14	½	15/32	5/16	⅛	17/32	4¼
¾		14	9/16	17/32	⅜	⅛	25/32	5¼
1		11½	9/16	17/32	⅜	5/32	1 1/32	4¼
1¼		11½	⅝	19/32	15/32	5/32	1 9/32	5½
1½		11½	⅝	19/32	15/32	5/32	1 17/32	5½
2		11½	¾	23/32	19/32	3/16	2 1/32	6¾
2½	Fire hose	7½	1	15/16	1 1/16	¼	2 17/32	5¼
3		6	1⅛	1 1/16	1 3/16	5/16	3 1/32	5
3½		6	1⅛	1 1/16	1 3/16	5/16	3 17/32	5
4½		4	1¼	1 3/16	1 5/16	7/16	4 17/32	3¾

TABLE 62.—*Limiting dimensions and tolerances, American National fire-hose coupling threads*

COUPLING THREAD

Nominal size of hose	Threads per inch	Pitch	Depth of thread	Major diameter			Pitch diameter			Minor diameter		
				Maximum	Tolerance	Minimum	Maximum	Tolerance	Minimum	Maximum	Tolerance	Minimum
1	2	3	4	5	6	7	8	9	10	11	12	13
Inches		*Inch*	*Inch*	*Inches*	*Inch*	*Inches*	*Inches*	*Inch*	*Inches*	*Inches*	*Inch*	*Inches*
2½	7½	0.13333	0.08660			[1] 3.0836	3.0130	0.0160	2.9970	2.9424	0.0320	2.9104
3	6	.16667	.10825+			[1] 3.6389	3.5486	.0180	3.5306	3.4583	.0360	3.4223
3½	6	.16667	.10825+			[1] 4.2639	4.1736	.0180	4.1556	4.0833	.0360	4.0473
4½	4	.25000	.16238			[1] 5.7859	5.6485	.0250	5.6235	5.5111	.0500	5.4611

NIPPLE THREAD

Nominal size of hose	Threads per inch	Pitch	Depth of thread	Major Maximum	Major Tolerance	Major Minimum	Pitch Maximum	Pitch Tolerance	Pitch Minimum	Minor Maximum	Minor Tolerance	Minor Minimum
2½	7½	0.13333	0.08660	3.0686	0.0320	3.0366	2.9820	0.0160	2.9660	[2] 2.8954		
3	6	.16667	.10825+	3.6239	.0360	3.5879	3.5156	.0180	3.4976	[2] 3.4073		
3½	6	.16667	.10825+	4.2439	.0360	4.2079	4.1356	.0180	4.1176	[2] 4.0273		
4½	4	.25000	.16238	5.7609	.0500	5.7109	5.5985	.0250	5.5735	[2] 5.4361		

[1] Dimensions for the minimum major diameter of the coupling correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the coupling shall be that corresponding to a flat at the major diameter of the maximum coupling equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the coupling.

[2] Dimensions given for the maximum minor diameter of the nipple are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the nipple shall be that corresponding to a flat at the minor diameter of the minimum nipple equal to $\frac{1}{24} \times p$, and may be determined by subtracting $1\frac{2}{9} \times h$ (or $0.7939p$) from the minimum pitch diameter of the nipple.

5. GAGES

(*a*) GAGES FOR AMERICAN NATIONAL FIRE-HOSE COUPLING THREADS.—It is recommended that American National fire-hose coupling threads be inspected in the field by means of gages made within the tolerances given in table 63. Limiting dimensions for these gages are given in tables 64 and 65.

It is further recommended that American National fire-hose coupling threads be given final inspection by the manufacturer by means of gages made within the limiting dimensions given in tables 64 and 65, by whatever amount may be desired, in order to avoid, as far as possible, disagreements which might otherwise arise as the result of slight differences in the sizes of gages.

TABLE 63.—*Tolerances on gages for American National fire-hose coupling threads*

Allowable variation in lead between any two threads not farther apart than length of engagement	Allowable variation in one half angle of thread	Tolerance on diameter of minimum thread gage	Tolerance on diameter of maximum thread gage
1	2	3	4
Inch	*Deg. Min.*	*Inch*	*Inch*
±0.0005	±0 10	−0.000 +.001	+0.000 −.001

Table 64.—*Limiting dimensions of field inspection thread plug gages for couplings (internal threads)* [1]

Nominal size of hose	Threads per inch	"Go" or minimum gage				"Not go" or maximum gage			
		Major diameter		Pitch diameter		Major diameter		Pitch diameter	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	2	3	4	5	6	7	8	9	10
Inches		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
2.500	7½	3.0846	3.0836	2.9980	2.9970	3.0836	3.0826	3.0130	3.0120
3.000	6	3.6399	3.6389	3.5316	3.5306	3.6389	3.6379	3.5486	3.5476
3.500	6	4.2649	4.2639	4.1566	4.1556	4.2639	4.2629	4.1736	4.1726
4.500	4	5.7869	5.7859	5.6245	5.6235	5.7859	5.7849	5.6485	5.6475

[1] The minor diameters of plug gages and the major diameters of ring gages are undercut beyond the nominal diameters to give a clearance for grinding or lapping. The allowable variation in lead between any two threads not farther apart than the length of engagement is ±0.0005 inch. The allowable variation in one half angle of thread is ±10 minutes.

Table 65.—*Limiting dimensions of field inspection thread ring gages for coupling nipples (external threads)* [1]

Nominal size of hose	Threads per inch	"Go" or maximum gage				"Not go" or minimum gage			
		Pitch diameter		Minor diameter		Pitch diameter		Minor diameter	
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
1	2	3	4	5	6	7	8	9	10
Inches		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
2.500	7½	2.9820	2.9810	2.9104	2.9094	2.9670	2.9660	2.9114	2.9104
3.000	6	3.5156	3.5146	3.4223	3.4213	3.4986	3.4976	3.4233	3.4223
3.500	6	4.1356	4.1346	4.0473	4.0463	4.1186	4.1176	4.0483	4.0473
4.500	4	5.5985	5.5975	5.4611	5.4601	5.5745	5.5735	5.4621	5.4611

[1] The minor diameters of plug gages and the major diameters of ring gages are undercut beyond the nominal diameters to give clearance for grinding or lapping. The allowable variation in lead between any two threads not farther apart than the length of engagement is ±0.0005 inch. The allowable variation in one half angle of thread is ±10 minutes.

SECTION IX. AMERICAN NATIONAL STANDARD GAS CYLINDER VALVE OUTLET THREADS, AND HOSE CONNECTIONS FOR WELDING AND CUTTING TORCHES

1. GAS CYLINDER VALVE OUTLET THREADS [22]

Standard sizes of threads for gas cylinder valve outlets of various types are presented in table 66. The purpose of these standards is to prevent cross-connections of equipment used with a given type of valve, with another type where such may be dangerous or undesirable, as well as to promote interchangeability among threads of a given type of valve.

[22] These thread sizes are in agreement with Federal Specification WW-V-61, Feb. 26, 1940, "Valves, Cylinder; Oxygen (for Standard Industrial Cylinders)," and with Navy Department Specification 45V13d, November 1, 1940, "Valves, Cylinder (Gas, Compressed and Liquefied)."

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Table 66.—*American National standard gas cylinder valve outlet threads*

Type of cylinder valve	Designation of thread [1]	Major diameter		Pitch diameter		Minor diameter	Length of thread
		Max.	Min.	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8
		Inches	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*
Oxygen, carbon-dioxide, or air.	0.903″-14NS-3	0.9030	0.8932	0.8566	0.8530	0.8154	⅝
Hydrogen, nitrogen, or helium.	0.830″-14NS-2LH	.8300	.8200	.7836	.7786	.7424	⅝
Acetylene	0.835″-14NS-3	.8350	.8290	.7780	.7740	.7368	⅝
Ethyl-chloride	½″-14 NPS form	.8350	.8290	.7780	.7740		
Anhydrous ammonia	⅜″-18 NPT (internal)						
Dichlorodifluoromethane	¾″-14 NPS form	1.031	1.025	.9717	.9677		

[1] For explanation of symbols see p. 7. All threads are external except for anhydrous ammonia, and all are right-hand except on valves for hydrogen, nitrogen, or helium.

2. HOSE CONNECTIONS FOR WELDING AND CUTTING TORCHES

Specifications covering hose connections for welding and cutting torches were formulated and adopted in 1925 by the International Acetylene Association, the Gas Products Association, and various manufacturers. Essentially the same specifications were adopted by the National Screw Thread Commission in 1926.

Revised specifications for these connections were adopted by the International Acetylene Association, March 9, 1939. These revised specifications were adopted by the Interdepartmental Screw Thread Committee and are presented below.

Dimensions essential to the interchangeability of parts have been standardized. Other dimensions and details of design are optional, so that manufacturers may use their own judgment and follow their usual practice as much as possible. Four sizes of connections are specified, as illustrated in table 67.

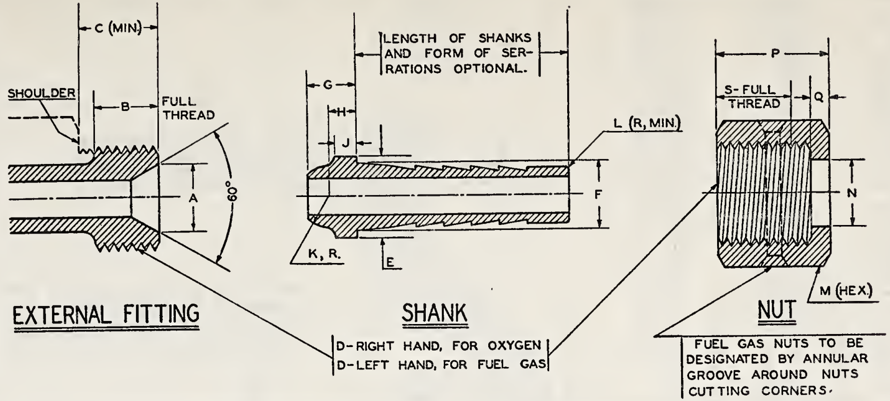
(a) STANDARD DIMENSIONS

1. Screw threads corresponding to class 3 of the American National fine-thread series are specified, for which dimensions are given in table 13. *Right-hand threads are specified for oxygen and left-hand threads for fuel gas.*
2. Angle and outside diameter of internal seat.
3. Radius and distance of radius center of external seat from shank shoulder.
4. Diameter of shank shoulder.
5. Diameter of hole in nut.
6. Large diameter of hose shank.
7. Fuel gas nuts to be designated by annular groove around nuts, cutting corners.

(b) OPTIONAL FEATURES

1. Material of strength equal to or greater than that of free-turning high brass.
2. Diameter of hole through external fitting and gland.
3. Form of end of shank, except seating section as dimensioned.
4. Length of hose shank.
5. Type and number of serrations on hose shank.
6. A second shoulder equal to the large diameter of the largest shank to extend through the hole in the nut for appearance, to be used or omitted for smaller diameter shanks.
7. Length and location of hexagon wrench section on nut.

TABLE 67.—*American National standard hose connections for welding and cutting torches, detail dimensions for classes A, B, C, and D*



Class	For hose sizes	External fitting				Shank							Nut				
		A, large diameter of seat	*B*, length of thread	*C*, length to shoulder	*D*, thread size, class 3	*E*, diameter of shoulder	*F*, diameter of shank	*G*, length to shoulder	*H*, radius distance	*J*, length of shoulder	*K*, radius	*L*, radius	*M*, width across flats	*N*, diameter of hole	*P*, length overall	*Q*, length of hole	*S*, depth of full thread
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Inch	*Inch*	*Inch*	*Inch*		*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inch*	*Inches*	*Inch*	*Inch*
A	3/16, 1/8	0.250 ±.005	1/4	9/32	3/8–24	0.326 ±.002	0.248 −.005	1/4	0.182 ±.005	1/8	0.099	1/32	7/16	0.257 +.003 −.000	15/32	3/32	1/4
B	3/8, 5/16, 1/4, 3/16, 1/8	.433 ±.005	5/16	13/32	9/16–18	.498 ±.002	.430 −.005	5/16	.175 ±.005	1/8	.196	3/64	11/16	.4375 +.003 −.000	5/8	1/8	5/16
C	1/2, 3/8, 5/16, 1/4	.625 ±.005	11/16	23/32	7/8–14	.750 ±.004	.578 −.010	7/16	.250 ±.005	3/16	.280	1/32	1 1/8	.5937 +.006 −.003	1	5/32	11/16
D	3/4, 5/8, 1/2, 3/8	.954 ±.008	7/8	31/32	1 1/4–12	1.136 ±.004	.875 −.010	5/8	.327 ±.008	3/16	.438	3/64	1 1/2	.9062 +.006 −.002	1 11/32	7/32	15/16

SECTION X. AMERICAN NATIONAL ROLLED THREADS FOR SCREW SHELLS OF ELECTRIC SOCKETS AND LAMP BASES [23]

The specifications given herein for American National rolled threads for screw shells of electric sockets and lamp bases, with the exception of the more recently adopted intermediate size, were originally published in Bulletin No. 1474 of the American Society of Mechanical Engineers entitled "Rolled Threads for Screw Shells of Electric Sockets and Lamp Bases," which was a report of the A.S.M.E. Committee on Standardization of Special Threads for Fixtures and Fittings.

1. FORM OF THREAD

The thread form is composed of two circular segments tangent to each other and of equal radii, as shown in figure 29.

2. THREAD SERIES

The sizes for which standard dimensions and tolerances have been adopted are designated as follows: "Miniature, candelabra, intermediate, medium, and mogul."

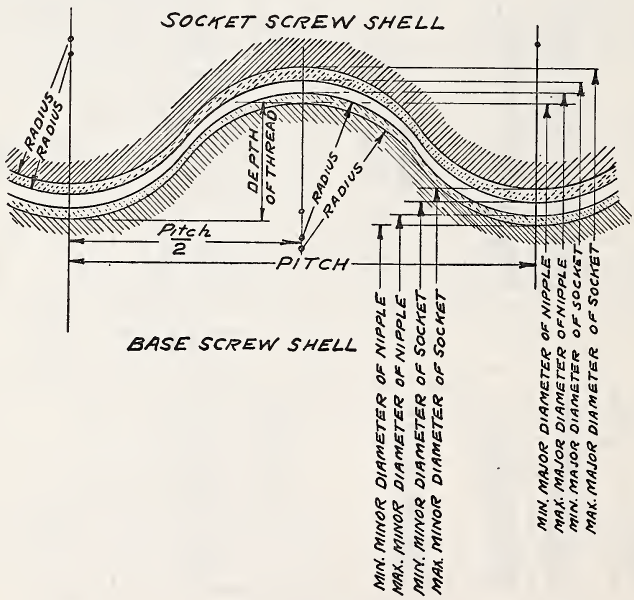


FIGURE 29.—*Illustration of allowance and tolerances, American National rolled threads for screw shells of electric sockets and lamp bases.*

The threads per inch, radii of thread form, and diameter limits for these sizes of lamp base screw shells, which are used on lamp bases, fuse plugs, attachment plugs, and similar devices, are given in table 68.

[23] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published as ASA C44–1931 "Rolled Threads for Screw Shells of Electric Sockets and Lamp Bases" by the A. S. M. E., 29 West 39th St., New York, N. Y.

The corresponding dimensions and limits for socket screw shells, which are used in electric sockets, receptacles, and similar devices, are given in table 69.

TABLE 68.—*American National rolled threads for lamp base screw shells*

Size	Threads per inch	Pitch	Depth of thread	Radius	Major diameter		Minor diameter	
					Maximum	Minimum	Maximum	Minimum
1	2	3	4	5	6	7	8	9
		Inch	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*
Miniature	14	0.07143	0.020	0.0210	0.375	0.370	0.335	0.330
Candelabra	10	.10000	.025	.0312	.465	.460	.415	.410
Intermediate	9	.11111	.027	.0353	.651	.645	.597	.591
Medium	7	.14286	.033	.0470	1.037	1.031	.971	.965
Mogul	4	.25000	.050	.0906	1.555	1.545	1.455	1.445

TABLE 69.—*American National rolled threads for socket screw shells*

Size	Threads per inch	Pitch	Depth of thread	Radius	Major diameter		Minor diameter	
					Maximum	Minimum	Maximum	Minimum
1	2	3	4	5	6	7	8	9
		Inch	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*
Miniature	14	0.07143	0.020	0.0210	0.3835	0.3775	0.3435	0.3375
Candelabra	10	.10000	.025	.0312	.476	.470	.426	.420
Intermediate	9	.11111	.027	.0353	.664	.657	.610	.603
Medium	7	.14286	.033	.0470	1.053	1.045	.987	.979
Mogul	4	.25000	.050	.0906	1.577	1.565	1.477	1.465

3. GAGES

Gages are necessary to control dimensions in manufacture and to insure interchangeability and proper assembly.

(*a*) GAGING OF LAMP BASE SCREW SHELLS—(1) *Working gages.*—For each size of lamp base screw shell there should be provided for control in manufacture, a "go" and a "not go" threaded ring gages to govern the minor diameter and thread form, and "go" and "not go" plain ring gages to govern major diameter.

(2) *Inspection gages.*—For purposes of inspection in the final acceptance of the product, a "go" threaded ring gage governing minor diameter and thread form, and a "not go" plain ring gage governing major diameter are sufficient.

(*b*) GAGING OF SOCKET SCREW SHELLS—(1) *Working gages.*—For each size of socket screw shell there should be provided, for control in manufacture, "go" and "not go" thread plug gages to govern the major diameter and thread form, and "go" and "not go" plain plug gages to govern minor diameter.

(2) *Inspection gages.*—For the final acceptance of the product, a "go" threaded plug gage governing the major diameter and thread form, and a "not go" plain plug governing minor diameter are sufficient.

(*c*) TOLERANCES ON GAGES.—Manufacturing tolerances on inspection or working gages shall be as follows:

BASE SCREW SHELL

"Go" thread ring gage, maximum thread size to minus 0.0003 in.
"Not go" thread ring gage, minimum thread size to plus 0.0003 in.
"Go" plain ring gage, maximum major diameter to minus 0.0002 in.
"Not go" plain ring gage, minimum major diameter to plus 0.0002 in.

SOCKET SCREW SHELL

"Go" thread plug gage, minimum thread size to plus 0.0003 in.
"Not go" thread plug gage, maximum thread size to minus 0.0003 in.
"Go" plain plug gage, minimum minor diameter to plus 0.0002 in.
"Not go" plain plug gage, maximum minor diameter to minus 0.0002 in.

CHECK GAGES FOR BASE SCREW SHELL GAGES

Thread check plug for "go" thread ring gage, maximum thread size to minus 0.0003 in.
Thread check plug for "not go" thread ring gage, minimum thread size to plus 0.0003 in.

SECTION XI. WRENCH-HEAD BOLTS AND NUTS, AND WRENCH OPENINGS [24]

These standards for wrench-head bolts and nuts and wrench openings are intended for general use and to replace such other series of dimensions as have been used.

In all cases the basic widths across flats of bolt heads and nuts are taken as maximum sizes and the tolerances on bolt heads and nuts are minus only. The minimum wrench openings are made to provide a positive clearance between maximum nut and minimum wrench, and the tolerances on wrench openings are plus only. This insures assembly of the wrench on the bolt head or nut, whereas the tolerances are as large as possible without causing the deformation of the corners of bolt heads or nuts by the wrenches.

Terms relating to bolt heads and nuts are defined in section II, p. 4.

1. SERIES OF BOLT HEADS AND NUTS

(*a*) Regular Series Bolt Heads and Nuts.—Regular bolt heads and nuts are for general use. The dimensions and the resulting strengths of these bolt heads and nuts are based on theoretical analysis of stresses and on results of numerous tests.

(*b*) Heavy Series Bolt Heads and Nuts.—Heavy bolt heads and nuts are for use where greater bearing surface is necessary, that is, where a large clearance between the bolt and hole or a greater wrench bearing surface is considered essential.

(*c*) Light Series Nuts.—Light nuts have smaller widths across flats than regular series nuts.

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[24] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published as ASA B 18.2–1941 "Wrench head bolts and nuts, and wrench openings" by the A. S. M. E., 29 West 39th St., New York, N. Y.

2. RECOMMENDED REQUIREMENTS, BOLTS AND CAP SCREWS

(*a*) Workmanship.—The workmanship shall be compatible with the type of product and class of fit and finish specified. The product shall be free from abnormal scale, fins, seams, or other defects. All bolts and screws shall be free from any defects which might affect their serviceability.

(*b*) Thread Series.—Unless otherwise specified the number of threads per inch shall be that specified for the American National coarse-thread series or the American National fine-thread series.

(*c*) Details of Design.—1. *Length of bolts.*—Bolt length is measured from the greatest diameter of the under surface of the head to the end of the bolt. The length of bolts shall not vary from the specified length by more than the following table given on p. 65 of the 1941 book of Standards of the American Institute of Bolt, Nut, and Rivet Manufacturers:

Length of bolt, L	Tolerance on length for sizes			
	¼ to ⅜ in., inclusive	7/16 to ½ in., inclusive	⅝ to 1¼ in., inclusive	1⅜ to 3 in., inclusive
	Inch ±	*Inch* ±	*Inch* ±	*Inch* ±
6 inches and under	1/32	1/16	⅛	¼
Over 6 inches	1/16	3/32	3/16	¼

2. *Length of threads.*—The minimum length of thread of all types of bolts, except cap screws, shall, unless otherwise specified, conform to table 70. The minimum thread length is measured from the end of the bolt to the last complete thread. The length of incomplete thread shall not exceed 2½ threads.

For bolts too short for the specified minimum thread lengths, threads shall be cut or rolled to within ¼ in. of head or neck on sizes up to and including ½ in.; ⅜ in. on sizes 9/16 to 1 in., inclusive; ½ in. on sizes 1⅛ to 2 in., inclusive; and ¾ in. on sizes 2⅛ to 3 in., inclusive.

3. *Tolerances on Body Diameter.*—Tolerances on body diameter of screws and bolts are not included in this handbook. The practice followed should be consistent with the type and class of product specified.

Body diameters are, of course, primarily controlled by stock sizes and process of manufacture. Close tolerances on body diameters will, therefore, require close control of stock sizes. Producers of screws and bolts should keep this fact in mind when ordering or inspecting screw and bolt stock. Purchasers of screws and bolts should also keep this in mind and should not insist on body diameter tolerances that are closer than necessary for the purpose.

4. *Taper of heads.*—The taper of the sides of bolt heads (the angle between one side and the axis) shall not exceed 2°. The largest width shall not exceed the specified maximum width across flats.

5. *Top of heads.*—The tops of heads of square and hexagonal bolts shall be flat and chamfered. The angle of chamfer with the top surface shall be 30° for hexagonal bolts and 25° for square bolts. The diameter of the top flat circle shall be the maximum width across flats, within a tolerance of minus 15 percent.

6. *Fillet under heads.*—The maximum radius under the head of bolts, except cap screws, for sizes ¼, to ½ in. shall be 1/32 in.; for sizes 9/16 to 1 in. shall be 1/16 in.; for sizes 1⅛ to 2 in. shall be ⅛ in.; and for sizes 2¼ to 3 in. shall be 3/16 in.

7. *Bearing Surface.*—(*a*) *Unfinished bolt heads.*—The bearing surface of unfinished bolt heads shall be at right angles to the axis of the body of the bolt within a tolerance of 3° for 1-in. bolts or smaller, and 2° for bolts larger than 1 in.; and shall be concentric with the axis of the body within a tolerance of 3 percent of the maximum width across flats.

(*b*) *Semifinished bolt heads.*—The bearing surface of semifinished bolt heads shall be washer faced. The thickness of the washer face shall be approximately 1/64 in. included in the height of head, and the diameter of the washer face shall be the maximum width across flats within a tolerance of minus 5 percent.

The bearing surface shall be at right angles to the axis of the body of the bolt within a tolerance of 2° for 1-in. bolts or smaller, and 1° for bolts larger than 1 in.; and shall be concentric with the axis of the body within a tolerance of 3 percent of the maximum width across flats.

3. TABLES OF DIMENSIONS, BOLTS AND CAP SCREWS

(*a*) Regular Bolt Heads.—1. *Unfinished square and hexagon.*—Head dimensions of unfinished square and hexagon regular bolts shall conform to table 71.

2. *Semifinished hexagon.*—Head dimensions of semifinished hexagon regular bolts shall conform to table 72.

3. *Finished hexagon.*—Finished regular bolt heads, when specified, shall be made to the dimensions and tolerances given for the semifinished product, the degree and character of finish to be specified in each case.

(*b*) Heavy Bolt Heads.—1. *Unfinished square and hexagon.*—Head dimensions of unfinished square and hexagon heavy bolts shall conform to table 73.

2. *Semifinished hexagon.*—Head dimensions of semifinished hexagon heavy bolts shall conform to table 74.

3. *Finished hexagon.*—Finished heavy bolt heads, when specified, shall be made to the dimensions and tolerances given for the semifinished product; the degree and character of finish to be specified in each case.

(*c*) Cap Screw Heads, Hexagon.—Full finished hexagon head cap screws have all surfaces, including body and all surfaces of the head, machined or otherwise treated to provide a surface which is equivalent in appearance. For special applications the quality of full finish may be agreed upon by the user and the manufacturer.

1. *Head dimensions.*—Head dimensions of hexagon cap screws shall conform to table 75, and these apply both to full-finished hexagon head cap screws and to automotive hexagon head bolts.

2. *Length of threads.*—The length of thread in either the coarse- or fine-thread series shall be equal to twice the diameter plus 1/4 in. The minimum thread length is measured from the extreme end of the bolt to the last complete thread. Product too short to permit the formula length of thread shall be threaded as close to the head as practicable.

3. *Fillet under head.*—The radius of fillet under head for sizes 1/4 to 5/8 in. shall be 0.01 to 1/64 in.; for sizes 11/16 to 1 in. shall be 1/64 to 1/32 in.; for sizes 1 1/16 to 1 1/4 in. shall be 1/32 to 3/64 in.

4. *Bearing surface.*—The bearing surface shall be washer faced unless otherwise specified. The thickness of the washer face shall be approximately 1/64 in. included in the height of head, and the diameter of the washer face shall be the maximum width across flats within a tolerance of minus 5 percent.

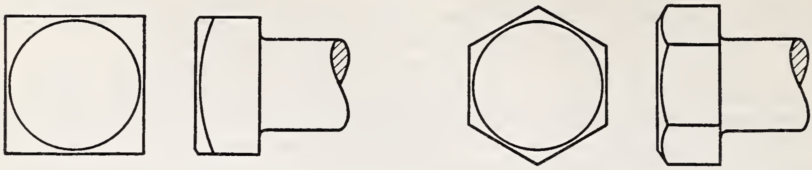
The bearing surface shall be at right angles to the axis of the body within a tolerance of 2° for 1 in. or smaller, and 1° for diameters larger than 1 in.; and shall be concentric with the axis of the body within a tolerance of 3 percent of the maximum width across flats.

TABLE 70.—*Minimum length of threaded portion of bolts*

Length of bolt [1]	Diameter of bolt, inches														
	No. 10, 1/4	5/16, 3/8	7/16, 1/2	9/16, 5/8	3/4	7/8	1	1 1/8, 1 1/4	1 3/8, 1 1/2	1 5/8, 1 3/4	1 7/8, 2	2 1/4	2 1/2	2 3/4	3
	MINIMUM THREAD LENGTH														
In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
3/4	1/2	1/2	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1	3/4	3/4	3/4	3/4	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1 1/4	3/4	3/4	1	1	1	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
1 1/2	3/4	7/8	1	1 1/8	1 1/8	1 1/8	-----	-----	-----	-----	-----	-----	-----	-----	-----
1 3/4	3/4	7/8	1	1 3/16	1 3/8	1 3/8	1 3/8	-----	-----	-----	-----	-----	-----	-----	-----
2	3/4	1	1 1/4	1 1/4	1 3/8	1 9/16	1 5/8	1 5/8	-----	-----	-----	-----	-----	-----	-----
2 1/2	3/4	1	1 1/4	1 1/2	1 1/2	1 9/16	1 3/4	2	2	-----	-----	-----	-----	-----	-----
3	7/8	1	1 1/4	1 1/2	1 3/4	1 3/4	1 3/4	2 1/8	2 1/2	2 1/2	-----	-----	-----	-----	-----
4	7/8	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/4	2 1/2	2 7/8	3 1/4	3 1/4	3 1/4	-----	-----
5	7/8	1 3/16	1 1/4	1 1/2	1 3/4	2	2 1/4	2 3/4	2 3/4	2 7/8	3 1/4	3 5/8	4	4 1/8	4 1/4
6	7/8	1 3/16	1 1/2	1 1/2	1 3/4	2	2 1/4	2 3/4	3 1/4	3 1/4	3 1/4	3 5/8	4	4 1/8	4 3/4
8	7/8	1 3/16	1 1/2	1 13/16	2	2	2 1/4	2 3/4	3 1/4	3 3/4	4	4	4	4 1/8	4 3/4
10	7/8	1 3/16	1 1/2	1 13/16	2 1/8	2 7/16	2 1/2	2 3/4	3 1/4	3 3/4	4 1/4	4 3/4	4 3/4	4 3/4	4 3/4
12	7/8	1 3/16	1 1/2	1 13/16	2 1/8	2 7/16	2 3/4	2 3/4	3 1/4	3 3/4	4 1/4	4 3/4	5 1/4	5 3/4	6 1/4
16	1	1 3/16	1 1/2	1 13/16	2 1/8	2 7/16	2 3/4	3 1/4	3 1/4	3 3/4	4 1/4	4 3/4	5 1/4	5 3/4	6 1/4
20	1	1 3/8	1 1/2	1 13/16	2 1/8	2 7/16	2 3/4	3 3/8	4	4 5/8	4 3/4	4 3/4	5 1/4	5 3/4	6 1/4
30	-----	-----	1 3/4	1 13/16	2 1/8	2 7/16	2 3/4	3 3/8	4	4 5/8	5 1/4	5 7/8	6 1/2	6 1/2	6 1/2

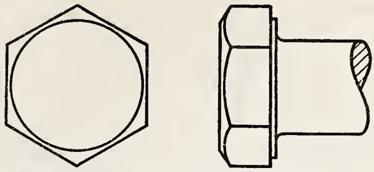
[1] For intermediate bolt lengths, the minimum thread length shall be the same as that specified in the table for the next shorter length of bolt of the same diameter.

TABLE 71.—*Dimensions of unfinished square and hexagon regular bolt heads*



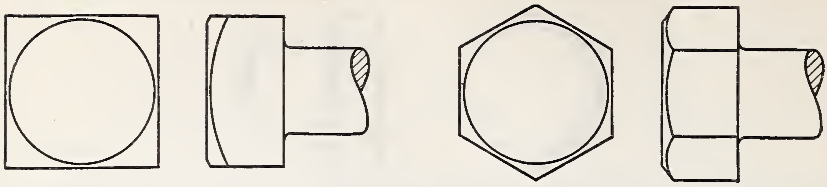
Nominal size or basic major diameter of thread	Width across flats		Width across corners, Min.		Height		
	Maximum (basic)	Min.	Sq.	Hex.	Nominal	Max.	Min.
1	2	3	4	5	6	7	8
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
¼ ---------- 0.2500	⅜ ---------- 0.3750	0.362	0.498	0.413	11/64	0.188	0.156
5/16 ---------- .3125	½ ---------- .5000	.484	.665	.552	13/64	.220	.186
⅜ ---------- .3750	9/16 ---------- .5625	.544	.747	.620	¼	.268	.232
7/16 ---------- .4375	⅝ ---------- .6250	.603	.828	.687	19/64	.316	.278
½ ---------- .5000	¾ ---------- .7500	.725	.995	.826	21/64	.348	.308
9/16 ---------- .5625	⅞ ---------- .8750	.847	1.163	.966	⅜	.396	.354
⅝ ---------- .6250	15/16 ---------- .9375	.906	1.244	1.033	27/64	.444	.400
¾ ---------- .7500	1⅛ ---------- 1.1250	1.088	1.494	1.240	½	.524	.476
⅞ ---------- .8750	1 5/16 ---------- 1.3125	1.269	1.742	1.447	19/32	.620	.568
1 ---------- 1.0000	1½ ---------- 1.5000	1.450	1.991	1.653	21/32	.684	.628
1⅛ ---------- 1.1250	1 11/16 ---------- 1.6875	1.631	2.239	1.859	¾	.780	.720
1¼ ---------- 1.2500	1⅞ ---------- 1.8750	1.812	2.489	2.066	27/32	.876	.812
1⅜ ---------- 1.3750	2 1/16 ---------- 2.0625	1.994	2.738	2.273	29/32	.940	.872
1½ ---------- 1.5000	2¼ ---------- 2.2500	2.175	2.986	2.480	1	1.036	.964
1⅝ ---------- 1.6250	2 7/16 ---------- 2.4375	2.356	3.235	2.686	1 3/32	1.132	1.056
1¾ ---------- 1.7500	2⅝ ---------- 2.6250	2.538	3.485	2.893	1 5/32	1.196	1.116
1⅞ ---------- 1.8750	2 13/16 ---------- 2.8125	2.719	3.733	3.100	1¼	1.292	1.208
2 ---------- 2.0000	3 ---------- 3.0000	2.900	3.982	3.306	1 11/32	1.388	1.300
2¼ ---------- 2.2500	3⅜ ---------- 3.3750	3.262	4.479	3.719	1½	1.548	1.452
2½ ---------- 2.5000	3¾ ---------- 3.7500	3.625	4.977	4.133	1 21/32	1.708	1.604
2¾ ---------- 2.7500	4⅛ ---------- 4.1250	3.988	5.476	4.546	1 13/16	1.889	1.777
3 ---------- 3.0000	4½ ---------- 4.5000	4.350	5.973	4.959	2	2.060	1.940

TABLE 72.—*Dimensions of semifinished hexagon regular bolt heads*



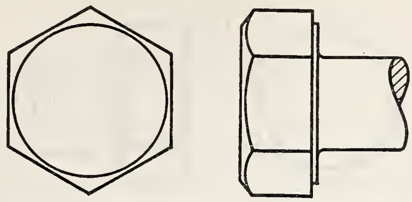
Nominal size or basic major diameter of thread	Width across flats		Width across corners	Height		
	Maximum (basic)	Min.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
¼ 0.2500	⅜ 0.3750	0.362	0.413	5/32	0.172	0.140
5/16 .3125	½ .5000	.484	.552	3/16	.205	.171
⅜ .3750	9/16 .5625	.544	.620	15/64	.252	.216
7/16 .4375	⅝ .6250	.603	.687	9/32	.300	.262
½ .5000	¾ .7500	.725	.826	19/64	.317	.277
9/16 .5625	⅞ .8750	.847	.966	11/32	.365	.323
⅝ .6250	15/16 .9375	.906	1.033	25/64	.413	.369
¾ .7500	1⅛ 1.1250	1.088	1.240	15/32	.493	.445
⅞ .8750	1 5/16 1.3125	1.269	1.447	9/16	.589	.536
1 1.0000	1½ 1.5000	1.450	1.653	19/32	.622	.566
1⅛ 1.1250	1 11/16 1.6875	1.631	1.859	11/16	.718	.658
1¼ 1.2500	1⅞ 1.8750	1.812	2.066	25/32	.813	.749
1⅜ 1.3750	2 1/16 2.0625	1.994	2.273	27/32	.878	.810
1½ 1.5000	2¼ 2.2500	2.175	2.480	15/16	.974	.902
1⅝ 1.6250	2 7/16 2.4375	2.356	2.686	1 1/32	1.069	.993
1¾ 1.7500	2⅝ 2.6250	2.538	2.893	1 3/32	1.134	1.054
1⅞ 1.8750	2 13/16 2.8125	2.719	3.100	1 3/16	1.230	1.146
2 2.0000	3 3.0000	2.900	3.306	1 7/32	1.263	1.175
2¼ 2.2500	3⅜ 3.3750	3.262	3.719	1⅜	1.423	1.327
2½ 2.5000	3¾ 3.7500	3.625	4.133	1 17/32	1.583	1.479
2¾ 2.7500	4⅛ 4.1250	3.988	4.546	1 11/16	1.744	1.632
3 3.0000	4½ 4.5000	4.350	4.959	1⅞	1.935	1.815

TABLE 73.—*Dimensions of unfinished square and hexagon heavy bolt heads*



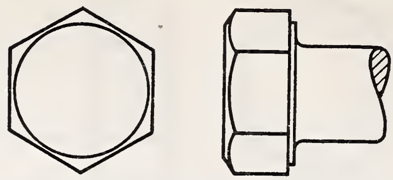
Nominal size or basic major diameter of thread	Width across flats		Width across corners (min.)		Height		
	Maximum (basic)	Min.	Sq.	Hex.	Nominal	Max.	Min.
1	2	3	4	5	6	7	8
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/2 ---------- 0.5000	7/8 ---------- 0.8750	0.850	1.167	0.969	7/16	0.458	0.418
9/16 ---------- .5625	15/16 ---------- .9375	.909	1.249	1.037	15/32	.490	.448
5/8 ---------- .6250	1 1/16 ---------- 1.0625	1.031	1.416	1.175	17/32	.553	.509
3/4 ---------- .7500	1 1/4 ---------- 1.2500	1.212	1.665	1.382	5/8	649	.601
7/8 ---------- .8750	1 7/16 ---------- 1.4375	1.394	1.914	1.589	23/32	.745	.693
1 ---------- 1.0000	1 5/8 ---------- 1.6250	1.575	2.162	1.796	13/16	.840	.784
1 1/8 ---------- 1.1250	1 13/16 ---------- 1.8125	1.756	2.411	2.002	29/32	.936	.876
1 1/4 ---------- 1.2500	2 ---------- 2.0000	1.938	2.661	2.209	1	1.032	.968
1 3/8 ---------- 1.3750	2 3/16 ---------- 2.1875	2.119	2.909	2.416	1 3/32	1.128	1.060
1 1/2 ---------- 1.5000	2 3/8 ---------- 2.3750	2.300	3.158	2.622	1 3/16	1.224	1.152
1 5/8 ---------- 1.6250	2 9/16 ---------- 2.5625	2.481	3.406	2.828	1 9/32	1.319	1.243
1 3/4 ---------- 1.7500	2 3/4 ---------- 2.7500	2.662	3.655	3.035	1 3/8	1.415	1.335
1 7/8 ---------- 1.8750	2 15/16 ---------- 2.9375	2.844	3.905	3.242	1 15/32	1.511	1.427
2 ---------- 2.0000	3 1/8 ---------- 3.1250	3.025	4.153	3.449	1 9/16	1.606	1.518
2 1/4 ---------- 2.2500	3 1/2 ---------- 3.5000	3.388	4.652	3.862	1 3/4	1.798	1.702
2 1/2 ---------- 2.5000	3 7/8 ---------- 3.8750	3.750	5.149	4.275	1 15/16	1.990	1.886
2 3/4 ---------- 2.7500	4 1/4 ---------- 4.2500	4.112	5.646	4.688	2 1/8	2.181	2.069
3 ---------- 3.0000	4 5/8 ---------- 4.6250	4.475	6.144	5.102	2 5/16	2.373	2.252

TABLE 74.—*Dimensions of semifinished hexagon heavy bolt heads*



Nominal size or basic major diameter of thread	Width across flats		Width across corners	Height		
	Maximum (basic)	Min.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/2 0.5000	7/8 0.8750	0.850	0.969	13/32	0.426	0.386
9/16 .5625	15/16 .9375	.909	1.037	7/16	.459	.417
5/8 .6250	1 1/16 1.0625	1.031	1.175	1/2	.522	.478
3/4 .7500	1 1/4 1.2500	1.212	1.382	19/32	.618	.570
7/8 .8750	1 7/16 1.4375	1.394	1.589	11/16	.714	.662
1 1.0000	1 5/8 1.6250	1.575	1.796	3/4	.778	.722
1 1/8 1.1250	1 13/16 1.8125	1.756	2.002	27/32	.874	.814
1 1/4 1.2500	2 2.0000	1.938	2.209	15/16	.970	.906
1 3/8 1.3750	2 3/16 2.1875	2.119	2.416	1 1/32	1.065	.997
1 1/2 1.5000	2 3/8 2.3750	2.300	2.622	1 1/8	1.161	1.089
1 5/8 1.6250	2 9/16 2.5625	2.481	2.828	1 7/32	1.257	1.181
1 3/4 1.7500	2 3/4 2.7500	2.662	3.035	1 5/16	1.352	1.272
1 7/8 1.8750	2 15/16 2.9375	2.844	3.242	1 13/32	1.448	1.364
2 2.0000	3 1/8 3.1250	3.025	3.449	1 7/16	1.482	1.394
2 1/4 2.2500	3 1/2 3.5000	3.388	3.862	1 5/8	1.673	1.577
2 1/2 2.5000	3 7/8 3.8750	3.750	4.275	1 13/16	1.864	1.760
2 3/4 2.7500	4 1/4 4.2500	4.112	4.688	2	2.056	1.944
3 3.0000	4 5/8 4.6250	4.475	5.102	2 3/16	2.248	2.128

TABLE 75.—*Dimensions of finished hexagon cap screw heads*



Nominal size or basic major diameter of thread	Width across flats		Width across corners	Height		
	Maximum (basic)	Min.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7
Inches	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*
1/4 .... 0.2500	7/16 .... 0.4375	0.428	0.488	3/16	0.194	0.181
5/16 .... .3125	1/2 .... .5000	.489	.557	15/64	.242	.227
3/8 .... .3750	9/16 .... .5625	.551	.628	9/32	.289	.273
7/16 .... .4375	5/8 .... .6250	.612	.698	21/64	.338	.319
1/2 .... .5000	3/4 .... .7500	.736	.840	3/8	.386	.364
9/16 .... .5625	13/16 .... .8125	.798	.910	27/64	.433	.410
5/8 .... .6250	7/8 .... .8750	.860	.980	15/32	.481	.456
3/4 .... .7500	1 .... 1.0000	.983	1.121	9/16	.577	.548
7/8 .... .8750	1 1/8 .... 1.1250	1.106	1.261	21/32	.672	.640
1 .... 1.0000	1 5/16 .... 1.3125	1.292	1.473	3/4	.768	.732
1 1/8 .... 1.1250	1 1/2 .... 1.5000	1.477	1.684	27/32	.864	.824
1 1/4 .... 1.2500	1 11/16 .... 1.6875	1.663	1.896	15/16	.959	.916

4. RECOMMENDED REQUIREMENTS, NUTS

(*a*) WORKMANSHIP.—The workmanship shall be compatible with the type of product and class of fit and finish specified. The product shall be free from abnormal scale, fins, seams, or other defects. All nuts shall be free from any defects which might affect their serviceability.

Unless otherwise specified, semifinished nuts shall be either cold-punched, hot-forged and trimmed, or machined from bar stock. Unfinished nuts may be cold- or hot-punched or hot-forged.

(*b*) THREAD SERIES.—When nuts are furnished with bolts, the threads of the nuts shall, unless otherwise specified, be of the same thread series and class of fit as the threads of the bolts. When nuts are ordered separately, the threads shall be of the thread series and class of fit specified.

(*c*) DETAILS OF DESIGN.—1. *Taper of nuts.*—The taper of the sides of nuts (the angle between one side and the axis) shall not exceed 2°. The largest width shall not exceed the specified maximum width across flats.

2. *Top of nuts.*—The tops of all nuts, except light castle nuts, shall be flat and chamfered, but unfinished nuts (except jam nuts) may be washer crowned. The angle of chamfer with the top surface shall be 30° for hexagonal nuts and 25° for square nuts, and the diameter of the top circle shall be the maximum width across flats, within a tolerance of minus 15 percent.

3. *Bearing surface.*—(*a*) *Unfinished nuts.*—The bearing surface of unfinished nuts shall be at right angles to the axis of the threaded hole within a tolerance of 3° for 1-in. nuts or smaller, and 2° for nuts larger than 1 in.

(*b*) *Semifinished nuts.*—The bearing surface of semifinished nuts shall be washer faced or have chamfered corners. The thickness of the washer face shall be approximately 1/64 in. included in the nut thickness, and the diameter of the washer face shall be the maximum width across flats within a tolerance of minus 5 percent.

The bearing surface shall be at right angles to the axis of the threaded hole within a tolerance of 2° for 5/8-in. nuts or smaller, and 1° for nuts larger than 5/8 in.

5. TABLES OF DIMENSIONS, NUTS

(*a*) Regular Nuts and Regular Jam Nuts.—1. *Unfinished square and hexagon.*—The dimensions of unfinished square and hexagon regular jam nuts shall conform to table 76.

2. *Semifiinished hexagon.*—The dimensions of semifinished hexagon regular nuts and regular jams nuts shall conform to table 77.

3. *Semifinished hexagon slotted.*—The dimensions of semifinished hexagon regular slotted nuts shall conform to table 78. Slots may have square or round bottoms at the option of the manufacturer.

(*b*) Heavy Nuts and Heavy Jam Nuts.—1. *Unfinished square and hexagon.*—The dimensions of unfinished square and hexagon heavy nuts and hexagon heavy jam nuts shall conform to table 79.

2. *Semifinished hexagon.*—The dimensions of semifinished hexagon heavy nuts and jam nuts shall conform to table 80.

3. *Semifinished hexagon slotted.*—The dimensions of semifinished hexagon heavy slotted nuts shall conform to table 81.

(*c*) Light Nuts and Light Jam Nuts.—1. *Semifinished hexagon.*—The dimensions of semifinished hexagon light nuts and light jam nuts shall conform to table 82.

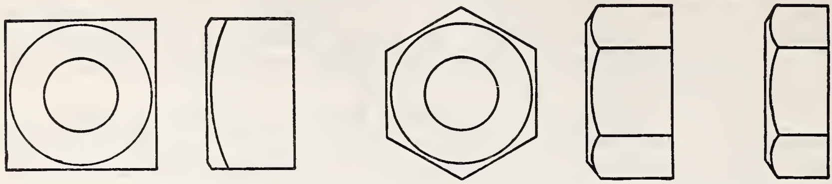
2. *Semifinished hexagon thick.*—The dimensions of semifinished hexagon light thick nuts shall conform to table 83.

3. *Semifinished hexagon slotted.*—The dimensions of semifinished hexagon light slotted nuts shall conform to table 84.

4. *Semifinished hexagon thick slotted.*—The dimensions of semifinished hexagon light thick slotted nuts shall conform to table 85.

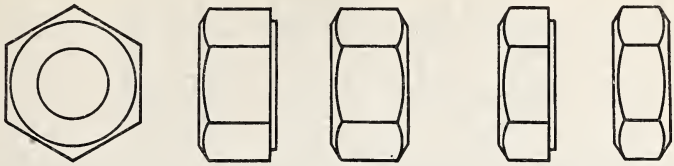
5. *Semifinished hexagon castle.*—The dimensions of semifinished hexagon light castle nuts shall conform to table 86.

TABLE 76.—*Dimensions of unfinished square and hexagon regular nuts and hexagon regular jam nuts*



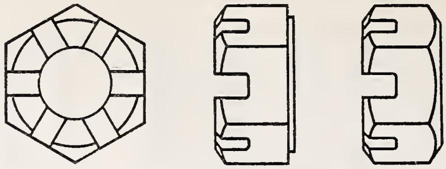
Nominal size or basic major diameter of thread	Width across flats		Width across corners Min		Thickness, regular nuts			Thickness, regular jam nuts		
	Maximum (basic)	Min.	Sq.	Hex.	Nominal	Max.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/4 --- 0.2500	7/16 --- 0.4375	0.425	0.584	0.484	7/32	0.235	0.203	5/32	0.172	0.140
5/16 --- .3125	9/16 --- .5625	.547	.751	.624	17/64	.283	.249	3/16	.204	.170
3/8 --- .3750	5/8 --- .6250	.606	.832	.691	21/64	.346	.310	7/32	.237	.201
7/16 --- .4375	3/4 --- .7500	.728	1.000	.830	3/8	.394	.356	1/4	.269	.231
1/2 --- .5000	13/16 --- .8125	.788	1.082	.898	7/16	.458	.418	5/16	.332	.292
9/16 --- .5625	7/8 --- .8750	.847	1.163	.966	1/2	.521	.479	11/32	.365	.323
5/8 --- .6250	1 --- 1.0000	.969	1.330	1.104	35/64	.569	.525	3/8	.397	.353
3/4 --- .7500	1 1/8 --- 1.1250	1.088	1.494	1.240	21/32	.680	.632	7/16	.462	.414
7/8 --- .8750	1 5/16 --- 1.3125	1.269	1.742	1.447	49/64	.792	.740	1/2	.526	.474
1 --- 1.0000	1 1/2 --- 1.5000	1.450	1.991	1.653	7/8	.903	.847	9/16	.590	.534
1 1/8 --- 1.1250	1 11/16 --- 1.6875	1.631	2.239	1.859	1	1.030	.970	5/8	.655	.595
1 1/4 --- 1.2500	1 7/8 --- 1.8750	1.812	2.489	2.066	1 3/32	1.126	1.062	3/4	.782	.718
1 3/8 --- 1.3750	2 1/16 --- 2.0625	1.994	2.738	2.273	1 13/64	1.237	1.169	13/16	.846	.778
1 1/2 --- 1.5000	2 1/4 --- 2.2500	2.175	2.986	2.480	1 5/16	1.348	1.276	7/8	.911	.839
1 5/8 --- 1.6250	2 7/16 --- 2.4375	2.356	3.235	2.686	1 27/64	1.460	1.384	15/16	.976	.900
1 3/4 --- 1.7500	2 5/8 --- 2.6250	2.538	3.485	2.893	1 17/32	1.571	1.491	1	1.040	.960
1 7/8 --- 1.8750	2 13/16 --- 2.8125	2.719	3.733	3.100	1 41/64	1.683	1.599	1 1/16	1.104	1.020
2 --- 2.0000	3 --- 3.0000	2.900	3.982	3.306	1 3/4	1.794	1.706	1 1/8	1.169	1.081
2 1/4 --- 2.2500	3 3/8 --- 3.3750	3.262	4.479	3.719	1 31/32	2.017	1.921	1 1/4	1.298	1.202
2 1/2 --- 2.5000	3 3/4 --- 3.7500	3.625	4.977	4.133	2 3/16	2.240	2.136	1 1/2	1.552	1.448
2 3/4 --- 2.7500	4 1/8 --- 4.1250	3.988	5.476	4.546	2 13/32	2.462	2.350	1 5/8	1.681	1.569
3 --- 3.0000	4 1/2 --- 4.5000	4.350	5.973	4.959	2 5/8	2.685	2.565	1 3/4	1.810	1.690

TABLE 77.—*Dimensions of semifinished hexagon regular nuts and hexagon regular jam nuts*



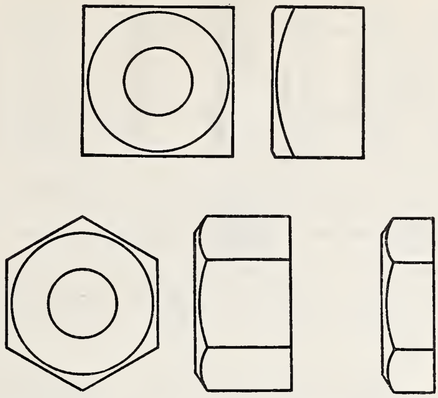
Nominal size or basic major of thread	Width across flats		Width across corners	Thickness, regular nuts			Thickness, regular jam nuts		
	Max. (basic)	Min.	Min.	Nominal	Max.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7	8	9	10
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/4 ---------- 0.2500	7/16 -------- 0.4375	0.425	0.484	13/64	0.219	0.187	9/64	0.157	0.125
5/16 -------- .3125	9/16 -------- .5625	.547	.624	1/4	.267	.233	11/64	.189	.155
3/8 ---------- .3750	5/8 ---------- .6250	.606	.691	5/16	.330	.294	13/64	.221	.185
7/16 -------- .4375	3/4 ---------- .7500	.728	.830	23/64	.378	.340	15/64	.253	.215
1/2 ---------- .5000	13/16 ------- .8125	.788	.898	27/64	.442	.402	19/64	.317	.277
9/16 -------- .5625	7/8 ---------- .8750	.847	.966	31/64	.505	.463	21/64	.349	.307
5/8 ---------- .6250	1 ------------ 1.0000	.969	1.104	17/32	.553	.509	23/64	.381	.337
3/4 ---------- .7500	1 1/8 -------- 1.1250	1.088	1.240	41/64	.665	.617	27/64	.446	.398
7/8 ---------- .8750	1 5/16 ------- 1.3125	1.269	1.447	3/4	.776	.724	31/64	.510	.458
1 ------------ 1.0000	1 1/2 -------- 1.5000	1.450	1.653	55/64	.887	.831	35/64	.575	.519
1 1/8 -------- 1.1250	1 11/16 ----- 1.6875	1.631	1.859	31/32	.999	.939	39/64	.639	.579
1 1/4 -------- 1.2500	1 7/8 -------- 1.8750	1.812	2.066	1 1/16	1.094	1.030	23/32	.751	.687
1 3/8 -------- 1.3750	2 1/16 ------- 2.0625	1.994	2.273	1 11/64	1.206	1.138	25/32	.815	.747
1 1/2 -------- 1.5000	2 1/4 -------- 2.2500	2.175	2.480	1 9/32	1.317	1.245	27/32	.880	.808
1 5/8 -------- 1.6250	2 7/16 ------- 2.4375	2.356	2.686	1 25/64	1.429	1.353	29/32	.944	.868
1 3/4 -------- 1.7500	2 5/8 -------- 2.6250	2.538	2.893	1 1/2	1.540	1.460	31/32	1.009	.929
1 7/8 -------- 1.8750	2 13/16 ----- 2.8125	2.719	3.100	1 39/64	1.651	1.567	1 1/32	1.073	.989
2 ------------ 2.0000	3 ------------ 3.0000	2.900	3.306	1 23/32	1.763	1.675	1 3/32	1.138	1.050
2 1/4 -------- 2.2500	3 3/8 -------- 3.3750	3.262	3.719	1 59/64	1.970	1.874	1 13/64	1.251	1.155
2 1/2 -------- 2.5000	3 3/4 -------- 3.7500	3.625	4.133	2 9/64	2.193	2.089	1 29/64	1.505	1.401
2 3/4 -------- 2.7500	4 1/8 -------- 4.1250	3.988	4.546	2 23/64	2.415	2.303	1 37/64	1.634	1.522
3 ------------ 3.0000	4 1/2 -------- 4.5000	4.350	4.959	2 37/64	2.638	2.518	1 45/64	1.763	1.643

TABLE 78.—*Dimensions of semifinished hexagon regular slotted nuts*



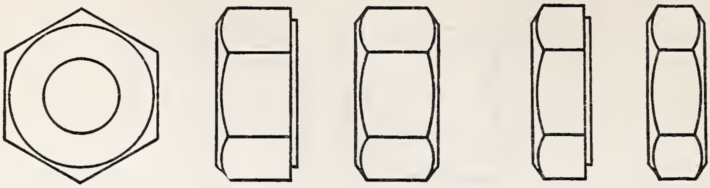
Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness			Slot	
	Max. (basic)	Min.	Min.	Nominal	Max.	Min.	Width	Depth
1	2	3	4	5	6	7	8	9
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/4 0.2500	7/16 0.4375	0.425	0.484	13/64	0.219	0.187	5/64	3/32
5/16 .3125	9/16 .5625	.547	.624	1/4	.267	.233	3/32	3/32
3/8 .3750	5/8 .6250	.606	.691	5/16	.330	.294	1/8	1/8
7/16 .4375	3/4 .7500	.728	.830	23/64	.378	.340	1/8	5/32
1/2 .5000	13/16 .8125	.788	.898	27/64	.442	.402	5/32	5/32
9/16 .5625	7/8 .8750	.847	.966	31/64	.505	.463	5/32	3/16
5/8 .6250	1 1.0000	.969	1.104	17/32	.553	.509	3/16	7/32
3/4 .7500	1 1/8 1.1250	1.088	1.240	41/64	.665	.617	3/16	1/4
7/8 .8750	1 5/16 1.3125	1.269	1.447	3/4	.776	.724	3/16	1/4
1 1.0000	1 1/2 1.5000	1.450	1.653	55/64	.887	.831	1/4	9/32
1 1/8 1.1250	1 11/16 1.6875	1.631	1.859	31/32	.999	.939	1/4	11/32
1 1/4 1.2500	1 7/8 1.8750	1.812	2.066	1 1/16	1.094	1.030	5/16	3/8
1 3/8 1.3750	2 1/16 2.0625	1.994	2.273	1 11/64	1.206	1.138	5/16	3/8
1 1/2 1.5000	2 1/4 2.2500	2.175	2.480	1 9/32	1.317	1.245	3/8	7/16
1 5/8 1.6250	2 7/16 2.4375	2.356	2.686	1 25/64	1.429	1.353	3/8	7/16
1 3/4 1.7500	2 5/8 2.6250	2.538	2.893	1 1/2	1.540	1.460	7/16	1/2
1 7/8 1.8750	2 13/16 2.8125	2.719	3.100	1 39/64	1.651	1.567	7/16	9/16
2 2.0000	3 3.0000	2.900	3.306	1 23/32	1.763	1.675	7/16	9/16
2 1/4 2.2500	3 3/8 3.3750	3.262	3.719	1 59/64	1.970	1.874	7/16	9/16
2 1/2 2.5000	3 3/4 3.7500	3.625	4.133	2 9/64	2.193	2.089	9/16	11/16
2 3/4 2.7500	4 1/8 4.1250	3.988	4.546	2 23/64	2.415	2.303	9/16	11/16
3 3.0000	4 1/2 4.5000	4.350	4.959	2 37/64	2.638	2.518	5/8	3/4

TABLE 79.—*Dimensions of unfinished square and hexagon heavy nuts and hexagon heavy jam nuts*



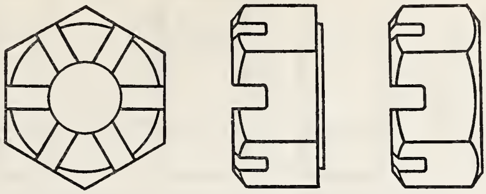
Nominal size or basic major diameter of thread	Width across flats		Width across corners, min.		Thickness, heavy nuts			Thickness, heavy jam nuts		
	Max. (basic)	Min.	Sq.	Hex.	Nominal	Max.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
¼ ---- 0.2500	½ ---- 0.5000	0.488	0.670	0.556	¼	0.266	0.234	3/16	0.204	0.172
5/16 ---- .3125	19/32 ---- .5938	.578	.794	.659	5/16	.330	.296	7/32	.236	.202
⅜ ---- .3750	11/16 ---- .6875	.669	.919	.763	⅜	.393	.357	¼	.268	.232
7/16 ---- .4375	25/32 ---- .7812	.759	1.042	.865	7/16	.456	.418	9/32	.300	.262
½ ---- .5000	⅞ ---- .8750	.850	1.167	.969	½	.520	.480	5/16	.332	.292
9/16 ---- .5625	15/16 ---- .9375	.909	1.249	1.037	9/16	.584	.542	11/32	.365	.323
⅝ ---- .6250	1 1/16 ---- 1.0625	1.031	1.416	1.175	⅝	.647	.603	⅜	.397	.353
¾ ---- .7500	1¼ ---- 1.2500	1.212	1.665	1.382	¾	.774	.726	7/16	.462	.414
⅞ ---- .8750	1 7/16 ---- 1.4375	1.394	1.914	1.589	⅞	.901	.849	½	.526	.474
1 ---- 1.0000	1⅝ ---- 1.6250	1.575	2.162	1.796	1	1.028	.972	9/16	.590	.534
1⅛ ---- 1.1250	1 13/16 ---- 1.8125	1.756	2.411	2.002	1⅛	1.155	1.095	⅝	.655	.595
1¼ ---- 1.2500	2 ---- 2.0000	1.938	2.661	2.209	1¼	1.282	1.218	¾	.782	.718
1⅜ ---- 1.3750	2 3/16 ---- 2.1875	2.119	2.909	2.416	1⅜	1.409	1.341	13/16	.846	.778
1½ ---- 1.5000	2⅜ ---- 2.3750	2.300	3.158	2.622	1½	1.536	1.464	⅞	.911	.839
1⅝ ---- 1.6250	2 9/16 ---- 2.5625	2.481	3.406	2.828	1⅝	1.663	1.587	15/16	.976	.900
1¾ ---- 1.7500	2¾ ---- 2.7500	2.662	3.655	3.035	1¾	1.790	1.710	1	1.040	.960
1⅞ ---- 1.8750	2 15/16 ---- 2.9375	2.844	3.905	3.242	1⅞	1.917	1.833	1 1/16	1.104	1.020
2 ---- 2.0000	3⅛ ---- 3.1250	3.025	4.153	3.449	2	2.044	1.956	1⅛	1.169	1.081
2¼ ---- 2.2500	3½ ---- 3.5000	3.388	4.652	3.862	2¼	2.298	2.202	1¼	1.298	1.202
2½ ---- 2.5000	3⅞ ---- 3.8750	3.750	5.149	4.275	2½	2.552	2.448	1½	1.552	1.448
2¾ ---- 2.7500	4¼ ---- 4.2500	4.112	5.646	4.688	2¾	2.806	2.694	1⅝	1.681	1.569
3 ---- 3.0000	4⅝ ---- 4.6250	4.475	6.144	5.102	3	3.060	2.940	1¾	1.810	1.690
3¼ ---- 3.2500	5 ---- 5.0000	4.838	6.643	5.515	3¼	3.314	3.186	1⅞	1.939	1.811
3½ ---- 3.5000	5⅜ ---- 5.3750	5.200	7.140	5.928	3½	3.568	3.432	2	2.068	1.932
3¾ ---- 3.7500	5¾ ---- 5.7500	5.562	7.637	6.341	3¾	3.822	3.678	2⅛	2.197	2.053
4 ---- 4.0000	6⅛ ---- 6.1250	5.925	8.135	6.755	4	4.076	3.924	2¼	2.326	2.174

TABLE 80.—*Dimensions of semifinished hexagon heavy nuts and heavy jam nuts*



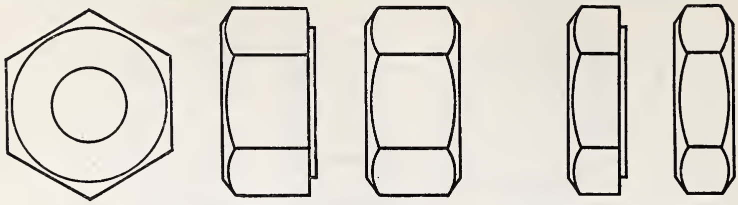
Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness, heavy nuts			Thickness, heavy jam nuts		
	Max. (basic)	Min.	Min.	Nominal	Max.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7	8	9	10
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/4 .... 0.2500	1/2 .... 0.5000	0.488	0.556	15/64	0.250	0.218	11/64	0.188	0.156
5/16 .... .3125	19/32 .... .5938	.578	.659	19/64	.314	.280	13/64	.220	.186
3/8 .... .3750	11/16 .... .6875	.669	.763	23/64	.377	.341	15/64	.252	.216
7/16 .... .4375	25/32 .... .7812	.759	.865	27/64	.441	.403	17/64	.285	.247
1/2 .... .5000	7/8 .... .8750	.850	.969	31/64	.504	.464	19/64	.317	.277
9/16 .... .5625	15/16 .... .9375	.909	1.037	35/64	.568	.526	21/64	.349	.307
5/8 .... .6250	1 1/16 .... 1.0625	1.031	1.175	39/64	.631	.587	23/64	.381	.337
3/4 .... .7500	1 1/4 .... 1.2500	1.212	1.382	47/64	.758	.710	27/64	.446	.398
7/8 .... .8750	1 7/16 .... 1.4375	1.394	1.589	55/64	.885	.833	31/64	.510	.458
1 .... 1.0000	1 5/8 .... 1.6250	1.575	1.796	63/64	1.012	.956	35/64	.575	.519
1 1/8 .... 1.1250	1 13/16 .... 1.8125	1.756	2.002	1 7/64	1.139	1.079	39/64	.639	.579
1 1/4 .... 1.2500	2 .... 2.0000	1.938	2.209	1 7/32	1.251	1.187	23/32	.751	.687
1 3/8 .... 1.3750	2 3/16 .... 2.1875	2.119	2.416	1 11/32	1.378	1.310	25/32	.815	.747
1 1/2 .... 1.5000	2 3/8 .... 2.3750	2.300	2.622	1 15/32	1.505	1.433	27/32	.880	.808
1 5/8 .... 1.6250	2 9/16 .... 2.5625	2.481	2.828	1 19/32	1.632	1.556	29/32	.944	.868
1 3/4 .... 1.7500	2 3/4 .... 2.7500	2.662	3.035	1 23/32	1.759	1.679	31/32	1.009	.929
1 7/8 .... 1.8750	2 15/16 .... 2.9375	2.844	3.242	1 27/32	1.886	1.802	1 1/32	1.073	.989
2 .... 2.0000	3 1/8 .... 3.1250	3.025	3.449	1 31/32	2.013	1.925	1 3/32	1.138	1.050
2 1/4 .... 2.2500	3 1/2 .... 3.5000	3.388	3.862	2 13/64	2.251	2.155	1 13/64	1.251	1.155
2 1/2 .... 2.5000	3 7/8 .... 3.8750	3.750	4.275	2 29/64	2.505	2.401	1 29/64	1.505	1.401
2 3/4 .... 2.7500	4 1/4 .... 4.2500	4.112	4.688	2 45/64	2.759	2.647	1 37/64	1.634	1.522
3 .... 3.0000	4 5/8 .... 4.6250	4.475	5.102	2 61/64	3.013	2.893	1 45/64	1.763	1.643
3 1/4 .... 3.2500	5 .... 5.0000	4.838	5.515	3 3/16	3.252	3.124	1 13/16	1.876	1.748
3 1/2 .... 3.5000	5 3/8 .... 5.3750	5.200	5.928	3 7/16	3.506	3.370	1 15/16	2.006	1.870
3 3/4 .... 3.7500	5 3/4 .... 5.7500	5.562	6.341	3 11/16	3.760	3.616	2 1/16	2.134	1.990
4 .... 4.0000	6 1/8 .... 6.1250	5.925	6.755	3 15/16	4.014	3.862	2 3/16	2.264	2.112

TABLE 81.—*Dimensions of semifinished hexagon heavy slotted nuts*



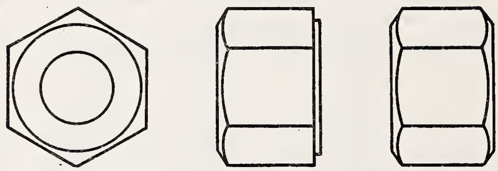
Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness			Slot	
	Max. (basic)	Min.	Min.	Nominal	Max.	Min.	Width	Depth
1	2	3	4	5	6	7	8	9
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*
1/4 .... 0.2500	1/2 .... 0.5000	0.488	0.556	15/64	0.250	0.218	5/64	3/32
5/16 .... .3125	19/32 .... .5938	.578	.659	19/64	.314	.280	3/32	3/32
3/8 .... .3750	11/16 .... .6875	.669	.763	23/64	.377	.341	1/8	1/8
7/16 .... .4375	25/32 .... .7812	.759	.865	27/64	.441	.403	1/8	5/32
1/2 .... .5000	7/8 .... .8750	.850	.969	31/64	.504	.464	5/32	5/32
9/16 .... .5625	15/16 .... .9375	.909	1.037	35/64	.568	.526	5/32	3/16
5/8 .... .6250	1 1/16 .... 1.0625	1.031	1.175	39/64	.631	.587	3/16	7/32
3/4 .... .7500	1 1/4 .... 1.2500	1.212	1.382	47/64	.758	.710	3/16	1/4
7/8 .... .8750	1 7/16 .... 1.4375	1.394	1.589	55/64	.885	.833	3/16	1/4
1 .... 1.0000	1 5/8 .... 1.6250	1.575	1.796	63/64	1.012	.956	1/4	9/32
1 1/8 .... 1.1250	1 13/16 .... 1.8125	1.756	2.002	1 7/64	1.139	1.079	1/4	11/32
1 1/4 .... 1.2500	2 .... 2.0000	1.938	2.209	1 7/32	1.251	1.187	5/16	3/8
1 3/8 .... 1.3750	2 3/16 .... 2.1875	2.119	2.416	1 11/32	1.378	1.310	5/16	3/8
1 1/2 .... 1.5000	2 3/8 .... 2.3750	2.300	2.622	1 15/32	1.505	1.433	3/8	7/16
1 5/8 .... 1.6250	2 9/16 .... 2.5625	2.481	2.828	1 19/32	1.632	1.556	3/8	7/16
1 3/4 .... 1.7500	2 3/4 .... 2.7500	2.662	3.035	1 23/32	1.759	1.679	7/16	1/2
1 7/8 .... 1.8750	2 15/16 .... 2.9375	2.844	3.242	1 27/32	1.886	1.802	7/16	9/16
2 .... 2.0000	3 1/8 .... 3.1250	3.025	3.449	1 31/32	2.013	1.925	7/16	9/16
2 1/4 .... 2.2500	3 1/2 .... 3.5000	3.388	3.862	2 13/64	2.251	2.155	7/16	9/16
2 1/2 .... 2.5000	3 7/8 .... 3.8750	3.750	4.275	2 29/64	2.505	2.401	9/16	11/16
2 3/4 .... 2.7500	4 1/4 .... 4.2500	4.112	4.688	2 45/64	2.759	2.647	9/16	11/16
3 .... 3.0000	4 5/8 .... 4.6250	4.475	5.102	2 61/64	3.013	2.893	5/8	3/4
3 1/4 .... 3.2500	5 .... 5.0000	4.838	5.515	3 3/16	3.252	3.124	5/8	3/4
3 1/2 .... 3.5000	5 3/8 .... 5.3750	5.200	5.928	3 7/16	3.506	3.370	5/8	3/4
3 3/4 .... 3.7500	5 3/4 .... 5.7500	5.562	6.341	3 11/16	3.760	3.616	5/8	3/4
4 .... 4.0000	6 1/8 .... 6.1250	5.925	6.755	3 15/16	4.014	3.862	5/8	3/4

TABLE 82.—*Dimensions of semifinished hexagon light nuts and light jam nuts*



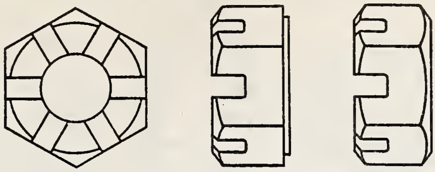
Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness, light nuts			Thickness, light jam nuts		
	Max. (basic)	Min.	Min.	Min.	Max.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7	8	9	10
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*
1/4 0.2500	7/16 0.4375	0.428	0.488	7/32	0.226	0.212	5/32	0.163	0.150
5/16 .3125	1/2 .5000	.489	.557	17/64	.273	.258	3/16	.195	.180
3/8 .3750	9/16 .5625	.551	.628	21/64	.337	.320	7/32	.227	.210
7/16 .4375	5/8 .6250	.612	.698	3/8	.385	.365	1/4	.260	.240
1/2 .5000	3/4 .7500	.736	.840	7/16	.448	.427	5/16	.323	.302
9/16 .5625	7/8 .8750	.861	.982	31/64	.496	.473	5/16	.324	.301
5/8 .6250	15/16 .9375	.922	1.051	35/64	.559	.534	3/8	.387	.363
3/4 .7500	1 1/16 1.0625	1.045	1.191	21/32	.670	.642	3/8	.389	.361
7/8 .8750	1 1/4 1.2500	1.231	1.403	49/64	.782	.750	7/16	.454	.421
1 1.0000	1 7/16 1.4375	1.417	1.615	7/8	.893	.857	1/2	.518	.482
1 1/8 1.1250	1 5/8 1.6250	1.602	1.826	63/64	1.004	.964	9/16	.582	.543
1 1/4 1.2500	1 13/16 1.8125	1.788	2.038	1 3/32	1.116	1.072	5/8	.647	.603
1 3/8 1.3750	2 2.0000	1.973	2.249	1 13/64	1.227	1.180	3/4	.774	.726
1 1/2 1.5000	2 3/16 2.1875	2.159	2.461	1 5/16	1.338	1.287	13/16	.838	.787

TABLE 83.—*Dimensions of semifinished hexagon light thick nuts*



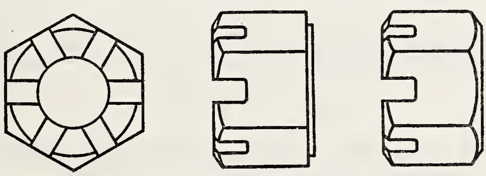
Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness		
	Max. (basic)	Min.	Min.	Nominal	Max.	Min.
1	2	3	4	5	6	7
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/4 0.2500	7/16 0.4375	0.428	0.488	9/32	0.288	0.274
5/16 .3125	1/2 .5000	.489	.557	21/64	.336	.320
3/8 .3750	9/16 .5625	.551	.628	13/32	.415	.398
7/16 .4375	5/8 .6250	.612	.698	29/64	.463	.444
1/2 .5000	3/4 .7500	.736	.840	9/16	.573	.552
9/16 .5625	7/8 .8750	.861	.982	39/64	.621	.598
5/8 .6250	15/16 .9375	.922	1.051	23/32	.731	.706
3/4 .7500	1 1/16 1.0625	1.045	1.191	13/16	.827	.798
7/8 .8750	1 1/4 1.2500	1.231	1.403	29/32	.922	.890
1 1.0000	1 7/16 1.4375	1.417	1.615	1	1.018	.982
1 1/8 1.1250	1 5/8 1.6250	1.602	1.826	1 5/32	1.176	1.136
1 1/4 1.2500	1 13/16 1.8125	1.788	2.038	1 1/4	1.272	1.228
1 3/8 1.3750	2 2.0000	1.973	2.249	1 3/8	1.399	1.351
1 1/2 1.5000	2 3/16 2.1875	2.159	2.461	1 1/2	1.526	1.474

TABLE 84.—*Dimensions of semifinished hexagon light slotted nuts*



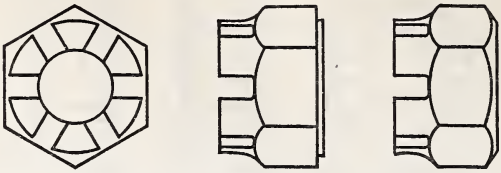
Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness			Slot	
	Max. (basic)	Min.	Min.	Nominal	Max.	Min.	Width	Depth
1	2	3	4	5	6	7	8	9
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*
1/4 .... 0.2500	7/16 .... 0.4375	0.428	0.488	7/32	0.226	0.212	5/64	3/32
5/16 .... .3125	1/2 .... .5000	.489	.557	17/64	.273	.258	3/32	3/32
3/8 .... .3750	9/16 .... .5625	.551	.628	21/64	.337	.320	1/8	1/8
7/16 .... .4375	5/8 .... .6250	.612	.698	3/8	.385	.365	1/8	5/32
1/2 .... .5000	3/4 .... .7500	.736	.840	7/16	.448	.427	5/32	5/32
9/16 .... .5625	7/8 .... .8750	.861	.982	31/64	.496	.473	5/32	3/16
5/8 .... .6250	15/16 .... .9375	.922	1.051	35/64	.559	.534	3/16	7/32
3/4 .... .7500	1 1/16 .... 1.0625	1.045	1.191	21/32	.670	.642	3/16	1/4
7/8 .... .8750	1 1/4 .... 1.2500	1.231	1.403	49/64	.782	.750	3/16	1/4
1 .... 1.0000	1 7/16 .... 1.4375	1.417	1.615	7/8	.893	.857	1/4	9/32
1 1/8 .... 1.1250	1 5/8 .... 1.6250	1.602	1.826	63/64	1.004	.964	1/4	11/32
1 1/4 .... 1.2500	1 13/16 .... 1.8125	1.788	2.038	1 3/32	1.116	1.072	5/16	3/8
1 3/8 .... 1.3750	2 .... 2.0000	1.973	2.249	1 13/64	1.227	1.180	5/16	3/8
1 1/2 .... 1.5000	2 3/16 .... 2.1875	2.159	2.461	1 5/16	1.338	1.287	3/8	7/16

TABLE 85.—*Dimensions of semifinished hexagon light thick slotted nuts*



Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness			Slot	
	Max. (basic)	Min.	Min.	Nominal	Max.	Min.	Width	Depth
1	2	3	4	5	6	7	8	9
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*
1/4 .... 0.2500	7/16 .... 0.4375	0.428	0.488	9/32	0.288	0.274	5/64	3/32
5/16 .... .3125	1/2 .... .5000	.489	.557	21/64	.336	.320	3/32	3/32
3/8 .... .3750	9/16 .... .5625	.551	.628	13/32	.415	.398	1/8	1/8
7/16 .... .4375	5/8 .... .6250	.612	.698	29/64	.463	.444	1/8	5/32
1/2 .... .5000	3/4 .... .7500	.736	.840	9/16	.573	.552	5/32	5/32
9/16 .... .5625	7/8 .... .8750	.861	.982	39/64	.621	.598	5/32	3/16
5/8 .... .6250	15/16 .... .9375	.922	1.051	23/32	.731	.706	3/16	7/32
3/4 .... .7500	1 1/16 .... 1.0625	1.045	1.191	13/16	.827	.798	3/16	1/4
7/8 .... .8750	1 1/4 .... 1.2500	1.231	1.403	29/32	.922	.890	3/16	1/4
1 .... 1.0000	1 7/16 .... 1.4375	1.417	1.615	1	1.018	.982	1/4	9/32
1 1/8 .... 1.1250	1 5/8 .... 1.6250	1.602	1.826	1 5/32	1.176	1.136	1/4	11/32
1 1/4 .... 1.2500	1 13/16 .... 1.8125	1.788	2.038	1 1/4	1.272	1.228	5/16	3/8
1 3/8 .... 1.3750	2 .... 2.0000	1.973	2.249	1 3/8	1.399	1.351	5/16	3/8
1 1/2 .... 1.5000	2 3/16 .... 2.1875	2.159	2.461	1 1/2	1.526	1.474	3/8	7/16

TABLE 86.—*Dimensions of semifinished hexagon light castle nuts*



Nominal size or basic major diameter of thread	Width across flats		Width across corners	Thickness			Height of flats[1]	Slot		Radius of fillet[2]	Diameter of cylindrical part,[3] Min.
	Maximum (basic)	Min.	Min.	Nominal	Max.	Min.		Width	Depth		
1	2	3	4	5	6	7	8	9	10	11	12
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*	*Inches*
1/4---- 0.2500	7/16---- 0.4375	0.428	0.488	9/32	0.288	0.274	3/16	5/64	3/32	3/32	0.371
5/16--- .3125	1/2----- .5000	.489	.557	21/64	.336	.320	15/64	3/32	3/32	3/32	.425
3/8---- .3750	9/16---- .5625	.551	.628	13/32	.415	.398	9/32	1/8	1/8	3/32	.478
7/16--- .4375	5/8----- .6250	.612	.698	29/64	.463	.444	19/64	1/8	5/32	3/32	.531
1/2---- .5000	3/4----- .7500	.736	.840	9/16	.573	.552	13/32	5/32	5/32	1/8	.637
9/16--- .5625	7/8----- .8750	.861	.982	39/64	.621	.598	27/64	5/32	3/16	5/32	.744
5/8---- .6250	15/16--- .9375	.922	1.051	23/32	.731	.706	1/2	3/16	7/32	5/32	.797
3/4---- .7500	1 1/16--- 1.0625	1.045	1.191	13/16	.827	.798	9/16	3/16	1/4	3/16	.903
7/8---- .8750	1 1/4---- 1.2500	1.231	1.403	29/32	.922	.890	21/32	3/16	1/4	3/16	1.063
1----- 1.0000	1 7/16--- 1.4375	1.417	1.615	1	1.018	.982	23/32	1/4	9/32	3/16	1.222
1 1/8--- 1.1250	1 5/8---- 1.6250	1.602	1.826	1 5/32	1.176	1.136	13/16	1/4	11/32	1/4	1.382
1 1/4--- 1.2500	1 13/16-- 1.8125	1.788	2.038	1 1/4	1.272	1.228	7/8	5/16	3/8	1/4	1.541
1 3/8--- 1.3750	2------ 2.0000	1.973	2.249	1 3/8	1.399	1.351	1	5/16	3/8	1/4	1.700
1 1/2--- 1.5000	2 3/16--- 2.1875	2.159	2.461	1 1/2	1.526	1.474	1 1/16	3/8	7/16	1/4	1.859

[1] Height of the hexagon is measured from the bearing surface to top of arc.
[2] Tolerance on the fillet radius is ±0.010.
[3] Maximum diameter of cylindrical part shall not exceed maximum width across flats.

6. WRENCH OPENINGS

Dimensions of open end wrench openings for regular, heavy, and light series bolts and nuts shall conform to table 87.

Wrenches shall be marked with the nominal size of wrench, which is equal to the basic or maximum width across flats of the corresponding bolt head or nut.

Table 87.—*Open end wrench openings for regular, heavy, and light series bolts and nuts*

Nominal size of wrench also basic or maximum width across flats, bolt heads and nuts	Allowance between bolt head or nut and jaws of wrench	Wrench openings			Nominal size of wrench also basic or maximum width across flats, bolt heads and nuts	Allowance between bolt head or nut and jaws of wrench	Wrench openings		
		Min.	Tolerance	Max.			Min.	Tolerance	Max.
1	2	3	4	5	1	2	3	4	5
Inches	*Inch*	*Inches*	*Inch*	*Inches*	*Inches*	*Inch*	*Inches*	*Inch*	*Inches*
5/32......0.1562	.002	0.158	0.005	0.163	1 13/16....1.8125	0.010	1.822	0.013	1.835
3/16...... .1875	.002	.190	.005	.195	1 7/8......1.8750	.010	1.885	.013	1.898
1/4...... .2500	.002	.252	.005	.257	2........2.0000	.011	2.011	.014	2.025
5/16...... .3125	.003	.316	.006	.322	2 1/16.....2.0625	.011	2.074	.014	2.088
11/32..... .3438	.003	.347	.006	.353	2 3/16.....2.1875	.012	2.200	.015	2.215
3/8...... .3750	.003	.378	.006	.384	2 1/4......2.2500	.012	2.262	.015	2.277
7/16...... .4375	.003	.440	.006	.446	2 3/8......2.3750	.013	2.388	.016	2.404
1/2...... .5000	.004	.504	.006	.510	2 7/16.....2.4375	.013	2.450	.016	2.466
9/16...... .5625	.004	.566	.007	.573	2 9/16.....2.5625	.014	2.576	.017	2.593
19/32..... .5938	.004	.598	.007	.605	2 5/8......2.6250	.014	2.639	.017	2.656
5/8...... .6250	.004	.629	.007	.636	2 3/4......2.7500	.015	2.765	.018	2.783
11/16..... .6875	.004	.692	.007	.699	2 13/16....2.8125	.015	2.827	.018	2.845
3/4...... .7500	.005	.755	.008	.763	2 15/16....2.9375	.016	2.954	.019	2.973
25/32..... .7812	.005	.786	.008	.794	3........3.0000	.016	3.016	.019	3.035
13/16..... .8125	.005	.818	.008	.826	3 1/8......3.1250	.017	3.142	.020	3.162
7/8...... .8750	.005	.880	.008	.888	3 3/8......3.3750	.018	3.393	.021	3.414
15/16..... .9375	.006	.944	.009	.953	3 1/2......3.5000	.018	3.518	.022	3.540
1........1.0000	.006	1.006	.009	1.015	3 3/4......3.7500	.020	3.770	.023	3.793
1 1/16.....1.0625	.006	1.068	.009	1.077	3 7/8......3.8750	.020	3.895	.023	3.918
1 1/8......1.1250	.007	1.132	.010	1.142	4 1/8......4.1250	.022	4.147	.025	4.172
1 1/4......1.2500	.007	1.257	.010	1.267	4 1/4......4.2500	.022	4.272	.025	4.297
1 5/16.....1.3125	.008	1.320	.011	1.331	4 1/2......4.5000	.024	4.524	.026	4.550
1 3/8......1.3750	.008	1.383	.011	1.394	4 5/8......4.6250	.024	4.649	.027	4.676
1 7/16.....1.4375	.008	1.446	.011	1.457	5........5.0000	.026	5.026	.029	5.055
1 1/2......1.5000	.008	1.508	.012	1.520	5 3/8......5.3750	.028	5.403	.031	5.434
1 5/8......1.6250	.009	1.634	.012	1.646	5 3/4......5.7500	.030	5.780	.033	5.813
1 11/16....1.6875	.009	1.696	.012	1.708	6 1/8......6.1250	.032	6.157	.035	6.192

SECTION XII. ROUND UNSLOTTED HEAD BOLTS [25]

These standards for round unslotted head bolts are intended for general use, and to replace such other series of dimensions as have been used. They constitute a single series of bolt heads of various types.

1. RECOMMENDED REQUIREMENTS

(*a*) Workmanship.—The workmanship shall be compatible with the type of product and class of fit and finish specified. The product shall be free from abnormal scale, fins, seams, or other defects. All bolts shall be free from any defects which might affect their serviceability.

(*b*) Thread Series.—Unless otherwise specified the number of threads per inch shall be that specified for the American National coarse-thread series. These bolts may be supplied with either rolled or cut threads. Rolled thread bolts are not pointed.

[25] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published as ASA B18.5–1939 "Round Unslotted Head Bolts," by the A. S. M. E., 29 West 39th St., New York, N. Y.

(*c*) Details of Design.—1. *Length of bolts.*—Bolt length, *L*, is measured from the greatest diameter of the bearing surface of (or under) the head, to the end of the bolt, in a line parallel to the axis of the bolt.

Tolerances for bolt lengths 6 in. and under are ±1/32 in. for diameters 1/4 to 3/8 in., inclusive; ±1/16 in. for diameters 7/16 and 1/2 in.; ±1/8 in. for diameters 5/8 to 1 1/4 in., inclusive; ±1/4 in. for diameters 1 3/8 to 2 in., inclusive.

Tolerances for bolt lengths over 6 in. are ±1/16 in. for diameters 1/4 to 3/8 in., inclusive; ±3/32 in. for diameters 7/16 and 1/2 in.; ±3/16 in. for diameters 5/8 to 1 1/4 in., inclusive; and ±1/4 in. for diameters 1 3/8 to 2 in., inclusive.

2. *Length of threads.*—The minimum length of thread, *T*, of all types of round unslotted head bolts shall, unless otherwise specified, conform to table 70, p. 145. The minimum thread length is measured from the extreme end of the bolt to the last complete thread. The length of incomplete thread shall not exceed 2 1/2 threads.

For bolts too short for the specified minimum thread lengths, threads shall be cut or rolled to within 1/4 in. of head or neck on sizes up to and including 1/2 in.; 3/8 in. on sizes 9/16 to 1 in., inclusive; and 1/2 in. on sizes 1 1/8 to 2 in., inclusive.

3. *Tolerances on body diameter.*—Tolerances on body diameter are not specified. See p. 143.

4. *Fillet under heads.*—The maximum radius, *S*, under the head of bolts for sizes No. 10 (0.190) to 1/2 in., inclusive, shall be 1/32 in., and for sizes 9/16 to 1 in., inclusive, shall be 1/16 in.

2. TABLES OF DIMENSIONS

(*a*) Square-Neck Carriage Bolts.—The dimensions of square-neck carriage bolts shall conform to table 88.

(*b*) Ribbed-Neck Carriage Bolts.—The dimensions of ribbed-neck carriage bolts shall conform to table 89. The included angle of the ribs shall be approximately 90°.

(*c*) Fin-Neck Carriage Bolts.—The dimensions of fin-neck carriage bolts shall conform to table 90.

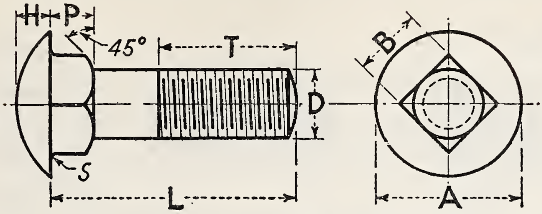
(*d*) Countersunk Carriage Bolts.—The dimensions of countersunk carriage bolts shall conform to table 91. The tolerance for the included angle of head is plus 2°.

(*e*) Buttonhead Bolts.—The dimensions of buttonhead bolts shall conform to table 92.

(*f*) Step Bolts.—The dimensions of step bolts shall conform to table 93.

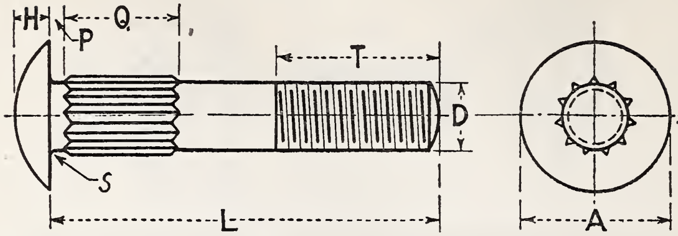
(*g*) Countersunk Bolts.—The dimensions of countersunk bolts shall conform to table 94. The depth of head, *H*, is given for construction purposes only. Variations in this dimension are controlled by the diameters *A* and *D*, and by the included angle of the head. The tolerance for included angle of head is plus 2°. For sizes smaller than 1/2 in. see section XIII.

TABLE 88.—*Dimensions of square-neck carriage bolts*



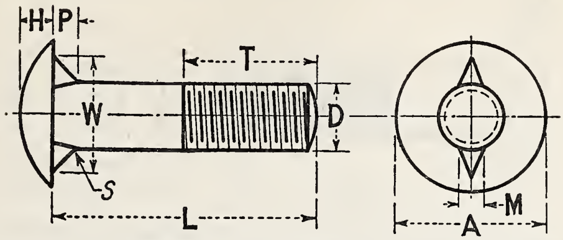
Nominal diameter of bolt, *D*	Diameter of head, *A*		Height of head, *H*		Depth of square, *P*			Width of square, *B*	
	Min.	Max.	Min.	Max.	For bolt lengths	Min.	Max.	Min.	Max.
1	2	3	4	5	6	7	8	9	10
Inch	*Inches*	*Inches*	*Inch*	*Inch*	*Inches*	*Inch*	*Inch*	*Inch*	*Inches*
No. 10 (0.190)	7/16 0.438	0.469	3/32 0.094	0.114	1 1/8 and shorter 1 1/4 and longer	0.094 .188	0.125 .219	0.185	0.199
1/4	9/16 .563	.594	1/8 .125	.145	1 1/4 and shorter 1 3/8 and longer	.125 .219	.156 .250	.245	.260
5/16	11/16 .688	.719	5/32 .156	.176	1 1/4 and shorter 1 3/8 and longer	.156 .250	.187 .281	.307	.324
3/8	13/16 .813	.844	3/16 .188	.208	1 1/2 and shorter 1 5/8 and longer	.188 .281	.219 .312	.368	.388
7/16	15/16 .938	.969	7/32 .219	.239	1 1/2 and shorter 1 5/8 and longer	.219 .313	.250 .344	.431	.452
1/2	1 1/16 1.063	1.094	1/4 .250	.270	1 7/8 and shorter 2 and longer	.250 .344	.281 .375	.492	.515
9/16	1 3/16 1.188	1.219	9/32 .281	.312	1 7/8 and shorter 2 and longer	.281 .375	.312 .406	.554	.579
5/8	1 5/16 1.313	1.344	5/16 .313	.344	1 7/8 and shorter 2 and longer	.313 .406	.344 .437	.616	.642
3/4	1 9/16 1.563	1.594	3/8 .375	.406	1 7/8 and shorter 2 and longer	.375 .469	.406 .500	.741	.768
7/8	1 13/16 1.813	1.844	7/16 .438	.469	1 7/8 and shorter 2 and longer	.438 .531	.469 .562	.865	.895
1	2 1/16 2.063	2.094	1/2 .500	.531	1 7/8 and shorter 2 and longer	.500 .594	.531 .625	.990	1.022

TABLE 89.—*Dimensions of ribbed-neck carriage bolts*



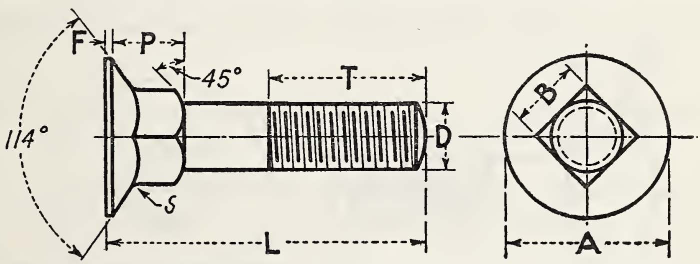
Nominal diameter of bolt, D	Diameter of head, A		Height of head, H		Distance of ribs below head, P			Length of ribs, Q			No. of ribs
	Min.	Max.	Min.	Max.	For L=⅞ or less	For L=1 or more	Tol.	For L=⅞ or less	For L=1 and 1⅛	For L=1¼ or more	
1	2	3	4	5	6	7	8	9	10	11	12
Inch	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch* ±	*Inch*	*Inch*	*Inch*	
No. 10 (0.190)	7/16 0.438	0.469	3/32 0.094	0.114	0.031	0.063	0.031	0.188	0.313	0.500	9
¼	9/16 .563	.594	⅛ .125	.145	.031	.063	.031	.188	.313	.500	10
5/16	11/16 .688	.719	5/32 .156	.176	.031	.063	.031	.188	.313	.500	12
⅜	13/16 .813	.844	3/16 .188	.208	.031	.063	.031	.188	.313	.500	12
7/16	15/16 .938	.969	7/32 .219	.239	.031	.063	.031	.188	.313	.500	14
½	1 1/16 1.063	1.094	¼ .250	.270	.031	.063	.031	.188	.313	.500	16
9/16	1 3/16 1.188	1.219	9/32 .281	.312	.094	.094	.031	.188	.313	.500	18
⅝	1 5/16 1.313	1.344	5/16 .313	.344	.094	.094	.031	.188	.313	.500	19
¾	1 9/16 1.563	1.594	⅜ .375	.406	.094	.094	.031	.188	.313	.500	22

TABLE 90.—*Dimensions of fin-neck carriage bolts*



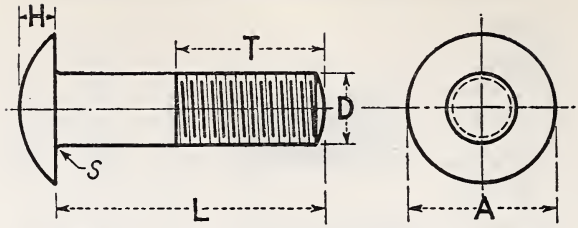
Nominal diameter of bolt, *D*	Diameter of head, *A*		Height of head, *H*		Depth of fins, *P*		Distance across fins, *W*		Thickness of fins, *M*	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	2	3	4	5	6	7	8	9	10	11
Inch	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
No. 10 (0.190)	15/32 0.469	0.489	5/64 0.078	0.098	5/64 0.078	0.088	3/8 0.375	0.395	5/64 0.078	0.098
1/4	19/32 .594	.614	7/64 .109	.129	3/32 .094	.104	7/16 .438	.458	3/32 .094	.114
5/16	23/32 .719	.739	9/64 .141	.161	1/8 .125	.135	17/32 .531	.551	1/8 .125	.145
3/8	27/32 .844	.864	11/64 .172	.192	9/64 .141	.151	5/8 .625	.645	9/64 .141	.161
7/16	31/32 .969	.989	13/64 .203	.223	11/64 .172	.182	23/32 .719	.739	11/64 .172	.192
1/2	1 3/32 1.094	1.114	15/64 .234	.254	3/16 .188	.198	13/16 .813	.833	3/16 .188	.208

TABLE 91.—*Dimensions of countersunk carriage bolts*



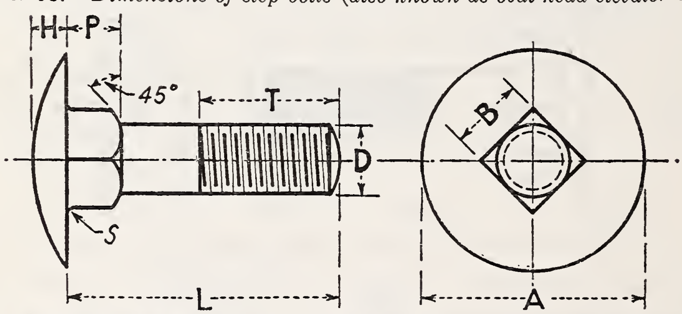
Nominal diameter of bolt, *D*	Diameter of head, *A*		Feed thickness, *F*	Depth of square and countersink, *P*		Width of square, *B*	
	Min.	Max.		Min.	Max.	Min.	Max.
1	2	3	4	5	6	7	8
Inch	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
No. 10 (0.190)	1/2 0.500	0.520	0.016	7/32 0.219	0.250	0.185	0.199
1/4	5/8 .625	.645	.016	9/32 .281	.312	.245	.260
5/16	3/4 .750	.770	.031	11/32 .344	.375	.307	.324
3/8	7/8 .875	.895	.031	13/32 .406	.437	.368	.388
7/16	1 1.000	1.020	.031	15/32 .469	.500	.431	.452
1/2	1 1/8 1.125	1.145	.031	17/32 .531	.562	.492	.515
9/16	1 1/4 1.250	1.275	.031	19/32 .594	.625	.554	.579
5/8	1 3/8 1.375	1.400	.031	21/32 .656	.687	.616	.642
3/4	1 5/8 1.625	1.650	.047	25/32 .781	.812	.741	.768

TABLE 92.—*Dimensions of buttonhead bolts*



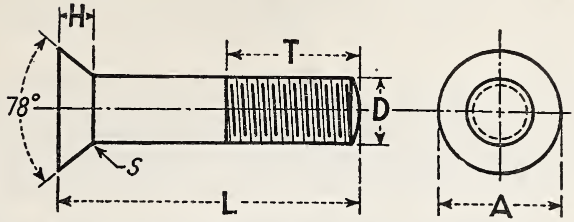
Nominal diameter of bolt, *D*	Diameter of head, *A*		Height of head, *H*	
	Min.	Max.	Min.	Max.
1	2	3	4	5
Inch	*Inches*	*Inches*	*Inch*	*Inch*
No. 10 (0.190)	7/16 0.438	0.469	3/32 0.094	0.114
1/4	9/16 .563	.594	1/8 .125	.145
5/16	11/16 .688	.719	5/32 .156	.176
3/8	13/16 .813	.844	3/16 .188	.208
7/16	15/16 .938	.969	7/32 .219	.239
1/2	1 1/16 1.063	1.094	1/4 .250	.270
9/16	1 3/16 1.188	1.219	9/32 .281	.312
5/8	1 5/16 1.313	1.344	5/16 .313	.344
3/4	1 9/16 1.563	1.594	3/8 .375	.406
7/8	1 13/16 1.813	1.844	7/16 .438	.469
1	2 1/16 2.063	2.094	1/2 .500	.531

TABLE 93.—*Dimensions of step bolts (also known as oval head elevator bolts)*



Nominal diameter of bolt, *D*	Diameter of head, *A*		Height of head, *H*		Depth of square, *P*			Width of square, *B*	
	Min.	Max.	Min.	Max.	For bolt lengths	Min.	Max.	Min.	Max.
1	2	3	4	5	6	7	8	9	10
Inch	*Inches*	*Inches*	*Inch*	*Inch*	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*
No. 10 (0.190)	0.625	0.656	0.094	0.114	1 1/8 and shorter 1 1/4 and longer	0.094 .188	0.125 .219	0.185	0.199
1/4	.813	.844	.125	.145	1 1/4 and shorter 1 3/8 and longer	.125 .219	.156 .250	.245	.260
5/16	1.000	1.031	.156	.176	1 1/4 and shorter 1 3/8 and longer	.156 .250	.187 .281	.307	.324
3/8	1.188	1.219	.188	.208	1 1/2 and shorter 1 5/8 and longer	.188 .281	.219 312	.368	.388
7/16	1.375	1.406	.219	.239	1 1/2 and shorter 1 5/8 and longer	.219 .313	.250 .344	.431	.452
1/2	1.563	1.594	.250	.270	1 7/8 and shorter 2 and longer	.250 .344	.281 .375	.492	.515

TABLE 94.—*Dimensions of countersunk bolts*



Nominal diameter of bolt, *D*	Diameter of head, *A*			Depth of head, *H*
	Basic	Max.	Min.	
1	2	3	4	5
Inches	*Inches*	*Inches*	*Inches*	*Inch*
½	0.905	0.936	0.874	0.250
9/16	1.018	1.049	.987	.281
⅝	1.131	1.194	1.068	.313
¾	1.358	1.421	1.295	.375
⅞	1.584	1.647	1.521	.438
1	1.810	1.873	1.747	.500
1⅛	2.036	2.114	1.973	.563
1¼	2.263	2.341	2.200	.625
1⅜	2.489	2.567	2.426	.688
1½	2.715	2.793	2.652	.750
1⅝	2.941	3.019	2.878	.813
1¾	3.168	3.262	3.105	.875
1⅞	3.394	3.488	3.331	.938
2	3.620	3.714	3.557	1.000

SECTION XIII. MACHINE SCREWS, MACHINE-SCREW AND STOVE-BOLT NUTS, AND SET SCREWS

These standards for machine screws, machine-screw and stove-bolt nuts, and square-head and slotted set screws are intended for general use and to replace such other series of dimensions as have been used. These standards for machine screws are in substantial agreement with ASA B18c–1930, and with other standards of the American Standards Association, as noted in footnotes to the tables. They constitute a single series of screw heads, with the exception of square-head set screws for which an optional design is presented, and a single series of nuts. For nuts of larger sizes see section XI.

1. RECOMMENDED REQUIREMENTS, MACHINE SCREWS AND SET SCREWS

(*a*) WORKMANSHIP.—The workmanship shall be compatible with the type of product and class of fit specified. The product shall be free from fins, seams, or other defects. All machine screws and set screws shall be free from any defects which might affect their serviceability.

Unless the method of manufacture is specifically stated the method of manufacture employed for the production of screw threads on machine screws and set screws shall be by chasing, milling, die cutting, or rolling.

(*b*) Thread Series and Classes of Fit.—The number of threads per inch shall be that specified for the American National coarse-thread series or the American National fine-thread series. Unless otherwise specified, machine screws shall be furnished class 2 fit, and set screws class 3 fit in the fractional sizes and class 2 in the numbered sizes.

(*c*) Details of Design.—1. *Length of screws.*—The length of machine screws is measured from the largest diameter of the bearing surface of the head to the extreme point, in a line parallel with the axis of the screw. Preferred lengths of machine screws are listed in table 95. The length of headless set screws is the over-all length. The length of square-head set screws is measured from the bottom of the square head to the extreme point, in a line parallel to the axis of the screw. The length of machine screws shall not vary from that specified by more than the following: Up to 1 inch in length, $+1/64$, $-1/32$ in.; over 1 to 2 inches, inclusive, $+1/32$, $-1/16$ in.; over 2 inches, $+3/64$, $-3/32$ in.

2. *Length of threads.*—When the length of the screw is 1¼ in. or less, the length of thread shall extend as near to the head as practicable. When the length of the screw is over 1¼ in., the length of thread shall be not less than 1¼ in.

Set screws shall be threaded the entire length of the cylindrical portion.

3. *Body diameter.*—The diameters of the unthreaded portions shall conform to the respective diameters given in tables 96 to 100, inclusive, except that the minimum body diameter on rolled-thread product may be the same as the minimum pitch diameter, unless otherwise specified.

4. *Bearing surface.*—The bearing surface of fillister and round machine-screw heads shall be at right angles to the body within 2°. The head of each screw shall be concentric with the body within a tolerance of 3 percent of the diameter of the head.

2. TABLES OF DIMENSIONS, MACHINE SCREWS AND SET SCREWS

(*a*) Machine Screws.—Dimensions of flat-head, round-head, oval-head, oval-fillister-head, and flat-fillister-head machine screws shall conform to tables 96, 97, 98, 99, and 100, respectively.

(*b*) Square-Head Set Screws.—Dimensions of square set screws shall conform to tables 101 or 102. Details of screws conforming to table 101 shall be as follows: Length of neck under head shall not be over two times the pitch of the thread. The under surface of the head shall be beveled not more than 40°. Top or crown of head shall be rounded to a radius of two and a half times the major diameter of the thread. The points of set screws shall be concentric with the threads.

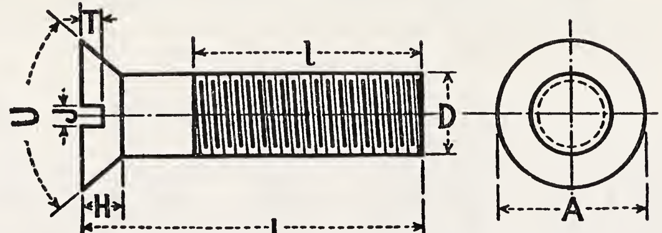
(*c*) Slotted Set Screws.—Dimensions of slotted set screws shall conform to table 102. The points of set screws shall be concentric with the threads.

TABLE 95.—*Preferred screw lengths for various styles of heads, machine screws*

Length	Steel screws, machine screw number or nominal size																Brass screws, machine screw number or nominal size												
	American National coarse-thread series												American National fine-thread series				American National coarse-thread series												American National fine-thread series
	2	3	4	5	6	8	10	12	¼	5/16	⅜	½	6	8	10	¼	2	3	4	5	6	8	10	12	¼	5/16	⅜	½	10
	Threads per inch																												
L	56	48	40	40	32	32	24	24	20	18	16	13	40	36	32	28	56	48	40	40	32	32	24	24	20	18	16	13	32
In.																													
⅛	*RP*	*RP*	*RP*	*RP*	*RP*												*RP*	*RP*	*R*	*R*	*R*								
3/16	FRP	FRP	*FRP*	*FRP*	*FRP*	*RP*	*R*						*R*		*R*		FRP	FRP	*FRP*	*FRP*	*FRP*	*RP*							*R*
¼	FRP	FRP	FROP	FRP	FROP	*FROP*	*FRP*	*R*	*R*				R	*FR*	*FRP*		FRP	FRP	FROP	FRP	FROP	*FROP*	*FRP*	*R*					*FRP*
5/16	FRP	FRP	FROP	FRP	FROP	FROP	*FROP*	*RP*	*RP*				R	FR	*FROP*	*R*	FRP	FR	FRO	FR	FROP	FROP	*FRP*		*R*				*FRP*
⅜	FRP	FRP	FROP	FRP	FROP	FROP	FROP	*FROP*	*FRP*	*R*			FR	FR	FROP	*FR*	FRP	FR	FROP	FRP	FROP	FROP	FROP	*FR*	*FR*	*R*			FROP
7/16	R	R	FROP	RP	FROP	FROP	FROP	FR	*FRP*						FROP	*F*	R	R	FR	R	FRO	FRO	R		*R*				FR
½	FRP	FRP	FROP	FRP	FROP	FROP	FROP	FROP	FROP	*FROP*	*FR*		FR	FR	FROP	FR	FRP	FR	FROP	FRP	FROP	FROP	FROP	FR	FROP	*FR*	*FR*		FROP
9/16			R		R	R	R		R						R						R	R	R						
⅝	FR	FR	FROP	FRP	FROP	FROP	FROP	FROP	FROP	FROP	FR		FR	FR	FROP	FR	FR	FR	FR	R	FROP	FROP	FROP	FR	FROP	FR	FR		FROP
¾	R	R	FRP	FRP	FROP	FROP	FROP	FROP	FROP	FROP	FRP	*F*	FR	FR	FROP	FR	R	R	FR	FR	FROP	FROP	FROP	FR	FROP	FRP	FR	*F*	FROP
⅞			FR	RP	FROP	FROP	FROP	FRP	FROP	FRP	FR				FROP	F			R		FR	FR	FR	R	FR	R	F		FR
1			FR	FRP	FROP	FROP	FROP	FROP	FROP	FROP	FRP	FR	FR	FR	FROP	FR			FR	FR	FROP	FROP	FROP	FR	FROP	FRP	FR	FR	FROP
1⅛				R	FR	FR	FR	R	FR	R	R				FR						R	R	R						R
1¼			R	R	FROP	FROP	FROP	FROP	FROP	FRP	FRP	FR	R	R	FROP	FR			R	R	FRO	FROP	FROP	FR	FROP	FRP	FR	FR	FROP
1½			R	R	FRP	FROP	FROP	FRP	FROP	FRP	FRP	FR			FROP	FR					FR	FROP	FROP	FR	FROP	FRP	FR	FR	FROP
1¾					FRP	FRP	FRP	RP	FRP	FRP	FRP	F			FRP						R	FR	FR		FR	R			FR
2				R	FRP	FRP	FRP	FRP	FRP	FRP	FRP	FR			FRP	R					FR	FR	FR	FR	FR	FR	FR	FR	FR
2¼						R	FR		FR	FR	F				R							R	R		R				R
2½						FR	FR		FRP	FRP	FRP	FR			FR							R	FR		FR	FR	FR		R
2¾						R	R		FR	FR					R														
3						FR	FR		FR	FR	FR	FR			FR							R	R		FR	FR	FR		R

NOTE.—This table of screw lengths is intended only as a guide to the users of these screws. Diameters, pitches, and lenths not regularly stocked by the manufacturers will be available on order of a sufficient quantity. Letters in the vertical column under the nominal screw sizes indicate the style of head for a particular length of screw thus: F=flat head, R=round head, *O*=oval head, *P*=fillister head. Short-length flat and oval head screws indicated in italics have undercut heads, with the countersunk portion approximately two-thirds of the standard height, with slot depths proportionately less, but with standard head diameters.

TABLE 96.—*Dimensions of flat-head machine screws*

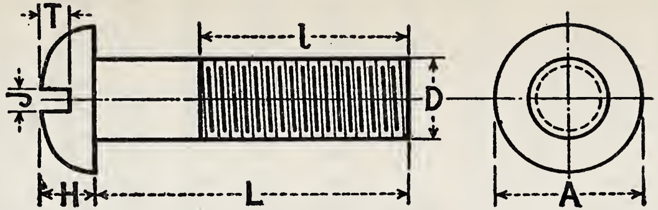


[Countersink angle: Maximum U=82°; minimum U=80°]

Nominal sizes	American National coarse-thread series, class 2 fit			American National fine-thread series, class 2 fit			Dimensions of head							
							D	A		H	J		T	
	Threads per inch	Body diameters		Threads per inch	Body diameters		Nominal diameter of wire	Diameter of head		Height of head	Width of slot		Depth of slot	
		Max.	Min.		Max.	Min.		Max.	Min.	Nominal	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Inch	*Inch*		*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
0				80	0.0600	0.0566								
1	64	0.0730	0.0692	72	.0730	.0694								
2	56	.0860	.0820	64	.0860	.0822	0.086	0.172	0.156	0.045	0.036	0.024	0.023	0.015
3	48	.0990	.0946	56	.0990	.0950	.099	.199	.181	.054	.038	.026	.027	.017
	40	.1120	.1072	48	.1120	.1076	.112	.225	.207	.060	.040	.028	.030	.020
5	[1] 40	.1250	.1202	44	.1250	.1204	.125	.252	.232	.068	.043	.031	.034	.022
6	32	.1380	.1326	40	.1380	.1332	.138	.279	.257	.076	.045	.033	.038	.024
8	[1] 32	.1640	.1586	36	.1640	.1590	.164	.332	.308	.092	.050	.037	.045	.029
10	[1] 24	.1900	.1834	32	.1900	.1846	.190	.385	.359	.108	.055	.041	.053	.034
12	[1] 24	.2160	.2094	28	.2160	.2098	.216	.438	.410	.122	.059	.045	.060	.039
¼	[1] 20	.2500	.2428	28	.2500	.2438	.250	.507	.477	.142	.066	.051	.070	.046
5/16	[1] 18	.3125	.3043	24	.3125	.3059	.3125	.636	.600	.180	.077	.061	.088	.058
⅜	[1] 16	.3750	.3660	24	.3750	.3684	.3750	.762	.722	.215	.088	.072	.106	.070
7/16 [2]	14	.4375	.4277	20	.4375	.4303	.4375	.813	.780	.220	.098	.083	.110	.075
½ [2]	13	.5000	.4896	20	.5000	.4928	.5000	.875	.841	.220	.110	.094	.110	.080
9/16 [2]	12	.5625	.5513	18	.5625	.5543	.5625	1.000	.962	.256	.123	.106	.128	.083
⅝ [2]	11	.6250	.6132	18	.6250	.6168	.6250	1.125	1.083	.293	.138	.119	.146	.096
¾ [2]	10	.7500	.7372	16	.7500	.7410	.7500	1.375	1.326	.366	.154	.134	.183	.123

[1] These sizes in the coarse-thread series are interchangeable with stove-bolt sizes. See table 103, p. 176.
[2] Sizes 7/16 inch and over are in agreement with A. S. A. standards for cap screws, ASA B18C–1930.

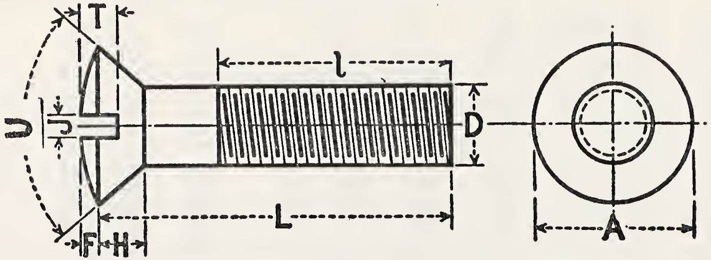
TABLE 97.—*Dimensions of round-head machine screws*



Nominal sizes	American National coarse-thread series, class 2 fit			American National fine-thread series, class 2 fit			Dimensions of head									
							D	A		H		J		T	
	Threads per inch	Body diameters		Threads per inch	Body diameter		Nominal diameter of wire	Diameter of head		Height of head		Width of slot		Depth of slot	
		Max.	Min.		Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Inch	Inch		Inch	Inch	Inch	Inches	Inches	Inch	Inch	Inch	Inch	Inch	Inch
0				80	0.0600	0.0566									
1	64	0.0730	0.0692	72	.0730	.0694									
2	56	.0860	.0820	64	.0860	.0822	0.086	0.162	0.146	0.070	0.059	0.036	0.024	0.048	0.036
3	48	.0990	.0946	56	.0990	.0950	.099	.187	.169	.078	.067	.038	.026	.053	.040
4	40	.1120	.1072	48	.1120	.1076	.112	.211	.193	.086	.075	.040	.028	.058	.043
5	[1] 40	.1250	.1202	44	.1250	.1204	.125	.236	.217	.095	.083	.043	.031	.062	.047
6	32	.1380	.1326	40	.1380	.1332	.138	.260	.240	.103	.091	.045	.033	.067	.050
8	[1] 32	.1640	.1586	36	.1640	.1590	.164	.309	.287	.119	.107	.050	.037	.076	.057
10	[1] 24	.1900	.1834	32	.1900	.1846	.190	.359	.334	.136	.124	.055	.041	.086	.064
12	[1] 24	.2160	.2094	28	.2160	.2098	.216	.408	.382	.152	.140	.059	.045	.095	.071
¼	[1] 20	.2500	.2428	28	.2500	.2438	.250	.472	.443	.174	.161	.066	.051	.108	.080
5/16	[1] 18	.3125	.3043	24	.3125	.3059	.3125	.591	.557	.214	.200	.077	.061	.130	.097
3/8	[1] 16	.3750	.3660	24	.3750	.3684	.3750	.708	.670	.254	.239	.088	.072	.153	.114
7/16 [2]	14	.4375	.4277	20	.4375	.4303	.4375	.750	.725	.328	.302	.098	.083	.202	.167
½ [2]	13	.5000	.4896	20	.5000	.4928	.5000	.813	.786	.355	.328	.110	.094	.219	.179
9/16 [2]	12	.5625	.5513	18	.5625	.5543	.5625	.938	.908	.410	.379	.123	.106	.253	.208
5/8 [2]	11	.6250	.6132	18	.6250	.6168	.6250	1.000	.970	.438	.405	.138	.119	.270	.220
¾ [2]	10	.7500	.7372	16	.7500	.7410	.7500	1.250	1.215	.547	.506	.154	.134	.337	.277

[1] These sizes in the coarse-thread series are interchangeable with stove-bolt sizes. See table 103, p. 176.
[2] Sizes 7/16 inch and over are in agreement with A. S. A. standards for cap screws, ASA B18C–1930.

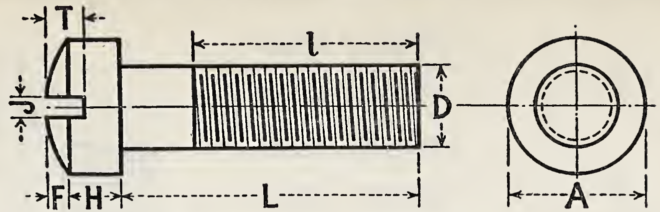
TABLE 98.—*Dimensions of oval-head machine screws*



[Countersink angle: Maximum U=82°; minimum U=80°]

Nominal sizes	American National coarse-thread series, class 2 fit: Threads per inch	Coarse: Body diameters Max.	Coarse: Body diameters Min.	American National fine-thread series, class 2 fit: Threads per inch	Fine: Body diameters Max.	Fine: Body diameters Min.	Dimensions of head: *D* Nominal diameter of wire	*A* Diameter of head Max.	*A* Diameter of head Min.	*H* Height of head, nominal	*J* Width of slot Max.	*J* Width of slot Min.	*T* Depth of slot Max.	*T* Depth of slot Min.	*F* Height of oval Max.	*F* Height of oval Min.	*F* and *H* Total height of head Max.	*F* and *H* Total height of head Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
		Inch	*Inch*		*Inch*	*Inch*	*Inch*	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
0				80	0.0600	0.0566												
1	64	0.0730	0.0692	72	.0730	.0694												
2	56	.0860	.0820	64	.0860	.0822	0.086	0.172	0.156	0.045	0.036	0.024	0.045	0.037	0.029	0.022	0.080	0.063
3	48	.0990	.0946	56	.0990	.0950	.099	.199	.181	.055	.038	.026	.052	.043	.033	.026	.092	.073
4	40	.1120	.1072	48	.1120	.1076	.112	.225	.207	.060	.040	.028	.059	.049	.037	.029	.104	.084
5	40	.1250	.1202	44	.1250	.1204	.125	.252	.232	.068	.043	.031	.067	.055	.041	.033	.116	.095
6	32	.1380	.1326	40	.1380	.1332	.138	.279	.257	.075	.045	.033	.074	.060	.045	.036	.128	.105
8	32	.1640	.1586	36	.1640	.1590	.164	.332	.308	.092	.050	.037	.088	.072	.053	.043	.152	.126
10	24	.1900	.1834	32	.1900	.1846	.190	.385	.359	.107	.055	.041	.103	.084	.061	.050	.176	.148
12	24	.2160	.2094	28	.2160	.2098	.216	.438	.410	.120	.059	.045	.117	.096	.069	.057	.200	.169
¼	20	.2500	.2428	28	.2500	.2438	.250	.507	.477	.142	.066	.051	.136	.112	.079	.066	.232	.197
5/16	18	.3125	.3043	24	.3125	.3059	.3125	.636	.600	.180	.077	.061	.171	.141	.098	.083	.290	.249
⅜	16	.3750	.3660	24	.3750	.3684	.3750	.762	.722	.215	.088	.072	.206	.170	.117	.100	.347	.300
7/16	14	.4375	.4277	20	.4375	.4303	.4375	.813	.780	.250	.100	.082	.241	.198	.136	.116	.405	.351
½	13	.5000	.4896	20	.5000	.4928	.5000	.875	.841	.285	.111	.092	.275	.227	.155	.133	.463	.402

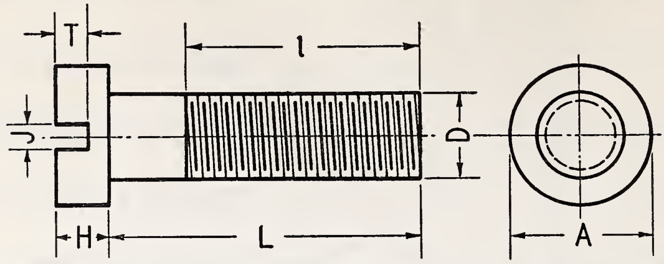
TABLE 99.—*Dimensions of oval-fillister-head machine screws*



Nominal sizes	American National coarse-thread series, class 2 fit			American National fine-thread series, class 2 fit			Dimensions of head													
							D	A		H		J		T		F		F and H	
	Threads per inch	Body diameters		Threads per inch	Body diameters		Nominal diameter of wire	Diameter of head		Height of head		Width of slot		Depth of slot		Height of oval		Total height of head	
		Max.	Min.		Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		Inch	*Inch*		*Inch*	*Inch*		*Inches*	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
0				80	0.0600	0.0566													
1	64	0.0730	0.0692	72	.0730	.0694													
2	56	.0860	.0820	64	.0860	.0822	0.086	0.140	0.124	0.055	0.045	0.036	0.024	0.037	0.021	0.028	0.018	0.083	0.063
3	48	.0990	.0946	56	.0990	.0950	.099	.161	.145	.063	.052	.038	.026	.043	.026	.032	.021	.095	.073
4	40	.1120	.1072	48	.1120	.1076	.112	.183	.166	.072	.060	.040	.028	.048	.031	.035	.024	.107	.084
5	40	.1250	.1202	44	.1250	.1204	.125	.205	.187	.081	.068	.043	.031	.054	.036	.039	.027	.120	.095
6	32	.1380	.1326	40	.1380	.1332	.138	.226	.208	.089	.076	.045	.033	.060	.041	.043	.029	.132	.105
8	32	.1640	1586	36	.1640	.1590	.164	.270	.250	.106	.091	.050	.037	.071	.050	.050	.035	.156	.126
10	24	.1900	.1834	32	.1900	.1846	.190	.313	.292	.123	.107	.055	.041	.083	.060	.057	.041	.180	.148
12	24	.2160	.2094	28	.2160	.2098	.216	.357	.334	.141	.123	.059	.045	.094	.070	.064	.047	.205	.169
¼	20	.2500	.2428	28	.2500	.2438	.250	.414	.389	.163	.143	.066	.051	.109	.083	.074	.054	.237	.197
5/16	18	.3125	.3043	24	.3125	.3059	.3125	.519	.490	.205	.181	.077	.061	.137	.106	.092	.068	.297	.249
⅜	16	.3750	.3660	24	.3750	.3684	.3750	.622	.590	.246	.218	.088	.072	.164	.129	.109	.082	.355	.300
7/16 [1]	14	.4375	.4277	20	.4375	.4303	.4375	.625	.608	.297	.274	.098	.083	.168	.133	.071	.063	.368	.337
½ [1]	13	.5000	.4896	20	.5000	.4928	.5000	.750	.731	.328	.301	.110	.094	.188	.148	.084	.075	.412	.376
9/16 [1]	12	.5625	.5513	18	.5625	.5543	.5625	.812	.792	.375	.347	.123	.106	.214	.169	.091	.081	.466	.428
⅝ [1]	11	.6250	.6132	18	.6250	.6168	.6250	.875	.853	.422	.392	.138	.119	.240	.190	.099	.088	.521	.480
¾ [1]	10	.7500	.7372	16	.7500	.7410	.7500	1.000	.976	.500	.466	.154	.134	.283	.233	.112	.100	.612	.566
⅞ [1]	9	.8750	.8610	14	.8750	.8652	.8750	1.125	1.098	.594	.556	.173	.151	.334	.264	.126	.113	.720	.669
1 [1]	8	1.0000	.9848	14	1.0000	.9902	1.0000	1.312	1.282	.656	.613	.194	.170	.372	.292	.146	.131	.802	.744

[1] Sizes 7/16 inch and over are in agreement with A. S. A. standard for cap screws, ASA B18C-1930.

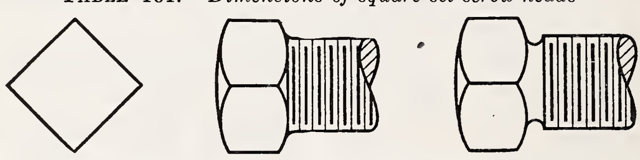
TABLE 100.—*Dimensions of flat-fillister-head machine screws* [1]



Nominal size	American National coarse-thread series, class 2 fit			American National fine-thread series, class 2 fit			Dimensions of head								
							D	A		H		J		T	
	Threads per inch	Body diameter		Threads per inch	Body diameter		Diamter of wire (nominal)	Diameter of head		Height of head		Width of slot		Depth of slot	
		Max.	Min.		Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Inch	*Inch*		*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
2	56	0.0860	0.0820	64	0.0860	0.0822	0.0860	0.140	0.124	0.083	0.063	0.036	0.024	0.037	0.021
3	48	.0990	.0946	56	.0990	.0950	.0990	.161	.145	.095	.073	.038	.026	.043	.026
4	40	.1120	.1072	48	.1120	.1076	.1120	.183	.166	.107	.084	.040	.028	.048	.031
5	40	.1250	.1202	44	.1250	.1204	.1250	.205	.187	.120	.095	.043	.031	.054	.036
6	32	.1380	.1326	40	.1380	.1332	.1380	.226	.208	.132	.105	.045	.033	.060	.041
8	32	.1640	.1586	36	.1640	.1590	.1640	.270	.250	.156	.126	.050	.037	.071	.050
10	24	.1900	.1834	32	.1900	.1846	.1900	.313	.292	.180	.148	.055	.041	.083	.060
12	24	.2160	.2094	28	.2160	.2098	.2160	.357	.334	.205	.169	.059	.045	.094	.070
1/4	20	.2500	.2428	28	.2500	.2438	.2500	.414	.389	.237	.197	.066	.051	.109	.083
5/16	18	.3125	.3043	24	.3125	.3059	.3125	.519	.490	.297	.249	.077	.061	.137	.106
3/8	16	.3750	.3660	24	.3750	.3684	.3750	.622	.590	.355	.300	.088	.072	.164	.129

[1] This table is not included in ASA B18C—1930.

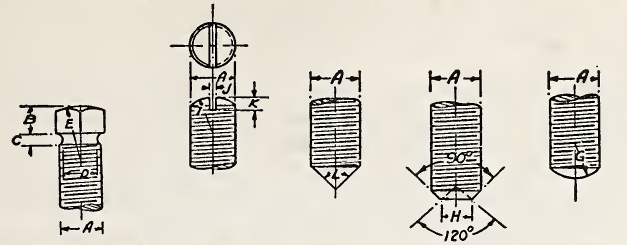
TABLE 101.—*Dimensions of square set screw heads* [1]



Nominal size or basic major diameter of thread	Width across flats		Width across corners	Height			Diameter of neck	
	Maximum (basic)	Min.	Min.	Nominal	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1/4 .... 0.2500	1/4 .... 0.2500	0.241	0.331	3/16	0.196	0.178	0.185	0.170
5/16 .... .3125	5/16 .... .3125	.302	.415	15/64	.245	.224	.240	.225
3/8 .... .3750	3/8 .... .3750	.362	.497	9/32	.293	.270	.294	.279
7/16 .... .4375	7/16 .... .4375	.423	.581	21/64	.341	.315	.345	.330
1/2 .... .5000	1/2 .... .5000	.484	.665	3/8	.389	.361	.400	.385
9/16 .... .5625	9/16 .... .5625	.545	.748	27/64	.437	.407	.454	.439
5/8 .... .6250	5/8 .... .6250	.606	.832	15/32	.485	.452	.507	.492
3/4 .... .7500	3/4 .... .7500	.729	1.001	9/16	.582	.544	.620	.605
7/8 .... .8750	7/8 .... .8750	.852	1.170	21/32	.678	.635	.731	.716
1 .... 1.0000	1 .... 1.0000	.974	1.337	3/4	.774	.726	.838	.823
1 1/8 .... 1.1250	1 1/8 .... 1.1250	1.096	1.505	27/32	.870	.817	.939	.914
1 1/4 .... 1.2500	1 1/4 .... 1.2500	1.219	1.674	15/16	.966	.908	1.064	1.039
1 3/8 .... 1.3750	1 3/8 .... 1.3750	1.342	1.843	1 1/32	1.063	1.000	1.159	1.134
1 1/2 .... 1.5000	1 1/2 .... 1.5000	1.464	2.010	1 1/8	1.159	1.091	1.284	1.259

[1] This table is in agreement with table 6 of ASA B18.2-1941.

TABLE 102.—*Dimensions of square (optional design) and slotted set screw heads*



Square head. OPTIONAL DESIGN Headless. Cone point. Cup point. Round point.

A	*B*	*C*	*D*	*E*	*G*	*H*	*I*	*J*	*K*
1	2	3	4	5	6	7	8	9	10
In. 3/16	*In.* 0.141	*In.* 1/16	*In.* 0.153 / .148	*In.* 3/8	*In.* 0.112	*In.* 0.125	*In.* 0.187	*In.* 0.033	*In.* 0.046
1/4	.187	5/64	.185 / .180	1/2	.150	.166	.250	.043	.062
5/16	.234	3/32	.240 / .235	5/8	.187	.208	.312	.054	.078
3/8	.281	1/8	.293 / .288	3/4	.225	.250	.375	.064	.093
7/16	.328	9/64	.344 / .339	7/8	.262	.291	.437	.075	.109
1/2	.375	9/64	.400 / .395	1	.300	.331	.500	.085	.125
9/16	.422	11/64	.454 / .449	1 1/8	.337	.375	.562	.095	.140
5/8	.469	3/16	.506 / .501	1 1/4	.375	.416	.625	.106	.156
3/4	.562	7/32	.620 / .615	1 1/2	.450	.500	.750	.127	.187
7/8	.656	1/4	.730 / .725	1 3/4	.525	.584	.875	.147	.218
1	.750	1/4	.837 / .832	2	.600	.666	1.000	.168	.250
1 1/8	.844	1/4	.939 / .934	2 1/4	.675	.750	1.125	.189	.281
1 1/4	.937	3/8	1.064 / 1.059	2 1/2	.750	.833	1.250	.210	.312

A=Diameter of screw and width across flats of square head.
B=Length of head=0.75A.
C=Width of neck.
D=Diameter of neck=Minor diam.+0.000−0.005.
E=Radius of square head screws=2A.
G=Radius of round-point screws=0.6A.
H=Diameter of cup points=2/3A.
I=Radius of slotted end on headless=A.
J=Width of slot=(A÷6)+0.002.
K=Depth of slot=(A÷4).
L=Angle of cone point=120° where length of screw is equal to or less than diameter of screw; 90° where length of screw is more than diameter of screw.

3. RECOMMENDED REQUIREMENTS, MACHINE-SCREW AND STOVE-BOLT NUTS

(*a*) WORKMANSHIP.—The workmanship shall be compatible with the type of product and class of fit and finish specified. The product shall be free from abnormal scale, fins, seams, or other defects. All nuts shall be free from any defects which might affect their serviceability.

Unless otherwise specified, nuts shall be either cold-punched, hot-forged and trimmed, or machined from bar stock.

(*b*) THREAD SERIES.—Unless otherwise specified machine screw nuts shall be threaded with the same class of fit as the machine screws to which they are to be mated. When nuts are ordered separately the threads shall be of the thread series and class of fit specified.

(*c*) DETAILS OF DESIGN.—1. *Taper of nuts.*—The taper of the sides of nuts (the angle between one side and the axis) shall not exceed 2°. The largest width shall not exceed the specified maximum width across flats.

2. *Top and bottom of nuts.*—The tops of hexagon nuts shall be flat and chamfered. The angle of chamfer with the top surface shall be 30°, and the diameter of the top circle shall be the maximum width across flats, within a tolerance of minus 15 percent. The bottoms of hexagon nuts are flat, or double chamfered, but for special purposes may be chamfered or washer faced if so specified.

Square machine screw nuts and stove bolt nuts shall have tops and bottoms flat without chamfer.

3. *Bearing surface.*—The bearing surface shall be at right angles to the axis of the threaded hole within a tolerance of 4°.

4. TABLE OF DIMENSIONS, NUTS

The dimensions of square and hexagon machine screw and stove bolt nuts shall conform to table 103. The distance from the top to the bearing surface of a nut shall be regarded as the thickness of the nut.

TABLE 103.—*Dimensions of square and hexagon machine-screw and stove-bolt nuts* [1]

Nominal size	Width across flats		Width across corners (min.)		Thickness		
	Maximum (basic)	Min.	Sq.	Hex.	Nominal	Max.	Min.[3]
1	2	3	4	5	6	7	8
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
0	5/32 0.1562	0.150	0.206	0.171	3/64	0.050	0.043
1	5/32 .1562	.150	.206	.171	3/64	.050	.043
2	3/16 .1875	.180	.247	.205	1/16	.066	.057
3	3/16 .1875	.180	.247	.205	1/16	.066	.057
4	1/4 .2500	.241	.331	.275	3/32	.098	.087
5 [2]	5/16 .3125	.302	.415	.344	7/64	.114	.102
6	5/16 .3125	.302	.415	.344	7/64	.114	.102
8 [2]	11/32 .3438	.332	.456	.378	1/8	.130	.117
10 [2]	3/8 .3750	.362	.497	.413	1/8	.130	.117
12 [2]	7/16 .4375	.423	.581	.482	5/32	.161	.148
1/4	7/16 .4375	.423	.581	.482	3/16	.193	.178
5/16	9/16 .5625	.545	.748	.621	7/32	.225	.208
3/8	5/8 .6250	.607	.833	.692	1/4	.257	.239

[1] This table is in agreement with table 10 of ASA B18.2-1941.

[2] These sizes in the coarse-thread series are interchangeable with the following sizes of stove-bolt nuts:

Machine screw	Stove bolt	Machine screw	Stove bolt
	Inch		*Inch*
No. 5	1/8	1/4 inch	1/4
No. 8	5/32	5/16 inch	5/16
No. 10	3/16	3/8 inch	3/8
No. 12	7/32		

[3] Minimum nut thicknesses of the following sizes are not sufficient to develop the full strength of screws, when minor diameters of nuts are at their maximum values: Nos. 0, 1, 2, 3, 10, 5/16, and 3/8 in.

SECTION XIV. SOCKET SET SCREWS AND SOCKET-HEAD CAP SCREWS [26]

These standards for socket set screws and socket head cap screws, together with standards for wrenches for same, are intended for general use and to replace such other series of dimensions as have been used.

1. SERIES OF SOCKET SET SCREWS AND SOCKET-HEAD CAP SCREWS

Two series are covered by this standard, namely, hexagon socket screws and fluted socket screws.

2. RECOMMENDED REQUIREMENTS, SOCKET SET SCREWS

(*a*) Workmanship.—The workmanship shall be compatible with the type of product and class of fit and finish specified. The product shall be free from abnormal scale, fins, seams, or other defects. All screws shall be free from any defects which might affect their serviceability.

(*b*) Thread Series.—Unless otherwise specified the number of threads per inch shall be that specified for the American National coarse-thread series set forth in section III.

(*c*) Details of Design.—1. *Length of screws, L.*—The length of the screw shall be measured over all on a line parallel to the axis. The difference between consecutive lengths shall be as follows:

For screw lengths ¼ to ⅝ in., difference=1/16 in.; for screw lengths ⅝ to 1 in., difference=⅛ in.; for screw lengths 1 to 4 in., difference=¼ in.; for screw lengths 4 to 6 in., difference =½ in.

Allowable tolerance on length, *L*, shall be 3 percent on lengths 2 in. and under with a minimum of 0.020 in., one half to be applied plus and one half minus; on lengths over 2 in. to 6 in. ±1/32 in.; on lengths over 6 in. ±1/16 in.

2. *Concentricity of dog point.*—The allowable eccentricity of dog-point axis with respect to axis of screw shall not exceed 3 percent of nominal diameter of screw with a minimum of 0.005 in.

3. *Chamfers and point angles.*—$W=45°+5°-0°$; $X=118°\pm5°$; $Z=35°+5°-0°$.

4. *Socket depth, T.*—The depth of the socket shall be as great as practicable, but varying conditions render it inadvisable to specify definite values.

5. *Socket end chamfer, V.*—Socket end of screw shall be flat and chamfered. The flat shall be normal to the axis of the screw and the chamfer, *V*, shall be at an angle of $35°+5°-0°$ with the surface of the flat. The chamfer shall extend to the bottom of the thread, and the edge between flat and chamfer shall be slightly rounded.

3. TABLES OF DIMENSIONS, SOCKET SET SCREWS

(*a*) Hexagon Socket Set Screws.—The dimensions of hexagon socket set screws shall conform to table 104.

(*b*) Fluted Socket Set Screws.—The dimensions of fluted socket set screws shall conform to table 105.

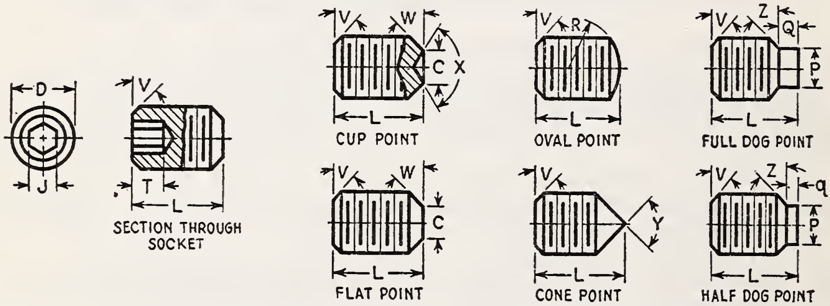
[26] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published as ASA B18.3-1936. "Socket Set Screws and Socket Head Cap Screws" by the A. S. M. E., 29 West 39th St., New York, N. Y.

4. RECOMMENDED REQUIREMENTS, SOCKET-HEAD CAP SCREWS

(*a*) Workmanship.—The workmanship shall be compatible with the type of product and class of fit and finish specified. The product shall be free from abnormal scale, fins, seams, or other defects. All screws shall be free from any defects which might affect their serviceability.

(*b*) Thread Series.—Unless otherwise specified the number of threads per inch shall be that specified for the American National coarse-thread series or the American National fine-thread series, set forth in section III.

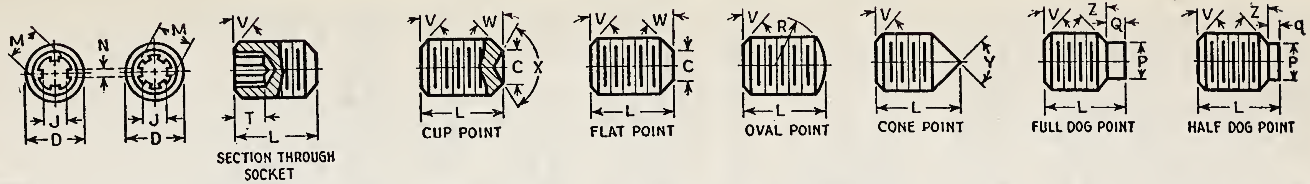
Table 104.—*Dimensions of hexagon socket set screws*



D	*C*			*R*	*Y*		*P*		*Q*	*q*	*J*	
Nominal size	Cup and flat point diameter			Oval point radius	Cone point angle		Full dog point and half dog point [1]				Socket width across flats	
	Mean	Max.	Min.		118°±2° for these lengths and under	90°±2° for these lengths and over	Diameter Max.	Diameter Min.	Full	Half	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*	*Inches*	*Inch*
5	1/16	0.067	0.057	3/32	1/8	3/16	0.083	0.078	0.06	0.03	0.0635	1/16
6	.069	.074	.064	7/64	1/8	3/16	.092	.087	.07	.03	.0635	1/16
8	5/64	.087	.076	1/8	3/16	1/4	.109	.103	.08	.04	.0791	5/64
10	3/32	.102	.088	9/64	3/16	1/4	.127	.120	.09	.04	.0947	3/32
12	7/64	.115	.101	5/32	3/16	1/4	.144	.137	.11	.06	.0947	3/32
1/4	1/8	.132	.118	3/16	1/4	5/16	5/32	.149	1/8	1/16	.1270	1/8
5/16	11/64	.172	.156	15/64	5/16	3/8	13/64	.195	5/32	5/64	.1582	5/32
3/8	13/64	.212	.194	9/32	3/8	7/16	1/4	.241	3/16	3/32	.1895	3/16
7/16	15/64	.252	.232	21/64	7/16	1/2	19/64	.287	7/32	7/64	.2207	7/32
1/2	9/32	.291	.270	3/8	1/2	9/16	11/32	.334	1/4	1/8	.2520	1/4
9/16	5/16	.332	.309	27/64	9/16	5/8	25/64	.379	9/32	9/64	.2520	1/4
5/8	23/64	.371	.347	15/32	5/8	3/4	15/32	.456	5/16	5/32	.3155	5/16
3/4	7/16	.450	.425	9/16	3/4	7/8	9/16	.549	3/8	3/16	.3780	3/8
7/8	33/64	.530	.502	21/32	7/8	1	21/32	.642	7/16	7/32	.5030	1/2
1	19/32	.609	.579	3/4	1	1 1/8	3/4	.734	1/2	1/4	.5655	9/16
1 1/8	43/64	.689	.655	27/32	1 1/8	1 1/4	27/32	.826	9/16	9/32	.5655	9/16
1 1/4	3/4	.767	.733	15/16	1 1/4	1 1/2	15/16	.920	5/8	5/16	.6290	5/8
1 3/8	53/64	.848	.808	1 1/32	1 3/8	1 5/8	1 1/32	1.011	11/16	11/32	.6290	5/8
1 1/2	29/32	.926	.886	1 1/8	1 1/2	1 3/4	1 1/8	1.105	3/4	3/8	.7540	3/4
1 3/4	1 1/16	1.086	1.039	1 5/16	1 3/4	2	1 5/16	1.289	7/8	7/16	1.0040	1
2	1 7/32	1.244	1.193	1 1/2	2	2 1/4	1 1/2	1.474	1	1/2	1.0040	1

[1] Where usable length of thread is less than nominal diameter, half dog point shall be used.

TABLE 105.—*Dimensions of fluted socket set screws*



D	C			R	Y		P		Q	q		J		M		N	
Nominal size	Cup and flat point diameter			Oval point radius	Cone point angle		Full dog point and half dog point [1]				Number of flutes	Socket diam., minor		Socket diam., major		Socket land width	
					118°±2° for these lengths and under	90°±2° for these lengths and over	Diameter		Full	Half							
	Mean	Max.	Min.				Max.	Min.				Max.	Min.	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*		*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inch*
5	1/16	0.067	0.057	3/32	1/8	3/16	0.083	0.078	0.06	0.03	4	0.053	0.052	0.071	0.070	0.022	0.021
6	.069	.074	.064	7/64	1/8	3/16	.092	.087	.07	.03	4	.056	.055	.079	.078	.025	.024
8	5/64	.087	.076	1/8	3/16	1/4	.109	.103	.08	.04	6	.079	.078	.098	.097	.022	.021
10	3/32	.102	.088	9/64	3/16	1/4	.127	.120	.09	.04	6	.097	.095	.113	.111	.027	.025
12	7/64	.115	.101	5/32	3/16	1/4	.144	.137	.11	.06	6	.097	.095	.113	.111	.027	.025
1/4	1/8	.132	.118	3/16	1/4	5/16	5/32	.149	1/8	1/16	6	.127	.125	.147	.145	.032	.030
5/16	11/64	.172	.156	15/64	5/16	3/8	13/64	.195	5/32	5/64	6	.160	.158	.185	.183	.041	.040
3/8	13/64	.212	.194	9/32	3/8	7/16	1/4	.241	3/16	3/32	6	.190	.188	.219	.217	.052	.050
7/16	15/64	.252	.232	21/64	7/16	1/2	19/64	.287	7/32	7/64	6	.221	.219	.256	.254	.062	.060
1/2	9/32	.291	.270	3/8	1/2	9/16	11/32	.334	1/4	1/8	6	.254	.252	.297	.295	.072	.070
9/16	5/16	.332	.309	27/64	9/16	5/8	25/64	.379	9/32	9/64	6	.254	.252	.297	.295	.072	.070
5/8	23/64	.371	.347	15/32	5/8	3/4	15/32	.456	5/16	5/32	6	.315	.312	.380	.377	.092	.089
3/4	7/16	.450	.425	9/16	3/4	7/8	9/16	.549	3/8	3/16	6	.386	.383	.463	.460	.112	.109
7/8	33/64	.530	.502	21/32	7/8	1	21/32	.642	7/16	7/32	6	.506	.503	.600	.597	.142	.139
1	19/32	.609	.579	3/4	1	1 1/8	3/4	.734	1/2	1/4	6	.568	.564	.654	.650	.157	.153
1 1/8	43/64	.689	.655	27/32	1 1/8	1 1/4	27/32	.826	9/16	9/32	6	.568	.564	.654	.650	.157	.153
1 1/4	3/4	.767	.733	15/16	1 1/4	1 1/2	15/16	.920	5/8	5/16	6	.631	.627	.790	.786	.184	.180
1 3/8	53/64	.848	.808	1 1/32	1 3/8	1 5/8	1 1/32	1.011	11/16	11/32	6	.631	.627	.790	.786	.184	.180
1 1/2	29/32	.926	.886	1 1/8	1 1/2	1 3/4	1 1/8	1.105	3/4	3/8	6	.756	.752	.958	.954	.221	.217
1 3/4	1 1/16	1.086	1.039	1 5/16	1 3/4	2	1 5/16	1.289	7/8	7/16	6	1.007	1.003	1.275	1.271	.298	.294
2	1 7/32	1.244	1.193	1 1/2	2	2 1/4	1 1/2	1.474	1	1/2	6	1.007	1.003	1.275	1.271	.298	.294

[1] Where usable length of thread is less than nominal diameter, half dog point shall be used.

(c) Details of Design.—1. *Length under head, L.*—The length of the screw shall be measured, on a line parallel to the axis, from the plane of the bearing surface under the head to the plane of the flat of the point. The difference between consecutive lengths shall be as follows: For screw lengths $\frac{1}{4}$ to 1 in. shall be $\frac{1}{8}$ in.; for screw lengths 1 to 4 in. shall be $\frac{1}{4}$ in.; for screw lengths 4 to 6 in. shall be $\frac{1}{2}$ in.

The allowable tolerance on the length, L, under the head, on lengths 2 in. and under shall be 3 percent of the nominal length with a minimum of 0.030 in., two thirds to be applied plus and one third minus; on lengths over 2 in. to 6 in. $\pm\frac{1}{32}$ in.; and on lengths over 6 in. $\pm\frac{1}{16}$ in.

2. *Thread length, l.*—The length of the screw thread is measured from the extreme point to the last usable thread and shall be as follows:

For American National coarse.	$l=2D+\frac{1}{2}$ in. (where this length of thread would be greater than half the screw length). $l=\frac{1}{2}L$ (where this length of thread would be greater than $2D+\frac{1}{2}$ in.).
For American National fine.	$l=1\frac{1}{2}D+\frac{1}{2}$ in. (where this length of thread would be greater than three-eighths the screw length). $l=\frac{3}{8}L$ (where this length of thread would be greater than $1\frac{1}{2}D+\frac{1}{2}$ in.).

Screws too short to allow application of these formulas shall be threaded as close to the head as practicable.

3. *Tolerances on body diameter.*—Limiting dimensions for body diameter are given in tables 106 and 107.

4. *Screw-point chamfer, Z.*—The point shall be flat and chamfered. The flat shall be normal to the axis of the screw and the chamfer, Z, shall be at an angle of $35°+5°, -0°$ with the plane of the flat. The chamfer shall extend to the bottom of the thread, and edge between flat and chamfer shall be slightly rounded.

5. *Head chamfer, E.*—The head shall be flat and chamfered. The flat shall be normal to the axis of the screw and the chamfer, E, shall be at an angle of $30°\pm 2°$ with the surface of the flat. The edge between flat and chamfer shall be slightly rounded.

6. *Socket depth, T.*—The depth of socket shall be as great as practicable, but varying conditions render it inadvisable to specify definite values for this dimension.

7. *Concentricity.*—The concentricity of head, body, and thread shall be such as to permit acceptance when checked with a compound "go" gage which will gage the maximum diameters of these three parts simultaneously. This gage shall have the head and body diameters at their maximum values (see columns D and A, tables 106 and 107), but expressed to four decimal places, and the pitch diameter at the maximum value allowed for class 3, NC and class 3, NF.

5. TABLES OF DIMENSIONS, SOCKET-HEAD CAP SCREWS

(*a*) Hexagon Socket-Head Cap Screws.—The dimensions of hexagon socket head cap screws shall conform to table 106.

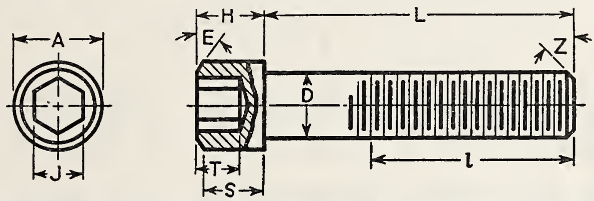
(*b*) Fluted Socket-Head Cap Screws.—The dimensions of fluted socket head cap screws shall conform to table 107.

6. TABLES OF DIMENSIONS, WRENCHES

(*a*) Hexagon Socket Wrenches.—The dimensions of wrenches for hexagon socket set screws and socket head cap screws shall conform to table 108.

(*b*) Fluted Socket Wrenches.—The dimensions of wrenches for fluted socket set screws and socket head cap screws shall conform to table 109.

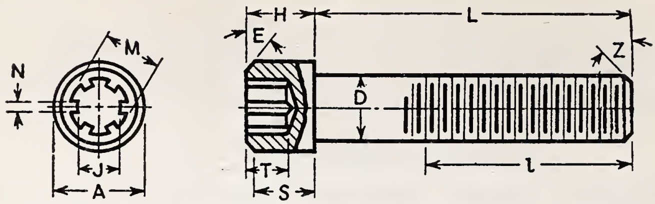
Table 106.—*Dimensions of hexagon socket head cap screws*



D			*A*		*H*		*S*			*J*	
Body diameter [1]			Head diameter		Head height		Head side-height			Socket, width across flats	
Nom.	Max.	Min.	Max.	Min.	Max.	Min.	Nom.	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*
8	0.1640	0.1613	9/32	0.276	0.164	0.160	0.1503	0.1522	0.1484	0.1270	1/8
10	.1900	.1867	5/16	.306	.190	.185	.1741	.1765	.1717	.1582	5/32
12	.2160	.2127	11/32	.337	.216	.211	.1980	.2005	.1957	.1582	5/32
1/4	.2500	.2464	3/8	.367	1/4	.244	.2291	.2317	.2265	.1895	3/16
5/16	.3125	.3084	7/16	.429	5/16	.306	.2864	.2894	.2834	.2207	7/32
3/8	.3750	.3705	9/16	.553	3/8	.368	.3437	.3469	.3405	.3155	5/16
7/16	.4375	.4326	5/8	.615	7/16	.430	.4010	.4046	.3974	.3155	5/16
1/2	.5000	.4948	3/4	.739	1/2	.492	.4583	.4620	.4546	.3780	3/8
9/16	.5625	.5569	13/16	.801	9/16	.554	.5156	.5196	.5116	.3780	3/8
5/8	.6250	.6191	7/8	.863	5/8	.616	.5729	.5771	.5687	.5030	1/2
3/4	.7500	.7436	1	.987	3/4	.741	.6875	.6920	.6830	.5655	9/16
7/8	.8750	.8680	1 1/8	1.111	7/8	.865	.8020	.8069	.7971	.5655	9/16
1	1.0000	.9924	1 5/16	1.297	1	.989	.9166	.9220	.9112	.6290	5/8
1 1/8	1.1250	1.1165	1 1/2	1.483	1 1/8	1.113	1.0312	1.0372	1.0254	.7540	3/4
1 1/4	1.2500	1.2415	1 3/4	1.733	1 1/4	1.238	1.1457	1.1516	1.1398	.7540	3/4
1 3/8	1.3750	1.3649	1 7/8	1.855	1 3/8	1.361	1.2604	1.2675	1.2533	.7540	3/4
1 1/2	1.5000	1.4899	2	1.979	1 1/2	1.485	1.3750	1.3821	1.3679	1.0040	1

[1] Body diameter, *D*, refers to the unthreaded portion, and is the nominal diameter of the screw, with a minus tolerance.

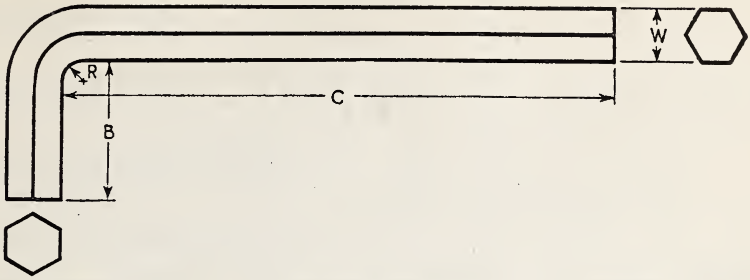
TABLE 107.—*Dimensions of fluted socket head cap screws*



D			*A*		*H*		*S*				*J*		*M*		*N*	
Body diameter [1]			Head diameter		Head height		Head side-height			Number of flutes	Socket diameter, minor		Socket diameter, major		Width of socket land	
Nom.	Max.	Min.	Max.	Min.	Max.	Min.	Nom.	Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*		*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
8	0.1640	0.1613	9/32	0.276	0.164	0.160	0.1503	0.1522	0.1484	6	0.127	0.125	0.147	0.145	0.035	0.033
10	.1900	.1867	5/16	.306	.190	.185	.1741	.1765	.1717	6	.127	.125	.147	.145	.035	.033
12	.2160	.2127	11/32	.337	.216	.211	.1980	.2005	.1957	6	.160	.158	.185	.183	.042	.040
1/4	.2500	.2464	3/8	.367	1/4	.244	.2291	.2317	.2265	6	.190	.188	.219	.217	.052	.050
5/16	.3125	.3084	7/16	.429	5/16	.306	.2864	.2894	.2834	6	.221	.219	.256	.254	.062	.060
3/8	.3750	.3705	9/16	.553	3/8	.368	.3437	.3469	.3405	6	.312	.310	.380	.378	.092	.090
7/16	.4375	.4326	5/8	.615	7/16	.430	.4010	.4046	.3974	6	.312	.310	.380	.378	.092	.090
1/2	.5000	.4948	3/4	.739	1/2	.492	.4583	.4620	.4645	6	.386	.383	.463	.460	.112	.109
9/16	.5625	.5569	13/16	.801	9/16	.554	.5156	.5196	.5116	6	.386	.383	.463	.460	.112	.109
5/8	.6250	.6191	7/8	.863	5/8	.616	.5729	.5771	.5687	6	.506	.503	.600	.597	.142	.139
3/4	.7500	.7436	1	.987	3/4	.741	.6875	.6920	.6830	6	.568	.564	.654	.650	.157	.153
7/8	.8750	.8680	1 1/8	1.111	7/8	.865	.8020	.8069	.7971	6	.568	.564	.654	.650	.157	.153
1	1.0000	.9924	1 5/16	1.297	1	.989	.9166	.9220	.9112	6	.631	.627	.790	.786	.184	.180
1 1/8	1.1250	1.1165	1 1/2	1.483	1 1/8	1.113	1.0312	1.0372	1.0254	6	.756	.752	.957	.953	.221	.217
1 1/4	1.2500	1.2415	1 3/4	1.733	1 1/4	1.238	1.1457	1.1516	1.1398	6	.756	.752	.957	.953	.221	.217
1 3/8	1.3750	1.3649	1 7/8	1.855	1 3/8	1.361	1.2604	1.2675	1.2533	6	.756	.752	.957	.953	.221	.217
1 1/2	1.5000	1.4899	2	1.979	1 1/2	1.485	1.3750	1.3821	1.3679	6	1.007	1.003	1.275	1.271	.298	.294

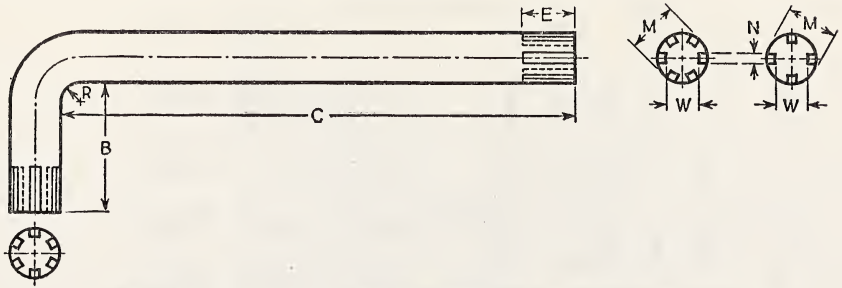
[1] Body diameter, *D*, refers to the unthreaded portion, and is the nominal diameter of the screw, with a minus tolerance.

TABLE 108.—*Dimensions of wrenches for hexagon socket set screws and socket head cap screws*



D		W		B		C				R
Screw size		Hexagon width across flats		Length, short arm		Length, long arm				Radius of bend
						Short series		Long series		
Set	Cap	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	
1	2	3	4	5	6	7	8	9	10	11
		Inch	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*
5	--------	1/16	0.0615	21/32	15/32	1 27/32	1 21/32	--------	--------	1/16
6	--------	1/16	.0615	21/32	15/32	1 27/32	1 21/32	--------	--------	1/16
8	--------	5/64	.0771	45/64	33/64	1 31/32	1 25/32	--------	--------	5/64
10	--------	3/32	.0927	3/4	9/16	2 3/32	1 29/32	--------	--------	3/32
12	--------	3/32	.0927	3/4	9/16	2 3/32	1 29/32	--------	--------	3/32
1/4	8	1/8	.1235	27/32	21/32	2 11/32	2 5/32	3 27/32	3 21/32	1/8
5/16	10, 12	5/32	.1547	15/16	3/4	2 19/32	2 13/32	4 7/32	4 1/32	5/32
3/8	1/4	3/16	.1860	1 1/32	27/32	2 27/32	2 21/32	4 19/32	4 13/32	3/16
7/16	5/16	7/32	.2172	1 1/8	15/16	3 3/32	2 29/32	4 31/32	4 25/32	7/32
1/2	--------	1/4	.2485	1 7/32	1 1/32	3 11/32	3 5/32	5 11/32	5 5/32	1/4
9/16	--------	1/4	.2485	1 7/32	1 1/32	3 11/32	3 5/32	5 11/32	5 5/32	1/4
5/8	3/8, 7/16	5/16	.3110	1 11/32	1 5/32	3 27/32	3 21/32	6 3/32	5 29/32	5/16
3/4	1/2. 9/16	3/8	.3735	1 15/32	1 9/32	4 11/32	4 5/32	6 27/32	6 21/32	3/8
7/8	5/8	1/2	.4985	1 23/32	1 17/32	5 11/32	5 5/32	8 11/32	8 5/32	1/2
1	--------	9/16	.5600	1 27/32	1 21/32	5 27/32	5 21/32	9 3/32	8 29/32	9/16
1 1/8	3/4, 7/8	9/16	.5600	1 27/32	1 21/32	5 27/32	5 23/32	9 3/32	8 29/32	9/16
1 1/4, 1 3/8	1	5/8	.6225	1 31/32	1 25/32	6 11/32	6 5/32	9 27/32	9 21/32	5/8
1 1/2	1 1/8, 1 1/4, 1 3/8	3/4	.7475	2 7/32	2 1/32	7 11/32	7 5/32	11 11/32	11 5/32	3/4
1 3/4	--------	1	.9975	2 23/32	2 17/32	9 11/32	9 5/32	14 11/32	14 5/32	1
2	1 1/2	1	.9975	2 23/32	2 17/32	9 11/32	9 5/32	14 11/32	14 5/32	1

TABLE 109.—*Dimensions of wrenches for fluted socket set screws and socket head cap screws*



D		*M*		*W*			*N*		*E*	*B*		*C*				*R*
Screw size		Major diameter		Minor diameter		Number of flutes	Width of flute		Length of flute	Length, short arm		Length, long arm				Radius of bend
												Short series		Long series		
Set	Cap	Max.	Min.	Max.	Min.		Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Inches	*Inches*	*Inch*	*Inch*		*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*
5		0.0690	0.0680	0.0510	0.0500	4	0.0260	0.0250	1/8	21/32	15/32	1 27/32	1 21/32			1/16
6		.0760	.0750	.0530	.0520	4	.0280	.0270	1/8	21/32	15/32	1 27/32	1 21/32			1/16
8		.0940	.0930	.0780	.0765	6	.0260	.0250	1/8	45/64	33/64	1 31/32	1 25/32			5/64
10		.1100	.1090	.0940	.0925	6	.0290	.0280	5/32	3/4	9/16	2 3/32	1 29/32			3/32
12		.1100	.1090	.0940	.0925	6	.0290	.0280	5/32	3/4	9/16	2 3/32	1 29/32			3/32
1/4	8	.1440	.1425	.1230	.1205	6	.0370	.0355	3/16	27/32	21/32	2 11/32	2 5/32	3 27/32	3 21/32	1/8
5/16	10, 12	.1830	.1815	.1580	.1565	6	.0440	.0425	7/32	15/16	3/4	2 19/32	2 13/32	4 7/32	4 1/32	5/32
3/8	1/4	.2160	.2145	.1720	.1705	6	.0550	.0535	1/4	1 1/32	27/32	2 27/32	2 21/32	4 19/32	4 13/32	3/16
7/16	5/16	.2510	.2495	.2010	.1995	6	.0655	.0640	9/32	1 1/8	15/16	3 3/32	2 29/32	4 31/32	4 25/32	7/32
1/2		.2910	.2895	.2390	.2375	6	.0775	.0760	5/16	1 7/32	1 1/32	3 11/32	3 5/32	5 11/32	5 5/32	1/4
9/16		.3310	.3295	.2730	.2715	6	.0875	.0860	11/32	1 7/32	1 1/32	3 11/32	3 5/32	5 11/32	5 5/32	9/32
5/8	3/8, 7/16	.3720	.3705	.3070	.3055	6	.0975	.0960	3/8	1 11/32	1 5/32	3 27/32	3 21/32	6 3/32	5 29/32	5/16
3/4	1/2, 9/16	.4540	.4525	.3770	.3755	6	.1185	.1170	7/16	1 15/32	1 9/32	4 11/32	4 5/32	7 27/32	6 21/32	3/8
7/8	5/8	.5950	.5935	.5000	.4975	6	.1460	.1445	1/2	1 23/32	1 17/32	5 11/32	5 5/32	8 11/32	8 5/32	1/2
1		.6480	.6455	.5620	.5595	6	.1590	.1565	9/16	1 27/32	1 21/32	5 27/32	5 21/32	9 3/32	8 29/32	1/2
1 1/8	3/4, 7/8	.6480	.6455	.5620	.5595	6	.1615	.1590	5/8	1 27/32	1 21/32	5 27/32	5 21/32	9 3/32	8 29/32	9/16
1 1/4, 1 3/8	1	.7840	.7815	.6250	.6225	6	.1875	.1850	11/16	1 31/32	1 25/32	6 11/32	6 5/32	9 27/32	9 21/32	5/8
1 1/2	1 1/8, 1 1/4, 1 3/8	.9550	.9525	.7500	.7475	6	.2245	.2220	13/16	2 7/32	2 1/32	7 11/32	7 5/32	11 11/32	11 5/32	3/4
1 3/4		1.2680	1.2655	1.0000	.9975	6	.3015	.2990	15/16	2 23/32	2 17/32	9 11/32	9 5/32	14 11/32	14 5/32	7/8
2	1 1/2	1.2680	1.2655	1.0000	.9975	6	.3015	.2990	1 1/16	2 23/32	2 17/32	9 11/32	9 5/32	14 11/32	14 5/32	1

SECTION XV. ACME AND OTHER TRANSLATING THREADS [27]

1. GENERAL AND HISTORICAL

When formulated, prior to 1895, Acme screw threads were intended to replace square threads and a variety of threads of other forms used chiefly for the purpose of producing traversing motions on machines, tools, etc. Acme screw threads are now extensively used for a variety of purposes. This standard covers the design and dimensions of Acme and similar single [28] screw threads intended primarily for translating screws, for which there is a general industrial demand. The designs included have been chosen with the dual purpose of meeting varied needs of the users to the greatest possible extent and at the same time establishing a product which can be economically produced.

The subject of Acme and kindred threads embraces a wide field and it is not possible to combine in a single standard all of the variables of all uses. The following applications are recognized as common usages, but each has special features which prevent inclusion in a general purpose standard.

(1) Feed or lead screws where back lash or end shake is objectionable. In such applications the nut is tapped first and then the screw is threaded to fit. The screw and nut so made are kept as a pair.

(2) Long lead screws where sagging causes threads to seize. In such applications the major or minor diameter clearance is reduced so that bearing takes place at major or minor diameter before seizing can occur.

(3) Assemblies where the thread must maintain some degree of alignment as well as transmit motion. Desk chairs, shop stools, piano stools, and the like are typical examples. In these applications a reduced major or minor diameter clearance is the most effective and economical means of obtaining satisfactory assemblies.

(4) There is a considerable demand in mechanical industries for threaded assemblies which provide faster advance per revolution and which give greater wear surface. The threaded forms covered by this specification are used frequently, incorporating changes in details to meet particular requirements. It is recommended that no coarser thread for a given diameter than those listed be used, but instead that a multiple thread giving the desired lead be adopted. Many applications in the valve industry are typical.

Four series of translating screw threads are included in this standard—the general purpose Acme, the 29 deg. stub, the 60 deg. stub, and a modified square thread.

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[27] This standard, in substantially the same form, has been approved by the American Standards Association. It is published as ASA B1.3-1941—"Acme and Other Translating Threads" by the A. S. M. E., 29 West 39th St., New York, N. Y.

[28] Where it is necessary to use multiple threads, the form of single thread corresponding to "crests per inch" of the multiple thread should be used.

400610°—42——13

2. ACME SCREW THREADS

(a) SPECIFICATIONS FOR ACME FORM OF THREAD

1. Angle of Thread.—The angle between the sides of the thread measured in an axial plane shall be 29°. The line bisecting this 29° angle shall be perpendicular to the axis of the screw thread.

2. Depth of Thread.—The basic depth of the thread shall be equal to one-half of the pitch.

3. Thickness of Thread.—The basic thickness of the thread at a diameter smaller by one-half the pitch than the basic major diameter shall be equal to one-half of the pitch.

4. Clearance at Major and Minor Diameters.—A clearance of at least 0.010 in. is added to the basic thread depth on threads of 10-pitch and coarser, and 0.005 in. on finer pitches, to produce extra depth, thus avoiding interference with threads of mating parts at minor or major diameters. It is recognized that there are conditions where a greater or less clearance may be desirable.

5. Basic Dimensions.—The basic dimensions of the Acme thread form, corresponding to the most generally used pitches, are given in table 110. The basic thread form is illustrated in figure 30.

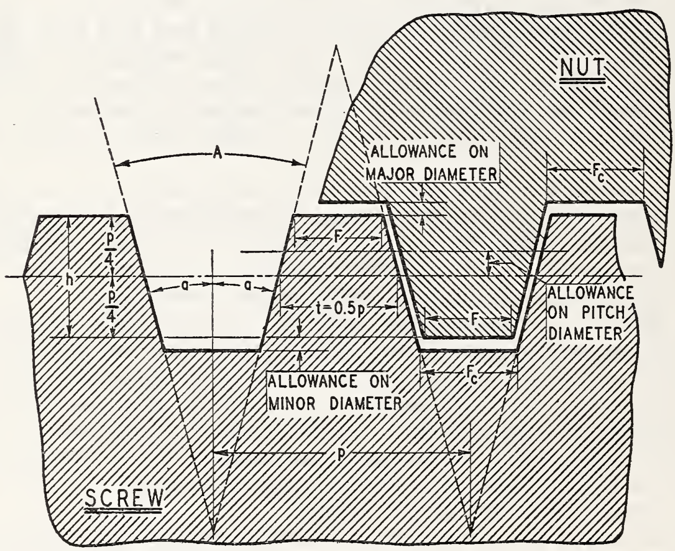


Figure 30.—*Acme form of thread.*

NOTATION

A = 29°00′
a = 14°30′
p = pitch
n = number of threads per inch
N = number of turns per inch
h = 0.5p, basic depth of thread
t = thickness of thread
F = 0.37069p = basic width of flat
F_c = 0.37069p − (0.52 × clearance).

(b) SERIES OF DIAMETERS AND PITCHES OF ACME THREADS

For general purposes there has been selected a series of diameters and pitches of Acme threads, listed in table 111, which are designated as standard. These diameters and pitches have been carefully selected with a view to meeting the present needs with the fewest number of items, in order to reduce to a minimum the inventory of both tools and gages.

(c) CLASSIFICATION AND TOLERANCES, ACME THREADS

There is established herein for general use a single class of fit of Acme screw threads.

The following general specifications apply to all standard Acme screw threads:

1. Basic Diameters.—The maximum major and pitch diameters of the screw, and the minimum minor diameter of the nut are basic.

2. Tolerances.—(*a*) The tolerances specified represent the extreme variations allowed on the product. They are such as to produce complete interchangeability and maintain a high grade of product.

(*b*) The tolerances on diameters of the nuts or threaded holes are plus, and are applied from the minimum nut sizes to above the minimum nut sizes.

(*c*) The tolerances on diameters of the screws are minus, and are applied from the maximum screw sizes to below the maximum screw sizes.

(*d*) The tolerances on the thicknesses of threads are minus, and are applied from the maximum thread thickness to below the maximum thread thickness.

(*e*) The thread thickness tolerances for a screw and nut of the same diameter and pitch are equal.

(*f*) The thread thickness tolerances include lead and angle errors.

(*g*) The tolerances on the major diameters of the screws and minor diameters of the nuts are based upon the pitch of the thread.

(d) LIMITING DIMENSIONS, ACME THREADS

Limiting dimensions for standard Acme threads are given in table 112. The application of these limits is illustrated in figure 31.

TABLE 110.—*Acme thread form, basic dimensions*

Threads per inch	Pitch, p	Depth of thread (basic), $h=0.5p$	Total depth of thread	Thread thickness (basic), t	Width of flat at— Crest of screw (basic), $F=0.37069p$	Width of flat at— Root of screw, $F_c=0.3707p-(0.52\times \text{clearance})$
1	2	3	4	5	6	7
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
16	0.06250	0.03125	0.0363	0.03125	0.0232	0.0206
14	.07143	.03571	.0407	.03571	.0265	.0239
12	.08333	.04167	.0467	.04167	.0309	.0283
10	.10000	.05000	.0600	.05000	.0371	.0319
9	.11111	.05556	.0656	.05556	.0412	.0360
8	.12500	.06250	.0725	.06250	.0463	.0411
7	.14286	.07143	.0814	.07143	.0530	.0478
6	.16667	.08333	.0933	.08333	.0618	.0566
5	.20000	.10000	.1100	.10000	.0741	.0689
4	.25000	.12500	.1350	.12500	.0927	.0875
3½	.28571	.14286	.1529	.14286	.1059	.1007
3	.33333	.16667	.1767	.16667	.1236	.1184
2½	.40000	.20000	.2100	.20000	.1483	.1431
2	.50000	.25000	.2600	.25000	.1853	.1801
1½	.66667	.33333	.3433	.33333	.2471	.2419
1⅓	.75000	.37500	.3850	.37500	.2780	.2728
1	1.00000	.50000	.5100	.50000	.3707	.3655

TABLE 111.—*Acme general purpose thread series*

Identification		Basic diameters			Thread data				
Sizes	Threads per inch	Major diameter, D	Pitch diameter, E	Minor diameter, K	Pitch, p	Thread thickness at pitch line	Basic depth of thread, $h=0.5p$	Basic width of flat, $F=0.37069p$	Helix angle at basic pitch diameter, s
1	2	3	4	5	6	7	8	9	10
		Inches	*Inches*	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Deg. Min.*
¼	16	0.2500	0.2187	0.1875	0.06250	0.03125	0.03125	0.0232	5 12
5/16	14	.3125	.2768	.2411	.07143	.03571	.03571	.0265	4 42
⅜	12	.3750	.3333	.2917	.08333	.04167	.04167	.0309	4 33
7/16	12	.4375	.3958	.3542	.08333	.04167	.04167	.0309	3 50
½	10	.5000	.4500	.4000	.10000	.05000	.05000	.0371	4 3
⅝	8	.6250	.5625	.5000	.12500	.06250	.06250	.0463	4 3
¾	6	.7500	.6667	.5833	.16667	.08333	.08333	.0618	4 33
⅞	6	.8750	.7917	.7083	.16667	.08333	.08333	.0618	3 50
1	5	1.0000	.9000	.8000	.20000	.10000	.10000	.0741	4 3
1⅛	5	1.1250	1.0250	.9250	.20000	.10000	.10000	.0741	3 33
1¼	5	1.2500	1.1500	1.0500	.20000	.10000	.10000	.0741	3 10
1⅜	4	1.3750	1.2500	1.1250	.25000	.12500	.12500	.0927	3 39
1½	4	1.5000	1.3750	1.2500	.25000	.12500	.12500	.0927	3 19
1¾	4	1.7500	1.6250	1.5000	.25000	.12500	.12500	.0927	2 48
2	4	2.0000	1.8750	1.7500	.25000	.12500	.12500	.0927	2 26
2¼	3	2.2500	2.0833	1.9167	.33333	.16667	.16667	.1236	2 55
2½	3	2.5000	2.3333	2.1667	.33333	.16667	.16667	.1236	2 43
2¾	3	2.7500	2.5833	2.4167	.33333	.16667	.16667	.1236	2 21
3	2	3.0000	2.7500	2.5000	.50000	.25000	.25000	.1853	3 19
4	2	4.0000	3.7500	3.5000	.50000	.25000	.25000	.1853	2 26
5	2	5.0000	4.7500	4.5000	.50000	.25000	.25000	.1853	1 55

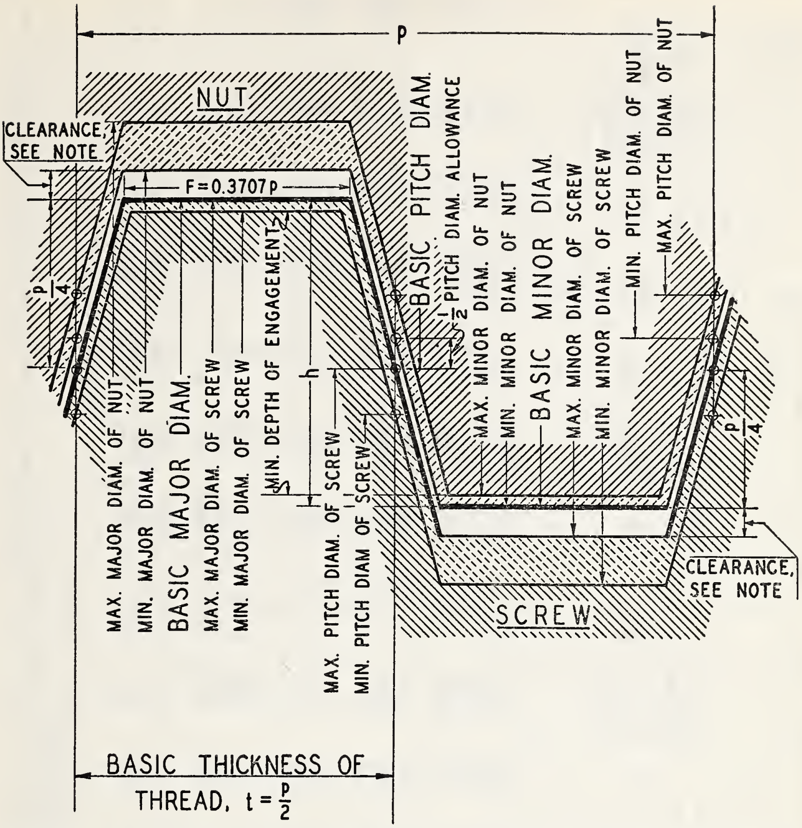


FIGURE 31.—*Illustration of allowances, tolerances, and crest clearances, Acme threads.*

NOTATION

p = pitch.
h = basic thread depth.
Heavy line shows basic size.

NOTE.—The maximum minor diameter of a screw and the maximum major diameter of a nut of a given pitch are such as to result in a flat at the root equal in inches to $0.3707p-(0.52\times\text{clearance})$ when the pitch diameter of the screw is at its maximum value, and the pitch diameter of the nut is at its minimum value.

TABLE 112.—*Acme general purpose thread series, limiting dimensions and tolerances*

Sizes	Threads per inch [1]	Screw sizes							Nut sizes					
		Major diameter [2]		Pitch diameter		Pitch [3] diameter tolerance in terms of thread thickness variation	Minor diameter [2]		Minor diameter [2]		Pitch diameter		Pitch [3] diameter tolerance in terms of thread thickness variation	Major diameter, minimum
		Maximum (basic)	Minimum	Maximum (basic)	Minimum		Maximum [4]	Minimum	Minimum (basic)	Maximum	Minimum	Maximum		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inch*	*Inches*
¼	16	0.2500	0.2469	0.2187	0.2087	0.0026	0.1775	0.1744	0.1875	0.1906	0.2237	0.2337	0.0026	0.2600
5/16	14	.3125	.3089	.2768	.2668	.0026	.2311	.2275	.2411	.2447	.2818	.2918	.0026	.3225
⅜	12	.3750	.3708	.3333	.3233	.0026	.2817	.2774	.2917	.2959	.3383	.3483	.0026	.3850
7/16	12	.4375	.4333	.3958	.3858	.0026	.3442	.3399	.3542	.3584	.4008	.4108	.0026	.4475
½	10	.5000	.4950	.4500	.4400	.0026	.3800	.3750	.4000	.4050	.4550	.4650	.0026	.5200
⅝	8	.6250	.6187	.5625	.5495	.0034	.4800	.4737	.5000	.5062	.5675	.5805	.0034	.6450
¾	6	.7500	.7417	.6667	.6537	.0034	.5633	.5550	.5833	.5916	.6717	.6847	.0034	.7700
⅞	6	.8750	.8667	.7917	.7757	.0041	.6883	.6800	.7083	.7166	.7967	.8127	.0041	.8950
1	5	1.0000	.9900	.9000	.8840	.0041	.7800	.7700	.8000	.8100	.9050	.9210	.0041	1.020
1⅛	5	1.1250	1.1150	1.0250	1.0060	.0049	.9050	.8950	.9250	.9350	1.0300	1.0490	.0049	1.1450
1¼	5	1.2500	1.2400	1.1500	1.1310	.0049	1.0300	1.0200	1.0500	1.0600	1.1550	1.1740	.0049	1.2700
1⅜	4	1.3750	1.3625	1.2500	1.2280	.0057	1.1050	1.0925	1.1250	1.1375	1.2550	1.2770	.0057	1.3950
1½	4	1.5000	1.4875	1.3750	1.3530	.0057	1.2300	1.2175	1.2500	1.2625	1.3800	1.4020	.0057	1.5200
1¾	4	1.7500	1.7375	1.6250	1.6000	.0065	1.4800	1.4675	1.5000	1.5125	1.6300	1.6550	.0065	1.7700
2	4	2.0000	1.9875	1.8750	1.8470	.0072	1.7300	1.7175	1.7500	1.7625	1.8800	1.9080	.0072	2.0200
2¼	3	2.2500	2.2333	2.0833	2.0523	.0080	1.8967	1.8800	1.9167	1.9334	2.0903	2.1213	.0080	2.2700
2½	3	2.5000	2.4833	2.3333	2.2993	.0088	2.1467	2.1300	2.1667	2.1834	2.3403	2.3743	.0088	2.5200
2¾	3	2.7500	2.7333	2.5833	2.5463	.0096	2.3967	2.3800	2.4167	2.4334	2.5903	2.6273	.0096	2.7700
3	2	3.0000	2.9750	2.7500	2.7100	.0103	2.4800	2.4550	2.5000	2.5250	2.7600	2.8000	.0103	3.0200
4	2	4.0000	3.9750	3.7500	3.7070	.0111	3.4800	3.4550	3.5000	3.5250	3.7600	3.8030	.0111	4.0200
5	2	5.0000	4.9750	4.7500	4.7070	.0111	4.4800	4.4550	4.5000	4.5250	4.7600	4.8030	.0111	5.0200

[1] The selection of threads per inch is arbitrary and is intended for the purpose of establishing a standard.
[2] These dimensions result in tolerances on major and minor diameters equal to $0.05p$.
[3] The length of gage should be equal to the length of engagement which in this case is one and one-half diameters.
[4] Maximum minor diameter of a screw of a given pitch is such as to result in a flat at the root equal in inches to $0.3707\ p - (0.52 \times \text{clearance})$ when the pitch diameter of the screw is at its maximum value.

(e) GAGES FOR ACME THREADS

Both "go" and "not go" gages, representing the extreme product limits, are necessary for the proper inspection of Acme screw threads.

Table 113 is given herein for the purpose of establishing definite limits for gages used in the inspection of Acme threads, rather than for the purpose of specifying the gages required for the various inspection operations. The dimensions of gages should be in accordance with the principles (*a*) that the "go" gage should check simultaneously as many elements as possible and a "not go" gage can effectively check but one element; and (*b*), that permissible variations in the gages be within the extreme product limits.

1. Tolerances on Lead.—The tolerances on lead given in table 113 are specified as an allowable variation between any two threads not farther apart than 12 inches.

2. Tolerances on Angle of Thread.—The tolerances on angle of thread, as specified in table 113 for the various pitches, are tolerances on one-half of the included angle. This insures that the bisector of the included angle will be perpendicular to the axis of the thread within proper limits. The equivalent deviation from the true thread form caused by such irregularities as convex or concave sides of thread, or slight projections on the thread form, should not exceed the tolerances permitted on angle of thread.

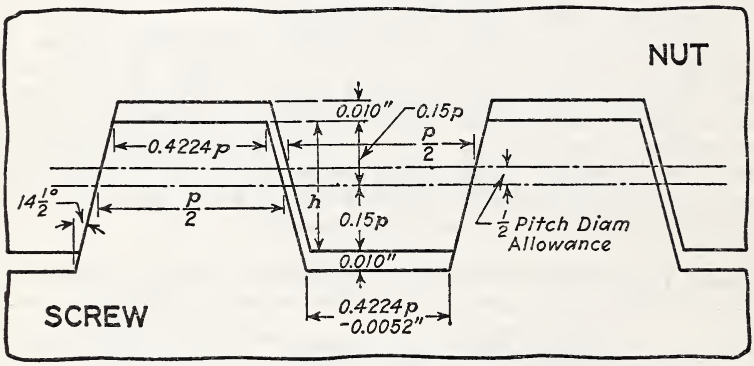
Table 113.—*Tolerances for "go" and "not go" thread gages, Acme threads*

Threads per inch	Tolerance on thread thickness at basic pitch line		Tolerance in lead	Tolerance on half angle of thread	Tolerance on major diameter		Tolerance on minor diameter	
	From—	To—			From—	To—	From—	To—
1	2	3	4	5	6	7	8	9
	Inch	*Inch*	*Inch* ±	*Deg. Min.* ±	*Inch*	*Inch*	*Inch*	*Inch*
16	0.0000	0.0002	0.0005	0 10	0.0000	0.0003	0.0000	0.0003
14	.0000	.0002	.0005	0 10	.0000	.0004	.0000	.0004
12	.0000	.0002	.0005	0 10	.0000	.0004	.0000	.0004
10	.0000	.0002	.0005	0 10	.0000	.0005	.0000	.0005
9	.0000	.0003	.0005	0 10	.0000	.0005	.0000	.0005
8	.0000	.0003	.0005	0 5	.0000	.0006	.0000	.0006
7	.0000	.0003	.0005	0 5	.0000	.0007	.0000	.0007
6	.0000	.0003	.0005	0 5	.0000	.0008	.0000	.0008
5	.0000	.0004	.0005	0 5	.0000	.0010	.0000	.0010
4	.0000	.0004	.0005	0 5	.0000	.0010	.0000	.0010
3½	.0000	.0004	.0005	0 5	.0000	.0010	.0000	.0010
3	.0000	.0005	.0005	0 5	.0000	.0010	.0000	.0010
2½	.0000	.0005	.0005	0 5	.0000	.0010	.0000	.0010
2	.0000	.0006	.0005	0 5	.0000	.0010	.0000	.0010
1½	.0000	.0006	.0005	0 5	.0000	.0010	.0000	.0010
1⅓	.0000	.0007	.0005	0 5	.0000	.0010	.0000	.0010
1	.0000	.0008	.0005	0 5	.0000	.0010	.0000	.0010

3. 29-DEGREE STUB THREADS

The angle between the sides of the thread is 29° as in the case of the general purpose Acme thread; the threads are truncated top and bottom, but the basic depth of thread is reduced to 0.30 of the pitch. The basic thread thickness is one-half the pitch as before, and the threads are symmetrical about a line perpendicular to the axis of the screw. This produces a very strong thread section, and in addition a thread admirably suited to applications where space limitations or other economic considerations make a shallow thread desirable. Basic dimensions of the 29 degree stub thread are given in table 114.

TABLE 114.—*Basic dimensions of 29 degree stub threads*



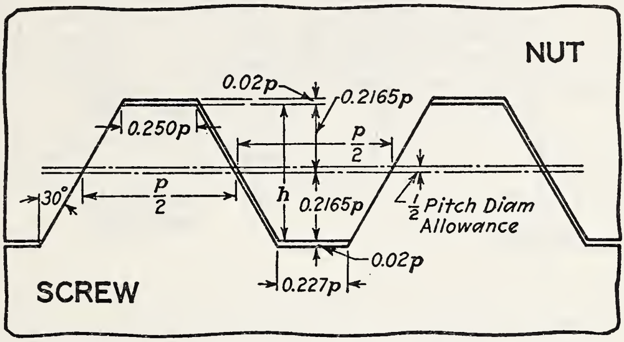
Threads per inch	Pitch, p	Depth of thread (basic), $h=0.3p$	Total[1] depth of thread	Thread thickness (basic), $t=0.5p$	Width of flat at	
					Crest of screw (basic), $F=0.4224p$	Root of screw, $F_c=0.4224p-(0.52\times \text{clearance})$
1	2	3	4	5	6	7
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
16	0.06250	0.0188	0.0238	0.0313	0.0264	0.0238
14	.07143	.0214	.0264	.0357	.0302	.0276
12	.08333	.0250	.0300	.0417	.0352	.0326
10	.10000	.0300	.0400	.0500	.0422	.0370
9	.11111	.0333	.0433	.0556	.0469	.0417
8	.12500	.0375	.0475	.0625	.0528	.0476
7	.14286	.0429	.0529	.0714	.0603	.0551
6	.16667	.0500	.0600	.0833	.0704	.0652
5	.20000	.0600	.0700	.1000	.0845	.0793
4	.25000	.0750	.0850	.1250	.1056	.1004
3½	.28571	.0857	.0957	.1429	.1207	.1155
3	.33333	.1000	.1100	.1667	.1408	.1356
2½	.40000	.1200	.1300	.2000	.1690	.1638
2	.50000	.1500	.1600	.2500	.2112	.2060

[1] A clearance of at least 0.010 in. is added to "h" on threads of 10-pitch and coarser, and 0.005 in. on finer pitches, to produce extra depth thus avoiding interference with threads of mating part at minor or major diameters. It is recognized that there are conditions where a greater or less clearance may be desirable.

4. 60-DEGREE STUB THREADS

The angle between the sides of the thread is 60°. The threads are truncated top and bottom, have a basic depth of 0.433 of the pitch, a basic thickness of one-half the pitch, and are symmetrical about a line perpendicular to the axis of the screw. Basic dimensions of the 60 degree stub thread are given in table 115.

TABLE 115.—*Basic dimensions of 60-degree stub threads*



Threads per inch	Pitch, p	Depth of thread (basic), $h=0.433p$	Total[1] depth of thread, $(h+0.02p)$	Thread thickness (basic), $t=0.5p$	Width of flat at: Crest of screw (basic), $F=0.250p$	Width of flat at: Root of screw $F_c=0.227p$
1	2	3	4	5	6	7
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
16	0.06250	0.0271	0.0283	0.0313	0.0156	0.0142
14	.07143	.0309	.0324	.0357	.0179	.0162
12	.08333	.0361	.0378	.0417	.0208	.0189
10	.10000	.0433	.0453	.0500	.0250	.0227
9	.11111	.0481	.0503	.0556	.0278	.0252
8	.12500	.0541	.0566	.0625	.0313	.0284
7	.14286	.0619	.0647	.0714	.0357	.0324
6	.16667	.0722	.0755	.0833	.0417	.0378
5	.20000	.0866	.0906	.1000	.0500	.0454
4	.25000	.1083	.1133	.1250	.0625	.0567

[1] A clearance of at least $0.02p$ is added to "h" to produce extra depth, thus avoiding interference with threads of mating part at minor or major diameters.

5. MODIFIED SQUARE THREADS

The angle between the sides of the thread is 10°. The threads are truncated top and bottom, have a basic depth of 0.50 of the pitch, a basic thread thickness of 0.50 of the pitch, and are symmetrical about a line perpendicular to the axis of the screw. The angle of 10 degrees results in a thread which is the equivalent of a "square thread" in so far as all practical considerations are concerned and yet capable of economical production. This thread form is illustrated in figure 32.

Multiple thread milling cutters and ground thread taps should not be specified for modified square threads of steep helix angle without consulting the cutting tool manufacturer.

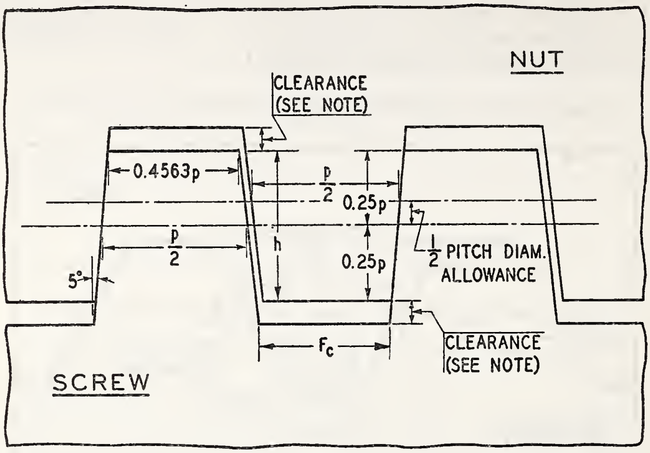


FIGURE 32.—*Modified square thread (10 degree included angle), basic proportions.*

p = pitch in inches
h (basic depth of thread) = $0.5p$
H (total depth of thread) = $0.5p$ + clearance
t (thickness of thread) = $0.5p$
F_c (flat at root of screw thread) = $0.4563p - (0.17 \times \text{clearance})$
F (basic width of flat at crest of screw thread) = $0.4563p$

NOTE.—A clearance should be added to "h" to produce extra depth, thus avoiding interference with threads of mating parts at minor or major diameters. The amount of this clearance must be determined from the application of the thread assembly.

APPENDIX 1. DERIVATION OF TOLERANCES

1. PITCH DIAMETER TOLERANCES

(*a*) TOLERANCES FOR FASTENING SCREWS.—The tolerances for fastening screws specified in section III were arrived at by combining two factors, known as the net pitch diameter tolerance and the gage tolerance. The theoretical net tolerances for all screws and nuts of a given class of fit bear a definite mathematical relationship to each other, and it was intended that these should in no way be reduced by permissible manufacturing tolerances for master gages; that is, gages within class X tolerances. Consequently the net tolerances were increased by the equivalent diametrical space required to provide for the class X tolerances on diameter, lead, and angle, to produce the extreme tolerances specified for the product. In practice, the actual net tolerances will depend upon the method of gaging and upon the accuracy of the gages used.

The net pitch diameter tolerances for the various classes of fit are based on the following series for a pitch of 1/20 inch:

	Inch
Class 1 fit	0.0045
Class 2 fit	.0030
Class 3 fit	.0020
Class 4 fit	.0010

Pitch diameter tolerances for pitches finer than 1/20 inch are to each other and to the tolerance for 1/20 inch as the 0.6th power of their respective pitches.

Pitch diameter tolerances for pitches coarser than 1/20 inch are to each other and to the tolerance for 1/20 inch as the 0.9th power of their respective pitches.

The exponent 0.6 was chosen for pitches finer than 1/20 inch because the resulting tolerances, except in two instances, do not vary more than 0.0001 inch from the pitch diameter tolerances specified in the A. S. M. E. Machine Screw Standard.

(*b*) TOLERANCES FOR SCREW THREADS OF SPECIAL DIAMETERS, PITCHES, AND LENGTHS OF ENGAGEMENT.—As stated in section VI, the pitch diameter tolerances for special sizes of threads of American National form as given in tables 38, 39, 40, and 41 were obtained by adding three values, or increments, one dependent upon the basic major diameter, another upon the length of engagement, and the third upon the pitch, except that pitch diameter tolerances listed in section III were inserted in the tables in the positions corresponding to standard sizes, pitches, and lengths of engagement of the American National coarse and fine thread series, and values above and to the left of these inserted values were reduced where necessary so that none should exceed these standard values. Likewise values below and to the right of these inserted values were increased where necessary so that none should be less than these standard values. The formulas from which the increments are derived are given in table 116.

TABLE 116.—*Schedule of tolerance increments for special threads*

Class of fit	Diameter increment	Length of engagement increment	Pitch increment
1	2	3	4
Class 1 fit	$0.002\sqrt{D}$	$0.002Q$	$0.020\sqrt{p}$
Class 2 fit	$.002\sqrt{D}$	$.002Q$	$.010\sqrt{p}$
Class 3 fit	$.002\sqrt{D}$	$.002Q$	$.005\sqrt{p}$
Class 4 fit	$.001\sqrt{D}$	$.001Q$	$.0025\sqrt{p}$

2. RELATION OF LEAD AND ANGLE ERRORS TO PITCH DIAMETER TOLERANCES

It has been stated in various sections of the handbook that the tolerances specified for pitch diameter include all errors of pitch diameter, lead, and angle. Also, there were tabulated the errors in lead and angle, each of which could be compensated for by one half of the specified pitch diameter tolerances. These equivalents were derived from definite mathematical relations, which are given below.

(*a*) DIAMETER EQUIVALENT OF LEAD ERROR.—The formula expressing the relation between lead error between any two threads within the length of engagement and its diameter equivalent is as follows:

$$E' = (\pm p') \cot a$$

in which

E' = pitch diameter increment due to lead error
p' = the maximum pitch error between any two of the threads engaged
a = half angle of thread

The quantity E' is always added to the measured pitch diameter in the case of an external thread, and it is always subtracted in the case of an internal thread, regardless of the sign introduced by the lead error p'.

For threads of American National form, the above formula reduces to—

$$E' = 1.7321\, p'$$

For threads of Acme form the above formula reduces to—

$$E' = 3.8667\ p'$$

(b) DIAMETER EQUIVALENT OF ANGLE ERROR.—The general formula expressing the relation between error in the half angle of thread and its diameter equivalent—that is, the amount of the pitch diameter tolerance absorbed by such an error—is:

$$\cot a' = \frac{h}{E'' \sin a \cos a} \pm \cot a$$

in which

E'' = pitch diameter increment due to error in half angle
h = basic thread depth
a = basic half angle of thread
a' = error in half angle of thread

In solving for E'' the average value of a' for the two sides of the thread, regardless of their signs, should be taken. The sign of cot a is plus when the half angle of thread is less than basic, and minus when the half angle is greater than basic. By omitting $\pm$ cot a from the formula an approximate mean value for a' or E'' is obtained which differs very little from either extreme value. The Committee has, therefore, adopted for general use the formula:

$$\cot a' = \frac{h}{E'' \sin a \cos a}$$

For threads of American National form this formula reduces to—

$$\cot a' = \frac{3p}{2E''}$$

or

$$E'' = 1.5\ p \tan a'$$

For the form of thread recommended for pipe-thread gages the formula becomes—

$$\cot a' = \frac{1.53812p}{E''}$$

or

$$E'' = \frac{1.53812}{n} \tan a'$$

For the Acme form of thread the formula becomes—

$$\cot a' = \frac{2.06267p}{E''}$$

or

$$E'' = \frac{2.06267}{n} \tan a'$$

APPENDIX 2. WIRE METHODS OF MEASUREMENT OF PITCH DIAMETER

Throughout this handbook emphasis has been placed on pitch diameter tolerances and limits, as upon these the fit of a screw thread largely depends. The maintenance of these tolerances and limits requires the use of limit thread gages, and these, in turn, depend upon the absolute values or measurements of master gages. The measurement of pitch diameter presents certain difficulties which may result in an uncertainty as to its true value. The adoption of a uniform practice in making such measurement is, therefore, desirable. The so-called "three-wire method" of measuring pitch diameter, as here outlined, has been found to be the most accurate and satisfactory when properly carried out, and is recommended for universal use in the direct measurement of thread-plug gages.

1. SIZE OF WIRES

In the three-wire method of measuring pitch diameter small hardened steel cylinders or wires of correct size are placed in the thread groove, two on one side of the screw and one on the opposite side, as shown in figure 33. The contact face of the micrometer anvil or spindle over the two wires must be sufficiently large in diameter to touch both wires; that is, it must be greater than the pitch of the thread. It is best to select wires of such a size that they touch the sides of the thread at the midslope, for the reason that the measurement of pitch diameter is least affected by any error in thread angle which may be present when such size is used. The size of wire which touches exactly at the midslope of a perfect thread of a given pitch is termed the "best-size" wire for that pitch. Any size, however, may be used which will permit the wires to rest on the sides of the thread and also project above the top of the thread.

The depth at which a wire of given diameter will rest in a thread groove depends primarily on the pitch and included angle of the thread; and secondarily, on the angle made by the helix, at the point of contact of the wire and the thread, with a plane perpendicular to the axis of the screw. Inasmuch as variation in the helix angle has a very small effect in determining the diameter of the wire which touches at the midslope of the thread, and as it is desirable to use one size of wire to measure all threads of a given pitch and included angle, the best size wire is taken as that size which will touch at the midslope of a groove cut around a cylinder perpendicular to the axis of the cylinder, and of the same angle and depth as the thread of the given pitch. This is equivalent to a thread of zero helix angle. The size of wire touching at the midslope, or "best-size" wire, is given by the formula:

$$G=\frac{p}{2}\sec a$$

in which

G=diameter of wire
p=pitch
a=½ included angle of thread

This formula reduces to—

$$G=0.57735\times p\text{, for }60^\circ\text{ threads}$$

It is frequently desirable, as, for example, when a best-size wire is not available, to measure pitch diameter by means of wires of other than the best size. The minimum size which may be used is limited to that permitting the wire to project above the crest of the thread, and the maximum to that permitting the wire to rest on the sides of the thread just below the crest, and not ride on the crest of the thread. The diameters of the best size, maximum, and minimum wires for American National coarse, fine, hose-coupling, and pipe threads are given in tables 117 and 119.

The diameters of the best size, maximum, and minimum wires for standard pitches of Acme threads are listed in table 118.

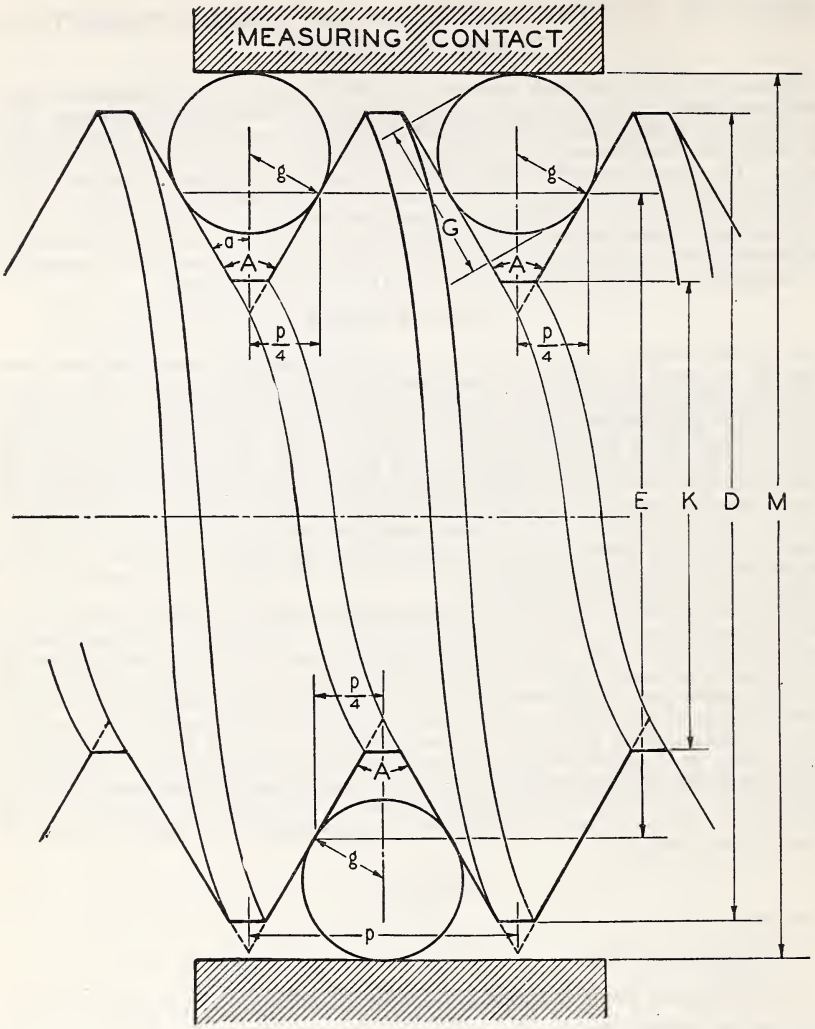


FIGURE 33.—*Three-wire method of measuring pitch diameter of thread plug gages.*

TABLE 117.—*Wire sizes and constants, American National coarse, fine, hose coupling, and pipe threads*

Wire sizes[1] Best 0.577350p	Maximum 1.010363p	Minimum 0.505182p	Threads per inch n	Pitch $p=\frac{1}{n}$	Pitch/2 $\frac{p}{2}=\frac{1}{2n}$	Depth of V thread $\frac{\cot 30°}{2n}$
1	2	3	4	5	6	7
Inch	*Inch*	*Inch*		*Inch*	*Inch*	*Inch*
0.00722	0.01263	0.00631	80	0.01250	0.00625	0.01083
.00802	.01403	.00702	72	.01389	.00694	.01203
.00902	.01579	.00789	64	.01562	.00781	.01353
.01031	.01804	.00902	56	.01786	.00893	.01546
.01203	.02105	.01052	48	.02083	.01042	.01804
.01312	.02296	.01148	44	.02273	.01136	.01968
.01443	.02526	.01263	40	.02500	.01250	.02165
.01604	.02807	.01403	36	.02778	.01389	.02406
.01804	.03157	.01579	32	.03125	.01562	.02706
.02062	.03608	.01804	28	.03571	.01786	.03093
.02138	.03742	.01871	27	.03704	.01852	.03208
.02406	.04210	.02105	24	.04167	.02083	.03608
.02887	.05052	.02526	20	.05000	.02500	.04330
.03208	.05613	.02807	18	.05556	.02778	.04811
.03608	.06315	.03157	16	.06250	.03125	.05413
.04124	.07217	.03608	14	.07143	.03571	.06186
.04441	.07772	.03886	13	.07692	.03846	.06662
.04811	.08420	.04210	12	.08333	.04167	.07217
.05020	.08786	.04393	11½	.08696	.04348	.07531
.05249	.09185	.04593	11	.09091	.04545	.07873
.05773	.10104	.05052	10	.10000	.05000	.08660
.06415	.11226	.05613	9	.11111	.05556	.09623
.07217	.12630	.06315	8	.12500	.06250	.10825
.07698	.13472	.06736	7½	.13333	.06667	.11547
.08248	.14434	.07217	7	.14286	.07143	.12372
.09623	.16839	.08420	6	.16667	.08333	.14434
.11547	.20207	.10104	5	.20000	.10000	.17321
.12830	.22453	.11226	4½	.22222	.11111	.19245
.14434	.25259	.12630	4	.25000	.12500	.21651

[1] These wire sizes are based on zero helix angle. Also maximum and minimum sizes are based on a width of flat at the crest equal to ⅛×p. The width of flat of American National pipe thread gages is slightly less than this, so that the minimum size listed is slightly too small for such gages. In any case the use of wires of either extreme size is to be avoided.

TABLE 118.—*Wire sizes and constants, Acme threads (29°)*

Threads per inch	Pitch $p=\frac{1}{n}$	Wire sizes[1] Best 0.516450p	Maximum, 0.650013p	Minimum, 0.487263p
1	2	3	4	5
	Inch	*Inch*	*Inch*	*Inch*
1	1.00000	0.51645	0.65001	0.48726
1⅓	.75000	.38734	.48751	.36545
1½	.66667	.34430	.43334	.32484
2	.50000	.25822	.32501	.24363
2½	.40000	.20658	.26001	.19491
3	.33333	.17215	.21667	.16242
3½	.28571	.14756	.18572	.13922
4	.25000	.12911	.16250	.12182
5	.20000	.10329	.13000	.09745
6	.16667	.08608	.10834	.08121
7	.14286	.07378	.09286	.06961
8	.12500	.06456	.08125	.06091
9	.11111	.05738	.07222	.05414
10	.10000	.05164	.06500	.04873
12	.08333	.04304	.05417	.04061
14	.07143	.03689	.04643	.03480
16	.06250	.03228	.04063	.03045

[1] Based on zero helix angle.

TABLE 119.—*Relation of best wire diameters and pitches*[1]—*wires for American National coarse, fine, hose-coupling, and pipe threads*

Best wire sizes (in inches)	Threads per inch																												
	80	72	64	56	48	44	40	36	32	28	27	24	20	18	16	14	13	12	11½	11	10	9	8	7½	7	6	5	4½	4
0.00722	⊗	×																											
0.00802	×	⊗	×																										
0.00902	×	×	⊗																										
0.01031	×	×	×	⊗																									
0.01203	×	×	×	×	⊗	×																							
0.01312		×	×	×	×	⊗	×																						
0.01443			×	×	×	×	⊗	×																					
0.01604				×	×	×	×	⊗	×																				
0.01804					×	×	×	×	⊗																				
0.02062					×	×	×	×	×	⊗	×																		
0.02138						×	×	×	×	×	⊗	×																	
0.02406							×	×	×	×	×	⊗																	
0.02887									×	×	×	×	⊗	×															
0.03208										×	×	×	×	⊗	×														
0.03608											×	×	×	×	⊗														
0.04124												×	×	×	×	⊗	×												
0.04441													×	×	×	×	⊗	×	×										
0.04811													×	×	×	×	×	⊗	×	×									
0.05020													×	×	×	×	×	×	⊗	×									
0.05249														×	×	×	×	×	×	⊗	×								
0.05773															×	×	×	×	×	×	⊗	×							
0.06415																×	×	×	×	×	×	⊗	×						
0.07217																	×	×	×	×	×	×	⊗	×					
0.07698																	×	×	×	×	×	×	×	⊗	×				
0.08248																		×	×	×	×	×	×	×	⊗				
0.09623																					×	×	×	×	×	⊗			
0.11547																							×	×	×	×	⊗	×	
0.12830																								×	×	×	×	⊗	×
0.14434																										×	×	×	⊗

[1] The crosses (×) indicate those wire diameters which can be used for each pitch. An encircled cross (⊗) indicates the "best wire" diameter for that pitch which heads the column.

2. METHODS OF MEASURING AND USING WIRES

The computed value for the pitch diameter of a screw thread gage obtained from readings over wires will depend upon the accuracy of the measuring instrument used, the contact pressure, and the value of the diameter of the wires used in the computations. In order to measure the pitch diameter of a screw-thread gage to an accuracy of 0.0001 inch by means of wires, it is necessary to know the wire diameters to 0.00002 inch. If the diameters of the wires are known only to an accuracy of 0.0001 inch, an accuracy better than 0.0003 inch in the measurement of pitch diameter cannot be expected. Accordingly, it is necessary to use a measuring instrument which reads accurately to 0.00001 inch.

Variations in diameter around the wire should be determined by rotating the wire between a measuring contact and an anvil having the form of a V-groove cut on a cylinder. The V-groove may be the thread space in a hardened and well-finished thread plug gage. Variations in diameter along the wire should be determined by measuring between a flat contact and a cylindrical anvil.

A wire presses on the sides of a 60° thread with the pressure that is applied to the wire by the measuring instrument. This fact would indicate that the diameter of the wire should be determined by readings made on the wire over a hardened and lapped cylinder having a radius equal to the radius of curvature of the helical surface of the thread at the point of contact, using the pressure to be used in determining the pitch diameter of the gage. However, it is not practical to employ such a variety of cylinders as would be required, and it is recommended for standard practice that diameters of wires be measured between a flat contact and a 0.750-inch hardened and accurately ground and lapped steel cylinder with the pressure used in measuring the pitch diameter of the gage. The plane of the flat contact should be parallel to the contact element of the cylinder within 0.00001 inch.

To avoid a deformation of the material of the wires and gages it is necessary to limit the contact pressure, and for consistent results a standard practice as to contact pressure in making wire measurements of hardened screw thread gages is necessary. Such a standard practice is included in the specifications below, and in section III, p. 48. The use of different contact pressures will cause a difference in the readings over the wires, and such errors can only be compensated by the use of a value for the diameter of the wires depending on the contact pressure used. The effect of variation in contact pressure in measuring threads of fine pitches is indicated by the difference in readings obtained with 2 and 5 pounds load on a 24-pitch thread plug gage. The reading over the wires with 5 pounds load was 0.00013 inch less than with 2 pounds load. The common shop practice of holding the wires down into the thread by means of elastic bands has a tendency to prevent the wires from adjusting themselves to the proper position in the thread grooves; thus a false measurement is obtained. In some cases it has also been the practice to support the gage being measured on two wires, which are in turn supported on a horizontal surface, and measuring from this surface to the top of a wire placed in a thread over the gage. If the gage is of large diameter, its weight causes a distortion of the wires and an inaccurate reading is obtained. For these reasons these practices should be avoided.

Measurements of a thread plug gage made in accordance with these instructions, with wires which conform to the following specifications, should be accurate to 0.0001 inch.

In the case of Acme threads the wire presses against the sides of the thread with a pressure of approximately twice that of the measuring instrument. This would indicate that the diameter of the wires should be measured against a hardened cylinder having a radius equal to the radius of curvature of the helical surface of the thread at the point of contact, using approximately twice the load to be used in making pitch diameter readings. As with 60° threads it is not practical to use such a variety of sizes, and it is recommended that the measurements of wire diameter be made between a flat contact and a 0.750-inch hardened and accurately finished steel cylinder. To limit the tendency of the wires to wedge in and deform the sides of an Acme thread, it is recommended that pitch diameter measurements on 8 threads per inch and finer be made at 1 pound. For coarser pitches and larger wires the deformation of wires and threads is less than for finer pitches. Furthermore, the coarser pitches are used on larger and heavier product, on which the pitch diameter tolerance is greater and a larger measuring load may be required to make satisfactory measurements. It is, therefore, recommended that for pitches coarser than 8, the pitch diameter be measured at 2½ pounds.

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3. STANDARD SPECIFICATION FOR WIRES AND STANDARD PRACTICE IN MEASUREMENT OF WIRES

The following specifications represent present practice relative to thread measuring wires:

1. Composition.—The wires shall be accurately finished hardened steel cylinders of the maximum possible hardness without being brittle. The hardness shall not be less than that corresponding to a Knoop indentation number of 630. A wire of this hardness can be cut with a file only with difficulty. The surface shall not be rougher than the equivalent of one measuring 3 microinches root mean square deviation from a true cylindrical surface, as measured with the profilometer.

2. Construction.—The working surface shall be at least 1 inch in length. The wire may be provided with a suitable means of suspension.

3. Container and Marking.—A suitable container shall be provided for each set of wires, and if wires are furnished without handles, the pitch for which the wires are the best size and the diameter of the working part of the wires, as determined by measurements under standard conditions as specified below, shall be marked on the container.

4. Diameter of Wires.—One set of wires shall consist of three wires which shall have the same diameter within 0.00002 inch, and this common diameter shall be within 0.0001 inch of that corresponding to the best size for the pitch for which the wire is to be used. Wires shall be measured between a flat contact and a 0.750-inch hardened and accurately ground and lapped steel cylinder with contact loads as follows: Wires for 60° threads and pitches finer than 20 threads per inch, 1 pound; wires for pitches of 20 threads per inch and coarser, 2½ pounds; wires for 29° Acme threads, 2½ pounds. It is recommended that wires, which are to be used for the measurement of gears, splines, dovetails, and other surfaces where the contact of the wire is a line contact, be measured between flat, parallel measuring contacts under a 1-pound load.

5. Variations in Diameter.—Variations in diameter around the wire (roundness) shall not exceed 0.00002 inch, as determined by measuring between a measuring contact and a hardened and well-finished 60° V-groove cut on a cylinder. Variations in diameter along the wire (taper), over the half-inch interval at the center of its length, shall not exceed 0.00002 inch, as determined by measuring between a flat contact and a cylindrical contact.

Tests for compliance of thread-measuring wires with the above specifications are made by the National Bureau of Standards for a fee stated in Fee Schedule 292*i*.

4. GENERAL FORMULA FOR MEASUREMENT OF PITCH DIAMETER

The general formula for determining the pitch diameter of any thread whose sides are symmetrical with respect to a line drawn through the vertex and perpendicular to the axis of the thread, in which the slight effect of helix angle is taken into account, is:

$$E=M+\frac{\cot a}{2n}-G\left(1+\operatorname{cosec} a+\frac{S^2}{2}\cos a\cot a\right)$$

in which

E=pitch diameter
M=measurement over wires
a=one half included angle of thread
n=number of threads per inch
G=diameter of wires
S=tangent of the helix angle.

The value of S, the tangent of the helix angle, is given by the formula

$$S=\frac{L}{3.1416E}=\frac{1}{3.1416NE}$$

in which

L=lead
N=number of turns per inch
E=nominal pitch diameter, or an approximation of the measured pitch diameter.

When extremely large helix angles (approaching 20°) are encountered, such as occur in multiple threads of small diameter, the above formula is subject to correction, as it is an approximation. However, if this formula is applied consistently to the measurement of both threaded setting plugs for thread ring gages and of thread plug gages, no difficulty should result from its universal application.

5. MEASUREMENT OF PITCH DIAMETER OF AMERICAN NATIONAL STRAIGHT THREADS

For standard threads of American National form the term $\left(\frac{GS^2}{2} \cos a \cot a\right)$ is neglected, as its value is small, being in all cases less than 0.00015 inch for standard fastening screws when the best-size wire is used, and the above formula takes the simplified form:

$$E = M + \frac{\cot a}{2n} - G\ (1 + \operatorname{cosec} a)$$

The practice is permissible provided that it is uniformly followed, and in order to maintain uniformity of practice, and thus avoid confusion, the National Bureau of Standards uses the latter formula except when the value of the term $\left(\frac{GS^2}{2} \cos a \cot a\right)$ exceeds 0.00015 inch, as in the case of multiple threads, or other threads having exceptionally large helix angles. For 60° threads this term exceeds 0.00015 when $NE\sqrt{n}$ exceeds 17.1.

For a 60° thread of correct angle and thread form the above formula simplifies to—

$$E = M + \frac{0.86603}{n} - 3G$$

For a given set of best-size wires

$$E = M - C$$

when

$$C = G(1 + \operatorname{cosec} a) - \frac{\cot a}{2n}$$

The quantity C is a constant for a given thread angle, and, when the wires are used for measuring threads of the pitch and angle for which they are the best size, the pitch diameter is obtained by the simple operation of subtracting this constant from the measurement taken over the wires. In fact, when best-size wires are used, this constant is changed very little by a moderate variation or error in the angle of the thread. Consequently, the constants for the various sets of wires in use may be tabulated, thus saving a considerable amount of time in the inspection of gages. However, when wires of other than the best size are used, this constant changes appreciably with a variation in the angle of the thread.

It has been shown that, with the exception of coarse pitch screws, variation in angle from the basic value causes no appreciable change in the quantity C for the best-size wires. On the other hand, when a wire near the maximum or minimum allowable size is used, a considerable change occurs, and the values of the cotangent and cosecant of the actual measured half angle are to be used. It is apparent, therefore, that there is a great advantage in using wires very closely approximating the best size. For convenience in carrying out computations, the values of $\frac{\cot a}{2n}$ for standard pitches are given in table 117, p. 199.

6. MEASUREMENT OF PITCH DIAMETER OF AMERICAN NATIONAL TAPER THREADS

The pitch diameter of a taper thread plug gage is measured in much the same manner as that of a straight thread gage, except that a definite position at which the measurement is to be made must be located. A point at a known distance L from the end of the gage is located by means of a combination of precision gage blocks and the cone point furnished as an accessory with these blocks, as

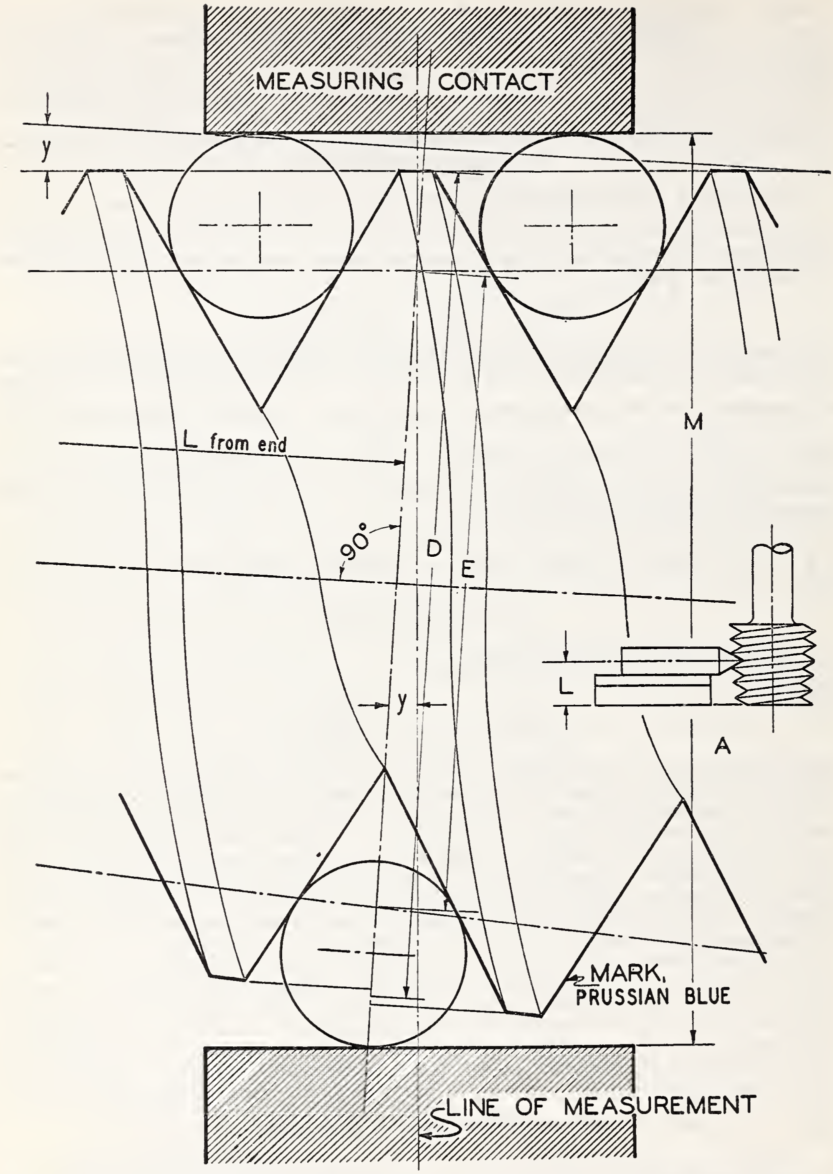

FIGURE 34.—*Measurement of pitch diameter of taper thread gages by the 3-wire method.*

shown in figure 34 at A. The gage is set vertically on a surface plate, the cone point is placed with its axis horizontal at the desired height, and the plug is turned until the point fits accurately into the thread. The position of this point is marked by placing a bit of prussian blue or wax immediately above it. Measurement is made over the wires in the usual manner, but care must be taken that the measuring contacts touch all three wires, since the line of measurement is not perpendicular to the axis of the screw when there is proper contact. (See fig. 34.) On account of this inclination, the measurement over the wires must be multiplied by the secant of the half angle of the taper of the thread. The formula for the pitch diameter of any taper thread plug gage, the threads of which are symmetrical with respect to a line perpendicular to the axis, then has the form: [1]

$$E = M \sec y + \frac{\cot a}{2n} - G\,(1 + \operatorname{cosec} a),$$

in which

E=pitch diameter
M=measurement over wires
y=half angle of taper of thread
n=number of threads per inch=$1/p$
a=half angle of thread
G=diameter of wires.

Thus the pitch diameter of an American National standard pipe-thread gage having correct angle (60°) and taper (¾ inch per foot) is then given by the formula:

$$E = 1.00049\,M + 0.86603\,p - 3G.$$

The pitch diameter at any other point along the thread, as at the gaging notch, is obtained by multiplying the distance parallel to the axis of the thread, between this point and the point at which the measurement was taken, by the taper per inch, then adding the product to or subtracting it from the measured pitch diameter according to the direction in which the second point is located with respect to the first.

Another method, illustrated in figure 35, has a theoretical advantage over the first method in that it is independent of the taper of the thread, and, therefore, requires less computation; or if the taper is not measured, but assumed to be correct, it is more accurate. The axis of the gage and the line of measurement are constrained perpendicular to each other. A single wire is inserted in the thread at the point located as in the previous method, and one other wire is placed in the upper thread on the opposite side. A measurement is taken over the two wires; the second wire is then moved to the thread immediately below and a second reading is taken. The mean of these two readings is substituted in any of the above formulas in the place of $M \sec y$, or $1.00049\,M$.

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[1] See footnote 19, p. 106. In the above formula for the value of E, the term $\frac{\cot a}{2n}$ is an approximation for the value of H. The exact value of H is used when the value of the term $\frac{\tan^2 y \tan a}{2n}$ exceeds 0.00004 inch, which ordinarily occurs only on special taper threads of coarse pitch or steep taper. Also the multiplication of the measurement over the wires by the secant of the half angle of the taper of the thread is not an exact correction for the inclination of the measurement. The complete formula is—

$$E = (M - G)\sec y + \frac{\cot a - \tan^2 y \tan a}{2n} - G\left(\operatorname{cosec} a + \frac{S^2}{2}\cos a \cot a\right)$$

This formula gives a value of E which is 0.000081 inch smaller than that given by the simplified formula for the 2½-8 American National taper pipe thread, the worst case in this thread series. (The standard symbol for "half angle of taper" has been changed from "y" to "β". See p. 7).

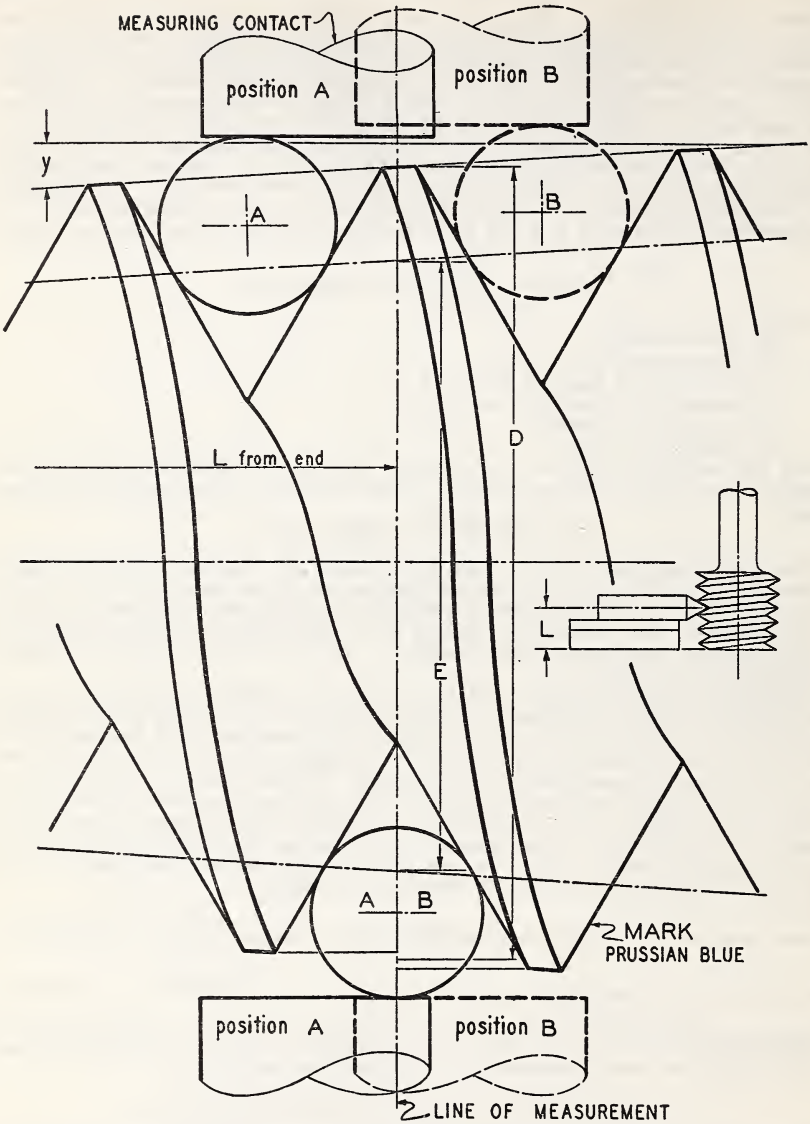

Figure 35.—*Measurement of pitch diameter of taper thread gages by the 2-wire method.*

7. MEASUREMENT OF PITCH DIAMETER OF THREAD RING GAGES

The application of direct methods of measurement to determine the pitch diameter of thread ring gages presents serious difficulties, particularly in securing proper contact pressure when a high degree of precision is required. The usual practice is to fit the ring gage to a threaded setting plug. When the thread ring gage is of correct lead, angle, and thread form, within close limits, this method is satisfactory and represents standard American practice. It is the only method available for small sizes of threads. For the larger sizes, various more or less satisfactory methods have been devised, but none of these have found wide application.

8. WIRE METHODS OF MEASUREMENT OF ACME THREADED PLUG GAGES

For Acme (29°) threads, either the pitch diameter or thread thickness in relation to basic major diameter (that is, the thread thickness at the nominal pitch diameter) may be used to determine the quality of fit. In both cases the three-wire method of measurement is used. Because the angle of the thread is small, and its cotangent large, it is always necessary to take the helix angle into account in deriving values of pitch diameter or thread thickness. The general formula for pitch diameter, the same as for 60° threads, is:

$$E=M+\frac{\cot a}{2n}-G\ (1+\operatorname{cosec} a+\frac{S^2}{2}\ \cos a \cot a).$$

The symbols are as given on page 202. For a 29° thread of correct angle and thread form, the formula reduces to:

$$E=M+\frac{1.93336}{n}-G\ (4.99393+1.87178\ S^2).$$

For standard sizes and pitches of Acme threads the computation is simplified further by means of table 120, if the best size wire is used, thus:

$$E=M-\text{col. } 7$$

or if E differs appreciably from the basic value given in column 3,

$$E=M-\text{col. } 7-100\ (\text{col. } 3-E_1)\times \text{col. } 8$$

where

$$E_1=M-\text{col. } 7.$$

If the measured wire diameter, G', differs slightly (not more than 0.0003 in.) from the best size, G, shown in column 4,

$$E=M-\text{col. } 7-5(G'-G)-100\ (\text{col. } 3-E_1)\times \text{col. } 8$$

Although the correction derived from column 8 may seldom be significant in amount for standard sizes and pitches of Acme threads, the procedure indicated will serve as a model of a short-cut method for the correct measurement of multiple Acme threads, with which such correction is important, as shown below.

If the general formula

$$E=M+\frac{\cot a}{2n}-G(1+\operatorname{cosec} a+\frac{S^2}{2}\cos a \cot a)$$

is used in the measurement of a multiple threaded screw having a large helix angle, the use of the nominal pitch diameter in the formula for the tangent of the helix angle, $S=\frac{1}{3.14159NE}$, may not be sufficiently accurate. If there is an appreciable difference between the nominal and measured pitch diameter, it is necessary to substitute the computed values of pitch diameter in the formula and derive a new value for pitch diameter. In cases of extremely large helix angle it may be necessary to make successive substitutions before a satisfactory agreement between the assumed and computed pitch diameter is obtained. Except where the helix angle is exceptionally large, a difference of 0.001 inch between assumed and computed pitch diameter can be tolerated.

Where a number of threads of the same nominal sizes are to be measured, the development and use of a table similar to table 120 will simplify the procedure.

To determine the thread thickness at the nominal pitch diameter, readings over three wires are made in the same manner as for pitch diameter. The thread thickness is given by the following formula:

$$t=p-\tan a\ [D-2B-M+G(1+\operatorname{cosec} a+\frac{S^2}{2}\cos a \cot a)]$$

in which

D=basic major diameter of screw
M=measurement over wires
G=diameter of wires
a=half angle of thread
S=tangent of helix angle at pitch line
p=pitch
B=depth at which thread thickness is measured
t=thread thickness at depth B.

On Acme screw threads

$$B=p/4$$

and the thread angle being 29°, the above formula reduces to—

$$t=1.12931p+0.25862(M-D)-G(1.29152+0.48407S^2).$$

The same formula applies to taps for Acme threads, although the major diameter is larger than basic, since the formula is based on the basic major diameter.

TABLE 120.—*Values for wire measurements of standard Acme threads*

Sizes	Threads per inch	Basic pitch diameter	Best wire size, G	$\frac{\cot a}{2n}$	$G(1+\operatorname{cosec} a+\frac{S^2}{2}\cos a \cot a)$	Col. 6 minus col. 5 [1]	Change in cols. 6 and 7 per 0.01 in. change in pitch diameter (col. 3)
1	2	3	4	5	6	7	8
Inches		*Inches*	*Inch*		*Inches*	*Inch*	*Inch*
1/4	16	0.2187	0.03228	0.120835	0.161704	0.040869	0.000049
5/16	14	.2768	.03689	.138097	.184692	.046595	.000036
3/8	12	.3333	.04304	.161113	.214449	.054336	.000032
7/16	12	.3958	.04304	.161113	.215301	.054188	.000019
1/2	10	.4500	.05164	.193336	.285370	.065034	.000022
5/8	8	.5625	.06456	.241670	.323013	.081343	.000022
3/4	6	.6667	.08608	.322226	.430898	.108672	.000031
7/8	6	.7917	.08608	.322226	.430601	.108375	.000019
1	5	.9000	.10329	.386671	.516790	.130119	.000022
1 1/8	5	1.0250	.10329	.386671	.516569	.129898	.000015
1 1/4	5	1.1500	.10329	.386671	.516415	.129744	.000010
1 3/8	4	1.2500	.12911	.483339	.645746	.162406	.000016
1 1/2	4	1.3750	.12911	.483339	.645576	.162236	.000012
1 3/4	4	1.6250	.12911	.483339	.645346	.162007	.000007
2	4	1.8750	.12911	.483339	.645202	.161862	.000005
2 1/4	3	2.0833	.17215	.644452	.860541	.216089	.000008
2 1/2	3	2.2333	.17215	.644452	.860432	.215980	.000007
2 3/4	3	2.5833	.17215	.644452	.860248	.215796	.000004
3	2	2.7500	.25822	.966678	1.291151	.324473	.000012
4	2	3.7500	.25822	.966678	1.290403	.323725	.000005
5	2	4.7500	.25822	.966678	1.290075	.323397	.000002

[1] Given to 6 decimal places for purposes of computation. After subtracting from M the final result should be rounded to 4 places.

APPENDIX 3. CONTROL OF ACCURACY OF THREAD ELEMENTS IN THE PRODUCTION OF THREADED PRODUCT

1. INTRODUCTION

In order to maintain the dimensions of threaded product within the limiting sizes specified, it is essential that the tools used and the processes applied be suitable for the particular requirements. An analysis of the various factors controlling the accuracy of the individual thread elements is here presented. In this analysis, the fundamental factors controlling the accuracy of the elements of a screw thread are stated, and are followed by a brief discussion of the relationship of these factors to each of the prevailing commercial methods of producing screw threads. It is recognized, however, that certain varying factors are involved, such as lubrication, method of holding the work or tool, sharpness of cutting edges, etc., so that it is not always possible to predetermine the exact sizes of the tools required to accomplish the desired results.

Screw threads are usually produced either by cutting or rolling. Five general methods of cutting, two of rolling, and two of finishing screw threads are in common use.

Screws or external threads are commonly produced by lathe tools, solid or adjustable dies, adjustable or opening die heads with removable chasers, thread milling cutters, threading hobs, and roller dies.

Of these, the dies, die-head chasers, and hobs are all multiple toothed, cutting in several thread spaces simultaneously, and finishing the operation at one pass. Lathe tools are ordinarily single-pointed and operate in a single thread, which is finished by repeated passes; but multiple-pointed chasers for use as lathe tools are sometimes made.

All rolled threads and many cut threads are produced with dies, chasers, or hobs made with master tools, such as hobs, taps, or milling cutters. These master tools are frequently made with forming cutters or other tools, but the primary tool is always made with a single-point tool. Angle and pitch errors tend to accumulate in a series of master tools and must be carefully considered in the design and use of this single-point tool.

Internal threads or tapped holes are commonly produced by means of taps and sometimes by lathe tools. Much progress has been made in the standardization of the dimensions and tolerances for cut and ground thread taps.[2]

2. FUNDAMENTAL FACTORS

The accuracy of the individual elements of a thread is controlled mainly as follows:

Angle by the angle between, and contour of the cutting edges of the tool used for cutting, or of the sides of the grooves of the die used for rolling.

Lead by the rate of the longitudinal motion of the tool with respect to the rate of revolution of the part to be threaded.

Major diameter of external thread by the outside diameter of the stock, or by the forming tool.

Minor diameter of internal thread by the diameter of the hole in the work before threading. In the case of a drilled hole, this depends on the diameter and accuracy of grinding of the tap drill used.

Pitch diameter by the radial setting of the forming surface of the tool.

Thread form by the form and position of the tool, and the conditions under which it is used.

(*a*) Control of Tooth Outlines.—Inspection of the angle and profile of the thread-forming tool is essential to control the accuracy of the thread produced. All threading tools, whether for use in a lathe, die head, thread miller, or roller, and whether single or multiple pointed, must produce the proper tooth profile on an axial section of the work. The final test of accuracy in any threading tool is its ability to produce a thread of the proper axial section as defined in the body of this handbook.

Most cutting tools for standard threads have their cutting edges in the axial plane of the work, so that the shape of those edges tends to reproduce itself on the screw thread. In forming and inspecting the cutting edges of these tools,

[2] See American Standard ASA B5.4–1939, "Taps: Cut and Ground Threads" of the American Standards Association, published by the A. S. M. E., 29 West 39th Street, New York, N. Y.

their forms may be directly compared with standard outlines. This can be done by means of accurately formed templets, carefully applied under the microscope. A more satisfactory and practical way is to draw the desired outline on a chart to a magnification of 30 to 100 times, and then project on this chart the image of the cutting tool under inspection magnified to the corresponding degree. By this means the tool shape may be quickly compared with the standard shape to a satisfactory degree of accuracy. Care must be taken to use a lens system free from distortion. Optical projection machines and comparators are available for this work in commercial designs. (See "Thread comparators," p. 224.)

In table 121 are given useful data for drawing the charts for any standard pitch.

TABLE 121.—*Dimensions for determining shape of cutter, chaser, hob, or tap teeth American National coarse, fine, and hose coupling threads*

Threads per inch, n	Pitch, p	$\frac{1}{2}\times p$	$\frac{1}{8}\times p$	$\frac{1}{24}\times p$	Depth of thread, h	$\frac{1}{2}\times h$	$\frac{1}{3}\times h$	$R=\frac{2}{9}\times h$	$\frac{1}{6}\times h$	$\frac{1}{18}\times h$	One half pitch diameter tolerance for class 2 fit, $\frac{1}{2}\times T$	$h+\frac{1}{2}\times T$
1	2	3	4	5	6	7	8	9	10	11	12	13
	Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
80	0.01250	0.00625	0.00156	0.00052	0.00812	0.00406	0.00271	0.00180	0.00135	0.00045	0.00085	0.00897
72	.01389	.00694	.00174	.00058	.00902	.00451	.00301	.00200	.00150	.00050	.00090	.00992
64	.01562	.00781	.00195	.00065	.01015	.00507	.00338	.00226	.00169	.00056	.00095	.01110
56	.01786	.00893	.00223	.00074	.01160	.00580	.00387	.00258	.00193	.00064	.00100	.01260
48	.02083	.01042	.00260	.00087	.01353	.00677	.00451	.00301	.00226	.00075	.00110	.01463
44	.02273	.01136	.00284	.00095	.01476	.00738	.00492	.00328	.00246	.00082	.00115	.01591
40	.02500	.01250	.00312	.00104	.01624	.00812	.00541	.00361	.00271	.00090	.00120	.01744
36	.02778	.01389	.00347	.00116	.01804	.00902	.00601	.00401	.00301	.00100	.00125	.01929
32	.03125	.01562	.00391	.00130	.02030	.01015	.00677	.00451	.00338	.00113	.00135	.02165
28	.03571	.01786	.00446	.00149	.02320	.01160	.00773	.00515	.00387	.00129	.00155	.02475
24	.04167	.02083	.00521	.00174	.02706	.01353	.00902	.00601	.00451	.00150	.00165	.02871
20	.05000	.02500	.00625	.00208	.03248	.01624	.01083	.00722	.00541	.00180	.00180	.03428
18	.05556	.02778	.00694	.00231	.03608	.01804	.01203	.00802	.00601	.00200	.00205	.03813
16	.06250	.03125	.00781	.00260	.04059	.02030	.01353	.00902	.00677	.00226	.00225	.04284
14	.07143	.03571	.00893	.00298	.04639	.02320	.01546	.01031	.00773	.00258	.00245	.04884
13	.07692	.03846	.00962	.00321	.04996	.02498	.01665	.01110	.00833	.00278	.00260	.05256
12	.08333	.04167	.01042	.00347	.05413	.02706	.01804	.01203	.00902	.00301	.00280	.05693
11½	.08696	.04348	.01087	.00362	.05648	.02824	.01833	.01255	.00941	.00314	[1] .00425	.06073
11	.09091	.04545	.01136	.00379	.05905	.02952	.01968	.01312	.00984	.00328	.00295	.06200
10	.10000	.05000	.01250	.00417	.06495	.03248	.02165	.01443	.01083	.00361	.00320	.06815
9	.11111	.05556	.01389	.00463	.07217	.03608	.02406	.01604	.01203	.00401	.00350	.07567
8	.12500	.06250	.01562	.00521	.08119	.04059	.02706	.01804	.01353	.00451	.00380	.08499
7½	.13333	.06667	.01667	.00556	.08660	.04330	.02887	.01925	.01443	.00481	[1] .00800	.09460
7	.14286	.07143	.01786	.00595	.09279	.04639	.03093	.02062	.01546	.00515	.00425	.09704
6	.16667	.08333	.02083	.00694	.10825	.05413	.03608	.02406	.01804	.00601	.00505	.11330
5	.20000	.10000	.02500	.00833	.12990	.06495	.04330	.02887	.02165	.00722	.00580	.13570
4½	.22222	.11111	.02778	.00926	.14434	.07217	.04811	.03208	.02406	.00802	.00635	.15069
4	.25000	.12500	.03125	.01042	.16238	.08119	.05413	.03608	.02706	.00902	.00700	.16938

[1] Based on hose-coupling thread tolerances.

(*b*) CONTROL OF LEAD ERRORS.—The sources of lead errors require special consideration, and for this purpose the methods of producing screw threads may be considered under two headings, namely, those in which relative longitudinal motion of the tool and product is controlled by means of a lead screw and those in which the tool is self-leading.

(*1*) *Tool controlled by lead screw.*—In cutting a thread on a lathe or other machine embodying a lead screw, using a single point cutting tool or single milling cutter, progressive lead errors are caused by (1) a progressive lead error in the lead screw; (2) lack of parallelism of the motion of the cutting tool, the axis of the lead screw, and the axis of the part to be threaded; and (3) incorrect ratio of the rate of revolution of the spindle to that of the lead screw, because of an incorrect or approximate combination of gears.

Local lead errors are caused by (1) local lead errors in the lead screw; (2) lost motion in the action of the lead screw or connecting mechanism; (3) varying frictional resistance in the mechanism; (4) when a live center is used, irregular play of its spindle in the bearings; and (5) variations in the amount of metal removed by the cutting tool.

Periodic lead errors are caused by (1) periodic lead errors in the lead screw; (2) eccentricity of motion of the lead screw; (3) thrust bearings of spindle or lead screw running out of true; (4) variations in the spacing of gear teeth, or eccentric gears or mountings; (5) when a live center is used, eccentricity of motion of its spindle; and (6) periodic variations in the amount of metal removed, because of lack of uniformity of the material in diameter, straightness, or physical properties.

When a multiple-toothed threading tool is controlled by a lead screw, variations from correct spacing of the teeth of the tool are superimposed on the lead errors resulting from any of the above causes in that portion of the thread not passed over by every tooth of the tool. In the portion of the thread completely passed over by the tool, the effect of the difference in lead between the tool and lead screw is to produce a thin thread.

The simplest method of inspecting a machine tool to determine whether it will cut a screw thread within satisfactory limits is to cut carefully a sample screw on the machine and measure the lead errors of the screw. The obvious remedy for errors from such sources is the careful inspection of the various elements of the machine, and correction of the errors thus located, either by improving the design or by carefully refinishing or remaking the parts to a greater degree of accuracy.

(*2*) *Self-leading threading tool.*—When a thread is cut by means of a tap or die, which, as ordinarily used, are self-leading and not controlled by a lead screw, lead errors may occur as the result of (1) incorrect lead of the tap or die; (2) too much or too little relief at the throat of the die or on the chamfer at the end of the tap; (3) the setting of an adjustable die or tap chaser to cut a thread considerably larger or smaller than that for which the tool was intended—that is, to cut a helix angle considerably different from the helix angle of the chaser; (4) excessive resistance to longitudinal motion; (5) improper alinement of the axis of the tap or die with that of the work, etc.; and (6) excessive angle relief.

The control of accuracy of the lead of the tap or of the chasers in the die is the most difficult of these sources of error, and indeed presents serious difficulties. There is, first, the difficulty of cutting a tap or chaser which is free from lead errors resulting from any of the causes outlined above; and second, the distortion which the steel composing the tap or die undergoes in hardening.

When especially accurate work is required, as in producing threaded product to class 4 fit specifications, it is very desirable, and sometimes necessary, that the feed of the tap or die be controlled by means of a lead screw.

In the inspection of such thread-forming tools practically the same means and methods can be applied as in the measurement of screw-thread gages. For checking the lead, indicating gages or some of the usual lead-measuring devices for screw-thread gages may be used. To measure the lead of a die chaser, the chaser must be held in a fixture in such a position that the direction of measurement corresponds to the direction of longitudinal motion of the chaser threads when cutting a thread.

(*c*) Sizes of Tap Drills.—The essential requirement of a tap drill is that the hole produced by it shall be such that, when tapped with a screw thread, the minor diameter of the tapped hole shall be within the specified limits. It should be noted that the minor diameters of the tapped holes are the same for classes 1 to 4, inclusive.

If the drill is too large, the minor diameter of the tapped hole will also be too large and the thread in the nut will be too shallow; that is, too small a percentage of a full thread. As an extreme case the threads in the tapped hole will engage only the tops of the threads on a screw of correct size, and under stress the threads of the screw will strip and the full strength of the fastening will not be developed.

If, on the other hand, the tap drill is too small, the tap will be forced to cut a thread of full depth, and in the extreme case to act as a reamer also. This will result in excessive power consumption and tap breakage, and will also make the minor diameter of the tapped hole dependent upon the minor diameter of the tap. This is undesirable, since the minor diameter of the tap is not, in general, held to the same close limits as the other tap elements, and as a result the minor diameter of a hole tapped under these conditions may be in error even though the tap is otherwise correct.

It is a well-known fact that the size of the hole produced by a tap drill depends to some extent upon the method of grinding the drill, the material drilled, the lubricant used, and the speed and feed of operation. This being true, it is apparent that fixing the diameter of the tap drill does not completely fix the diameter of the drilled hole. The most that can be accomplished is to fix the drill diameters between certain limits and to depend upon correct grinding, lubrication, and operation to keep the diameter of the holes within prescribed limits.

There are given in tables 122 and 123 all drills regularly carried in stock, both English and metric, which fall between the limiting dimensions of the minor diameter of the threaded hole for the American National coarse and fine thread series, as well as drills outside of the minor diameter limits corresponding in size to thread depths from 50 to 100 percent.

Table 122.—*Sizes of tap drills, American National coarse-thread series* [1]

Size of thread	Threads per inch	Minor diameter of nut			Stock drills corresponding to 100 percent to 50 percent of basic thread depth [2]		
		Basic	Maximum	Minimum	Nominal size	Diameter	Percent of depth of basic thread
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*		*Inch*	
1	64	0.0527	0.0623	0.0561	*0.0531*	*0.0531*	*98*
					0.0550	*.0550*	*89*
					0.0571	.0571	78
					0.0591	.0591	68
					0.0610	*.0610*	*59*
					0.0625	*.0625*	*52*
2	56	.0628	.0737	.0667	*0.0630*	*.0630*	*99*
					0.0650	*.0650*	*91*
					0.0670	.0670	82
					0.0700	.0700	69
					0.0730	.0730	56
3	48	.0719	.0841	.0764	*0.0730*	*.0730*	*96*
					0.0760	*.0760*	*85*
					0.0781	.0781	77
					0.0810	.0810	67
					0.0827	.0827	60
4	40	.0795	.0938	.0849	*0.0810*	*.0810*	*95*
					0.0827	*.0827*	*90*
					0.0860	.0860	80
					0.0890	.0890	71
					0.0906	.0906	66
					0.0937	.0937	56
5	40	.0925	.1062	.0979	*0.0937*	*.0937*	*96*
					0.0960	*.0960*	*89*
					0.0995	.0995	79
					0.1024	.1024	70
					0.1040	.1040	65
					0.1065	*.1065*	*57*
6	32	.0974	.1145	.1042	*0.0995*	*.0995*	*95*
					0.1024	*.1024*	*88*
					0.1040	*.1040*	*84*
					0.1065	.1065	78
					0.1094	.1094	70
					0.1130	.1130	62
					0.1160	*.1160*	*54*
8	32	.1234	.1384	.1302	*0.1250*	*.1250*	*96*
					0.1285	*.1285*	*87*
					0.1299	*.1299*	*84*
					0.1339	.1339	74
					0.1360	.1360	69
					0.1378	.1378	65
					0.1406	*.1406*	*58*

[1] Drill sizes up to ½ inch are in agreement with ASA B5.12–1940, Twist Drills, Straight Shank, published by the A. S. M. E., 29 West 39th Street, New York, N. Y.

[2] Sizes in italics are not within the specified limits for minor diameter of nut.

TABLE 122.—*Sizes of tap drills, American National coarse-thread series* —Con.

Size of thread	Threads per inch	Minor diameter of nut			Stock drills corresponding to 100 percent to 50 percent of basic thread depth		
		Basic	Maximum	Minimum	Nominal size	Diameter	Percent of depth of basic thread
1	2	3	4	5	6	7	8
		Inch	Inch	Inch		Inch	
10	24	0.1359	0.1559	0.1449	0.1378	0.1378	96
					0.1406	.1406	91
					0.1440	.1440	85
					0.1470	.1470	79
					0.1520	.1520	70
					0.1562	.1562	62
					0.1610	.1610	54
12	24	.1619	.1801	.1709	0.1660	.1660	92
					0.1695	.1695	86
					0.1719	.1719	82
					0.1730	.1730	79
					0.1770	.1770	72
					0.1800	.1800	67
					0.1850	.1850	57
					0.1875	.1875	53
¼	20	.1850	.2060	.1959	0.1850	.1850	100
					0.1875	.1875	96
					0.1910	.1910	91
					0.1935	.1935	87
					0.1960	.1960	83
					0.1990	.1990	79
					0.2031	.2031	72
					0.2090	.2090	63
					0.2130	.2130	57
5/16	18	.2403	.2630	.2524	0.2460	.2460	92
					0.2500	.2500	87
					0.2520	.2520	84
					0.2570	.2570	77
					0.2610	.2610	71
					0.2656	.2656	65
					0.2720	.2720	56
⅜	16	.2938	.3184	.3073	0.2969	.2969	96
					0.3020	.3020	90
					0.3071	.3071	84
					0.3125	.3125	77
					0.3160	.3160	73
					0.3230	.3230	64
					0.3281	.3281	58
					0.3320	.3320	53
7/16	14	.3447	.3721	.3602	0.3480	.3480	96
					0.3543	.3543	90
					0.3594	.3594	84
					0.3680	.3680	75
					0.3750	.3750	67
					0.3860	.3860	56
					0.3906	.3906	51
½	13	.4001	.4290	.4167	0.4062	.4062	94
					0.4219	.4219	78
					0.4375	.4375	63
9/16	12	.4542	.4850	.4723	0.4687	.4687	87
					0.4844	.4844	72
					0.5000	.5000	58
					0.5062	.5062	52
⅝	11	.5069	.5397	.5266	13 mm	.5118	96
					33/64	.5156	93
					17/32	.5312	79
					13.5 mm	.5315	79
					35/64	.5469	66
					14 mm	.5512	62
					9/16	.5625	53

TABLE 122.—*Sizes of tap drills, American National coarse-thread series*—Con.

Size of thread	Threads per inch	Minor diameter of nut			Stock drills corresponding to 100 percent to 50 percent of basic thread depth		
		Basic	Maximum	Minimum	Nominal size	Diameter	Percent of depth of basic thread
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*		*Inch*	
					5/8	0.6250	96
					16 mm	.6299	92
					41/64	.6406	84
¾	10	0.6201	0.6553	0.6417	16.5 mm	.6496	77
					21/32	.6562	72
					17 mm	.6693	62
					43/64	.6719	60
					47/64	.7344	97
					19 mm	.7480	88
					3/4	.7500	87
⅞	9	.7307	.7689	.7547	49/64	.7656	76
					19.5 mm	.7677	74
					25/32	.7812	65
					20 mm	.7874	61
					51/64	.7969	54
					27/32	.8438	96
					21.5 mm	.8465	95
					55/64	.8594	87
					22 mm	.8661	82
1	8	.8376	.8795	.8647	7/8	.8750	77
					22.5 mm	.8858	70
					57/64	.8906	67
					23 mm	.9055	58
					29/32	.9062	58
					24 mm	.9449	97
					61/64	.9531	93
					24.5 mm	.9646	86
					31/32	.9688	84
					25 mm	.9842	76
1⅛	7	.9394	.9858	.9704	63/64	.9844	76
					1	1.0000	67
					25.5 mm	1.0039	65
					1 1/64	1.0156	59
					26 mm	1.0236	55
					1 1/32	1.0312	51
					1 5/64	1.0781	93
					27.5 mm	1.0827	90
					1 3/32	1.0938	84
					28 mm	1.1024	80
1¼	7	1.0644	1.1108	1.0954	1 7/64	1.1094	76
					28.5 mm	1.1220	69
					1 1/8	1.1250	67
					1 9/64	1.1406	59
					29 mm	1.1417	58
					1 5/32	1.1562	51
					29.5 mm	1.1614	99
					1 11/64	1.1719	94
					30 mm	1.1811	90
					1 3/16	1.1875	87
					30.5 mm	1.2008	80
					1 13/64	1.2031	79
1⅜	6	1.1585	1.2126	1.1946	1 7/32	1.2188	72
					31 mm	1.2205	71
					1 15/64	1.2344	65
					31.5 mm	1.2402	62
					1 1/4	1.2500	58
					32 mm	1.2598	53
					1 17/64	1.2656	51

TABLE 122.—*Sizes of tap drills, American National coarse-thread series*—Con.

Size of thread	Threads per inch	Minor diameter of nut			Stock drills corresponding to 100 percent to 50 percent of basic thread depth		
		Basic	Maximum	Minimum	Nominal size	Diameter	Percent of depth of basic thread
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*		*Inch*	
1½	6	1.2835	1.3376	1.3196	*1 19/64*	*1.2969*	*94*
					33 mm	*1.2992*	*93*
					1 5/16	*1.3125*	*87*
					33.5 mm	*1.3189*	*84*
					1 21/64	1.3281	79
					34 mm	*1.3386*	*75*
					1 11/32	*1.3438*	*72*
					34.5 mm	*1.3583*	*65*
					1 23/64	*1.3594*	*65*
					1 3/8	*1.3750*	*58*
					35 mm	*1.3780*	*56*
					1 25/64	*1.3906*	*51*
1¾	5	1.4902	1.5551	1.5335	*38 mm*	*1.4961*	*98*
					1 1/2	*1.5000*	*96*
					1 33/64	*1.5156*	*90*
					38.5 mm	*1.5157*	*90*
					1 17/32	*1.5312*	*84*
					39 mm	1.5354	83
					1 35/64	1.5469	78
					39.5 mm	1.5551	75
					1 9/16	*1.5625*	*72*
					40 mm	*1.5748*	*67*
					1 37/64	*1.5781*	*66*
					1 19/32	*1.5938*	*60*
					40.5 mm	*1.5945*	*60*
					1 39/64	*1.6094*	*54*
					41 mm	*1.6142*	*52*
2	4½	1.7113	1.7835	1.7594	*43.5 mm*	*1.7126*	*100*
					1 23/32	*1.7188*	*97*
					44 mm	*1.7323*	*93*
					1 47/64	*1.7344*	*92*
					1 3/4	*1.7500*	*87*
					44.5 mm	*1.7520*	*86*
					1 49/64	1.7656	81
					45 mm	1.7716	79
					1 25/32	1.7812	76
					45.5 mm	*1.7913*	*72*
					1 51/64	*1.7969*	*70*
					46 mm	*1.8110*	*65*
					1 13/16	*1.8125*	*65*
					1 53/64	*1.8281*	*60*
					46.5 mm	*1.8307*	*59*
					1 27/32	*1.8438*	*54*
					47 mm	*1.8504*	*52*
2¼	4½	1.9613	2.0335	2.0094	*50 mm*	*1.9685*	*98*
					1 31/32	*1.9688*	*97*
					1 63/64	*1.9844*	*92*
					50.5 mm	*1.9882*	*91*
					2	*2.0000*	*87*
					51 mm	*2.0079*	*84*
					2 1/64	2.0156	81
					51.5 mm	2.0276	77
					2 1/32	2.0312	76
					2 3/64	*2.0469*	*70*
					52 mm	*2.0472*	*70*
					2 1/16	*2.0625*	*65*
					52.5 mm	*2.0669*	*63*
					2 5/64	*2.0781*	*60*
					53 mm	*2.0866*	*57*
					2 3/32	*2.0938*	*54*

TABLE 122.—*Sizes of tap drills, American National coarse-thread series*—Con.

Size of thread	Threads per inch	Minor diameter of nut			Stock drills corresponding to 100 percent to 50 percent of basic thread depth		
		Basic	Maximum	Minimum	Nominal size	Diameter	Percent of depth of basic thread
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*		*Inch*	
2½	4	2.1752	2.2564	2.2294	55.5 mm	2.1850	97
					2 3/16	2.1875	96
					2 13/64	2.2031	91
					56 mm	2.2047	91
					2 7/32	2.2188	87
					56.5 mm	2.2244	85
					2 15/64	2.2344	82
					57 mm	2.2441	79
					2 1/4	2.2500	77
					57.5 mm	2.2638	73
					2 17/64	2.2656	72
					2 9/32	2.2812	67
					58 mm	2.2835	67
					2 19/64	2.2969	63
					58.5 mm	2.3031	61
					2 5/16	2.3125	58
					59 mm	2.3228	55
					2 21/64	2.3281	53
2¾	4	2.4252	2.5064	2.4794	2 7/16	2.4375	96
					62 mm	2.4409	95
					2 29/64	2.4531	91
					62.5 mm	2.4606	89
					2 15/32	2.4688	87
					63 mm	2.4803	83
					2 31/64	2.4844	82
					63.5 mm	2.5000	77
					2 1/2	2.5000	77
					2 33/64	2.5156	72
					64 mm	2.5197	71
					2 17/32	2.5312	67
					64.5 mm	2.5394	65
					2 35/64	2.5469	63
					65 mm	2.5590	59
					2 9/16	2.5625	58
					2 37/64	2.5781	53
					65.5 mm	2.5787	53
3	4	2.6752	2.7564	2.7294	68 mm	2.6772	99
					2 11/16	2.6875	96
					68.5 mm	2.6968	93
					2 45/64	2.7031	91
					69 mm	2.7165	87
					2 23/32	2.7188	87
					2 47/64	2.7344	82
					69.5 mm	2.7362	81
					2 3/4	2.7500	77
					70 mm	2.7559	75
					2 49/64	2.7656	72
					70.5 mm	2.7756	69
					2 25/32	2.7812	67
					71 mm	2.7953	63
					2 51/64	2.7969	63
					2 13/16	2.8125	58
					71.5 mm	2.8150	57
					2 53/64	2.8281	53
					72 mm	2.8346	51
3¼	4	2.9252	3.0064	2.9794	74.5 mm	2.9331	98
					2 15/16	2.9375	96
					75 mm	2.9528	92
					2 61/64	2.9531	91
					2 31/32	2.9688	87
					75.5 mm	2.9724	85
					2 63/64	2.9844	82
					76 mm	2.9921	79
					3	3.0000	77
					3 1/32	3.0312	67
					3 1/16	3.0625	58
3½	4	3.1752	3.2564	3.2294	3 3/16	3.1875	96
					3 7/32	3.2188	87
					3 ¼	3.2500	77
					3 9/32	3.2812	67
					3 5/16	3.3125	58
3¾	4	3.4252	3.5064	3.4794	3 7/16	3.4375	96
					3 ½	3.5000	77

TABLE 123.—*Sizes of tap drills, American National fine-thread series* [1]

Size of thread	Threads per inch	Minor diameter of nut			Stock drills corresponding to 100 percent to 50 percent of basic thread depth [2]		
		Basic	Maximum	Minimum	Nominal size	Diameter	Percent of depth of basic thread
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*		*Inch*	
0	80	0.0438	0.0514	0.0465	*0.0453*	*0.0453*	*91*
					0.0469	.0469	81
					0.0492	.0492	67
					0.0512	*.0512*	*54*
1	72	.0550	.0634	.0580	*0.0550*	*.0550*	*100*
					0.0571	*.0571*	*88*
					0.0591	.0591	77
					0.0610	.0610	67
					0.0625	*.0625*	*58*
					0.0630	*.0630*	*55*
2	64	.0657	.0746	.0691	*0.0670*	*.0670*	*94*
					0.0700	.0700	79
					0.0730	.0730	64
3	56	.0758	.0856	.0797	*0.0760*	*.0760*	*99*
					0.0781	*.0781*	*90*
					0.0810	.0810	78
					0.0827	.0827	70
					0.0860	.0860	56
4	48	.0849	.0960	.0894	*0.0860*	*.0860*	*96*
					0.0890	*.0890*	*85*
					0.0906	.0960	79
					0.0937	.0937	68
					0.0960	.0960	59
5	44	.0955	.1068	.1004	*0.0960*	*.0960*	*98*
					0.0995	*.0995*	*86*
					0.1024	.1024	77
					0.1040	.1040	71
					0.1065	.1065	63
					0.1094	*.1094*	*53*
6	40	.1055	.1179	.1109	*0.1065*	*.1065*	*97*
					0.1094	*.1094*	*88*
					0.1130	.1130	77
					0.1160	.1160	68
					0.1200	*.1200*	*55*
8	36	.1279	.1402	.1339	*0.1285*	*.1285*	*98*
					0.1299	*.1299*	*95*
					0.1339	.1339	83
					0.1360	.1360	78
					0.1378	.1378	73
					0.1406	.1406	65
					0.1440	*.1440*	*55*
10	32	.1494	.1624	.1562	*0.1520*	*.1520*	*94*
					0.1562	.1562	83
					0.1610	.1610	71
					0.1660	.1660	59
					0.1695	*.1695*	*50*
12	28	.1696	.1835	.1773	*0.1719*	*.1719*	*95*
					0.1730	*.1730*	*93*
					0.1770	*.1770*	*84*
					0.1800	.1800	78
					0.1850	.1850	67
					0.1875	.1875	61
					0.1910	*.1910*	*54*
¼	28	.2036	.2173	.2113	*0.2090*	*.2090*	*88*
					0.2130	.2130	80
					0.2187	*.2187*	*67*
					0.2244	*.2244*	*55*

[1] Drill sizes up to ½ inch are in agreement with ASA B5.12-1940, Twist Drills, Straight Shank, published by the A. S. M. E., 29 West 39th Street, New York, N. Y.

[2] Sizes in italics are not within the specified limits for minor diameter of nut.

400610°—42——15

TABLE 123.—*Sizes of tap drills, American National fine-thread series*—Continued

Size of thread	Threads per inch	Minor diameter of nut: Basic	Minor diameter of nut: Maximum	Minor diameter of nut: Minimum	Stock drills corresponding to 100 percent to 50 percent of basic thread depth: Nominal size	Diameter	Percent of depth of basic thread
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*		*Inch*	
5/16	24	0.2584	0.2739	0.2674	*0.2610*	*0.2610*	*95*
					0.2656	.2656	87
					0.2720	.2720	75
					0.2770	*.2770*	*66*
					0.2812	*.2812*	*58*
					0.2854	*.2854*	*50*
3/8	24	.3209	.3364	.3299	*0.3230*	*.3230*	*96*
					0.3281	*.3281*	*87*
					0.3320	.3320	79
					0.3390	*.3390*	*67*
					0.3437	*.3437*	*58*
7/16	20	.3725	.3906	.3834	*0.3750*	*.3750*	*96*
					0.3860	.3860	79
					0.3906	.3906	72
					0.3970	*.3970*	*62*
1/2	20	.4350	.4531	.4459	*0.4375*	*.4375*	*96*
					0.4531	.4531	72
9/16	18	.4903	.5100	.5024	*0.5000*	*.5000*	*87*
					0.5062	.5062	78
					13 mm	*.5118*	*70*
					33/64	*.5156*	*65*
5/8	18	.5528	.5725	.5649	*9/16*	*.5625*	*87*
					14.5 mm	.5709	75
					37/64	*.5781*	*65*
3/4	16	.6688	.6903	.6823	*17 mm*	*.6693*	*99*
					43/64	*.6719*	*96*
					11/16	.6875	77
					17.5 mm	.6890	75
					45/64	*.7031*	*58*
					18 mm	*.7087*	*51*
7/8	14	.7822	.8062	.7977	*20 mm*	*.7874*	*94*
					51/64	*.7969*	*84*
					20.5 mm	*.8071*	*73*
					13/16	*.8125*	*67*
					21 mm	*.8268*	*52*
					53/64	*.8281*	*51*
1	14	.9072	.9312	.9227	*59/64*	*.9219*	*84*
					23.5 mm	.9252	81
					15/16	*.9375*	*67*
					24 mm	*.9449*	*59*
					61/64	*.9531*	*51*
1 1/8	12	1.0167	1.0438	1.0348	*26 mm*	*1.0236*	*94*
					1 1/32	*1.0312*	*87*
					26.5 mm	1.0433	75
					1 3/64	*1.0469*	*72*
					1 1/16	*1.0625*	*58*
					27 mm	*1.0630*	*57*
1 1/4	12	1.1417	1.1688	1.1598	*29 mm*	*1.1417*	*100*
					1 5/32	*1.1562*	*87*
					29.5 mm	1.1614	82
					1 11/64	*1.1719*	*72*
					30 mm	*1.1811*	*64*
					1 3/16	*1.1875*	*58*
1 3/8	12	1.2667	1.2938	1.2848	*32.5 mm*	*1.2795*	*88*
					1 9/32	*1.2812*	*87*
					1 19/64	*1.2969*	*72*
					33 mm	*1.2992*	*70*
					1 5/16	*1.3125*	*58*
					33.5 mm	*1.3189*	*52*
1 1/2	12	1.3917	1.4188	1.4098	*35.5 mm*	*1.3976*	*95*
					1 13/32	*1.4062*	*87*
					36 mm	1.4173	76
					1 27/64	*1.4219*	*72*
					36.5 mm	*1.4370*	*58*
					1 7/16	*1.4375*	*58*

3. CUTTING OF SCREW THREADS

(*a*) Single-Point Tool.—A screw thread may be produced by traversing a single-point threading tool—shaped to correspond to the shape of the thread space in an axial plane, and so placed as to cut an angle, equal to the angle of the top surface of the tool, in correct relation to the axis of the thread—along the revolving part to be threaded at such a rate as to produce a thread of the desired lead. This is the common method of cutting screws in an engine lathe, a lead screw driven by gearing being the usual means for imparting to the tool the longitudinal motion at the desired rate. This method is used commercially only when special conditions make it necessary, as when the thread to be cut is not standard, or when it is not practicable to apply other methods.

Various forms of single-point cutting tools for cutting threads of American National form are illustrated in figure 36 at *A*, *B*, *C*, and *D*. The circular tool shown at *C* has the advantage that it can be reground indefinitely without destroying its correct form. The diagram at *D* shows the method for calculating the angle *X* of the cutting tool, having a clearance angle *V*, in a plane perpendicular to the edge *MN;* and the formula for determining the clearance angle *V*, of a tool for cutting a thread of helix angle *s*, is also given. Such tools usually consist of hardened tool steel, ground to the correct form after hardening; special alloys such as "stellite" and "carboloy" are also used for this purpose.

(*b*) Thread Chaser.—A screw thread may be produced by successively traversing a multiple-point thread tool, known as a chaser, along the part to be threaded, each tooth following in the thread in the same manner as a single-point thread tool. Two forms of chasers are shown in figure 36 at *E* and *F*, the one at *F* being especially suitable for cutting fine threads. Chasers are well adapted to roughing out threads, as they cut rapidly, and may be used for finishing threads accurately if the teeth are ground after hardening.

(*c*) Tap or Die.[3]—A screw thread may be produced by using a tap for internal threads or a die for external threads. These tools occur in considerable variety in their commercial forms, but consist essentially of a number of multiple-point cutters or chasers, usually four, arranged circumferentially. They may be either solid or adjustable, and collapsible or self-opening, respectively, for withdrawing quickly from the work after threading. By their use a thread is generally finished by one passage of the tool, although a second or finishing cut is sometimes made to secure greater accuracy. Dies [4] are applied, in general, to threading screws, bolts, and studs; and taps to nuts or other internal threads within the usual range of sizes. They are also applied to the threading of pipe and pipe fittings. The rapidity with which threading operations may be performed by the use of taps and dies, within the limits of accuracy suitable for a large percentage of commercial work, makes them most efficient and widely used threading tools. It is only in cutting large sizes or coarse pitches, or where a high degree of accuracy is desired, that their use may be less economical than other means of cutting threads.

Aside from lead errors, which have been previously considered, the accuracy of the thread produced depends on the form of the cutting teeth, character of the cutting edges, clearance or relief for cutting edges, construction of the tool, and the conditions under which it is used.

A defect which commonly occurs in general purpose bolts and nuts is that the thread angle of the nut is larger than nominal by several degrees. In such production bent-shank tapper taps are commonly used. The enlarged thread angle may be the result of the fact that the weight of the nuts, which are above the nut being tapped, resists the self-leading of the tap, and also the fact that the axis of the tap is not rigidly constrained to coincide with the axis of the hole in the nut to be tapped. An attempt should be made to correct this condition by using taps which have the thread angle smaller than nominal by an amount equal to the prevalent average angle error.

(*d*) Milling Cutter.—A screw thread may be produced by feeding in to the depth of the thread and then traversing a rapidly revolving single milling cutter along the slower revolving part to be threaded at such a rate as to produce a thread of the desired lead; the profile of the cutting edges of the cutter conform-

[3] A considerable amount of valuable information regarding accurate cutting of threads with taps and dies is available in catalogs and handbooks of tap and die manufacturers.

[4] Simplified lists of sizes and varieties, for threads of American National form, of die-head chasers for self-opening and adjustable die heads, as adopted at general conferences of representative manufacturers, distributors, and users, are promulgated in United States Department of Commerce Simplified Practice Recommendation R51–29.

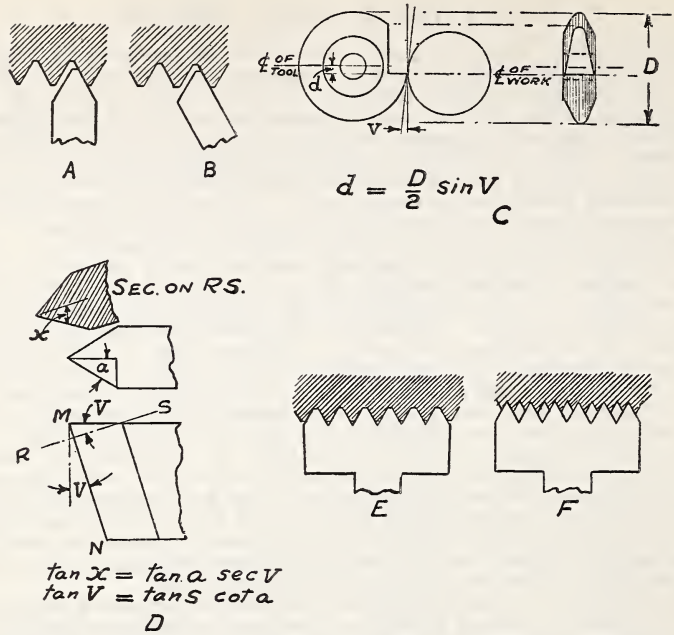

FIGURE 36.—*Single point and multiple point thread-cutting tools.*

ing approximately to the shape of the thread groove in an axial plane, and the axis of the cutter being set at an angle to the axis of the thread, in a plane parallel to the axis of the thread, equal to the mean helix angle of the thread cut. The single-cutter method of thread milling is especially applicable to the cutting of large threads of coarse pitch, multiple threads, and the heavier classes of work. When the amount of metal to be removed is large, as compared with the size of the screw, this method is especially suitable because the torsional strain is much smaller than that produced by a die, and consequently the accuracy of the screw produced is greater.[5]

(*e*) MULTIPLE-THREAD MILLING CUTTER.—A screw thread may be produced by feeding in to the depth of the thread, and then traversing a rapidly revolving multiple milling cutter or thread hob, somewhat longer than the length of the thread to be cut—which consists of annular rows of teeth, whose centers lie in planes perpendicular to the axis of the cutter (in effect a series of single cutters formed into one solid piece), and the axis of which is parallel to the axis of the thread—along the slowly revolving part to be threaded slightly more than either one or two complete revolutions of the work, at a rate per revolution of the work equal to the pitch of the thread. The multiple-cutter method of thread milling is used largely for cutting comparatively short threads, usually of fine or medium pitches, when smoothness or a considerable degree of accuracy is desired, or when the thread must maintain a fixed relation with a point or surface on the work.

The error introduced in the form of thread produced by cutter teeth having the same form as that of the intended form of thread, as the result of the axes of cutter and thread being parallel, is usually not serious except when the helix angle is large.[6]

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[5] For refinements in connection with the determination of the profile of cutting edge of a thread milling cutter, see The Milling of Screw Threads and Other Problems in the Theory of Screw Threads, by H. H. Jeffcott. Proceedings of the Institution of Mechanical Engineers, 1922–I, pp. 515–528, and discussion pp. 529–562; or Engineering (London), vol. 113, Apr. 7, 1922, pp. 441–442, and discussion pp. 412–414.

[6] For formulas which may be applied in such cases to determine and plot the exact contour of the cutting edges to produce, as nearly as possible, the thread form required, see Side-Cutting of Thread Milling Hobs, by Earle Buckingham, Transactions of the American Society of Mechanical Engineers, vol. 42, 1920, pp. 569–593; The Design of Hobs for Taper-threaded Joints, by Earle Buckingham, American Machinist, vol. 69, Nov. 15 and 22, 1928, pp. 759–763, 801–803; also the reference cited in footnote 5, for thread milling cutter profile.

4. ROLLING OF SCREW THREADS

The second general process for forming screw threads—namely, that of rolling—is a hot- or cold-forging process. It may be defined as an impression or displacement method whereby the threads are formed by means of a die or roll having threads or ridges, which are forced into the material to be threaded, and, by displacing it, produce a thread of the required form and pitch. In this process no material is removed, but the metal is displaced from the thread space and forced up on each side above the original surface of the piece to be threaded. Thus, the major diameter of a V-shaped 60° thread so produced is found in practice to be greater than the original diameter of the blank by an amount varying from 65 percent of the single depth of thread for small screws to 85 percent for large screws. An approximate formula, based on geometrical considerations only, for the diameter of a blank to be threaded to American National form is as follows:

$$D_1 = \sqrt{D^2 - 1.3Dp + 0.63p^2},$$

in which

D_1 = diameter of blank
D = major diameter of thread
p = pitch of thread.

In case the thread required must be accurate within close limits, the exact value of D_1 necessary in any given case must be determined experimentally, as its value is affected by the physical properties of the material.[7]

The thread-rolling process is the most rapid and economical method of forming screw threads in quantity production, when the part to be threaded is of such form as to permit its use. It is used only for external threads and is not regarded as being feasible for internal threads, since the area of contact of the roll in an internal thread is relatively much larger than on an external thread, and in order to displace the metal a very heavy pressure is required. It is difficult to support the work with the necessary rigidity to withstand the heavy pressure, and to provide a bearing for the roll which will withstand the stress.

Screw threads may be rolled by either of two methods, as follows:

(*a*) Threading Roll.—By forcing a cylindrical disk or roll, having a threaded periphery and being free to rotate on the pin or bolt on which it is mounted, against the piece to be threaded while the latter is revolving. The cylindrical roll is used when the work is in an automatic screw machine or turret lathe, and it is impossible to cut the thread required by means of a thread-cutting die, or when an additional operation would be necessary before cutting the thread. The thread on the roll corresponds in pitch, and approximately in form, to the thread to be rolled. The roll may be presented to the work in either a tangential direction as shown at *A*, figure 37, or radially as shown at *B*; a satisfactory thread is formed in either case.

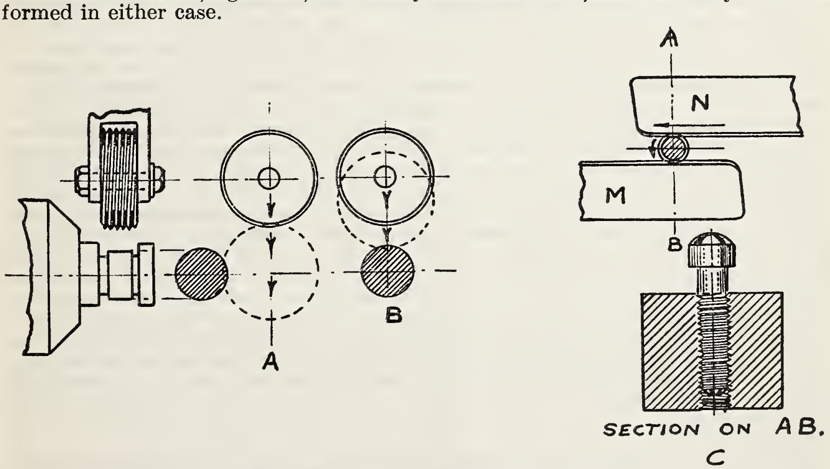

Figure 37.—*Methods of rolling screw threads.*

[7] This formula is derived in Size of Stock for Bolts Having Rolled Threads, by F. Webster, American Machinist, vol. 30, Oct. 31, 1907, p. 630.

(*b*) Thread-Rolling Dies.—By rolling the blank between dies, which may be either flat or cylindrical in form, when performed by machines designed exclusively for this work. When flat dies are used, as shown in figure 37 at *C*, one die, *M*, remains stationary and the other die, *N*, which is parallel or nearly parallel to *M*, has a reciprocating movement. The faces of the dies have parallel milled or planed grooves of approximately the same form as that of the required thread, which are set at an angle to the line of motion of the blank equal to the helix angle of the thread to be produced. The angles of the grooves and ridges in a plane perpendicular to the direction of the grooves are given by the formula—

$$\text{Tan } a_1 = \tan a \cos s,$$

in which

a_1 = half angle of ridge of die
a = half angle of thread to be rolled
s = helix angle of thread

The spacing of the ridges is determined by the formula—

$$p_1 = p \cos s,$$

in which

p_1 = spacing of ridges of die
p = pitch of thread to be rolled
s = helix angle of thread.

The blank is inserted at one end of the stationary die, and rolls between the die faces until it is ejected at the other, the thread being formed in one passage of the blank. When cylindrical dies are used, one of the dies, which is a complete cylinder revolves continuously in one direction and the other is a stationary cylindrical segment. This method is used extensively for threading almost all forms of small and medium sizes of screws and bolts, when required in sufficiently large quantities to warrant the use of a thread-rolling machine.[8]

5. FINISHING OF SCREW THREADS

On account of the difficulty of producing an accurately finished thread by means of a cutting tool, in ordinary gage-making practice the thread is ground, lapped, or ground and lapped, in order to finish all elements of the thread to correct dimensions. The process of grinding is applied to hardened screws only, and is intended to correct any errors present as the result of distortion in the hardening process, as well as those resulting from the cutting operation. Threads are also sometimes "ground from the solid," that is, the entire thread is produced by grinding. Lapping is usually applied to hardened screw threads, and may be either substituted for grinding, or performed after grinding to remove the marks left by the grinding wheel and to produce a smooth and highly finished surface. These processes are used largely in the production of screw-thread gages.

(*a*) Grinding.—The grinding of a thread is similar to the process of milling a thread by the single-cutter method. The profile of the periphery of the grinding wheel is "dressed" by means of a diamond to conform to the shape of the thread groove in an axial plane, with the axis of the wheel set at an angle to the axis of the thread, in a plane parallel to the axis of the thread, equal to the helix angle. In order to produce a thread having straight sides and correct angle, the periphery of the wheel should be dressed to the required angle after the wheel has been set to the helix angle, in the plane containing the axis of the thread and the center of the wheel. The same considerations as to the exact profile of the periphery of the grinding wheel, to produce a thread of exactly correct form, apply as for the tooth profile of a single milling cutter set at the helix angle of the thread. The principal differences between the thread milling and grinding processes are that a large diameter of grinding wheel is desirable, and one or more light cuts are taken, whereas, a small diameter of milling cutter is desirable and a single heavy cut is taken.

[8] The principles involved in determining the spacing and angle of ridges of flat dies, and position of the dies, are considered in Principles of Thread Rolling and the Setting of Dies, by J. F. Springer, American Machinist, vol. 33, Apr. 21, 1910, pp. 739–741.

(*b*) Lapping.—The lapping of a screw thread may be defined as a process of abrasion by successively traversing the thread, as it revolves, with a so-called lap, which consists of an engaging screw thread of softer material, usually fine-grained cast iron, brass, or cold-rolled steel, in which very fine abrasive material is embedded in the thread surface. For removing considerable material, the laps are charged with coarser abrasive, and for imparting fine finish, a finer abrasive; in either case the abrasive used is very fine, and the lap is thoroughly lubricated. A number of laps may be necessary to finish either an internal or external thread to the required form and dimensions, as illustrated in figure 38.

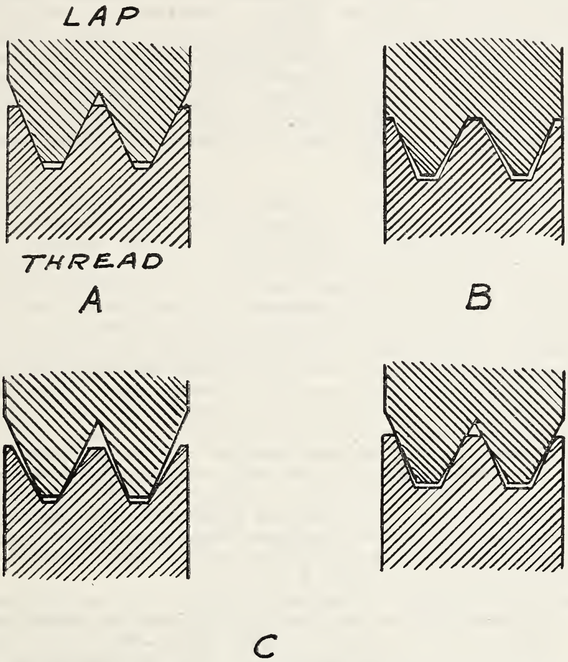

Figure 38.—*Thread form of laps for lapping screw threads.*

6. GAGING PRACTICES AND TYPES OF GAGES

The production of accurate parts is primarily a matter of constant vigilance and of training of workmen. The smaller the tolerances which are to be maintained, the more complete the inspection or gaging system must be. In order to secure satisfactory results, the manufacturing tools provided must be sufficiently accurate, and the manufacturing methods must be sufficiently reliable to produce the required results. After tools and methods of proved reliability are provided, it is necessary to watch the wear on the tools or changes in their set-up to insure that the required conditions are maintained. This is accomplished by periodical tests of the tools and by periodical gaging of the product.

The most difficult element of a screw thread to gage is the lead. Lead-testing devices for checking tools and gages are available, but, in general, their operation is too slow for use as production inspection equipment. In addition, the lead is the most important element of a screw thread as regards the nature of the contact between the surfaces of the mating parts. Furthermore, the result of an error in lead is almost double that of an equal error in diameter as regards interchangeability. For exacting threaded work, if the method of inspection of the product does not effectively detect lead errors, the tools used must be carefully inspected for lead. In order to reduce the possibilities of disagreement to a minimum, the manufacturer should strive to produce parts well within the specified limits rather than close to the limiting sizes.

(*a*) Thread Micrometers.—Thread micrometers are sometimes used to measure the pitch diameter of taps and screws. Thread micrometers should be calibrated periodically against a master gage, to avoid errors due to wear on the anvils of the instrument. As thread micrometers give no indication of lead and angle errors, the results of tests made with thread micrometers alone cannot be taken as conclusive, and a "go" gage should always be used as a supplementary test. Thread micrometers are very effective means of checking against the change in set-up due to wear on tools, etc.

(*b*) Thread Snap Gages.—Thread snap gages are generally adjustable and have contact points consisting of cone-pointed anvils, wedge-shaped prisms with rounded edges, serrated or grooved plates, or grooved or threaded cylinders adjustably mounted and suitably spaced in a U-shaped frame. These gages are used to some extent in gaging external threads and have the advantages that work may be inspected with great rapidity by the single motion of passing it between the anvils of the gage and given a visual examination for clearance as well as a tactile inspection. The positions of the anvils are set to a setting gage, and the anvils are then clamped in position and sealed. Thread snap gages are to be preferred as "not go" gages.

The cone-pointed snap gage usually has a single point on each side of the frame, and is an effective "not go" gage. It does not, however, fully meet the requirements for a "go" gage, as it does not check the lead, and therefore, must be supplemented with some type of indicating gage to check the lead when used for checking pitch diameter, angle, and thread form. Also, as it checks only a single diameter at a time, the "go" snap gage must be tried at a series of points to determine whether the maximum pitch diameter of an external thread is within the tolerance. When provided with three contact points, two on one side spaced an integral number of threads apart and one on the other, such a gage checks the lead for progressive, but not always for local or periodic lead errors, and, thus, it more nearly fulfills the requirements for a "go" thread gage. This type or other types of short engagement are suitable for product of classes 4 and 5, provided that an independent inspection of the lead is made.

Thread snap gages having multiple toothed contact points, that is, toothed blades, serrated or grooved plates, or grooved or threaded cylinders, are made in a variety of forms, either as separate or combined "go" and "not go" gages. The fit of a screw in such a gage is affected by variations in pitch diameter, lead, and angle of the screw, and the gage accordingly may be used as a "go" gage for the less accurate classes of work, such as classes 1 and 2, and, if well designed and accurately made, also for classes 3, 4, and 5.

(*c*) Thread Ring Gages.—Thread ring gages are extensively used to inspect the threads on screws. These are usually adjustable to suitable setting gages. When the product is to be within specified limits, "go" and "not go" gages are required. The use of such gages gives some information as to lead and angle errors as well as pitch diameter errors.

(*d*) Thread Comparators.—A development in the art of measuring threaded parts is the optical thread comparator, which embodies the principle of gaging in an optical projection system. In addition to giving a rapid indication of whether or not the elements of the screw thread lie within the limiting dimensions specified, such instruments furnish more detailed information as to the errors in screw threads than is usually obtained by means of mechanical gages, particularly as to irregularities in thread form, lead, and diameter. These instruments can be adapted to measure taps and other threading tools.

The available forms of projection comparators differ somewhat in design and principle, but each consists primarily of a source of parallel light, such as a mercury arc or concentrated filament lamp with condensing lens system, a projection lens system, a screen upon which the magnified shadow image of the work is projected, and a device for holding the work in position in front of the projection lenses. Measurements are made of the projected shadow image, or there may be a tolerance chart on the screen on which two outlines of the correct thread form at the magnification used are spaced one above the other a distance equal to the tolerance multiplied by the magnification. The chart and gage holder are adjusted to position by projecting the shadow image of a setting gage and adjusting to bring the outline of the shadow image and certain lines of the chart into coincidence, after which the system may be used as a gaging device.

The above types of optical thread comparators are applicable to external threads. Two types of optical thread comparators for internal threads have been developed by the National Bureau of Standards, one known as an "optical coincidence thread gage", and the other as a "stereoscopic thread gage."[9]

(e) Indicating Gages.—An indicating thread gage has movable contact points, which are set to a setting gage, and is intended to give an exact indication of the variations of the dimensions of a screw thread within the specified limits, rather than to show merely that the thread is within, or outside of, the specified limits, as is the case with limit gages. In such gages the movable contact points actuate a multiplying lever system, or other means for magnifying their motion, and the amount of the motion is registered on a graduated dial or scale. Indicating gages are made according to a variety of designs, some to indicate progressive lead error only, some to indicate pitch diameter only, some to indicate both separately but on the same gage, others to indicate the major and minor diameters as well, and still others to indicate the apparent size. They have been applied almost exclusively to external threads. Those which indicate the apparent size may be considered as most nearly fulfilling the requirements of a gaging system. However, those indicating lead errors are very useful in controlling lead errors in threading tools and screw-thread products. Also certain types can be used to indicate the variation in roundness on pitch or major diameters.

(f) Thread Plug Gages.—At the present time the most practical means of gaging threaded holes or nuts is by the use of thread plug gages. When the product is to be within specified limits, "go" and "not go" gages are required. The use of such gages gives some information as to lead and angle errors as well as pitch diameter errors. A correct "go" plug gage will reject any parts which fall below the minimum dimensions specified.

One practice of inspecting tapped holes is first to inspect the tap, and then to test the tapped holes periodically with "go" and "not go" gages. The tap can be watched for wear by testing the tapped holes with a "go" thread gage. One widely used practice consists of using a "go" thread plug gage, and a "not go" plain plug gage for the minor diameter.

One practice of inspecting taps is to measure the several elements, such as pitch diameter, angle, and lead. Another practice consists of tapping a hole with each tap before it is issued from the tool crib and testing these tapped holes with "go" and "not go" thread plug gages.

Sometimes the tap is tested after it is returned to the tool crib. If it is correct, it is replaced in its proper compartment. If it has worn below the limit, it is discarded and work which has been produced by it is checked and corrected when necessary.

(g) Plain Gages.—"Go" and "not go" plain cylindrical plug gages are used for inspecting the minor diameter of the tapped hole. Plain ring or snap gages are used for inspecting the major diameter of the screw. When used, it is recommended that the "go" inspection gage be a ring gage and the "not go" inspection gage be a snap gage. The working gages may be combined as a "go" and "not go" snap gage.

(h) Gear-Tooth Caliper for Thread Thickness.—A device which is particularly useful in the measurement of thread thickness of Acme screw threads, or of tools for producing them, is the gear-tooth caliper. With this device the depth at which the measurement is made is controlled by means of a scale and vernier or a micrometer and the thickness is determined by means of another.

(i) Testing of Gages.—Gages should be tested periodically for wear and to insure that the gages are properly distributed. When successive inspections in the same plant are involved, it is good practice to inspect all gages of the same nominal size against each other periodically, and to distribute these gages so that the earlier inspections are made with those which are the greatest amount inside of the component limits, while the later inspections are made with those gages closest in size to the component limits.

The original testing of a thread gage should include measurements of diameters, lead, and angle. If these elements test satisfactorily, the later inspection need be only measurements of pitch diameter.[10]

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[9] Described in B. S. J. Research, 6, pp. 229–237 (February 1931).

[10] Methods of measuring pitch diameter of screw-thread gages are described in appendix 2, p. 197.

APPENDIX 4. CLASS 5 FIT FOR THREADED STUDS (TENTATIVE SPECIFICATIONS)

The tentative specifications embodied herein for class 5 fit for threaded studs are based partly upon experimental data obtained in an investigation conducted by the National Bureau of Standards and partly upon data obtained from manufacturers relative to existing practice. The specifications are complete only for studs set in hard materials (cast iron, steel, bronze, etc.), and are not complete for studs set in aluminum for which larger interference of metal is permissible. They are presented for the information of those who may have use for them but are in no way mandatory.

1. FORM OF THREAD

The American National form of thread profile, as specified in section III, shall be used. The thread form of the tapped hole is modified, however, by truncating the crest of the thread a greater amount than that specified for threads of strictly American National form. This truncation is such that the minimum depth of thread engagement is one half of the basic thread depth, to provide clearance space into which the metal can flow. The maximum depth of engagement is governed by the tolerances specified for the major diameter of the stud and the minor diameter of the tapped hole.

2. THREAD SERIES

The range of sizes from ¼ inch to 1½ inches, inclusive, of the American National coarse-thread series and the American National fine-thread series of sizes and pitches as given in section III, are recommended for general use for class 5 fit for threaded studs.

3. CLASSIFICATION AND TOLERANCES

The accompanying specifications are intended for use in the production and assembly of threaded studs and tapped holes on an interchangeable basis.

(a) GENERAL SPECIFICATIONS

The following general specifications apply for all materials to class 5 fit for threaded studs, American National coarse-thread series and American National fine-thread series.

1. Definition.—The wrench fit class is intended to cover the manufacture of threaded studs and holes which are to be assembled permanently by the application of power.

2. Minimum Tapped Hole.—The pitch diameter of the minimum threaded hole corresponds to the basic size, the tolerances being applied above the basic size.

3. Maximum and Minimum Stud Above Basic.—The pitch diameter of both the maximum and minimum studs of a given size and pitch are above the basic dimensions, which are computed from the basic major diameter of the thread. The maximum major diameter of the stud is basic.

4. Length of Engagement.—A length of engagement equal to one and one half times the basic major diameter for studs set in hard materials, and two times the basic major diameter for studs set in soft materials, is the basis of the tolerances and allowances specified herein. The length of engagement of two diameters is especially desirable for studs set in soft materials when subject to alternating stresses or to vibration.

5. Minimum Interferences.—The minimum interferences specified are such that a wrench-tight fit will result in all cases. If the thread surfaces are smooth and thread form is maintained, these interferences will permit disassembly and reassembly of the same stud and hole as many as four times and still produce a wrench-tight fit.

6. Maximum Interferences.—The maximum interferences specified are such that all conditions necessary for a good wrench fit are fulfilled. If threads are well lubricated with a suitable lute no galling or seizing of the threads will result. Also, mild-steel studs, even of the smaller sizes, will not break if the rate of assembly is not excessive.

When a mixture of white lead and oil is used as a lute it is important that it be of a thick fluid consistency in order to prevent galling or seizing, particularly when fine threads in hard materials are concerned, and that it be applied liberally. If a lute consisting of 40 percent zinc dust, which has passed through a 200-mesh sieve, and 60 percent petrolatum is used, the tendency for the threads to gall or seize with maximum interference is materially reduced.

7. Tolerances.—(*a*) The tolerances specified represent the extreme variations permitted on the product.

(*b*) The tolerance on the tapped hole is plus, and is applied from the basic size to above basic size.

(*c*) The tolerance on the screw is minus, and is applied from the maximum screw size to below the maximum screw size.

(*d*) The pitch diameter tolerances for the tapped hole are the same as for the class 4 fit nut, except on the ¼-inch size, as noted in table 124. These tolerances necessitate the use of ground-thread taps.

(*e*) The pitch diameter tolerances for the stud are as given in tables 124 and 125. They are the maximum variations permissible for each individual size of stud, as determined by the maximum and minimum interferences.

(*f*) Pitch diameter tolerances include angle variations but do not include lead variations.

(*g*) The tolerances on the major diameters of class 5 fit studs are the same as for class 2 fit finished screws.

(*h*) The minimum minor diameter of a stud of a given pitch is such as to result in a basic flat ($1/8 \times p$) at the root. It is equal to the measured pitch diameter of the stud minus the basic thread depth.

(*i*) The maximum minor diameter of a stud of a given pitch may be such as results from the use of a worn or rounded threading tool, when the pitch diameter is at its maximum value. In no case, however, should the form of the thread, as results from tool wear, be such as to cause the stud to be rejected on the maximum minor diameter by a "go" ring gage, the minor diameter of which is equal to the minimum minor diameter of the class 2 nut.

(*j*) The maximum major diameter of the tapped hole of a given pitch is such as to result in a flat equal to one third of the basic flat ($1/24 \times p$). When the minimum hole is basic, its maximum major diameter will be above the basic major diameter by the amount of the specified pitch diameter tolerance plus two ninths of the basic thread depth.

(*k*) The minimum major diameter of a tapped hole is the basic major diameter. In no case, however, should the minimum major diameter of the hole, as results from a worn tap or cutting tool, be such as to cause it to be rejected on the minimum major diameter by a "go" plug gage made to the standard form at the crest.

(*l*) The tolerance on the minor diameter of a tapped hole of a given pitch is one sixth of the basic thread depth.

8. Illustration.—The relations of the maximum and minimum major, pitch, and minor diameters of stud and tapped hole specified herein are shown in figures 39, 40, and 41.

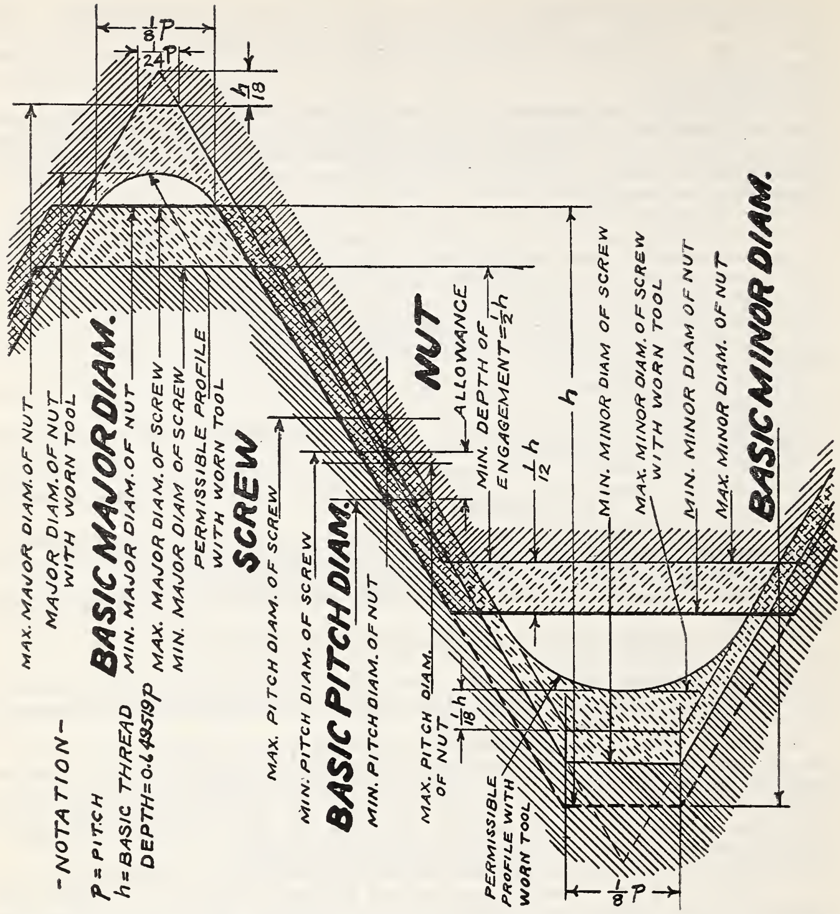

FIGURE 39.—*Illustration of tolerances, allowance, and crest clearances for class 5 fit for threaded studs.*

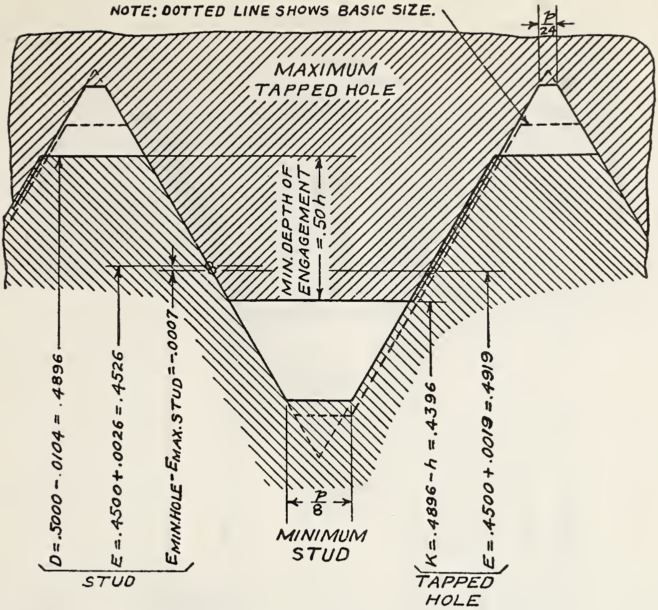

FIGURE 40.—*Illustration of loosest condition for class 5 fit for threaded studs, one-half inch, 13 threads, set in hard materials.*

NOTATION

D=major diameter.
E=pitch diameter.
K=minor diameter.
h=0.0500=basic thread depth.

(b) CLASSIFICATION

1. ALLOWANCE AND TOLERANCE VALUES.—Allowances and tolerances are specified in tables 124, and 125, inclusive, for coarse-threaded and fine-threaded studs set in hard materials—namely, cast iron, steel, and bronze. These are based upon data obtained in an experimental investigation and fulfill the conditions outlined in the above specifications.

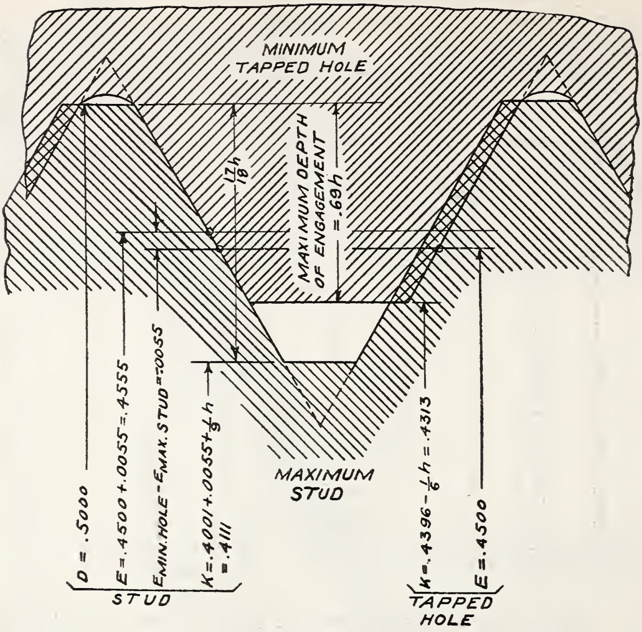

FIGURE 41.—*Illustration of tightest condition for class 5 fit for threaded studs, one-half inch, 13 threads, set in hard materials.*

NOTATION

D=major diameter.
E=pitch diameter.
K=minor diameter.
h=0.0500=basic thread depth.

4. TABLES OF DIMENSIONS

Tables 126 and 127 give recommended thread dimensions of studs and tapped holes which meet the above specifications for coarse-threaded and fine-threaded studs set in hard materials. Also the limiting values of the torques at full engagement (lever-arm times force) which may be expected in the assembly of studs and tapped holes made to these dimensions are given.

TABLE 124.—*Class 5 fit for threaded studs, allowances and tolerances for studs and tapped holes, coarse threaded studs in hard materials*

Sizes	Threads per inch	Interference on pitch diameter		Pitch diameter tolerances [1]		Errors in half angle consuming one half of pitch diameter tolerances	
		Minimum	Maximum	Stud	Tapped hole [2]	Stud	Tapped hole
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*	*Inch*	*Deg. Min.*	*Deg. Min.*
¼	20	0.0003	0.0018	0.0007	0.0008	0 16	0 25
5/16	18	.0005	.0040	.0020	.0015	0 41	0 31
⅜	16	.0005	.0045	.0024	.0016	0 44	0 29
7/16	14	.0006	.0050	.0026	.0018	0 42	0 29
½	13	.0007	.0055	.0029	.0019	0 44	0 28
9/16	12	.0008	.0060	.0032	.0020	0 44	0 28
⅝	11	.0008	.0060	.0031	.0021	0 39	0 26
¾	10	.0009	.0065	.0033	.0023	0 38	0 26
⅞	9	.0010	.0065	.0031	.0024	0 32	0 25
1	8	.0011	.0065	.0027	.0027	0 25	0 25
1⅛	7	.0011	.0065	.0024	.0030	0 19	0 24
1¼	7	.0012	.0065	.0023	.0030	0 18	0 24
1⅜	6	.0012	.0065	.0017	.0036	0 12	0 25
1½	6	.0013	.0070	.0021	.0036	0 14	0 25

[1] Inasmuch as a moderate difference in lead between stud and tapped hole (about 0.005 inch per inch) has been shown to improve the quality of a stud fit having minimum pitch diameter interference, no lead tolerance is specified. Therefore, the tolerances specified for pitch dimeter include all errors of pitch diameter and angle but not of lead. (See "5. Gages and gaging" herein.) Excessive lead errors, however, should be avoided, as they increase the tendency of the stud to loosen when subjected to load. Columns 7 and 8 give, for information, the errors in angle which can be compensated for by half the tolerances on pitch diameter given in columns 5 and 6.

[2] The tolerances on the tapped hole given in column 6 are the same as those specified for class 4 fit screws and nuts, with the exception of the ¼-inch size.

TABLE 125.—*Class 5 fit for threaded studs, allowances and tolerances for studs and tapped holes, fine-threaded studs in hard materials*

Sizes	Threads per inch	Interference on pitch diameter		Pitch diameter tolerances [1]		Errors in half angle consuming one half of pitch diameter tolerances	
		Minimum	Maximum	Stud	Tapped hole [2]	Stud	Tapped hole
1	2	3	4	5	6	7	8
		Inch	*Inch*	*Inch*	*Inch*	*Deg. Min.*	*Deg. Min.*
¼	28	0.0005	0.0034	0.0018	0.0011	0 58	0 35
5/16	24	.0005	.0037	.0020	.0012	0 55	0 33
⅜	24	.0006	.0044	.0026	.0012	1 11	0 33
7/16	20	.0006	.0044	.0025	.0013	0 57	0 30
½	20	.0007	.0050	.0030	.0013	1 9	0 30
9/16	18	.0007	.0050	.0028	.0015	0 58	0 31
⅝	18	.0008	.0055	.0032	.0015	1 6	0 31
¾	16	.0008	.0059	.0035	.0016	1 4	0 29
⅞	14	.0008	.0061	.0035	.0018	0 56	0 29
1	14	.0009	.0069	.0042	.0018	1 7	0 29
1⅛	12	.0009	.0067	.0038	.0020	0 52	0 28
1¼	12	.0011	.0060	.0029	.0020	0 40	0 28
1⅜	12	.0011	.0055	.0024	.0020	0 33	0 28
1½	12	.0012	.0050	.0018	.0020	0 25	0 28

[1] Inasmuch as a moderate difference in lead between stud and tapped hole (about 0.005 inch per inch) has been shown to improve the quality of a stud fit having minimum pitch diameter interference, no lead tolerance is specified. Therefore, the tolerances specified for pitch diameter include all errors of pitch diameter and angle but not of lead. (See "5. Gages and gaging" herein.) Excessive lead errors, however, should be avoided, as they increase the tendency of the stud to loosen when subjected to load. Columns 7 and 8 give, for information, the errors in angle which can be compensated for by half the tolerances on pitch diameter given in columns 5 and 6.

[2] The tolerances on the tapped hole given in column 6 are the same as those specified for class 4 fit screws and nuts.

TABLE 126.—*Class 5 fit, American National coarse-thread series, steel studs set in hard materials (cast iron, semisteel, bronze, etc.)*

Sizes	Threads per inch	Stud sizes					Tapped-hole sizes					Recommended tap drill size		Approximate torque at full engagement of 1½D	
		Major diameter		Pitch diameter		Minor diameter	Minor diameter		Pitch diameter		Major diameter				
		Maximum	Minimum	Maximum	Minimum	Maximum [1]	Minimum	Maximum	Minimum	Maximum	Minimum [2]	Nominal size	Diameter	Maximum	Minimum
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*In.-lb.*	*In.-lb.*
¼ [3]	20	0.2500	0.2428	0.2193	0.2186	0.1904	0.2049	0.2103	0.2175	0.2183	0.2500	0.2090	0.2090	105	35
5/16	18	.3125	.3043	.2804	.2784	.2483	.2622	.2682	.2764	.2779	.3125	.2656	.2656	265	80
3/8	16	.3750	.3660	.3389	.3365	.3028	.3186	.3254	.3344	.3360	.3750	.3230	.3230	420	120
7/16	14	.4375	.4277	.3961	.3935	.3549	.3736	.3813	.3911	.3929	.4375	.3750	.3750	610	180
½	13	.5000	.4896	.4555	.4526	.4111	.4313	.4396	.4500	.4519	.5000	.4375	.4375	850	265
9/16	12	.5625	.5513	.5144	.5112	.4663	.4882	.4972	.5084	.5104	.5625	12.5 mm	.4921	1,170	360
5/8	11	.6250	.6132	.5720	.5689	.5195	.5444	.5542	.5660	.5681	.6250	35/64	.5469	1,450	450
¾	10	.7500	.7372	.6915	.6882	.6338	.6614	.6722	.6850	.6873	.7500	43/64	.6719	2,300	730
7/8	9	.8750	.8610	.8093	.8062	.7452	.7768	.7888	.8028	.8052	.8750	25/32	.7812	3,200	1,080
1	8	1.0000	.9848	.9253	.9226	.8531	.8901	.9036	.9188	.9215	1.0000	57/64	.8906	4,250	1,500
1⅛	7	1.1250	1.1080	1.0387	1.0363	.9562	.9998	1.0152	1.0322	1.0352	1.1250	1	1.0000	5,300	1,875
1¼	7	1.2500	1.2330	1.1637	1.1614	1.0812	1.1248	1.1402	1.1572	1.1602	1.2500	1⅛	1.1250	6,950	2,535
1⅜	6	1.3750	1.3548	1.2732	1.2715	1.1770	1.2286	1.2466	1.2667	1.2703	1.3750	1 15/64	1.2344	8,150	2,970
1½	6	1.5000	1.4798	1.3987	1.3966	1.3025	1.3536	1.3716	1.3917	1.3953	1.5000	1 23/64	1.3594	10,400	3,900

[1] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h, (or $0.6495p$) from the minimum pitch diameter of the screw.

[2] Dimensions for the minimum major diameter of the tapped hole correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the tapped hole shall be that corresponding to a flat at the major diameter of the tapped hole equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the nut.

[3] Selective assembly in the case of the ¼-inch size may be required on account of the small tolerances necessary on pitch diameter. To avoid breaking a mild steel stud, the maximum interference on pitch diameter of 0.0018 inch must not be exceeded. The use of ¼″–28, instead of ¼″–20, is recommended.

TABLE 127.—*Class 5 fit, American National fine-thread series, steel studs set in hard materials (cast iron, semisteel, bronze, etc.)*

Sizes	Threads per inch	Stud sizes					Tapped-hole sizes					Recommended tap drill size		Approximate torque at full engagement of 1½*D*	
		Major diameter		Pitch diameter		Minor diameter	Minor diameter		Pitch diameter		Major diameter				
		Maximum	Minimum	Maximum	Minimum	Maximum [1]	Minimum	Maximum	Minimum	Maximum	Minimum [2]	Nominal size	Diameter	Maximum	Minimum
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*In.-lb.*	*In.-lb.*
¼	28	0.2500	0.2438	0.2302	0.2284	0.2096	0.2167	0.2206	0.2268	0.2279	0.2500	0.2187	0.2187	140	45
5/16	24	.3125	.3059	.2891	.2871	.2650	.2743	.2788	.2854	.2866	.3125	.2770	.2770	230	70
⅜	24	.3750	.3684	.3523	.3497	.3282	.3368	.3413	.3479	.3491	.3750	.3390	.3390	410	125
7/16	20	.4375	.4303	.4094	.4069	.3805	.3924	.3978	.4050	.4063	.4375	.3970	.3970	540	170
½	20	.5000	.4928	.4725	.4695	.4436	.4549	.4603	.4675	.4688	.5000	----------	.4576	810	260
9/16	18	.5625	.5543	.5314	.5286	.4993	.5122	.5182	.5264	.5279	.5625	33/64	.5156	1,040	330
⅝	18	.6250	.6168	.5944	.5912	.5623	.5747	.5807	.5889	.5904	.6250	37/64	.5781	1,430	460
¾	16	.7500	.7410	.7153	.7118	.6792	.6936	.7004	.7094	.7110	.7500	----------	.6970	2,200	685
⅞	14	.8750	.8652	.8347	.8312	.7935	.8111	.8188	.8286	.8304	.8750	13/16	.8125	3,070	945
1	14	1.0000	.9902	.9605	.9563	.9193	.9361	.9438	.9536	.9554	1.0000	15/16	.9375	4,590	1,410
1⅛	12	1.1250	1.1138	1.0776	1.0738	1.0295	1.0507	1.0597	1.0709	1.0729	1.1250	----------	1.0552	5,620	1,750
1¼	12	1.2500	1.2388	1.2019	1.1990	1.1538	1.1757	1.1847	1.1959	1.1979	1.2500	30.0 mm	1.1811	6,960	2,530
1⅜	12	1.3750	1.3638	1.3264	1.3240	1.2782	1.3007	1.3097	1.3209	1.3229	1.3750	----------	1.3052	8,440	3,225
1½	12	1.5000	1.4888	1.4509	1.4491	1.4028	1.4257	1.4347	1.4459	1.4479	1.5000	----------	1.4302	10,070	4,215

[1] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h, (or $0.6495p$) from the minimum pitch diameter of the screw.

[2] Dimensions for the minimum major diameter of the tapped hole correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the tapped hole shall be that corresponding to a flat at the major diameter of the tapped hole equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the nut.

5. GAGES AND GAGING

The fundamentals of this subject, as it relates to screw threads, are laid down in section III. The relatively close limits on pitch diameter specified for class 5 fit for threaded studs, necessitate careful and accurate gaging of both the stud and tapped hole, particularly since the actual measurements obtained depend somewhat upon the methods of gaging used.

Considering first the case of minimum interference: The minimum stud and maximum hole are selected by means of "not go" gages. With the usual or recommended forms of "not go" gages, the presence of lead errors does not affect the gaging, if the gage is not allowed to enter the work more than 1½ turns. It has been shown by the experimental data obtained that this is a desirable condition, as the presence of a slight difference in lead between stud and hole is an advantage, especially with minimum pitch diameter interference. It is important, however, as with the other classes of fit, that the "not go" gage should check primarily the pitch diameter, for upon this the minimum tightness of a stud fit depends, assuming that the correct thread form and smoothness of thread surface are maintained.

In the case of maximum interference the maximum stud and minimum hole are selected by means of "go" gages, and these may or may not be the usual types of threaded plugs and rings. Plug and ring gages control pitch diameter, lead, thread angle, maximum minor diameter of stud, and minimum major diameter of hole. The minimum minor diameter of the hole being considerably above basic, it is not controlled by the "go" threaded plug gage, and as it has been shown that a certain minimum clearance at minor diameter must be maintained, it is very important that the hole should be gaged further by means of a "go" plain plug gage. Gaging the tapped hole by means of a "not go" plain plug gage is also desirable, but not strictly necessary.

Gaging of the major diameter of the stud thread is not essential; this element may be controlled by the size of stock. Some means of controlling the minimum minor diameter of the stud is, however, very desirable, particularly on studs of the smaller sizes, because the shearing strength of the stud depends upon this element. For this purpose the projection comparator is very useful, but inspection of the cutting tool to assure a width of flat at the root of the thread not less than $\frac{1}{8} \times p$ is sufficient.

The use of thread micrometers or "go" thread snap gages of short engagement for checking the pitch diameter of the stud is good practice provided that the thread form is ascertained by optical inspection. Gaging for lead errors is not essential provided that the lead of the threading tools is maintained within the usual limits of good commercial practice.

If the tap (ground thread tap) is a close fit in the hole after tapping—that is, if the tap cannot be screwed easily (without the use of a wrench) through the hole after tapping—it may be assumed that the pitch diameter of the hole is very nearly the same as that of the tap.

6. ALTERNATIVE SYSTEM OF STUD FITS

Some dissatisfaction with the above system of class 5 fits has been expressed, on account of the difficulty of maintaining tapped holes within the tolerances specified, whereas the threads on studs can readily be made within smaller tolerances than those specified. There has also been some indication that the minimum interference is too small, and that the theoretical maximum interference can be increased slightly.

The interferences, as determined experimentally, were based on direct pitch diameter measurements of the stud and of the tap. If, in practice, the interferences are controlled by "go" and "not go" thread gages, the actual maximum and minimum interferences obtained may be less than those tabulated, on account of lead, angle, and pitch diameter tolerances of gages. It should, therefore, be possible to increase the theoretical maximum interferences, and desirable to increase the minimum interferences.

There are presented in tables 128 and 129, *for trial*, revised interferences and tolerances, and in tables 130 and 131 the corresponding limiting dimensions, which are in substantial agreement with some present commercial practice. The revised system is predicated upon the definite use of W thread plug and ring gages to control thread sizes of both studs and tapped holes. That is, the maximum interferences have been increased, in general (with slight deviations for smoothing of tables), by the diameter equivalent of pitch diameter, lead, and angle gage tolerances of W gages. This equivalent is taken for one W gage, and therefore represents an average condition.

In order to maintain minimum interferences it is important that the "not go" gages should not assemble with the product more than 1½ turns.

TABLE 128.—*Alternate class 5 fit for threaded studs, allowances and tolerances for studs and tapped holes, coarse threaded studs in hard materials*

Sizes	Threads per inch	Interference on pitch diameter		Pitch diameter tolerances	
		Minimum	Maximum	Stud [1]	Tapped hole [2]
1	2	3	4	5	6
		Inch	*Inch*	*Inch*	*Inch*
5/16	18	0.0005	0.0046	0.0015	0.0026
3/8	16	.0005	.0051	.0016	.0030
7/16	14	.0007	.0057	.0018	.0032
1/2	13	.0009	.0062	.0019	.0034
9/16	12	.0011	.0066	.0020	.0035
5/8	11	.0012	.0069	.0021	.0036
3/4	10	.0013	.0073	.0023	.0037
7/8	9	.0013	.0074	.0024	.0037
1	8	.0013	.0075	.0025	.0037
1 1/8	7	.0014	.0076	.0025	.0037
1 1/4	7	.0014	.0076	.0025	.0037
1 3/8	6	.0014	.0076	.0025	.0037
1 1/2	6	.0016	.0081	.0025	.0040

[1] These are class 4 tolerances from 5/16 to 7/8 in. inclusive. Tolerances for larger sizes are less than class 4.
[2] These tolerances lie between classes 3 and 4 tolerances.

TABLE 129.—*Alternate class 5 fit for threaded studs, allowances and tolerances for studs and tapped holes, fine-threaded studs in hard materials*

Sizes	Threads per inch	Interference on pitch diameter		Pitch diameter tolerances	
		Minimum	Maximum	Stud [1]	Tapped hole [2]
1	2	3	4	5	6
		Inch	*Inch*	*Inch*	*Inch*
1/4	28	0.0006	0.0039	0.0011	0.0022
5/16	24	.0006	.0042	.0012	.0024
3/8	24	.0008	.0044	.0012	.0024
7/16	20	.0008	.0047	.0013	.0026
1/2	20	.0011	.0050	.0013	.0026
9/16	18	.0011	.0056	.0015	.0030
5/8	18	.0011	.0056	.0015	.0030
3/4	16	.0011	.0059	.0016	.0032
7/8	14	.0011	.0065	.0018	.0036
1	14	.0015	.0069	.0018	.0036
1 1/8	12	.0015	.0075	.0020	.0040
1 1/4	12	.0015	.0072	.0020	.0037
1 3/8	12	.0015	.0067	.0020	.0032
1 1/2	12	.0015	.0062	.0020	.0027

[1] These are class 4 tolerances.
[2] These are class 3 tolerances from 1/4 to 1 1/8 in., inclusive.

TABLE 130.—*Alternate class 5 fit, American National coarse-thread series, steel studs set in hard materials (cast iron, semisteel, bronze, etc.)*

Sizes	Threads per inch	Stud sizes					Tapped-hole sizes					Recommended tap drill size		Approximate torque at full engagement of 1½D	
		Major diameter		Pitch diameter		Minor diameter	Minor diameter		Pitch diameter		Major diameter				
		Maximum	Minimum	Maximum	Minimum	Maximum [1]	Minimum	Maximum	Minimum	Maximum	Minimum [2]	Nominal size	Diameter	Maximum	Minimum
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*In.-lb.*	*In.-lb.*
5/16	18	0.3125	0.3043	0.2810	0.2795	0.2483	0.2622	0.2682	0.2764	0.2790	0.3125	0.2656	0.2656	265	80
3/8	16	.3750	.3660	.3395	.3379	.3028	.3186	.3254	.3344	.3374	.3750	.3230	.3230	420	120
7/16	14	.4375	.4277	.3968	.3950	.3549	.3736	.3813	.3911	.3943	.4375	.3750	.3750	610	195
1/2	13	.5000	.4896	.4562	.4543	.4111	.4313	.4396	.4500	.4534	.5000	.4375	.4375	850	295
9/16	12	.5625	.5513	.5150	.5130	.4663	.4882	.4972	.5084	.5119	.5625	12.5 mm	.4921	1,170	425
5/8	11	.6250	.6132	.5729	.5708	.5195	.5444	.5542	.5660	.5696	.6250	35/64	.5469	1,450	560
3/4	10	.7500	.7372	.6923	.6900	.6338	.6614	.6722	.6850	.6887	.7500	43/64	.6719	2,300	880
7/8	9	.8750	.8610	.8102	.8078	.7452	.7768	.7888	.8028	.8065	.8750	25/32	.7812	3,200	1,230
1	8	1.0000	.9848	.9263	.9238	.8531	.8901	.9036	.9188	.9225	1.0000	57/64	.8906	4,250	1,630
1 1/8	7	1.1250	1.1080	1.0398	1.0373	.9562	.9998	1.0152	1.0322	1.0359	1.1250	1	1.0000	5,300	2,120
1 1/4	7	1.2500	1.2330	1.1648	1.1623	1.0812	1.1248	1.1402	1.1572	1.1609	1.2500	1 1/8	1.1250	6,950	2,780
1 3/8	6	1.3750	1.3548	1.2743	1.2718	1.1770	1.2286	1.2466	1.2667	1.2704	1.3750	1 15/64	1.2344	8,150	3,210
1 1/2	6	1.5000	1.4798	1.3998	1.3973	1.3025	1.3536	1.3716	1.3917	1.3957	1.5000	1 23/64	1.3594	10,400	4,340

[1] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h (or $0.6495p$) from the minimum pitch diameter of the screw.

[2] Dimensions for the minimum major diameter of the tapped hole correspond to the basic flat ($\frac{1}{8} \times p$), and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the tapped hole shall be that corresponding to a flat at the major diameter of the tapped hole equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the nut.

TABLE 131.—*Alternate class 5 fit, American National fine-thread series, steel studs set in hard materials (cast iron, semisteel, bronze, etc.)*

Sizes	Threads per inch	Stud sizes					Tapped-hole sizes					Recommended tap drill size		Approximate torque at full engagement of 1½D	
		Major diameter		Pitch diameter		Minor diameter	Minor diameter		Pitch diameter		Major diameter				
		Maximum	Minimum	Maximum	Minimum	Maximum [1]	Minimum	Maximum	Minimum	Maximum	Minimum [2]	Nominal size	Diameter	Maximum	Minimum
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
		Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*In.-lb.*	*In.-lb.*
¼	28	0.2500	0.2438	0.2307	0.2296	0.2096	0.2167	0.2206	0.2268	0.2290	0.2500	0.2187	0.2187	140	50
5/16	24	.3125	.3059	.2896	.2884	.2650	.2743	.2788	.2854	.2878	.3125	.2770	.2770	230	80
⅜	24	.3750	.3684	.3523	.3511	.3282	.3368	.3413	.3479	.3503	.3750	.3390	.3390	410	145
7/16	20	.4375	.4303	.4097	.4084	.3805	.3924	.3978	.4050	.4076	.4375	.3970	.3970	540	195
½	20	.5000	.4928	.4725	.4712	.4436	.4549	.4603	.4675	.4701	.5000	----------	.4576	810	320
9/16	18	.5625	.5543	.5320	.5305	.4993	.5122	.5182	.5264	.5294	.5625	33/64	.5156	1,040	410
⅝	18	.6250	.6168	.5945	.5930	.5623	.5747	.5807	.5889	.5919	.6250	37/64	.5781	1,430	540
¾	16	.7500	.7410	.7153	.7137	.6792	.6936	.7004	.7094	.7126	.7500	----------	.6970	2,200	805
⅞	14	.8750	.8652	.8351	.8333	.7935	.8111	.8188	.8286	.8322	.8750	13/16	.8125	3,070	1,110
1	14	1.0000	.9902	.9605	.9587	.9193	.9361	.9438	.9536	.9572	1.0000	15/16	.9375	4,590	1,820
1⅛	12	1.1250	1.1138	1.0784	1.0764	1.0295	1.0507	1.0597	1.0709	1.0749	1.1250	----------	1.0552	5,620	2,260
1¼	12	1.2500	1.2388	1.2031	1.2011	1.1538	1.1757	1.1847	1.1959	1.1996	1.2500	30.0mm	1.1811	6,960	2,960
1⅜	12	1.3750	1.3638	1.3276	1.3256	1.2782	1.3007	1.3097	1.3209	1.3241	1.3750	----------	1.3052	8,440	3,770
1½	12	1.5000	1.4888	1.4521	1.4501	1.4028	1.4257	1.4347	1.4459	1.4486	1.5000	----------	1.4302	10,070	4,710

[1] Dimensions given for the maximum minor diameter of the screw are figured to the intersection of the worn tool arc with a center line through crest and root. The minimum minor diameter of the screw shall be that corresponding to a flat at the minor diameter of the screw equal to $\frac{1}{8} \times p$, and may be determined by subtracting the basic thread depth, h (or $0.6495p$) from the minimum pitch diameter of the screw.

[2] Dimensions for the minimum major diameter of the tapped hole correspond to the basic flat ($\frac{1}{8} \times p$) and the profile at the major diameter produced by a worn tool must not fall below the basic outline. The maximum major diameter of the tapped hole shall be that corresponding to a flat at the major diameter of the tapped hole equal to $\frac{1}{24} \times p$, and may be determined by adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the nut.

APPENDIX 5. COMMON PRACTICE AS TO THREAD SERIES AND CLASS OF FIT FOR SCREWS, BOLTS, AND NUTS

The usual commercial practice as to application of thread series and class of fit to screws, bolts, and nuts is indicated in table 132.

TABLE 132.—*Common practice as to thread series and class of fit for screws, bolts, and nuts*

Product	Thread series	Class of fit
1	2	3
Machine bolts	Coarse	Class 2.
Semifinished machine bolts	do	Do.
Finished bolts	Coarse or fine	Class 3.
Machine screws	do	Class 2.
Machine-screw nuts:		
Numbered sizes	do	Class 1.
Fractional sizes	do	Class 2.
Other standard nuts	do	Do.
Cap screws	do	Do.
Stove bolts	Coarse	Class 1.
Carriage bolts	do	Class 2.
Step bolts	do	Do.
Button-head bolts	do	Do.
Set screws	do	Class 3.[1]
Threaded studs:		
Nut end	{do Fine	Class 2. Class 3.
Stud end	Coarse or fine	Class 5.
Tap bolts	Coarse	Class 2.
Tap rivets	do	Do.

[1] See p. 168.

APPENDIX 6. ENDORSEMENTS

The Committee endorses the following specifications, which may be purchased from the Superintendent of Documents, Washington, D. C.

Commercial Standards of the U. S. Department of Commerce, National Bureau of Standards:

CS8–41. Gage Blanks.

Simplified Practice Recommendations of the U. S. Department of Commerce, National Bureau of Standards:

R51. Chasers for Self-opening and Adjustable Die Heads.

R169. Machine, Carriage, and Lag Bolts (Steel), (Stock Production Sizes).

Federal Specifications:

FF–B–561. Bolts, Lag; Steel (Lag-screws).

FF–S–111. Screws; Wood.

The Committee also endorses the following standards, not included in this handbook, approved and promulgated by the American Standards Association, and issued by the A. S. M. E., 29 West 39th Street, New York:

B 5.12–1940. Twist Drills, Straight Shank.

B 5.4–1939. Taps, Cut and Ground Threads.

The Committee further endorses the screw thread and screw-thread gage specifications included in the following American Petroleum Institute standards, which are issued by the American Petroleum Institute, Division of Production, Dallas, Texas.

No. 3. A. P. I. Dimensional Standards for Cable Drilling Tools.

No. 5–A. A. P. I. Pipe Specification; Casing, Drill Pipe and Tubing.

No. 5–F. A. P. I. Tentative Specification for Threads in Valves, Fittings, and Flanges.

No. 5–L. A. P. I. Line Pipe Specification.

No. 7–B. A. P. I. Specifications for Rotary Drilling Equipment.

No. 7–B–1. A. P. I. Dimensional Information on External Upset, Internal Flush Drill Pipe and Internal-Flush Rotary Drilling Tool Joints.

No. 11–A. A. P. I. Specifications for Cold Drawn and Machined Working Barrels.

No. 11–B. A. P. I. Sucker Rod Specifications.

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