U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

1950 SUPPLEMENT TO SCREW-THREAD STANDARDS FOR FEDERAL SERVICES 1944

1950 Supplement to Handbook H28 (1944)

Related Publications . . . .

Screw-Thread Standards for Federal Services, 1944

Screw-thread standards for the Federal Government have been established by the Interdepartmental Screw-Thread Committee of the Army, Navy, Air Force, and Commerce Departments in order to insure the interchangeability of threaded parts.

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Order NBS Circular 479, Unified Screw-Thread Standards, 27 large pages, illustrated, from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

UNITED STATES DEPARTMENT OF COMMERCE • • • CHARLES SAWYER, *Secretary*
NATIONAL BUREAU OF STANDARDS • E. U. CONDON, *Director*

1950 SUPPLEMENT TO NATIONAL BUREAU OF STANDARDS HANDBOOK H28 (1944)

1950 SUPPLEMENT TO SCREW-THREAD STANDARDS FOR FEDERAL SERVICES 1944

Prepared by direction of the
Interdepartmental Screw-Thread Committee
and superseding the Supplement issued June 15, 1949

[Issued March 20, 1951]

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1951

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. - - - - - - - - - - - Price 50 cents

Foreword

This 1950 Supplement to Handbook H28 (1944), Screw Thread Standards for Federal Services, replaces and augments the Supplement issued June 15, 1949. The former Supplement is reproduced herein with the exceptions of Section I, Appendix 6, and Appendix 9, which are superseded by Section I, Section II, and Section XV, respectively, in this supplement. Sections XVI and XVII herein, constitute new material. In order to preserve the topography of the previous Supplement, Sections II, XV, XVI, and XVII follow the Appendices.

The approval of these standards by the Federal Departments represented on the Interdepartmental Screw Thread Committee, as indicated on page v, makes them available for application to new designs and for acceptance of bolts, screws, nuts, and other threaded products that conform to these standards. The revision of the Handbook in its entirety will follow later.

On November 18, 1948, the Declaration of Accord with respect to the Unification of Screw Threads shown on the opposite page was signed by representatives of government and industry of Canada, the United Kingdom, and the United States. The publication of the Interdepartmental Screw Thread Committee, which was referred to in the Accord, was entitled, Unified Screw Threads as Recommended by the Interdepartmental Screw Thread Committee. The proceedings at which this Accord was signed are recorded in National Bureau of Standards Circular 479, Unified Screw Thread Standards.

This 1950 Supplement to Handbook H28 (1944) includes the Unified standards for thread form, for the coarse-thread series in sizes from ¼ inch to 4 inches, inclusive, and for the fine-thread series in sizes from ¼ inch to 1½ inches, inclusive, as agreed upon at the time the Declaration of Accord was signed. It also includes subsequently agreed upon Unified special threads and American National diameter-pitch combinations that have not been recognized as Unified standards, but for which allowances and tolerances have been formulated in accordance with the principles of Unified threads. Unified threads are distinguished from others by the inclusion of the letter U in the thread designation. To emphasize the distinction, bold-face type is used throughout the tables. Tables of tolerances, allowances, and other thread data for threads of special diameters, pitches, and lengths of engagement are also included.

E. U. Condon, *Chairman.*

Declaration of Accord

with respect to the

Unification of Screw Threads

It is hereby declared that the undersigned, representatives of their Government and Industry Bodies, charged with the development of standards for screw threads, Agree that the standards for the Unified Screw Threads given in the publications of the Committees of the British Standards Institution, Canadian Standards Association, American Standards Association and of the Interdepartmental Screw Thread Committee fulfill all of the basic requirements for general interchangeability of threaded products made in accordance with any of these standards.

The Bodies noted above will maintain continuous cooperation in the further development and extension of these standards.

Signed in Washington, D. C., this 18th day of November, 1948, at the National Bureau of Standards of the United States.

C. D. Howe.	Ministry of Trade and Commerce, Dominion of Canada
J. G. Morrow	Canadian Standards Association
T. R. B. Sanders.	Ministry of Supply, United Kingdom
Percy Good	British Standards Institution
Ewart Smith	Representative of British Industry
E. U. Condon	National Bureau of Standards U. S. Department of Commerce Interdepartmental Screw Thread Committee
Fred P. Tisch	American Standards Association The American Society of Mechanical Engineers Society of Automotive Engineers
William L. Batt	Sponsors Council of United States and United Kingdom on the Unification of Screw Threads

APPROVAL BY

THE SECRETARIES OF DEFENSE AND COMMERCE AND THE SECRETARIES OF THE DEPARTMENTS OF THE ARMY, NAVY, AND AIR FORCE

The accompanying 1950 Supplement to Handbook H28 (1944) on Screw-Thread Standards for Federal Services, submitted by the Interdepartmental Screw Thread Committee, is hereby approved for use by the Departments of Defense and Commerce. Deviations from these standards may be made where the need therefor is shown.

Secretary of Defense.

Acting Secretary of Commerce.

Secretary, Department of the Army.

Secretary, Department of the Navy.

Secretary, Department of the Air Force.

CONTENTS

1950 SUPPLEMENT TO SCREW-THREAD STANDARDS FOR FEDERAL SERVICES 1944

SECTION I. INTRODUCTION

Page 1, revise the second division of this section as follows:

2. PERSONNEL OF THE COMMITTEE

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

Representing the Department of the Army:

Mr. Stanley Farrow, Industrial Division, Ordnance Department, Department of the Army, Washington 25, D. C.
Mr. Eugene Von Loesch, Research and Development Division, Office of the Chief of Engineers, Department of the Army, Washington 25, D. C.

Representing the Department of the Navy:

Mr. James W. Jenkins, Metallurgical and Mechanical Branch, Research Division (Code 343), Department of the Navy, Washington 25, D. C.
Mr. H. B. Bothwell, Engineering Department, U. S. Naval Gun Factory, Washington 25, D. C.

Representing the Department of the Air Force:

Mr. Arthur F. Wentzel, Air Matériel Command, MCREXU7-Engineering Standards Section, Engineering Division, Wright-Patterson Air Force Base, Dayton, Ohio.
Lt. Col. Irving H. Hare, Chief, Standards Group, Deputy Chief of Staff Development, Headquarters, U. S. Air Force, Washington 25, D. C.

Representing the Department of Commerce:

Dr. Edward U. Condon, chairman, Director, National Bureau of Standards, Washington 25, D. C.
Mr. David R. Miller, Gage Section, Optics and Metrology Division, National Bureau of Standards, Washington 25, D. C.
Mr. Irvin H. Fullmer, Secretary and Alternate, Gage Section, Optics and Metrology Division, National Bureau of Standards, Washington 25, D. C.

Liaison Representatives of Sectional Committees Organized Under the Procedure of the American Standards Association and Sponsored by The American Society of Mechanical Engineers and the Society of Automotive Engineers or the American Gas Association:

Mr. William L. Barth, Executive Secretary, Engineering Standards, General Motors Corporation, 3044 West Grand Blvd., Detroit 2, Michigan. (Member of ASA Committees B1, B2, and B18.)
Mr. H. C. Erdman, Technical Asst. to Pres., The National Screw & Manufacturing Co., 2440 E. 75th Street, Cleveland 4, Ohio. (Member of ASA Committees B1 and B18.)
Mr. H. W. Robb, Standards Division, General Electric Co., 1 River Road, Schenectady, New York. (Member of ASA Committees B1 and B18.)
Mr. Paul G. Schulz, Assistant Engineer of Standards, Engineering and Research Division, Crane Co., 836 S. Michigan Avenue, Chicago 5, Ill. (Member of ASA Committees B1 and B2.)
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Mr. Frank P. Tisch, Chief Engineer, Pheoll Manufacturing Co., 5700 Roosevelt Road, Chicago 50, Ill. (Member of ASA Committees B1 and B18.)

Subgroup Members Who Participated in the Preparation of the 1950 Supplement:

Mr. R. F. Bosron, MXREXU7, Wright-Patterson Air Force Base, Dayton, Ohio.
Mr. R. F. Holmes, AC Spark Plug Div., General Motors Corp., Flint, Michigan.
Mr. F. F. Jacobs, Bur. of Aeronautics, Dept. of the Navy, Washington 25, D. C.
Mr. S. P. Johnson, Bur. of Ships, Dept. of the Navy, Washington 25, D. C.
Mr. A. M. Kronstadt, Bur. of Ordnance, U. S. Naval Gun Factory, Washington 25, D. C.

SECTION II. NOMENCLATURE, DEFINITIONS, AND LETTER SYMBOLS

[In order to preserve the typography of the previous Supplement, the revision of this section appears herein beginning on page 35.]

SECTION III. AMERICAN NATIONAL FORM OF THREAD

The following corrections and revisions are to be inserted:

Page 7, table 1, col. 15, change ".09622" to ".09623."

Pages 9 and 13, Figures 4 and 7, change "2×P. D. TOL. ON RADIUS" to "TOLERANCE ON MAJOR DIAMETER OF SCREW IS TWICE THE TOLERANCE ON PITCH DIAMETER."

Pages 9, 13, 16, 19, Figures 4, 7, 10, 13, change "TABLES 7 to 16, INCLUSIVE" to "TABLES 16, 24, ETC."

Pages 19 to 23. Delete class 4 here and wherever it appears elsewhere.

Pages 23 to 28. 5. Class 5 Fit.—

The following is a resolution agreed upon by a subcommittee of the Interdepartmental Screw Thread Committee, Mr. W. S. Brown, chairman, (American Locomotive Co., Schenectady, N. Y.), appointed to investigate the class 5 fit:

> In view of the well-recognized fact that figures for pitch diameter tolerances for interference thread fits, published in the 1944 edition of the H28 Handbook, have not produced an all-round satisfactory solution to the difficulties inherent in the older "Tentative Class 5" and have not been widely accepted commercially; and in view of the large amount of work necessary to produce some possibly improved system of tolerances, it is the opinion of this subcommittee *that the status shown in the H28 (1942) Handbook be restored. This includes the "Tentative Class 5" and the "Alternative Class 5" Tolerances and comments relative to gaging.* This restoration would stand until a further investigation of the whole subject can be made.
>
> The subcommittee further is of the opinion that potential difficulties of *moderate* lead error are probably minimized by effects produced during mating of the studs and tapped holes. Thus, pitch diameter should be measured directly across opposing threads and grooves, that is, NOT BY RING GAGE. Lead error should be checked by independent means to prevent mating of parts with excessive amounts.

The following discussion of interference thread fits was also submitted by the chairman of the subcommittee:

> It is recognized, from the outset, that the problem of producing and mating external and internal components of interference thread fits involves so many vari-

ables that, in the present state of the mechanical arts, it is virtually impossible to set up standards which will satisfy all the requirements. Most users appear to find it necessary to use some version of the principle of "selection" or "fitting" for at least a portion of their products. The main requirements of an interference fit appear to be:

(a) Enough interference allowance between pitch diameters of minimum metal studs and tapped holes to create sufficient grip to prevent unscrewing the stud when the nut, which holds the joint, is backed off the outer end of the stud.

(b) Tolerances on the pitch diameter of the studs and tapped holes, minimum values of which are set by *currently commercially available* equipment and practices.

(c) Possibility of assembling the maximum interference fit as produced by mating maximum metal studs and maximum metal tapped holes. This fit derives from the accumulation of the allowance (par. a), the two maximum limits of tolerances (par. b), of the stud and tapped hole, and the added effects of lead error and error in half-angle of the thread section.

(d) In many cases, attempts to mate such maximum metal components result in seizure by galling, it being impossible to screw the stud either further in or out. Other studs break during driving. Due to this condition it is often expedient to pare the maximum interferences to amounts which permit practical assembly. This in turn pares one or both of the component maximum metal limits below those desirable to producers of components. The tables of pitch diameter tolerances given as "tentative" in publications up to and including H28 (1942), favored the producers of studs. Due to complaints from prominent users, a tentative "alternative" standard was added in the H28 (1942) edition. This gave more tolerance to the producers of tapped holes, largely by reducing the tolerances permitted for the mating studs. In H28 (1944) the "alternative standard" became the *only* set of figures printed, the older "tentative" figures being eliminated. It is now apparent that commercial manufacturers of studs, and many private manufacturers, have not accepted the 1944 tolerances for studs. Some stud users have adopted the 1944 tolerances for holes. Possibly some users have mated manufacturer's studs in the wider toleranced holes resulting in fits which were not tight enough. Some stud manufacturers have warned their clients but this warning should be issued by all who retain the older practice.

In accordance with the above resolution, the tentative class 5, as published in Handbook H28 (1942), is republished below, and the class 5 fit, as published in Handbook H28 (1944), is restored as the alternate class 5 fit.

5. Tentative Class 5 Fit.—(a, b, c, d, e, and f). As in H28 (1944).

(g) *Allowance and tolerance values.*—Allowances and tolerances are specified in tables 6A and 7A 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. The system is predicated upon the use of the gaging system outlined in the following paragraph. (This gaging system corresponds to that given on page 234 of Handbook H28 (1942), modified in accordance with the resolution quoted above, and substitutes for par. 2 of section (C), page 41, H28 (1944) for the alternate class 5 fit.)

(h) *Gages and gaging.*—The relatively close limits on pitch diameter specified for the class 5 fit necessitate careful and accurate gaging of both the stud and the tapped hole.

The pitch diameter of the stud should be gaged by means of a cone-pointed snap gage, see p. 41, H28 (1944), or measured by means of a thread micrometer, see p. 239, H28 (1944). The major diameter may be gaged by means of "go" and "not go" plain ring or snap gages. Lead error, thread angle, minor diameter, and thread form should be checked by means of a projection comparator, see p. 239, H28 (1944), or other independent means. The minor diameter of the stud should preferably be maintained near the maximum limit.

The hole should be gaged by means of minimum and maximum limit thread plug gages, and the minor diameter by means of "go" and "not go" plain plug gages, after threading.

(i) *Limiting dimensions.*—The tables of limiting dimensions for the class 5 fit are included in section IV, herein, as tables 17A and 25A. Caution: Studs made to the tentative class 5 tolerances will not produce a satisfactory interference fit when assembled with holes made to the alternate class 5 tolerances.

Table 6A. *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*
1/4	20	0.0003	0.0018	0.0007	0.0008	0 16	0 25
5/16	18	.0005	.0040	.0020	.0015	0 41	0 31
3/8	16	.0005	.0045	.0024	.0016	0 44	0 29
7/16	14	.0006	.0050	.0026	.0018	0 42	0 29
1/2	13	.0007	.0055	.0029	.0019	0 44	0 28
9/16	12	.0008	.0060	.0032	.0020	0 44	0 28
5/8	11	.0008	.0060	.0031	.0021	0 39	0 26
3/4	10	.0009	.0065	.0033	.0023	0 38	0 26
7/8	9	.0010	.0065	.0031	.0024	0 32	0 25
1	8	.0011	.0065	.0027	.0027	0 25	0 25
1 1/8	7	.0011	.0065	.0024	.0030	0 19	0 24
1 1/4	7	.0012	.0065	.0023	.0030	0 18	0 24
1 3/8	6	.0012	.0065	.0017	.0036	0 12	0 25
1 1/2	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 diameter include all errors of pitch diameter and angle but not of lead. (See "3. 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 1/4-inch size.

TABLE 7A. *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*
1/4	28	0.0005	0.0034	0.0018	0.0011	0	58	0	35
5/16	24	.0005	.0037	.0020	.0012	0	55	0	33
3/8	24	.0006	.0044	.0026	.0012	1	11	0	33
7/16	20	.0006	.0044	.0025	.0013	0	57	0	30
1/2	20	.0007	.0050	.0030	.0013	1	9	0	30
9/16	18	.0007	.0050	.0028	.0015	0	58	0	31
5/8	18	.0008	.0055	.0032	.0015	1	6	0	31
3/4	16	.0008	.0059	.0035	.0016	1	4	0	29
7/8	14	.0008	.0061	.0035	.0018	0	56	0	29
1	14	.0009	.0069	.0042	.0018	1	7	0	29
1 1/8	12	.0009	.0067	.0038	.0020	0	52	0	28
1 1/4	12	.0011	.0060	.0029	.0020	0	40	0	28
1 3/8	12	.0011	.0055	.0024	.0020	0	33	0	28
1 1/2	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 toleranee is speeified. Therefore, the tolerances specified for pitch diameter include all errors of pitch diameter and angle but not of lead. (See "3. 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 crrors 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 serews and nuts.

Page 29. Change paragraphs 1 and 2 to read as follows:

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 is accomplished usually by the use of plug and ring thread gages. This requires the use of maximum-metal limit gages known generally 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 minimum-metal limit gages known generally 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.

2. PURPOSE OF LIMIT GAGES.—The maximum-metal limit or "go" gages control the extent of the tolerance in the direction of the limit of maximum metal, and represent the maximum limit of external threads and the minimum limit of internal threads. 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 external threads and the maximum limit of internal threads. All parts shall be accepted if an approved "not go" gage does not enter or is not entered, or if, on or before the third turn of assembly, a definite drag is obtained which is the result of metal to metal contact simultaneously on both flanks of the thread at a number of counter positioned points. Beyond this point the gage shall not be forced by applying a torque sensibly greater than that already applied to obtain the drag fit.

This definition applies only to the use of "not go" plug and ring thread gages. This requirement is to preclude any possibility of accepting internal threads that are oversize for more that three threads or accepting external threads that are undersize, at the entering end, for more than three threads. The requirements of extreme applications such as exceptionally thin or ductile material, small number of threads, etc., may necessitate modification of this practice.

An approved "not go" thread gage is one of nominal size at the minimum metal product limit with tolerance inside this limit, as shown in tables 9 and 10. In case the product is so close to the minimum metal limit that its acceptability is doubtful, a "not go" inspection gage which is at, rather than within, this limit may be used. See paragraph 3, page 42. Furthermore, the purchaser can elect to use an inspection "not go" gage with tolerance outside the minimum metal product limit. See par. 6, page 31.

There is a broad, general principle in regard to limit gages which should be kept in mind; a maximum-metal limit or "go" gage should check simultaneously as many elements as possible, a minimum-metal limit 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 minimum-metal limit or "not go" thread gage made to check the pitch diameter is usually sufficient for practical purposes. The minimum-metal limit gage is made to approximate a gage for checking pitch diameter only, by reducing both the length of the thread flank and the length of thread. 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 width of 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 approximately 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. 32, H28 (1944). 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.

Page 30, 2d col., par. 5 (b), lines 5 to 11, change two sentences to read:

"Threaded setting plugs are of two standard designs, which are designated as "basic-form setting plugs" and "truncated setting plugs."

"The basic-form setting plug is one having a width of flat at the crest equal to $p/8$."

Page 31, 1st col., line 9, insert after "determined": "In setting the ring gage, extreme care should be taken to prevent damage to the crest of the full portion of the setting plug."

Pages 31 to 34, "1. Gage Tolerances", revise to read as follows:

1. Gage Tolerances.—Screw-thread gages for classes 1, 2, 3, and 5 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 minimum-metal limit or "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. See "recommended gage practice," p. 41, H28 (1944).

Page 32, 2d col., par. 2 (a), lines 9 through 17, change to read:

"A relief shall be provided at the root of the 'go' thread plug or ring gage, the maximum width of which is one-eighth of the pitch. This relief may be an extension of the sides of the thread from the position corresponding to this maximum width toward a sharp V. The 'go' thread ring gage shall clear the maximum major diameter of the screw, and the 'go' thread plug gage shall clear the minimum minor diameter of the nut."

Page 32, 2d col., par. 2 (b), change to read:

"(b) '*Not go' thread gages.*—(1) The maximum major diameter of the 'not go' thread plug gage shall be equal to the maximum pitch diameter of the nut plus $2h/3$. This corresponds to a width of flat at the crest of the gage equal to one-fourth of the pitch. However, the maximum major diameter of the thread plug gage shall not exceed[9] the minimum major diameter of the nut minus $0.05h$.

"(2) The minimum minor diameter of the 'not go' thread ring gage shall be equal to the minimum pitch diameter of the screw minus $h/3$. This corresponds to a width of flat at the crest of the gage equal to three-eighths of the pitch. However, the minimum minor diameter of the thread ring gage shall not be less than the minimum minor diameter of the nut plus $0.05h$. This requirement is necessary to insure that the minor diameter of the 'not go' thread ring gage is not less than the minor diameter of the 'go' ring gage, which can occur with a three-eighths pitch flat on the 'not go' thread ring crest when there is a pitch diameter allowance on the screw combined with a large pitch diameter tolerance.[9]

(3) A relief shall be provided at the root of the "not go" thread plug or thread ring gage, the width of which is approximately one-fourth of the pitch. In small diameters and fine pitches, this relief may be an extension of the sides of the thread from the position corresponding to this approximate width toward a sharp V. Thus, contact of the thread gage can occur on the sides of the threads, but not on the crest or root. Also the effect of angle error on the fit of the gage with the product is minimized. The "not go" thread ring gage shall clear the maximum major diameter of the screw, and the "not go" thread plug gage shall clear the minimum minor diameter of the nut. The above requirements are illustrated in figure 20.

3. Thread Form of Setting Plug Gages.—The specifications for thread form of setting plug gages are stated in detail below, and are summarized in table 8 and figures 21 and 21A.

(a) *Truncated or basic-form maximum-metal limit thread setting plugs.*—(1) The major diameter of the basic-form setting plug, and of the full portion of the truncated maximum-metal limit thread setting plug corresponds to basic American National form (one-eighth pitch flat) with a plus gage tolerance.

(2) The major diameter of the truncated portion of the truncated maximum-metal limit setting plug is the same as the minimum major diameter of the screw with a minus gage tolerance.

(3) A relief shall be provided at the root of the maximum-metal limit thread setting plug gage, the maximum width of which is one-fourth of the pitch. This relief may be an extension of the sides of the thread from the position corresponding to this maximum width toward a sharp V.

(b) *Truncated minimum-metal limit thread setting plugs.*—(1) The major diameter of the full portion of the minimum-metal limit thread setting plug shall be the same as that of the maximum-metal limit thread setting plug of the same nominal size and having American National form, with the tolerance taken plus, but with the following

[9] This condition occurs in connection with small sizes of class 1 coarse and fine series threads and may occur for extreme combinations of large diameter and fine pitch of class 1 threads of special diameters, pitches, and lengths of engagement.

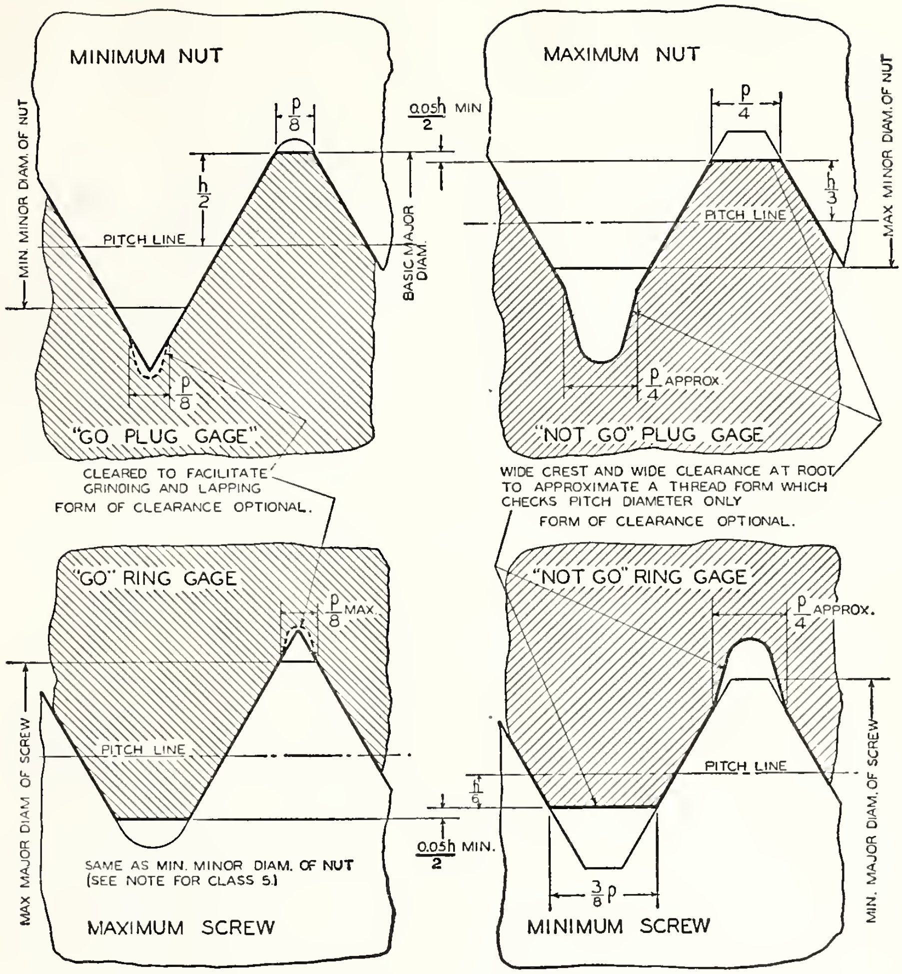


FIGURE 20.—*Thread form of thread plug and ring gages.*

NOTE.—For alternate class 5 the minor diameter of the "go" ring gage is larger than that for the other classes by the amount of the allowance.

exceptions: In no case shall the width of flat at the crest be less than 0.001 inch. This exception represents the maximum practicable sharpness of the crest of the setting plug thread.

When this exception applies, the thread root of a "not go" thread ring set to fit the plug may not clear the maximum major diameter of the screw. Therefore, the ring gage should be made with, and optically inspected for, ample depth of root clearance. (For revised major diameters, see table A, p. 16.)

(2) The truncation at the major diameter of the truncated portion of the minimum-metal limit thread setting plug shall be one-sixth of the basic thread depth from full American National form. Thus, the major diameter is equal to the pitch diameter of the gage plus two-thirds of the basic thread depth, with the tolerance taken minus.

(3) A relief shall be provided at the root of the minimum-metal limit thread setting plug gage, the width of which is approximately one-fourth of the pitch. This relief may be an extension of the sides of the thread from the position corresponding to this approximate width toward a sharp V.

(c) *Basic-form minimum-metal limit thread setting plugs.*—(1) The major diameter of the basic-form minimum-metal limit thread setting plug shall be such that the minimum width of flat at crest equals $p/8$; that is, the maximum major diameter equals the minimum pitch diameter plus the basic thread depth, h.

(2) A relief shall be provided at the root of the minimum-metal limit thread setting plug gage, the width of which shall be approximately one-fourth of the pitch. This relief may be an extension of the sides of the thread from the position corresponding to this approximate width toward a sharp V.

Pages 35 and 36, table 8, revise as herein.

Page 37, table 9, add to footnote 3 the following: The cumulative tolerance applies plus from the minimum pitch diameter limit of thread plug

TABLE 8. *Specifications for thread form, major, pitch, and minor diameters, and direction of gage tolerances of gages for American National form, and straight pipe thread form of thread* [1]

Type of gage	Major diameter: Dimension D_g	Major diameter: Direction of tolerance	Major diameter: Width of relief [2, 3]	Pitch diameter: Dimension E_g	Pitch diameter: Direction of tolerance: Standard	Pitch diameter: Direction of tolerance: Optional (see par. 6, p. 31)	Minor diameter: Dimension K_g	Minor diameter: Direction of tolerance	Minor diameter: Width of relief [2, 3]
1	2	3	4	5	6	7	8	9	10
MAXIMUM-METAL LIMIT OR "GO" GAGES									
Thread plug, all threads	Min D_n	+		Min E_n	+				p/8 max.
Thread ring:									
Classes 1, 2, 3			$p/8$ max	Max E_s	−		[6] Min K_n	−	
Class 5			$p/8$ max	Max E_s	−		Max $E_s-2h/3$	−	
Basic form setting plug, all threads	Max E_s+h	+		Max E_s	−				$p/4$ max.
Truncated setting plug, all threads:									
Full portion	Max E_s+h	+		Max E_s	−				$p/4$ max.
Truncated portion	Min D_s	−		Max E_s	−				$p/4$ max.
Plain snap gage, all threads	Max D_s	−							
Plain plug gage, all threads							Min K_n	+	
Plain check plug gages for thread ring gage: [4]									
"Go"							Min K_g	+	
"Not go"							Max K_g	−	
MINIMUM-METAL LIMIT OR "NOT GO" GAGES									
Thread plug	Max $E_n+2h/3$, but not to exceed min $D_n-0.05h$.	−		Max E_n	−	+			p/4 approx.
Thread ring			$p/4$ approx	Min E_s	+	−	[6] Min $E_s-h/3$, but not less than min $K_n+0.05h$.	+	
Basic form setting plug, all threads	Min E_s+h	−		Min E_s	+	−			$p/4$ approx.
Truncated setting plug, all threads:									
Full portion	[5] Max E_s+h	+		Min E_s	+	−			$p/4$ approx.
Truncated portion	Min $E_s+2h/3$	−		Min E_c	+	−			$p/4$ approx.
Plain snap gage, all threads	Min D_s	+							
Plain plug gage, all threads							Max K_n	−	
Plain check plug gages for thread ring gage:									
"Go"							Min K_g	+	
"Not go"							Max K_g	−	

[1] The symbols used in this table are as follows:

h=basic depth of thread $\begin{cases} =0.649519p \text{ for American National form.} \\ =0.666025p \text{ for straight pipe thread form, except Dryseal.} \end{cases}$ (See table 72, col. 3, p. 136, H28(1944).

p=pitch.
D_g=major diameter of gage.
D_n=major diameter of nut.
D_s=major diameter of screw.
E_g=pitch diameter of gage.
E_n=pitch diameter of nut.
E_s=pitch diameter of screw.
K_g=minor diameter of thread ring gage.
K_n=minor diameter of nut.
H=depth of sharp-V thread.

[2] The thread ring gages shall clear the maximum major diameter of the screw. The thread plug gages shall clear the minimum minor diameter of the nut.

[3] The width of relief on maximum-metal limit or "go" gages for straight pipe threads is $p/9$, and on minimum-metal limit or "not go" gages is $p/4$.

[4] For the minor diameter of adjustable thread ring gages, "go" and "not go" plain cylindrical check plug gages made to XX tolerances are required for sizes ½ in. and less, and are desirable for larger sizes. See table 12.

[5] The width of flat crest shall not be less than 0.001 in.; that is, Max E_s+h shall not exceed Min $E_s+H-0.0017$ in. See par. 3(b) herein.

[6] For straight pipe thread ring gages, K_g=Max E_s-h for the maximum-metal limit or "go" gage, and K_g=Min $E_s-2h/3$ for the minimum-metal limit or "not go" gage.

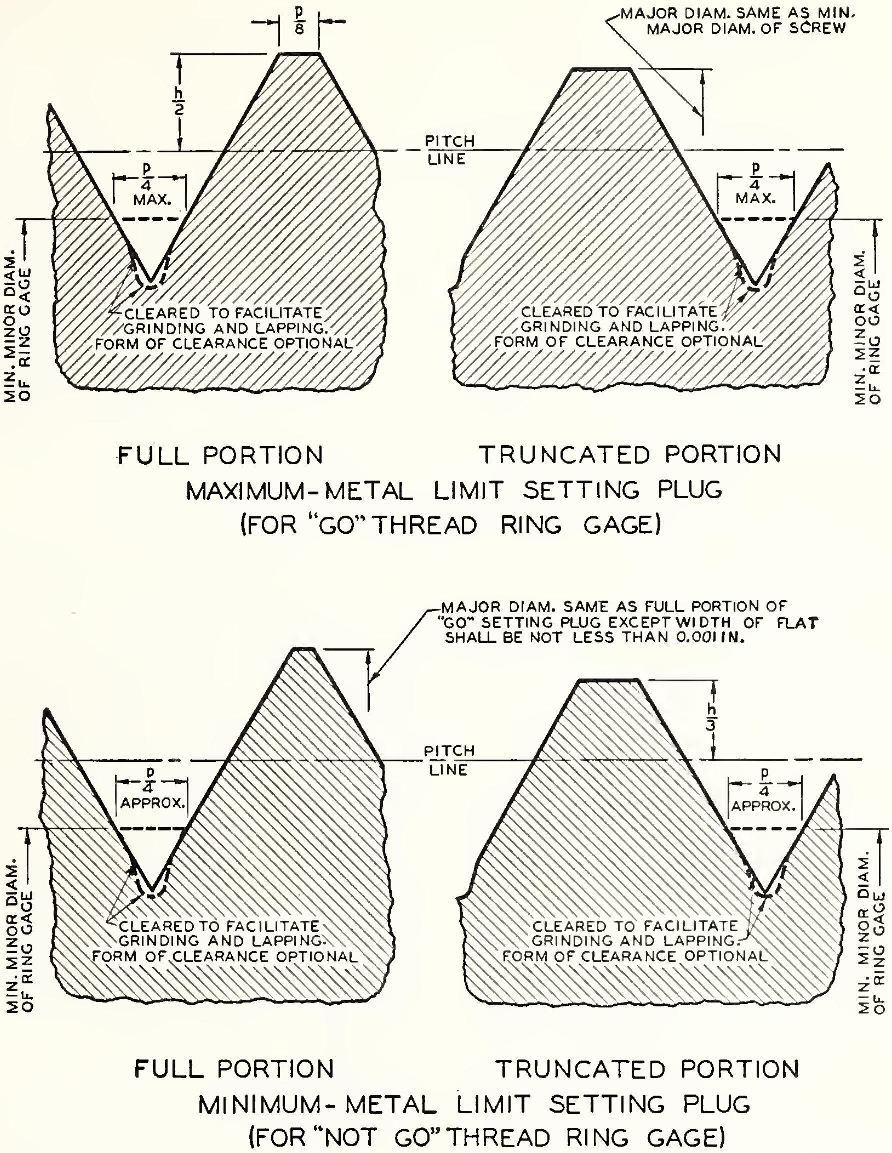


FIGURE 21.—*Thread form of maximum-metal and minimum-metal limit thread setting plug gages.*

gages and minus from the maximum pitch diameter limit of thread ring gages. The diameter equivalents of lead and angle errors are determined by applying formulas given on pages 222 and 223, H28 (1944).

Page 42, first col., par. beginning "Gaging of," line 7, after "sizes" insert: "to reduce failure by shear when torque is applied,".

SECTION IV. AMERICAN NATIONAL THREAD SERIES

The following are corrections and revisions of this section:

Page 47, table 16, delete class 4.

Page 49, table 17, change "class 5 fit" to "alternate class 5 fit."

Pages 50 and 51, table 18. Revise as shown herein.

Pages 53 and 54, table 19, delete class 4.

Page 55, table 20, delete class 4.

Page 56, table 21, column headed "1¼" change "1.1623" to "1.1023." Under "NOT GO THREAD GAGES FOR SCREWS," first line, delete "full-form setting plug and." (The major diameters for basic-form minimum-metal limit setting plugs should correspond to a p/8 width of flat.) Change "class 5 fit" to "alternate class 5 fit."

Page 57, table 22, change "class 5 fit" to "alternate class 5 fit."

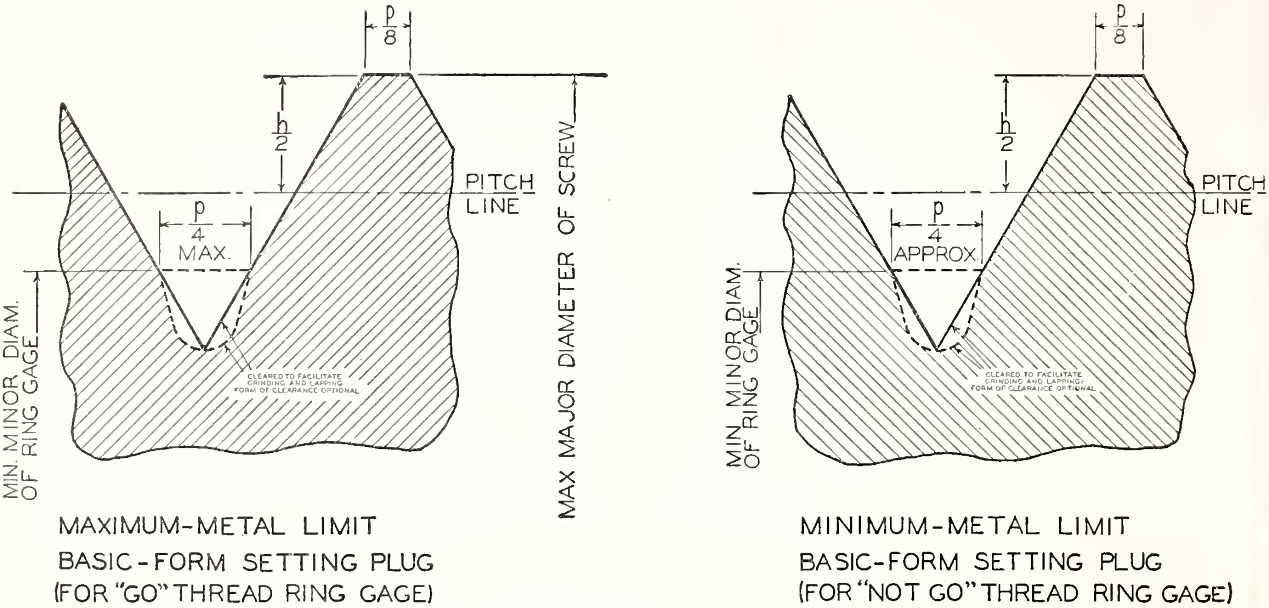


FIGURE 21A.—*Thread form of basic-form thread setting plug gages.*

Pages 60 and 61, table 24, delete class 4.

Page 62, table 25, change "class 5 fit" to "alternate class 5 fit."

Pages 63 and 64, table 26. Revise as shown herein.

Page 65, table 27, delete class 4. Change major diameter limits of class 1 minimum-metal limit, "not go", plug gage for size 0-80 from ".0597" and ".0594" to "0.0596" and ".0593".

Page 67, table 28, delete class 4.

Page 68, table 29. Change "class 5 fit" to "alternate class 5 fit". Under "NOT GO THREAD GAGES FOR SCREWS," first line, delete "full-form setting plug, and". (See reference above to p. 56.)

Page 69, table 30, change "class 5 fit" to "alternate class 5 fit."

Page 70, table 31, revise as herein. Certain drills outside of product limits have been eliminated or set in italics.

Page 71, table 32, column headed "$1\frac{1}{16}$"", change "1.0216" to "1.0213"; change ".0048" to ".0051" in two places; and change "1.0312" to "1.0315".

Page 72, table 33, change the limits for the major diameter of the full portion of the minimum-metal limit, "not go", setting plugs for the first three sizes to read as follows: (See footnote 1, revised table 18):

Size	1/4"	5/16"	3/8"
Min	.2492	.3118	.3742
Max	.2497	.3123	.3747

In column head "3/8", change ".2653" to ".3653". Add limits for major diameter of minimum-metal limit basic-form setting plugs as given in table A, p. 16, herein.

Page 73, table 33, column headed "$1\frac{1}{16}$"", change "1.0216" to "1.0213" in two places; change "1.0219" to "1.0216"; and change "1.0213" to "1.0210."

Page 75, table 34, column headed "$1\frac{1}{16}$"", change "1.0312" to "1.0315" in two places; change "1.0309" to "1.0312"; and change "1.0315" to "1.0318".

Page 80, table 38, add limits for major diameters of minimum-metal limit basic-form setting plugs as given in table A. p. 16, herein.

Page 83, table 40, column 3, change "4.44985" to "4.49985."

Page 88, table 43, add limits for major diameters of minimum-metal limit basic-form setting plugs as given in table A, p. 16, herein.

Page 92, table 44, in col. headed "$3\frac{1}{4}$" change "3.1951" to "3.1961."

Page 93, table 45, column 3, change "4.74980" to "4.74981".

Pages 95 to 97, table 47, change side headings "Major diameter" to "Classes 2 and 3, major diameter;" and "Minor diameter" to "Classes 2 and 3, minor diameter."

Page 96, table 47, column headed "$1\frac{3}{16}$"", change heading to "$1\frac{13}{16}$"".

Page 98, table 48, add limits for major diameters of minimum-metal limit basic-form setting plugs as given in table A, p. 16, herein.

Page 103, table 50, column 1, change first "$2\frac{1}{2}$"" to "$2\frac{1}{4}$"".

TABLE 17A.—*Limits of size of tentative 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 $1\frac{1}{2}D$	
		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.*
1/4 [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
1/2	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
3/4	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
1 1/8	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
1 1/4	7	1.2500	1.2330	1.1637	1.1614	1.0812	1.1248	1.1402	1.1572	1.1602	1.2500	1 1/8	1.1250	6,950	2,535
1 3/8	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
1 1/2	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 1/4-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 1/4″–28, instead of 1/4″–20, is recommended.

TABLE 18. *Limits of size of setting plug and thread ring gages for screws of classes 1, 2, and 3 fits, American National coarse-thread series*

Limits of size	Size (inches) 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
MAXIMUM-METAL LIMIT OR "GO" GAGES FOR SCREWS											
Major diameter of basic-form setting plug, and full portion of truncated setting plug:	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Class 1 — Max	0.0727	0.0856	0.0985	0.1114	0.1244	0.1374	0.1634	0.1892	0.2152	0.2490	0.3114
Class 1 — Min	.0723	.0852	.0981	.1110	.1240	.1369	.1629	.1887	.2147	.2485	.3109
Classes 2 and 3 — Max	.0734	.0864	.0994	.1124	.1254	.1385	.1645	.1905	.2165	.2505	.3130
Classes 2 and 3 — Min	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
Major diameter of truncated portion of truncated setting plug:											
Class 1 — Max	.0671	.0796	.0919	.1042	.1172	.1293	.1553	.1795	.2055	.2383	.2995
Class 1 — Min	.0667	.0792	.0915	.1038	.1168	.1288	.1548	.1790	.2050	.2378	.2990
Classes 2 and 3 — Max	.0692	.0820	.0946	.1072	.1202	.1326	.1586	.1834	.2094	.2428	.3043
Classes 2 and 3 — Min	.0688	.0816	.0942	.1068	.1198	.1321	.1581	.1829	.2089	.2423	.3038
Pitch diameter of setting plug or ring gage:											
Class 1 — Max. Y	------	------	------	------	------	------	------	------	------	.2158	.2746
Class 1 — Min. Y										.2155	.2743
Class 1 — Max. X	.0622	.0736	.0846	.0948	.1078	.1166	.1426	.1616	.1876	.2160	.2748
Class 1 — Min. X	.0620	.0734	.0844	.0946	.1076	.1163	.1423	.1613	.1873	.2157	.2745
Classes 2 and 3 — Max. Y	------	------	------	------	------	------	------	------	------	.2173	.2762
Classes 2 and 3 — Min. Y										.2170	.2759
Classes 2 and 3 — Max. X	.0629	.0744	.0855	.0958	.1088	.1177	.1437	.1629	.1889	.2175	.2764
Classes 2 and 3 — Min. X	.0627	.0742	.0853	.0956	.1086	.1174	.1434	.1626	.1886	.2172	.2761
Minor diameter of ring gage:											
Classes 1, 2, and 3 — Max	.0561	.0667	.0764	.0849	.0979	.1042	.1302	.1449	.1709	.1959	.2524
Classes 1, 2, and 3 — Min	.0557	.0663	.0760	.0845	.0975	.1037	.1297	.1444	.1704	.1954	.2519
MINIMUM-METAL LIMIT OR "NOT GO" GAGES FOR SCREWS											
Major diameter of full portion of truncated setting plug:											
Class 1 — Min	.0710	.0841	.0974	.1109	.1239	.1369	.1629	.1887	.2147	.2485	.3109
Class 1 — Max	[1] .0714	[1] .0845	[1] .0978	[1] .1113	[1] .1243	.1374	.1634	.1892	.2152	.2490	.3114
Class 2 — Min	.0724	.0857	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
Class 2 — Max	[1] .0728	[1] .0861	.0994	.1124	.1254	.1385	.1645	.1905	.2165	.2505	.3130
Class 3 — Min	.0729	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
Class 3 — Max	[1] .0733	.0864	.0994	.1124	.1254	.1385	.1645	.1905	.2165	.2505	.3130
Major diameter of truncated portion of truncated setting plug:											
Class 1 — Min	.0660	.0781	.0901	.1018	.1148	.1258	.1518	.1745	.2005	.2321	.2927
Class 1 — Max	.0664	.0785	.0905	.1022	.1152	.1263	.1523	.1750	.2010	.2326	.2932
Class 2 — Min	.0674	.0797	.0919	.1038	.1168	.1280	.1540	.1771	.2031	.2351	.2959
Class 2 — Max	.0678	.0801	.0923	.1042	.1172	.1285	.1545	.1776	.2036	.2356	.2964
Class 3 — Min	.0679	.0802	.0925	.1045	.1175	.1288	.1548	.1780	.2040	.2361	.2970
Class 3 — Max	.0683	.0806	.0929	.1049	.1179	.1293	.1553	.1785	.2045	.2366	.2975
Major diameter of basic-form setting plug:											
Class 1 — Min	.0693	.0820	.0946	.1072	.1202	.1326	.1586	.1836	.2096	.2429	.3047
Class 1 — Max	.0697	.0824	.0950	.1076	.1206	.1331	.1591	.1841	.2101	.2434	.3052
Class 2 — Min	.0707	.0836	.0964	.1092	.1222	.1348	.1608	.1862	.2122	.2459	.3079
Class 2 — Max	.0711	.0840	.0968	.1096	.1226	.1353	.1613	.1867	.2127	.2464	.3084
Class 3 — Min	.0712	.0841	.0970	.1099	.1229	.1356	.1616	.1871	.2131	.2469	.3090
Class 3 — Max	.0716	.0845	.0974	.1103	.1233	.1361	.1621	.1876	.2136	.2474	.3095
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
Class 1 — 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
Class 2 — 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
Class 3 — Max	.0617	.0731	.0841	.0943	.1073	.1161	.1421	.1608	.1868	.2152	.2737
(OPTIONAL)											
Pitch diameter of setting plug or ring gages for inspection (see par. 6, p. 31):											
Class 1 — Min	.0594	.0706	.0813	.0912	.1042	.1125	.1385	.1567	.1827	.2106	.2688
Class 1 — 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
Class 2 — 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
Class 3 — Max	.0615	.0729	.0839	.0941	.1071	.1158	.1418	.1605	.1865	.2149	.2734
Minor diameter of ring gage:											
Class 1 — Min	.0566	.0673	.0771	.0860	.0990	.1060	.1320	.1480	.1740	.2001	.2571
Class 1 — Max	.0570	.0677	.0775	.0864	.0994	.1065	.1325	.1485	.1745	.2006	.2576
Class 2 — Min	.0576	.0685	.0788	.0880	.1010	.1082	.1342	.1506	.1766	.2031	.2603
Class 2 — Max	.0580	.0689	.0792	.0884	.1014	.1087	.1347	.1511	.1771	.2036	.2608
Class 3 — Min	.0581	.0690	.0794	.0887	.1017	.1090	.1350	.1515	.1775	.2041	.2614
Class 3 — Max	.0585	.0694	.0798	.0891	.1021	.1095	.1355	.1520	.1780	.2046	.2619

[1] See footnote at end of table.

TABLE 18. *Limits of size of setting plug and thread ring gages for screws of classes 1, 2, and 3 fits, American National coarse-thread series*—Continued

Limits of size	Size (inches)										
	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
MAXIMUM-METAL LIMIT OR "GO" GAGES FOR SCREWS											
Major diameter of basic-form setting plug, and full portion of truncated setting plug:	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*
Class 1, Max.	0.3738	0.4360	0.4984	0.5607	0.6230	0.7478	0.8726	0.9973	1.1218	1.2468	1.3714
Class 1, 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
Classes 2 and 3, Min.	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750
Major diameter of truncated portion of truncated setting plug:											
Class 1, Max.	.3606	.4214	.4830	.5443	.6054	.7288	.8519	.9744	1.0963	1.2213	1.3416
Class 1, Min.	.3600	.4208	.4824	.5437	.6048	.7282	.8512	.9737	1.0956	1.2206	1.3408
Classes 2 and 3, Max.	.3660	.4277	.4896	.5513	.6132	.7372	.8610	.9848	1.1080	1.2330	1.3548
Classes 2 and 3, Min.	.3654	.4271	.4890	.5507	.6126	.7366	.8603	.9841	1.1073	1.2323	1.3540
Pitch diameter of setting plug or ring gage:											
Class 1, Max. Y	.3324	.3888	.4476	.5058	.5632	.6820	.7995	.9152	1.0281	1.1531	1.2620
Class 1, Min. Y	.3320	.3884	.4472	.5054	.5628	.6816	.7990	.9147	1.0276	1.1526	1.2615
Class 1, Max. X	.3326	.3890	.4478	.5060	.5634	.6822	.7997	.9154	1.0283	1.1533	1.2623
Class 1, Min. X	.3323	.3887	.4475	.5057	.5631	.6819	.7994	.9150	1.0279	1.1529	1.2619
Classes 2 and 3, Max. Y	.3342	.3909	.4498	.5082	.5658	.6848	.8026	.9186	1.0320	1.1570	1.2664
Classes 2 and 3, Min. Y	.3338	.3905	.4494	.5078	.5654	.6844	.8021	.9181	1.0315	1.1565	1.2659
Classes 2 and 3, Max. X	.3344	.3911	.4500	.5084	.5660	.6850	.8028	.9188	1.0322	1.1572	1.2667
Classes 2 and 3, Min. X	.3341	.3908	.4497	.5081	.5657	.6847	.8025	.9184	1.0318	1.1568	1.2663
Minor diameter of ring gage:											
Classes 1, 2, and 3, Max.	.3073	.3602	.4167	.4723	.5266	.6417	.7547	.8647	.9704	1.0954	1.1946
Classes 1, 2, and 3, Min.	.3067	.3596	.4161	.4717	.5260	.6411	.7540	.8640	.9697	1.0947	1.1938
MIMINUM-METAL LIMIT OR "NOT GO" GAGES FOR SCREWS											
Major diameter of full portion of truncated setting plug:											
Class 1, Min.	.3732	.4354	.4978	.5601	.6224	.7472	.8719	.9966	1.1211	1.2461	1.3706
Class 1, Max.	.3738	.4360	.4984	.5607	.6230	.7478	.8726	.9973	1.1218	1.2468	1.3714
Classes 2 and 3, Min.	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750
Classes 2 and 3, Max.	.3756	.4381	.5006	.5631	.6256	.7506	.8757	1.0007	1.1257	1.2507	1.3758
Major diameter of truncated portion of truncated setting plug:											
Class 1, Min.	.3528	.4123	.4731	.5336	.5937	.7157	.8371	.9577	1.0771	1.2021	1.3192
Class 1, 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
Class 2, 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
Class 3, Max.	.3583	.4184	.4796	.5405	.6012	.7238	.8460	.9675	1.0882	1.2132	1.3318
Major diameter of basic-form setting plug:											
Class 1, Min.	.3663	.4278	.4898	.5516	.6133	.7374	.8612	.9848	1.1080	1.2330	1.3553
Class 1, Max.	.3669	.4284	.4904	.5522	.6139	.7380	.8619	.9855	1.1087	1.2337	1.3561
Class 2, Min.	.3699	.4320	.4942	.5563	.6185	.7430	.8673	.9917	1.1158	1.2408	1.3641
Class 2, Max.	.3705	.4326	.4948	.5569	.6191	.7436	.8680	.9924	1.1165	1.2415	1.3649
Class 3, Min.	.3712	.4333	.4957	.5579	.6202	.7449	.8694	.9939	1.1184	1.2434	1.3671
Class 3, Max.	.3718	.4339	.4963	.5585	.6208	.7455	.8701	.9946	1.1191	1.2441	1.3679
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
Class 1, 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
Class 2, 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
Class 3, Max.	.3315	.3878	.4466	.5047	.5621	.6808	.7982	.9138	1.0267	1.1517	1.2600
(OPTIONAL)											
Pitch diameter of setting plug or ring gages for inspection (see par. 6, p. 31):											
Class 1, Min.	.3260	.3817	.4401	.4978	.5546	.6727	.7894	.9039	1.0155	1.1405	1.2474
Class 1, 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
Class 2, 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
Class 3, Max.	.3312	.3875	.4463	.5044	.5618	.6805	.7979	.9134	1.0263	1.1513	1.2596
Minor diameter of ring gage:											
Class 1, Min.	.3128	.3665	.4238	.4801	.5352	.6514	.7656	.8772	.9850	1.1100	1.2117
Class 1, 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
Class 2, 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
Class 3, Max.	.3183	.3726	.4303	.4870	.5427	.6595	.7745	.8870	.9961	1.1211	1.2243

[1] See footnote at end of table.

TABLE 18. *Limits of size of setting plug and thread ring gages for screws of classes 1, 2, and 3, fits, American National coarse-thread series*—Continued

Limits of size		Size (inches)										
		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
MAXIMUM METAL LIMIT OR "GO" GAGES FOR SCREWS												
Major diameter of basic form setting plug, and full portion of truncated setting plug:		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
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
Major diameter of truncated portion of truncated setting plug:												
Class 1	Max	1.4666	1.7110	1.9575	2.2075	2.4528	2.7028	2.9528	3.2028	3.4528	3.7028	3.9528
	Min	1.4658	1.7102	1.9567	2.2067	2.4519	2.7019	2.9519	3.2019	3.4519	3.7019	3.9519
Classes 2 and 3	Max	1.4798	1.7268	1.9746	2.2246	2.4720	2.7220	2.9720	3.2220	3.4720	3.7220	3.9720
	Min	1.4790	1.7260	1.9738	2.2238	2.4711	2.7211	2.9711	3.2211	3.4711	3.7211	3.9711
Pitch diameter of setting plug or ring gage:												
Class 1	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	1.6139	1.8490	2.0990	2.3301	2.5801	2.8301	3.0801	3.3301	3.5801	3.8301
	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	1.6144	1.8495	2.0995	2.3307	2.5807	2.8307	3.0807	3.3307	3.5807	3.8307
Classes 2 and 3	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	1.6191	1.8547	2.1047	2.3365	2.5865	2.8365	3.0865	3.3365	3.5865	3.8365
	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	1.6196	1.8552	2.1052	2.3371	2.5871	2.8371	3.0871	3.3371	3.5871	3.8371
Minor diameter of ring gage:												
Classes 1, 2, and 3	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
MINIMUM METAL LIMIT OR "NOT GO" GAGES FOR SCREWS												
Major diameter of full portion of truncated setting plug:												
Class 1	Min	1.4956	1.7448	1.9943	2.2443	2.4936	2.7436	2.9936	3.2436	3.4936	3.7436	3.9936
	Max	1.4964	1.7456	1.9951	2.2451	2.4945	2.7445	2.9945	3.2445	3.4945	3.7445	3.9945
Classes 2 and 3	Min	1.5000	1.7500	2.0000	2.2500	2.5000	2.7500	3.0000	3.2500	3.5000	3.7500	4.0000
	Max	1.5008	1.7508	2.0008	2.2508	2.5009	2.7509	3.0009	3.2509	3.5009	3.7509	4.0009
Major diameter of truncated portion 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
Major diameter of basic-form setting plug:												
Class 1	Min	1.4803	1.7271	1.9751	2.2251	2.4723	2.7223	2.9723	3.2223	3.4723	3.7223	3.9723
	Max	1.4811	1.7279	1.9759	2.2259	2.4732	2.7232	2.9732	3.2232	3.4732	3.7232	3.9732
Class 2	Min	1.4891	1.7376	1.9865	2.2365	2.4851	2.7351	2.9851	3.2351	3.4851	3.7351	3.9851
	Max	1.4899	1.7384	1.9873	2.2373	2.4860	2.7360	2.9860	3.2360	3.4860	3.7360	3.9860
Class 3	Min	1.4921	1.7410	1.9903	2.2403	2.4894	2.7394	2.9894	3.2394	3.4894	3.7394	3.9894
	Max	1.4929	1.7418	1.9911	2.2411	2.4903	2.7403	2.9903	3.2403	3.4903	3.7403	3.9903
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	1.5985	1.8321	2.0821	2.3113	2.5613	2.8113	3.0613	3.3113	3.5613	3.8113
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	1.6090	1.8435	2.0935	2.3241	2.5741	2.8241	3.0741	3.3241	3.5741	3.8241
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	1.6124	1.8473	2.0973	2.3284	2.5784	2.8284	3.0784	3.3284	3.5784	3.8284
(OPTIONAL)												
Pitch diameter of setting plug for ring gages for inspection. (See par. 6, p. 31.):												
Class 1	Min	1.3724	1.5975	1.8311	2.0811	2.3103	2.5603	2.8103	3.0603	3.3103	3.5603	3.8103
	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	1.6080	1.8425	2.0925	2.3231	2.5731	2.8231	3.0731	3.3231	3.5731	3.8231
	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	1.6114	1.8463	2.0963	2.3274	2.5774	2.8274	3.0774	3.3274	3.5774	3.8274
	Max	1.3846	1.6119	1.8468	2.0968	2.3279	2.5779	2.8279	3.0779	3.3279	3.5779	3.8279
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

[1] These major diameters represent the maximum practicable sharpness of crest of the setting plug, in accordance with par. 3 (b), p. 4.

TABLE 25A. *Limits of size of tentative 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	.3528	.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	1.1364	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 he that corresponding to a flat at the minor diameter of the screw equal to $\frac{1}{8} \times p$, and may be determined by suhtracting 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 he that corresponding to a flat at the major diameter of the tapped hole equal to $\frac{1}{24} \times p$, and may he determined hy adding $1\frac{2}{9} \times h$ (or $0.7939p$) to the maximum pitch diameter of the nut.

TABLE 26. *Limits of size of setting plug and thread ring gages for screws of classes 1, 2, and 3 fits, American National fine-thread series*

Limits of size	Size (inches)											
	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
MAXIMUM-METAL LIMIT OR "GO" GAGES FOR SCREWS												
Major diameter of basic-form setting plug, and full portion of truncated setting plug:	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
Class 1 — Max	0.0596	0.0726	0.0857	0.0986	0.1115	0.1245	0.1374	0.1633	0.1894	0.2153	0.2493	0.3117
Class 1 — 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	.1905	.2165	.2505	.3130
Classes 2 and 3 — Min	.0600	.0730	.0860	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
Major diameter of truncated portion of truncated setting plug:												
Class 1 — Max	.0545	.0673	.0801	.0926	.1049	.1177	.1302	.1557	.1813	.2062	.2402	.3020
Class 1 — Min	.0542	.0670	.0797	.0922	.1045	.1173	.1298	.1553	.1808	.2057	.2397	.3015
Classes 2 and 3 — Max	.0566	.0694	.0822	.0950	.1076	.1204	.1332	.1590	.1846	.2098	.2438	.3059
Classes 2 and 3 — Min	.0563	.0691	.0818	.0946	.1072	.1200	.1328	.1586	.1841	.2093	.2433	.3054
Pitch diameter of setting plug or ring gage:												
Class 1 — Max. Y	------	------	------	------	------	------	------	------	------	------	.2254	.2839
Class 1 — Min. Y	------	------	------	------	------	------	------	------	------	------	.2251	.2836
Class 1 — Max. X	.0512	.0633	.0752	.0866	.0976	.1093	.1208	.1449	.1686	.1916	.2256	.2841
Class 1 — Min. X	.0510	.0631	.0750	.0864	.0974	.1091	.1206	.1447	.1683	.1913	.2253	.2838
Classes 2 and 3 — Max. Y	------	------	------	------	------	------	------	------	------	------	.2266	.2852
Classes 2 and 3 — Min. Y	------	------	------	------	------	------	------	------	------	------	.2263	.2849
Classes 2 and 3 — Max. X	.0519	.0640	.0759	.0874	.0985	.1102	.1218	.1460	.1697	.1928	.2268	.2854
Classes 2 and 3 — Min. X	.0517	.0638	.0757	.0872	.0983	.1100	.1216	.1458	.1694	.1925	.2265	.2851
Minor diameter of ring gage:												
Classes 1, 2, and 3 — Max	.0465	.0580	.0691	.0797	.0894	.1004	.1109	.1339	.1562	.1773	.2113	.2674
Classes 1, 2, and 3 — Min	.0462	.0577	.0687	.0793	.0890	.1000	.1105	.1335	.1557	.1768	.2108	.2669
MINIMUM-METAL LIMIT OR "NOT GO" GAGES FOR SCREWS												
Major diameter of full portion of truncated setting plug:												
Class 1 — Min	.0576	.0708	.0840	.0971	.1104	.1236	.1369	.1629	.1889	.2148	.2488	.3112
Class 1 — Max	[1].0579	[1].0711	[1].0844	[1].0975	[1].1108	[1].1240	[1].1373	.1633	.1894	.2153	.2493	.3117
Class 2 — Min	.0590	.0722	.0854	.0987	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
Class 2 — Max	[1].0593	[1].0725	[1].0858	[1].0991	.1124	.1254	.1384	.1644	.1905	.2165	.2505	.3130
Class 3 — Min	.0594	.0727	.0859	.0990	.1120	.1250	.1380	.1640	.1900	.2160	.2500	.3125
Class 3 — Max	[1].0597	[1].0730	[1].0863	.0994	.1124	.1254	.1384	.1644	.1905	.2165	.2505	.3130
Major diameter of truncated portion of truncated setting plug:												
Class 1 — Min	.0539	.0665	.0790	.0911	.1031	.1155	.1278	.1529	.1779	.2023	.2363	.2970
Class 1 — 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
Class 2 — 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
Class 3 — Max	.0560	.0687	.0813	.0936	.1059	.1184	.1309	.1562	.1813	.2061	.2401	.3010
Major diameter of basic-form setting plug:												
Class 1 — Min	.0566	.0695	.0823	.0950	.1076	.1205	.1332	.1589	.1846	.2100	.2440	.3061
Class 1 — Max	.0569	.0698	.0827	.0954	.1080	.1209	.1336	.1593	.1851	.2105	.2445	.3066
Class 2 — Min	.0580	.0709	.0837	.0966	.1094	.1223	.1352	.1611	.1868	.2124	.2464	.3087
Class 2 — Max	.0583	.0712	.0841	.0970	.1098	.1227	.1356	.1615	.1873	.2129	.2469	.3092
Class 3 — Min	.0584	.0714	.0842	.0971	.1100	.1230	.1359	.1618	.1876	.2133	.2473	.3096
Class 3 — Max	.0587	.0717	.0846	.0975	.1104	.1234	.1363	.1622	.1881	.2138	.2478	.3101
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
Class 1 — 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
Class 2 — 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
Class 3 — Max	.0508	.0629	.0747	.0861	.0971	.1088	.1203	.1444	.1681	.1909	.2249	.2833
(OPTIONAL)												
Pitch diameter of setting plug and ring gages for inspection. (See par. 6, p. 31):												
Class 1 — Min	.0486	.0606	.0724	.0836	.0943	.1059	.1172	.1411	.1645	.1870	.2210	.2792
Class 1 — 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
Class 2 — 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	.2827
Class 3 — Max	.0506	.0627	.0745	.0859	.0969	.1086	.1201	.1442	.1678	.1906	.2246	.2830
Minor diameter of ring gage:												
Class 1 — Min	.0469	.0585	.0696	.0803	.0901	.1012	.1120	.1353	.1580	.1796	.2136	.2705
Class 1 — Max	.0472	.0588	.0700	.0807	.0905	.1016	.1124	.1357	.1585	.1801	.2141	.2710
Class 2 — Min	.0475	.0592	.0706	.0815	.0918	.1030	.1140	.1375	.1602	.1820	.2160	.2731
Class 2 — Max	.0478	.0595	.0710	.0819	.0922	.1034	.1144	.1379	.1607	.1825	.2165	.2736
Class 3 — Min	.0479	.0597	.0711	.0820	.0924	.1037	.1147	.1382	.1610	.1829	.2169	.2740
Class 3 — Max	.0482	.0600	.0715	.0824	.0928	.1041	.1151	.1386	.1615	.1834	.2174	.2745

[1] See footnote at end of table.

TABLE 26. *Limits of size of setting plug and thread ring gages for screws of classes 1, 2, and 3 fits, American National fine-thread series*—Continued

Limits of size	Size (inches)											
	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
MAXIMUM-METAL LIMIT OR "GO" GAGES FOR SCREWS												
Major diameter of basic-form setting plug, and full portion of truncated setting plug:	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
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
Class 1 — 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
Classes 2 and 3 — Min	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000
Major diameter of truncated portion of truncated setting plug:												
Class 1 — Max	.3645	.4258	.4883	.5495	.6120	.7356	.8589	.9839	1.1068	1.2318	1.3568	1.4818
Class 1 — Min	.3640	.4253	.4878	.5490	.6115	.7350	.8583	.9833	1.1062	1.2312	1.3562	1.4812
Classes 2 and 3 — Max	.3684	.4303	.4928	.5543	.6168	.7410	.8652	.9902	1.1138	1.2388	1.3638	1.4888
Classes 2 and 3 — Min	.3679	.4298	.4923	.5538	.6163	.7404	.8646	.9896	1.1132	1.2382	1.3632	1.4882
Pitch diameter of setting plug or ring gage:												
Class 1 — Max Y	.3464	.4033	.4658	.5246	.5871	.7074	.8263	.9513	1.0683	1.1933	1.3183	1.4433
Class 1 — Min Y	.3461	.4030	.4655	.5243	.5868	.7070	.8259	.9509	1.0679	1.1929	1.3179	1.4429
Class 1 — Max X	.3466	.4035	.4660	.5248	.5873	.7076	.8265	.9515	1.0685	1.1935	1.3185	1.4435
Class 1 — Min X	.3463	.4032	.4657	.5245	.5870	.7073	.8262	.9512	1.0682	1.1932	1.3182	1.4432
Classes 2 and 3 — Max Y	.3477	.4048	.4673	.5262	.5887	.7092	.8284	.9534	1.0707	1.1957	1.3207	1.4457
Classes 2 and 3 — Min Y	.3474	.4045	.4670	.5259	.5884	.7088	.8280	.9530	1.0703	1.1953	1.3203	1.4453
Classes 2 and 3 — Max X	.3479	.4050	.4675	.5264	.5889	.7094	.8286	.9536	1.0709	1.1959	1.3209	1.4459
Classes 2 and 3 — Min X	.3476	.4047	.4672	.5261	.5886	.7091	.8283	.9533	1.0706	1.1956	1.3206	1.4456
Minor diameter of ring gage:												
Classes 1, 2, and 3 — Max	.3299	.3834	.4459	.5024	.5649	.6823	.7977	.9227	1.0348	1.1598	1.2848	1.4098
Classes 1, 2, and 3 — Min	.3294	.3829	.4454	.5019	.5644	.6817	.7971	.9221	1.0342	1.1592	1.2842	1.4092
MINIMUM-METAL LIMIT OR "NOT GO" GAGES FOR SCREWS												
Major diameter of full portion of truncated setting plug:												
Class 1 — Min	.3737	.4360	.4985	.5609	.6234	.7482	.8729	.9979	1.1226	1.2476	1.3726	1.4976
Class 1 — Max	.3742	.4365	.4990	.5614	.6239	.7488	.8735	.9985	1.1232	1.2482	1.3732	1.4982
Classes 2 and 3 — Min	.3750	.4375	.5000	.5625	.6250	.7500	.8750	1.0000	1.1250	1.2500	1.3750	1.5000
Classes 2 and 3 — Max	.3755	.4380	.5005	.5630	.6255	.7506	.8756	1.0006	1.1256	1.2506	1.3756	1.5006
Major diameter of truncated portion of truncated setting plug:												
Class 1 — Min	.3595	.4196	.4821	.5427	.6052	.7278	.8498	.9748	1.0961	1.2211	1.3461	1.4711
Class 1 — 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
Class 2 — 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
Class 3 — Max	.3635	.4241	.4866	.5475	.6100	.7333	.8559	.9809	1.1030	1.2280	1.3530	1.4780
Major diameter of basic-form setting plug:												
Class 1 — Min	.3686	.4304	.4929	.5547	.6172	.7413	.8653	.9903	1.1141	1.2391	1.3641	1.4891
Class 1 — Max	.3691	.4309	.4934	.5552	.6177	.7419	.8659	.9909	1.1147	1.2397	1.3647	1.4897
Class 2 — Min	.3712	.4334	.4959	.5579	.6204	.7449	.8695	.9945	1.1188	1.2438	1.3688	1.4938
Class 2 — Max	.3717	.4339	.4964	.5584	.6209	.7455	.8701	.9951	1.1194	1.2444	1.3694	1.4944
Class 3 — Min	.3721	.4344	.4969	.5590	.6215	.7462	.8708	.9958	1.1204	1.2454	1.3704	1.4954
Class 3 — Max	.3726	.4349	.4974	.5595	.6220	.7468	.8714	.9964	1.1210	1.2460	1.3710	1.4960
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
Class 1 — 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
Class 2 — 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
Class 3 — Max	.3458	.4027	.4652	.5237	.5862	.7065	.8253	.9503	1.0672	1.1922	1.3172	1.4422
(OPTIONAL)												
Pitch diameter of setting plug and ring gages for inspection. (See par. 6, p. 31):												
Class 1 — Min	.3417	.3981	.4606	.5188	.5813	.7010	.8192	.9442	1.0603	1.1853	1.3103	1.4353
Class 1 — 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
Class 2 — 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
Class 3 — Max	.3455	.4024	.4649	.5234	.5859	.7062	.8250	.9500	1.0669	1.1919	1.3169	1.4419
Minor diameter of ring gage:												
Class 1 — Min	.3330	.3876	.4501	.5071	.5696	.6878	.8040	.9290	1.0426	1.1676	1.2926	1.4176
Class 1 — 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
Class 2 — 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
Class 3 — Max	.3370	.3921	.4546	.5119	.5744	.6933	.8101	.9351	1.0495	1.1745	1.2995	1.4245

[1] These major diameters represent the maximum practicable sharpness of crest of the setting plug, in accordance with par. 3 (b), p. 4.

TABLE A. *Major diameters of minimum-metal limit basic-form setting plugs, American National extra-fine, 8-pitch, 12-pitch, and 16-pitch thread series*

Sizes	Limits of size of major diameters of minimum-metal limit basic-form setting plugs															
	Extra-fine tbread series table 33, p. 72 and 73				8-piteb thread series table 38, p. 80 and 81				12-pitch thread series table 43, p. 88 to 90				16-pitch thread series table 48, p. 98 to 100			
	Class 2		Class 3		Class 2		Class 3		Class 2		Class 3		Class 2		Class 3	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	0.2463	0.2468	0.2473	0.2478												
5/16	.3087	.3092	.3097	.3102												
3/8	.3711	.3716	.3721	.3726												
7/16	.4334	.4339	.4345	.4350												
1/2	.4958	.4963	.4969	.4974					0.4938	0.4944	0.4954	0.4960				
9/16	.5580	.5586	.5592	.5597					.5563	.5569	.5579	.5585				
5/8	.6204	.6209	.6216	.6221					.6188	.6194	.6204	.6210				
11/16	.6829	.6834	.6841	.6846					.6813	.6819	.6829	.6835				
3/4	.7449	.7454	.7463	.7468					.7438	.7444	.7454	.7460	0.7449	0.7455	0.7462	0.7468
13/16	.8074	.8079	.8088	.8093					.8063	.8069	.8079	.8085	.8068	.8074	.8084	.8090
7/8	.8698	.8703	.8712	.8717					.8688	.8694	.8704	.8710	.8693	.8699	.8708	.8714
15/16	.9323	.9328	.9337	.9342					.9313	.9319	.9329	.9335	.9317	.9323	.9333	.9339
1	.9947	.9952	.9961	.9966	0.9917	0.9924	0.9939	0.9946	.9938	.9944	.9954	.9960	.9942	.9948	.9957	.9963
1 1/16	1.0572	1.0577	1.0584	1.0589					1.0563	1.0569	1.0579	1.0585	1.0566	1.0572	1.0582	1.0588
1 1/8	1.1193	1.1198	1.1209	1.1214	1.1164	1.1171	1.1188	1.1195	1.1188	1.1194	1.1204	1.1210	1.1190	1.1196	1.1206	1.1212
1 3/16	1.1818	1.1823	1.1834	1.1839					1.1813	1.1819	1.1829	1.1835	1.1815	1.1821	1.1831	1.1837
1 1/4	1.2442	1.2447	1.2458	1.2463	1.2410	1.2417	1.2435	1.2442	1.2438	1.2444	1.2454	1.2460	1.2439	1.2445	1.2456	1.2462
1 5/16	1.3067	1.3072	1.3083	1.3088					1.3063	1.3069	1.3079	1.3085	1.3064	1.3070	1.3080	1.3086
1 3/8	1.3691	1.3696	1.3707	1.3712	1.3657	1.3664	1.3682	1.3689	1.3688	1.3694	1.3704	1.3710	1.3688	1.3694	1.3705	1.3711
1 7/16									1.4313	1.4319	1.4329	1.4335	1.4313	1.4319	1.4329	1.4335
1 1/2	1.4316	1.4321	1.4332	1.4337	1.4903	1.4910	1.4930	1.4937	1.4938	1.4944	1.4954	1.4960	1.4937	1.4943	1.4954	1.4960
1 9/16	1.4940	1.4945	1.4957	1.4962									1.5561	1.5567	1.5579	1.5585
1 5/8	1.5565	1.5570	1.5581	1.5586	1.6150	1.6157	1.6178	1.6185	1.6180	1.6186	1.6199	1.6205	1.6186	1.6192	1.6203	1.6209
1 11/16	1.6189	1.6194	1.6206	1.6211									1.6811	1.6817	1.6648	1.6654
1 3/4	1.6814	1.6819	1.6831	1.6836	1.7396	1.7403	1.7425	1.7432	1.7429	1.7435	1.7448	1.7454	1.7435	1.7441	1.7453	1.7459
1 13/16	1.7435	1.7441	1.7453	1.7459									1.8060	1.8066	1.8077	1.8083
1 7/8					1.8643	1.8650	1.8673	1.8680	1.8678	1.8684	1.8698	1.8704	1.8684	1.8690	1.8702	1.8708
1 15/16													1.9309	1.9315	1.9327	1.9333
2	1.9933	1.9939	1.9951	1.9957	1.9889	1.9896	1.9920	1.9927	1.9927	1.9933	1.9947	1.9953	1.9333	1.9939	1.9951	1.9957
2 1/16													2.0558	2.0564	2.0576	2.0582
2 1/8					2.1136	2.1143	2.1168	2.1175	2.1176	2.1182	2.1196	2.1202	2.1182	2.1188	2.1201	2.1207
2 3/16													2.1807	2.1813	2.1826	2.1832
2 1/4					2.2383	2.2390	2.2416	2.2423	2.2425	2.2431	2.2446	2.2452	2.2432	2.2438	2.2450	2.2456
2 5/16													2.3056	2.3062	2.3075	2.3081
2 3/8									2.3674	2.3680	2.3695	2.3701	2.3681	2.3687	2.3700	2.3706
2 7/16													2.4305	2.4311	2.4324	2.4330
2 1/2					2.4876	2.4883	2.4911	2.4918	2.4923	2.4929	2.4945	2.4951	2.4930	2.4936	2.4949	2.4955
2 5/8									2.6173	2.6179	2.6194	2.6200	2.6179	2.6185	2.6199	2.6205
2 3/4					2.7369	2.7376	2.7406	2.7413	2.7422	2.7428	2.7444	2.7450	2.7428	2.7434	2.7448	2.7454
2 7/8									2.8671	2.8677	2.8693	2.8699	2.8678	2.8684	2.8698	2.8704
3					2.9863	2.9870	2.9901	2.9908	2.9920	2.9926	2.9943	2.9949	2.9927	2 9933	2.9947	2.9953
3 1/8									3.1170	3.1176	3.1192	3.1198	3.1176	3.1182	3.1197	3.1203
3 1/4					3.2361	3.2368	3.2400	3.2407	3.2419	3.2425	3.2442	3.2448	3.2425	3.2431	3.2446	3.2452
3 3/8									3.3668	3.3674	3.3691	3.3697	3.3675	3.3681	3.3696	3.3702
3 1/2					3.4860	3.4867	3.4900	3.4907	3.4918	3.4924	3.4941	3.4947	3.4924	3.4930	3.4945	3.4951
3 5/8									3.6167	3.6173	3.6190	3.6196	3.6173	3.6179	3.6195	3.6201
3 3/4					3.7359	3.7366	3.7399	3.7406	3.7416	3.7422	3.7440	3.7446	3.7423	3.7429	3.7444	3.7450
3 7/8									3.8666	3.8672	3.8689	3.8695	3.8672	3.8678	3.8694	3.8700
4					3.9858	3.9865	3.9898	3.9905	3.9915	3.9921	3.9939	3.9945	3.9922	3.9928	3.9943	3.9949
4 1/4					4.2356	4.2363	4.2397	4.2404	4.2414	4.2420	4.2438	4.2444				
4 1/2					4.4855	4.4862	4.4896	4.4903	4.4913	4.4919	4.4937	4.4943				
4 3/4					4.7354	4.7361	4.7395	4.7402	4.7411	4.7417	4.7436	4.7442				
5					4.9853	4.9860	4.9894	4.9901	4.9910	4.9916	4.9935	4.9941				
5 1/4					5.2352	5.2359	5.2394	5.2401	5.2409	5.2415	5.2435	5.2441				
5 1/2					5.4851	4.4858	5.4893	5.4900	5.4908	5.4914	5.4934	5.4940				
5 3/4					5.7350	5.7357	5.7392	5.7399	5.7407	5.7413	5.7433	5.7439				
6					5.9849	5.9856	5.9891	5.9898	5.9906	5.9912	5.9932	5.9938				

Table 31.—*Sizes of tap drills, American National fine thread series* [1]

Size of thread	Threads per inch	Minor diameter of nut: Basic	Minor diameter of nut: Maximum	Minor diameter of nut: Minimum	Stock drills and corresponding percentage of basic thread depth [2]: Nominal size	Diameter	Percentage of depth of basic thread
		Inch	*Inch*	*Inch*		*Inch*	
0	80	0.0438	0.0514	0.0465	3/64 in. 1.25 mm	0.0469 .0492	81 67
1	72	.0550	.0634	.0580	1.50 mm 1.55 mm	.0591 .0610	77 67
2	64	.0657	.0746	.0691	#50 #49	.0700 .0730	79 64
3	56	.0758	.0856	.0797	#46 2.10 mm	.0810 .0827	78 70
4	48	.0849	.0960	.0894	2.30 mm 3/32 in #41	.0906 .0937 .0960	79 68 59
5	44	.0955	.1068	.1004	2.60 mm #37 #36	.1024 .1040 .1065	77 71 63
6	40	.1055	.1179	.1109	#33 #32	.1130 .1160	77 68
8	36	.1279	.1402	.1339	3.40 mm #29 3.50 mm	.1339 .1360 .1378	83 78 73
10	32	.1494	.1624	.1562	5/32 in #21[3] #20	.1562 .1590 .1610	83 76 71
12	28	.1696	.1835	.1773	#15	.1800	78
1/4	28	.2036	.2173	.2113	#3	.2130	80
5/16	24	.2584	.2739	.2674	I	.2720	75
3/8	24	.3209	.3364	.3299	Q	.3320	79
7/16	20	.3725	.3906	.3834	W 25/64 in	.3860 .3906	79 72
1/2	20	.4350	.4531	.4459	29/64 in	.4531	72
9/16	18	.4903	.5100	.5024	0.5062	.5062	78
5/8	18	.5528	.5725	.5649	14.5 mm	.5709	75
3/4	16	.6688	.6903	.6823	11/16 in 17.5 mm	.6875 .6890	77 75
7/8	14	.7822	.8062	.7977	*51/64 in* *20.5 mm*	*.7969* *.8071*	*84* *73*
1	14	.9072	.9312	.9227	23.5 mm	.9252	81
1 1/8	12	1.0167	1.0438	1.0348	26.5 mm	1.0433	75
1 1/4	12	1.1417	1.1688	1.1598	29.5 mm	1.1614	82
1 3/8	12	1.2667	1.2938	1.2848	*1 9/32 in* *1 19/64 in*	*1.2812* *1.2969*	*87* *72*
1 1/2	12	1.3917	1.4188	1.4098	36 mm	1.4173	76

[1] Sizes in italic type are not within the specified limits for minor diameter of nut. See p. 43, H28 (1944). Sizes of tap drills for class 5 fit are given in table 25.

[2] Drill sizes up to 1/2 inch are in agreement with ASA B5.12-1940, Twist Drills, Straight Shank, published by the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

[3] This size is not included as standard in ASA B5.12-1940 but is listed in an appendix thereto.

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

Page 106, 2d col., line 2, change "four" to "three."

Page 107, par. (*l*). Substitute the following for this paragraph and footnote 15:

"(*l*) The tolerance on minor diameter of a nut of a given diameter, pitch, and length of engagement shall be taken from table 54A."

Page 109, par. 2, substitute the following for this paragraph:

"2. Tolerances on pitch diameter for pitches between those for which values are given in the tables shall be those of the next coarser pitch, except that for screws having 80, 72, 44, 13, 11, 9, 7, 5, or 4 1/2 threads per inch and 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 IV, the tolerances given in section III shall be used."

Page 109, insert after par. 5:

"6. For pitches finer than 64 threads per inch, apply the formulas in table 143. If the resulting tolerance is greater than that for 64 threads per inch as given in tables 55 to 57 for the same diameter and class, apply the tolerance for 64 threads."

Page 109, 2d col., insert the following above "5. GAGES":

(*d*) Table of Nut Minor Diameter Tolerances.—Table 54A provides tolerances for all diameters and lengths of engagement, and for the selected pitches recommended in this section, with 80 and 72 threads per inch in addition.

The principal practical factors which govern these tolerances are tapping difficulties, particularly tap breakage in the small sizes, and depth of engagement. Depth of engagement correlates with the stripping strength of the thread assembly, and thus also with the length of engagement. It also correlates with the tendency toward disengagement of the threads on one side, when assembly is eccentric. The amount of possible eccentricity is one-half of the sum of the pitch diameter allowance and tolerances. For a given pitch, or depth of thread, this sum increases with the diameter, and accordingly this factor would require a decrease in minor diameter tolerance with increase in diameter.

Thus, for any given pitch and length of engagement, the tolerances do not increase or decrease proportionately with the diameter or a function of the diameter. Starting with the smallest size

TABLE 54A.—*Minor diameter tolerances for internal special screw threads, classes 1, 2, and 3*

Threads per inch	Lengths of engagement: Over—	Lengths of engagement: To and incl.—	Above 0.053 to 0.066 in.	Above 0.066 to 0.079 in.	Above 0.079 to 0.092 in.	Above 0.092 to 0.105 in.	Above 0.105 to 0.118 in.	Above 0.118 to 0.131 in.	Above 0.131 to 0.151 in.	Above 0.151 to 0.177 in.	Above 0.177 to 0.203 in.	Above 0.203 to 0.233 in.	Above 0.233 to 0.281 in.	Above 0.281 to 0.344 in.	Above 0.344 to 0.406 in.	Above 0.406 to 0.469 in.
			Minor diameter tolerances for thread sizes having basic major diameters													
			Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
80	-------	1/3 D	0.0027	0.0022	0.0017	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
	1/3 D	2/3 D	.0041	.0033	.0026	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
	2/3 D	1 1/2 D	.0049	.0044	.0034	.0026	.0026	.0026	.0026	.0026	.0026	.0026	.0026	.0026	.0026	.0026
	1 1/2 D	-------	.0049	.0049	.0042	.0033	.0033	.0033	.0033	.0033	.0033	.0033	.0033	.0033	.0033	.0033
72	-------	1/3 D	.0032	.0027	.0022	.0017	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013	.0013
	1/3 D	2/3 D	.0048	.0040	.0033	.0025	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020	.0020
	2/3 D	1 1/2 D	.0054	.0054	.0044	.0033	.0027	.0027	.0027	.0027	.0027	.0027	.0027	.0027	.0027	.0027
	1 1/2 D	-------	.0054	.0054	.0054	.0041	.0034	.0034	.0034	.0034	.0034	.0034	.0034	.0034	.0034	.0034
64	-------	1/3 D	.0038	.0033	.0028	.0022	.0017	.0014	.0014	.0014	.0014	.0014	.0014	.0014	.0014	.0014
	1/3 D	2/3 D	.0057	.0049	.0041	.0034	.0026	.0021	.0021	.0021	.0021	.0021	.0021	.0021	.0021	.0021
	2/3 D	1 1/2 D	.0062	.0062	.0055	.0045	.0035	.0028	.0028	.0028	.0028	.0028	.0028	.0028	.0028	.0028
	1 1/2 D	-------	.0062	.0062	.0062	.0056	.0044	.0035	.0035	.0035	.0035	.0035	.0038	.0042	.0044	.0044
56	-------	1/3 D	-------	.0040	.0035	.0029	.0024	.0019	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.0015
	1/3 D	2/3 D	-------	.0060	.0052	.0044	.0037	.0029	.0023	.0023	.0023	.0023	.0023	.0023	.0023	.0023
	2/3 D	1 1/2 D	-------	.0070	.0069	.0059	.0049	.0038	.0030	.0030	.0030	.0030	.0030	.0030	.0030	.0030
	1 1/2 D	-------	-------	.0070	.0070	.0070	.0061	.0048	.0038	.0038	.0038	.0038	.0038	.0044	.0046	.0046
48	-------	1/3 D	-------	-------	.0044	.0039	.0033	.0028	.0023	.0016	.0016	.0016	.0016	.0016	.0016	.0016
	1/3 D	2/3 D	-------	-------	.0066	.0058	.0050	.0042	.0035	.0024	.0024	.0024	.0024	.0024	.0024	.0024
	2/3 D	1 1/2 D	-------	-------	.0082	.0077	.0067	.0057	.0046	.0032	.0032	.0032	.0032	.0032	.0032	.0032
	1 1/2 D	-------	-------	-------	.0082	.0082	.0082	.0071	.0058	.0041	.0041	.0041	.0041	.0046	.0048	.0048
40	-------	1/3 D	-------	-------	-------	.0050	.0045	.0040	.0035	.0025	.0020	.0019	.0019	.0019	.0019	.0019
	1/3 D	2/3 D	-------	-------	-------	.0076	.0068	.0060	.0053	.0037	.0030	.0029	.0029	.0029	.0029	.0029
	2/3 D	1 1/2 D	-------	-------	-------	.0098	.0091	.0080	.0070	.0050	.0040	.0039	.0039	.0039	.0039	.0039
	1 1/2 D	-------	-------	-------	-------	.0098	.0098	.0098	.0088	.0063	.0049	.0049	.0049	.0049	.0049	.0049
36	-------	1/3 D	-------	-------	-------	-------	.0053	.0048	.0043	.0032	.0022	.0022	.0022	.0022	.0022	.0022
	1/3 D	2/3 D	-------	-------	-------	-------	.0079	.0072	.0064	.0049	.0033	.0032	.0032	.0032	.0032	.0032
	2/3 D	1 1/2 D	-------	-------	-------	-------	.0106	.0095	.0085	.0065	.0044	.0043	.0043	.0043	.0043	.0043
	1 1/2 D	-------	-------	-------	-------	-------	.0109	.0109	.0106	.0081	.0055	.0052	.0054	.0054	.0054	.0054
32	-------	1/3 D	-------	-------	-------	-------	-------	-------	.0052	.0041	.0031	.0026	.0024	.0024	.0024	.0024
	1/3 D	2/3 D	-------	-------	-------	-------	-------	-------	.0077	.0062	.0046	.0040	.0037	.0037	.0037	.0037
	2/3 D	1 1/2 D	-------	-------	-------	-------	-------	-------	.0103	.0082	.0062	.0053	.0049	.0049	.0049	.0049
	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	.0123	.0103	.0078	.0066	.0061	.0061	.0061	.0061
28	-------	1/3 D	-------	-------	-------	-------	-------	-------	-------	-------	.0042	.0033	.0030	.0028	.0028	.0028
	1/3 D	2/3 D	-------	-------	-------	-------	-------	-------	-------	-------	.0068	.0050	.0044	0042	.0042	.0042
	2/3 D	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	.0084	.0066	.0059	.0056	.0056	.0056
	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0104	.0083	.0074	.0070	.0070	.0070
24	-------	1/3 D	-------	-------	-------	-------	-------	-------	-------	-------	.0055	.0045	.0038	.0032	.0032	.0032
	1/3 D	2/3 D	-------	-------	-------	-------	-------	-------	-------	-------	.0083	.0067	.0057	.0049	.0049	.0049
	2/3 D	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	.0110	.0090	.0077	.0065	.0065	.0065
	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0138	.0112	.0096	.0081	.0081	.0081
20	-------	1/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0050	.0044	.0037	.0036
	1/3 D	2/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0076	.0066	.0056	.0054
	2/3 D	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0101	.0088	.0075	.0072
	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0126	.0110	.0094	.0090
18	-------	1/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0052	.0045	.0039
	1/3 D	2/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0078	.0068	.0058
	2/3 D	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0104	.0091	.0078
	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0130	.0113	.0097
16	-------	1/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0055	.0049
	1/3 D	2/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0083	.0073
	2/3 D	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0110	.0097
	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0138	.0131
14	-------	1/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0061
	1/3 D	2/3 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0092
	2/3 D	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0123
	1 1/2 D	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	.0154

TABLE 54A.—*Minor diameter tolerances for internal special screw threads, classes 1, 2, and 3*—Continued

Threads per inch	Lengths of engagement: Over—	Lengths of engagement: To and incl.—	Above 0.469 to 0.531 in.	Above 0.531 to 0.594 in.	Above 0.594 to 0.656 in.	Above 0.656 to 0.719 in.	Above 0.719 to 0.781 in.	Above 0.781 to 0.844 in.	Above 0.844 to 0.906 in.	Above 0.906 to 0.969 in.	Above 0.969 to 1.031 in.	Above 1.031 to 1.500 in.	Above 1.500 to 2.5 in.	Above 2.5 to 4.5 in.	Above 4.5 in.
			Inch	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	Same as respective pitch diameter tolerances for each class but not less than values in preceding column.
72		1/3D	0.0013	0.0014	0.0014	0.0015	0.0015								
	1/3D	2/3D	.0020	.0021	.0022	.0022	.0023								
	2/3D	1 1/2D	.0027	.0028	.0029	.0030	.0031								
	1 1/2D		.0034	.0039	.0042	.0042	.0042								
64		1/3D	.0014	.0014	.0014	.0015	.0015	0.0016	0.0016	0.0017	0.0017	0.0018			
	1/3D	2/3D	.0021	.0021	.0022	.0022	.0023	.0024	.0025	.0025	.0025	.0026			
	2/3D	1 1/2D	.0028	.0028	.0029	.0030	.0031	.0032	.0033	.0034	.0034	.0035			
	1 1/2D		.0044	.0044	.0047	.0047	.0047	.0050	.0050	.0050	.0050	.0052			
56		1/3D	.0015	.0015	.0016	.0016	.0016	.0016	.0017	.0018	.0018	.0020			
	1/3D	2/3D	.0023	.0023	.0023	.0024	.0024	.0025	.0025	.0026	.0027	.0031			
	2/3D	1 1/2D	.0030	.0030	.0031	.0032	.0032	.0033	.0034	.0035	.0036	.0041			
	1 1/2D		.0046	.0049	.0049	.0052	.0052	.0056	.0056	.0056	.0056	.0056			
48		1/3D	.0016	.0016	.0016	.0018	.0018	.0020	.0020	.0020	.0020	.0022	0.0022		
	1/3D	2/3D	.0024	.0024	.0024	.0028	.0028	.0029	.0029	.0029	.0029	.0033	.0033		
	2/3D	1 1/2D	.0034	.0037	.0037	.0037	.6037	.0039	.0039	.0039	.0039	.0044	.0044		
	1 1/2D		.0048	.0051	.0051	.0057	.0057	.0059	.0062	.0062	.0062	.0062	.0062		
40		1/3D	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0019	.0020	.0022	.0024		
	1/3D	2/3D	.0029	.0029	.0029	.0029	.0029	.0029	.0029	.0029	.0031	.0034	.0036		
	2/3D	1 1/2D	.0039	.0039	.0039	.0039	.0039	.0041	.0041	.0041	.0041	.0045	.0048		
	1 1/2D		.0051	.0054	.0054	.0057	.0057	.0062	.0068	.0068	.0068	.0068	.0068		
36		1/3D	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0022	.0023	.0025	0.0025	
	1/3D	2/3D	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0035	.0038	.0038	
	2/3D	1 1/2D	.0043	.0043	.0043	.0043	.0043	.0043	.0043	.0043	.0043	.0046	.0050	.0050	
	1 1/2D		.0054	.0057	.0057	.0057	.0057	.0065	.0070	.0070	.0070	.0072	.0072	.0072	
32		1/3D	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0027	.0027	
	1/3D	2/3D	.0037	.0037	.0037	.0037	.0037	.0037	.0037	.0037	.0037	.0037	.0041	.0041	
	2/3D	1 1/2D	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0054	.0054	.0054	
	1 1/2D		.0061	.0061	.0061	.0061	.0061	.0065	.0070	.0070	.0070	.0076	.0076	.0076	
28		1/3D	.0028	.0028	.0028	.0028	.0028	.0028	.0028	.0028	.0028	.0028	.0028	.0031	
	1/3D	2/3D	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0046	
	2/3D	1 1/2D	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0056	.0062	.0062	
	1 1/2D		.0070	.0070	.0070	.0070	.0070	.0070	.0070	.0070	.0070	.0079	.0086	.0086	
24		1/3D	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0032	.0033	
	1/3D	2/3D	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0049	.0049	
	2/3D	1 1/2D	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0065	.0066	
	1 1/2D		.0081	.0081	.0081	.0081	.0081	.0081	.0081	.0081	.0081	.0081	.0089	.0092	
20		1/3D	.0036	.0036	.0036	.0036	.0036	.0036	.0036	.0036	.0036	.0036	.0036	.0036	
	1/3D	2/3D	.0054	.0054	.0054	.0054	.0054	.0054	.0054	.0054	.0054	.0054	.0054	.0054	
	2/3D	1 1/2D	.0072	.0072	.0072	.0072	.0072	.0072	.0072	.0072	.0072	.0072	.0072	.0072	
	1 1/2D		.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0090	.0102	.0102	.0102	.0102	
18		1/3D	.0038	.0038	.0038	.0038	.0038	.0038	.0038	.0038	.0038	.0038	.0038	.0038	
	1/3D	2/3D	.0057	.0057	.0057	.0057	.0057	.0057	.0057	.0057	.0057	.0057	.0057	.0057	
	2/3D	1 1/2D	.0076	.0076	.0076	.0076	.0076	.0076	.0076	.0076	.0076	.0076	.0076	.0082	
	1 1/2D		.0095	.0095	.0095	.0095	.0095	.0095	.0095	.0095	.0114	.0114	.0114	.0114	
16		1/3D	.0042	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	.0040	
	1/3D	2/3D	.0063	.0060	.0060	.0060	.0060	.0060	.0060	.0060	.0060	.0060	.0060	.0060	
	2/3D	1 1/2D	.0084	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0080	.0085	
	1 1/2D		.0114	.0100	.0100	.0100	.0100	.0100	.0100	.0100	.0115	.0120	.0123	.0126	
14		1/3D	.0055	.0048	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	.0042	
	1/3D	2/3D	.0083	.0072	.0062	.0062	.0062	.0062	.0062	.0062	.0062	.0062	.0062	.0062	
	2/3D	1 1/2D	.0110	.0096	.0083	.0083	.0083	.0083	.0083	.0083	.0083	.0096	.0098	.0098	
	1 1/2D		.0138	.0120	.0103	.0103	.0103	.0103	.0103	.0103	.0115	.0127	.0133	.0139	
12		1/3D		.0065	.0058	.0052	.0045	.0045	.0045	.0045	.0045	.0045	.0045	.0045	
	1/3D	2/3D		.0097	.0087	.0077	.0067	.0067	.0067	.0067	.0067	.0067	.0067	.0067	
	2/3D	1 1/2D		.0129	.0116	.0103	.0090	.0090	.0090	.0090	.0090	.0090	.0098	.0108	
	1 1/2D			.0161	.0145	.0129	.0112	.0112	.0112	.0112	.0127	.0131	.0137	.0143	
10		1/3D				.0074	.0068	.0061	.0054	.0054	.0054	.0054	.0054	.0054	
	1/3D	2/3D				.0111	.0101	.0092	.0081	.0081	.0081	.0081	.0081	.0081	
	2/3D	1 1/2D				.0148	.0135	.0122	.0108	.0108	.0108	.0108	.0108	.0112	
	1 1/2D					.0185	.0169	.0152	.0135	.0135	.0135	.0135	.0184	.0184	
8		1/3D						.0094	.0087	.0081	.0074	.0063	.0063	.0063	
	1/3D	2/3D						.0140	.0130	.0121	.0111	.0101	.0101	.0101	
	2/3D	1 1/2D						.0187	.0174	.0161	.0148	.0135	.0135	.0135	
	1 1/2D							.0234	.0218	.0201	.0180	.0169	.0195	.0210	
6		1/3D									.0090	.0090	.0090	.0090	
	1/3D	2/3D									.0135	.0135	.0135	.0135	
	2/3D	1 1/2D									.0180	.0180	.0180	.0180	
	1 1/2D										.0226	.0226	.0226	.0226	
4		1/3D										.0135	.0135	.0135	
	1/3D	2/3D										.0203	.0203	.0203	
	2/3D	1 1/2D										.0270	.0270	.0270	
	1 1/2D											.0337	.0337	.0337	

at the left of table 54A the tolerance is large, and decreases as the diameter increases, then remains constant over a considerable range, and increases in the larger diameters in accordance with the general tendency for tolerances to increase with increase in diameter. The large values at the left minimize tap breakage, but with short lengths of engagement the stripping strength is sacrificed to the extent that the full tensile strength of the screw is not developed. However, strength in small sizes is usually not important, but in larger sizes strength is the primary factor determining the selection of size, and smaller but adequate minor diameter tolerances tend to permit the selection of a smaller size than would otherwise be possible for a given strength.

The tolerances in table 54A increase with increases in length of engagement and in pitch.

The fundamental basis of table 54A is the present set of minor diameter tolerances established for the American National coarse and fine thread series on the basis of experience in production. That is, values in the table corresponding to standard diameters and pitches, and lengths of engagement from $\frac{2}{3}D$ to $1\frac{1}{2}D$, are in close agreement with the NC and NF values, with slight deviations in some cases to conform with formulas used. These formulas express curves of a General Motors Engineering Standard chart, which subdivide the tolerance-diameter relationship into four zones, with a particular proportion of tolerance to diameter applicable in each zone, and apply to lengths of engagement from $\frac{2}{3}D$ to $1\frac{1}{2}D$. Tolerances for lengths of engagement less than $\frac{1}{3}D$ are ½ of these, for $\frac{1}{3}D$ to $\frac{2}{3}D$ are ¾ of these, and for over $1\frac{1}{2}D$ are 1¼ times these. However, where the resulting tolerance would result in a depth of thread less than 53 percent of the basic thread depth, the values are adjusted to produce the 53 percent depth of thread. In the fourth zone, corresponding to the larger diameters at the right of the table, tolerances for lengths of engagement from $\frac{2}{3}D$ to $1\frac{1}{2}D$ are adjusted to equality with class 2 pitch diameter tolerances, and for lengths greater than $1\frac{1}{2}D$ to equality with class 1 pitch diameter tolerances.

Attention is called to the simplified, preferred minor diameter tolerances given in table XVI. 2, p. 88, columns 6 to 9, inclusive, prepared subsequently to table 54A.

Page 111, table 54. Omit column 12, which is replaced by table 54A.

Page 115. Delete table 58. (See reference to p. 19 to 23 herein.)

SECTION VI. AMERICAN STANDARD PIPE THREADS [18]

This section is to be brought into agreement with ASA B2.1–1945, "Pipe Threads" by making the following revisions and corrections:

Throughout the section, change "American National" to "American Standard." The term "American National" is thus reserved to identify the thread form specified in section III.

Page 116. Revise the introduction to read as follows:

"The American Standard for Pipe Threads, originally known as the Briggs Standard, was formulated by Mr. Robert Briggs. For several years around 1862 Mr. Briggs was superintendent of the Pascal Iron Works of Morris, Tasker & Co., Philadelphia, Pa., and later engineering editor of the Journal of the Franklin Institute. After his death on July 24, 1882, a paper by Mr. Briggs containing detailed information regarding American pipe and pipe thread practice, as developed by him when superintendent of the Pascal Iron Works, was read before the Institution of Civil Engineers of Great Britain. This is recorded in the Excerpt Minutes, volume LXXI, Session 1882–83, part 1, of that Society.

"It is of interest to note that the nominal sizes (diameters) of pipe 10 inches and under, and the pitches of the thread were for the most part established between 1820 and 1840.

"By publishing his data, based on years of practice, Mr. Briggs was the means of establishing definite detail dimensions. The Briggs formula did not provide for the internal threads or gaging requirements for making taper threaded joints. It established only the external thread on pipe, with no tolerance.

"In 1886 the large majority of American manufacturers threaded pipe to practically the Briggs Standard, and acting jointly with the American Society of Mechanical Engineers they adopted it as a standard practice that year, and master plug and ring gages were made.

"Later, at various conferences, representatives of the manufacturers and the ASME established additional sizes, certain details of gaging, tolerances, special applications of the standard and, in addition, tabulated the formulas and dimensions more completely than was done by Mr. Briggs.

[18] This standard, in substantially the same form, has been adopted by the American Standards Association. It is published as ASA B2.1–1945, "American Standard Pipe Threads," by the ASME, 29 West Thirty-ninth Street, New York 18, N. Y. The specifications for gages are in agreement with Federal Specification GGG–P–351a, "Pipe Threads; Taper (American National)."

"In 1913 a Committee on the Standardization of Pipe Threads was organized for the purpose of reediting and expanding the Briggs Standard. The American Gas Association and The American Society of Mechanical Engineers served as joint sponsors. After 6 years of work this committee completed the revised standard for taper-pipe threads, which was published in the ASME Transactions of 1919. During this period the thin ring gage was established, and the crests of the thread plug and ring gages were truncated. 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 Standard became evident, as well as the necessity of adding to it the recent developments in pipe threading practice. Accordingly, the Sectional Committee on the Standardization of Pipe Threads, B2, was organized in 1927 under the joint sponsorship of the AGA and the ASME. The specifications in this section are in agreement with the current standard developed by that committee.

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

Page 117, at bottom, correct formula to read "$L_2=(0.8D+6.8)/n$."

Page 118, figure 23, revise as follows:

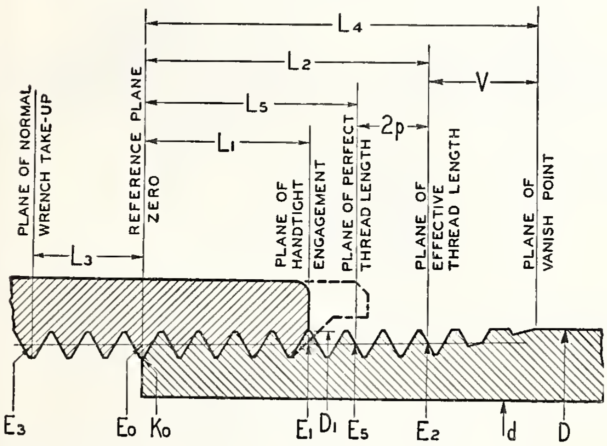


FIGURE 23. *American Standard taper pipe thread notation.*

NOTATION

$$E_0=D-(0.05D+1.1)1/n$$
$$E_1=E_0+0.0625L_1$$
$$L_2=\left(\frac{0.8D+6.8}{n}\right)$$

Page 118, 2d col., revise par. 1 to read as follows:

"1. MANUFACTURING TOLERANCE ON PRODUCT USING WORKING GAGES.—The maximum allowable variation in the commercial product is 1 turn large or 1 turn small from the gaging notch on plug and gaging face of ring when working gages are screwed up firmly by hand on or in the product. (See figs. 27 and 28.) This is equivalent to a maximum allowable variation of the product of 1½ turns large or small from the basic dimensions, on account of the permissible tolerance of ½ turn large or small on working gages."

Page 119, table 59, add to table heading, "NPT." Delete the 2-inch API line pipe from table and corresponding footnote number 7.

Page 120, footnote 8, add at end of first sentence: "for the 3-inch size and smaller."

Page 121, table 60, add "NPT" at end of table heading. In note at bottom, line 3, change "elimination" to "eliminating."

Page 122, 1st col., par. 2 and table 61, revise to read as follows:

"2. TOLERANCES ON THREAD ELEMENTS.—The permissible variations in thread elements on steel products and all pipe made of steel, wrought iron, or brass, exclusive of butt-weld pipe, are given in tables 60, 61, and 66. These tables are a guide for establishing limits of the thread elements of taps, dies, and thread chasers. These limits may be required on product threads.

"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, will provide for a satisfactory check of accumulated variations in such product of taper, lead, and angle. Therefore, no tolerances on thread elements have been established for this class.

"For service conditions, where more exact check is required, procedures have been developed by industry to supplement the regulation plug and ring gage method of gaging. See pars. (d) 1 (*b*) and (d) 1 (*c*), p. 123, H28(1944)."

TABLE 61. *Tolerances on taper, lead, and angle of pipe threads of steel products and of all pipe of steel, wrought-iron, or brass*

Nominal pipe size (inches)	Threads per inch	Limits on taper at pitch line, per foot		Lead in length of effective thread [1]	60° angle of thread
		Maximum	Minimum		
		Inch	*Inch*	*Inch* ±	*Degrees* ±
1/16, 1/8	27	7/8	1 1/16	0.003	2½
1/4, 3/8	18	7/8	1 1/16	.003	2
1/2, 3/4	14	27/32	1 1/16	[1].003	2
1, 1¼, 1½, 2	11½	27/32	1 1/16	[1].003	1½
2½ and larger	8	13/16	23/32	[1].006	1½

[1] The tolerance on lead shall be ±0.003 in. per in. on any size threaded to an effective thread length greater than 1 in.

NOTE.—For tolerances on depth of thread, see table 60, and for tolerances on pitch diameter, see par. (*c*) 1. For tolerances on Dryseal threads, see table 66.

Page 122, figure 24, change "L_3" to "L_2."

Page 123, 1st col., line 8, change "basic" to "reference." Line 18, after "notch," insert "is not essential but."

Page 123. Insert figure 26A, as follows:

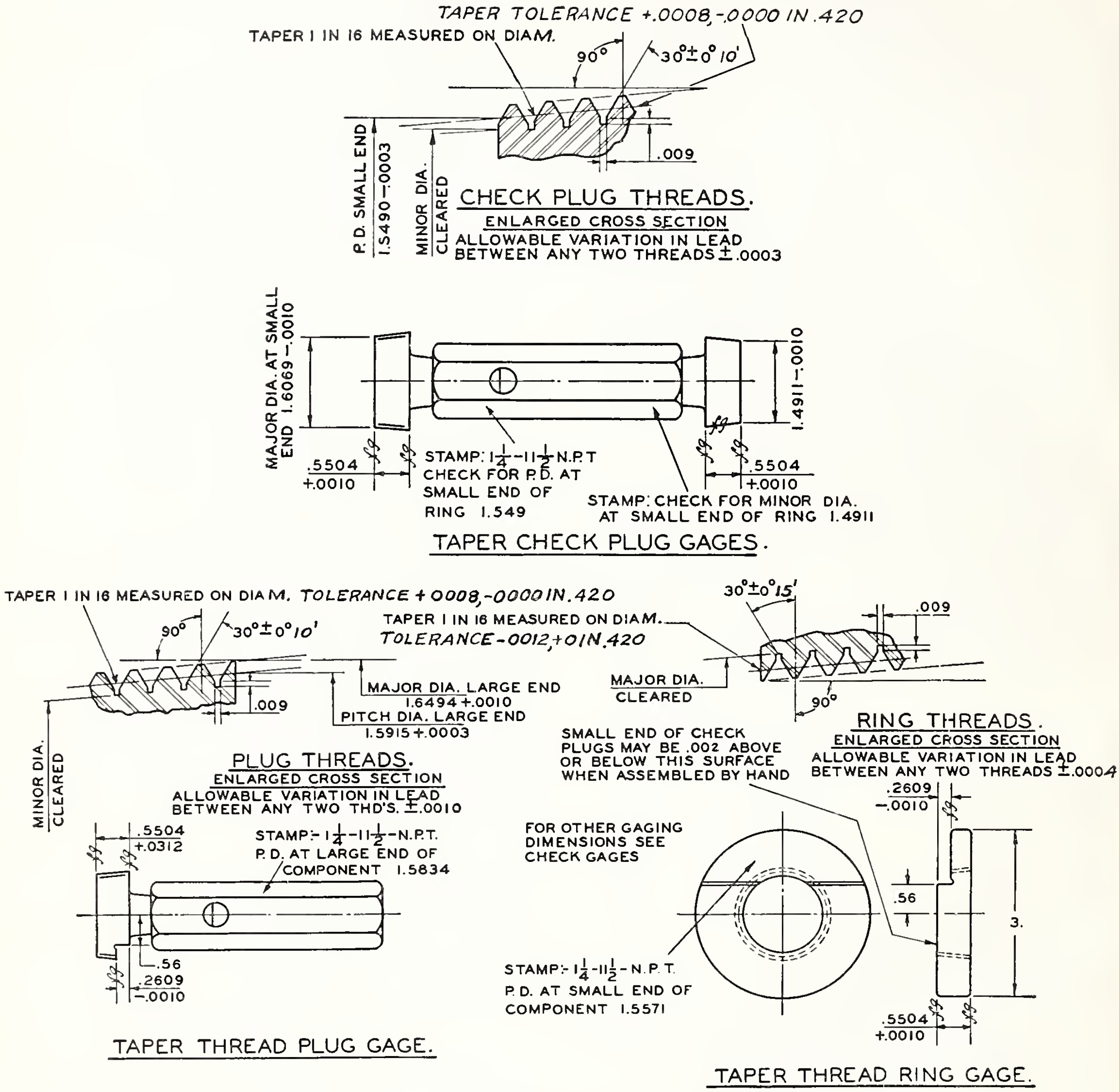


FIGURE 26A. *Methods of dimensioning taper pipe thread gages.*

Page 125, 1st col., under par. (c), add:

"It is to be noted that these gages are truncated at the crest an amount equal to $0.1p$, so that they bear only on the flanks of the thread. Thus, although they do not check the crest truncations specified in table 60, they are satisfactory for the inspection of the general run of product. When it is deemed necessary to determine whether or not such truncations are within the limits specified, or particularly to see that the maximum truncation is not exceeded, it is necessary to make further inspection. For this purpose optical projection, or Air Force-Navy aeronautical specification gages, may be used."

Page 127, table 62: Add "NPT" to table heading. Correct figures in table as follows:

Column	*Now reads*	*Should read*
4	1. 27155	1. 27154
4	1. 61505	1. 61504
4	2. 32694	2. 32693
5	1. 29655	1. 29654
5	1. 64130	1. 64129
5	2. 35419	2. 35418
10	1. 15571	1. 15572
10	1. 49921	1. 49922
10	3. 25737	3. 25738
11	2. 67890	2. 67891
12	2. 70737	2. 70738
12	3. 33237	2. 33238

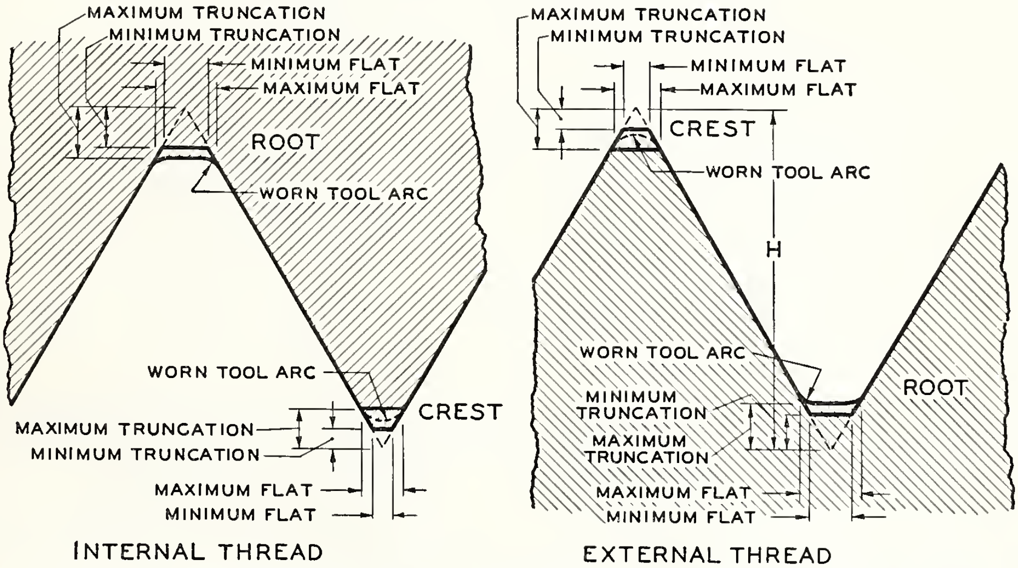
In footnote 1 insert after "when": "the product thread is."

Page 129, table 64, add "NPT" to table heading.

Page 131, table 66: Add "NPTF" to table heading.

Page 132, table 67, revise as shown:

TABLE 67. *Limits of size on crest and root of Dryseal American Standard external and internal taper pipe threads;*[1] *(pressure-tight joints without lubricant or sealer), NPTF*



Threads per inch	Depth of sharp V thread, *H*	Depth of pipe thread		Truncation				Tolerance on truncation	Equivalent width of flat[2]				Tolerance on equivalent width of flat
		Maximum, *h*	Minimum	Minimum		Maximum			Minimum		Maximum		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Inch	*Inch*	*Inch*	*Formula*	*Inch*	*Formula*	*Inch*	*Inch*	*Formula*	*Inch*	*Formula*	*Inch*	*Inch*
27—													
Crest	0. 03208	0. 02685	0. 02426	$0.047p$	0. 0017	$0.094p$	0. 0035	0. 0018	$0.054p$	0. 0020	$0.108p$	0. 0040	0. 0020
Root				$.094p$	.0035	$.140p$	.0052	.0017	$.108p$	.0040	$.162p$	.0060	.0020
18—													
Crest	.04811	.04117	.03856	$.047p$	.0026	$.078p$	.0043	.0017	$.054p$	.0030	$.090p$	.0050	.0020
Root				$.078p$	.0043	$.109p$	.0061	.0018	$.090p$	.0050	$.126p$	.0070	.0020
14—													
Crest	.06186	.05500	.05236	$.036p$	.0026	$.060p$	.0043	.0017	$.042p$	.0030	$.070p$	.0050	.0020
Root				$.060p$	.0043	$.085p$	.0061	.0018	$.070p$	.0050	$.098p$	.0070	.0020
11½—													
Crest	.07531	.06661	.06313	$.040p$	.0035	$.060p$	.0052	.0017	$.046p$	.0040	$.069p$	.0060	.0020
Root				$.060p$	.0052	$.090p$	.0078	.0026	$.069p$	.0060	$.103p$	.0090	.0030
8—													
Crest	.10825	.09613	.09275	$.042p$	.0052	$.055p$	.0069	.0017	$.048p$	.0060	$.064p$	.0080	.0020
Root				$.055p$	.0069	$.076p$	.0095	.0026	$.064p$	.0080	$.088p$	.0110	.0030

[1] Although these threads are designed for use without a lubricant or sealer, its use may be found to be desirable.

[2] The major diameter of plug gages and the minor diameter of ring gages used for gaging Dryseal threads shall be truncated $0.20p$ for 27 threads per inch, and $0.15p$ for 18, 14, 11½, and 8 threads per inch.

NOTE.—Dimensions are specified to 4 and 5 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.

Page 133, table 68, add "NPTR" to table heading.

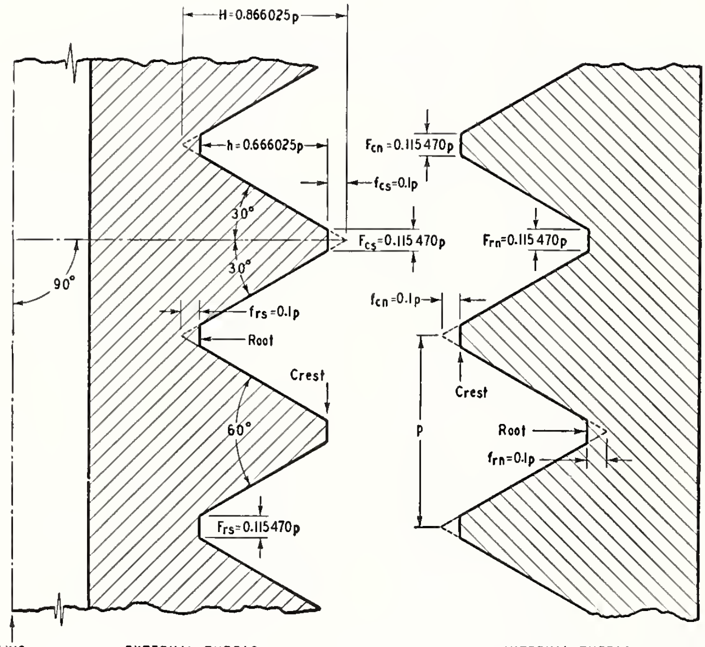
Page 134, table 69, revise figures in table as follows:

Column	*Now reads*	*Should read*
9	0. 36	0. 357
9	. 43	. 435
9	. 81	. 812
9	. 94	. 937
11	1. 31	1. 312
11	1. 44	1. 437

Page 135, table 70, add to table heading, "NPSC."

Page 136, table 71, add to table heading, "NPSF."

Page 136, table 72, add to table heading, "NPSM," and insert the following illustration:



Page 136, last sentence of text, revise to read: "Major and minor diameters have been calculated on the basis of a truncation of $0.1p$, to provide no interference at crest and root when product is gaged with gages made in accordance with par. (c) 4, below."

Page 137, add at end of text: "Major and minor diameters have been calculated on the basis of a truncation of $0.1p$."

On page 137, table 73, add to table heading, "NPSL," and insert the above illustration, as indicated for table 72.

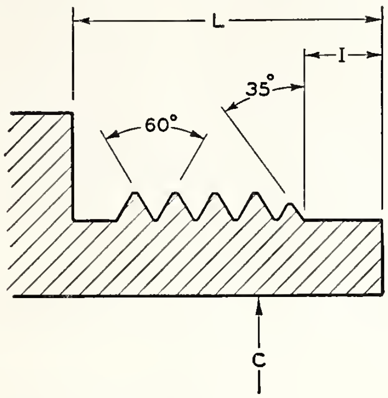
SECTION VII. AMERICAN NATIONAL HOSE-COUPLING AND FIRE-HOSE COUPLING THREADS

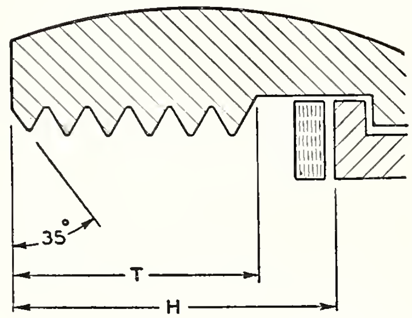
Page 140, 2d col. of text, add to end of sentence above "Examples:—" "to be made up with standard pipe threads."

Page 140, table 74, insert as 2d col., heading "Identification symbol." Insert as symbols "NH" for first three items, and "NPSH" for remaining six items. Make corresponding insertions in tables 76, 77, and 78, with symbol "NH" for fire-hose threads.

Page 141, table 75, add to table heading "NH."

Page 144, table 78, revise illustration to show truncated threads, thus:





Page 145, table 79, add to table heading "NH."

Pages 146, 147, tables 80 and 81, in headings for 2d, 3d, and 4th columns insert "NH," and for 5th column insert "NPSH."

SECTION VIII. MISCELLANEOUS STANDARDIZED PRODUCT THREADS OF AMERICAN NATIONAL FORM, OR AMERICAN STANDARD PIPE THREAD FORM (PAGE 148)

1. GAS CYLINDER VALVE THREADS

The valves for cylinders containing compressed gases embody several screw threads, namely: (1) The outlet connection, (2) the neck, or valve to cylinder connection, (3) the safety device cap or plug, and (4) the various threads associated with the valve mechanism. While the practice for all of these threads is fairly well established, only the outlet threads (1) have been fully standardized.

(a) OUTLET CONNECTIONS.

The threads for valve outlets were not specifically defined in the past and their form, tolerances, and sizes varied considerably in practice. Such threads were not officially recorded by the industry but were simply made in accordance with the best understanding and judgment of various manufacturers and users who usually handled either the cylinder with its valve, and not the connecting equipment, or the other way around. This separation of interests at the valve outlet caused wide discrepancies as compared, for example, with a special thread on a pipe union where the entire fitting is made as one unit by one manufacturer.

The Compressed Gas Manufacturers' Association, Inc., had had valve outlet standards for industrial and medical oxygen for a good many years, revising them from time to time to bring them closer to National practice. Likewise, the Chlorine Institute had set up its standard for chlorine some time ago.

The Valve Thread Standardization Committee of the Compressed Gas Manufacturers' Association, working in conjunction with federal services and other interested groups, was given a splendid opportunity during the late war to study valve outlets, especially those for federal services which were made and inspected to strict specifications. The study resulted in a closer definition and appreciation of each outlet, and in a more balanced relationship of the many outlets to each other to achieve the utmost in safety. In January, 1946, the findings and formulated standards, upon which the federal data contained herein are based, appeared in the Committee's report "Standard Compressed Gas Cylinder Valve Outlets."

Either a single gas, or else several gases which create no hazard if interchanged, are assigned to the same outlet. With the exception of outlets having taper pipe threads which seal at the threads, each outlet provides for a seat and nipple which make a gas-tight joint against leaks and also provides for 14-pitch American National form screw threads not in the regular series. These threads do not seal but merely hold the nipple against its seat.

The threads on the valves fall into four divisions, right-hand or left-hand (RH or LH) and external or internal (EXT or INT). These four basic divisions are so vital to prevent undesirable cross-connecting that the full designation of each gas-outlet thread includes the terms RH or LH and EXT or INT. In general, where practicable, right-hand threads are used for nonfuel or for water-pumped gases, and left-hand threads for fuel or for oil-pumped gases. Left-hand threads are identified by a groove across the corners of the hexagon nut.

The nominal diameters of the threads in each division are spaced far enough apart so they will not engage with the thread of an adjoining size. An allowance (minimum clearance) of 0.0050 inch between the mating parts is established to provide the desired looseness of fit at the threads and to assure uninterrupted interchangeability between products of different manufacturers, who lacked a common standard in the past. The tolerances are in the direction of greater looseness and are determined on the basis of NS-3 data, except for the major diameter of the external thread where the tolerance is 0.0050 inch instead of 0.0098 inch.

Screw threads meeting the above specifications bear the designation NGO, National Gas Outlet, as a separate and distinct symbol for valve outlet threads. This symbol was suggested and designated by the Interdepartmental Screw Thread Committee, representing the Federal agencies, to provide for the peculiar needs of the industry. The designation NGO (Cl) applies to the alternate chlorine thread which has been used successfully without change for many years.

The data in table 85 list the industrial and

TABLE 85.—*U. S. A. compressed gas cylinder valve outlet threads*

Number	Gas	Thread of valve	Mating thread
1	2	3	4
1	Acetylene, standard	0.885″-14NGO-LH-INT	0.880″-14NGO-LH-EXT.
2	Acetylene, alternate [1]	.825″-14NGO-RH-EXT	.830″-14NGO-RH-INT.
3	Air, water-pumped	.965″-14NGO-RH-INT	.960″-14NGO-RH-EXT.
4	Air, oil-pumped	.965″-14NGO-LH-INT	.960″-14NGO-LH-EXT.
5A, 5B	Ammonia, anhydrous, standard [2]	3/8″-18NPT-RH-INT, or 1/2″-14NPT-RH-INT	3/8″-18NPT-RH-EXT, or 1/2″-14NPT-RH-EXT.
6	Ammonia, anhydrous, alternate [1]	3/8″-18NPT-RH-INT, with 1″-14NF-2LH-EXT for nut	3/8″-18NPT-RH-EXT, with 1″-14NF-2LH-INT for nut.
7	Argon, water-pumped	.965″-14NGO-RH-INT	.960″-14NGO-RH-EXT.
8	Argon, oil-pumped	.965″-14NGO-LH-INT	.960″-14NGO-LH-EXT.
9	Butadiene	.885″-14NGO-LH-INT	.880″-14NGO-LH-EXT.
10	Butane, standard	.885″-14NGO-LH-INT	.880″-14NGO-LH-EXT.
11	Butane, No. 1 alternate [1]	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
12	Butane, No. 2 alternate [1]	.825″-14NGO-RH-EXT	.830″-14NGO-RH-INT.
13	Carbon dioxide, standard	.825″-14NGO-RH-EXT	.830″-14NGO-RH-INT.
14	Carbon dioxide, medical	Standard medical gas flush outlet for yoke	Standard medical gas flush outlet for yoke.
15	Chlorine, standard	1.030″-14NGO-RH-EXT	1.035″-14NGO-RH-INT.
16	Chlorine, alternate [1]	1.034″-14NGO(Cl)-RH-EXT	1.035″-14NGO(Cl)-RH-INT.
17	Cyclopropane	Standard medical gas flush outlet for yoke	Standard medical gas flush outlet for yoke.
18	Dichlorodifluoro-methane	1.030″-14NGO-RH-EXT	1.035″-14NGO-RH-INT.
19	Ethane	0.825″-14NGO-LH-EXT	0.830″-14NGO-LH-INT.
20	Ethyl chloride	.825″-14NGO-RH-EXT	.830″-14NGO-RH-INT.
21	Ethylene, industrial and medical	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
22	Ethylene, medical	Standard medical gas flush outlet for yoke	Standard medical gas flush outlet for yoke.
23	Ethylene oxide, standard	.885″-14NGO-LH-INT	.880″-14NGO-LH-EXT.
24	Ethylene oxide, alternate [1]	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
25	Helium, water-pumped, standard	.965″-14NGO-RH-INT	.960″-14NGO-RH-EXT.
26	Helium, medical	Standard medical gas flush outlet for yoke	Standard medical gas flush outlet for yoke.
27	Helium, oil-pumped, standard	.965″-14NGO-LH-INT	.960″-14NGO-LH-EXT.
28	Helium, oil-pumped, alternate [4]	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
29	Hydrogen	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
30	Isobutane, standard	.885″-14NGO-LH-INT	.880″-14NGO-LH-EXT.
31	Isobutane, alternate [1]	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
32	Methane	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
33	Methyl chloride, standard	1.030″-14NGO-RH-EXT	1.035″-14NGO-RH-INT.
34	Methyl chloride, alternate [1]	1/2″-14NPT-RH-EXT	1/2″-14NPT-RH-INT.
35	Nitrogen, water-pumped	.965″-14NGO-RH-INT	.960″-14NGO-RH-EXT.
36	Nitrogen, oil-pumped	.965″-14NGO-LH-INT	.960″-14NGO-LH-EXT.
37	Nitrous oxide, standard	.825″-14NGO-RH-EXT	.830″-14NGO-RH-INT.
38	Nitrous oxide, medical	Standard medical gas flush outlet for yoke	Standard medical gas flush outlet for yoke.
39	Oxygen, industrial and medical	.903″-14NGO-RH-EXT	.908″-14NGO-RH-INT.
40	Oxygen, medical [3]	.825″-14NGO-RH-EXT	.830″-14NGO-RH-INT.
41	Oxygen, medical	Standard medical gas flush outlet for yoke	Standard medical gas flush outlet for yoke.
42	Propane, standard	.885″-14NGO-LH-INT	.880″-14NGO-LH-EXT.
43	Propane, No. 1 alternate [1]	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
44	Propane, No. 2 alternate [1]	.825″-14NGO-RH-EXT	.830″-14NGO-RH-INT.
45	Propylene, standard	.885″-14NGO-LH-INT	.880″-14NGO-LH-EXT.
46	Propylene, alternate [1]	.825″-14NGO-LH-EXT	.830″-14NGO-LH-INT.
47	Sulfur dioxide, standard	1.030″-14NGO-RH-EXT	1.035″-14NGO-RH-INT.
48	Sulfur dioxide, alternate [1]	1/2″-14NPT-RH-EXT	1/2″-14NPT-RH-INT.

[1] Alternate outlet dimensions are shown to indicate valve outlet threads widely used by industry in addition to the approved standards. Federal services shall not specify alternate outlet dimensions. In areas where gases cannot be readily procured commercially in cylinders equipped with valves complying with these standards, cylinders equipped with valves complying with the alternate standards may be accepted, provided authority to do so is specifically granted by the Government department concerned. Alternates may be used only during a limited transition period.

[2] Outlet 5A is standard for Federal services.

[3] Outlet 40, extensively used by the medical profession for oxygen, is not authorized for Federal services.

[4] Outlet 28 is past practice and is authorized for interim use but not for new procurement by Federal services.

NOTE.—Details of valve outlets and connections are published by the Compressed Gas Manufacturers' Association, Inc., 11 West Forty-second Street, New York 18, N. Y., as ASA B57.1-1950, American Standard Compressed Gas Cylinder Valve Outlet and Inlet Connections.

medical gases with the threads used on the respective valves and on their mating parts, while the data in table 85A give complete thread information for the use of toolmakers, manufacturers, and inspectors. Table 85B is a rearrangement of the data in the first three columns of table 85 to show interchangeability among gases and outlet threads. Attention is directed to footnote 1 of table 85 relative to alternates, which are to be eliminated as rapidly as possible.

For a complete and detailed design of each gas outlet and its connecting parts, see "Standard Compressed Gas Cylinder Valve Outlets" published by the Compressed Gas Manufacturers' Association, Inc., 11 West Forty-second Street, New York 18, N. Y.

Gages for "NGO" threads specified in table 85A shall be made in accordance with the gage specifications in section III. Gages for the "NPT" threads listed in table 85 shall be made in accordance with the gage specifications in section VI.

(b) INLET CONNECTIONS

The screw threads on the inlet connections on the valve and in the cylinder neck are taper pipe threads subject to very high pressures and are longer than the American Standard taper pipe threads but otherwise conform to the dimensions given in tables 59 and 60. Proper control of the dimensions within the tolerances specified for all elements of the threads is necessary to prevent leakage and requires gages of special design.

[The remainder of this subsection is in process of being revised.]

Further corrections:

Page 151, table 86 column 3, next to last line, change "1″–14NPT" to "1″–11½ NPT."

Page 152, table 87B, in right-hand view of plug, delete diameter D and show diameter K_1 at notch B located at length L_1 from end. Page 154, footnote 24, insert "of" after "dimensions."

TABLE 85A. *Limits of size of U. S. A. compressed gas cylinder valve outlet threads series NGO*

Symbol (designation of thread)	External thread					Internal thread				
	Major diameter		Pitch diameter		Minor diameter	Minor diameter		Pitch diameter		Major diameter
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1	2	3	4	5	6	7	8	9	10	11
	Inches	*Inches*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inches*
.745″–14NGO$^{-RH}_{-LH}$-EXT	0.7450	0.7400	0.6986	0.6950	0.6574					
.750″–14NGO$^{-RH}_{-LH}$-INT						0.6727	0.6804	0.7036	0.7072	0.7500
.825″–14NGO$^{-RH}_{-LH}$-EXT	.8250	.8200	.7786	.7750	.7374					
.830″–14NGO$^{-RH}_{-LH}$-INT						.7527	.7604	.7836	.7872	.8300
.880″–14NGO-LH-EXT	.8800	.8750	.8336	.8300	.7924					
.885″–14NGO-LH-INT						.8077	.8154	.8386	.8422	.8850
.903″–14NGO-RH-EXT	.9030	.8980	.8566	.8530	.8154					
.908″–14NGO-RH-INT						.8307	.8384	.8616	.8652	.9080
.960″–14NGO$^{-RH}_{-LH}$-EXT	.9600	.9550	.9136	.9100	.8724					
.965″–14NGO$^{-RH}_{-LH}$-INT						.8877	.8954	.9186	.9222	.9650
1.030″–14NGO$^{-RH}_{-LH}$-EXT	1.0300	1.0250	.9836	.9796	.9424					
1.035″–14NGO$^{-RH}_{-LH}$-INT						.9577	.9654	9886	.9926	1 0350
1.034″–14NGO(C1)-RH-EXT	1.0340	1.0300	.9835	.9795	.9330					
1.035″–14NGO(C1)-RH-INT						.9400	.9530	.9845	.9885	1.0350

TABLE 85B. *Correlation of threads of valve and gases to show interchangeability*

Thread of valve	Number	Gas
0.825-14NGO-RH-EXT	2	Acetylene, alternate.
	12	Butane, No. 2 alternate.
	13	Carbon dioxide, standard.
	20	Ethyl chloride.
	37	Nitrous oxide, standard.
	40	Oxygen, medical.
	44	Propane, No. 2 alternate.
0.825-14NGO-LH-EXT	11	Butane, No. 1 alternate.
	19	Ethane.
	21	Ethylene, industrial and medical.
	24	Ethylene oxide, alternate.
	28	Helium, oil-pumped, alternate.
	29	Hydrogen.
	31	Isobutane, alternate.
	32	Methane.
	43	Propane, No. 1 alternate.
	46	Propylene, alternate.
0.885-14NGO-LH-INT	1	Acetylene, standard.
	9	Butadiene.
	10	Butane, standard.
	23	Ethylene oxide, standard.
	30	Isobutane, standard.
	42	Propane, standard.
	45	Propylene, standard.
0.903-14NGO-RH-EXT	39	Oxygen, industrial and medical.
0.965-14NGO-RH-INT	3	Air, water-pumped.
	7	Argon, water-pumped.
	25	Helium, water-pumped, standard.
	35	Nitrogen, water-pumped.
0.965-14NGO-LH-INT	4	Air, oil-pumped.
	8	Argon, oil-pumped.
	27	Helium, oil-pumped, standard.
	36	Nitrogen, oil-pumped.
1.030-14NGO-RH-EXT	15	Chlorine, standard.
	18	Dichlorodifluoro-methane.
	33	Methyl chloride, standard.
	47	Sulfur dioxide, standard.
1.034-14NGO(C1)-RH-EXT	16	Chlorine, alternate.
⅜″-18NPT-RH-INT	5A	Ammonia, anhydrous, standard.
	6	Ammonia, anhydrous, alternate.
½″-14NPT-RH-EXT	34	Methyl chloride alternate.
	48	Sulfur dioxide, alternate.
½″-14NPT-RH-INT	5B	Ammonia, anhydrous, standard.
Standard medical gas flush outlet for yoke.	14	Carbon dioxide, medical.
	17	Cyclopropane.
	22	Ethylene, medical.
	26	Helium, medical.
	38	Nitrous oxide, medical.
	41	Oxygen, medical.

SECTION X. ACME THREADS

The American War Standard ASA B1.5–1945, "Acme Threads," of the American Standards Association, is being considered by the ASA Sectional Committee B1 for adoption as an American Standard. It is to be anticipated that there will be some revisions.

The following revisions and corrections to be made in this section are necessary to bring it into substantial agreement with the American War Standard as published, and with the specifications for gages in section III of this supplement:

Page 158, 2d col., at end of "1. GENERAL AND HISTORICAL," insert:

"While threads for valve operation may be made to this standard, the application is highly specialized and these data should not be used without consultation with the valve manufacturer."

Page 159, 2d col., 3d sentence under table change to read: "It is suggested that screws and nuts of the same class be used together for either general purpose or centralizing assemblies."

Page 159, 2d col., last line: Delete remainder of paragraph and substitute: "Classes 5C and 6C screws and nuts can be used interchangeably, but if a class 5C nut is used with a class 6C screw, the available backlash is less than when used with a class 5C screw."

Page 160, 2d col., par. No. 4, line 6, change "column 8" to "column 4." (Same correction applies to ASA B1. 5–1945.)

Page 161, 2d col., line 7 from bottom, change "*BD*" to "*B*."

Page 174, table 98, column headed ⅜, change ".2731" to ".2730."

Pages 177–179, revise the text to read as follows:

7. GAGES FOR ACME THREADS

Gages representing both extreme product limits, or adequate gaging instruments for thread elements, are necessary for the proper inspection of Acme screw threads. The dimensions of "go" and "not go" gages should be in accordance with the principles: (a) that the maximum-metal limit, or "go", gage should check simultaneously as many elements as possible, and that a minimum-metal limit or "not go" thread gage can effectively check but one element; and (b) that permissible variations in the gages be kept within the extreme product limits.

(a) GAGE TOLERANCES

Tolerances for the thread elements of "go" and "not go" thread gages for Acme threads are given in tables 12, p. 39, and 100, p. 179, H28(1944).

1. TOLERANCES ON PITCH DIAMETER.—The pitch diameter tolerances for gages for class 2 screws and nuts are given in table 100, column 2, and for gages for classes 3, 4, 5, and 6 screws and nuts, in table 100, column 3.

2. TOLERANCES ON MAJOR AND MINOR DIAMETERS.—The major and minor diameter tolerances for Acme thread gages are given in table 100, column 4. These are applicable to all gages except the "go" and "not go" thread plug gages for major diameter of all classes of centralizing nuts, and for "go" and "not go" plain ring or snap gages for major diameter of centralizing screws. For these gages the tolerances are class Z, as given in table 12, p. 39, H28(1944).

3. TOLERANCES ON LEAD.—The variation in lead of all Acme thread gages for classes 3, 4, 5, and 6 product shall not exceed 0.0002 inch between any two threads not farther apart than one inch. However, the cumulative error in lead shall not exceed 0.0003 inch for gages with a length over 1

to 3 inches, inclusive; or 0.0004 inch for gages with a length over 3 to 5 inches, inclusive; or 0.0006 inch for gages with a length over 5 to 10 inches, inclusive. For gages for class 2 product, 0.0001 inch shall be added to the above values. For multiple threads, the cumulative tolerance for pitch and lead shall be multiplied by 1.5.

4. Tolerances on Angle of Thread.—The tolerances on angle of thread, as specified in table 100, column 5, 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.

(b) GAGES FOR SCREW

1. "Go" Thread Ring or Thread Snap Gage.—(*a*) *Major diameter.*—The major diameter of the "go" thread ring or thread snap gage shall clear a diameter greater by 0.01 inch than the maximum major diameter of the screw.

(*b*) *Pitch diameter.*—The pitch diameter shall fit the maximum-metal limit thread setting plug gage.

(*c*) *Minor diameter.*—For general purpose screws, the minor diameter of the "go" thread ring gage shall be the same as the maximum minor diameter of the screw plus 0.005 inch for pitches finer than 10 threads per inch, and plus 0.010 inch for 10 threads per inch and coarser, to allow for possible errors in concentricity of the pitch and minor diameters of the product. The tolerance shall be minus.

For centralizing screws, the minor diameter of the "go" thread ring gage shall be less than the minimum minor diameter of the nut by the amount of the allowance on pitch diameter, table 94, columns 3 to 5. The tolerance (table 100, column 4) shall be minus.

(*d*) *Length.*—The length of the "go" thread ring or thread snap gage should approximate the length of engagement (see footnote to table 101) but should not exceed the length specified in table 101, col. 3.

2. Maximum-Metal Limit Thread Setting Plug for "Go" Thread Ring or Snap Gages.—(*a*). *Major diameter.*—The major diameter of the basic-form maximum-metal limit thread setting plug gage shall be the same as the maximum major diameter of the screw. The gage tolerance (table 100, column 4) shall be taken plus. The major diameter of the truncated maximum-metal limit thread setting plug gage shall be smaller by one-third of the basic thread depth ($=p/6$) than the maximum major diameter of the screw. The gage tolerance (table 100, column 4) shall be taken minus.

(*b*) *Pitch diameter.*—The pitch diameter of the maximum-metal limit thread setting plugs for all general purpose screws shall be the same as the maximum pitch diameter of the screw. For centralizing screws, if the product length of engagement exceeds the length of the ring gage, table 101, column 3, the pitch diameter of the maximum-metal limit thread setting plugs shall be less than the maximum pitch diameter of the screw by the amount stated in table 101, column 5. The gage tolerance (table 100, columns 2 and 3) shall be minus.

(*c*) *Minor diameter.*—The minor diameter shall be cleared below the minimum minor diameter of the "go" thread ring gage.

(*d*) *Length.*—The length of the maximum-metal limit thread setting plug gage should approximate the length of the "go" thread ring or thread snap gage.

3. "Go" Plain Ring or Snap Gage for Major Diameter.—The diameter of the "go" plain ring gage, or gaging dimension of the "go" plain snap gage, shall be the same as the maximum major diameter of the screw. The class Z tolerances given in table 12, p. 39, H28 (1944), shall be applicable to gages for centralizing threads. Tolerances given in table 100, column 4, shall be applicable to gages for general purpose threads. The tolerances shall be taken in the minus direction.

4. "Not Go" Thread Ring or Thread Snap Gage.—(*a*) *Major diameter.*—The major diameter of the "not go" thread ring or thread snap gage shall clear a diameter greater by 0.01 inch than the maximum major diameter of the screw. The clearance cut may have $0.435p$ maximum width between intersections with the flanks of the thread.

(*b*) *Pitch diameter.*—The pitch diameter shall fit the minimum-metal limit thread setting plug gage.

(*c*) *Minor diameter.*—The minor diameter shall be the basic minor diameter of the nut plus $p/4$, with the tolerance (table 100, column 4) taken plus.

(*d*) *Length.*—The length of the "not go" thread ring or thread snap gage should approximate 3 pitches (see footnote to table 101). When a multiple thread is involved, the "not go" thread ring or snap gage shall be of such length as to provide at least 1 full turn of thread.

5. Thread Setting Plug for "Not Go" Thread Ring or Thread Snap Gage.—(*a*) *Major diameter.*—The major diameter of the basic-form minimum-metal limit thread setting plug gage shall be the same as the maximum major diameter of the screw. The gage tolerance (table 100, column 4) shall be taken plus. The major diameter of the truncated minimum-metal limit thread setting plug gage shall be truncated one-third basic thread depth ($=p/6$) smaller than the maximum major diameter of the screw. The gage

tolerance (table 100, column 4) shall be taken minus.

(*b*) *Pitch diameter.*—The pitch diameter shall be the same as the minimum pitch diameter of the screw, with the tolerance taken plus.

(*c*) *Minor diameter.*—The minor diameter shall be cleared below the minimum minor diameter of the "not go" thread ring gage.

(*d*) *Length.*—The length shall be at least equal to the length of the "not go" thread ring or thread snap gage.

6. "Not Go" Plain Snap Gage for Major Diameter.—The gaging dimension of the "not go" plain snap gage shall be the same as the minimum major diameter of the screw. Class Z tolerances given in table 12, p. 39, H28 (1944) shall be applicable to gages for centralizing threads. Tolerances given in table 100, column 4 shall be applicable to gages for general purpose threads. The gage tolerance shall be taken in the plus direction.

(c) GAGES FOR NUT

1. "Go" Thread Plug Gage, General Purpose Threads.—The major diameter of the "go" thread plug gage for general purpose threads shall be equal to the minimum major diameter of the nut minus 0.005 inch for pitches finer than 10 threads per inch, and minus 0.010 inch for 10 threads per inch and coarser, to allow for possible errors in concentricity of the pitch and major diameters of the product. The gage tolerance (table 100, column 4) shall be plus.

(*b*) *Pitch diameter.*—The pitch diameter shall be equal to the minimum (basic) pitch diameter of the nut, with the tolerance (table 100, columns 2 and 3) taken plus.

(*c*) *Minor diameter.*—The minor diameter shall clear a diameter less by 0.01 inch than the minimum minor diameter of the nut.

(*d*) *Length.*—The length of the "go" thread plug gage should approximate the length of engagement (see footnote to table 101) but shall not exceed twice the nominal major diameter unless specifically requested.

2. "Go" Thread Plug Gage for Centralizing Threads.—(*a*) *Major diameter.*—The major diameter of the "go" thread plug gage for centralizing threads shall be the same as the minimum major diameter of the nut with a plus tolerance, class Z (table 12, p. 39, H28 (1944). Both corners at the crest shall be chamfered equally at an angle of 45°, leaving a width of flat at crest of $0.28p + 0.00, -0.02p$.

(*b*) *Pitch diameter, minor diameter, and length.*—The pitch diameter, minor diameter, and length of gage shall be the same as those given in 1 (b), 1 (c), and 1 (d) above.

3. "Not Go" Thread Plug Gage for Pitch Diameter of All Nuts.—(*a*) *Major diameter.*—The major diameter of the "not go" thread plug gage shall be equal to the maximum (basic) major diameter of the screw minus $p/4$, with the tolerance (table 100, column 4) taken minus.

(*b*) *Pitch diameter.*—The pitch diameter shall be the same as the maximum pitch diameter of the nut, with the tolerance (table 100, columns 2 and 3) taken minus.

(*c*) *Minor diameter.*—The minor diameter shall clear a diameter less by 0.01 inch than the minimum minor diameter of the nut. The clearance cut may have $0.435p$ maximum width between intersections with the flanks of the thread.

(*d*) *Length.*—The length of the "not go" thread plug gage should approximate 3 pitches (see footnote to table 101). When a multiple thread is involved, the "not go" thread plug gage shall be of such length as to provide at least 1 full turn of thread.

4. "Not Go" Thread Plug Gage for Major Diameter of Centralizing Nut.—The major diameter shall be equal to the maximum major diameter of the nut. The tolerance shall be class Z (table 12, p. 39, H28 (1944), taken minus. The included angle of the thread shall be 29°. The pitch diameter shall be the maximum pitch diameter of the class 4C centralizing *screw* (for centralizing nuts, classes 2C, 3C, and 4C) or the maximum pitch diameter of the class 6C centralizing *screw* (for centralizing nuts, classes 5C and 6C), with a minus tolerance of twice that given in table 100, column 3. The crest corners shall be chamfered 45° equally to leave a central crest flat not more than $0.24p$ wide. The approximate depth of chamfer is $0.07p$. The minor diameter shall clear a diameter less by 0.01 inch than the minimum minor diameter of the nut. The length should approximate 3 pitches (see footnote to table 101). When a multiple thread is involved, the "not go" gage shall be of such length as to provide at least 1 full turn of thread.

5. "Go" Plain Plug Gage for Minor Diameter of Nut.—The diameter of the "go" plain plug gage shall be the same as the minimum minor diameter of the nut. The gage tolerance shall be class Z (table 12, p. 39, H28 (1944)), taken plus. The gage length shall be in accordance with Commercial Standard CS8–41, Gage Blanks, or the latest revision thereof.

6. "Not Go" Plain Plug for Minor Diameter of Nut.—The diameter of the "not go" plain plug gage shall be the same as the maximum minor diameter of the nut. The gage tolerance shall be class Z (table 12, p. 39, H28 (1944)), taken minus. The gage length shall be in accordance with CS8–41 or the latest revision thereof.

(d) CONCENTRICITY

Methods of securing concentricity between major and pitch diameters of screw or nut must be determined for each individual application.

Page 180, revise note under table 101 to read as follows:

NOTE.—The above compensation is based on a length of engagement not exceeding two diameters and on a lead error in the product not exceeding the following values (in inch):

0.0003 in length of ½ inch or less.
.0004 in length over ½ to 1½ inches.
.0005 in length over 1½ to 3 inches.
.0007 in length over 3 to 6 inches.
.0010 in length over 6 to 10 inches.

The principles have been established in the foregoing requirements that "go" gages should approximate the length of engagement, and "not go" gages should be 3 pitches long. For reasons of economy or limitations in gage manufacture or use, it may be desirable to modify these principles to: (1) Take advantage of the economies of using standard blanks, as listed in CS8–41, wherever they may be utilized successfully. (2) Avoid too cumbersome ring gages as well as excessively expensive gages by limiting the length of "go" thread ring gages to maximum lengths given in column 3 above. (3) Avoid excessively cumbersome thread plug gages by limiting maximum length to 2 diameters wherever possible. (4) Take full advantage of modern equipment for producing and checking accurate leads, particularly where long engagements are involved, thus permitting the use of standard or moderate length thread plug, thread ring, or thread snap gages. Alternatively, of course, instruments might be used for checking diameters and angles independently.

Should a "go" gage shorter than the length of engagement be chosen, independent means should be used to measure lead error in product. The maximum metal condition must be reduced to assure free assembly of product, if the lead error in the length of engagement, δp, so determined, exceeds 0.259 G, where G is the product pitch diameter allowance. The required amount of change in pitch diameter, ΔE, of the product (minus on external thread, plus on internal thread) accordingly is

$$\Delta E=3.867\left(1-\frac{L_g}{L_e}\right)\delta p,$$

where L_g is the length of the gage, and L_e is the length of engagement. When instruments are used for checking diameter it is a simple matter to make this allowance. When thread plug and ring gages are used, the allowance is sometimes increased a fixed amount, as outlined in the above table. This arbitrarily reduces the tolerance on diameter.

SECTION XI. WRENCH-HEAD BOLTS AND NUTS, AND WRENCH OPENINGS

Page 181, footnote 26, add: "Stock production sizes (lengths, diameters, etc.) of regular square and hexagon head machine bolts and heavy, regular, and light nuts are given in Simplified Practice Recommendation R169–37, Machine, Carriage, and Lag Bolts (Steel) (Stock Production Sizes)."

Page 185, table 104, col. 2, change "1.2500" to "1.8750."

SECTION XII. ROUND UNSLOTTED HEAD BOLTS

Page 197, footnote 29, add: "Stock production sizes (lengths, diameters, etc.) of square neck carriage bolts, step bolts, and elevator bolts are given in Simplified Practice Recommendation R169–37, Machine, Carriage, and Lag Bolts (Steel) (Stock Production Sizes)."

SECTION XIII. MACHINE SCREWS, MACHINE-SCREW AND STOVE-BOLT NUTS, AND SET SCREWS

The data in this section relative to slotted machine, cap, and set screws are, for the present, superseded by the corresponding data in American Standard ASA B18.6–1947, Slotted and Recessed Head Screws. A complete revision of this section is deferred until a revision, now in progress, of Federal Specification FF–S–91, Screws, Machine; (Including Screws, Set) has been completed, in order that this section and the revised Federal specifications will be in complete agreement.

SECTION XIV. SOCKET SET SCREWS, SOCKET-HEAD CAP SCREWS, AND SOCKET-HEAD SHOULDER SCREWS

The data in this section are, for the present, superseded by American Standard ASA B18.3–1947, Socket Head Cap Screws and Socket Set Screws. A complete revision of this section is deferred until Federal Specifications covering these items, now in process of development, have been completed, in order that this section and the Federal Specifications will be in complete agreement.

APPENDIX 2. WIRE METHODS OF MEASUREMENT OF PITCH DIAMETER

Pages 228 to 233, subsections 4 to 8, inclusive, revise to read as follows:

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 lead angle is taken into account, is

$$E=M_w+\frac{\cot\alpha}{2n}-w\,[1+(\operatorname{cosec}^2\alpha+\cot^2\alpha\tan^2\lambda')^{\frac{1}{2}}], \quad (1)$$

in which

E=pitch diameter
M_w=measurement over wires
α=half angle of thread
n=number of threads per inch=$1/p$
w=mean diameter of wires
λ'=angle between axis of wire and plane perpendicular to axis of thread.

This formula is a very close approximation, being based on certain assumptions regarding the positions of the points of contact between the wire and the thread.

Formula 1 can be converted to the following simplified form, which is particularly useful when measuring threads of large lead angle:

$$E=M_w+\frac{\cot\alpha}{2n}-w(1+\operatorname{cosec}\alpha'), \quad (2)$$

in which α'=the angle whose tangent=$\tan \alpha \cos \lambda'$.

When formula 1 is used, the usual practice is to expand the square root term as a series, retaining only the first and second terms, which gives the following:

$$E=M_w+\frac{\cot \alpha}{2n}-w\left(1+\operatorname{cosec}\alpha+\frac{\tan^2 \lambda' \cos \alpha \cot \alpha}{2}\right). \tag{3}$$

For large lead angles it is necessary to measure the wire angle, λ', but for lead angles of 5° or less, if the "best-size" wire is used, this angle may be assumed to be equal to the lead angle of the thread at the pitch line, λ. The value of $\tan \lambda$, the tangent of the lead angle, is given by the formula

$$\tan \lambda=\frac{l}{3.1416E}=\frac{1}{3.1416NE},$$

in which

l=lead
N=number of turns per inch
E=nominal pitch diameter, or an approximation of the measured pitch diameter.

5. MEASUREMENT OF PITCH DIAMETER OF AMERICAN NATIONAL STRAIGHT THREADS

For threads of the American National coarse, fine, extra-fine, 8-pitch, 12-pitch, and 16-pitch thread series, the term

$$\frac{w \tan^2 \lambda' \cos \alpha \cot \alpha}{2}$$

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 3 takes the simplified form

$$E=M_w+\frac{\cot \alpha}{2n}-w\,(1+\operatorname{cosec}\alpha). \tag{4}$$

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 formula 4 for such threads. The Bureau also uses formula 4 for special 60° threads, except when the value of the term

$$\left(\frac{w \tan^2 \lambda' \cos \alpha \cot \alpha}{2}\right)$$

exceeds 0.00015 inch, as in the case of multiple threads, or other threads having exceptionally large lead angles. For 60° threads this term exceeds 0.00015 when $NE\sqrt{n}$ is less than 17.1.

For a 60° thread of correct angle and thread form the formula 4 simplifies to

$$E=M_w+\frac{0.86603}{n}-3w. \tag{5}$$

For a given set of best-size wires

$$E=M_w-C$$

when

$$C=w\,(1+\operatorname{cosec}\alpha)-\frac{\cot \alpha}{2n}.$$

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 size 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 $(\cot \alpha)/2n$ for standard pitches are given in table 144, p. 225, H28 (1944).

6. MEASUREMENT OF PITCH DIAMETER OF 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 reference 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 shown in the inset in figure 39. 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 carefully with a pencil or a bit of prussian blue.

1. Two-Wire Method.—Assuming that the measurement is to be made with a horizontal comparator, the gage is set in the comparator with its axis vertical, that is, the line of measurement and the thread axis are perpendicular to each other. The measurement is made with two wires, as shown in figure 39, one of which is placed in the thread to make contact at the same axial section of the thread as was touched by the cone point. This wire is designated the fixed wire. The second wire is placed in the thread groove on the opposite side of the gage, which is next above the fixed wire, and the measurement over the wires is made. The second wire is then placed in the thread groove next below the fixed wire, and a second measurement is made. The average of these two measurements is M_w, the measurement over the wires at the position of the fixed wire.

The general formula for a taper thread, corresponding to formula 3 is

$$E=M_w+\frac{\cot \alpha-\tan^2 \beta \tan \alpha}{2n} -w\left(1+\operatorname{cosec}\alpha+\frac{\tan^2 \lambda' \cos \alpha \cot \alpha}{2}\right), \tag{6}$$

in which

E=pitch diameter
M_w=measurement over wires
β=half angle of taper of thread
n=number of threads per inch=$1/p$
α=half angle of thread
w=mean diameter of wires
λ'=wire angle.

The term $\dfrac{\cot \alpha-\tan^2 \beta \tan \alpha}{2n}$

is the exact value of the depth of the fundamental triangle of a taper thread, which is less than that of the same pitch thread cut on a cylinder. For steep-tapered thread gages, having an included taper larger than ¾ in. per foot this more accurate term should be applied. For such a thread, which has a small lead angle, formula 6 take the form

$$E=M_w+\frac{\cot\alpha-\tan^2\beta\tan\alpha}{2n}-w(1+\operatorname{cosec}\alpha) \qquad (7)$$

Otherwise, as for American National taper pipe threads having an included taper of ¾ in. per foot, the simplified formula 5

$$E=M_w+\frac{0.86603}{n}-3w$$

for 60° threads may be used. This simplified formula gives a value of E that is 0.00005 inch larger than that given by the above general formula 6 for the 2½″–8 American National taper pipe thread, the worst case in this thread series.

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.

2. Three Wire Method.—Depending on the measuring facilities available or other circumstances, it is sometimes more convenient to use three wires. In such cases measurement is made 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. 38.) On account of this inclination, the measured distance between the axes of 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 corresponding to formula 4:

$$E=(M_w-w)\sec\beta+\frac{\cot\alpha}{2n}-w\operatorname{cosec}\alpha, \qquad (8)$$

in which β=half-angle of taper of thread. 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

$$E=1.00049(M_w-w)+0.86603\,p-2w. \qquad (9)$$

An adaption of the three-wire method is frequently used to reduce the time required when the pitch diameter of a number of gages of the same size is to be measured. Only light gages, up to about 2 in., can be measured accurately by this method. The gage is supported on two wires placed several threads apart, which are in turn supported on a taper thread testing fixture. The third wire is placed in the threads at the top of the gage and measurement is made from the top of this wire to the bottom of the fixture with a vertical comparator having a flat anvil, using a gage block combination as the standard. The fixture consists of block, the upper surface of which is at an angle to the base plane equal to the nominal angle of taper of the thread, 2β. Thus the element of the cone at the top of the thread gage is made parallel to the base of the instrument. The direction of measurement is not perpendicular to the axis of the gage but at an angle, β, from perpendicularity. A stop is provided at the thick end of the block with respect to which the gage is positioned on the fixture. As the plane of the end of the gage may not be perpendicular to the axis, a roll approximately equal to the diameter of the gage should be inserted between the stop and the gage to assure contact at the axis of the gage. For a given fixture and roll, a constant is computed which, when subtracted from the measured distance from the top of the upper wire to the base plane, gives M corresponding to the pitch diameter E_0 at the small end of the gage. E_0 is then determined by applying formulas 8 or 9.

3. Four-Wire Method.—A four-wire method of measurement which yields measurements of the pitch diameter, E_0, at the small end of the gage, and the half-angle of taper, β, is also sometimes used. This method is illustrated in figure 39A, and requires four thread wires of equal diameter, a pair of gage blocks of equal thickness, and two pairs of rolls of different diameters, the rolls of each pair being equal in diameter. Two measurements, M_1 and M_2, are made over the rolls and formulas are applied as follows:

$$\cot\frac{90-\beta}{2}=\frac{M_2-M_1+d_1-d_2}{d_2-d_1}, \qquad (10)$$

$$M_w=M_2-d_2\left(1+\cot\frac{90°-\beta}{2}\right)-2g\sec\beta, \qquad (11)$$

in which

M_2=measurement over larger rolls
M_1=measurement over smaller rolls
d_2=diameter of larger rolls
d_1=diameter of smaller rolls
β=actual half-angle of taper of thread
g=thickness of each gage block.

To determine E_0, the pitch diameter at the small end of the gage, M_w, as determined from formula 11, is substituted in formulas 6 or 7.

The errors of measurement by this method may be slightly but not significantly larger than by the other methods described, on account of elastic deformations of the rolls and gage blocks under the measuring load, and differing conditions of loading of the thread wires.

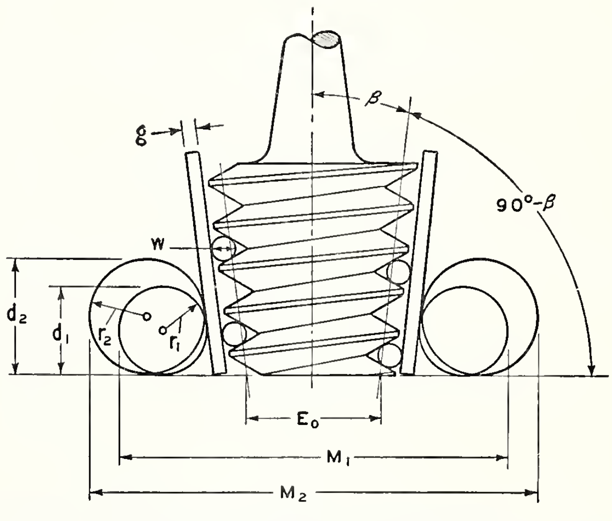


Figure 39A. *Measurement of pitch diameter of taper thread gage by the four-wire method.*

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 load 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 THREAD PLUG GAGES

For Acme (29°) threads, 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 lead angle into account in deriving pitch diameter. The general formula, 2, given again here, has been found to be the most convenient to apply,

$$E = M_w + \frac{\cot \alpha}{2n} - w(1 + \operatorname{cosec} \alpha'), \tag{2}$$

in which

$\alpha' = \tan^{-1} (\tan \alpha \cos \lambda')$
λ' = measured wire angle.

For a half-angle of thread of 14° 30′, formula 2 takes the form

$$E = M_w + \frac{1.933357}{n} - w(1 + \operatorname{cosec} \alpha') \tag{12}$$

The diameter, w, of the wires used should be as close to the size which will contact the flanks of the thread at the pitch line as practicable, to avoid errors caused by deviation of the thread angle from nominal. The following formula, which takes into account the lead angle, yields a size of wire which touches the flanks of the thread close to the pitch line:

$$w_b = \frac{p}{2} \sec \alpha' = \frac{p}{2} \sec \tan^{-1}(\tan \alpha \cos \lambda). \tag{13}$$

If best size wires are used, and the lead angle, λ, does not exceed 5°, it may be assumed that $\alpha' = 14°30'$. The best wire sizes for the standard Acme thread series, resulting from this formula, are given in col. 4, table 147. The quantities, $1.933357/n$ are given in col. 5, table 147, H28 (1944).

TABLE 147A. $(1+\operatorname{cosec} \alpha')$ *for* $\alpha = 14°30'$ *and* wire angles from 0° to 28°

Wire angle		1+ cosec α′	Difference	Wire angle		1+ cosec α′	Difference	Wire angle		1+ cosec α′	Difference
deg.	*min.*			*deg.*	*min.*			*deg.*	*min.*		
0	0	4.9939		10	0	5.0517	20	20	0	5.2346	43
	30	41	1		10	37	20		10	5.2389	43
	40	42	1		20	57	20		20	5.2432	43
	50	43	2		30	77	21		30	5.2475	44
1	0	45	2		40	98	21		40	5.2519	44
	10	47	2		50	5.0619	21		50	5.2563	45
	20	49	3	11	0	40	22	21	0	5.2608	45
	30	52	3		10	62	22		10	5.2653	46
	40	55	3		20	84	23		20	5.2699	46
	50	58	4		30	5.0707	23		30	5.2745	47
2	0	62	4		40	30	23		40	5.2792	47
	10	66	4		50	53	23		50	5.2839	47
	20	70	5	12	0	76	24	22	0	5.2886	48
	30	75	5		10	5.0800	24		10	5.2934	48
	40	80	5		20	5.0824	25		20	5.2982	49
	50	85	5		30	5.0849	25		30	5.3031	49
3	0	90	6		40	5.0874	25		40	5.3080	50
	10	96	7		50	5.0899	26		50	5.3130	50
	20	5.0003	6	13	0	5.0925	26	23	0	5.3180	51
	30	9	7		10	5.0951	26		10	5.3231	51
	40	16	7		20	5.0977	27		20	5.3282	52
	50	23	8		30	5.1004	27		30	5.3334	52
4	0	31	8		40	5.1031	27		40	5.3386	53
	10	39	8		50	5.1058	28		50	5.3439	53
	20	47	8	14	0	5.1086	28	24	0	5.3492	53
	30	55	9		10	5.1114	29		10	5.3545	54
	40	64	9		20	5.1143	29		20	5.3599	55
	50	73	9		30	5.1172	29		30	5.3654	55
5	0	82	10		40	5.1201	30		40	5.3709	56
	10	92	10		50	5.1231	30		50	5.3765	56
	20	5.0102	10	15	0	5.1261	31	25	0	5.3821	56
	30	12	11		10	5.1292	31		10	5.3877	57
	40	23	11		20	5.1323	31		20	5.3934	58
	50	34	11		30	5.1354	31		30	5.3992	58
6	0	45	12		40	5.1385	32		40	5.4050	59
	10	57	12		50	5.1417	33		50	5.4109	59
	20	69	12	16	0	5.1450	33	26	0	5.4168	60
	30	81	13		10	5.1483	33		10	5.4228	60
	40	94	13		20	5.1516	33		20	5.4288	61
	50	5.0207	13		30	5.1549	34		30	5.4349	61
7	0	20	14		40	5.1583	34		40	5.4410	62
	10	34	14		50	5.1617	35		50	5.4472	62
	20	48	14	17	0	5.1652	35	27	0	5.4534	63
	30	62	15		10	5.1687	36		10	5.4597	64
	40	77	15		20	5 1723	36		20	5.4661	64
	50	92	15		30	5.1759	36		30	5.4725	65
8	0	5.0307	16		40	5.1795	37		40	5.4790	65
	10	23	16		50	5.1832	37		50	5.4855	66
	20	39	16	18	0	5.1869	37	28	0	5.4921	
	30	55	17		10	5.1906	38				
	40	72	17		20	5.1944	38				
	50	89	17		30	5.1982	39				
9	0	5.0406	18		40	5.2021	39				
	10	24	18		50	5.2060	40				
	20	42	18	19	0	5.2100	40				
	30	60	19		10	5.2140	40				
	40	79	19		20	5.2180	41				
	50	98	19		30	5.2221	41				
					40	5.2262	42				
					50	5.2304	42				

To measure the wire angle, if the wires are reasonably straight and have a length greater than the major diameter of the gage, the angle $2\lambda'$ between wires held in place in the thread on opposite sides of the gage can be measured in a projection comparator. Otherwise, λ' can be determined with a toolmakers' microscope.

The quantities ($1+\operatorname{cosec}\alpha'$) for wire angles, λ', from 0°0′ to 28°0′, inclusive, at 10′ intervals, are given in table 147A. The amount of ($1+\operatorname{cosec}\alpha'$) for an intermediate angle may be determined by interpolation, as shown by the following example for 7°33′:

$$(1+\operatorname{cosec}\alpha') \text{ for } \lambda'=5.0262$$
$$0.0015\times 0.3=0.00045$$
$$(1+\operatorname{cosec}\alpha') \text{ for } \lambda'=5.02665$$

9. MEASUREMENT OF PITCH DIAMETER OF BUTTRESS THREADS

This subsection will be prepared when the ASA standard for Buttress threads becomes available.

APPENDIX 4. SCREW THREADS OF TRUNCATED WHITWORTH FORM (TO BE KNOWN AS AMERICAN TRUNCATED WHITWORTH THREADS)—American War Standard

This appendix is to be omitted in future editions of this Handbook. In revised form it will be printed as ASA B1.6 Screw Threads of Truncated Whitworth Form, which will be available only in a limited edition but not for sale.

APPENDIX 5. MISCELLANEOUS STANDARD THREAD PROFILES

2 (a). 29 DEGREE STUB THREADS

Revised standards for these threads are in process of being developed by ASA Sectional Committee B1.

4. BUTTRESS THREADS

Revised standards for these threads are in process of being developed by ASA Sectional Committee B1.

APPENDIX 6. DEFINITIONS OF SYMBOLS DESIGNATING THE DIMENSIONS OF TAPER THREAD ELEMENTS

There are presented herein, as a substitute for this appendix, tables II.1 and II.2 of Section II, page 41.

APPENDIX 8. REFERENCES

Page 271, revise this appendix to read as follows:

The following standards and specifications may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Commercial Standards of the U. S. Department of Commerce, National Bureau of Standards:
- CS24–43. Screw Threads and Tap Drill Sizes (15 cents).

Simplified Practice Recommendations of the U. S. Department of Commerce, National Bureau of Standards:
- R51. Chasers for Self-opening and Adjustable Die Heads (10 cents).
- R169. Machine, Carriage, and Lag Bolts (Steel), (Stock Production Sizes (5 cents)).

Federal Specifications:
- FF–S–103. Screws. Set (10 cents).
- FF–S–107, Screws, Tapping, Slotted and Plain Head (Sheet Metal, Machine, and Drive) (20 cents).
- WW–C–571. Conduit; Steel, Rigid, Enameled, amended August 22, 1945 (5 cents).
- WW–C–581a. Conduit; Steel, Rigid, Zinc-Coated (5 cents).

The following standards are not included in this Handbook, but have been approved and promulgated by the American Standards Association, and issued by the American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.
- B5.12–1940. Twist Drills, Straight Shank (65 cents).
- B5.4–1948. Taps, Cut and Ground Threads ($1.50).

The following American Petroleum Institute Standards for screw threads and screw-thread gages are issued by the American Petroleum Institute, Division of Production, Dallas, Texas.
- No. 3. API Specification for Cable Drilling Tools (75 cents).
- No. 5–A. API Pipe Specifications for Casing, Drill Pipe, and Tubing ($1.50).
- No. 5–B. API Inspection of Threads of Oil Country Tubular Goods (50 cents).
- No. 5–F. API Tentative Specification for Threads in Valves, Fittings, and Flanges (75 cents).
- No. 5–L. API Specification for Line Pipe ($1.25).
- No. 6–A. API Specification for Threads in Valves, Fittings, and Flanges (Tentative) (75 cents).
- No. 7–B. API Specifications for Rotary Drilling Equipment ($1.00).
- No. 11–A. API Specification for Oil Well Pumps ($1.25).
- No. 11–B. API Sucker Rod Specifications (75 cents).

SECTION II. NOMENCLATURE, DEFINITIONS, AND LETTER SYMBOLS

1. INTRODUCTORY

The purposes of this section[1] are to establish uniform practices with regard to: (1) Screw-thread nomenclature, and (2) letter symbols for designating dimensions of screw threads for use on drawings, in tables of dimensions which set forth dimensional standards, and in other records, and for expressing mathematical relationships.

The section consists of a glossary of terms, two tables of screw-thread dimensional symbols, three illustrations showing the application of dimensional symbols, and one table of identification symbols.

Typography.—In accordance with the usual practice in published text, letter symbols and letter subscripts, whether upper or lower case, should be printed in italic type. An exception is Greek letters; Greek capital letters are always vertical, and lower case always resemble italics. In manuscripts this is indicated by underlining each symbol to be italicized. Coefficients, numeral subscripts, and exponents should be printed in vertical Arabic numerals. Standard mathematical notation should be followed.

[1] This standard is in agreement with American Standard ASA B1.7–1949, "Nomenclature, Definitions, and Letter Symbols for Screw Threads", published by the The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

2. DEFINITION OF TERMS

The terms commonly applied to screw threads may be classified in five general groups, namely: (1) Those relating to types of screw threads; (2) those relating to size of mechanical parts in general; (3) those relating to geometrical elements of both straight and taper screw threads; (4) those relating to dimensions of screw threads; and (5) those relating only to taper screw threads.

The definitions presented herein apply to theoretically correct thread forms unless otherwise indicated.

(*a*) Terms Relating to Types of Screw Threads.—Screw threads and the terms generally applied to designate the types of screw threads are defined as follows:

1. *Screw thread.*—A screw thread (hereinafter referred to as a thread), is 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 or frustum of a cone. A thread formed on a cylinder is known as a "straight" or "parallel" thread, to distinguish it from a "taper" thread which is formed on a cone or frustum of a cone.

2. *External thread.*—An external thread is a thread on the external surface of a cylinder or cone.

3. *Internal thread.*—An internal thread is a thread on the internal surface of a hollow cylinder or cone.

4. *Right-hand thread.*—A thread is a right-hand thread if, when viewed axially, it winds in a clockwise and receding direction.

5. *Left-hand thread.*—A thread is a left-hand thread if, when viewed axially, it winds in a counterclockwise and receding direction. All left-hand threads are designated "L H."

6. *Single thread.*—A single (single-start) thread is one having lead equal to the pitch. (See (d) 1 and (d) 2.)

7. *Multiple thread.*—A multiple (multiple-start) thread is one in which the lead is an integral multiple of the pitch. (See (d) 1 and (d) 2.)

8. *Classes of threads.*—Classes of threads are distinguished from each other by the amount of tolerance or tolerance and allowance specified. (Formerly known as "classes of fit" and so designated in Handbook H28 (1944), government specifications, etc.)

(*b*) Terms Relating to Size of Parts.—Terms relating to the size of parts, which are generally applicable to mechanical parts, including threads, are defined as follows:

1. *Dimension.*—A dimension is a geometrical characteristic such as a diameter, length, angle, circumference, or center distance, of which the size is specified.

2. *Size.*—Size is a designation of magnitude.

3. *Nominal size.*—The nominal size is the designation which is used for the purpose of general identification.

4. *Basic size.*—The basic size of a dimension is the theoretical size from which the limits of size for that dimension are derived by the application of the allowance and tolerances.

5. *Design size.*—The design size of a dimension is the size in relation to which the limits of tolerance for that dimension are assigned. Where there is no allowance the design size is the same as the basic size.

6. *Actual size.*—The actual size of a dimension is the measured size of that dimension on an individual part.

7. *Limits of size.*—These limits are the maximum and minimum sizes permissible for a specific dimension.

8. *Tolerance.*—The tolerance on a dimension is the total permissible variation in its size. The tolerance is the difference between the limits of size.

9. *Allowance.*—An allowance is an intentional difference in correlated dimensions of mating parts. It is the minimum clearance (positive allowance) or maximum interference (negative allowance) between such parts.

10. *Fit.*—The fit between two mating parts is the relationship existing between them with respect to the amount of clearance or interference which is present when they are assembled.

(*c*) Terms Relating to Geometrical Elements of Screw Threads.—Terms relating to geometrical elements of both straight and taper threads are defined as follows:

1. *Axis.*—The axis of a thread is the axis of its pitch cylinder or cone.

2. *Pitch line.*—The pitch line is a generator of the imaginary cylinder or cone specified in the definition of pitch diameter.

3. *Form.*—The form of thread is its profile in an axial plane for a length of one pitch.

4. *Basic form of thread.*—The basic form of a thread is the theoretical profile of the thread for a length of one pitch in an axial plane, on which the design forms of the threads for both the external and internal threads are based.

5. *Design forms of thread.*—The design forms for a thread are the maximum metal forms permitted for the external and internal threads.

6. *Fundamental triangle.*—The fundamental triangle is the triangle whose corners coincide with three consecutive intersections of the extended flanks of the basic form.

7. *Flank.*—The flank (or side) of a thread is either surface connecting the crest with the root, the intersection of which, with an axial plane, is a straight line.

8. *Leading flank.*—The leading flank of a thread is the one which, when the thread is about to be assembled with a mating thread, faces the mating thread.

9. *Following flank.*—The following flank of a thread is the one which is opposite to the leading flank.

10. *Pressure flank.*—The pressure flank is that which takes the thrust or load in an assembly. The term is used particularly in relation to buttress and other similar threads.

11. *Clearance (or trailing) flank.*—The clearance flank is that which does not take the thrust or load in an assembly.

12. *Crest.*—The crest is that surface of the thread which joins the flanks of the thread and is farthest from the cylinder or cone from which the thread projects.

13. *Root.*—The root is that surface of the thread which joins the flanks of adjacent thread forms and is identical with or immediately adjacent to the cylinder or cone from which the thread projects.

14. *Sharp crest (or crest apex).*—The sharp crest is the apex formed by the intersection of the flanks of a thread when extended, if necessary, beyond the crest.

15. *Sharp root (or root apex).*—The sharp root is the apex formed by the intersection of the flanks of adjacent thread forms when extended, if necessary, beyond the root.

16. *Base.*—The base of a thread is that section of the thread which coincides with the cylinder or cone from which the thread projects.

17. *Major cylinder or cone.*—See "major diameter" and "major cone."

18. *Minor cylinder or cone.*—See "minor diameter" and "minor cone."

19. *Pitch cylinder or cone.*—See "pitch diameter" and "pitch cone."

20. *Complete thread.*—The complete (or full) thread is that part of the thread having full form at both crest and root. When there is a chamfer at the start of the thread, not exceeding two pitches in length, it is included within the length of complete thread. When designing threaded products, it is necessary to take cognizance of: (1) Such permissible length of chamfer and (2) the first three threads which by virtue of the "not go" gaging practice may exceed the product limits, which may be included within the length of complete thread.

21. *Incomplete thread.*—This is also known as the vanish or washout thread. On straight threads, the incomplete thread is that portion at the end having roots not fully formed by the lead or chamfer on threading tools.

On taper threads, the crest at the end may also be not fully formed due to the intersection of the major cone of an external thread, or the minor cone of an internal thread, with the cylindrical surface of the work.

22. *Effective thread.*—The effective (or useful) thread includes the complete thread and that portion of the incomplete thread having fully formed roots but having crests not fully formed.

23. *Total thread.*—The total thread includes the complete or effective thread and the incomplete thread.

24. *Vanish cone.*—The vanish cone is an imaginary cone, the surface of which would pass through the roots of the incomplete thread formed by the lead or chamfer of the threading tool.

25. *Vanish point.*—The vanish point of an external thread is the intersection of a generator of the vanish cone with a generator of the cylinder of the largest major diameter of the thread.

26. *Blunt start.*—"Blunt start" designates the removal of the partial thread at the entering end of thread. This is a feature of threaded parts which are repeatedly assembled by hand, such as hose couplings and thread plug gages, to prevent cutting of hands and crossing of threads, and which was formerly known as a "Higbee cut." (See fig. II.1.)

(*d*) Terms Relating to Dimensions of Screw Threads.—Terms relating to dimensions of both straight and taper threads are defined as follows:

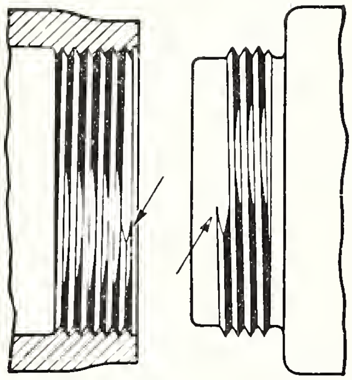


Figure II.1.—*Blunt start.*

1. *Pitch.*—The pitch of a thread is the distance, measured parallel to its axis, between corresponding points on adjacent thread forms in the same axial plane and on the same side of the axis.

2. *Lead.*—The lead is the distance a threaded part moves axially, with respect to a fixed mating part, in one complete rotation.

3. *Threads per inch.*—The number of threads per inch is the reciprocal of the pitch in inches.

4. *Turns per inch.*—The number of turns per inch is the reciprocal of the lead in inches.

5. *Included angle.*—The included angle of a thread (or angle of thread) is the angle between the flanks of the thread measured in an axial plane.

6. *Flank angle.*—The flank angles are the angles between the individual flanks and the perpendicular to the axis of the thread, measured in an axial plane. A flank angle of a symmetrical thread is commonly termed the "half-angle of thread."

7. *Lead angle.*—On a straight thread the lead angle is the angle made by the helix of the thread at the pitch line with a plane perpendicular to the axis. On a taper thread, the lead angle at a given axial position is the angle made by the conical spiral of the thread at the pitch line with the plane perpendicular to the axis at that position.

8. *Thickness.*—The thickness of thread is the distance between the flanks of the thread measured at a specified position and parallel to the axis.

9. *Height of fundamental triangle.*—The height of the fundamental triangle of a thread, or the height of a sharp-V thread, is the distance measured perpendicular to the axis between the sharp major and minor cylinders or cones, respectively.

10. *Height of thread.*—The height (or depth) of thread is the distance, measured perpendicular to the axis, between the major and minor cylinders or cones, respectively.

11. *Addendum.*—The addendum of an external thread is the distance, measured perpendicular to the axis, between the major and pitch cylinders or cones, respectively. The addendum of an internal thread is the distance, measured perpendicular to the axis, between the minor and pitch cylinders or cones, respectively.

12. *Dedendum.*—The dedendum of an external thread is the distance, measured perpendicular to the axis, between the pitch and minor cylinders or cones, respectively. The dedendum of an internal thread is the distance, measured perpendicular to the axis, between the major and pitch cylinders or cones, respectively.

13. *Crest truncation.*—The crest truncation of a thread is the distance, measured perpendicular to the axis, between the sharp crest (or crest apex) and the cylinder or cone which bounds the crest.

14. *Root truncation.*—The root truncation of a thread is the distance, measured perpendicular to the axis, between the sharp root (or root apex) and the cylinder or cone which bounds the root.

15. *Major diameter.*—On a straight thread, the major diameter is the diameter of the imaginary co-axial cylinder which bounds the crest of an external thread or the root of an internal thread.

On a taper thread, the major diameter, at a given position on the thread axis, is the diameter of the major cone at that position.

16. *Minor diameter.*—On a straight thread, the minor diameter is the diameter of the imaginary co-axial cylinder which bounds the root of an external thread or the crest of an internal thread.

On a taper thread, the minor diameter, at a given position on the thread axis, is the diameter of the minor cone at that position.

17. *Pitch diameter* (*simple effective diameter*).—On a straight thread, the pitch diameter is the diameter of the imaginary co-axial cylinder, the surface of which would pass through the thread profiles at such points as to make the width of the groove equal to one-half of the basic pitch. On a perfect thread this occurs at the point where the widths of the thread and groove are equal.

On a taper thread, the pitch diameter at a given position on the thread axis is the diameter of the pitch cone at that position.

18. *Effective size* (*or virtual effective diameter*).—The effective size of an external or internal thread is the diameter derived by adding to the pitch diameter, in the case of an external thread, or subtracting from the pitch diameter, in the case of an internal thread, the cumulative effects of pitch and angle errors.

19. *Depth of thread engagement.*—The depth (or height) of thread engagement between two mating threads is the distance, measured perpendicular to the axis, by which their thread forms overlap each other.

20. *Length of thread engagement.*—The length of thread engagement of two mating threads is the distance between the extreme points of contact on the pitch cylinders or cones, measured parallel to the axis.

21. *Crest clearance.*—The crest clearance in a thread assembly is the distance, measured perpendicular to the axis, between the crest of a thread and the root of its mating thread.

22. *Tensile stress area.*—The tensile stress area is the assumed area of an external threaded part which is used for the purpose of computing the tensile strength.

(e) Terms Relating Only to Taper Screw Threads.—Terms relating only to taper threads are defined as follows:

1. *Pitch cone.*—The pitch cone is an imaginary cone, the surface of which would pass through the thread profiles at such points as to make the width of the groove equal to one half of the basic pitch. On a perfect thread this occurs at the point where the widths of the thread and groove are equal.

2. *Major cone.*—The major cone is an imaginary cone having an apex angle equal to that of the pitch cone, the surface of which bounds the crest of an external thread or the root of an internal thread.

3. *Sharp major cone.*—The sharp major cone is an imaginary cone having an apex angle equal to that of the pitch cone, the surface of which would pass through the sharp crest of an external thread or the sharp root of an internal thread.

4. *Minor cone.*—The minor cone is an imaginary cone having an apex angle equal to that of the pitch cone, the surface of which bounds the root of an external thread or the crest of an internal thread.

5. *Sharp minor cone.*—The sharp minor cone is an imaginary cone having an apex angle equal to that of the pitch cone, the surface of which would pass through the sharp root of an external thread or the sharp crest of an internal thread.

6. *Standoff.*—The standoff is the axial distance between specified reference points on external and internal taper threaded members or gages, when

assembled with a specified torque or under other specified conditions.

3. LETTER SYMBOLS AND ABBREVIATIONS

Symbols associated with screw threads are of two kinds: (1) Letter symbols for designating dimensions of screw threads and threaded products; and (2) abbreviations used as identification symbols for designating various standard thread forms and thread series.

(a) Dimensional Symbols.—Standard letter symbols to designate the dimensions of screw threads are given in tables II.1 and II.2. General symbols are given in table II.1 and pipe thread symbols in table II.2. The application of general symbols is illustrated in figures II.2 and II.3, inclusive, and pipe thread symbols in figure II.4.

(b) Identification Symbols.—Identification symbols are capital letter abbrevations of names used to designate various forms of thread and thread series, and commonly consist of combinations of such abbreviations. There are assembled in table 3 the names and abbreviations which are now in use, together with references to standards in which they occur, of various standard threads.

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 per inch, all in Arabic characters, and followed by the classification of allowance and tolerance in Arabic numerals. The identification symbols applicable to each thread series is stated in the section where such series is presented,

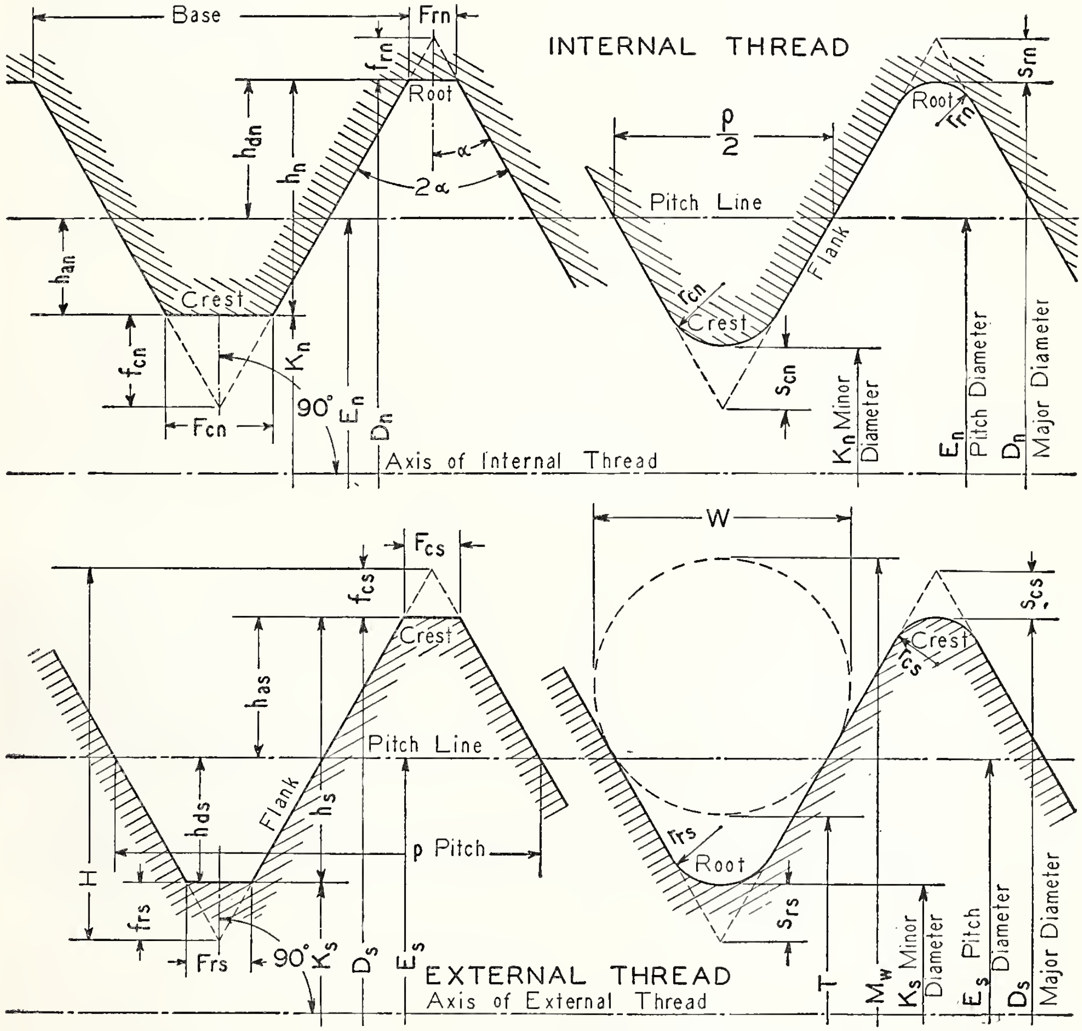


Figure II.2.—*General screw thread symbols.*

Note.—These diagrams are not intended to show standard thread forms but illustrate only the applications of symbols.

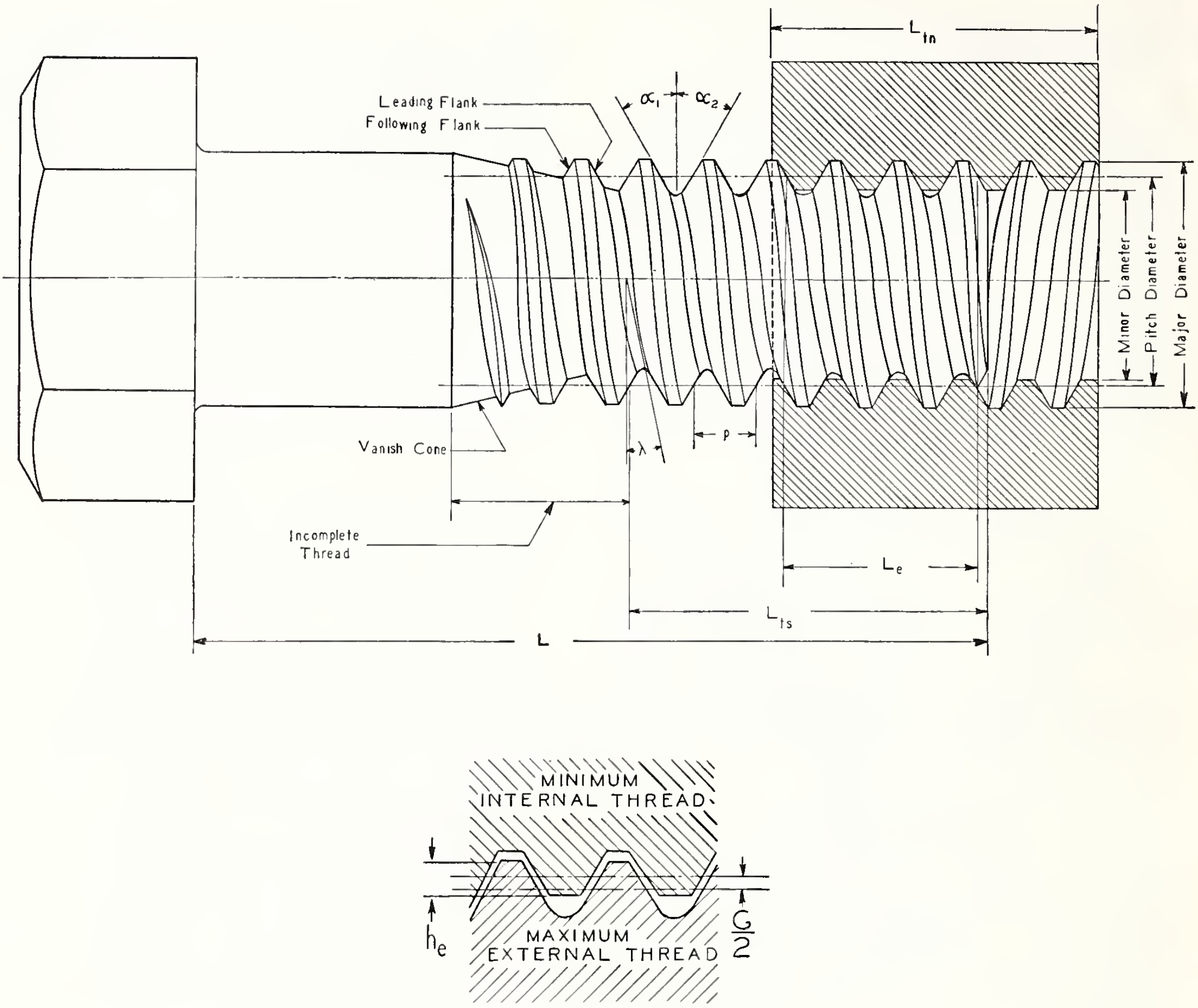


FIGURE II.3.—*General screw thread symbols.*

together with examples. If the thread is left hand, the symbol "LH" shall follow the class. 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.

It is occasionally desirable to modify a standard thread by the inclusion of some nonstandard feature. Thus, it might be necessary to limit the maximum major diameter of a 1″–8UNC–2A screw to 0.9800 inch in order to provide clearance for a shoulder. The word "modify" should be added to the designation with an asterisk (*), and the nonstandard feature or dimension of the thread should be enclosed in brackets and likewise marked with an asterisk (*).

Multiple threads shall be designated by showing both the pitch and the lead in accordance with examples given on p. 162, H28 (1944).

Table II.1—*General symbols (see figs. II.2 and II.3)*

Symbols	Dimensions	Remarks
D	Major diameter	*Exception:* B is used for basic major diameter when this differs from the nominal major diameter. Subscripts s or n, indicating external or internal thread, may be used if necessary.
E	Pitch diameter	Subscripts s or n, indicating external or internal thread, may be used if necessary.
K	Minor diameter	
p	Pitch	Equals $1/n$.
l	Lead	Equals 1/N.
n	Number of threads per unit of length (per inch).	
N	Number of turns per unit of length (per inch).	
H	Height of fundamental triangle	
h	Height of thread	Subscripts s or n, indicating external or internal thread, may be used if necessary.
h_a	Addendum.	
h_d	Dedendum.	
h_b	Equals $2h_a$ of basic external thread.	
h_e	Depth of thread engagement.	
α (alpha)	Half-angle of symmetrical thread.	
α_1	Angle between leading flank of thread and normal to axis of thread.	
α_2	Angle between following flank of thread and normal to axis of thread.	
λ (lambda)	Lead angle	Tan $\lambda=\frac{l}{\pi E}$.
r	Radius of rounding at crest, or radius of rounding at root.	Subscripts c or r indicating crest or root, and s or n indicating external or internal thread may be used if necessary.
	Depth from apex of fundamental triangle to adjacent root or crest of thread:	
s	(1) If rounded.	
f	(2) If flat.	
	Depth from apex of fundamental triangle to:	
f_{cs}	(1) Flat at crest of external thread.	
f_{rs}	(2) Flat at root of external thread.	
f_{cn}	(3) Flat at crest of internal thread.	
f_{rn}	(4) Flat at root of internal thread.	
	Width of:	
F	(1) Flat (general).	
F_{cs}	(2) Flat at crest of external thread.	
F_{rs}	(3) Flat at root of external thread.	
F_{cn}	(4) Flat at crest of internal thread.	
F_{rn}	(5) Flat at root of internal thread.	
L	Length of bolt or screw.	
L_t	Length of full thread	Subscripts s or n may be used.
L_e	Length of thread engagement.	
w	Diameter of measuring wires.	
M_w	Measurement over wires.	
T	Measurement under wires.	
C	Correction to measurement over wires to give pitch diameter.	$E=M_w-C-c$. $C=w(1+\operatorname{cosec}\alpha)-(\cot\alpha)/2n$.
P	Correction to measurement under wires to give pitch diameter.	$E=T+P-c$. $P=1/2p\cot\alpha-(\operatorname{cosec}\alpha-1)w$.
λ'	Wire angle	See NPL "Notes on Screw Gages", August 1944, p. 23, or NBS Handbook H28 (1944), p. 228.
c	Wire angle correction	
Prefix symbol with δ (delta).	Error in any dimension	*Examples:* Error in pitch, δp; error in half-angle, $\delta\alpha_1$ or $\delta\alpha_2$.
ΔE_α (delta E_α).	Pitch-diameter equivalent of errors in flank angles.	
ΔE_p (delta E_p).	Pitch-diameter equivalent of error in pitch.	
G	Allowance at pitch diameter.	

Table II.2.—*Pipe-thread symbols (see fig. II.4)*

Symbols	Dimensions	Remarks
D	Outside diameter of pipe	Subscript 4 is used for dimensions in plane of vanish point when these differ from D, d, or t, respectively.
d	Inside diameter of pipe	
t	Wall thickness of pipe	
D_x	Major diameter	Subscript x denotes plane containing the diameter. For axial positions of planes see foot of table II. 2. Subscripts s or n designating screw or nut may also be used if necessary.
E_x	Pitch diameter	
K_x	Minor diameter	
L_x	Length of thread from plane of pipe end to plane containing basic diameter D_x, E_x, or K_x.	For axial position of plane containing basic diameter, see foot of table II.2.
V	Length of washout (vanish cone) threads.	
β (beta)	Half apex angle of pitch cone of taper thread.	
γ (gamma)	Angle of chamfer at end of pipe measured from a plane normal to the axis.	
A	Hand tight standoff of face of coupling from plane containing vanish point on pipe.	
M	Length from plane of hand tight engagement to the face of coupling on internally threaded member.	
S	Distance of gaging step of plug gage from face of ring gage for hand tight engagement.	
L_n	Length from center line of coupling, face of flange, or bottom of internal thread chamber to face of fitting.	
b	Width of bearing face on coupling.	
τ (tau)	Angle of chamfer at bottom of recess or counterbore measured from the axis.	
ϵ (epsilon)	Half apex angle of vanish cone.	
J	Length from center line of coupling, face of flange, or bottom of internal thread chamber to end of pipe, wrenched engagement.	
L_t	(1) Length of straight full thread (see table II.1). (2) Length from plane of hand-tight engagement to small end of full internal taper thread.	
Q	Diameter of recess or counterbore in fitting.	
q	Depth of recess or counterbore in fitting.	
W	Outside diameter of coupling or hub of fitting.	
	DEFINITION OF PLANES DENOTED BY SUBSCRIPT x	
$x=0$	Plane of pipe end	
$x=1$	Plane of handtight engagement or plane at mouth of coupling (excluding recess, if present). On British pipe threads this is designated the "gauge plane," and the major diameter in this plane is designated the "gauge diameter."	
$x=2$	Plane at which washout threads on pipe commence.	
$x=3$	Plane in coupling reached by end of pipe in wrenched condition. (L_3 is measured from plane containing pipe end in position of handtight engagement.)	
$x=4$	Plane containing vanish point of thread on pipe.	
$x=5$	Plane at which major diameter cone of thread intersects outside diameter of pipe.	

Note.—Additional special subscripts are as follows: Plane $x=6$ is the plane of the pipe end for railing joints. Plane $x=7$ is the plane of the API gage point at a specified length from the plane of vanish point. Plane $x=8$ is the plane of the large end of the "L_8 thread ring gage" for the compressed-gas cylinder valve inlet connection thread. Plane $x=9$ is the plane of the small end of the "L_9 thread plug gage" for the compressed-gas cylinder inlet thread.

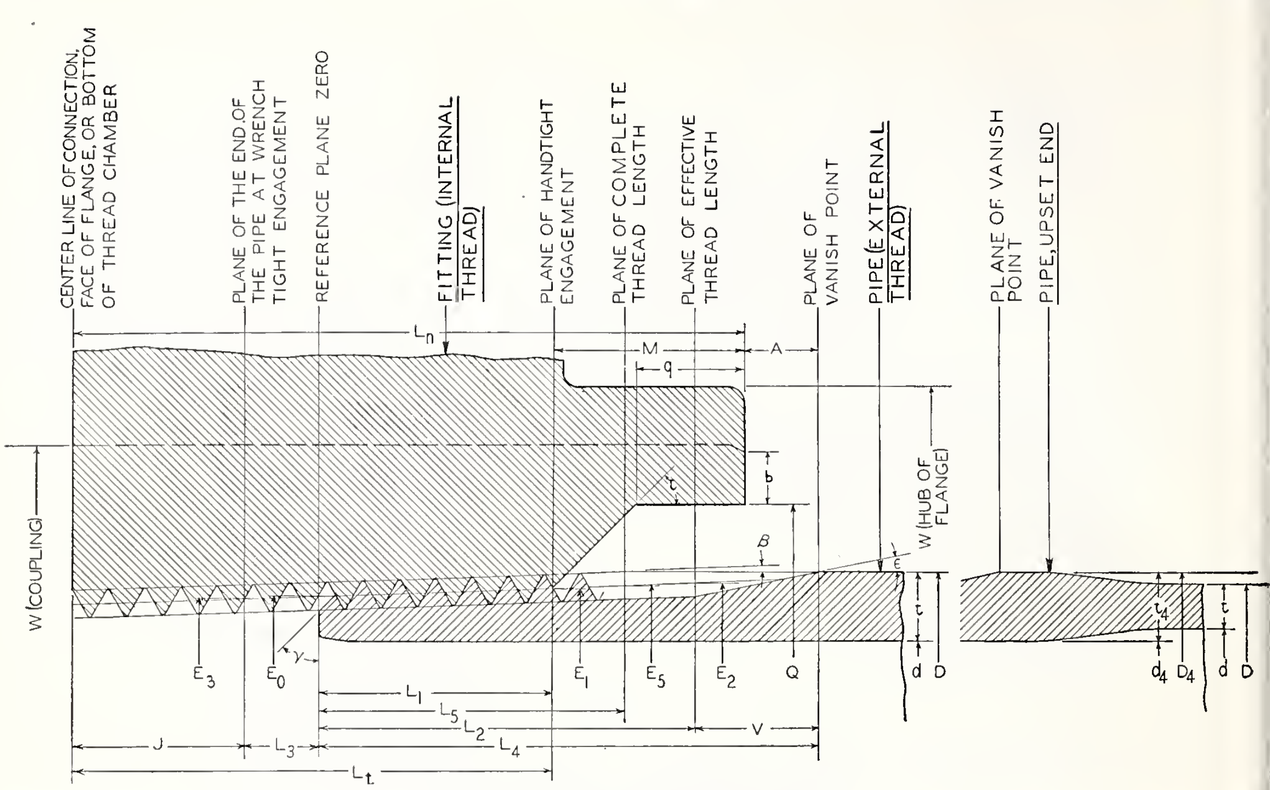


FIGURE II.4.—*Pipe thread symbols.*

TABLE II.3.—*Identification symbols* [1] [2]

Symbol	Thread series	References	
		ASA Standards	Handbook H28 (1944), section No.
Acme-C	Acme threads, centralizing	B1.5–1945	X.
Acme-G	Acme threads, general purpose	B1.5–1945	X.
Stub Acme	Stub Acme thread	B1.11	
AMO	American Standard microscope objective thread	Under development	
Butt	American Standard buttress thread	Under development	Appendix 5.
NC	American National coarse thread series	B1.1–1949	IV.
NF	American National fine thread series	B1.1–1949	IV.
NEF	American National extra-fine thread series		IV.
8N	American National 8-thread series	B1.1–1949	IV.
12N	American National 12-thread series	B1.1–1949	IV.
16N	American National 16-thread series	B1.1–1949	IV.
NH	American National hose coupling and fire hose coupling threads		VII.
NGO	American National gas outlet thread	B57.1–1950	VIII (revised).
NS	Special threads of American National form		V.
NPT	American Standard taper pipe thread	B2.1–1945	VI.
NPTF	American Standard taper pipe thread (dryseal)	B2.1–1945	VI.
NPTR	American Standard taper pipe thread for railing fittings	B2.1–1945	VI.
NPS	American Standard straight pipe thread	B2.1–1945	VI.
NPSC	American Standard straight pipe thread in couplings	B2.1–1945	VI.
NPSF	American Standard internal straight pipe thread (dryseal)	B2.1–1945	VI.
NPSI	American Standard intermediate internal straight pipe thread (dryseal)	B2.1–1945, App. E	
NPSM	American Standard straight pipe thread for mechanical joints	B2.1–1945	VI.
NPSL	American Standard straight pipe thread for locknuts and locknut pipe threads	B2.1–1945	VI.
NPSH	American Standard straight pipe thread for hose couplings and nipples	B2.1–1945	VI.
ANPT	Aeronautical taper pipe thread	(3)	(3)
RMS	American Standard surveying instrument mounting thread	Under development	
UNC	Unified coarse thread series	B1.1–1949	XV.
UNEF	Unified selected diameter-pitch combinations of the extra-fine thread series	B1.1–1949	XV.
UNF	Unified fine thread series	B1.1–1949	XV.
UN	Unified selected diameter-pitch combinations of the 8-, 12-, and 16-thread series	B1.1–1949	XV.
UNS	Unified threads of special diameters, pitches, and lengths of engagement	B1.1–1949	XVI.

[1] Methods of designating multiple threads are shown in ASA B1.5–1945, American War Standard for Acme Threads, and section X of Handbook H28 (1944.)
[2] All threads, except NGO, are right hand, unless otherwise designated. For NGO threads, designations "RH" or "LH" are required.
[3] Army-Navy Aeronautical Specification AN-P-363.

SECTION XV. UNIFIED THREAD FORM AND SERIES

1. INTRODUCTION

The Unified thread standards,[1] which have been agreed upon by standards bodies of Canada, the United Kingdom, and the United States, constitute the basic American standards for fastening screw threads. In relation to previous American practice, as covered by sections III and IV of this handbook, these standards are not an altogether new design. The practical differences between threaded parts as produced to either the Unified or the American National specifications are of minor significance. Unified threads have substantially the same thread form, and are mechanically interchangeable with American National threads of the same diameter and pitch.

The principal differences between the two systems relate to the application of allowances, the variation of tolerances with size, difference in amount of pitch diameter tolerance on external and internal threads, and differences in thread designations. Under the Unified system an allowance is provided on both the classes 1A and 2A external threads, whereas under the American National system only the class 1 external thread has an allowance. Under the Unified system, the pitch diameter tolerance of an internal thread is 30 percent greater than that of the external thread, but such tolerances are equal under the American National system. Unified tolerances and allowances for both standard and special diameter-pitch combinations are derived from the same formula but American National tolerances for special threads have a different basis from that for standard threads.

Under the American National system, the nut and bolt pitch diameter tolerances are equal for a given class and the same thread designation applies to the bolt and nut, i. e., 1″–8NC–2 is applicable both to the internal and external thread. Under the new system, this symbol would be written 1″–8UNC–2A if it were an external thread and 1″–8UNC–2B if it were an internal thread.

2. THE UNIFIED FORM OF THREAD

1. Angle of Thread.—The basic angle of thread between the flanks 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. Form of Crest.—The form of the crest of external threads may be either flat or rounded. The crest of the basic thread form of the external thread shall be truncated from the sharp crest an amount equal to $1/8 \times H$, where H is the depth of the fundamental triangle. The form of the crest of internal threads is flat and the crest shall be truncated from the sharp crest an amount equal to $1/4 \times H$.

3. Form of Root.—The crest clearances allowed are such as to permit rounded root forms in both the external and internal threads. Rounded roots are required in some applications and are made by tools which are purposely rounded. Otherwise, rounded roots may be the result of tool wear.

4. Clearance at Minor Diameter.—A clearance is provided at the minor diameter of the internal thread by truncating from the sharp crest an amount equal to $1/4 \times H$.

5. Clearance at Major Diameter.—A clearance is provided at the major diameter of the internal thread by making the thread form at the root such that its width is less than $1/8 \times p$.

6. Illustration.—Figure XV.1 shows the design forms (maximum metal condition) of the external and internal threads of the Unified form of thread.

7. Basic Thread Data.—The basic thread data for all standard pitches of the Unified form of thread are given in table XV.1.

3. THREAD SERIES, SYMBOLS, AND SUGGESTED APPLICATIONS

1. Coarse Thread Series.—The basic dimensions of the coarse-thread series, including both Unified thread sizes and additional American National thread sizes, are given in table XV.2. The limits of size, allowances, and tolerances for the Unified classes, based on a length of engagement of one diameter, are given in tables XV.9 to XV.14, inclusive. Thread sizes of the coarse-thread series which are recognized as Unified are designated by the symbol "UNC". All others are designated by "NC" with the Unified class designations to indicate their conformance to the Unified thread formulas.[2]

The 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.

2. Fine Thread Series.—The basic dimensions of the fine-thread series, including both Unified thread sizes and additional American National

[1] The Unified thread standards presented in this section are in agreement with ASA B1.1-1949, "Unified and American Screw Threads," published by the ASME, 29 West 39th Street, New York 18, N. Y.; also with CSA B1.1-1949, "Standard for Unified and American Screw Threads," published by the Canadian Standards Association, Ottawa, Canada; and with British Standard 1580:1949, "Unified Screw Threads," published by the British Standards Institution, 24/28 Victoria Street, London, S. W. 1.

[2] The 1/2″–13 size will continue in use pending further discussions with the British and Canadians regarding unification of the 1/2-in. size.

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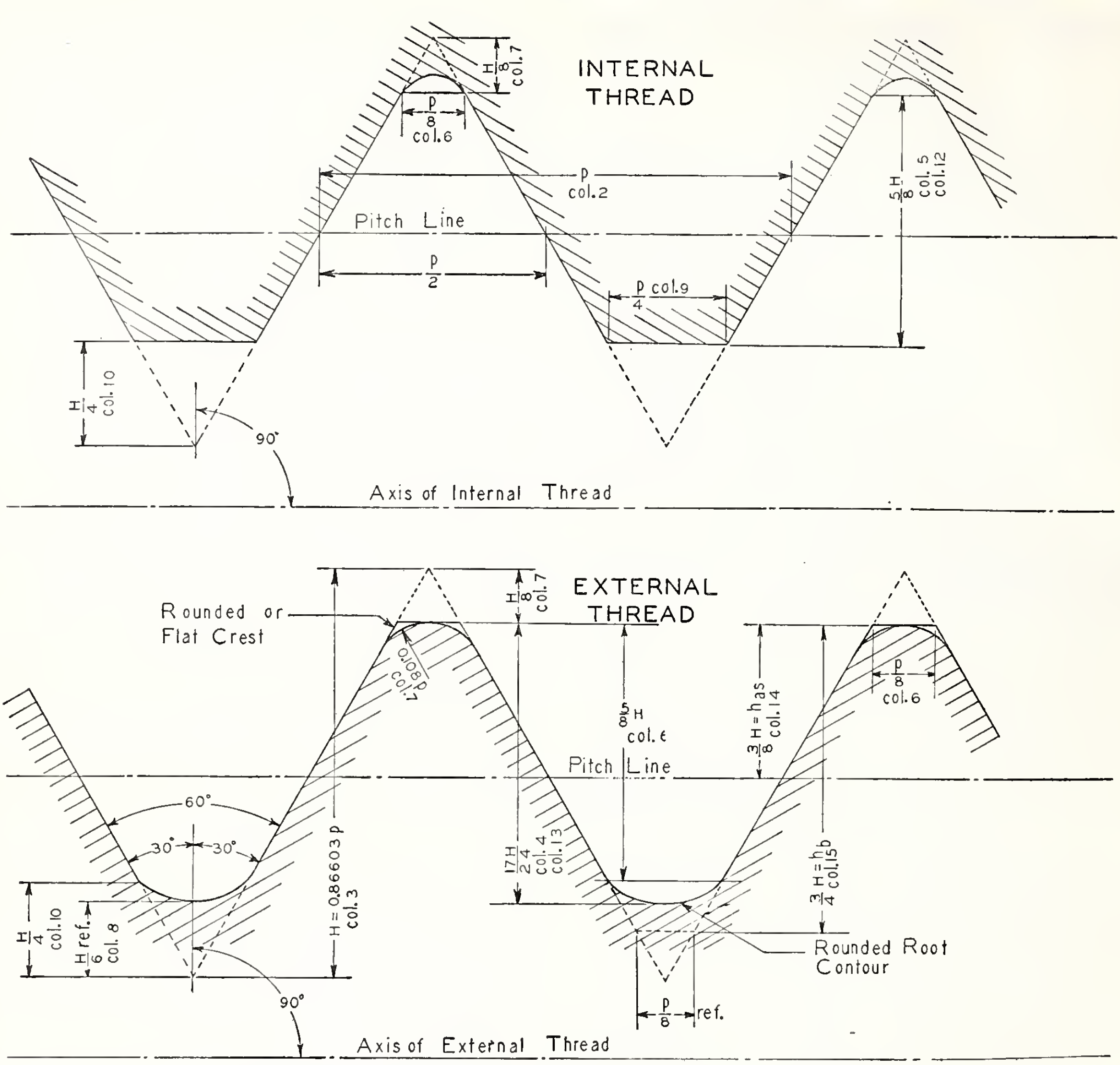

FIGURE XV.1.—*Unified internal and external screw thread design forms (maximum metal condition).*

NOTE.—See table XV.1 for numerical values as indicated by the column references.

thread sizes, are given in table XV.3. The limits of size, allowances, and tolerances for the Unified classes, based on a length of engagement of one diameter, are given in tables XV.15 to XV.20, inclusive. Thread sizes of the fine thread series which are recognized as Unified are designated by the symbol "UNF". All others are designated "NF" with the Unified class designations to indicate their conformance to the Unified thread classes.

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

3. EXTRA-FINE THREAD SERIES.—The extra-fine thread series is used particularly in aircraft and aeronautical equipment 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 is required within a given thread length. The basic dimensions of the extra-fine thread series, including Unified sizes designated "UNEF" and American National sizes designated [3] "NEF" with Unified class designations to indicate their conformance to the Unified thread formulas, are given in table XV.4. The limits of size, allowance, and tolerances for the Unified classes, based on a length of engagement of 9 pitches, are given in tables XV.21 to XV.24, inclusive.

4. 8–THREAD SERIES.—The 8-thread series has come into general use in many classes of engineering work as a substitute for the coarse-thread series, particularly on bolts for high-pressure pipe

flanges, cylinder-head studs, and similar fasteners against pressure. The basic dimensions of the 8-thread series are given in table XV.5. Sizes of the 8-thread series [3] larger than 1½ inches in even ¼ inches are recognized as Unified sizes when limits of size are based on a length of engagement of 9 pitches, or 1⅛ in. However, in American practice, the limits of size of this series are customarily based on a length of engagement of one diameter, as given in tables XV.25 to XV.28, inclusive. Such threads are designated "8N" with the Unified class designations to indicate their conformance to the Unified thread classes.

5. 12-Thread Series.—The 12-thread series is widely used in machine construction 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 ⅛-inch steps. Twelve threads per inch is the coarsest pitch 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 ⅛ inch. Sizes of the 12-thread series from ½ inch to and including 1¾ 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 1/16 inch throughout most of the range. The 12-thread series also provides continuation of the fine-thread series for diameters larger than 1½ inches.

The basic dimensions of the 12-thread series, including Unified sizes designated [3] 12UN and American National sizes designated 12N, with Unified class designations to indicate their conformance to the Unified thread formulas, are given in table XV.6. The limits of size, allowances, and tolerances for the Unified classes, based on a length of engagement of 9 pitches or ¾ inch, are given in tables XV.29 to XV.32, inclusive.

6. 16-Thread Series.—The 16-thread 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. The basic dimensions, including Unified sizes designated [3] 16UN and American National sizes designated 16N, with Unified class designations to indicate their conformance to the Unified thread formulas, are given in table XV.7. The limits of size, allowance, and tolerances for the Unified classes, based on a length of engagement of 9

[3] The British designation for Unified sizes in this series is "UNS".

Table XV.1.—*Thread data, Unified thread form (see fig. 1)*

Threads per inch, n	Pitch, p	Height of sharp V-thread, $H=0.86603p$	Height of external thread, $h_s=17/24H=0.61343p$	Height of internal thread and depth of thread engagement, $h_n=h_e=5/8H=0.54127p$	Flat at external thread crest and internal thread root, $F_{cs}=F_{rn}=p/8=0.125p$	Truncation of external thread crest and internal thread root, $f_{cs}=f_{rn}=H/8=0.10825p$	Truncation of external thread root, $s_{rs}=H/6=0.14434p$	Flat at internal thread crest, $F_{cn}=p/4=0.25p$	Truncation of internal thread crest,[1] $f_{cn}=H/4=0.21651p$	Difference between max. major and pitch diameters of internal thread,[2] $11/12H=0.79386p$	Double height of internal thread, $1\ 1/4H=1.08253p$	Double height of external thread, $1\ 5/12H=1.22687p$	Addendum of external thread,[3] $h_{as}=3/8H=0.32476p$	Twice the external thread addendum,[4] $h_b=2h_{as}=3/4H=0.64952p$
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
80	0.01250	0.01083	0.00767	0.00677	0.00156	0.00135	0.00180	0.00312	0.00271	0.00992	0.01353	0.01534	0.00406	0.00812
72	.01389	.01203	.00852	.00752	.00174	.00150	.00200	.00347	.00301	.01103	.01504	.01704	.00451	.00902
64	.01563	.01353	.00958	.00846	.00195	.00169	.00226	.00391	.00338	.01240	.01691	.01917	.00507	.01015
56	.01786	.01546	.01095	.00967	.00223	.00193	.00258	.00446	.00387	.01418	.01933	.02191	.00580	.01160
48	.02083	.01804	.01278	.01128	.00260	.00226	.00301	.00521	.00451	.01654	.02255	.02556	.00677	.01353
44	.02273	.01968	.01394	.01230	.00284	.00246	.00328	.00568	.00492	.01804	.02460	.02788	.00738	.01476
40	.02500	.02165	.01534	.01353	.00312	.00271	.00361	.00625	.00541	.01985	.02706	.03067	.00812	.01624
36	.02778	.02406	.01704	.01504	.00347	.00301	.00401	.00694	.00601	.02205	.03007	.03408	.00902	.01804
32	.03125	.02706	.01917	.01691	.00391	.00338	.00451	.00781	.00677	.02481	.03383	.03834	.01015	.02030
28	.03571	.03093	.02191	.01933	.00446	.00387	.00515	.00893	.00773	.02835	.03866	.04382	.01160	.02320
24	.04167	.03608	.02556	.02255	.00521	.00451	.00601	.01042	.00902	.03308	.04511	.05112	.01353	.02706
20	.05000	.04330	.03067	.02706	.00625	.00541	.00722	.01250	.01083	.03969	.05413	.06134	.01624	.03248
18	.05556	.04811	.03408	.03007	.00694	.00601	.00802	.01389	.01203	.04410	.06014	.06816	.01804	.03608
16	.06250	.05413	.03834	.03383	.00781	.00677	.00902	.01562	.01353	.04962	.06766	.07668	.02030	.04059
14	.07143	.06186	.04382	.03866	.00893	.00773	.01031	.01786	.01546	.05670	.07732	.08763	.02320	.04639
13	.07692	.06662	.04719	.04164	.00962	.00833	.01110	.01923	.01665	.06107	.08327	.09437	.02498	.04996
12	.08333	.07217	.05112	.04511	.01042	.00902	.01203	.02083	.01804	.06615	.09021	.10224	.02706	.05413
11 1/2	.08696	.07531	.05334	.04707	.01087	.00941	.01255	.02174	.01883	.06903	.09413	.10668	.02824	.05648
11	.09091	.07873	.05577	.04921	.01136	.00984	.01312	.02273	.01968	.07217	.09841	.11153	.02952	.05905
10	.10000	.08660	.06134	.05413	.01250	.01083	.01443	.02500	.02165	.07939	.10825	.12269	.03248	.06495
9	.11111	.09623	.06816	.06014	.01389	.01203	.01604	.02778	.02406	.08821	.12028	.13632	.03608	.07217
8	.12500	.10825	.07668	.06766	.01562	.01353	.01804	.03125	.02706	.09923	.13532	.15336	.04059	.08119
7	.14286	.12372	.08763	.07732	.01786	.01546	.02062	.03571	.03093	.11341	.15465	.17527	.04639	.09279
6	.16667	.14434	.10224	.09021	.02083	.01804	.02406	.04167	.03608	.13231	.18042	.20448	.05413	.10825
5	.20000	.17321	.12269	.10825	.02500	.02165	.02887	.05000	.04330	.15877	.21651	.24537	.06495	.12990
4 1/2	.22222	.19245	.13632	.12028	.02778	.02406	.03208	.05556	.04811	.17641	.24056	.27264	.07217	.14434
4	.25000	.21651	.15336	.13532	.03125	.02706	.03608	.06250	.05413	.19846	.27063	.30672	.08119	.16238

[1] $h_{an}=f_{cn}=H/4$.
[2] See figs. XV.2 and XV.3.
[3] $h_{an}=h_{as}=3/8H$.
[4] Equivalent to the "basic height" h of the original American National form.

TABLE XV.2.—*Basic dimensions, coarse thread series*

UNC and NC

Designation				Basic major diameter, D	Basic pitch diameter,[1] E	Minor diameter, external threads, K_s	Minor diameter, internal threads, K_n	Lead angle at basic pitch diameter, λ	Sectional area at minor diameter at $D-2h_b$	Tensile stress area [2]
Size		Threads per inch, n	Thread symbol							
1		2	3	4	5	6	7	8	9	10
No.	*in.*			*in.*	*in.*	*in.*	*in.*	*deg min*	*sq in.*	*sq in.*
1	0.073	64	NC	0.0730	0.0629	0.0538	0.0561	4 31	0.0022	0.0026
2	.086	56	NC	.0860	.0744	.0641	.0667	4 22	.0031	.0036
3	.099	48	NC	.0990	.0855	.0734	.0764	4 26	.0041	.0048
4	.112	40	NC	.1120	.0958	.0813	.0849	4 45	.0050	.0060
5	.125	40	NC	.1250	.1088	.0943	.0979	4 11	.0067	.0079
6	.138	32	NC	.1380	.1177	.0997	.1042	4 50	.0075	.0090
8	.164	32	NC	.1640	.1437	.1257	.1302	3 58	.0120	.0139
10	.190	24	NC	.1900	.1629	.1389	.1449	4 39	.0145	.0174
12	.216	24	NC	.2160	.1889	.1649	.1709	4 1	.0206	.0240
	1/4	20	UNC	.2500	.2175	.1887	.1959	4 11	.0269	.0317
	5/16	18	UNC	.3125	.2764	.2443	.2524	3 40	.0454	.0522
	3/8	16	UNC	.3750	.3344	.2983	.3073	3 24	.0678	.0773
	7/16	14	UNC	.4375	.3911	.3499	.3602	3 20	.0933	.1060
	1/2	13	NC	.5000	.4500	.4056	.4167	3 7	.1257	.1416
	1/2 [3]	12	UNC	.5000	.4459	.3978	.4098	3 24	.1205	.1374
	9/16	12	UNC	.5625	.5084	.4603	.4723	2 59	.1620	.1816
	5/8	11	UNC	.6250	.5660	.5135	.5266	2 56	.2018	.2256
	3/4	10	UNC	.7500	.6850	.6273	.6417	2 40	.3020	.3340
	7/8	9	UNC	.8750	.8028	.7387	.7547	2 31	.4193	.4612
	1	8	UNC	1.0000	.9188	.8466	.8647	2 29	.5510	.6051
	1 1/8	7	UNC	1.1250	1.0322	.9497	.9704	2 31	.6931	.7627
	1 1/4	7	UNC	1.2500	1.1572	1.0747	1.0954	2 15	.8898	.9684
	1 3/8	6	UNC	1.3750	1.2667	1.1705	1.1946	2 24	1.0541	1.1538
	1 1/2	6	UNC	1.5000	1.3917	1.2955	1.3196	2 11	1.2938	1.4041
	1 3/4	5	UNC	1.7500	1.6201	1.5046	1.5335	2 15	1.7441	1.8983
	2	4 1/2	UNC	2.0000	1.8557	1.7274	1.7594	2 11	2.3001	2.4971
	2 1/4	4 1/2	UNC	2.2500	2.1057	1.9774	2.0094	1 55	3.0212	3.2464
	2 1/2	4	UNC	2.5000	2.3376	2.1933	2.2294	1 57	3.7161	3.9976
	2 3/4	4	UNC	2.7500	2.5876	2.4433	2.4794	1 46	4.6194	4.9326
	3	4	UNC	3.0000	2.8376	2.6933	2.7294	1 36	5.6209	5.9659
	3 1/4	4	UNC	3.2500	3.0876	2.9433	2.9794	1 29	6.7205	7.0992
	3 1/2	4	UNC	3.5000	3.3376	3.1933	3.2294	1 22	7.9183	8.3268
	3 3/4	4	UNC	3.7500	3.5876	3.4433	3.4794	1 16	9.2143	9.6546
	4	4	UNC	4.0000	3.8376	3.6933	3.7294	1 11	10.6084	11.0805

[1] British: Effective diameter.
[2] Based on the average of the mean pitch and minor diameters of the external thread.
[3] See footnote 2, p. 43.

pitches or 3/16 inch, are given in table XV.33 to XV.36, inclusive.

4. CLASSIFICATION AND TOLERANCES

There are established for general use six distinct classes of screw-thread tolerances and allowances as specified in the following brief outline. These classes, together with the accompanying specifications, are for the purpose of insuring the interchangeable manufacture of screw-thread parts. This standard includes classes 1A, 2A, and 3A, applied to external threads only, and classes 1B, 2B, and 3B applied to internal threads only. The requirements for a screw-thread fit for specific applications can be met by specifying the proper combination of classes for the components. For example, an external thread made to class 2A limits can be used with tapped holes made to classes, 1B, 2B, or 3B limits for specific applications.

It is not the purpose of this standard to limit applications of the various standard classes. However, classes 2A and 2B were designed for the normal production of screws, bolts, and nuts, and so far as practicable such production should be limited to these classes. They are also suitable for a wide variety of other applications.

Thread sizes less than 1/4 inch have not been unified, but the Unified tolerances and allowances are applied to these sizes in the United States and Canada.

(a) GENERAL

The following general specifications apply to all classes specified for applications of the Unified form of thread.

1. UNIFORM MINIMUM INTERNAL THREAD.—The minimum major, pitch, and minor diameters of the internal thread are respectively the same for classes 1B, 2B, and 3B.

2. DIRECTION AND SCOPE OF TOLERANCES.—

(*a*) The tolerance on the internal thread is plus, and is applied from the basic size to above basic size.

TABLE XV.3.—*Basic dimensions, fine thread series*

UNF and NF

Designation			Basic major diameter, D	Basic pitch diameter, E	Minor diameter, external threads, K_s	Minor diameter, internal threads, K_n	Lead angle at basic pitch diameter, λ	Sectional area at minor diameter at $D-2h_b$	Tensile stress area [2]
Size [1]	Threads per inch, n	Thread symbol							
1	2	3	4	5	6	7	8	9	10
No. *in.*			*in.*	*in.*	*in.*	*in.*	*deg* *min*	*sq in.*	*sq in.*
0 0.060	80	NF	0.0600	0.0519	0.0447	0.0465	4 23	0.0015	0.0018
1 .073	72	NF	.0730	.0640	.0560	.0580	3 57	.0024	.0027
2 .086	64	NF	.0860	.0759	.0668	.0691	3 45	.0034	.0039
3 .099	56	NF	.0990	.0874	.0771	.0797	3 43	.0045	.0052
4 .112	48	NF	.1120	.0985	.0864	.0894	3 51	.0057	.0065
5 .125	44	NF	.1250	.1102	.0971	.1004	3 45	.0072	.0082
6 .138	40	NF	.1380	.1218	.1073	.1109	3 44	.0087	.0101
8 .164	36	NF	.1640	.1460	.1299	.1339	3 28	.0128	.0146
10 .190	32	NF	.1900	.1697	.1517	.1562	3 21	.0175	.0199
12 .216	28	NF	.2160	.1928	.1722	.1773	3 22	.0226	.0257
1/4	28	UNF	.2500	.2268	.2062	.2113	2 52	.0326	.0362
5/16	24	UNF	.3125	.2854	.2614	.2674	2 40	.0524	.0579
3/8	24	UNF	.3750	.3479	.3239	.3299	2 11	.0809	.0876
7/16	20	UNF	.4375	.4050	.3762	.3834	2 15	.1090	.1185
1/2	20	UNF	.5000	.4675	.4387	.4459	1 57	.1486	.1597
9/16	18	UNF	.5625	.5264	.4943	.5024	1 55	.1888	.2026
5/8	18	UNF	.6250	.5889	.5568	.5649	1 43	.2400	.2555
3/4	16	UNF	.7500	.7094	.6733	.6823	1 36	.3513	.3724
7/8	14	UNF	.8750	.8286	.7874	.7977	1 34	.4805	.5088
1	14	NF	1.0000	.9536	.9124	.9227	1 22	.6464	.6791
1	12	UNF	1.0000	.9459	.8978	.9098	1 36	.6245	.6624
1 1/8	12	UNF	1.1250	1.0709	1.0228	1.0348	1 25	.8118	.8549
1 1/4	12	UNF	1.2500	1.1959	1.1478	1.1598	1 16	1.0237	1.0721
1 3/8	12	UNF	1.3750	1.3209	1.2728	1.2848	1 9	1.2602	1.3137
1 1/2	12	UNF	1.5000	1.4459	1.3978	1.4098	1 3	1.5212	1.5799

[1] For sizes larger than 1 1/2 in., use the 12-thread series. See table XV. 6.
[2] Based on the average of the mean pitch and minor diameters of the external thread.

TABLE XV.4.—*Basic dimensions, extra-fine thread series*

UNEF and NEF

Designation			Basic major diameter, D	Basic pitch diameter,[1] E	Minor diameter, external threads, K_s	Minor diameter, internal threads, K_n	Lead angle at basic pitch diameter, λ	Sectional area at minor diameter at $D-2h_b$	Tensile stress area [2]
Size [3]	Threads per inch, n	Thread symbol							
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*deg* *min*	*sq in.*	*sq in.*
1/4	32	NEF	0.2500	0.2297	0.2117	0.2162	2 29	0.0344	0.0377
5/16	32	NEF	.3125	.2922	.2742	.2787	1 57	.0581	.0622
3/8	32	NEF	.3750	.3547	.3367	.3412	1 36	.0878	.0929
7/16	28	UNEF	.4375	.4143	.3937	.3988	1 34	.1201	.1270
1/2	28	UNEF	.5000	.4768	.4562	.4613	1 22	.1616	.1695
9/16	24	NEF	.5625	.5354	.5114	.5174	1 25	.2030	.2134
5/8	24	NEF	.6250	.5979	.5739	.5799	1 16	.2560	.2676
11/16	24	NEF	.6875	.6604	.6364	.6424	1 9	.3151	.3280
3/4	20	UNEF	.7500	.7175	.6887	.6959	1 16	.3685	.3855
13/16	20	UNEF	.8125	.7800	.7512	.7584	1 10	.4388	.4573
7/8	20	UNEF	.8750	.8425	.8137	.8209	1 5	.5153	.5352
15/16	20	UNEF	.9375	.9050	.8762	.8834	1 0	.5979	.6194
1	20	UNEF	1.0000	.9675	.9387	.9459	0 57	.6866	.7095
1 1/16	18	NEF	1.0625	1.0264	.9943	1.0024	0 59	.7702	.7973
1 1/8	18	NEF	1.1250	1.0889	1.0568	1.0649	0 56	.8705	.8993
1 3/16	18	NEF	1.1875	1.1514	1.1193	1.1274	0 53	.9770	1.0074
1 1/4	18	NEF	1.2500	1.2139	1.1818	1.1899	0 50	1.0895	1.1216
1 5/16	18	NEF	1.3125	1.2764	1.2443	1.2524	0 48	1.2082	1.2420
1 3/8	18	NEF	1.3750	1.3389	1.3068	1.3149	0 45	1.3330	1.3684
1 7/16	18	NEF	1.4375	1.4014	1.3693	1.3774	0 43	1.4640	1.5010
1 1/2	18	NEF	1.5000	1.4639	1.4318	1.4399	0 42	1.6011	1.6397
1 9/16	18	NEF	1.5625	1.5264	1.4943	1.5024	0 40	1.7444	1.7846
1 5/8	18	NEF	1.6250	1.5889	1.5568	1.5649	0 38	1.8937	1.9357
1 11/16	18	NEF	1.6875	1.6514	1.6193	1.6274	0 37	2.0493	2.0929

[1] British: Effective diameter.
[2] Based on the average of the mean pitch and minor diameters of the external thread.
[3] For sizes larger than 1 11/16 in., use 16-thread series. See table XV. 7.

TABLE XV.5.—*Basic dimensions, 8-thread series* 8UN and 8N

Designation			Basic major diameter, D	Basic pitch diameter, E	Minor diameter, external threads, K_s	Minor diameter, internal threads, K_n	Lead angle at basic pitch diameter, λ	Sectional area at minor diameter at $D-2h_b$	Tensile-stress area [2]
Size [1]	Threads per inch, n	Thread symbol							
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*deg min*	*sq in.*	*sq in.*
1 1/8	8	N	1.1250	1.0438	0.9716	0.9897	2 11	0.7277	0.7896
1 1/4	8	N	1.2500	1.1688	1.0966	1.1147	1 57	.9290	.9985
1 3/8	8	N	1.3750	1.2938	1.2216	1.2397	1 46	1.1548	1.2319
1 1/2	8	N	1.5000	1.4188	1.3466	1.3647	1 36	1.4052	1.4899
1 5/8	8	N	1.6250	1.5438	1.4716	1.4897	1 29	1.6801	1.7723
1 3/4	8	UN	1.7500	1.6688	1.5966	1.6147	1 22	1.9796	2.0792
1 7/8	8	N	1.8750	1.7938	1.7216	1.7397	1 16	2.3036	2.4107
2	8	UN	2.0000	1.9188	1.8466	1.8647	1 11	2.6521	2.7665
2 1/8	8	N	2.1250	2.0438	1.9716	1.9897	1 7	3.0252	3.1469
2 1/4	8	UN	2.2500	2.1688	2.0966	2.1147	1 3	3.4228	3.5519
2 1/2	8	UN	2.5000	2.4188	2.3466	2.3647	0 57	4.2917	4.4352
2 3/4	8	UN	2.7500	2.6688	2.5966	2.6147	0 51	5.2588	5.4164
3	8	UN	3.0000	2.9188	2.8466	2.8647	0 47	6.3240	6.4957
3 1/4	8	UN	3.2500	3.1688	3.0966	3.1147	0 43	7.4874	7.6738
3 1/2	8	UN	3.5000	3.4188	3.3466	3.3647	0 40	8.7490	8.9504
3 3/4	8	UN	3.7500	3.6688	3.5966	3.6147	0 37	10.1088	10.3249
4	8	UN	3.0000	3.9188	3.8466	3.8647	0 35	11.5667	11.7975
4 1/4	8	UN	4.2500	4.1688	4.0966	4.1147	0 33	13.1228	13.3683
4 1/2	8	UN	4.5000	4.4188	4.3466	4.3647	0 31	14.7771	15.0372
4 3/4	8	UN	4.7500	4.6688	4.5966	4.6147	0 29	16.5295	16.8042
5	8	UN	5.0000	4.9188	4.8466	4.8647	0 28	18.3802	18.6694
5 1/4	8	UN	5.2500	5.1688	5.0966	5.1147	0 26	20.3290	20.6330
5 1/2	8	UN	5.5000	5.4188	5.3466	5.3647	0 25	22.3760	22.6945
5 3/4	8	UN	5.7500	5.6688	5.5966	5.6147	0 24	24.5211	24.8541
6	8	UN	6.0000	5.9188	5.8466	5.8647	0 23	26.7645	27.1118

[1] The 1″-8 size is in the coarse thread series, table XV. 2. [2] Based on the average of the mean pitch and minor diameters of the external thread.

TABLE XV.6.—*Basic dimensions, 12-thread series* 12UN and 12N

Designation			Basic major diameter, D	Basic pitch diameter, E	Minor diameter, external threads, K_s	Minor diameter, internal threads, K_n	Lead angle at basic pitch diameter, λ	Sectional area at minor diameter at $D-2h_b$	Tensile stress area [2]
Size [1]	Threads per inch, n	Thread symbol							
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*deg min*	*sq in.*	*sq in.*
1 1/16	12	UN	1.0625	1.0084	0.9603	0.9723	1 30	0.7151	0.7556
1 3/16	12	UN	1.1875	1.1334	1.0853	1.0973	1 20	.9147	.9604
1 5/16	12	UN	1.3125	1.2584	1.2103	1.2223	1 12	1.1389	1.1898
1 7/16	12	UN	1.4375	1.3834	1.3353	1.3473	1 6	1.3876	1.4438
1 5/8	12	N	1.6250	1.5709	1.5228	1.5348	0 58	1.8067	1.8701
1 3/4	12	UN	1.7500	1.6959	1.6478	1.6598	0 54	2.1168	2.1853
1 7/8	12	N	1.8750	1.8209	1.7728	1.7848	0 50	2.4514	2.5250
2	12	UN	2.0000	1.9459	1.8978	1.9098	0 47	2.8106	2.8892
2 1/8	12	N	2.1250	2.0709	2.0228	2.0348	0 44	3.1943	3.2779
2 1/4	12	UN	2.2500	2.1959	2.1478	2.1598	0 42	3.6025	3.6914
2 3/8	12	N	2.3750	2.3209	2.2728	2.2848	0 39	4.0353	4.1291
2 1/2	12	UN	2.5000	2.4459	2.3978	2.4098	0 37	4.4927	4.5916
2 5/8	12	N	2.6250	2.5709	2.5228	2.5348	0 35	4.9745	5.0784
2 3/4	12	UN	2.7500	2.6959	2.6478	2.6598	0 34	5.4810	5.5900
2 7/8	12	N	2.8750	2.8209	2.7728	2.7848	0 32	6.0119	6.1259
3	12	UN	3.0000	2.9459	2.8978	2.9098	0 31	6.5674	6.6865
3 1/8	12	N	3.1250	3.0709	3.0228	3.0348	0 30	7.1475	7.2714
3 1/4	12	UN	3.2500	3.1959	3.1478	3.1598	0 29	7.7521	7.8812
3 3/8	12	N	3.3750	3.3209	3.2728	3.2848	0 27	8.3812	8.5152
3 1/2	12	UN	3.5000	3.4459	3.3978	3.4098	0 26	9.0349	9.1740
3 5/8	12	N	3.6250	3.5709	3.5228	3.5348	0 26	9.7132	9.8570
3 3/4	12	UN	3.7500	3.6959	3.6478	3.6598	0 25	10.4159	10.5649
3 7/8	12	N	3.8750	3.8209	3.7728	3.7848	0 24	11.1433	11.2970
4	12	UN	4.0000	3.9459	3.8978	3.9098	0 23	11.8951	12.0540
4 1/4	12	UN	4.2500	4.1959	4.1478	4.1598	0 22	13.4725	13.6411
4 1/2	12	UN	4.5000	4.4459	4.3978	4.4098	0 21	15.1480	15.3265
4 3/4	12	UN	4.7500	4.6959	4.6478	4.6598	0 19	16.9217	17.1099
5	12	UN	5.0000	4.9459	4.8978	4.9098	0 18	18.7936	18.9916
5 1/4	12	UN	5.2500	5.1959	5.1478	5.1598	0 18	20.7636	20.9717
5 1/2	12	UN	5.5000	5.4459	5.3978	5.4098	0 17	22.8319	23.0496
5 3/4	12	UN	5.7500	5.6959	5.6478	5.6598	0 16	24.9983	25.2257
6	12	UN	6.0000	5.9459	5.8978	5.9098	0 15	27.2628	27.4998

[1] For sizes less than 1 1/16 in. and for intermediate sizes from 1 1/16 to 1 5/8 in., see the fine thread series, table XV 3.
[2] Based on the average of the mean pitch and minor diameters of the external thread.

TABLE XV.7.—*Basic dimensions, 16-thread series*

16UN and 16N

Designation			Basic major diameter, D	Basic pitch diameter, E	Minor diameter, external threads, K_s	Minor diameter, internal threads, K_n	Lead angle at basic pitch diameter, λ	Sectional area at minor diameter at $D-2h_b$	Tensile stress area [2]
Size [1]	Threads per inch, n	Thread symbol							
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*deg min*	*sq in.*	*sq in.*
1 3/4	**16**	**UN**	**1.7500**	**1.7094**	**1.6733**	**1.6823**	**0 40**	**2.1873**	**2.2382**
1 13/16	16	N	1.8125	1.7719	1.7358	1.7448	0 39	2.3542	2.4070
1 7/8	16	N	1.8750	1.8344	1.7983	1.8073	0 37	2.5272	2.5819
1 15/16	16	N	1.9375	1.8969	1.8608	1.8698	0 36	2.7064	2.7629
2	**16**	**UN**	**2.0000**	**1.9594**	**1.9233**	**1.9323**	**0 35**	**2.8917**	**2.9501**
2 1/16	16	N	2.0625	2.0219	1.9858	1.9948	0 34	3.0831	3.1434
2 1/8	16	N	2.1250	2.0844	2.0483	2.0573	0 33	3.2807	3.3427
2 3/16	16	N	2.1875	2.1469	2.1108	2.1198	0 32	3.4844	3.5483
2 1/4	**16**	**UN**	**2.2500**	**2.2094**	**2.1733**	**2.1823**	**0 31**	**3.6943**	**3.7601**
2 5/16	16	N	2.3125	2.2719	2.2358	2.2448	0 30	3.9103	3.9780
2 3/8	16	N	2.3750	2.3344	2.2983	2.3073	0 29	4.1324	4.2018
2 7/16	16	N	2.4375	2.3969	2.3608	2.3698	0 29	4.3606	4.4319
2 1/2	**16**	**UN**	**2.5000**	**2.4594**	**2.4233**	**2.4323**	**0 28**	**4.5950**	**4.6682**
2 5/8	16	N	2.6250	2.5844	2.5483	2.5573	0 26	5.0822	5.1790
2 3/4	**16**	**UN**	**2.7500**	**2.7094**	**2.6733**	**2.6823**	**0 25**	**5.5940**	**5.6745**
2 7/8	16	N	2.8750	2.8344	2.7983	2.8073	0 24	6.1303	6.2143
3	**16**	**UN**	**3.0000**	**2.9594**	**2.9233**	**2.9323**	**0 23**	**6.6911**	**6.7789**
3 1/8	16	N	3.1250	3.0844	3.0483	3.0573	0 22	7.2765	7.3678
3 1/4	**16**	**UN**	**3.2500**	**3.2094**	**3.1733**	**3.1823**	**0 21**	**7.8864**	**7.9814**
3 3/8	16	N	3.3750	3.3344	3.2983	3.3073	0 21	8.5209	8.6194
3 1/2	**16**	**UN**	**3.5000**	**3.4594**	**3.4233**	**3.4323**	**0 20**	**9.1799**	**9.2821**
3 5/8	16	N	3.6250	3.5844	3.5483	3.5573	0 19	9.8634	9.9691
3 3/4	**16**	**UN**	**3.7500**	**3.7094**	**3.6733**	**3.6823**	**0 18**	**10.5715**	**10.6809**
3 7/8	16	N	3.8750	3.8344	3.7983	3.8073	0 18	11.3042	11.4170
4	**16**	**UN**	**4.0000**	**3.9594**	**3.9233**	**3.9323**	**0 17**	**12.0614**	**12.1779**
4 1/4	**16**	**UN**	**4.2500**	**4.2094**	**4.1733**	**4.1823**	**0 16**	**13.6494**	**13.7730**
4 1/2	**16**	**UN**	**4.5000**	**4.4594**	**4.4233**	**4.4323**	**0 15**	**15.3355**	**15.4662**
4 3/4	**16**	**UN**	**4.7500**	**4.7094**	**4.6733**	**4.6823**	**0 15**	**17.1199**	**17.2575**
5	**16**	**UN**	**5.0000**	**4.9594**	**4.9233**	**4.9323**	**0 14**	**19.0024**	**19.1470**
5 1/4	**16**	**UN**	**5.2500**	**5.2094**	**5.1733**	**5.1823**	**0 13**	**20.9831**	**21.1350**
5 1/2	**16**	**UN**	**5.5000**	**5.4594**	**5.4233**	**5.4323**	**0 13**	**23.0620**	**23.2208**
5 3/4	**16**	**UN**	**5.7500**	**5.7094**	**5.6733**	**5.6823**	**0 12**	**25.2390**	**25.4047**
6	**16**	**UN**	**6.0000**	**5.9594**	**5.9233**	**5.9323**	**0 11**	**27.5142**	**27.6868**

[1] For sizes less than **1 3/4** in., see the extra-fine-thread series, table XV.4.
[2] Based on the average of the mean pitch and minor diameters of the external thread.

(*b*) The tolerance on the external thread is minus, and is applied from the maximum (or design) size to below the maximum size.

(*c*) The tolerances specified represent the extreme variations permitted on the product.

3. BASIC FORMULA FOR ALLOWANCES AND TOLERANCES.—The basic formula, from which allowances on all diameters and tolerances on pitch diameter are derived, is:

$$\text{Tolerance (or allowance)} = C(0.0015\ \sqrt[3]{D} + 0.0015\ \sqrt{L_e} + 0.015\ \sqrt[3]{p^2}),$$

where

C=a factor which differs for each allowance or tolerance for each class
D=basic major diameter
L_e=length of engagement
p=pitch.

This formula is based on the accuracy of present-day threading practice, and is applicable to all reasonable combinations of diameter, pitch, and length of engagement. Numerical values of the increments in the formula for standard diameters, pitches, and lengths of engagement are given in table XV.8.

4. ALLOWANCES.—Allowances are applied only to external threads. The values of the factor C (par. 3 above) for allowances are as follows:

Class	Factor C
1A	0.300
2A	.300
3A	.000

5. PITCH DIAMETER[4] TOLERANCES.—(*a*) *Values of factor C.*—The values of the factor C (par. 3 above) for pitch diameter tolerances are as follows:

[4] The British designation for "pitch diameter" is "effective diameter."

Class	Factor C
1A	1. 500
1B	1. 950
2A	1. 000
2B	1. 300
3A	. 750
3B	. 975

It will be noted that the factor C is 30 percent greater for internal than for external threads of a given class number on account of the relative difficulties of manufacture.

(*b*) *Tolerances cumulative.*—The tolerances on pitch diameter are cumulative, that is, they include the variations of lead and angle. Therefore, the full tolerance is not available for pitch diameter unless the lead and angle of the thread are perfect.

(*c*) *Length of engagement.*—The tolerances on pitch diameter for the coarse and fine thread series are based on a length of engagement equal to the basic major diameter.

6. Major Diameter Tolerances.—(*a*) *External threads.*—The tolerance on major diameter for class 1A is equal to $0.09\sqrt[3]{p^2}$ and for classes 2A and 3A is equal to $0.06\sqrt[3]{p^2}$. Tolerances equal to $0.09\sqrt[3]{p^2}$ are provided for class 2A coarse and 8-thread series threads of unfinished, hot-rolled material.

(*b*) *Internal threads.*—No tolerance is specified, as the maximum major diameter is established by the crest of an unworn tool. See footnotes to tables.

7. Minor Diameter Tolerances.—(*a*) *External threads.*—No tolerance is specified, as the minimum minor diameter is established by the crest of an unworn tool. See footnotes to tables.

(*b*) *Internal threads.*—The tolerance on minor diameter for a given size and pitch of thread is the same for all classes.

For all Unified coarse and fine series threads 1 inch and larger in size, the tolerance is equal to $0.120p$. For sizes less than 1 inch in size, most tolerances are larger than $0.120p$ to minimize tapping difficulties.

Table XV.8.—*Increments in pitch-diameter tolerance formula* [1]

(PD tolerance $=C(0.0015\sqrt[3]{D}+0.0015\sqrt{L_e}+0.015\sqrt[3]{p^2})$)

Diameter						Length of engagement								Pitch	
D	$0.0015\sqrt[3]{D}$	D	$0.0015\sqrt[3]{D}$	D	$0.0015\sqrt[3]{D}$	L_e	$0.0015\sqrt{L_e}$	L_e	$0.0015\sqrt{L_e}$	L_e	$0.0015\sqrt{L_e}$	L_e	$0.0015\sqrt{L_e}$	Threads per inch	$0.015\sqrt[3]{p^2}$
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*		*in.*
0. 0600	0. 000587	1. 3125	0. 001642	3. 8750	0. 002356	0. 0600	0. 000367	0. 3214	0. 000850	1. 2500	0. 001677	4. 2500	0. 003092	80	0. 000808
. 0625	. 000595	1. 3750	. 001668	4. 0000	. 002381	. 0625	. 000375	. 3281	. 000859	1. 2857	. 001701	4. 3750	. 003137	72	. 000867
. 0730	. 000627	1. 4375	. 001693	4. 2500	. 002430	. 0730	. 000405	. 3438	. 000880	1. 3125	. 001718	4. 5000	. 003182	64	. 000938
. 0860	. 000662	1. 5000	. 001717	4. 5000	. 002476	. 0781	. 000419	. 3571	. 000896	1. 3750	. 001759	4. 6250	. 003226	56	. 001025
. 0938	. 000682	1. 5625	. 001741	4. 7500	. 002521	. 0860	. 000440	. 3594	. 000899	1. 4286	. 001793	4. 7500	. 003269	48	. 001136
. 0990	. 000694	1. 6250	. 001764	5. 0000	. 002565	. 0938	. 000459	. 3750	. 000919	1. 4375	. 001798	4. 8750	. 003312	44	. 001204
. 1120	. 000723	1. 6875	. 001786	5. 2500	. 002607	. 0990	. 000472	. 3906	. 000937	1. 5000	. 001837	5. 0000	. 003354	40	. 001282
. 1250	. 000750	1. 7500	. 001808	5. 5000	. 002648	. 1094	. 000496	. 4063	. 000956	1. 6250	. 001912	5. 1250	. 003396	36	. 001376
. 1380	. 000775	1. 8125	. 001829	5. 7500	. 002687	. 1120	. 000502	. 4167	. 000968	1. 6667	. 001936	5. 2500	. 003437	32	. 001488
. 1640	. 000821	1. 8750	. 001850	6. 0000	. 002726	. 1125	. 000503	. 4219	. 000974	1. 7500	. 001984	5. 3750	. 003478	28	. 001627
. 1875	. 000859	1. 9375	. 001870	7. 0000	. 002869	. 1250	. 000530	. 4375	. 000992	1. 8750	. 002054	5. 5000	. 003518	24	. 001803
. 1900	. 000862	2. 0000	. 001890	8. 0000	. 003000	. 1380	. 000557	. 4500	. 001006	2. 0000	. 002121	5. 6250	. 003558	20	. 002036
. 2160	. 000900	2. 0625	. 001909	9. 0000	. 003120	. 1406	. 000562	. 5000	. 001061	2. 1250	. 002187	5. 7500	. 003597	18	. 002184
. 2500	. 000945	2. 1250	. 001928	10. 0000	. 003232	. 1563	. 000593	. 5556	. 001118	2. 2500	. 002250	5. 8750	. 003636	16	. 002362
. 3125	. 001018	2. 1875	. 001947	12. 0000	. 003434	. 1607	. 000601	. 5625	. 001125	2. 3750	. 002312	6. 0000	. 003674	14	. 002582
. 3750	. 001082	2. 2500	. 001966	14. 0000	. 003615	. 1640	. 000607	. 6250	. 001186	2. 5000	. 002372	6. 5000	. 003824	13	. 002713
. 4375	. 001139	2. 3125	. 001984	16. 0000	. 003780	. 1719	. 000622	. 6429	. 001203	2. 6250	. 002430	7. 0000	. 003969	12	. 002862
. 5000	. 001191	2. 3750	. 002001	18. 0000	. 003931	. 1875	. 000650	. 6875	. 001244	2. 7500	. 002487	7. 5000	. 004108	11	. 003033
. 5625	. 001238	2. 4375	. 002019	20. 0000	. 004072	. 1900	. 000654	. 7143	. 001268	2. 8750	. 002543	8. 0000	. 004243	10	. 003232
. 6250	. 001282	2. 5000	. 002036	24. 0000	. 004327	. 2031	. 000676	. 7500	. 001299	3. 0000	. 002598	8. 5000	. 004373	9	. 003467
. 6875	. 001324	2. 6250	. 002069	------	------	. 2160	. 000697	. 8125	. 001352	3. 1250	. 002652	9. 0000	. 004500	8	. 003750
. 7500	. 001363	2. 7500	. 002102	------	------	. 2188	. 000702	. 8333	. 001369	3. 2500	. 002704	9. 5000	. 004623	7	. 004099
. 8125	. 001400	2. 8750	. 002133	------	------	. 2250	. 000712	. 8750	. 001403	3. 3333	. 002739	10. 0000	. 004743	6	. 004543
. 8750	. 001435	3. 0000	. 002163	------	------	. 2344	. 000726	. 9000	. 001423	3. 3750	. 002756	10. 5000	. 004861	5	. 005130
. 9375	. 001468	3. 1250	. 002193	------	------	. 2500	. 000750	. 9375	. 001452	3. 5000	. 002806	11. 0000	. 004975	4½	. 005503
1. 0000	. 001500	3. 2500	. 002222	------	------	. 2656	. 000773	1. 0000	. 001500	3. 6250	. 002856	11. 5000	. 005087	4	. 005953
1. 0625	. 001531	3. 3750	. 002250	------	------	. 2778	. 000791	1. 0625	. 001546	3. 7500	. 002905	12. 0000	. 005196	------	------
1. 1250	. 001560	3. 5000	. 002277	------	------	. 2813	. 000796	1. 1111	. 001581	3. 8750	. 002953	------	------	------	------
1. 1875	. 001588	3. 6250	. 002304	------	------	. 2969	. 000817	1. 1250	. 001591	4. 0000	. 003000	------	------	------	------
1. 2500	. 001616	3. 7500	. 002330	------	------	. 3125	. 000839	1. 1875	. 001635	4. 1250	. 003047	------	------	------	------

[1] For class 2A, $C=1$. For other classes, values of C are given above.

(b) SCREW-THREAD CLASSES

1. Classes 1A and 1B.—(*a*) *Definition.*—The combination of classes 1A and 1B is intended to cover the manufacture of threaded parts where quick and easy assembly is necessary, and where an allowance is required to permit ready assembly, even when the threads are slightly bruised or dirty.

(*b*) *Allowances and tolerances.*—Allowances and tolerances for the respective thread series are specified in tables and their application is shown in figure XV.2.

2. Classes 2A and 2B.—(*a*) *Definition.*—Class 2A for external threads and 2B for internal threads are standards designed for screws, bolts, and nuts. They are also suitable for a wide variety of other applications. A moderate allowance is provided which minimizes galling and seizure encountered in assembly and use; it also accommodates platings, finishes, or coatings. (Where the allowance is not sufficient for thicknesses of plating or coating required, special provisions are necessary.) The maximum dimensions of threads which are electroplated or have coatings of similar thickness are increased by the amount of the allowance.

(*b*) *Allowances and tolerances.*—Allowances and tolerances for the respective thread series are specified in tables and their application is shown in figure XV.2. Comparisons of the resulting pitch diameter limits with those of American National class 2 are shown in figures XV.4 and XV.5.

3. Classes 3A and 3B.—(*a*) *Definition.*—Class 3A for external threads and class 3B for internal threads provides a class for such applications where closeness of fit and accuracy of lead and angle of thread are important. They are obtainable consistently only by the use of high quality production equipment supported by a very efficient system of gaging and inspection.

(*b*) *Allowances*[5] *and tolerances.*—No allowance is provided, but since the tolerances on "go" gages are within the limits of size of the product, the gages will assure a slight clearance between product made to the maximum-metal limits. Tolerances for the respective thread series are specified in tables and their application is shown in figure XV.3. Comparisons of the resulting pitch diameter limits with those of American National class 3 are shown in figures XV.6 and XV.7.

5. METHOD OF DESIGNATING A SCREW THREAD

The method of designating a screw thread 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 per inch, all in Arabic characters, and followed by the class designation in Arabic numerals, with or without pitch diameter tolerances or limits of size.

An example of an external thread designation and its meaning is given below:

Example: ¼″—20 UNC—2A

Class.

Thread series (see tables).

Number of threads per inch (n).

Nominal size.

A left-hand thread shall be identified by the letters "LH" following the class designation. If no such designation is used, the thread will be understood to be right hand. An example of a left-hand external thread designation is:

Example: ¼″—20 UNC—2A—LH

Left hand.

Class.

Thread series (see tables).

Number of threads per inch (n).

Nominal size.

If a standard thread is modified by the inclusion of some nonstandard feature, such as a smaller major diameter, etc., the word "modified" should be added with an asterisk and the nonstandard feature or dimension of the thread should be enclosed in brackets and likewise marked with an asterisk. If a standard thread has a long length of engagement for which standard allowances and tolerances are not applicable, such special length should be noted on the drawing or included in the designation, as for example:

Example: ¾″—16 UNF—2A (1½″ length of engagement)

With reference to this example, tolerances and allowances for the UNF Series are calculated for a length of engagement equal to the nominal diameter. When the length of engagement exceeds 1½ times the nominal diameter, tolerances and allowances should be obtained from the special thread step tables, tables XVI.3 to XVI.8, inclusive, if applicable, or computed from the formulas, constants for which are given in table XV.8, p. 50. In this example, the tolerance for pitch diameter should be 0.0056 and the allowance, 0.0017 (corresponding to increases of 0.0006 and 0.0002, respectively, over the table XV.17 values for a length of engagement equal to the nominal diameter).

For screw threads of Unified thread form but of special diameters, pitches, and lengths of engagement, see section XVI.

[5] A possible slight interference of metal may occur at the crest corners at the major diameter when a British-made minimum internal thread is assembled with a maximum American-made class 3A external thread having a flat crest.

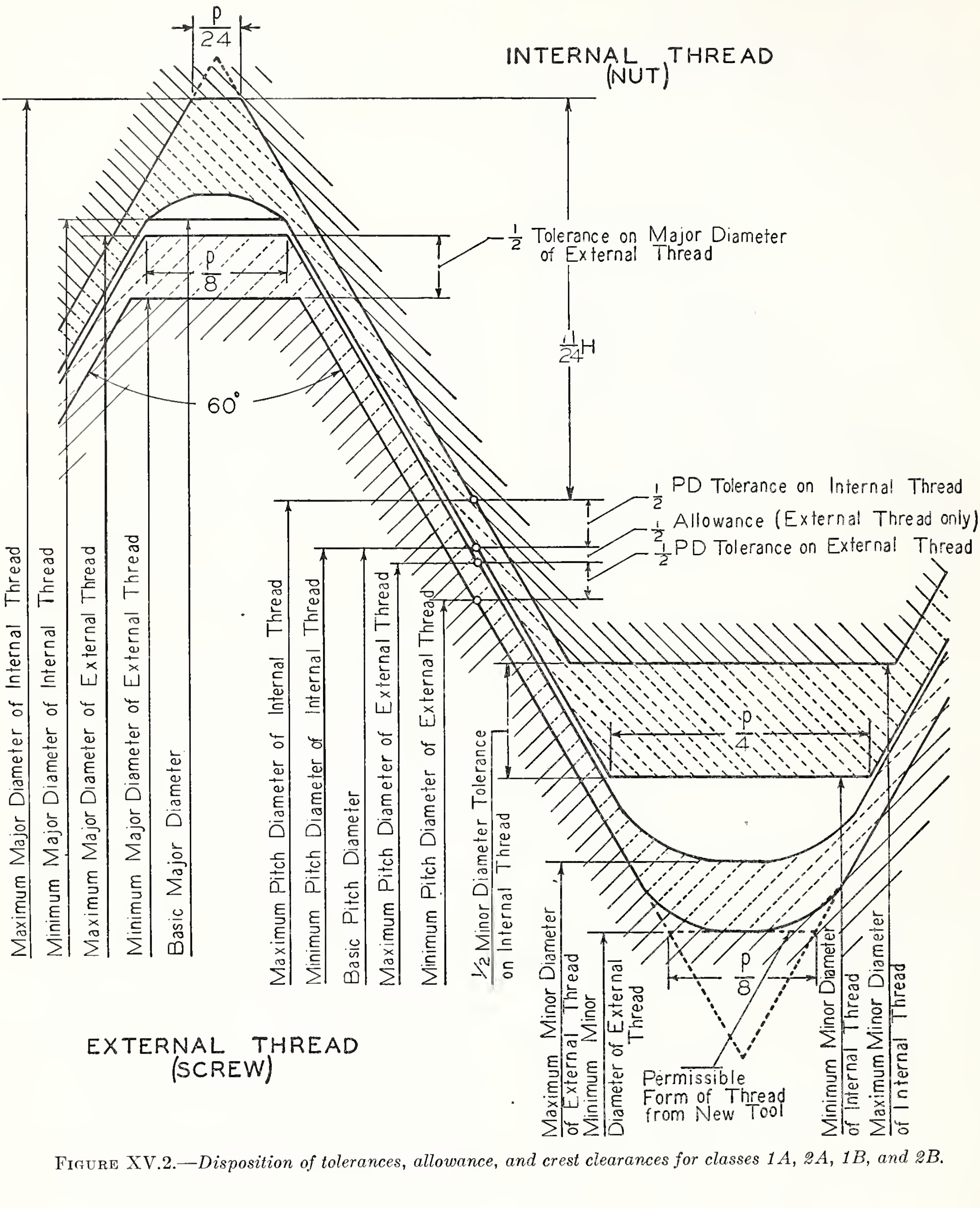

FIGURE XV.2.—*Disposition of tolerances, allowance, and crest clearances for classes 1A, 2A, 1B, and 2B.*

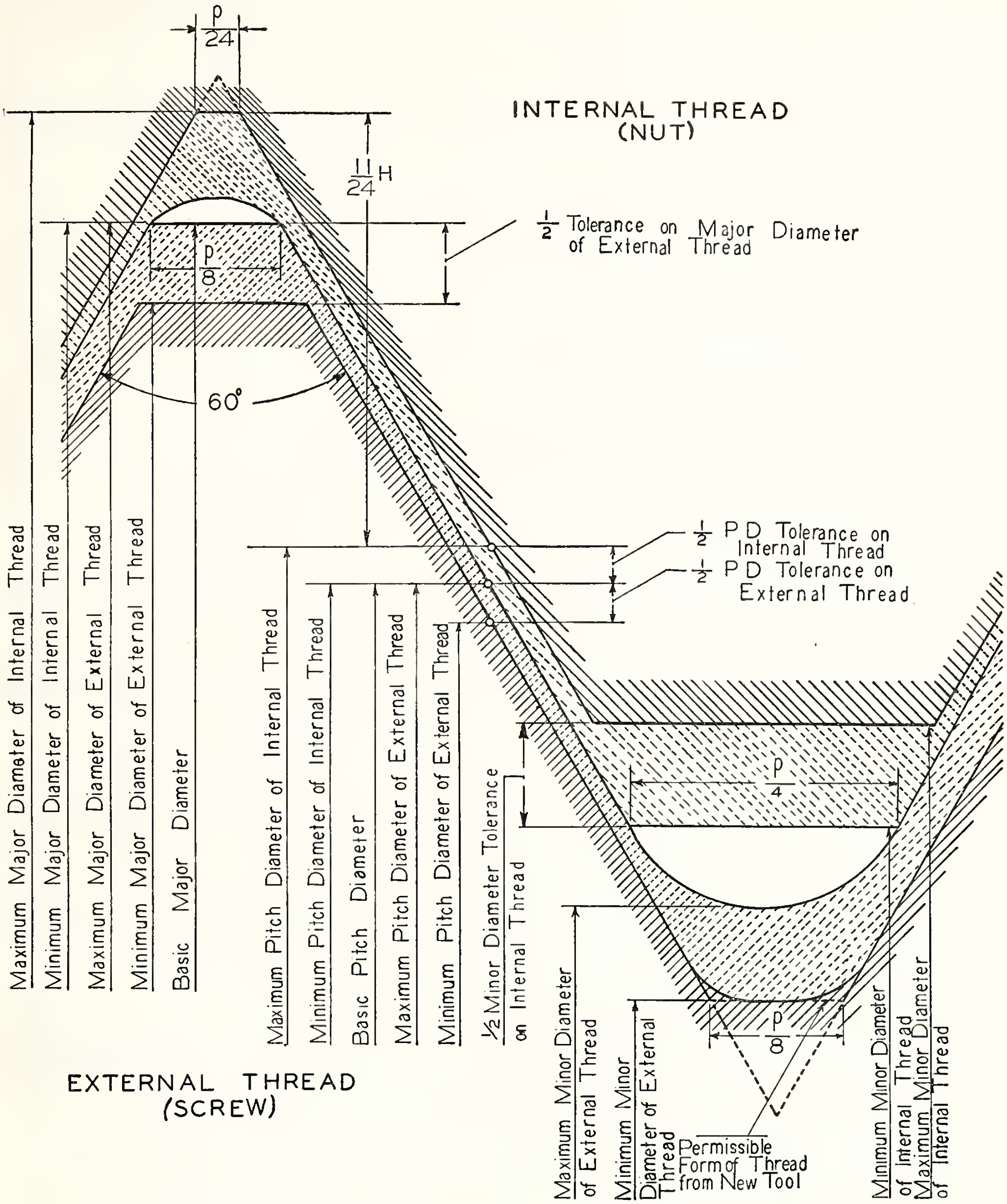

FIGURE XV.3.—*Disposition of tolerances and crest clearances for classes 3A and 3B.*

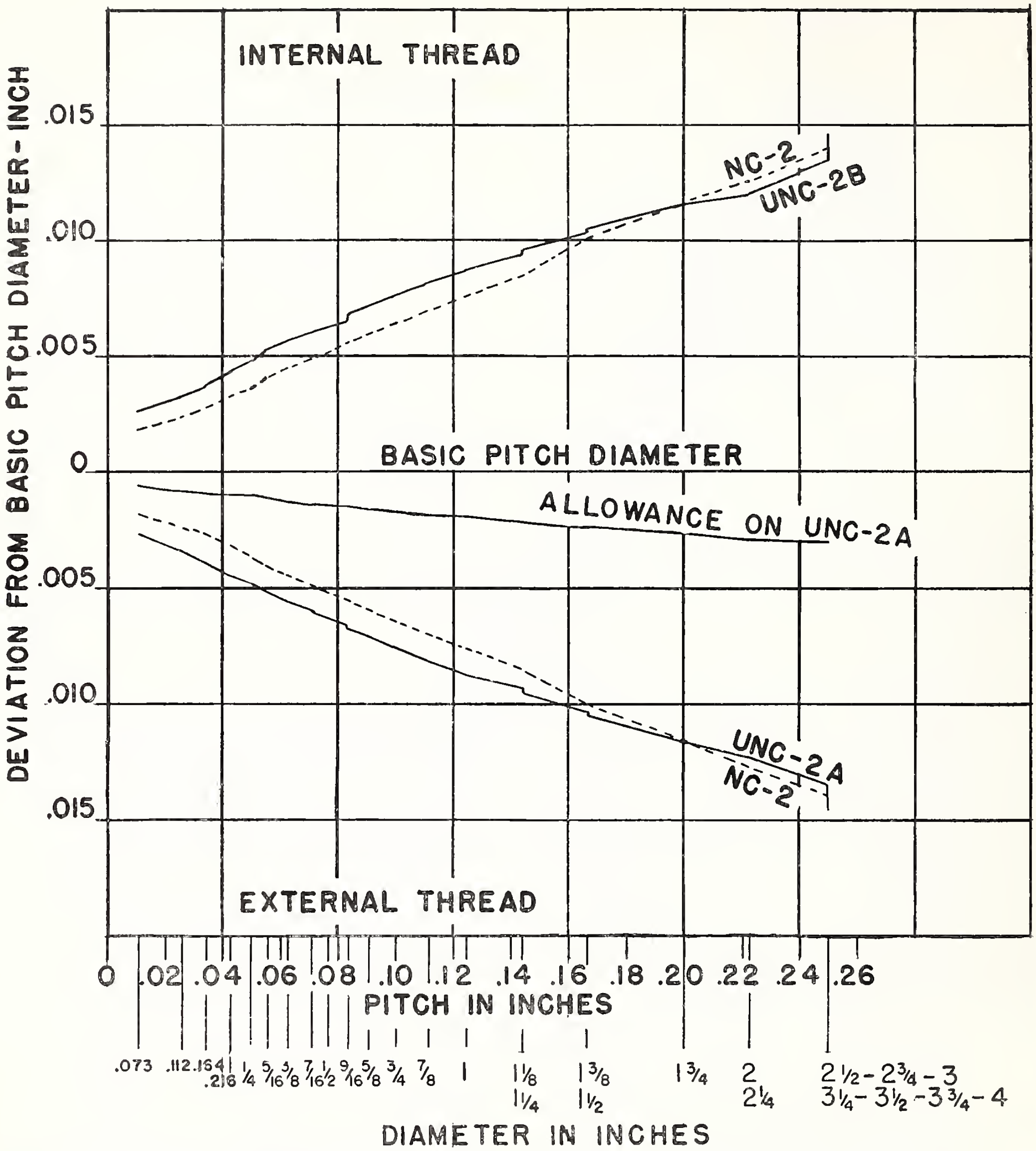

FIGURE XV.4.—*Comparison of Unified classes 2A and 2B with American National class 2, coarse thread series.*

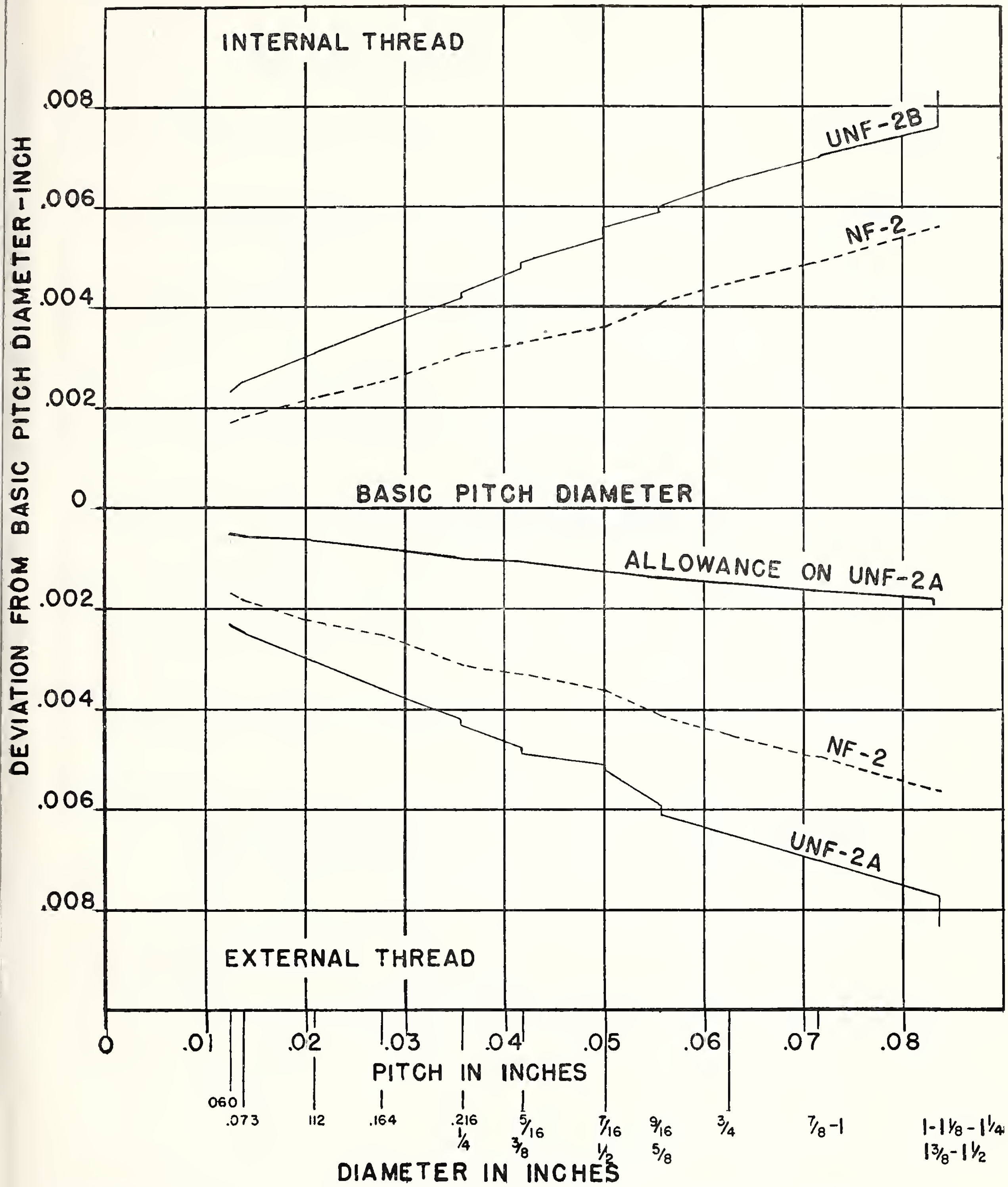

FIGURE XV.5.—*Comparison of Unified classes 2A and 2B with American National class 2, fine thread series.*

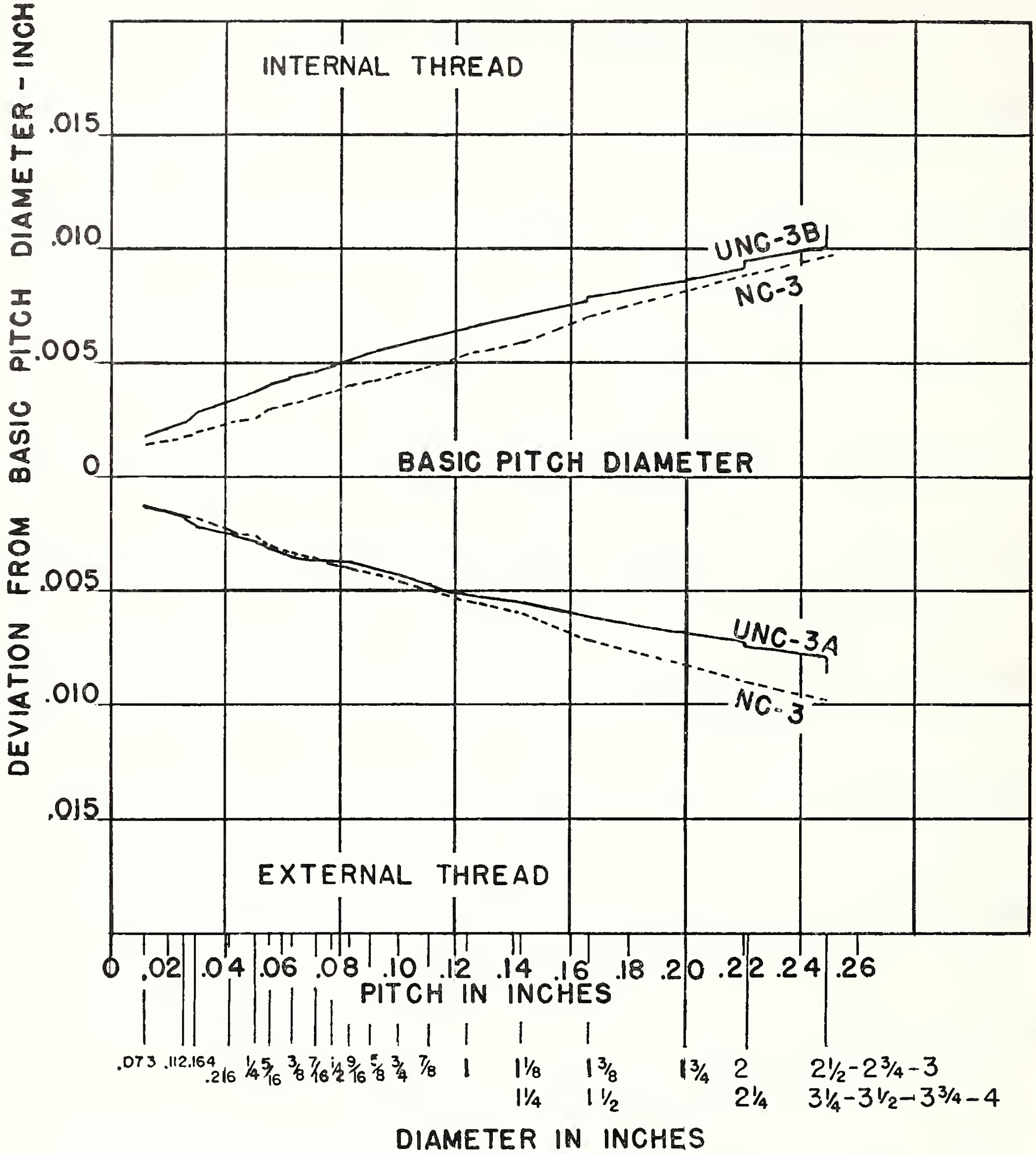

FIGURE XV.6.—*Comparison of Unified classes 3A and 3B with American National class 3, coarse thread series.*

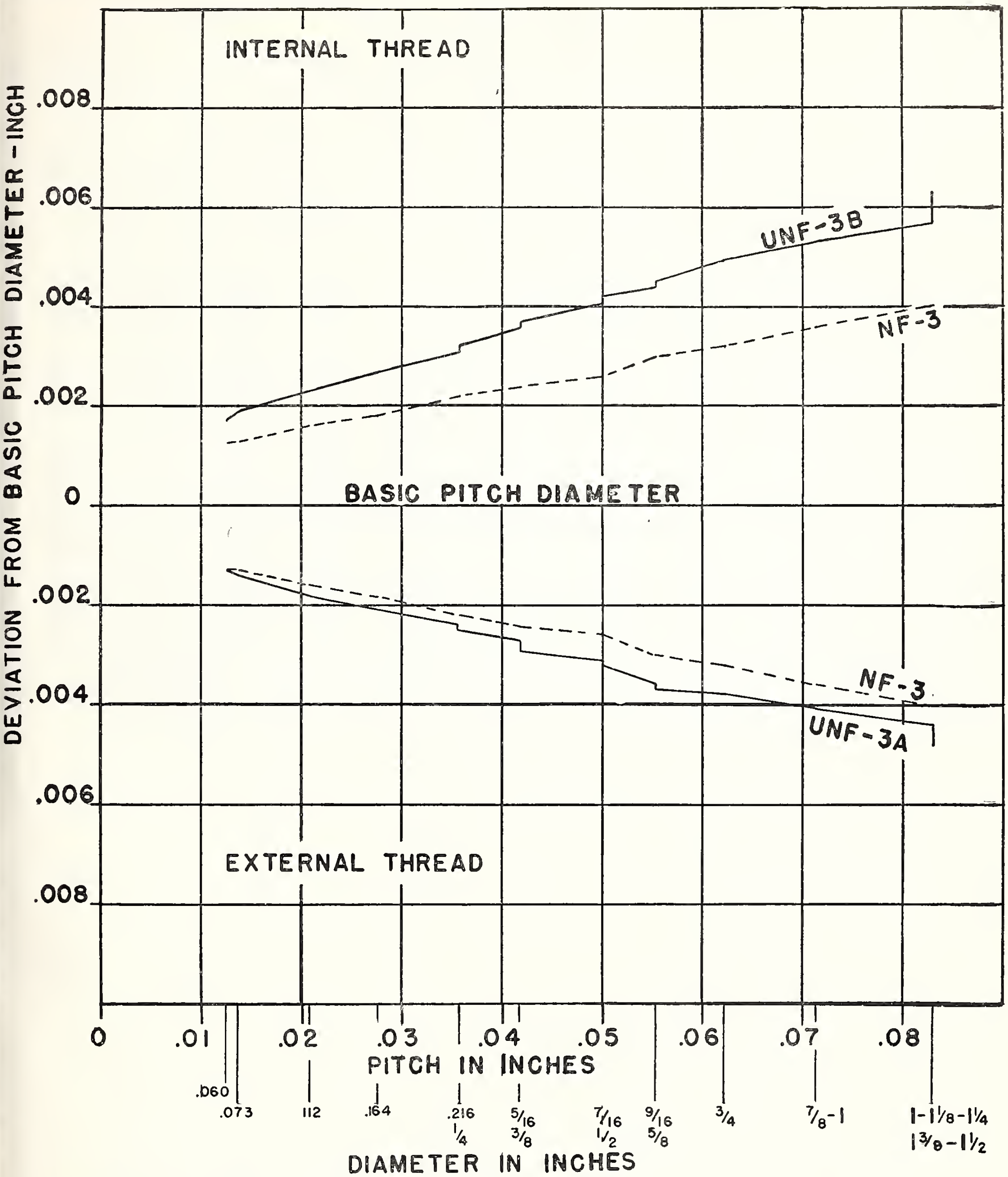

FIGURE XV.7.—*Comparison of Unified classes 3A and 3B with American National class 3, fine thread series.*

TABLE XV.9.—*Limits of size, coarse-thread series, external threads, class 1A*

UNC–1A and NC–1A

Designation			External thread limits of size [1]							
				Major diameter			Pitch diameter			
Size	Threads per inch	Thread symbol	Allowance	Limits		Tolerance	Limits		Tolerance	Minor diameter, ref.[2]
				Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10	11
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	20	UNC–1A	0.0011	0.2489	0.2367	0.0122	0.2164	0.2108	0.0056	0.1876
5/16	18	UNC–1A	.0012	.3113	.2982	.0131	.2752	.2691	.0061	.2431
3/8	16	UNC–1A	.0013	.3737	.3595	.0142	.3331	.3266	.0065	.2970
7/16	14	UNC–1A	.0014	.4361	.4206	.0155	.3897	.3826	.0071	.3485
1/2	13	NC–1A	.0015	.4985	.4822	.0163	.4485	.4411	.0074	.4041
1/2	12	UNC–1A	.0015	.4985	.4813	.0172	.4444	.4367	.0077	.3963
9/16	12	UNC–1A	.0016	.5609	.5437	.0172	.5068	.4990	.0078	.4587
5/8	11	UNC–1A	.0016	.6234	.6052	.0182	.5644	.5561	.0083	.5119
3/4	10	UNC–1A	.0018	.7482	.7288	.0194	.6832	.6744	.0088	.6255
7/8	9	UNC–1A	.0019	.8731	.8523	.0208	.8009	.7914	.0095	.7368
1	8	UNC–1A	.0020	.9980	.9755	.0225	.9168	.9067	.0101	.8446
1 1/8	7	UNC–1A	.0022	1.1228	1.0982	.0246	1.0300	1.0191	.0109	.9475
1 1/4	7	UNC–1A	.0022	1.2478	1.2232	.0246	1.1550	1.1439	.0111	1.0725
1 3/8	6	UNC–1A	.0024	1.3726	1.3453	.0273	1.2643	1.2523	.0120	1.1681
1 1/2	6	UNC–1A	.0024	1.4976	1.4703	.0273	1.3893	1.3772	.0121	1.2931
1 3/4	5	UNC–1A	.0027	1.7473	1.7165	.0308	1.6174	1.6040	.0134	1.5019
2	4 1/2	UNC–1A	.0029	1.9971	1.9641	.0330	1.8528	1.8385	.0143	1.7245
2 1/4	4 1/2	UNC–1A	.0029	2.2471	2.2141	.0330	2.1028	2.0882	.0146	1.9745
2 1/2	4	UNC–1A	.0031	2.4969	2.4612	.0357	2.3345	2.3190	.0155	2.1902
2 3/4	4	UNC–1A	.0032	2.7468	2.7111	.0357	2.5844	2.5686	.0158	2.4401
3	4	UNC–1A	.0032	2.9968	2.9611	.0357	2.8344	2.8183	.0161	2.6901
3 1/4	4	UNC–1A	.0033	3.2467	3.2110	.0357	3.0843	3.0680	.0163	2.9400
3 1/2	4	UNC–1A	.0033	3.4967	3.4610	.0357	3.3343	3.3177	.0166	3.1900
3 3/4	4	UNC–1A	.0034	3.7466	3.7109	.0357	3.5842	3.5674	.0168	3.4399
4	4	UNC–1A	.0034	3.9966	3.9609	.0357	3.8342	3.8172	.0170	3.6899

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=3/4H$, table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

TABLE XV.10.—*Limits of size, coarse-thread series, internal threads, class 1B*

UNC–1B and NC–1B

Designation			Internal thread limits of size [1]						
			Minor diameter			Pitch diameter			Major diameter, min [2]
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	20	UNC–1B	0.1959	0.2067	0.0108	0.2175	0.2248	0.0073	0.2500
5/16	18	UNC–1B	.2524	.2630	.0106	.2764	.2843	.0079	.3125
3/8	16	UNC–1B	.3073	.3182	.0109	.3344	.3429	.0085	.3750
7/16	14	UNC–1B	.3602	.3717	.0115	.3911	.4003	.0092	.4375
1/2	13	NC–1B	.4167	.4284	.0117	.4500	.4597	.0097	.5000
1/2	12	UNC–1B	.4098	.4223	.0125	.4459	.4559	.0100	.5000
9/16	12	UNC–1B	.4723	.4843	.0120	.5084	.5186	.0102	.5625
5/8	11	UNC–1B	.5266	.5391	.0125	.5660	.5767	.0107	.6250
3/4	10	UNC–1B	.6417	.6545	.0128	.6850	.6965	.0115	.7500
7/8	9	UNC–1B	.7547	.7681	.0134	.8028	.8151	.0123	.8750
1	8	UNC–1B	.8647	.8797	.0150	.9188	.9320	.0132	1.0000
1 1/8	7	UNC–1B	.9704	.9875	.0171	1.0322	1.0463	.0141	1.1250
1 1/4	7	UNC–1B	1.0954	1.1125	.0171	1.1572	1.1716	.0144	1.2500
1 3/8	6	UNC–1B	1.1946	1.2146	.0200	1.2667	1.2822	.0155	1.3750
1 1/2	6	UNC–1B	1.3196	1.3396	.0200	1.3917	1.4075	.0158	1.5000
1 3/4	5	UNC–1B	1.5335	1.5575	.0240	1.6201	1.6375	.0174	1.7500
2	4 1/2	UNC–1B	1.7594	1.7861	.0267	1.8557	1.8743	.0186	2.0000
2 1/4	4 1/2	UNC–1B	2.0094	2.0361	.0267	2.1057	2.1247	.0190	2.2500
2 1/2	4	UNC–1B	2.2294	2.2594	.0300	2.3376	2.3578	.0202	2.5000
2 3/4	4	UNC–1B	2.4794	2.5094	.0300	2.5876	2.6082	.0206	2.7500
3	4	UNC–1B	2.7294	2.7594	.0300	2.8376	2.8585	.0209	3.0000
3 1/4	4	UNC–1B	2.9794	3.0094	.0300	3.0876	3.1088	.0212	3.2500
3 1/2	4	UNC–1B	3.2294	3.2594	.0300	3.3376	3.3591	.0215	3.5000
3 3/4	4	UNC–1B	3.4794	3.5094	.0300	3.5876	3.6094	.0218	3.7500
4	4	UNC–1B	3.7294	3.7594	.0300	3.8376	3.8597	.0221	4.0000

[1] The values in this table are based on a length of engagement equal to the nominal diameter.
[2] The maximum major diameter of the internal thread may be determined by adding $0.7939p(=11/12H$, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

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TABLE XV.11.—*Limits of size, coarse-thread series, external threads, class 2A*

UNC–2A and NC–2A

Designation			External thread limits of size [1] [2]									
Size	Threads per inch	Thread symbol	Allowance	Major diameter					Pitch diameter			Minor diameter, ref.[5]
				Limits			Tolerance		Limits		Tolerance	
				Max	Min [3]	Min [4]	([3])	([4])	Max	Min		
1	2	3	4	5	6	7	8	9	10	11	12	13
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 0.073	64	NC–2A	0.0006	0.0724	0.0686	-------	0.0038	-------	0.0623	0.0603	0.0020	0.0532
2 .086	56	NC–2A	.0006	.0854	.0813	-------	.0041	-------	.0738	.0717	.0021	.0635
3 .099	48	NC–2A	.0007	.0983	.0938	-------	.0045	-------	.0848	.0825	.0023	.0727
4 .112	40	NC–2A	.0008	.1112	.1061	-------	.0051	-------	.0950	.0925	.0025	.0805
5 .125	40	NC–2A	.0008	.1242	.1191	-------	.0051	-------	.1080	.1054	.0026	.0935
6 .138	32	NC–2A	.0008	.1372	.1312	-------	.0060	-------	.1169	.1141	.0028	.0989
8 .164	32	NC–2A	.0009	.1631	.1571	-------	.0060	-------	.1428	.1399	.0029	.1248
10 .190	24	NC–2A	.0010	.1890	.1818	-------	.0072	-------	.1619	.1586	.0033	.1379
12 .216	24	NC–2A	.0010	.2150	.2078	-------	.0072	-------	.1879	.1845	.0034	.1639
1/4	20	UNC–2A	.0011	.2489	.2408	0.2367	.0081	0.0122	.2164	.2127	.0037	.1876
5/16	18	UNC–2A	.0012	.3113	.3026	.2982	.0087	.0131	.2752	.2712	.0040	.2431
3/8	16	UNC–2A	.0013	.3737	.3643	.3595	.0094	.0142	.3331	.3287	.0044	.2970
7/16	14	UNC–2A	.0014	.4361	.4258	.4206	.0103	.0155	.3897	.3850	.0047	.3485
1/2	13	NC–2A	.0015	.4985	.4876	.4822	.0109	.0163	.4485	.4435	.0050	.4041
1/2	12	UNC–2A	.0015	.4985	.4871	.4813	.0114	.0172	.4444	.4393	.0051	.3963
9/16	12	UNC–2A	.0016	.5609	.5495	.5437	.0114	.0172	.5068	.5016	.0052	.4587
5/8	11	UNC–2A	.0016	.6234	.6113	.6052	.0121	.0182	.5644	.5589	.0055	.5119
3/4	10	UNC–2A	.0018	.7482	.7353	.7288	.0129	.0194	.6832	.6773	.0059	.6255
7/8	9	UNC–2A	.0019	.8731	.8592	.8523	.0139	.0208	.8009	.7946	.0063	.7368
1	8	UNC–2A	.0020	.9980	.9830	.9755	.0150	.0225	.9168	.9100	.0068	.8446
1 1/8	7	UNC–2A	.0022	1.1228	1.1064	1.0982	.0164	.0246	1.0300	1.0228	.0072	.9475
1 1/4	7	UNC–2A	.0022	1.2478	1.2314	1.2232	.0164	.0246	1.1550	1.1476	.0074	1.0725
1 3/8	6	UNC–2A	.0024	1.3726	1.3544	1.3453	.0182	.0273	1.2643	1.2563	.0080	1.1681
1 1/2	6	UNC–2A	.0024	1.4976	1.4794	1.4703	.0182	.0273	1.3893	1.3812	.0081	1.2931
1 3/4	5	UNC–2A	.0027	1.7473	1.7268	1.7165	.0205	.0308	1.6174	1.6085	.0089	1.5019
2	4 1/2	UNC–2A	.0029	1.9971	1.9751	1.9641	.0220	.0330	1.8528	1.8433	.0095	1.7245
2 1/4	4 1/2	UNC–2A	.0029	2.2471	2.2251	2.2141	.0220	.0330	2.1028	2.0931	.0097	1.9745
2 1/2	4	UNC–2A	.0031	2.4969	2.4731	2.4612	.0238	.0357	2.3345	2.3241	.0104	2.1902
2 3/4	4	UNC–2A	.0032	2.7468	2.7230	2.7111	.0238	.0357	2.5844	2.5739	.0105	2.4401
3	4	UNC–2A	.0032	2.9968	2.9730	2.9611	.0238	.0357	2.8344	2.8237	.0107	2.6901
3 1/4	4	UNC–2A	.0033	3.2467	3.2229	3.2110	.0238	.0357	3.0843	3.0734	.0109	2.9400
3 1/2	4	UNC–2A	.0033	3.4967	3.4729	3.4610	.0238	.0357	3.3343	3.3233	.0110	3.1900
3 3/4	4	UNC–2A	.0034	3.7466	3.7228	3.7109	.0238	.0357	3.5842	3.5730	.0112	3.4399
4	4	UNC–2A	.0034	3.9966	3.9728	3.9609	.0238	.0357	3.8342	3.8229	.0113	3.6899

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] Maximum limits (columns 5, 10, and 13) are increased by the amount of the allowance (column 4) for threads which are electroplated or have coatings of similar thicknesses.

[3] For semifinished and finished screws and bolts, threaded portion only.

[4] For unfinished hot rolled material, threaded portion only.

[5] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=\frac{3}{4}H$, table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

TABLE XV.12.—*Limits of size, coarse thread series, internal threads, class 2B*

UNC–2B and NC–2B

Designation				Internal thread limits of size [1]						
Size		Threads per inch	Thread symbol	Minor diameter			Pitch diameter			Major diameter, min [2]
				Limits		Tolerance	Limits		Tolerance	
				Min	Max		Min	Max		
1		2	3	4	5	6	7	8	9	10
No.	*in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1	0.073	64	NC–2B	0.0561	0.0623	0.0062	0.0629	0.0655	0.0026	0.0730
2	.086	56	NC–2B	.0667	.0737	.0070	.0744	.0772	.0028	.0860
3	.099	48	NC–2B	.0764	.0845	.0081	.0855	.0885	.0030	.0990
4	.112	40	NC–2B	.0849	.0939	.0090	.0958	.0991	.0033	.1120
5	.125	40	NC–2B	.0979	.1062	.0083	.1088	.1121	.0033	.1250
6	.138	32	NC–2B	.1042	.1140	.0098	.1177	.1214	.0037	.1380
8	.164	32	NC–2B	.1302	.1389	.0087	.1437	.1475	.0038	.1640
10	.190	24	NC–2B	.1449	.1555	.0106	.1629	.1672	.0043	.1900
12	.216	24	NC–2B	.1709	.1807	.0098	.1889	.1933	.0044	.2160
	1/4	20	UNC–2B	.1959	.2067	.0108	.2175	.2223	.0048	.2500
	5/16	18	UNC–2B	.2524	.2630	.0106	.2764	.2817	.0053	.3125
	3/8	16	UNC–2B	.3073	.3182	.0109	.3344	.3401	.0057	.3750
	7/16	14	UNC–2B	.3602	.3717	.0115	.3911	.3972	.0061	.4375
	1/2	13	NC–2B	.4167	.4284	.0117	.4500	.4565	.0065	.5000
	1/2	12	UNC–2B	.4098	.4223	.0125	.4459	.4525	.0066	.5000
	9/16	12	UNC–2B	.4723	.4843	.0120	.5084	.5152	.0068	.5625
	5/8	11	UNC–2B	.5266	.5391	.0125	.5660	.5732	.0072	.6250
	3/4	10	UNC–2B	.6417	.6545	.0128	.6850	.6927	.0077	.7500
	7/8	9	UNC–2B	.7547	.7681	.0134	.8028	.8110	.0082	.8750
	1	8	UNC–2B	.8647	.8797	.0150	.9188	.9276	.0088	1.0000
	1 1/8	7	UNC–2B	.9704	.9875	.0171	1.0322	1.0416	.0094	1.1250
	1 1/4	7	UNC–2B	1.0954	1.1125	.0171	1.1572	1.1668	.0096	1.2500
	1 3/8	6	UNC–2B	1.1946	1.2146	.0200	1.2667	1.2771	.0104	1.3750
	1 1/2	6	UNC–2B	1.3196	1.3396	.0200	1.3917	1.4022	.0105	1.5000
	1 3/4	5	UNC–2B	1.5335	1.5575	.0240	1.6201	1.6317	.0116	1.7500
	2	4 1/2	UNC–2B	1.7594	1.7861	.0267	1.8557	1.8681	.0124	2.0000
	2 1/4	4 1/2	UNC–2B	2.0094	2.0361	.0267	2.1057	2.1183	.0126	2.2500
	2 1/2	4	UNC–2B	2.2294	2.2594	.0300	2.3376	2.3511	.0135	2.5000
	2 3/4	4	UNC–2B	2.4794	2.5094	.0300	2.5876	2.6013	.0137	2.7500
	3	4	UNC–2B	2.7294	2.7594	.0300	2.8376	2.8515	.0139	3.0000
	3 1/4	4	UNC–2B	2.9794	3.0094	.0300	3.0876	3.1017	.0141	3.2500
	3 1/2	4	UNC–2B	3.2294	3.2594	.0300	3.3376	3.3519	.0143	3.5000
	3 3/4	4	UNC–2B	3.4794	3.5094	.0300	3.5876	3.6021	.0145	3.7500
	4	4	UNC–2B	3.7294	3.7594	.0300	3.8376	3.8523	.0147	4.0000

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] The maximum major diameter of the internal thread may be determined by adding $0.7939p(=11/12H$, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

Table XV.13.—*Limits of size, coarse-thread series, class 3A*

UNC–3A and NC–3A

Designation			External thread limits of size [1]						
			Major diameter			Pitch diameter			
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	Minor diameter, ref.[2]
			Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 0.073	64	NC–3A	0.0730	0.0692	0.0038	0.0629	0.0614	0.0015	0.0538
2 .086	56	NC–3A	.0860	.0819	.0041	.0744	.0728	.0016	.0641
3 .099	48	NC–3A	.0990	.0945	.0045	.0855	.0838	.0017	.0734
4 .112	40	NC–3A	.1120	.1069	.0051	.0958	.0939	.0019	.0813
5 .125	40	NC–3A	.1250	.1199	.0051	.1088	.1068	.0019	.0943
6 .138	32	NC–3A	.1380	.1320	.0060	.1177	.1156	.0021	.0997
8 .164	32	NC–3A	.1640	.1580	.0060	.1437	.1415	.0022	.1257
10 .190	24	NC–3A	.1900	.1828	.0072	.1629	.1604	.0025	.1389
12 .216	24	NC–3A	.2160	.2088	.0072	.1889	.1863	.0026	.1649
1/4	20	UNC–3 A	.2500	.2419	.0081	.2175	.2147	.0028	.1887
5/16	18	UNC–3 A	.3125	.3038	.0087	.2764	.2734	.0030	.2443
3/8	16	UNC–3 A	.3750	.3656	.0094	.3344	.3311	.0033	.2983
7/16	14	UNC–3 A	.4375	.4272	.0103	.3911	.3876	.0035	.3499
1/2	13	NC–3A	.5000	.4891	.0109	.4500	.4463	.0037	.4056
1/2	12	UNC–3 A	.5000	.4886	.0114	.4459	.4421	.0038	.3978
9/16	12	UNC–3 A	.5625	.5511	.0114	.5084	.5045	.0039	.4603
5/8	11	UNC–3 A	.6250	.6129	.0121	.5660	.5619	.0041	.5135
3/4	10	UNC–3 A	.7500	.7371	.0129	.6850	.6806	.0044	.6273
7/8	9	UNC–3 A	.8750	.8611	.0139	.8028	.7981	.0047	.7387
1	8	UNC–3 A	1.0000	.9850	.0150	.9188	.9137	.0051	.8466
1 1/8	7	UNC–3 A	1.1250	1.1086	.0164	1.0322	1.0268	.0054	.9497
1 1/4	7	UNC–3 A	1.2500	1.2336	.0164	1.1572	1.1517	.0055	1.0747
1 3/8	6	UNC–3 A	1.3750	1.3568	.0182	1.2667	1.2607	.0060	1.1705
1 1/2	6	UNC–3 A	1.5000	1.4818	.0182	1.3917	1.3856	.0061	1.2955
1 3/4	5	UNC–3 A	1.7500	1.7295	.0205	1.6201	1.6134	.0067	1.5046
2	4 1/2	UNC–3 A	2.0000	1.9780	.0220	1.8557	1.8486	.0071	1.7274
2 1/4	4 1/2	UNC–3 A	2.2500	2.2280	.0220	2.1057	2.0984	.0073	1.9774
2 1/2	4	UNC–3 A	2.5000	2.4762	.0238	2.3376	2.3298	.0078	2.1933
2 3/4	4	UNC–3 A	2.7500	2.7262	.0238	2.5876	2.5797	.0079	2.4433
3	4	UNC–3 A	3.0000	2.9762	.0238	2.8376	2.8296	.0080	2.6933
3 1/4	4	UNC–3 A	3.2500	3.2262	.0238	3.0876	3.0794	.0082	2.9433
3 1/2	4	UNC–3 A	3.5000	3.4762	.0238	3.3376	3.3293	.0083	3.1933
3 3/4	4	UNC–3 A	3.7500	3.7262	.0238	3.5876	3.5792	.0084	3.4433
4	4	UNC–3 A	4.0000	3.9762	.0238	3.8376	3.8291	.0085	3.6933

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=3/4H$, table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

TABLE XV.14.—*Limits of size, coarse thread series, internal threads, class 3B*

UNC–3B and NC–3B

Designation			Internal thread limits of size [1]						
			Minor diameter			Pitch diameter			
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	Major diameter, min [2]
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 0.073	64	NC–3B	0.0561	0.0623	0.0062	0.0629	0.0648	0.0019	0.0730
2 .086	56	NC–3B	.0667	.0737	.0070	.0744	.0765	.0021	.0860
3 .099	48	NC–3B	.0764	.0845	.0081	.0855	.0877	.0022	.0990
4 .112	40	NC–3B	.0849	.0939	.0090	.0958	.0982	.0024	.1120
5 .125	40	NC–3B	.0979	.1062	.0083	.1088	.1113	.0025	.1250
6 .138	32	NC–3B	.1042	.1140	.0098	.1177	.1204	.0027	.1380
8 .164	32	NC–3B	.1302	.1389	.0087	.1437	.1465	.0028	.1640
10 .190	24	NC–3B	.1449	.1555	.0106	.1629	.1661	.0032	.1900
12 .216	24	NC–3B	.1709	.1807	.0098	.1889	.1922	.0033	.2160
1/4	**20**	**UNC–3B**	**.1959**	**.2067**	**.0108**	**.2175**	**.2211**	**.0036**	**.2500**
5/16	**18**	**UNC–3B**	**.2524**	**.2630**	**.0106**	**.2764**	**.2803**	**.0039**	**.3125**
3/8	**16**	**UNC–3B**	**.3073**	**.3182**	**.0109**	**.3344**	**.3387**	**.0043**	**.3750**
7/16	**14**	**UNC–3B**	**.3602**	**.3717**	**.0115**	**.3911**	**.3957**	**.0046**	**.4375**
1/2	13	NC–3B	.4167	.4284	.0117	.4500	.4548	.0048	.5000
1/2	**12**	**UNC–3B**	**.4098**	**.4223**	**.0125**	**.4459**	**.4509**	**.0050**	**.5000**
9/16	**12**	**UNC–3B**	**.4723**	**.4843**	**.0120**	**.5084**	**.5135**	**.0051**	**.5625**
5/8	**11**	**UNC–3B**	**.5266**	**.5391**	**.0125**	**.5660**	**.5714**	**.0054**	**.6250**
3/4	**10**	**UNC–3B**	**.6417**	**.6545**	**.0128**	**.6850**	**.6907**	**.0057**	**.7500**
7/8	**9**	**UNC–3B**	**.7547**	**.7681**	**.0134**	**.8028**	**.8089**	**.0061**	**.8750**
1	**8**	**UNC–3B**	**.8647**	**.8797**	**.0150**	**.9188**	**.9254**	**.0066**	**1.0000**
1 1/8	**7**	**UNC–3B**	**.9704**	**.9875**	**.0171**	**1.0322**	**1.0393**	**.0071**	**1.1250**
1 1/4	**7**	**UNC–3B**	**1.0954**	**1.1125**	**.0171**	**1.1572**	**1.1644**	**.0072**	**1.2500**
1 3/8	**6**	**UNC–3B**	**1.1946**	**1.2146**	**.0200**	**1.2667**	**1.2745**	**.0078**	**1.3750**
1 1/2	**6**	**UNC–3B**	**1.3196**	**1.3396**	**.0200**	**1.3917**	**1.3996**	**.0079**	**1.5000**
1 3/4	**5**	**UNC–3B**	**1.5335**	**1.5575**	**.0240**	**1.6201**	**1.6288**	**.0087**	**1.7500**
2	**4 1/2**	**UNC–3B**	**1.7594**	**1.7861**	**.0267**	**1.8557**	**1.8650**	**.0093**	**2.0000**
2 1/4	**4 1/2**	**UNC–3B**	**2.0094**	**2.0361**	**.0267**	**2.1057**	**2.1152**	**.0095**	**2.2500**
2 1/2	**4**	**UNC–3B**	**2.2294**	**2.2594**	**.0300**	**2.3376**	**2.3477**	**.0101**	**2.5000**
2 3/4	**4**	**UNC–3B**	**2.4794**	**2.5094**	**.0300**	**2.5876**	**2.5979**	**.0103**	**2.7500**
3	**4**	**UNC–3B**	**2.7294**	**2.7594**	**.0300**	**2.8376**	**2.8480**	**.0104**	**3.0000**
3 1/4	**4**	**UNC–3B**	**2.9794**	**3.0094**	**.0300**	**3.0876**	**3.0982**	**.0106**	**2.2500**
3 1/2	**4**	**UNC–3B**	**3.2294**	**3.2594**	**.0300**	**3.3376**	**3.3484**	**.0108**	**3.5000**
3 3/4	**4**	**UNC–3B**	**3.4794**	**3.5094**	**.0300**	**3.5876**	**3.5985**	**.0169**	**3.7500**
4	**4**	**UNC–3B**	**3.7294**	**3.7594**	**.0300**	**3.8376**	**3.8487**	**.0111**	**4.0000**

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] The maximum major diameter of the internal thread may be determined by adding $0.7939p(=11/12H$, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

Table XV.15.—*Limits of size, fine thread series, external threads, class 1A*

UNF–1A and NF–1A

Designation			External thread limits of size [1]							
Size	Threads per inch	Thread symbol	Allowance	Major diameter			Pitch diameter			Minor diameter ref.[2]
				Limits		Tolerance	Limits		Tolerance	
				Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10	11
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	28	UNF–1A	0.0010	0.2490	0.2392	0.0098	0.2258	0.2208	0.0050	0.2052
5/16	24	UNF–1A	.0011	.3114	.3006	.0108	.2843	.2788	.0055	.2603
3/8	24	UNF–1A	.0011	.3739	.3631	.0108	.3468	.3411	.0057	.3228
7/16	20	UNF–1A	.0013	.4362	.4240	.0122	.4037	.3975	.0062	.3749
1/2	20	UNF–1A	.0013	.4987	.4865	.0122	.4662	.4598	.0064	.4374
9/16	18	UNF–1A	.0014	.5611	.5480	.0131	.5250	.5182	.0068	.4929
5/8	18	UNF–1A	.0014	.6236	.6105	.0131	.5875	.5805	.0070	.5554
3/4	16	UNF–1A	.0015	.7485	.7343	.0142	.7079	.7004	.0075	.6718
7/8	14	UNF–1A	.0016	.8734	.8579	.0155	.8270	.8189	.0081	.7858
1	14	NF–1A	.0017	.9983	.9828	.0155	.9519	.9435	.0084	.9107
1	12	UNF–1A	.0018	.9982	.9810	.0172	.9441	.9353	.0088	.8960
1 1/8	12	UNF–1A	.0018	1.1232	1.1060	.0172	1.0691	1.0601	.0090	1.0210
1 1/4	12	UNF–1A	.0018	1.2482	1.2310	.0172	1.1941	1.1849	.0092	1.1460
1 3/8	12	UNF–1A	.0019	1.3731	1.3559	.0172	1.3190	1.3096	.0094	1.2709
1 1/2	12	UNF–1A	.0019	1.4981	1.4809	.0172	1.4440	1.4344	.0096	1.3959

[1] The values in this table are based on a length of engagement equal to the nominal diameter.
[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=3/4H$, table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

Table XV.16.—*Limits of size, fine thread series, internal threads, class 1B*

UNF–1B and NF–1B

Designation			Internal thread limits of size [1]						
Size	Threads per inch	Thread symbol	Minor diameter			Pitch diameter			Major diameter, min [2]
			Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	28	UNF–1B	0.2113	0.2190	0.0077	0.2268	0.2333	0.0065	0.2500
5/16	24	UNF–1B	.2674	.2754	.0080	.2854	.2925	.0071	.3125
3/8	24	UNF–1B	.3299	.3372	.0073	.3479	.3553	.0074	.3750
7/16	20	UNF–1B	.3834	.3916	.0082	.4050	.4131	.0081	.4375
1/2	20	UNF–1B	.4459	.4537	.0078	.4675	.4759	.0084	.5000
9/16	18	UNF–1B	.5024	.5106	.0082	.5264	.5353	.0089	.5625
5/8	18	UNF–1B	.5649	.5730	.0081	.5889	.5980	.0091	.6250
3/4	16	UNF–1B	.6823	.6908	.0085	.7094	.7192	.0098	.7500
7/8	14	UNF–1B	.7977	.8068	.0091	.8286	.8392	.0106	.8750
1	14	NF–1B	.9227	.9315	.0088	.9536	.9645	.0109	1.0000
1	12	UNF–1B	.9098	.9198	.0100	.9459	.9573	.0114	1.0000
1 1/8	12	UNF–1B	1.0348	1.0448	.0100	1.0709	1.0826	.0117	1.1250
1 1/4	12	UNF–1B	1.1598	1.1698	.0100	1.1959	1.2079	.0120	1.2500
1 3/8	12	UNF–1B	1.2848	1.2948	.0100	1.3209	1.3332	.0123	1.3750
1 1/2	12	UNF–1B	1.4098	1.4198	.0100	1.4459	1.4584	.0125	1.5000

[1] The values in this table are based on a length of engagement equal to the nominal diameter.
[2] The maximum major diameter of the internal thread may be determined by adding $0.7939p(=11/12H$, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

Table XV.17.—*Limits of size, fine thread series, external threads, class 2A*

UNF–2A and NF–2A

Designation			External thread limits of size [1] [2]							
Size	Threads per inch	Thread symbol	Allowance	Major diameter			Pitch diameter			Minor diameter ref.[3]
				Limits		Tolerance	Limits		Tolerance	
				Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10	11
No. in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
0 0.060	80	NF–2A	0.0005	0.0595	0.0563	0.0032	0.0514	0.0496	0.0018	0.0442
1 .073	72	NF–2A	.0006	.0724	.0689	.0035	.0634	.0615	.0019	.0554
2 .086	64	NF–2A	.0006	.0854	.0816	.0038	.0753	.0733	.0020	.0662
3 .099	56	NF–2A	.0007	.0983	.0942	.0041	.0867	.0845	.0022	.0764
4 .112	48	NF–2A	.0007	.1113	.1068	.0045	.0978	.0954	.0024	.0857
5 .125	44	NF–2A	.0007	.1243	.1195	.0048	.1095	.1070	.0025	.0964
6 .138	40	NF–2A	.0008	.1372	.1321	.0051	.1210	.1184	.0026	.1065
8 .164	36	NF–2A	.0008	.1632	.1577	.0055	.1452	.1424	.0028	.1291
10 .190	32	NF–2A	.0009	.1891	.1831	.0060	.1688	.1658	.0030	.1508
12 .216	28	NF–2A	.0010	.2150	.2085	.0065	.1918	.1886	.0032	.1712
1/4	28	UNF–2A	.0010	.2490	.2425	.0065	.2258	.2225	.0033	.2052
5/16	24	UNF–2A	.0011	.3114	.3042	.0072	.2843	.2806	.0037	.2603
3/8	24	UNF–2A	.0011	.3739	.3667	.0072	.3468	.3430	.0038	.3228
7/16	20	UNF–2A	.0013	.4362	.4281	.0081	.4037	.3995	.0042	.3749
1/2	20	UNF–2A	.0013	.4987	.4906	.0081	.4662	.4619	.0043	.4374
9/16	18	UNF–2A	.0014	.5611	.5524	.0087	.5250	.5205	.0045	.4929
5/8	18	UNF–2A	.0014	.6236	.6149	.0087	.5875	.5828	.0047	.5554
3/4	16	UNF–2A	.0015	.7485	.7391	.0094	.7079	.7029	.0050	.6718
7/8	14	UNF–2A	.0016	.8734	.8631	.0103	.8270	.8216	.0054	.7858
1	14	NF–2A	.0017	.9983	.9880	.0103	.9519	.9463	.0056	.9107
1	12	UNF–2A	.0018	.9982	.9868	.0114	.9441	.9382	.0059	.8960
1 1/8	12	UNF–2A	.0018	1.1232	1.1118	.0114	1.0691	1.0631	.0060	1.0210
1 1/4	12	UNF–2A	.0018	1.2482	1.2368	.0114	1.1941	1.1879	.0062	1.1460
1 3/8	12	UNF–2A	.0019	1.3731	1.3617	.0114	1.3190	1.3127	.0063	1.2709
1 1/2	12	UNF–2A	.0019	1.4981	1.4867	.0114	1.4440	1.4376	.0064	1.3959

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] Maximum limits (columns 5, 8, and 11) are increased by the amount of the allowance (column 4) for threads which are electroplated or have coatings of similar thicknesses.

[3] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=3/4H$, table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

Note.—For sizes larger than 1 inch given in 16ths and for all sizes larger than 1 1/2 inch, use the 12-thread series. See table XV.29.

TABLE XV.18.—*Limits of size, fine thread series, internal threads, class 2B*

UNF–2B and NF–2B

Designation			Internal thread limits of size [1]						
Size	Threads per inch	Thread symbol	Minor diameter: Limits, Min	Minor diameter: Limits, Max	Minor diameter: Tolerance	Pitch diameter: Limits, Min	Pitch diameter: Limits, Max	Pitch diameter: Tolerance	Major diameter, min [2]
1	2	3	4	5	6	7	8	9	10
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
0 0.060	80	NF–2B	0.0465	0.0514	0.0049	0.0519	0.0542	0.0023	0.0600
1 .073	72	NF–2B	.0580	.0635	.0055	.0640	.0665	.0025	.0730
2 .086	64	NF–2B	.0691	.0753	.0062	.0759	.0786	.0027	.0860
3 .099	56	NF–2B	.0797	.0865	.0068	.0874	.0902	.0028	.0990
4 .112	48	NF–2B	.0894	.0968	.0074	.0985	.1016	.0031	.1120
5 .125	44	NF–2B	.1004	.1079	.0075	.1102	.1134	.0032	.1250
6 .138	40	NF–2B	.1109	.1186	.0077	.1218	.1252	.0034	.1380
8 .164	36	NF–2B	.1339	.1416	.0077	.1460	.1496	.0036	.1640
10 .190	32	NF–2B	.1562	.1641	.0079	.1697	.1736	.0039	.1900
12 .216	28	NF–2B	.1773	.1857	.0084	.1928	.1970	.0042	.2160
1/4	28	UNF–2B	.2113	.2190	.0077	.2268	.2311	.0043	.2500
5/16	24	UNF–2B	.2674	.2754	.0080	.2854	.2902	.0048	.3125
3/8	24	UNF–2B	.3299	.3372	.0073	.3479	.3528	.0049	.3750
7/16	20	UNF–2B	.3834	.3916	.0082	.4050	.4104	.0054	.4375
1/2	20	UNF–2B	.4459	.4537	.0078	.4675	.4731	.0056	.5000
9/16	18	UNF–2B	.5024	.5106	.0082	.5264	.5323	.0059	.5625
5/8	18	UNF–2B	.5649	.5730	.0081	.5889	.5949	.0060	.6250
3/4	16	UNF–2B	.6823	.6908	.0085	.7094	.7159	.0065	.7500
7/8	14	UNF–2B	.7977	.8068	.0091	.8286	.8356	.0070	.8750
1	14	NF–2B	.9227	.9315	.0088	.9536	.9609	.0073	1.0000
1	12	UNF–2B	.9098	.9198	.0100	.9459	.9535	.0076	1.0000
1 1/8	12	UNF–2B	1.0348	1.0448	.0100	1.0709	1.0787	.0078	1.1250
1 1/4	12	UNF–2B	1.1598	1.1698	.0100	1.1959	1.2039	.0080	1.2500
1 3/8	12	UNF–2B	1.2848	1.2948	.0100	1.3209	1.3291	.0082	1.3750
1 1/2	12	UNF–2B	1.4098	1.4198	.0100	1.4459	1.4542	.0083	1.5000

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] The maximum major diameter of the internal thread may be determined by adding $0.7939p(=11/12H$, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes larger than 1 inch given in 16ths and for all sizes larger than 1 1/2 inch, use the 12-thread series. See table XV.30.

TABLE XV.19.—*Limits of size, fine thread series, external threads, class 3A*

UNF–3A and NF–3A

Designation			External thread limits of size [1]						
			Major diameter			Pitch diameter			
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	Minor diameter, ref.[2]
			Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
0 0.060	80	NF-3A	0.0600	0.0568	0.0032	0.0519	0.0506	0.0013	0.0447
1 .073	72	NF-3A	.0730	.0695	.0035	.0640	.0626	.0014	.0560
2 .086	64	NF-3A	.0860	.0822	.0038	.0759	.0744	.0015	.0668
3 .099	56	NF-3A	.0990	.0949	.0041	.0874	.0858	.0016	.0771
4 .112	48	NF-3A	.1120	.1075	.0045	.0985	.0967	.0018	.0864
5 .125	44	NF-3A	.1250	.1202	.0048	.1102	.1083	.0019	.0971
6 .138	40	NF-3A	.1380	.1329	.0051	.1218	.1198	.0020	.1073
8 .164	36	NF-3A	.1640	.1585	.0055	.1460	.1439	.0021	.1299
10 .190	32	NF-3A	1900	.1840	.0060	.1697	.1674	.0023	.1517
12 .216	28	NF-3A	2160	.2095	.0065	.1928	.1904	.0024	.1722
1/4	28	UNF-3A	.2500	.2435	.0065	.2268	.2243	.0025	.2062
5/16	24	UNF-3A	.3125	.3053	.0072	.2854	.2827	.0027	.2614
3/8	24	UNF-3A	.3750	.3678	.0072	.3479	.3450	.0029	.3239
7/16	20	UNF-3A	.4375	.4294	.0081	.4050	.4019	.0031	.3762
1/2	20	UNF-3A	.5000	.4919	.0081	.4675	.4643	.0032	.4387
9/16	18	UNF-3A	.5625	.5538	.0087	.5264	.5230	.0034	.4943
5/8	18	UNF-3A	.6250	.6163	.0087	.5889	.5854	.0035	.5568
3/4	16	UNF-3A	.7500	.7406	.0094	.7094	.7056	.0038	.6733
7/8	14	UNF-3A	.8750	.8647	.0103	.8286	.8245	.0041	.7874
1	14	NF-3A	1.0000	.9897	.0103	.9536	.9494	.0042	.9124
1	12	UNF-3A	1.0000	.9886	.0114	.9459	.9415	.0044	.8978
1 1/8	12	UNF-3A	1.1250	1.1136	.0114	1.0709	1.0664	.0045	1.0228
1 1/4	12	UNF-3A	1.2500	1.2386	.0114	1.1959	1.1913	.0046	1.1478
1 3/8	12	UNF-3A	1.3750	1.3636	.0114	1.3209	1.3162	.0047	1.2728
1 1/2	12	UNF-3A	1.5000	1.4886	.0114	1.4459	1.4411	.0048	1.3978

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage of dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=3/4H$, table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes larger than 1 inch given in 16ths and for all sizes larger than 1 1/2 inch, use the 12-thread series. See table XV.31.

TABLE XV.20.—*Limits of size, fine thread series, internal threads, class 3B*

UNF–3B and NF–3B

Designation				Internal thread limits of size [1]						
Size		Threads per inch	Thread symbol	Minor diameter			Pitch diameter			Major diameter, min [2]
				Limits		Tolerance	Limits		Tolerance	
				Min	Max		Min	Max		
1		2	3	4	5	6	7	8	9	10
No.	*in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
0	0.060	80	NF–3B	0.0465	0.0514	0.0049	0.0519	0.0536	0.0017	0.0600
1	.073	72	NF–3B	.0580	.0635	.0055	.0640	.0659	.0019	.0730
2	.086	64	NF–3B	.0691	.0753	.0062	.0759	.0779	.0020	.0860
3	.099	56	NF–3B	.0797	.0865	.0068	.0874	.0895	.0021	.0990
4	.112	48	NF–3B	.0894	.0968	.0074	.0985	.1008	.0023	.1120
5	.125	44	NF–3B	.1004	.1079	.0075	.1102	.1126	.0024	.1250
6	.138	40	NF–3B	.1109	.1186	.0077	.1218	.1243	.0025	.1380
8	.164	36	NF–3B	.1339	.1416	.0077	.1460	.1487	.0027	.1640
10	.190	32	NF–3B	.1562	.1641	.0079	.1697	.1726	.0029	.1900
12	.216	28	NF–3B	.1773	.1857	.0084	.1928	.1959	.0031	.2160
	1/4	**28**	**UNF–3B**	**.2113**	**.2190**	**.0077**	**.2268**	**.2300**	**.0032**	**.2500**
	5/16	**24**	**UNF–3B**	**.2674**	**.2754**	**.0080**	**.2854**	**.2890**	**.0036**	**.3125**
	3/8	**24**	**UNF–3B**	**.3299**	**.3372**	**.0073**	**.3479**	**.3516**	**.0037**	**.3750**
	7/16	**20**	**UNF–3B**	**.3834**	**.3916**	**.0082**	**.4050**	**.4091**	**.0041**	**.4375**
	1/2	**20**	**UNF–3B**	**.4459**	**.4537**	**.0078**	**.4675**	**.4717**	**.0042**	**.5000**
	9/16	**18**	**UNF–3B**	**.5024**	**.5106**	**.0082**	**.5264**	**.5308**	**.0044**	**.5625**
	5/8	**18**	**UNF–3B**	**.5649**	**.5730**	**.0081**	**.5889**	**.5934**	**.0045**	**.6250**
	3/4	**16**	**UNF–3B**	**.6823**	**.6908**	**.0085**	**.7094**	**.7143**	**.0049**	**.7500**
	7/8	**14**	**UNF–3B**	**.7977**	**.8068**	**.0091**	**.8286**	**.8339**	**.0053**	**.8750**
	1	14	NF–3B	.9227	.9315	.0088	.9536	.9590	.0054	1.0000
	1	**12**	**UNF–3B**	**.9098**	**.9198**	**.0100**	**.9459**	**.9516**	**.0057**	**1.0000**
	1 1/8	**12**	**UNF–3B**	**1.0348**	**1.0448**	**.0100**	**1.0709**	**1.0768**	**.0059**	**1.1250**
	1 1/4	**12**	**UNF–3B**	**1.1598**	**1.1698**	**.0100**	**1.1959**	**1.2019**	**.0060**	**1.2500**
	1 3/8	**12**	**UNF–3B**	**1.2848**	**1.2948**	**.0100**	**1.3209**	**1.3270**	**.0061**	**1.3750**
	1 1/2	**12**	**UNF–3B**	**1.4098**	**1.4198**	**.0100**	**1.4459**	**1.4522**	**.0063**	**1.5000**

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] The maximum major diameter of the internal thread may be determined by adding $0.7939p(=11/12H$, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes larger than 1 inch given in 16ths and for all sizes larger than 1 1/2 in use the 12-thread series. See table XV.32.

TABLE XV.21.—*Limits of size, extra-fine thread series, external threads, class 2A*

UNEF–2A and NEF–2A

Designation			External thread limits of size [1] [2]							
Size	Threads per inch	Thread symbol	Allowance	Major diameter			Pitch diameter			Minor diameter, ref.[3]
				Limits		Tolerance	Limits		Tolerance	
				Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10	11
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	32	NEF-2A	0.0010	0.2490	0.2430	0.0060	0.2287	0.2255	0.0032	0.2107
5/16	32	NEF-2A	.0010	.3115	.3055	.0060	.2912	.2880	.0032	.2732
3/8	32	NEF-2A	.0010	.3740	.3680	.0060	.3537	.3503	.0034	.3357
7/16	28	UNEF-2A	.0011	.4364	.4299	.0065	.4132	.4096	.0036	.3926
1/2	28	UNEF-2A	.0011	.4989	.4924	.0065	.4757	.4720	.0037	.4551
9/16	24	NEF-2A	.0012	.5613	.5541	.0072	.5342	.5303	.0039	.5102
5/8	24	NEF-2A	.0012	.6238	.6166	.0072	.5967	.5927	.0040	.5727
11/16	24	NEF-2A	.0012	.6863	.6791	.0072	.6592	.6552	.0040	.6352
3/4	20	UNEF-2A	.0013	.7487	.7406	.0081	.7162	.7118	.0044	.6874
13/16	20	UNEF-2A	.0013	.8112	.8031	.0081	.7787	.7743	.0044	.7498
7/8	20	UNEF-2A	.0013	.8737	.8656	.0081	.8412	.8368	.0044	.8124
15/16	20	UNEF-2A	.0014	.9361	.9280	.0081	.9036	.8991	.0045	.8748
1	20	UNEF-2A	.0014	.9986	.9905	.0081	.9661	.9616	.0045	.9373
1 1/16	18	NEF-2A	.0014	1.0611	1.0524	.0087	1.0250	1.0203	.0047	.9929
1 1/8	18	NEF-2A	.0014	1.1236	1.1149	.0087	1.0875	1.0828	.0047	1.0554
1 3/16	18	NEF-2A	.0015	1.1860	1.1773	.0087	1.1499	1.1450	.0049	1.1178
1 1/4	18	NEF-2A	.0015	1.2485	1.2398	.0087	1.2124	1.2075	.0049	1.1803
1 5/16	18	NEF-2A	.0015	1.3110	1.3023	.0087	1.2749	1.2700	.0049	1.2428
1 3/8	18	NEF-2A	.0015	1.3735	1.3648	.0087	1.3374	1.3325	.0049	1.3053
1 7/16	18	NEF-2A	.0015	1.4360	1.4273	.0087	1.3999	1.3949	.0050	1.3678
1 1/2	18	NEF-2A	.0015	1.4985	1.4898	.0087	1.4624	1.4574	.0050	1.4303
1 9/16	18	NEF-2A	.0015	1.5610	1.5523	.0087	1.5249	1.5199	.0050	1.4928
1 5/8	18	NEF-2A	.0015	1.6235	1.6148	.0087	1.5874	1.5824	.0050	1.5553
1 11/16	18	NEF-2A	.0015	1.6860	1.6773	.0087	1.6499	1.6448	.0051	1.6178

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASAB1.1–1949 step tables.

[2] Maximum limits (columns 5, 8, and 11) are increased by the amount of the allowance (column 4) for threads which are electroplated or have coatings of similar thicknesses.

[3] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=3/4H$, table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes larger than 1 11/16 inch, use the 16-thread series, see table XV.33.

TABLE XV.22.—*Limits of size, extra-fine thread series, internal threads, class 2B*

UNEF–2B and NEF–2B

Designation			Internal thread limits of size [1]						
Size	Threads per inch	Thread symbol	Minor diameter			Pitch diameter			Major diameter, min [2]
			Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	32	NEF–2B	0.2162	0.2229	0.0067	0.2297	0.2339	0.0042	0.2500
5/16	32	NEF–2B	.2787	.2847	.0060	.2922	.2964	.0042	.3125
3/8	32	NEF–2B	.3412	.3469	.0057	.3547	.3591	.0044	.3750
7/16	28	UNEF–2B	.3988	.4051	.0063	.4143	.4189	.0046	.4375
1/2	28	UNEF–2B	.4613	.4676	.0063	.4768	.4816	.0048	.5000
9/16	24	NEF–2B	.5174	.5244	.0070	.5354	.5405	.0051	.5625
5/8	24	NEF–2B	.5799	.5869	.0070	.5979	.6031	.0052	.6250
11/16	24	NEF–2B	.6424	.6494	.0070	.6604	.6656	.0052	.6875
3/4	20	UNEF–2B	.6959	.7037	.0078	.7175	.7232	.0057	.7500
13/16	20	UNEF–2B	.7584	.7662	.0078	.7800	.7857	.0057	.8125
7/8	20	UNEF–2B	.8209	.8287	.0078	.8425	.8482	.0057	.8750
15/16	20	UNEF–2B	.8834	.8912	.0078	.9050	.9109	.0059	.9375
1	20	UNEF–2B	.9459	.9537	.0078	.9675	.9734	.0059	1.0000
1 1/16	18	NEF–2B	1.0024	1.0105	.0081	1.0264	1.0326	.0062	1.0625
1 1/8	18	NEF–2B	1.0649	1.0730	.0081	1.0889	1.0951	.0062	1.1250
1 3/16	18	NEF–2B	1.1274	1.1355	.0081	1.1514	1.1577	.0063	1.1875
1 1/4	18	NEF–2B	1.1899	1.1980	.0081	1.2139	1.2202	.0063	1.2500
1 5/16	18	NEF–2B	1.2524	1.2605	.0081	1.2764	1.2827	.0063	1.3125
1 3/8	18	NEF–2B	1.3149	1.3230	.0081	1.3389	1.3452	.0063	1.3750
1 7/16	18	NEF–2B	1.3774	1.3855	.0081	1.4014	1.4079	.0065	1.4375
1 1/2	18	NEF–2B	1.4399	1.4480	.0081	1.4639	1.4704	.0065	1.5000
1 9/16	18	NEF–2B	1.5024	1.5105	.0081	1.5264	1.5329	.0065	1.5625
1 5/8	18	NEF–2B	1.5649	1.5730	.0081	1.5889	1.5954	.0065	1.6250
1 11/16	18	NEF–2B	1.6274	1.6355	.0081	1.6514	1.6580	.0066	1.6875

[1] The values in this table are based on a length of engagement equal to 9 pitches, and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.
[2] The maximum major diameter of the internal thread may be determined by adding $0.7939p (=11/12H$, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes larger than 1 11/16 inch, use the 16-thread series. See table XV.34.

TABLE XV. 23.—*Limits of size, extra-fine thread series, external threads, class 3A*

UNEF—3A and NEF—3A

Designation			External thread limits of size [1]						
Size	Threads per inch	Thread symbol	Major diameter			Pitch diameter			Minor diameter, ref. [2]
			Limits		Tolerance	Limits		Tolerance	
			Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	32	NEF-3A	0.2500	0.2440	0.0060	0.2297	0.2273	0.0024	0.2117
5/16	32	NEF-3A	.3125	.3065	.0060	.2922	.2898	.0024	.2742
3/8	32	NEF-3A	.3750	.3690	.0060	.3547	.3522	.0025	.3367
7/16	28	UNEF-3A	.4375	.4310	.0065	.4143	.4116	.0027	.3937
1/2	28	UNEF-3A	.5000	.4935	.0065	.4768	.4740	.0028	.4562
9/16	24	NEF-3A	.5625	.5553	.0072	.5354	.5325	.0029	.5114
5/8	24	NEF-3A	.6250	.6178	.0072	.5979	.5949	.0030	.5739
11/16	24	NEF-3A	.6875	.6803	.0072	.6604	.6574	.0030	.6364
3/4	20	UNEF-3A	.7500	.7419	.0081	.7175	.7142	.0033	.6887
13/16	20	UNEF-3A	.8125	.8044	.0081	.7800	.7767	.0033	.7512
7/8	20	UNEF-3A	.8750	.8669	.0081	.8425	.8392	.0033	.8137
15/16	20	UNEF-3A	.9375	.9294	.0081	.9050	.9016	.0034	.8762
1	20	UNEF-3A	1.0000	.9919	.0081	.9675	.9641	.0034	.9387
1 1/16	18	NEF-3A	1.0625	1.0538	.0087	1.0264	1.0228	.0036	.9943
1 1/8	18	NEF-3A	1.1250	1.1163	.0087	1.0889	1.0853	.0036	1.0568
1 3/16	18	NEF-3A	1.1875	1.1788	.0087	1.1514	1.1478	.0036	1.1193
1 1/4	18	NEF-3A	1.2500	1.2413	.0087	1.2139	1.2103	.0036	1.1818
1 5/16	18	NEF-3A	1.3125	1.3038	.0087	1.2764	1.2728	.0036	1.2443
1 3/8	18	NEF-3A	1.3750	1.3663	.0087	1.3389	1.3353	.0036	1.3068
1 7/16	18	NEF-3A	1.4375	1.4288	.0087	1.4014	1.3977	.0037	1.3693
1 1/2	18	NEF-3A	1.5000	1.4913	.0087	1.4639	1.4602	.0037	1.4318
1 9/16	18	NEF-3A	1.5625	1.5538	.0087	1.5264	1.5227	.0037	1.4943
1 5/8	18	NEF-3A	1.6250	1.6163	.0087	1.5889	1.5852	.0037	1.5568
1 11/16	18	NEF-3A	1.6875	1.6788	.0087	1.6514	1.6476	.0038	1.6193

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.

[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting $0.6495p(=3/4H,$ table XV.1) from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes larger than 1 11/16 inch, use the 16-thread series. See table XV.35.

TABLE XV.24.—*Limits of size, extra-fine thread series, internal threads, class 3B*

UNEF–3B and NEF–3B

Designation			Internal thread limits of size [1]						
			Minor diameter			Pitch diameter			Major diameter, min [2]
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/4	32	NEF–3B	0.2162	0.2229	0.0067	0.2297	0.2328	0.0031	0.2500
5/16	32	NEF–3B	.2787	.2847	.0060	.2922	.2953	.0031	.3125
3/8	32	NEF–3B	.3412	.3469	.0057	.3547	.3580	.0033	.3750
7/16	**28**	**UNEF–3B**	**.3988**	**.4051**	**.0063**	**.4143**	**.4178**	**.0035**	**.4375**
1/2	**28**	**UNEF–3B**	**.4613**	**.4676**	**.0063**	**.4768**	**.4804**	**.0036**	**.5000**
9/16	24	NEF–3B	.5174	.5244	.0070	.5354	.5392	.0038	.5625
5/8	24	NEF–3B	.5799	.5869	.0070	.5979	.6018	.0039	.6250
11/16	24	NEF–3B	.6424	.6494	.0070	.6604	.6643	.0039	.6875
3/4	**20**	**UNEF–3B**	**.6959**	**.7037**	**.0078**	**.7175**	**.7218**	**.0043**	**.7500**
13/16	**20**	**UNEF–3B**	**.7584**	**.7662**	**.0078**	**.7800**	**.7843**	**.0043**	**.8125**
7/8	**20**	**UNEF–3B**	**.8209**	**.8287**	**.0078**	**.8425**	**.8468**	**.0043**	**.8750**
15/16	**20**	**UNEF–3B**	**.8834**	**.8912**	**.0078**	**.9050**	**.9094**	**.0044**	**.9375**
1	**20**	**UNEF–3B**	**.9459**	**.9537**	**.0078**	**.9675**	**.9719**	**.0044**	**1.0000**
1 1/16	18	NEF–3B	1.0024	1.0105	.0081	1.0264	1.0310	.0046	1.0625
1 1/8	18	NEF–3B	1.0649	1.0730	.0081	1.0889	1.0935	.0046	1.1250
1 3/16	18	NEF–3B	1.1274	1.1355	.0081	1.1514	1.1561	.0047	1.1875
1 1/4	18	NEF–3B	1.1899	1.1980	.0081	1.2139	1.2186	.0047	1.2500
1 5/16	18	NEF–3B	1.2524	1.2605	.0081	1.2764	1.2811	.0047	1.3125
1 3/8	18	NEF–3B	1.3149	1.3230	.0081	1.3389	1.3436	.0047	1.3750
1 7/16	18	NEF–3B	1.3774	1.3855	.0081	1.4014	1.4062	.0048	1.4375
1 1/2	18	NEF–3B	1.4399	1.4480	.0081	1.4639	1.4687	.0048	1.5000
1 9/16	18	NEF–3B	1.5024	1.5105	.0081	1.5264	1.5312	.0048	1.5625
1 5/8	18	NEF–3B	1.5649	1.5730	.0081	1.5889	1.5937	.0048	1.6250
1 11/16	18	NEF–3B	1.6274	1.6355	.0081	1.6514	1.6563	.0049	1.6875

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.

[2] The maximum major diameter of the internal thread may be determined by adding 0.7939p(=11/12*H*, table XV.1) to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes larger than 1 11/16 inch use the 16-thread series. See table XV.36.

TABLE XV.25.—*Limits of size, 8-thread series, external threads, class 2A*

8N–2A

Designation			External thread limits of size [1] [2]									
Size	Threads per inch	Thread symbol	Allow-ance	Major diameter					Pitch diameter			Minor di-ameter, ref.[5]
				Limits			Tolerance		Limits		Toler-ance	
				Max	Min [3]	Min [4]	(3)	(4)	Max	Min		
1	2	3	4	5	6	7	8	9	10	11	12	13
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/8	8	N–2A	0.0021	1.1229	1.1079	1.1004	0.0150	0.0225	1.0417	1.0348	0.0069	0.9695
1 1/4	8	N–2A	.0021	1.2479	1.2329	1.2254	.0150	.0225	1.1667	1.1597	.0070	1.0945
1 3/8	8	N–2A	.0022	1.3728	1.3578	1.3503	.0150	.0225	1.2916	1.2844	.0072	1.2194
1 1/2	8	N–2A	.0022	1.4978	1.4828	1.4753	.0150	.0225	1.4166	1.4093	.0073	1.3444
1 5/8	8	N–2A	.0022	1.6228	1.6078	1.6003	.0150	.0225	1.5416	1.5342	.0074	1.4694
1 3/4	8	N–2A	.0023	1.7477	1.7327	1.7252	.0150	.0225	1.6665	1.6590	.0075	1.5943
1 7/8	8	N–2A	.0023	1.8727	1.8577	1.8502	.0150	.0225	1.7915	1.7838	.0077	1.7193
2	8	N–2A	.0023	1.9977	1.9827	1.9752	.0150	.0225	1.9165	1.9037	.0078	1.8443
2 1/8	8	N–2A	.0024	2.1226	2.1076	2.1001	.0150	.0225	2.0414	2.0335	.0079	1.9692
2 1/4	8	N–2A	.0024	2.2476	2.2326	2.2251	.0150	.0225	2.1664	2.1584	.0080	2.0942
2 1/2	8	N–2A	.0024	2.4976	2.4826	2.4751	.0150	.0225	2.4164	2.4082	.0082	2.3442
2 3/4	8	N–2A	.0025	2.7475	2.7325	2.7250	.0150	.0225	2.6663	2.6580	.0083	2.5941
3	8	N–2A	.0026	2.9974	2.9824	2.9749	.0150	.0225	2.9162	2.9077	.0085	2.8440
3 1/4	8	N–2A	.0026	3.2474	3.2324	3.2249	.0150	.0225	3.1662	3.1575	.0087	3.0940
3 1/2	8	N–2A	.0026	3.4974	3.4824	3.4749	.0150	.0225	3.4162	3.4074	.0088	3.3440
3 3/4	8	N–2A	.0027	3.7473	3.7323	3.7248	.0150	.0225	3.6661	3.6571	.0090	3.5939
4	8	N–2A	.0027	3.9973	3.9823	3.9748	.0150	.0225	3.9161	3.9070	.0091	3.8439
4 1/4	8	N–2A	.0028	4.2472	4.2322	4.2247	.0150	.0225	4.1660	4.1567	.0093	4.0938
4 1/2	8	N–2A	.0028	4.4972	4.4822	4.4747	.0150	.0225	4.4160	4.4066	.0094	4.3438
4 3/4	8	N–2A	.0029	4.7471	4.7321	4.7246	.0150	.0225	4.6659	4.6564	.0095	4.5937
5	8	N–2A	.0029	4.9971	4.9821	4.9746	.0150	.0225	4.9159	4.9062	.0097	4.8437
5 1/4	8	N–2A	.0029	5.2471	5.2321	5.2246	.0150	.0225	5.0659	5.0561	.0098	5.0937
5 1/2	8	N–2A	.0030	5.4970	5.4820	5.4745	.0150	.0225	5.4158	5.4059	.0099	5.3436
5 3/4	8	N–2A	.0030	5.7470	5.7320	5.7245	.0150	.0225	5.6658	5.6558	.0100	5.5936
6	8	N–2A	.0030	5.9970	5.9820	5.9745	.0150	.0225	5.9158	5.9056	.0102	5.8436

[1] The values in this table are based on a length of engagement equal to the nominal diameter.
[2] Maximum limits (columns 5, 10, and 13) are increased by the amount of the allowance (column 4) for threads which are electroplated or have coatings of similar thicknesses.
[3] For semifinished and finished screws and bolts, threaded portion only.
[4] For unfinished hot rolled material, threaded portion only.
[5] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting 0.0812 inch from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—The 1″–8 size is in the coarse thread series, table XV.11.

Table XV.26.—*Limits of size, 8-thread series, internal threads, class 2B*

8N–2B

Designation			Internal thread limits of size [1]						
			Minor diameter			Pitch diameter			Major diameter, min [2]
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/8	8	N-2B	0. 9897	1. 0047	0. 0150	1. 0438	1. 0528	0. 0090	1. 1250
1 1/4	8	N-2B	1. 1147	1. 1297	. 0150	1. 1688	1. 1780	. 0092	1. 2500
1 3/8	8	N-2B	1. 2397	1. 2547	. 0150	1. 2938	1. 3031	. 0093	1. 3750
1 1/2	8	N-2B	1. 3647	1. 3797	. 0150	1. 4188	1. 4283	. 0095	1. 5000
1 5/8	8	N-2B	1. 4897	1. 5047	. 0150	1. 5438	1. 5535	. 0097	1. 6250
1 3/4	8	N-2B	1. 6147	1. 6297	. 0150	1. 6688	1. 6786	. 0098	1. 7500
1 7/8	8	N-2B	1. 7397	1. 7547	. 0150	1. 7938	1. 8038	. 0100	1. 8750
2	8	N-2B	1. 8647	1. 8797	. 0150	1. 9188	1. 9289	. 0101	2. 0000
2 1/8	8	N-2B	1. 9897	2. 0047	. 0150	2. 0438	2. 0540	. 0102	2. 1250
2 1/4	8	N-2B	2. 1147	2. 1297	. 0150	2. 1688	2. 1792	. 0104	2. 2500
2 1/2	8	N-2B	2. 3647	2. 3797	. 0150	2. 4188	2. 4294	. 0106	2. 5000
2 3/4	8	N-2B	2. 6147	2. 6297	. 0150	2. 6688	2. 6796	. 0108	2. 7500
3	8	N-2B	2. 8647	2. 8797	. 0150	2. 9188	2. 9299	. 0111	3. 0000
3 1/4	8	N-2B	3. 1147	3. 1297	. 0150	3. 1688	3. 1801	. 0113	3. 2500
3 1/2	8	N-2B	3. 3647	3. 3797	. 0150	3. 4188	3. 4303	. 0115	3. 5000
3 3/4	8	N-2B	3. 6147	3. 6297	. 0150	3. 6688	3. 6805	. 0117	3. 7500
4	8	N-2B	3. 8647	3. 8797	. 0150	3. 9188	3. 9307	. 0119	4. 0000
4 1/4	8	N-2B	4. 1147	4. 1297	. 0150	4. 1688	4. 1809	. 0121	4. 2500
4 1/2	8	N-2B	4. 3647	4. 3797	. 0150	4. 4188	4. 4310	. 0122	4. 5000
4 3/4	8	N-2B	4. 6147	4. 6297	. 0150	4. 6688	4. 6812	. 0124	4. 7500
5	8	N-2B	4. 8647	4. 8797	. 0150	4. 9188	4. 9314	. 0126	5. 0000
5 1/4	8	N-2B	5. 1147	5. 1297	. 0150	5. 1688	5. 1815	. 0127	5. 2500
5 1/2	8	N-2B	5. 3647	5. 3797	. 0150	5. 4188	5. 4317	. 0129	5. 5000
5 3/4	8	N-2B	5. 6147	5. 6297	. 0150	5. 6688	5. 6818	. 0130	5. 7500
6	8	N-2B	5. 8647	5. 8797	. 0150	5. 9188	5. 9320	. 0132	6. 0000

[1] The values in this table are based on a length of engagement equal to the nominal diameter.
[2] The maximum major diameter of the internal thread may be determined by adding 0.0992 inch to the maximum pitch diameter of the internal thread This maximum diameter is not controlled by gages but by the form of the threading tool.

Note.—The 1″-8 size is in the coarse thread series, table XV.12.

TABLE XV.27.—*Limits of size, 8-thread series, external threads, class 3A*

8N-3A

Designation			External thread limits of size [1]						
			Major diameter			Pitch diameter			Minor diameter, ref. [2]
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	
			Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/8	8	N-3A	1.1250	1.1100	0.0150	1.0438	1.0386	0.0052	0.9716
1 1/4	8	N-3A	1.2500	1.2350	.0150	1.1688	1.1635	.0053	1.0966
1 3/8	8	N-3A	1.3750	1.3600	.0150	1.2938	1.2884	.0054	1.2216
1 1/2	8	N-3A	1.5000	1.4850	.0150	1.4188	1.4133	.0055	1.3466
1 5/8	8	N-3A	1.6250	1.6100	.0150	1.5438	1.5382	.0056	1.4716
1 3/4	8	N-3A	1.7500	1.7350	.0150	1.6688	1.6632	.0056	1.5966
1 7/8	8	N-3A	1.8750	1.8600	.0150	1.7938	1.7881	.0057	1.7216
2	8	N-3A	2.0000	1.9850	.0150	1.9188	1.9130	.0058	1.8466
2 1/8	8	N-3A	2.1250	2.1100	.0150	2.0438	2.0379	.0059	1.9716
2 1/4	8	N-3A	2.2500	2.2350	.0150	2.1688	2.1628	.0060	2.0966
2 1/2	8	N-3A	2.5000	2.4850	.0150	2.4188	2.4127	.0061	2.3466
2 3/4	8	N-3A	2.7500	2.7350	.0150	2.6688	2.6626	.0062	2.5966
3	8	N-3A	3.0000	2.9850	.0150	2.9188	2.9124	.0064	2.8466
3 1/4	8	N-3A	3.2500	3.2350	.0150	3.1688	3.1623	.0065	3.0966
3 1/2	8	N-3A	3.5000	3.4850	.0150	3.4188	3.4122	.0066	3.3466
3 3/4	8	N-3A	3.7500	3.7350	.0150	3.6688	3.6621	.0067	3.5966
4	8	N-3A	4.0000	3.9850	.0150	3.9188	3.9120	.0068	3.8466
4 1/4	8	N-3A	4.2500	4.2350	.0150	4.1688	4.1618	.0070	4.0966
4 1/2	8	N-3A	4.5000	4.4850	.0150	4.4188	4.4117	.0071	4.3466
4 3/4	8	N-3A	4.7500	4.7350	.0150	4.6688	4.6616	.0072	4.5966
5	8	N-3A	5.0000	4.9850	.0150	4.9188	4.9116	.0072	4.8466
5 1/4	8	N-3A	5.2500	5.2350	.0150	5.1688	5.1615	.0073	5.0966
5 1/2	8	N-3A	5.5000	5.4850	.0150	5.4188	5.4114	.0074	5.3466
5 3/4	8	N-3A	5.7500	5.7350	.0150	5.6688	5.6613	.0075	5.5966
6	8	N-3A	6.0000	5.9850	.0150	5.9188	5.9112	.0076	5.8466

[1] The values in this table are based on a length of engagement equal to the nominal diameter.
[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting 0.0812 inch from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—The 1″-8 size is in the coarse thread series, table XV.13.

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TABLE XV.28.—*Limits of size, 8-thread series, internal threads, class 3B*

8N–3B

Designation			Internal thread limits of size [1]						
			Minor diameter			Pitch diameter			Major diameter, min [2]
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/8	8	N-3B	0. 9897	1. 0047	0. 0150	1. 0438	1. 0505	0. 0067	1. 1250
1 1/4	8	N-3B	1. 1147	1. 1297	. 0150	1. 1688	1. 1757	. 0069	1. 2500
1 3/8	8	N-3B	1. 2397	1. 2547	. 0150	1. 2938	1. 3008	. 0070	1. 3750
1 1/2	8	N-3B	1. 3647	1. 3797	. 0150	1. 4188	1. 4259	. 0071	1. 5000
1 5/8	8	N-3B	1. 4897	1. 5047	. 0150	1. 5438	1. 5510	. 0072	1. 6250
1 3/4	8	N-3B	1. 6147	1. 6297	. 0150	1. 6688	1. 6762	. 0074	1. 7500
1 7/8	8	N-3B	1. 7397	1. 7547	. 0150	1. 7938	1. 8013	. 0075	1. 8750
2	8	N-3B	1. 8647	1. 8797	. 0150	1. 9188	1. 9264	. 0076	2. 0000
2 1/8	8	N-3B	1. 9897	2. 0047	. 0150	2. 0438	2. 0515	. 0077	2. 1250
2 1/4	8	N-3B	2. 1147	2. 1297	. 0150	2. 1688	2. 1766	. 0078	2. 2500
2 1/2	8	N-3B	2. 3647	2. 3797	. 0150	2. 4188	2. 4268	. 0080	2. 5000
2 3/4	8	N-3B	2. 6147	2. 6297	. 0150	2. 6688	2. 6769	. 0081	2. 7500
3	8	N-3B	2. 8647	2. 8797	. 0150	2. 9188	2. 9271	. 0083	3. 0000
3 1/4	8	N-3B	3. 1147	3. 1297	. 0150	3. 1688	3. 1772	. 0084	3. 2500
3 1/2	8	N-3B	3. 3647	3. 3797	. 0150	3. 4188	3. 4274	. 0086	3. 5000
3 3/4	8	N-3B	3. 6147	3. 6297	. 0150	3. 6688	3. 6776	. 0088	3. 7500
4	8	N-3B	3. 8647	3. 8797	. 0150	3. 9188	3. 9277	. 0089	4. 0000
4 1/4	8	N-3B	4. 1147	4. 1297	. 0150	4. 1688	4. 1778	. 0090	4. 2500
4 1/2	8	N-3B	4. 3647	4. 3797	. 0150	4. 4188	4. 4280	. 0092	4. 5000
4 3/4	8	N-3B	4. 6147	4. 6297	. 0150	4. 6688	4. 6781	. 0093	4. 7500
5	8	N-3B	4. 8647	4. 8797	. 0150	4. 9188	4. 9282	. 0094	5. 0000
5 1/4	8	N-3B	5. 1147	5. 1297	. 0150	5. 1688	5. 1783	. 0095	5. 2500
5 1/2	8	N-3B	5. 3647	5. 3797	. 0150	5. 4188	5. 4285	. 0097	5. 5000
5 3/4	8	N-3B	5. 6147	5. 6297	. 0150	5. 6688	5. 6786	. 0098	5. 7500
6	8	N-3B	5. 8647	5. 8797	. 0150	5. 9188	5. 9287	. 0099	6. 0000

[1] The values in this table are based on a length of engagement equal to the nominal diameter.

[2] The maximum major diameter of the internal thread may be determined by adding 0.0992 inch to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—The 1″–8 size is in the coarse thread series, table XV.14.

TABLE XV.29.—*Limits of size, 12-thread series, external threads, class 2A*

12UN–2A and 12N–2A

Designation			Allowance	External thread limits of size [1,2]						
Size	Threads per inch	Thread symbol		Major diameter			Pitch diameter		Tolerance	Minor diameter ref.[3]
				Limits		Tolerance	Limits			
				Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10	11
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/16	12	UN–2A	0.0017	1.0608	1.0494	0.0114	1.0067	1.0010	0.0057	0.9586
1 3/16	12	UN–2A	.0017	1.1858	1.1744	.0114	1.1317	1.1259	.0058	1.0836
1 5/16	12	UN–2A	.0017	1.3108	1.2994	.0114	1.2567	1.2509	.0058	1.2086
1 7/16	12	UN–2A	.0018	1.4357	1.4243	.0114	1.3816	1.3757	.0059	1.3335
1 5/8	12	N–2A	.0018	1.6232	1.6118	.0114	1.5691	1.5632	.0059	1.5210
1 3/4	12	UN–2A	.0018	1.7482	1.7368	.0114	1.6941	1.6881	.0060	1.6460
1 7/8	12	N–2A	.0018	1.8732	1.8618	.0114	1.8191	1.8131	.0060	1.7710
2	12	UN–2A	.0018	1.9982	1.9868	.0114	1.9441	1.9380	.0061	1.8960
2 1/8	12	N–2A	.0018	2.1232	2.1118	.0114	2.0691	2.0630	.0061	2.0210
2 1/4	12	UN–2A	.0018	2.2482	2.2368	.0114	2.1941	2.1880	.0061	2.1460
2 3/8	12	N–2A	.0019	2.3731	2.3617	.0114	2.3190	2.3128	.0062	2.2709
2 1/2	12	UN–2A	.0019	2.4981	2.4867	.0114	2.4440	2.4378	.0062	2.3959
2 5/8	12	N–2A	.0019	2.6231	2.6117	.0114	2.5690	2.5628	.0062	2.5209
2 3/4	12	UN–2A	.0019	2.7481	2.7367	.0114	2.6940	2.6878	.0062	2.6459
2 7/8	12	N–2A	.0019	2.8731	2.8617	.0114	2.8190	2.8127	.0063	2.7709
3	12	UN–2A	.0019	2.9981	2.9867	.0114	2.9440	2.9377	.0063	2.8959
3 1/8	12	N–2A	.0019	3.1231	3.1117	.0114	3.0690	3.0627	.0063	3.0209
3 1/4	12	UN–2A	.0019	3.2481	3.2367	.0114	3.1940	3.1877	.0063	3.1459
3 3/8	12	N–2A	.0019	3.3731	3.3617	.0114	3.3190	3.3126	.0064	3.2709
3 1/2	12	UN–2A	.0019	3.4981	3.4867	.0114	3.4440	3.4376	.0064	3.3959
3 5/8	12	N–2A	.0019	3.6231	3.6117	.0114	3.5690	3.5626	.0064	3.5209
3 3/4	12	UN–2A	.0019	3.7481	3.7367	.0114	3.6940	3.6876	.0064	3.6459
3 7/8	12	N–2A	.0020	3.8730	3.8616	.0114	3.8189	3.8124	.0065	3.7708
4	12	UN–2A	.0020	3.9980	3.9866	.0144	3.9439	3.9374	.0065	3.8958
4 1/4	12	UN–2A	.0020	4.2480	4.2366	.0114	4.1939	4.1874	.0065	4.1458
4 1/2	12	UN–2A	.0020	4.4980	4.4866	.0114	4.4439	4.4374	.0065	4.3958
4 3/4	12	UN–2A	.0020	4.7480	4.7366	.0114	4.6939	4.6872	.0067	4.6458
5	12	UN–2A	.0020	4.9980	4.9866	.0114	4.9439	4.9372	.0067	4.8958
5 1/4	12	UN–2A	.0020	5.2480	5.2366	.0114	5.1939	5.1872	.0067	5.1458
5 1/2	12	UN–2A	.0020	5.4980	5.4866	.0114	5.4439	5.4372	.0067	5.3958
5 3/4	12	UN–2A	.0021	5.7479	5.7365	.0114	5.6938	5.6869	.0069	5.6457
6	12	UN–2A	.0021	5.9979	5.9865	.0114	5.9438	5.9369	.0069	5.8957

[1] The values in this table are based on a length of engagement equal to 9 pitches, and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.
[2] Maximum limits (columns 5, 8, and 11) are increased by the amount of the allowance (column 4) for threads which are electroplated or have coatings of similar thicknesses.
[3] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting 0.0541 inch from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes less than 1 1/16 inch and for intermediate sizes from 1 1/16 to 1 5/8 inch, see the fine thread series, table XV.17.

TABLE XV.30.—*Limits of size, 12-thread series, internal threads, class 2B*

12UN–2B and 12N–2B

Designation			Internal thread limits of size [1]						
			Minor diameter			Pitch diameter			
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	Major diameter, min [2]
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/16	**12**	**UN–2B**	**0.9723**	**0.9823**	**0.0100**	**1.0084**	**1.0158**	**0.0074**	**1.0625**
1 3/16	**12**	**UN–2B**	**1.0973**	**1.1073**	**.0100**	**1.1334**	**1.1409**	**.0075**	**1.1875**
1 5/16	**12**	**UN–2B**	**1.2223**	**1.2323**	**.0100**	**1.2584**	**1.2659**	**.0075**	**1.3125**
1 7/16	**12**	**UN–2B**	**1.3473**	**1.3573**	**.0100**	**1.3834**	**1.3910**	**.0076**	**1.4375**
1 5/8	12	N–2B	1.5348	1.5448	.0100	1.5709	1.5785	.0076	1.6250
1 3/4	**12**	**UN–2B**	**1.6598**	**1.6698**	**.0100**	**1.6959**	**1.7037**	**.0078**	**1.7500**
1 7/8	12	N–2B	1.7848	1.7948	.0100	1.8209	1.8287	.0078	1.8750
2	**12**	**UN–2B**	**1.9098**	**1.9198**	**.0100**	**1.9459**	**1.9538**	**.0079**	**2.0000**
2 1/8	12	N–2B	2.0348	2.0448	.0100	2.0709	2.0788	.0079	2.1250
2 1/4	**12**	**UN–2B**	**2.1598**	**2.1698**	**.0100**	**2.1959**	**2.2038**	**.0079**	**2.2500**
2 3/8	12	N–2B	2.2848	2.2948	.0100	2.3209	2.3290	.0081	2.3750
2 1/2	**12**	**UN–2B**	**2.4098**	**2.4198**	**.0100**	**2.4459**	**2.4540**	**.0081**	**2.5000**
2 5/8	12	N–2B	2.5348	2.5448	.0100	2.5709	2.5790	.0081	2.6250
2 3/4	**12**	**UN–2B**	**2.6598**	**2.6698**	**.0100**	**2.6959**	**2.7040**	**.0081**	**2.7500**
2 7/8	12	N–2B	2.7848	2.7948	.0100	2.8209	2.8291	.0082	2.8750
3	**12**	**UN–2B**	**2.9098**	**2.9198**	**.0100**	**2.9459**	**2.9541**	**.0082**	**3.0000**
3 1/8	12	N–2B	3.0348	3.0448	.0100	3.0709	3.0791	.0082	3.1250
3 1/4	**12**	**UN–2B**	**3.1598**	**3.1698**	**.0100**	**3.1959**	**3.2041**	**.0082**	**3.2500**
3 3/8	12	N–2B	3.2848	3.2948	.0100	3.3209	3.3293	.0084	3.3750
3 1/2	**12**	**UN–2B**	**3.4098**	**3.4198**	**.0100**	**3.4459**	**3.4543**	**.0084**	**3.5000**
3 5/8	12	N–2B	3.5348	3.5448	.0100	3.5709	3.5793	.0084	3.6250
3 3/4	**12**	**UN–2B**	**3.6598**	**3.6698**	**.0100**	**3.6959**	**3.7043**	**.0084**	**3.7500**
3 7/8	12	N–2B	3.7848	3.7948	.0100	3.8209	3.8294	.0085	3.8750
4	**12**	**UN–2B**	**3.9098**	**3.9198**	**.0100**	**3.9459**	**3.9544**	**.0085**	**4.0000**
4 1/4	**12**	**UN–2B**	**4.1598**	**4.1698**	**.0100**	**4.1959**	**4.2044**	**.0085**	**4.2500**
4 1/2	**12**	**UN–2B**	**4.4098**	**4.4198**	**.0100**	**4.4459**	**4.4544**	**.0085**	**4.5000**
4 3/4	**12**	**UN–2B**	**4.6598**	**4.6698**	**.0100**	**4.6959**	**4.7046**	**.0087**	**4.7500**
5	**12**	**UN–2B**	**4.9098**	**4.9198**	**.0100**	**4.9459**	**4.9546**	**.0087**	**5.0000**
5 1/4	**12**	**UN–2B**	**5.1598**	**5.1698**	**.0100**	**5.1959**	**5.2046**	**.0087**	**5.2500**
5 1/2	**12**	**UN–2B**	**5.4098**	**5.4198**	**.0100**	**5.4459**	**5.4546**	**.0087**	**5.5000**
5 3/4	**12**	**UN–2B**	**5.6598**	**5.6698**	**.0100**	**5.6959**	**5.7049**	**.0090**	**5.7500**
6	**12**	**UN–2B**	**5.9098**	**5.9198**	**.0100**	**5.9459**	**5.9549**	**.0090**	**6.0000**

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.
[2] The maximum major diameter of the internal thread may be determined by adding 0.0662 inch to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes less than 1 1/16 inch and for intermediate sizes from 1 1/16 to 1 5/8 inch, see the fine thread series, table XV.18

TABLE XV.31.—*Limits of size, 12-thread series, external threads, class 3A*

12UN–3A and 12N–3A

Designation			External thread limits of size [1]						
			Major diameter			Pitch diameter			Minor diameter, ref. [2]
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	
			Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/16	12	UN-3A	1.0625	1.0511	0.0114	1.0084	1.0042	0.0042	0.9603
1 3/16	12	UN-3A	1.1875	1.1761	.0114	1.1334	1.1291	.0043	1.0853
1 5/16	12	UN-3A	1.3125	1.3011	.0114	1.2584	1.2541	.0043	1.2103
1 7/16	12	UN-3A	1.4375	1.4261	.0114	1.3834	1.3790	.0044	1.3353
1 5/8	12	N-3A	1.6250	1.6136	.0114	1.5709	1.5665	.0044	1.5228
1 3/4	12	UN-3A	1.7500	1.7386	.0114	1.6959	1.6914	.0045	1.6478
1 7/8	12	N-3A	1.8750	1.8636	.0114	1.8209	1.8164	.0045	1.7728
2	12	UN-3A	2.0000	1.9886	.0114	1.9459	1.9414	.0045	1.8978
2 1/8	12	N-3A	2.1250	2.1136	.0114	2.0709	2.0664	.0045	2.0228
2 1/4	12	UN-3A	2.2500	2.2386	.0114	2.1959	2.1914	.0045	2.1478
2 3/8	12	N-3A	2.3750	2.3636	.0114	2.3209	2.3163	.0046	2.2728
2 1/2	12	UN-3A	2.5000	2.4886	.0114	2.4459	2.4413	.0046	2.3978
2 5/8	12	N-3A	2.6250	2.6136	.0114	2.5709	2.5663	.0046	2.5228
2 3/4	12	UN-3A	2.7500	2.7386	.0114	2.6959	2.6913	.0046	2.6478
2 7/8	12	N-3A	2.8750	2.8636	.0114	2.8209	2.8162	.0047	2.7728
3	12	UN-3A	3.0000	2.9886	.0114	2.9459	2.9412	.0047	2.8978
3 1/8	12	N-3A	3.1250	3.1136	.0114	3.0709	3.0662	.0047	3.0228
3 1/4	12	UN-3A	3.2500	3.2386	.0114	3.1959	3.1912	.0047	3.1478
3 3/8	12	N-3A	3.3750	3.3636	.0114	3.3209	3.3161	.0048	3.2728
3 1/2	12	UN-3A	3.5000	3.4886	.0114	3.4459	3.4411	.0048	3.3978
3 5/8	12	N-3A	3.6250	3.6136	.0114	3.5709	3.5661	.0048	3.5228
3 3/4	12	UN-3A	3.7500	3.7386	.0114	3.6959	3.6911	.0048	3.6478
3 7/8	12	N-3A	3.8750	3.8636	.0114	3.8209	3.8160	.0049	3.7728
4	12	UN-3A	4.0000	3.9886	.0114	3.9459	3.9410	.0049	3.8978
4 1/4	12	UN-3A	4.2500	4.2386	.0114	4.1959	4.1910	.0049	4.1478
4 1/2	12	UN-3A	4.5000	4.4886	.0114	4.4459	4.4410	.0049	4.3978
4 3/4	12	UN-3A	4.7500	4.7386	.0114	4.6959	4.6909	.0050	4.6478
5	12	UN-3A	5.0000	4.9886	.0114	4.9459	4.9409	.0050	4.8978
5 1/4	12	UN-3A	5.2500	5.2386	.0114	5.1959	5.1909	.0050	5.1478
5 1/2	12	UN-3A	5.5000	5.4886	.0114	5.4459	5.4409	.0050	5.3978
5 3/4	12	UN-3A	5.7500	5.7386	.0114	5.6959	5.6907	.0052	5.6478
6	12	UN-3A	6.0000	5.9886	.0114	5.9459	5.9407	.0052	5.8978

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.

[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting 0.0541 inch from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes less than 1 1/16 inch and for intermediate sizes from 1 1/16 to 1 5/8 inch, see the fine thread series, table XV.19.

Table XV.32.—*Limits of size, 12-thread series, internal threads, class 3B*

12UN–3B and 12N–3B

Designation			Internal thread limits of size [1]						
			Minor diameter			Pitch diameter			Major diameter, min [2]
			Limits		Tolerance	Limits		Tolerance	
Size	Threads per inch	Thread symbol	Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 1/16	12	UN–3B	0.9723	0.9823	0.0100	1.0084	1.0139	0.0055	1.0625
1 3/16	12	UN–3B	1.0973	1.1073	.0100	1.1334	1.1390	.0056	1.1875
1 5/16	12	UN–3B	1.2223	1.2323	.0100	1.2584	1.2640	.0056	1.3125
1 7/16	12	UN–3B	1.3473	1.3573	.0100	1.3834	1.3891	.0057	1.4375
1 5/8	12	N–3B	1.5348	1.5448	.0100	1.5709	1.5766	.0057	1.6250
1 3/4	12	UN–3B	1.6598	1.6698	.0100	1.6959	1.7017	.0058	1.7500
1 7/8	12	N–3B	1.7848	1.7948	.0100	1.8209	1.8267	.0058	1.8750
2	12	UN–3B	1.9098	1.9198	.0100	1.9459	1.9518	.0059	2.0000
2 1/8	12	N–3B	2.0348	2.0448	.0100	2.0709	2.0768	.0059	2.1250
2 1/4	12	UN–3B	2.1598	2.1698	.0100	2.1959	2.2018	.0059	2.2500
2 3/8	12	N–3B	2.2848	2.2948	.0100	2.3209	2.3269	.0060	2.3750
2 1/2	12	UN–3B	2.4098	2.4198	.0100	2.4459	2.4519	.0060	2.5000
2 5/8	12	N–3B	2.5348	2.5448	.0100	2.5709	2.5769	.0060	2.6250
2 3/4	12	UN–3B	2.6598	2.6698	.0100	2.6959	2.7019	.0060	2.7500
2 7/8	12	N–3B	2.7848	2.7948	.0100	2.8209	2.8271	.0062	2.8750
3	12	UN–3B	2.9098	2.9198	.0100	2.9459	2.9521	.0062	3.0000
3 1/8	12	N–3B	3.0348	3.0448	.0100	3.0709	3.0771	.0062	3.1250
3 1/4	12	UN–3B	3.1598	3.1698	.0100	3.1959	3.2021	.0062	3.2500
3 3/8	12	N–3B	3.2848	3.2948	.0100	3.3209	3.3272	.0063	3.3750
3 1/2	12	UN–3B	3.4098	3.4198	.0100	3.4459	3.4522	.0063	3.5000
3 5/8	12	N–3B	3.5348	3.5448	.0100	3.5709	3.5772	.0063	3.6250
3 3/4	12	UN–3B	3.6598	3.6698	.0100	3.6959	3.7022	.0063	3.7500
3 7/8	12	N–3B	3.7848	3.7948	.0100	3.8209	3.8273	.0064	3.8750
4	12	UN–3B	3.9098	3.9198	.0100	3.9459	3.9523	.0064	4.0000
4 1/4	12	UN–3B	4.1598	4.1698	.0100	4.1959	4.2023	.0064	4.2500
4 1/2	12	UN–3B	4.4098	4.4198	.0100	4.4459	4.4523	.0064	4.5000
4 3/4	12	UN–3B	4.6598	4.6698	.0100	4.6959	4.7024	.0065	4.7500
5	12	UN–3B	4.9098	4.9198	.0100	4.9459	4.9525	.0066	5.0000
5 1/4	12	UN–3B	5.1598	5.1698	.0100	5.1959	5.2025	.0066	5.2500
5 1/2	12	UN–3B	5.4098	5.4198	.0100	5.4459	5.4525	.0066	5.5000
5 3/4	12	UN–3B	5.6598	5.6698	.0100	5.6959	5.7026	.0067	5.7500
6	12	UN–3B	5.9098	5.9198	.0100	5.9459	5.9526	.0067	6.0000

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.
[2] The maximum major diameter of the internal thread may be determined by adding 0.0662 inch to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

Note.—For sizes less than 1 1/16 inches and for intermediate sizes from 1 1/16 to 1 5/8 inches, see the fine thread series. See table XV.20.

TABLE XV.33.—*Limits of size, 16-thread series, external threads, class 2A*

16UN–2A and 16N–2A

Designation			External thread limits of size [1] [2]							
Size	Threads per inch	Thread symbol	Allowance	Major diameter			Pitch diameter			Minor diameter, ref.[3]
				Limits		Tolerance	Limits		Tolerance	
				Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10	11
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 3/4	16	UN-2A	0.0016	1.7484	1.7390	0.0094	1.7078	1.7025	0.0053	1.6717
1 13/16	16	N-2A	.0016	1.8109	1.8015	.0094	1.7703	1.7650	.0053	1.7342
1 7/8	16	N-2A	.0016	1.8734	1.8640	.0094	1.8328	1.8275	.0053	1.7967
1 15/16	16	N-2A	.0016	1.9359	1.9265	.0094	1.8953	1.8899	.0054	1.8592
2	16	UN-2A	.0016	1.9984	1.9890	.0094	1.9578	1.9524	.0054	1.9217
2 1/16	16	N-2A	.0016	2.0609	2.0515	.0094	2.0203	2.0149	.0054	1.9842
2 1/8	16	N-2A	.0016	2.1234	2.1140	.0094	2.0828	2.0774	.0054	2.0467
2 3/16	16	N-2A	.0016	2.1859	2.1765	.0094	2.1453	2.1399	.0054	2.1092
2 1/4	16	UN-2A	.0016	2.2484	2.2390	.0094	2.2078	2.2024	.0054	2.1717
2 5/16	16	N-2A	.0017	2.3108	2.3014	.0094	2.2702	2.2647	.0055	2.2341
2 3/8	16	N-2A	.0017	2.3733	2.3639	.0094	2.3327	2.3272	.0055	2.2966
2 7/16	16	N-2A	.0017	2.4358	2.4264	.0094	2.3952	2.3897	.0055	2.3591
2 1/2	16	UN-2A	.0017	2.4983	2.4889	.0094	2.4577	2.4522	.0055	2.4216
2 5/8	16	N-2A	.0017	2.6233	2.6139	.0094	2.5827	2.5772	.0055	2.5466
2 3/4	16	UN-2A	.0017	2.7483	2.7389	.0094	2.7077	2.7022	.0055	2.6716
2 7/8	16	N-2A	.0017	2.8733	2.8639	.0094	2.8327	2.8271	.0056	2.7966
3	16	UN-2A	.0017	2.9983	2.9889	.0094	2.9577	2.9521	.0056	2.9216
3 1/8	16	N-2A	.0017	3.1233	3.1139	.0094	3.0827	3.0771	.0056	3.0466
3 1/4	16	UN-2A	.0017	3.2483	3.2389	.0094	3.2077	3.2021	.0056	3.1716
3 3/8	16	N-2A	.0017	3.3733	3.3639	.0094	3.3327	3.3269	.0058	3.2966
3 1/2	16	UN-2A	.0017	3.4983	3.4889	.0094	3.4577	3.4519	.0058	3.4216
3 5/8	16	N-2A	.0017	3.6233	3.6139	.0094	3.5827	3.5769	.0058	3.5466
3 3/4	16	UN-2A	.0017	3.7483	3.7389	.0094	3.7077	3.7019	.0058	3.6716
3 7/8	16	N-2A	.0018	3.8732	3.8638	.0094	3.8326	3.8267	.0059	3.7965
4	16	UN-2A	.0018	3.9982	3.9888	.0094	3.9576	3.9517	.0059	3.9215
4 1/4	16	UN-2A	.0018	4.2482	4.2388	.0094	4.2076	4.2017	.0059	4.1715
4 1/2	16	UN-2A	.0018	4.4982	4.4888	.0094	4.4576	4.4517	.0059	4.4215
4 3/4	16	UN-2A	.0018	4.7482	4.7388	.0094	4.7076	4.7015	.0061	4.6715
5	16	UN-2A	.0018	4.9982	4.9888	.0094	4.9576	4.9515	.0061	4.9215
5 1/4	16	UN-2A	.0018	5.2482	5.2388	.0094	5.2076	5.2015	.0061	5.1715
5 1/2	16	UN-2A	.0018	5.4982	5.4888	.0094	5.4576	5.4515	.0061	5.4215
5 3/4	16	UN-2A	.0019	5.7481	5.7387	.0094	5.7075	5.7013	.0062	5.6714
6	16	UN-2A	.0019	5.9981	5.9887	.0094	5.9575	5.9513	.0062	5.9214

[1] The values in this table are based on a length of engagement equal to 9 pitches, and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.

[2] Maximum limits (columns 5, 8, and 11) are increased by the amount of the allowance (column 4) for threads which are electroplated or have coatings of similar thicknesses.

[3] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting 0.0406 inch from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes less than 1 3/4 inch, see the extra-fine thread series, table XV.21.

TABLE XV.34.—*Limits of size, 16-thread series, internal threads, class 2B*

16UN–2B and 16N–2B

Designation			Internal thread limits of size [1]						
Size	Threads per inch	Thread symbol	Minor diameter			Pitch diameter			Major diameter, min [2]
			Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 3/4	**16**	**UN–2B**	**1.6823**	**1.6908**	**0.0085**	**1.7094**	**1.7163**	**0.0069**	**1.7500**
1 13/16	16	N–2B	1.7448	1.7533	.0085	1.7719	1.7788	.0069	1.8125
1 7/8	16	N–2B	1.8073	1.8158	.0085	1.8344	1.8413	.0069	1.8750
1 15/16	16	N–2B	1.8698	1.8783	.0085	1.8969	1.9039	.0070	1.9375
2	**16**	**UN–2B**	**1.9323**	**1.9408**	**.0085**	**1.9594**	**1.9664**	**.0070**	**2.0000**
2 1/16	16	N–2B	1.9948	2.0033	.0085	2.0219	2.0289	.0070	2.0625
2 1/8	16	N–2B	2.0573	2.0658	.0085	2.0844	2.0914	.0070	2.1250
2 3/16	16	N–2B	2.1198	2.1283	.0085	2.1469	2.1539	.0070	2.1875
2 1/4	**16**	**UN–2B**	**2.1823**	**2.1908**	**.0085**	**2.2094**	**2.2164**	**.0070**	**2.2500**
2 5/16	16	N–2B	2.2448	2.2533	.0085	2.2719	2.2791	.0072	2.3125
2 3/8	16	N–2B	2.3073	2.3158	.0085	2.3344	2.3416	.0072	2.3750
2 7/16	16	N–2B	2.3698	2.3783	.0085	2.3969	2.4041	.0072	2.4375
2 1/2	**16**	**UN–2B**	**2.4323**	**2.4408**	**.0085**	**2.4594**	**2.4666**	**.0072**	**2.5000**
2 5/8	16	N–2B	2.5573	2.5658	.0085	2 5844	2.5916	.0072	2.6250
2 3/4	**16**	**UN–2B**	**2.6823**	**2.6908**	**.0085**	**2.7094**	**2.7166**	**.0072**	**2.7500**
2 7/8	16	N–2B	2.8073	2.8158	.0085	2.8344	2.8417	.0073	2.8750
3	**16**	**UN–2B**	**2.9323**	**2.9408**	**.0085**	**2.9594**	**2.9667**	**.0073**	**3.0000**
3 1/8	16	N–2B	3.0573	3.0658	.0085	3.0844	3.0917	.0073	3.1250
3 1/4	**16**	**UN–2B**	**3.1823**	**3.1908**	**.0085**	**3.2094**	**3.2167**	**.0073**	**3.2500**
3 3/8	16	N–2B	3.3073	3.3158	.0085	3.3344	3.3419	.0075	3.3750
3 1/2	**16**	**UN–2B**	**3.4323**	**3.4408**	**.0085**	**3.4594**	**3.4669**	**.0075**	**3.5000**
3 5/8	16	N–2B	3.5573	3.5658	.0085	3.5844	3.5919	.0075	3.6250
3 3/4	**16**	**UN–2B**	**3.6823**	**3.6908**	**.0085**	**3.7094**	**3.7169**	**.0075**	**3.7500**
3 7/8	16	N–2B	3.8073	3.8158	.0085	3.8344	3.8420	.0076	3.8750
4	**16**	**UN–2B**	**3.9323**	**3.9408**	**.0085**	**3.9594**	**3.9670**	**.0076**	**4.0000**
4 1/4	**16**	**UN–2B**	**4.1823**	**4.1908**	**.0085**	**4.2094**	**4.2170**	**.0076**	**4.2500**
4 1/2	**16**	**UN–2B**	**4.4323**	**4.4408**	**.0085**	**4.4594**	**4.4670**	**.0076**	**4.5000**
4 3/4	**16**	**UN–2B**	**4.6823**	**4.6908**	**.0085**	**4.7094**	**4.7173**	**.0079**	**4.7500**
5	**16**	**UN–2B**	**4.9323**	**4.9408**	**.0085**	**4.9594**	**4.9673**	**.0079**	**5.0000**
5 1/4	**16**	**UN–2B**	**5.1823**	**5.1908**	**.0085**	**5.2094**	**5.2173**	**.0079**	**5.2500**
5 1/2	**16**	**UN–2B**	**5.4323**	**5.4408**	**.0085**	**5.4594**	**5.4673**	**.0079**	**5.5000**
5 3/4	**16**	**UN–2B**	**5.6823**	**5.6908**	**.0085**	**5.7094**	**5.7175**	**.0081**	**5.7500**
6	**16**	**UN–2B**	**5.9323**	**5.9408**	**.0085**	**5.9594**	**5.9675**	**.0081**	**6.0000**

[1] The values in this table are based on a length of engagement equal to 9 pitches, and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.
[2] The maximum major diameter of the internal thread may be determined by adding 0.0496 inch to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes less than 1 3/4 inch, see the extra-fine thread series, table XV.22.

TABLE XV.35.—*Limits of size, 16-thread series, external threads, class 3A*

16UN–3A and 16N–3A

Designation			External thread limits of size [1]						
			Major diameter			Pitch Diameter			
Size	Threads per inch	Thread symbol	Limits		Tolerance	Limits		Tolerance	Minor diameter, ref.[2]
			Max	Min		Max	Min		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 3/4	16	**UN–3A**	**1.7500**	**1.7406**	**0.0094**	**1.7094**	**1.7054**	**0.0040**	**1.6733**
1 13/16	16	N–3A	1.8125	1.8031	.0094	1.7719	1.7679	.0040	1.7358
1 7/8	16	N–3A	1.8750	1.8656	.0094	1.8344	1.8304	.0040	1.7983
1 15/16	16	N–3A	1.9375	1.9281	.0094	1.8969	1.8929	.0040	1.8608
2	**16**	**UN–3A**	**2.0000**	**1.9906**	**.0094**	**1.9594**	**1.9554**	**.0040**	**1.9233**
2 1/16	16	N–3A	2.0625	2.0531	.0094	2.0219	2.0179	.0040	1.9858
2 1/8	16	N–3A	2.1250	2.1156	.0094	2.0844	2.0804	.0040	2.0483
2 3/16	16	N–3A	2.1875	2.1781	.0094	2.1469	2.1429	.0040	2.1108
2 1/4	**16**	**UN–3A**	**2.2500**	**2.2406**	**.0094**	**2.2094**	**2.2054**	**.0040**	**2.1733**
2 5/16	16	N–3A	2.3125	2.3031	.0094	2.2719	2.2678	.0041	2.2358
2 3/8	16	N–3A	2.3750	2.3656	.0094	2.3344	2.3303	.0041	2.2983
2 7/16	16	N–3A	2.4375	2.4281	.0094	2.3969	2.3928	.0041	2.3608
2 1/2	**16**	**UN–3A**	**2.5000**	**2.4906**	**.0094**	**2.4594**	**2.4553**	**.0041**	**2.4233**
2 5/8	16	N–3A	2.6250	2.6156	.0094	2.5844	2.5803	.0041	2.5483
2 3/4	**16**	**UN–3A**	**2.7500**	**2.7406**	**.0094**	**2.7094**	**2.7053**	**.0041**	**2.6733**
2 7/8	16	N–3A	2.8750	2.8656	.0094	2.8344	2.8302	.0042	2.7983
3	**16**	**UN–3A**	**3.0000**	**2.9906**	**.0094**	**2.9594**	**2.9552**	**.0042**	**2.9233**
3 1/8	16	N–3A	3.1250	3.1156	.0094	3.0844	3.0802	.0042	3.0483
3 1/4	**16**	**UN–3A**	**3.2500**	**3.2406**	**.0094**	**3.2094**	**3.2052**	**.0042**	**3.1733**
3 3/8	16	N–3A	3.3750	3.3656	.0094	3.3344	3.3301	.0043	3.2983
3 1/2	**16**	**UN–3A**	**3.5000**	**3.4906**	**.0094**	**3.4594**	**3.4551**	**.0043**	**3.4233**
3 5/8	16	N–3A	3.6250	3.6156	.0094	3.5844	3.5801	.0043	3.5483
3 3/4	**16**	**UN–3A**	**3.7500**	**3.7406**	**.0094**	**3.7094**	**3.7051**	**.0043**	**3.6733**
3 7/8	16	N–3A	3.8750	3.8656	.0094	3.8344	3.8300	.0044	3.7983
4	**16**	**UN–3A**	**4.0000**	**3.9906**	**.0094**	**3.9594**	**3.9550**	**.0044**	**3.9233**
4 1/4	**16**	**UN–3A**	**4.2500**	**4.2406**	**.0094**	**4.2094**	**4.2050**	**.0044**	**4.1733**
4 1/2	**16**	**UN–3A**	**4.5000**	**4.4906**	**.0094**	**4.4594**	**4.4550**	**.0044**	**4.4233**
4 3/4	**16**	**UN–3A**	**4.7500**	**4.7406**	**.0094**	**4.7094**	**4.7049**	**.0045**	**4.6733**
5	**16**	**UN–3A**	**5.0000**	**4.9906**	**.0094**	**4.9594**	**4.9549**	**.0045**	**4.9233**
5 1/4	**16**	**UN–3A**	**5.2500**	**5.2406**	**.0094**	**5.2094**	**5.2049**	**.0045**	**5.1733**
5 1/2	**16**	**UN–3A**	**5.5000**	**5.4906**	**.0094**	**5.4594**	**5.4549**	**.0045**	**5.4233**
5 3/4	**16**	**UN–3A**	**5.7500**	**5.7406**	**.0094**	**5.7094**	**5.7047**	**.0047**	**5.6733**
6	**16**	**UN–3A**	**6.0000**	**5.9906**	**.0094**	**5.9594**	**5.9547**	**.0047**	**5.9233**

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.

[2] Maximum minor diameter corresponding to a rounded root contour (but which is not a gage dimension). The minimum minor diameter may be determined by subtracting 0.0406 inch from the minimum pitch diameter of the external thread. This minimum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes less than 1 3/4 inch see the extra-fine thread series, table XV.23.

TABLE XV.36.—*Limits of size, 16-thread series, internal threads, class 3B*

16UN–3B and 16N–3B

Designation			Internal thread limits of size [1]						
Size	Threads per inch	Thread symbol	Minor diameter			Pitch Diameter			Major diameter, min [2]
			Limits		Tolerance	Limits		Tolerance	
			Min	Max		Min	Max		
1	2	3	4	5	6	7	8	9	10
in.			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1 3/4	16	UN-3B	1.6823	1.6908	0.0085	1.7094	1.7146	0.0052	1.7500
1 13/16	16	N-3B	1.7448	1.7533	.0085	1.7719	1.7771	.0052	1.8125
1 7/8	16	N-3B	1.8073	1.8158	.0085	1.8344	1.8396	.0052	1.8750
1 15/16	16	N-3B	1.8698	1.8783	.0085	1.8969	1.9021	.0052	1.9375
2	16	UN-3B	1.9323	1.9408	.0085	1.9594	1.9646	.0052	2.0000
2 1/16	16	N-3B	1.9948	2.0033	.0085	2.0219	2.0271	.0052	2.0625
2 1/8	16	N-3B	2.0573	2.0658	.0085	2.0844	2.0896	.0052	2.1250
2 3/16	16	N-3B	2.1198	2.1283	.0085	2.1469	2.1521	.0052	2.1875
2 1/4	16	UN-3B	2.1823	2.1908	.0085	2.2094	2.2146	.0052	2.2500
2 5/16	16	N-3B	2.2448	2.2533	.0085	2.2719	2.2773	.0054	2.3125
2 3/8	16	N-3B	2.3073	2.3158	.0085	2.3344	2.3398	.0054	2.3750
2 7/16	16	N-3B	2.3698	2.3783	.0085	2.3969	2.4023	.0054	2.4375
2 1/2	16	UN-3B	2.4323	2.4408	.0085	2.4594	2.4648	.0054	2.5000
2 5/8	16	N-3B	2.5573	2.5658	.0085	2.5844	2.5898	.0054	2.6250
2 3/4	16	UN-3B	2.6823	2.6908	.0085	2.7094	2.7148	.0054	2.7500
2 7/8	16	N-3B	2.8073	2.8158	.0085	2.8344	2.8399	.0055	2.8750
3	16	UN-3B	2.9323	2.9408	.0085	2.9594	2.9649	.0055	3.0000
3 1/8	16	N-3B	3.0573	3.0658	.0085	3.0844	3.0899	.0055	3.1250
3 1/4	16	UN-3B	3.1823	3.1908	.0085	3.2094	3.2149	.0055	3.2500
3 3/8	16	N-3B	3.3073	3.3158	.0085	3.3344	3.3400	.0056	3.3750
3 1/2	16	UN-3B	3.4323	3.4408	.0085	3.4594	3.4650	.0056	3.5000
3 5/8	16	N-3B	3.5573	3.5658	.0085	3.5844	3.5900	.0056	3.6250
3 3/4	16	UN-3B	3.6823	3.6908	.0085	3.7094	3.7150	.0056	3.7500
3 7/8	16	N-3B	3.8073	3.8158	.0085	3.8344	3.8401	.0057	3.8750
4	16	UN-3B	3.9323	3.9408	.0085	3.9594	3.9651	.0057	4.0000
4 1/4	16	UN-3B	4.1823	4.1908	.0085	4.2094	4.2151	.0057	4.2500
4 1/2	16	UN-3B	4.4323	4.4408	.0085	4.4594	4.4651	.0057	4.5000
4 3/4	16	UN-3B	4.6823	4.6908	.0085	4.7094	4.7153	.0059	4.7500
5	16	UN-3B	4.9323	4.9408	.0085	4.9594	4.9653	.0059	5.0000
5 1/4	16	UN-3B	5.1823	5.1908	.0085	5.2094	5.2153	.0059	5.2500
5 1/2	16	UN-3B	5.4323	5.4408	.0085	5.4594	5.4653	.0059	5.5000
5 3/4	16	UN-3B	5.6823	5.6908	.0085	5.7094	5.7155	.0061	5.7500
6	16	UN-3B	5.9323	5.9408	.0085	5.9594	5.9655	.0061	6.0000

[1] The values in this table are based on a length of engagement equal to 9 pitches and pitch diameter tolerances are taken from ASA B1.1–1949 step tables.
[2] The maximum major diameter of the internal thread may be determined by adding 0.0496 inch to the maximum pitch diameter of the internal thread. This maximum diameter is not controlled by gages but by the form of the threading tool.

NOTE.—For sizes less than 1 3/4 inch, see the extra-fine thread series, table XV.24.

6. GAGES

The specifications for gages beginning on page 3 of this Supplement and beginning on page 29 of Handbook H28(1944) are applicable to Unified screw threads, with the following exceptions:

1. "Go" Thread Ring Gages.—The minor diameter of the classes 1A and 2A "go" thread ring gages shall be equal to the minimum minor diameter of the mating internal thread minus the allowance on the externally threaded product. The minor diameter gage tolerance is minus.

2. Setting Plugs for "Not Go" (LO) Thread Ring Gages.—The major diameter of the basic-form setting plug for the "not go" (LO) thread ring or snap gage shall be the same as that of the full portion of the truncated setting plug. The method of calculating this major diameter is that specified on pp. 4–5 of this Supplement for the full portion of the truncated setting plug, except that for 64 threads per inch and coarser the width of flat shall be not less than $0.067p$ (corresponding to $0.058p$ truncation) and 0.001 in., for finer pitches.

7. USE OF EXISTING THREAD GAGES

As a measure of economy in the adoption of the new Unified threads, a considerable proportion of existing thread gages and setting plugs made for classes 1, 2, or 3 can be utilized in the acceptance gaging of the Unified classes until such time as they become worn and require replacement by gages conforming to the Unified limits.

There are shown below which of the existing NC and NF thread gages for classes 1, 2, or 3 threads may be used to gage threads of the new UNC and UNF classes 1A, 2A, 3A, 1B, 2B, or 3B. It is also indicated where new gages are required to gage the new Unified classes. The ½″–13 NC and 1″–14 NF gages are, of course, not applicable to the ½″–12 UNC and 1″–12 UNF threads.

This summary is predicated on the basis that gages of the old classes are either identical with or moderately outside of the pitch diameter product limits of the new classes, or, if inside, the difference between them does not exceed 0.0003 in. for sizes 1 in. and less in size and 0.0005 in. for sizes larger than 1 in. This assures that product made to unified classes either conforms to those classes or conforms closely to them within the limits of correspondingly designated American National classes.

Although this summary covers only the UNC and UNF series, the same general principles can be applied to the extra-fine, 8-, 12-, and 16-thread series and special threads. When it is desired to utilize existing gages, each such thread should be investigated to determine their applicability.

"Go" Thread Gages

Class 1A. UNC series: New "go" gages are required.
UNF series: From ¼ to ¾ in., inclusive, class 1 gages are applicable. For other sizes new gages are required.

Class 2A. UNC and UNF series: For plated product basic-size gages (same as for classes 2 or 3) are applicable. For unplated product, unless the specified 2A allowance is required, basic-size gages are likewise applicable.

Class 3A. UNC and UNF series: Basic-size gages (same as classes 2 or 3) are applicable.

Class 1B. UNC and UNF series: Basic-size gages are applicable.

Class 2B. UNC and UNF series: Basic-size gages are applicable.

Class 3B. UNC and UNF series: Basic-size gages are applicable.

"Not Go" Thread Gages

Also Designated Low Limit, "LO", and High Limit, "HI", Thread Gages

Class 1A. UNC series: Class 1 gages are applicable. (That is, product which is acceptable to class 1A gages is also acceptable to class 1 gages.)
UNF series: New gages are required.

Class 2A. UNC series: In sizes 1⅜ and from 1¾ to 3½ in., inclusive, class 2 gages are applicable. For other sizs new gages are required.
UNF series: New gages are required.

Class 3A. UNC series: Class 3 gages are applicable.
UNF series: In sizes ¼ to 5/16 in., inclusive, class 3 gages are applicable. For other sizes new gages are required.

Class 1B. UNC series: In sizes 2, 2½, and 2¾ in., class 1 gages are applicable. For other sizes new gages are required.
UNF series: New gages are required.

Class 2B. UNC series: In sizes from No. 1 to ⅞ in., inclusive, class 1 gages are applicable if an increase in tolerance up to about 20 per cent is not objectionable; in sizes from 1⅜ to 3¾ in., inclusive, class 2 gages are applicable.
UNF series: Class 1 gages are applicable except for the ½ in. size.

Class 3B. UNC series: In sizes No. 1 to 7/16 in., inclusive, class 2 gages are applicable. For other sizes new gages are required.
UNF series: In sizes No. 0 to 5/16 in., class 2 gages are applicable. For other sizes new gages are required.

SECTION XVI. UNIFIED THREADS OF SPECIAL DIAMETERS, PITCHES, AND LENGTHS OF ENGAGEMENT

1. INTRODUCTION

The thread series, tolerances, and allowances specified in section XV of this Handbook apply in general to bolts, nuts, and tapped holes of standard pitches and diameters. In addition, there are large quantities of threaded parts produced where the relations of diameter to pitch are necessarily different from those of the standard thread series, and the lengths of engagement either shorter or longer than for bolt and nut practice. Such threads are commonly designated "special threads".

There are various degrees of specialization in the design of special threads which may be classified as follows: (1) A standard thread which is modified by the inclusion of some nonstandard feature as discussed in Section XV, p. 51. (2) A thread of a standard diameter such as is found in one or more of the thread series in Section XV associated with a standard pitch as listed in table XVI, forming a diameter-pitch combination which is not in a standard thread series; for example, 1″–10 NS. (3) A diameter of odd size such as 11/64 in. or 1.137 in. associated with a standard pitch. (4) A thread of either standard or nonstandard diameter associated with a nonstandard pitch; for example 1″–15 NS or 0.895″–27 NS. (5) A thread of any of the first four degrees of specialization to which special tolerances are applied. (6) A completely special thread which deviates from the standard Unified thread form.

TABLE XVI.1.—*Thread data,*[1] *Unified thread form*

Threads per inch, n	Pitch, p	$3/4H=$ $0.64952p$	$11/12H=$ $0.79386p$	$1\ 1/4H=$ $1.08253p$	$1\ 5/12H=$ $1.22687p$
1	2	3	4	5	6
	in.	*in.*	*in.*	*in.*	*in.*
72	0.01389	0.00902	0.01103	0.01504	0.01704
64	.01563	.01015	.01240	.01691	.01917
56	.01786	.01160	.01418	.01933	.02191
48	.02083	.01353	.01654	.02255	.02556
40	.02500	.01624	.01985	.02706	.03067
36	.02778	.01804	.02205	.03007	.03408
32	.03125	.02030	.02481	.03383	.03834
28	.03571	.02320	.02835	.03866	.04382
24	.04167	.02706	.03308	.04511	.05112
20	.05000	.03248	.03969	.05413	.06134
18	.05556	.03608	.04410	.06014	.06816
16	.06250	.04059	.04962	.06766	.07668
14	.07143	.04639	.05670	.07732	.08763
12	.08333	.05413	.06615	.09021	.10224
10	.10000	.06495	.07939	.10825	.12269
8	.12500	.08119	.09923	.13532	.15336
6	.16667	.10825	.13231	.18042	.20448
4	.25000	.16238	.19846	.27063	.30672

[1] See also table XV.1, p. 45.

In the interest of economy, the designer should adhere to standard threads or to thread features conforming as closely as possible to established standards. It should be remembered that special threads entail the design and manufacture of special threading tools and gages with consequent greater costs, increase in inventories, and difficulties in procuring spare parts when replacements are necessary.

In this section, standards for special threads are presented, including thread form, preferred diameters and pitches, allowances and tolerances, a discussion of factors affecting the design of special threads, and detailed directions for specifying special threads on drawings.

2. UNIFIED FORM OF THREAD

The Unified form of thread profile as specified in section XV, p. 43, shall be used.

3. PREFERRED DIAMETERS AND PITCHES

The use, wherever possible, of the standard thread series in section XV is recommended for all applications. Whenever sizes and pitches in the Unified or American National coarse, fine, or extra-fine, or the 8-, 12-, or 16-thread series are not suitable, the designer can usually select a diameter or pitch from a preferred list.

1. PREFERRED DIAMETERS.—Whenever possible, the basic diameter should be selected from series of diameter increments as follows:

Range	Diameter increments	
	First choice	Second choice
in.	*in.*	*in.*
1/4 to 5/8	1/16	----
5/8 to 1 1/2	1/8	1/16
1 1/2 to 6	1/4	0.1
6 to 16	1/2	1/4
16 to 24	1	1/4

It is recommended that diameters less than 1/4 inch conform to the numbered sizes of screws as there is virtually no necessity for the selection of a diameter not included in the numbered sizes. Furthermore, the coarse and fine thread series provide ample choice as to diameter-pitch combinations. It is suggested that the fine-thread series in the numbered sizes be selected unless there is a definite indication that a thread of the coarse-thread series is required.

2. PREFERRED PITCHES.—Whenever possible, the pitch should be selected from the series 40, 36, 32, 28, 24, 20, 16, 12, 10, 8, 6, and 4 threads per inch. Intermediate pitches should be used only when absolutely necessary.[1] Pitches coarser than 4 threads per inch are not recommended.

There are practical limits to both the largest and smallest diameters suitable for any pitch. The curves of figure XVI.2 stop at such limits.

3. BASIC THREAD DATA.—Basic thread data for standard pitches are given in table XVI.1. These are to be used in conjunction with the directions for specifying special threads on drawings, as given on p. 93. It will be noted that these data are based on H, the height of the fundamental triangle, whereas formerly the data were given in terms of h, the basic height of the thread. In applying these data to determine thread dimensions, the end results are the same as before.

[1] The accompanying graph, figure XVI.2, includes 14 and 18 threads per inch only because they were previously specified in Handbook H28.

4. CLASSIFICATION AND TOLERANCES

There are established for general use six distinct classes of screw-thread tolerances and two classes of allowances, as specified in the following brief outline. These classes, together with the accompanying specifications, are for the purpose of insuring the interchangeable manufacture of screw-thread parts. This standard includes Unified classes 1A, 2A, and 3A, applied to external threads only, and classes 1B, 2B, and 3B applied to internal threads only. In addition, it includes American National class 1AR, applied to external threads only, 16 threads per inch and coarser, produced by combining the American National class 1 allowances with class 1A tolerances. The requirements for a screw thread fit for specific applications can be met by specifying the proper combinations of classes for the components. For example, an external thread made to class 2A limits can be used with tapped holes made to classes 1B, 2B, or 3B limits for specific applications.

(a) GENERAL

The following general specifications apply to all classes specified for applications of the Unified form of thread.

1. Uniform Minimum Internal Thread.—The minimum major, pitch, and minor diameters of the internal thread are respectively the same for classes 1B, 2B, and 3B.

2. Direction and Scope of Tolerances.—

(*a*) The tolerance on the internal thread is plus, and is applied from the basic size to above basic size.

(*b*) The tolerance on the external thread is minus, and is applied from the maximum (or design) size to below the maximum size.

(*c*) The tolerances specified represent the extreme variations permitted on the product.

3. Basic Formula for Allowances and Tolerances.—The basic formula, from which allowances on all diameters and tolerances on pitch diameter are derived, is

$$\text{Tolerance (or allowance)} = C(0.0015\sqrt[3]{D}+0.0015\sqrt{L_e}+0.015\sqrt[3]{p^2}),$$

where

C=a factor which differs for each allowance or tolerance for each class
D=basic major diameter
L_e=length of engagement
p=pitch.

This formula is based on the accuracy of present day threading practice, and is applicable to all reasonable combinations of diameter, pitch, and length of engagement. Numerical values of the increments in the formula for standard diameters, pitches, and lengths of engagement are given in table XV.8, p. 50.

4. Allowances.—Allowances are applied only to external threads. The values of the factor C (par. 3 above) for allowances are as follows:

Class	Factor C
1A	0. 300
2A	. 300
3A	. 000

The above formula is not applicable to class 1AR as this class is produced by combining the American National class 1 allowances with class 1A tolerances. These allowances are larger than those for classes 1A and 2A and provide for ready assembly under adverse conditions. Numerical values of allowances for each pitch are given in table XVI. 2. A single value of the allowance is applicable to all diameters because the variation with diameter is practically negligible when the formula is applied.

5. Pitch Diameter Tolerances.—(*a*) *Values of factor C.*—The values of the factor C (par. 3 above) for pitch diameter tolerances are as follows:

Class	Factor C
1A and 1AR	1. 500
1B	1. 950
2A	1. 000
2B	1. 300
3A	0. 750
3B	. 975

It will be noted that the factor C is 30 percent greater for internal than for external threads of a given class number on account of the relative difficulties of manufacture.

(*b*) *Tolerances cumulative.*—The tolerances on pitch diameter are cumulative, that is, they include the variations of lead and angle. Therefore, the full tolerance is not available for pitch diameter unless the lead and angle of the thread are perfect.

(*c*) *Tables of pitch diameter tolerances.*—Numerical values of pitch diameter tolerances for classes 1A, 1B, 2A, 2B, 3A, and 3B are given in tables XVI.3 to XVI.8, inclusive. These tolerances are based on a length of engagement of 9 pitches but are recommended for all normal lengths of engagement found in ordinary work.

(This length should not be confused with the lengths of thread on mating parts as they may be considerably longer than the length of engagement.) If excessively small or large lengths of engagement are encountered, the thread tolerances *may* be calculated from the formulas, if considered advisable.

6. Major Diameter Tolerances.—(*a*) *External threads.*—The tolerance on major diameter for special threads is not specified as it must be determined in relation to the requirements of a given design in accordance with the procedure outlined on p. 96. Preferred tolerances equal to $0.060\sqrt[3]{p^2}$ for classes 2A and 3A, and equal to $0.090\sqrt{p^2}$ for classes A1 and 1AR are given in table XVI.2.

(*b*) *Internal threads.*—No tolerance is specified, as the maximum major diameter is established by the crest of an unworn tool and is not controlled by gages. The maximum major diameter of the internal thread may be determined by adding $0.7939p(=11/12H$, table XVI.1) to the maximum pitch diameter of the internal thread.

7. Minor Diameter Tolerances.—(*a*) *External threads.*—No tolerance is specified, as the minimum minor diameter is established by the crest of an unworn tool and is not controlled by gages. The minimum minor diameter of the external thread may be determined by subtracting $0.6495p(=3/4H$, table XVI.1) from the minimum pitch diameter of the external thread.

(*b*) *Internal threads.*—Preferred minor diameter tolerances for special threads are given in table XVI.2, columns 6, 7, 8, and 9, and these are generally applicable for normal lengths of engagement. In exceptional cases the minor diameter tolerance must be determined in relation to the requirements of a given design in accordance with the procedure outlined in subsection 7, p. 93. Limiting values for this tolerance are given in table XVI.2, columns 10 and 11. The maximum tolerances shown are equal to $0.394p$. The resulting minimum thread height is 53 percent of the basic height. Specifying the minimum tolerance is indicated when the length of engagement is exceptionally small. The minimum tolerance listed represents the practical limitation, particularly for the larger diameters that may be associated with a given pitch. Specifying the maximum tolerance is indicated when the ratio of length of engagement to diameter (L_e/D) is exceptionally large. A larger tolerance up to the maximum may also be required when the diameter is less than 1/2 in. to minimize tap breakage.

(b) SCREW THREAD CLASSES

1. Classes 1A, 1AR, and 1B.—(*a*) *Definition.*—The combinations of classes 1A or 1AR and 1B are intended to cover the manufacture of threaded parts where quick and easy assembly is necessary,

Table XVI.2.—*Allowances and major and minor diameter tolerances, special threads*

Threads per inch, n	Allowance, G		Preferred tolerance on major diameter of external thread, T_{D_s}		Preferred tolerances (T_{K_n}) on minor diameter of internal threads for nominal diameters (in inches) above—				Recommended limiting values of tolerance on minor diameter of internal thread,[2] T_{K_n}	
					1/4	1/2	3/4	1		
					To and including—					
	Classes 1A and 2A	Classes 1 and 1AR [1]	Classes 1A and 1AR	Classes 2A and 3A	1/2	3/4	1	—	Min	Max=$0.394p$
1	2	3	4	5	6	7	8	9	10	11
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
72	0.0007	----------	----------	0.0035	0.0017	----------	----------	----------	0.0015	0.0055
64	.0008	----------	----------	.0038	.0020	----------	----------	----------	.0016	.0062
56	.0009	----------	----------	.0041	.0025	0.0020	----------	----------	.0018	.0070
48	.0009	----------	----------	.0045	.0029	.0024	----------	----------	.0021	.0082
40	.0010	(0.0010)	0.0077	.0051	.0038	.0030	----------	----------	.0024	.0098
36	.0011	(.0011)	.0083	.0055	.0048	.0039	----------	----------	.0026	.0109
32	.0011	(.0011)	.0089	.0060	.0050	.0045	0.0039	----------	.0029	.0123
28	.0012	(.0012)	.0098	.0065	.0063	.0051	.0046	0.0043	.0032	.0141
24	.0013	(.0013)	.0108	.0072	.0069	.0061	.0055	.0048	.0035	.0164
20	.0015	(.0015)	.0122	.0081	.0088	.0072	.0065	.0060	.0039	.0197
18	.0016	(.0016)	.0131	.0087	----------	.0080	.0072	.0066	.0041	.0219
16	.0016	.0018	.0142	.0094	----------	.0089	.0080	.0075	.0043	.0246
14	.0018	.0021	.0155	.0103	----------	----------	.0092	.0086	.0044	.0281
12	.0019	.0024	.0172	.0114	----------	----------	.0104	.0100	.0050	.0328
10	.0022	.0028	.0194	.0129	----------	----------	----------	.0120	.0060	.0394
8	.0024	.0034	.0225	.0150	----------	----------	----------	.0150	.0075	.0492
6	.0028	.0044	.0273	.0182	----------	----------	----------	.0200	.0100	.0657
4	.0033	.0064	.0357	.0238	----------	----------	----------	.0300	.0150	.0985

[1] For values in parentheses there is no class 1AR as these are identical with those for class 1A.
[2] When preferred values (cols. 6 to 9) are not suitable and thread is designed in accordance with subsection 7.

Table XVI.3.—*Pitch diameter tolerances for external threads of special diameters, pitches, and lengths of engagement, classes 1A and 1AR*

UNS–1A, NS–1A, and NS–1AR

Designation		Sum of pitch and length of engagement increments	Pitch diameter tolerances [1] for nominal diameters (in inches), above—											
Threads per inch, $n=1/p$	Thread symbol		1/8	1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15
			To and including—											
			1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15	20
		in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
40	NS–1A	0.002991	0.0043	0.0046	0.0049	0.0052	-----	-----	-----	-----	-----	-----	-----	-------
36	**UNS–1A**	**.003189**	**.0045**	**.0048**	**.0051**	**.0054**	**0.0058**	-----	-----	-----	-----	-----	-----	-------
32	NS–1A	.003426	.0047	.0050	.0053	.0057	.0061	0.0065	-----	-----	-----	-----	-----	-------
28	**UNS–1A**	**.003716**	**.0050**	**.0053**	**.0056**	**.0060**	**.0064**	**.0068**	-----	-----	-----	-----	-----	-------
24	NS–1A	.004083	.0054	.0057	.0060	.0063	.0067	.0071	0.0075	-----	-----	-----	-----	-------
20	**UNS–1A**	**.004563**	**.0059**	**.0062**	**.0065**	**.0068**	**.0072**	**.0076**	**.0080**	**0.0084**	-----	-----	-----	-------
18	NS–1A	.004868	.0062	.0065	.0068	.0071	.0075	.0079	.0083	.0087	-----	-----	-----	-------
16	**UNS–1A**	**.005230**	-----	**.0069**	**.0072**	**.0075**	**.0079**	**.0083**	**.0086**	**.0091**	**0.0095**	-----	-----	-------
14	NS–1A	.005678	-----	.0073	.0076	.0079	.0083	.0087	.0091	.0095	.0100	0.0104	-----	-------
12	**UNS–1A**	**.006242**	-----	**.0079**	**.0082**	**.0085**	**.0089**	**.0093**	**.0097**	**.0101**	**.0105**	**.0110**	-----	-------
10	NS–1A	.006982	-----	.0086	.0089	.0092	.0096	.0100	.0104	.0108	.0113	.0117	0.0123	-------
8	**UNS–1A**	**.008012**	-----	-----	**.0099**	**.0103**	**.0107**	**.0111**	**.0114**	**.0119**	**.0123**	**.0128**	**.0133**	**0.9139**
6	NS–1A	.009570	-----	-----	.0115	.0118	.0122	.0126	.0130	.0134	.0139	.0143	.0149	.0154
4	**UNS–1A**	**.012304**	-----	-----	**.0142**	**.0146**	**.0150**	**.0154**	**.0157**	**.0162**	**.0166**	**.0171**	**.0176**	**.0181**
Diameter increment			0.001288	0.001623	0.001923	0.002250	0.002646	0.003054	0.003416	0.003848	0.004304	0.004764	0.005290	0.005841

[1] The pitch diameter tolerances shown in this table equal the sum of the pitch and length of engagement increments shown in the second column, $1.5(0.015\sqrt[3]{p^2}+0.015\sqrt{L_e})$, where $L_e=9p$, plus the diameter increment in the bottom line, $1.5\times0.0015\sqrt[3]{D}$, where D equals the mean diameter of the range. See table XV.8 for basic increments.

Table XVI.4.—*Pitch diameter tolerances for internal threads of special diameters, pitches, and lengths of engagement, class 1B*

UNS–1B and NS–1B

Designation		Sum of pitch and length of engagement increments	Pitch diameter tolerances [1] for nominal diameters (in inches), above—											
Threads per inch, $n=1/p$	Thread symbol		1/8	1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15
			To and including—											
			1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15	20
		in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
40	NS–1B	0.003888	0.0056	0.0060	0.0064	0.0068	-----	-----	-----	-----	-----	-----	-----	-------
36	**UNS–1B**	**.004146**	**.0058**	**.0063**	**.0066**	**.0071**	**0.0076**	-----	-----	-----	-----	-----	-----	-------
32	NS–1B	.004454	.0061	.0066	.0070	.0074	.0079	0.0084	-----	-----	-----	-----	-----	-------
28	**UNS–1B**	**.004830**	**.0065**	**.0069**	**.0073**	**.0078**	**.0083**	**.0088**	-----	-----	-----	-----	-----	-------
24	NS–1B	.005308	.0070	.0074	.0078	.0082	.0087	.0093	0.0097	-----	-----	-----	-----	-------
20	**UNS–1B**	**.005932**	**.0076**	**.0080**	**.0084**	**.0089**	**.0094**	**.0099**	**.0104**	**0.0109**	-----	-----	-----	-------
18	NS–1B	.006328	.0080	.0084	.0088	.0093	.0098	.0103	.0108	.0113	-----	-----	-----	-------
16	**UNS–1B**	**.006800**	-----	**.0089**	**.0093**	**.0097**	**.0102**	**.0108**	**.0112**	**.0118**	**0.0124**	-----	-----	-------
14	NS–1B	.007381	-----	.0095	.0099	.0103	.0108	.0114	.0118	.0124	.0130	0.0136	-----	-------
12	**UNS–1B**	**.008114**	-----	**.0102**	**.0106**	**.0110**	**.0116**	**.0121**	**.0126**	**.0131**	**.0137**	**.0143**	-----	-------
10	NS–1B	.009077	-----	.0119	.0116	.0120	.0125	.0130	.0135	.0141	.0147	.0153	0.0160	-------
8	**UNS–1B**	**.010415**	-----	-----	**.0129**	**.0133**	**.0139**	**.0144**	**.0149**	**.0154**	**.0160**	**.0166**	**.0173**	**0.0180**
6	NS–1B	.012441	-----	-----	.0149	.0154	.0159	.0164	.0169	.0174	.0180	.0186	.0193	.0200
4	**UNS–1B**	**.015996**	-----	-----	**.0185**	**.0189**	**.0194**	**.0200**	**.0204**	**.0210**	**.0216**	**.0222**	**.0229**	**.0236**
Diameter increment			0.001675	0.002110	0.002500	0.002925	0.003440	0.003970	0.004440	0.005002	0.005595	0.006193	0.006878	0.007593

[1] The pitch diameter tolerances shown in this table equal the sum of the pitch and length of engagement increments shown in the second column, $1.95(0.015\sqrt[3]{p^2}+0.015\sqrt{L_e})$, where $L_e=9p$, plus the diameter increment in the bottom line, $1.95\times0.0015\sqrt[3]{D}$, where D equals the mean diameter of the range. See table XV.8 for basic increments.

TABLE XVI.5.—*Pitch diameter tolerances for external threads of special diameters, pitches, and lengths of engagement, class 2A*

UNS–2A and NS–2A

Designation: Threads per inch, $n=1/p$	Designation: Thread symbol	Sum of pitch and length of engagement increments	Pitch diameter tolerances [1] for nominal diameters (in inches), above— 1/8, to and including— 1/4	1/4 to 1/2	1/2 to 3/4	3/4 to 1 1/4	1 1/4 to 2	2 to 3	3 to 4	4 to 6	6 to 8	8 to 11	11 to 15	15 to 20
		in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
72	NS-2A	0.001397	0.0023	0.0025	-----	-----	-----	-----	-----	-----	-----	-----	-----	------
64	NS-2A	.001500	.0024	.0026	-----	-----	-----	-----	-----	-----	-----	-----	-----	------
56	NS-2A	.001626	.0025	.0027	0.0029	-----	-----	-----	-----	-----	-----	-----	-----	------
48	NS-2A	.001786	.0026	.0029	.0031	-----	-----	-----	-----	-----	-----	-----	-----	------
40	NS-2A	.001994	.0029	.0031	.0033	0.0035	-----	-----	-----	-----	-----	-----	-----	------
36	**UNS-2A**	**.002126**	**.0030**	**.0032**	**.0034**	**.0036**	**0.0039**	-----	-----	-----	-----	-----	-----	------
32	NS-2A	.002284	.0031	.0034	.0036	.0038	.0040	0.0043	-----	-----	-----	-----	-----	------
28	**UNS-2A**	**.002477**	**.0033**	**.0036**	**.0038**	**.0040**	**.0042**	**.0045**	-----	-----	-----	-----	-----	------
24	NS-2A	.002722	.0036	.0038	.0040	.0042	.0045	.0048	0.0050	-----	-----	-----	-----	------
20	**UNS-2A**	**.003042**	**.0039**	**.0041**	**.0043**	**.0045**	**.0048**	**.0051**	**.0053**	**0.0056**	-----	-----	-----	------
18	NS-2A	.003245	.0041	.0043	.0045	.0047	.0050	.0053	.0055	.0058	-----	-----	-----	------
16	**UNS-2A**	**.003487**	-----	**.0046**	**.0048**	**.0050**	**.0053**	**.0055**	**.0058**	**.0061**	**0.0062**	-----	-----	------
14	NS-2A	.003785	-----	.0049	.0051	.0053	.0055	.0058	.0061	.0064	.0067	0.0070	-----	------
12	**UNS-2A**	**.004161**	-----	**.0052**	**.0054**	**.0057**	**.0059**	**.0062**	**.0064**	**.0067**	**.0070**	**.0073**	-----	------
10	NS-2A	.004655	-----	.0057	.0059	.0062	.0064	.0067	.0069	.0072	.0075	.0078	0.0082	------
8	**UNS-2A**	**.005341**	-----	-----	**.0066**	**.0068**	**.0071**	**.0074**	**.0076**	**.0079**	**.0082**	**.0085**	**.0089**	**0.0092**
6	NS-2A	.006380	-----	-----	.0077	.0079	.0081	.0084	.0087	.0089	.0092	.0096	.0099	.0103
4	**UNS-2A**	**.008203**	-----	-----	**.0095**	**.0097**	**.0100**	**.0102**	**.0105**	**.0108**	**.0111**	**.0114**	**.0117**	**.0121**
Diameter increment			0.000859	0.001082	0.001282	0.001500	0.001764	0.002036	0.002277	0.002565	0.002869	0.003176	0.003527	0.003894

[1] The pitch diameter tolerances shown in this table equal the sum of the pitch and length of engagement increments shown in the second column, $1.0(0.015\sqrt[3]{p^2}+0.015\sqrt{L_e})$, where $L_e=9p$, plus the diameter increment in the bottom line, $1.0\times0.0015\sqrt[3]{D}$, where D equals the mean diameter of the range. See table XV.8 for basic increments.

TABLE XVI.6.—*Pitch diameter tolerances for internal threads of special diameters, pitches, and lengths of engagement, class 2B*

UNS–2B and NS–2B

Designation: Threads per inch $n=1/p$	Designation: Thread symbol	Sum of pitch and length of engagement increments	Pitch diameter tolerances [1] for nominal diameters (in inches), above— 1/8, to and including— 1/4	1/4 to 1/2	1/2 to 3/4	3/4 to 1 1/4	1 1/4 to 2	2 to 3	3 to 4	4 to 6	6 to 8	8 to 11	11 to 15	15 to 20
		in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
72	NS-2B	0.001816	0.0029	0.0032	-----	-----	-----	-----	-----	-----	-----	-----	-----	-------
64	NS-2B	.001950	.0031	.0034	-----	-----	-----	-----	-----	-----	-----	-----	-----	-------
56	NS-2B	.002114	.0032	.0035	0.0038	-----	-----	-----	-----	-----	-----	-----	-----	-------
48	NS-2B	.002322	.0034	.0037	.0040	-----	-----	-----	-----	-----	-----	-----	-----	-------
40	NS-2B	.002592	.0037	.0040	.0043	0.0045	-----	-----	-----	-----	-----	-----	-----	-------
36	**UNS-2B**	**.002764**	**.0039**	**.0042**	**.0044**	**.0047**	**0.0051**	-----	-----	-----	-----	-----	-----	-------
32	NS-2B	.002969	.0041	.0044	.0046	.0049	.0053	0.0056	-----	-----	-----	-----	-----	-------
28	**UNS-2B**	**.003220**	**.0043**	**.0046**	**.0049**	**.0052**	**.0055**	**.0059**	-----	-----	-----	-----	-----	-------
24	NS-2B	.003539	.0047	.0049	.0052	.0055	.0058	.0062	0.0065	-----	-----	-----	-----	-------
20	**UNS-2B**	**.003955**	**.0051**	**.0054**	**.0056**	**.0059**	**.0062**	**.0066**	**.0069**	**0.0073**	-----	-----	-----	-------
18	NS-2B	.004218	.0053	.0056	.0059	.0062	.0065	.0069	.0072	.0076	-----	-----	-----	-------
16	**UNS-2B**	**.004533**	-----	**.0059**	**.0062**	**.0065**	**.0068**	**.0072**	**.0075**	**.0079**	**0.0083**	-----	-----	-------
14	NS-2B	.004920	-----	.0063	.0066	.0069	.0072	.0076	.0079	.0083	.0087	0.0090	-----	-------
12	**UNS-2B**	**.005409**	-----	**.0068**	**.0071**	**.0074**	**.0077**	**.0081**	**.0084**	**.0087**	**.0091**	**.0095**	-----	-------
10	NS-2B	.006052	-----	.0075	.0077	.0080	.0083	.0087	.0090	.0094	.0098	.0102	0.0106	-------
8	**UNS-2B**	**.006943**	-----	-----	**.0086**	**.0089**	**.0092**	**.0096**	**.0099**	**.0103**	**.0107**	**.0111**	**.0115**	**0.0120**
6	NS-2B	.008294	-----	-----	.0100	.0102	.0106	.0109	.0113	.0116	.0120	.0124	.0129	.0134
4	**UNS-2B**	**.010664**	-----	-----	**.0123**	**.0126**	**.0130**	**.0133**	**.0136**	**.0140**	**.0144**	**.0148**	**.0152**	**.0157**
Diameter increment			0.001117	0.001407	0.001667	0.001950	0.002293	0.002647	0.002960	0.003334	0.003730	0.004129	0.004585	0.005062

[1] The pitch diameter tolerances shown in this table equal the sum of the pitch and length of engagement increments shown in the second column, $1.3(0.015\sqrt[3]{p^2}+0.015\sqrt{L_e})$, where $L_e=9p$, plus the diameter increment in the bottom line, $1.3\times0.0015\sqrt[3]{D}$, where D equals the mean diameter of the range. See table XV.8 for basic increments.

Table XVI.7.—*Pitch diameter tolerances for external threads of special diameters, pitches, and lengths of engagement, class 3A*

UNS–3A and NS–3A

Designation		Sum of pitch and length of engagement increments	Pitch diameter tolerances[1] for nominal diameters (in inches), above—											
Threads per inch $n=1/p$	Thread symbol		1/8	1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15
			To and including—											
			1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15	20
		in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
72	NS–3A	0.001048	0.0017	0.0019	-----	-----	-----	-----	-----	-----	-----	-----	-----	------
64	NS–3A	.001125	.0018	.0019	-----	-----	-----	-----	-----	-----	-----	-----	-----	------
56	NS–3A	.001220	.0019	.0020	0.0022	-----	-----	-----	-----	-----	-----	-----	-----	------
48	NS–3A	.001340	.0020	.0022	.0023	-----	-----	-----	-----	-----	-----	-----	-----	------
40	NS–3A	.001496	.0021	.0023	.0025	0.0026	-----	-----	-----	-----	-----	-----	-----	------
36	**UNS–3A**	**.001594**	**.0022**	**.0024**	**.0026**	**.0027**	**0.0029**	-----	-----	-----	-----	-----	-----	------
32	NS–3A	.001713	.0024	.0025	.0027	.0028	.0030	0.0032	-----	-----	-----	-----	-----	------
28	**UNS–3A**	**.001858**	**.0025**	**.0027**	**.0028**	**.0030**	**.0032**	**.0034**	-----	-----	-----	-----	-----	------
24	NS–3A	.002042	.0027	.0029	.0030	.0032	.0034	.0036	0.0038	-----	-----	-----	-----	------
20	**UNS–3A**	**.002282**	**.0029**	**.0031**	**.0032**	**.0034**	**.0036**	**.0038**	**.0040**	**0.0042**	-----	-----	-----	------
18	NS–3A	.002434	.0031	.0032	.0034	.0036	.0038	.0040	.0041	.0044	-----	-----	-----	------
16	**UNS–3A**	**.002615**	-----	**.0034**	**.0036**	**.0037**	**.0039**	**.0041**	**.0043**	**.0045**	**0.0048**	-----	-----	------
14	NS–3A	.002839	-----	.0037	.0038	.0040	.0042	.0044	.0045	.0048	.0050	0.0052	-----	------
12	**UNS–3A**	**.003121**	-----	**.0039**	**.0041**	**.0042**	**.0044**	**.0046**	**.0048**	**.0050**	**.0053**	**.0055**	-----	------
10	NS–3A	.003491	-----	.0043	.0045	.0046	.0048	.0050	.0052	.0054	.0056	.0059	0.0061	------
8	**UNS–3A**	**.004006**	-----	-----	**.0050**	**.0051**	**.0053**	**.0055**	**.0057**	**.0059**	**.0062**	**.0064**	**.0067**	**0.0069**
6	NS–3A	.004785	-----	-----	.0057	.0059	.0061	.0063	.0065	.0067	.0069	.0072	.0074	.0077
4	**UNS–3A**	**.006152**	-----	-----	**.0071**	**.0073**	**.0075**	**.0077**	**.0079**	**.0081**	**.0083**	**.0085**	**.0088**	**.0091**
Diameter increment			0.000644	0.000812	0.000962	0.001125	0.001323	0.001527	0.001708	0.001924	0.002152	0.002382	0.002645	0.002920

[1] The pitch diameter tolerances shown in this table equal the sum of the pitch and length of engagement increments shown in the second column, $0.75(0.015\sqrt[3]{p^2}+0.015\sqrt{L_e})$, where $L_e=9p$, plus the diameter increment in the bottom line, $0.75\times0.0015\sqrt[3]{D}$, where D equals the mean diameter of the range. See table XV.8 for basic increments.

Table XVI.8.—*Pitch diameter tolerances for internal threads of special diameters, pitches, and lengths of engagement, class 3B*

UNS–3B and NS–3B

Designation		Sum of pitch and length of engagement increments	Pitch diameter tolerances[1] for nominal diameters (in inches), above—											
Threads per inch $n=1/p$	Thread symbol		1/8	1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15
			To and including—											
			1/4	1/2	3/4	1 1/4	2	3	4	6	8	11	15	20
		in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
72	NS–3B	0.001362	0.0022	0.0024	-----	-----	-----	-----	-----	-----	-----	-----	-----	------
64	NS–3B	.001462	.0023	.0025	-----	-----	-----	-----	-----	-----	-----	-----	-----	------
56	NS–3B	.001585	.0024	.0026	0.0028	-----	-----	-----	-----	-----	-----	-----	-----	------
48	NS–3B	.001741	.0026	.0028	.0030	-----	-----	-----	-----	-----	-----	-----	-----	------
40	NS–3B	.001944	.0028	.0030	.0032	0.0034	-----	-----	-----	-----	-----	-----	-----	------
36	**UNS–3B**	**.002073**	**.0029**	**.0031**	**.0033**	**.0035**	**0.0038**	-----	-----	-----	-----	-----	-----	------
32	NS–3B	.002227	.0031	.0033	.0035	.0037	.0039	0.0042	-----	-----	-----	-----	-----	------
28	**UNS–3B**	**.002415**	**.0033**	**.0035**	**.0037**	**.0039**	**.0041**	**.0044**	-----	-----	-----	-----	-----	------
24	NS–3B	.002654	.0035	.0037	.0039	.0041	.0044	.0046	0.0049	-----	-----	-----	-----	------
20	**UNS–3B**	**.002966**	**.0038**	**.0040**	**.0042**	**.0044**	**.0047**	**.0050**	**.0052**	**0.0055**	-----	-----	-----	------
18	NS–3B	.003164	.0040	.0042	.0044	.0046	.0049	.0051	.0054	.0057	-----	-----	-----	------
16	**UNS–3B**	**.003400**	-----	**.0045**	**.0046**	**.0049**	**.0051**	**.0054**	**.0056**	**.0059**	**0.0062**	-----	-----	------
14	NS–3B	.003690	-----	.0047	.0049	.0052	.0054	.0057	.0059	0062	.0065	0.0068	-----	------
12	**UNS–3B**	**.004057**	-----	**.0051**	**.0053**	**.0055**	**.0058**	**.0060**	**.0063**	**.0066**	**.0069**	**.0072**	-----	------
10	NS–3B	.004539	-----	.0056	.0058	.0060	.0063	.0065	.0068	.0070	.0073	.0076	0.0080	------
8	**UNS–3B**	**.005207**	-----	-----	**.0065**	**.0067**	**.0069**	**.0072**	**.0074**	**.0077**	**.0080**	**.0083**	**.0086**	**0.0090**
6	NS–3B	.006220	-----	-----	.0075	.0077	.0079	.0082	0084	.0087	.0090	.0093	.0097	.0100
4	**UNS–3B**	**.007998**	-----	-----	**.0092**	**.0095**	**.0097**	**.0100**	**.0102**	**.0105**	**.0108**	**.0111**	**.0114**	**.0118**
Diameter increment			0.000838	0.001055	0.001250	0.001462	0.001720	0.001985	0.002220	0.002501	0.002797	0.003097	0.003439	0.003797

[1] The pitch diameter tolerances shown in this table equal the sum of the pitch and length of engagement increments shown in the second column, $0.975(0.015\sqrt[3]{p^2}+0.015\sqrt{L_e})$, where $L_e=9p$, plus the diameter increment in the bottom line, $0.975\times0.0015\sqrt[3]{D}$, where D equals the mean diameter of the range. See table XV.8 for basic increments.

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and where an allowance is required to permit ready assembly, even when the threads are slightly bruised or dirty.

(*b*) *Allowances and tolerances.*—Allowances for all diameters and pitch diameter tolerances are specified in tables XVI.2, XVI.3, and XVI.4, and their application is shown in figure XV.2, p. 52.

2. Classes 2A and 2B.—(*a*) *Definition.*—Class 2A for external threads and 2B for internal threads are standards designed for general use. A moderate allowance is provided which minimizes galling and seizure encountered in assembly and use; it also accommodates platings, finishes, or coatings. (Where the allowance is not sufficient for thicknesses of plating or coating required, special provisions are necessary.) The maximum dimensions of threads which are electroplated or have coatings of similar thicknesses are increased by the amount of the allowance.

(*b*) *Allowances and tolerances.*—Allowances for all diameters and pitch diameter tolerances are specified in tables XVI.2, XVI.5, and XVI.6, and their application is shown in figure XV.3, p. 53.

3. Classes 3A and 3B.—(*a*) *Definition.*—Class 3A for external threads and class 3B for internal threads provides a class for such applications where closeness of fit and accuracy of lead and angle of thread are important. They are obtainable consistently only by the use of high quality production equipment supported by a very efficient system of gaging and inspection.

(*b*) *Allowances* [2] *and tolerances.*—No allowance is provided, but since the tolerances on "go" gages are within the limits of size of the product, the gages will assure a slight clearance between product made to the maximum-metal limits. Pitch diameter tolerances are specified in tables XV.7 and XV.8 and their application is shown in figure XV.3, p. 53.

5. METHOD OF DESIGNATING

The method of designating a special thread [3] is by the use of the letters UNS or NS, as indicated in tables XVI.3 to XVI.8, inclusive, preceded by the diameter in inches and the number of threads per inch, all in Arabic characters, and followed by the tolerance classification, with or without pitch diameter tolerances or limits of size. See "Method of designating a screw thread," p. 51.

An example of an external thread designation and its meaning is given as follows:

Example: ¼″–24 UNS–1A

- 1A — Class.
- UNS — Unified special thread.
- 24 — Number of threads per inch (n).
- ¼″ — Nominal size.

6. DIRECTIONS FOR DETERMINING LIMITS OF SIZE OF SPECIAL THREADS

The following directions are intended to simplify the task of the designer or specification writer in preparing the specification for a special thread:

The procedure to be followed in determining values for the essential thread elements, as shown in figure XVI.1, and the associated tolerances, is outlined in table XVI.9. The application of this and other tables is illustrated by the following example:

Internal thread, 1½–28UNS–2B
Length of engagement, 1 inch

Min major diameter	=1.5000 inches
Min pitch diameter=basic major diameter−3/4H, table XVI.1,=1.5000−0.0232	=1.4768
Max pitch diameter=min pitch diameter +tolerance, table XVI.6,=1.4768+0.0055	=1.4823
Min minor diameter=basic major diameter−1¼H, table XVI.1,=1.5000−0.0387	=1.4613
Max minor diameter=min minor diameter+tolerance, table XVI.2,=1.4613 +0. 0043	=1.4656

The dimensions of the above internal thread may be stated on the drawing as follows:

Major diameter, 1.5000 min

Pitch diameter, $1.4768{+0.0055 \atop -0.0000}$

Minor diameter, $1.4613{+0.0043 \atop -0.0000}$

External thread, 1½–28UNS–2A
To mate with the above thread

Max major diameter=basic major diameter −allowance, table XVI. 2,=1.5000−0.0012	=1.4988
Min major diameter=max major diameter−tolerance, table XVI. 2,=1.4988−0.0065	=1.4923
Max pitch diameter=max major diameter −3/4H, table XVI.1,=1.4988−0.0232	=1.4756
Min pitch diameter=max pitch diameter−tolerance, table XVI.5=1.4756−0.0042	=1.4714
Max minor diameter=max major diameter−1$\frac{5}{12}$H, table XVI.1=1.4988−0.0438	=1.4550

The dimensions of the above external thread may be stated on the drawing as follows:

Major diameter, $1.4988{+0.0000 \atop -0.0065}$

Pitch diameter, $1.4756{+0.0000 \atop -0.0042}$

Minor diameter, 1.4550 max.

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[2] A possible slight interference of metal may occur at the crest corners at the major diameter when a British made minimum internal thread is assembled with a maximum American made class 3A external thread.

[3] Certain diameter-pitch combinations are becoming recognized as preferred and the present tendency in unification of screw thread standards is to assemble all preferred diameter-pitch combinations, other than those in the coarse and fine series, into a single tabulation. Such a tabulation already exists as tables 22 and 23 of ASA B1.1–1949 and table 16 of British Standard 1580: 1949, and it includes diameter-pitch combinations in the present extra-fine, 8-thread, 12-thread, and 16-thread series as well as other preferred diameter-pitch combinations. The adoption of a single thread symbol applicable to all such preferred combinations of diameter, pitch, and tolerances, such as "UNR," is under discussion in the various standards committees.

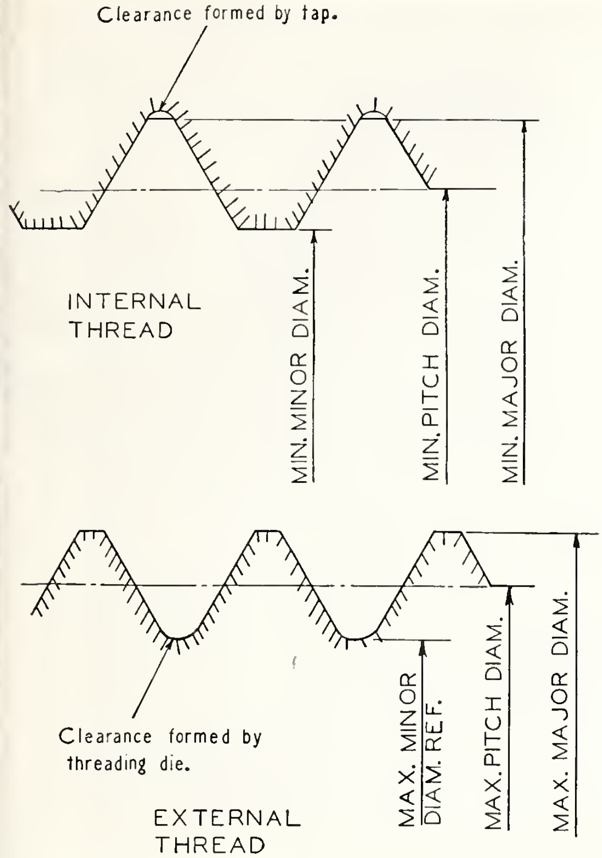

FIGURE XVI.1.—*Thread dimensions to be determined for a special thread.*

The design of a special thread usually requires that consideration be given to various factors in order that the thread assembly will function properly. These factors are discussed in the following subsection. It is to be noted particularly that deviations from the preferred tolerances for major diameter of the external thread and for minor diameter of the internal thread may be necessary in order to arrive at the optimium design.

7. DESIGN OF SPECIAL THREADS

1. GENERAL.—In general, any given problem in thread design may be susceptible to several more or less satisfactory solutions based on the preliminary selection of certain elements of the design and the proper adjustment of the other elements. In other words, thread design is to a large extent empirical and is partially based on previous experience with similar designs and the judgment of the designer. Accordingly, it is not practicable to present a definite system of approach to the design of a threaded assembly but merely to present a discussion of various design factors.

The interrelation of length of engagement, minimum major diameter of the external thread, maximum minor diameter of the internal thread, and the strength of the assembled thread needs to be understood and carefully considered in order to produce the optimum design of a special thread. It is not economical to use either a length of thread engagement which is longer than required or shorter than that which will develop the full

TABLE XVI.9.—*Consolidated method for the calculation of dimensions of special threads*

Thread element	External thread				Internal thread		
	1A	1AR	2A	3A	1B	2B	3B
1	2	3	4	5	6	7	8
Major diameter	Nominal size minus allowance			Nominal size	Nominal size		
	Table XVI.2, col. 2	Table XVI.2, col. 3	Table XVI.2, col. 2				
Tolerance on major diameter	Use preferred value in table XVI.2, col. 4 or 5, or compute in accordance with directions for designing special threads, p. 93. Apply minus				None specified as the maximum is established by the crest of an unworn tool		
Pitch diameter	Subtract $3/4H$, table XVI.1, col. 3 from maximum major diameter				Subtract $3/4H$, table XVI.1, col. 3 from basic major diameter		
Tolerance on pitch diameter	Table XVI.3. Apply minus	Table XVI.3. Apply minus	Table XVI.5. Apply minus	Table XVI.7. Apply minus	Table XVI.4. Apply plus	Table XVI.6. Apply plus	Table XVI.8. Apply plus
Minor diameter	Subtract 1 $5/12H$, table XVI.1, col. 6 from maximum major diameter. This is a reference dimension only				Subtract 1 $1/4H$, table XVI.1, col. 5 from the basic major diameter		
Tolerance on minor diameter	None specified as the minimum is established by the crest of an unworn tool				Use preferred value in table XVI.2, col. 6, 7, 8, or 9, or compute in accordance with directions for designing special threads, p. 93. See table XVI.2, cols. 10 and 11. Apply plus		

TABLE XVI.10.—*Data for determining strength factors in special thread design*

NOTATION

D =basic major diameter.
D_s =major diameter of screw.
K_n =minor diameter of tapped hole.
T_{Kn}=tolerance on minor diameter of tapped hole.
T_{Es} =tolerance on pitch diameter of screw.
G =allowance on all diameters of screw.
L_e=length of thread engagement.
A_s=stress area of screw.
S_s =area in shear on screw in line with K_n.
S_n =area in shear in tapped hole in line with D_s.

CONSTANTS

$C_1=\frac{3}{4}\pi=2.356$	Threads per inch, n													
	40	36	32	28	24	20	18	16	14	12	10	8	6	4
$C_2=\frac{5}{8}\frac{\cot 30°}{n}=\frac{1.08253}{n}=$	0.0271	0.0301	0.0338	0.0387	0.0451	0.0541	0.0601	0.0677	0.0773	0.0902	0.1083	0.1353	0.1804	0.2706
$C_3=\frac{9}{16}\frac{\cot 30°}{n}=\frac{0.974279}{n}=$	.0244	.0271	.0304	.0348	.0406	.0487	.0541	.0609	.0696	.0812	.0974	.1218	.1624	.2436
$C_4=n \tan 30°=0.57735n=$	23.09	20.78	18.48	16.17	13.86	11.55	10.39	9.328	8.083	6.928	5.774	4.619	3.464	2.309
$C_5=\pi n \tan 30°=1.8138n=$	72.55	65.30	58.04	50.79	43.53	36.25	32.65	29.02	25.39	21.76	18.14	14.51	10.88	7.255

FORMULAS

Item

MAXIMUM METAL FOR BOTH SCREW AND TAPPED HOLE

1. K_n min$=D-C_2$.
2. Max area in shear of screw per inch$=S_s$ max per inch$=C_1K_n$ min.
3. Min length of thread engagement, L_e min$=\frac{L_e}{D}\times D_s$ max, with $\frac{L_e}{D}$ taken from graph, figure XVI.2.
4. Area in shear of screw in length L_e min$=S_s$ max per inch$\times L_e$ min (=item 2$\times$item 3).
5. Max stress area of screw$=A_s$ max$=\frac{S_s \text{ max per inch}\times L_e \text{ min}}{2}\left(=\frac{1}{2}\text{item 4}\right)=\frac{C_1K_n \text{ min}\times\frac{L_e}{D}\times D_s \text{ max}}{2}$.

MAXIMUM METAL SCREW, K_n MAXIMUM

6. K_n max$=K_n$ min$+T_{Kn}$.
7. Min area in shear of screw per inch$=S_s$ min per inch$=K_n$ max $(C_1-C_5\ T_{Kn})$.
8. L_e required to develop full strength of screw for T_{Kn} selected$=\frac{2A_s \text{ max}}{S_s \text{ min per inch}}=\left(\frac{2\times\text{item 5}}{\text{item 7}}\right)$ or$=\left(\frac{\text{item 4}}{\text{item 7}}\right)$.

MINIMUM METAL FOR BOTH SCREW AND TAPPED HOLE

9. Min stress area of screw$=A_s$ min$=0.7854\ [D-C_3-(T_{Es}+G)]^2$.
10. Min area in shear of screw in length $L_e=S_s$ min$=K_n$ max $[C_1-C_5\ (T_{Kn}+T_{Es}+G)]\ L_e$ or$=\pi K_n$ max $[0.75-C_4\ (T_{Kn}+T_{Es}+G)]\ L_e$.
11. Min area in shear of tapped hole in length $L_e=S_n$ min$=\pi D_s$ min $[0.875-C_4\ (T_{Ds}+T_{En}+G)]\ L_e$.

MINIMUM METAL TAPPED HOLE, D_s MINIMUM, WHEN TAPPED MATERIAL IS WEAKER THAN SCREW

12. $R_1=\frac{\text{area in shear of screw in length } L_e}{\text{area in shear of tapped hole in length } L_e}=\left(\frac{\text{item 4}}{\text{item 11}}\right)=\frac{0.75\ K_n \text{ min}}{D_s \text{ min}\ [0.875-C_4\ (T_{Ds}+T_{En}+G)]}$.
13. $R_2=\frac{\text{ultimate tensile strength of tapped material}}{\text{ultimate tensile strength of screw material}}$.
14. If $R_2<R_1$, then L_e required$=L_e$ for T_{Kn} selected$\times\frac{R_1}{R_2}=\left(\frac{\text{item 8}\times\text{item 12}}{\text{item 13}}\right)$.

strength of the externally threaded member. Other factors, such as control of tap breakage, proper seating of a threaded part on a shoulder, the prevention of cross threading, conditions of loading when the assembled parts are not concentric, and possible collapse of a hollow externally threaded member, require careful analysis and adjustment of the design with respect to selection of the diameter-pitch combination, the class of thread, length of engagement, and major and minor diameter tolerances.

2. SELECTION OF CLASS OF THREAD.—Consideration should first be given to the use of a class 2A external thread with a class 2B internal thread since these classes are designed for general use. The use of class 2A provides that there will always be a small clearance between maximum-metal parts except when the external thread is plated. Plated parts are intended to be gaged with basic-size "go" gages. In either case, it is expected that parts will assemble readily without galling or seizing. Tolerances are sufficiently large so that ordinary production methods are generally applicable.

Past experience with similar designs may indicate that a more accurately made or closer fitting thread is required than that which is permitted by classes 2A and 2B tolerances. In such cases, consideration should be given to the use of classes 3A and 3B. If these tolerances are not sufficiently close, it may be necessary to apply the American National class 3 tolerances. The necessary increase in cost should not be overlooked.

In some designs there may be advantages in providing for greater average looseness of fit than that obtained with classes 2A and 2B. Such

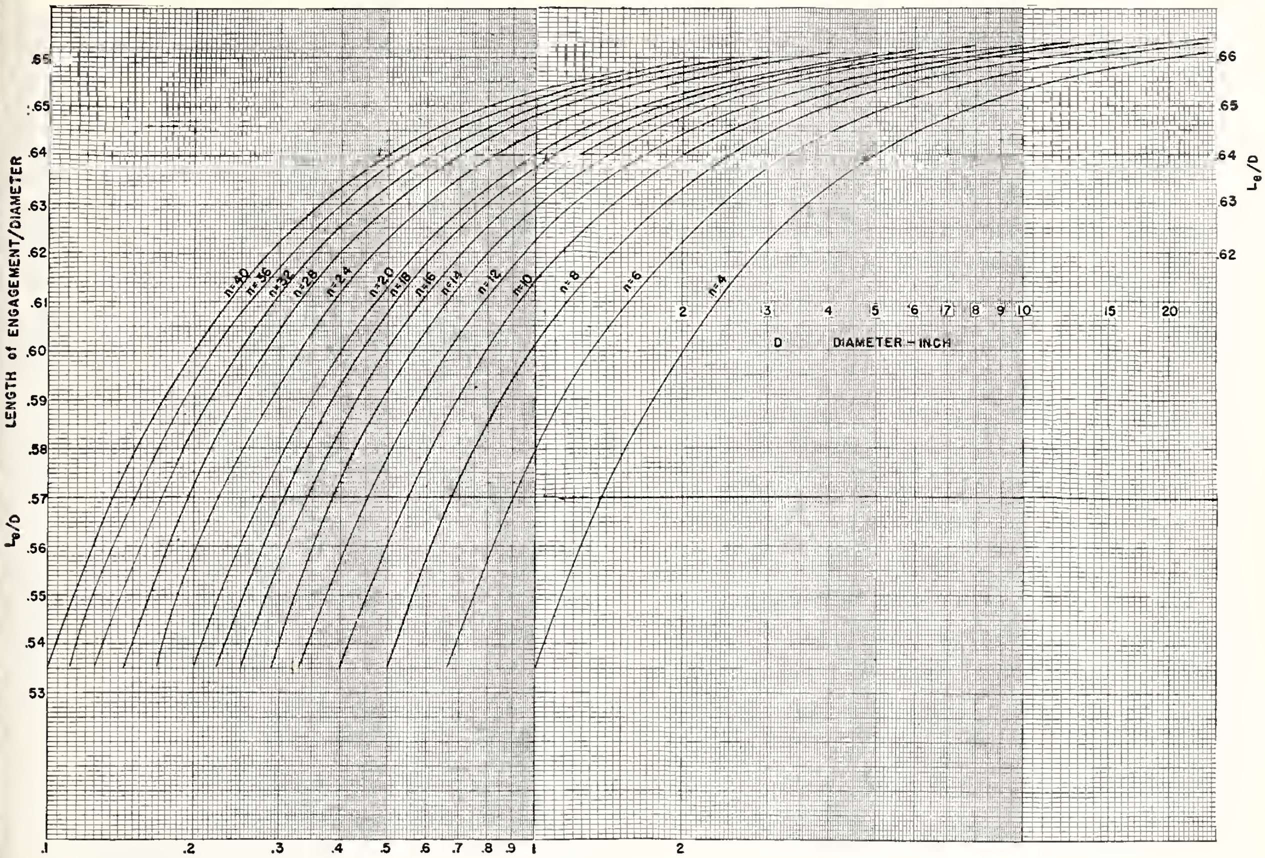

FIGURE XVI.2.—*Chart for determining minimum length of thread engagement.*

greater average looseness is provided by classes 1A and 1B or the assembly of class 1A external threads with class 2B internal threads. The minimum looseness, however, is the same as for classes 2A and 2B except that a positive allowance is provided for plated parts. When a greater minimum looseness is requisite to provide for adverse conditions of assembly, class 1AR is available, which is not a Unified class and is based on the American National class 1 allowance combined with class 1A tolerance. These classes also provide larger tolerances to the manufacturer, which may be of advantage if the thread is difficult to produce.

It should be noted that any class of external thread may be associated with any class of internal thread, there being no requirement to combine classes of like number.

In redesigning threads from American National to Unified standards, it should be remembered that exact correspondence between the old and new class numbers does not exist. For most, but not all, diameter-pitch combinations, the combined tolerances and allowances of the Unified classes are somewhat larger than American National classes of corresponding number. Recommended procedure is to convert the thread to the corresponding class of Unified thread, compare the new major, pitch, and minor diameter tolerances with the old tolerances, and then give careful consideration to the desirability of the new limits of size.

Taking, for example, the conversion of a class 1 thread to classes 1A and 1B: Under ordinary conditions where the thread is being used only as a simple fastener and the length of engagement is normal, such substitution may be made. If, for any reason, the previously specified tolerances may not be exceeded, it may be necessary to specify class 2A or 2B or both. Also, if the thread must carry a high axial stress or if concentricity of the two mating parts is a factor, the conversion should be from class 1 to classes 2A and 2B.

A close fitting thread assembly under some conditions may fail whereas the cause of failure may be eliminated by providing a looser fit. A cap screw that seats only on one side of the bearing surface under the head may break off when the screw is tightened. When a screw has a large bearing surface under the head or when the head must be square with a projecting pin, sufficient pitch diameter clearance must be provided to allow for any out-of-squareness of the screw axis with the bearing surface under the head. Thus, as large a pitch diameter tolerance as possible, together with providing proper tolerances on squareness of face with the thread axis where seating is required may avoid the necessity for specifying a heat treated bolt.

3. Eccentricity of Assembly and Cross Threading.—The axis of the internal thread can be displaced radially from coincidence with the axis of the external thread by an amount equal to the sum of the pitch diameter tolerances and the allowance. This radial displacement may be sufficient so that the flank contact is entirely on one side and on the opposite side the crest of the external thread will be in line with the crest of the internal thread with the following results when the screw is constrained in such a position in a tapped hole: (1) There will be danger of crossing the threads in starting, and (2) the screw may pull out of the hole when tension is exerted in this constrained position. Such a condition will occur when the sum of the major diameter tolerance on the external thread and the minor diameter tolerance on the internal thread, $T_{Ds}+T_{Kn}$, is equal to or greater than basic $D-K_n$ min$-2G-e_s-e_n$, where G is the allowance and e is the pitch diameter tolerance. As basic $D-K_n$ min equals $1\frac{1}{4}H$, the maximum value for the sum of these tolerances should be

$$T_{Ds}+T_{Kn}=1\tfrac{1}{4}H-2G-T_{Es}-T_{En}$$

It should be noted that, if the tolerance on the minor diameter of the internal thread must necessarily be large, the major diameter of the external thread must be held close to the maximum major diameter and vice versa. However, if the allowance, the tolerance on major diameter of the external thread, and the tolerance on minor diameter of the internal thread do not exceed the values shown in table XVI. 2, and if the pitch diameter tolerances do not exceed the values for classes 1A and 1B shown in tables XVI.3 and XVI.4, cross threading or eccentric pull-out will not occur.

4. Strength Factors.—It is of primary interest to assure that the length of thread engagement, L_e, is sufficiently long so that, if failure should occur, the external thread (screw) will break rather than that either the external or internal thread will strip. In other words, the length of thread engagement shall be sufficient to develop the full strength of the screw. Various formulas applicable to the determination of the relation of critical areas to thread dimensions are given in table XVI.10. These areas, as indicated in figure XVI.3, are (1) the effective cross-sectional area, or stress area, of the screw, (2) the shear area of the screw thread which depends principally on the minor diameter of the tapped hole, and (3) the shear area of the tapped hole thread which depends principally on the major diameter of the screw.

(*a*) *Length of engagement determined by shear area of screw.*—Formula 8, table XVI.10, gives the length of engagement required to develop the full strength of the screw when the strength of the material in which the hole is tapped is the same as, or slightly less than, the strength of the material of the screw. The value of L_e thus

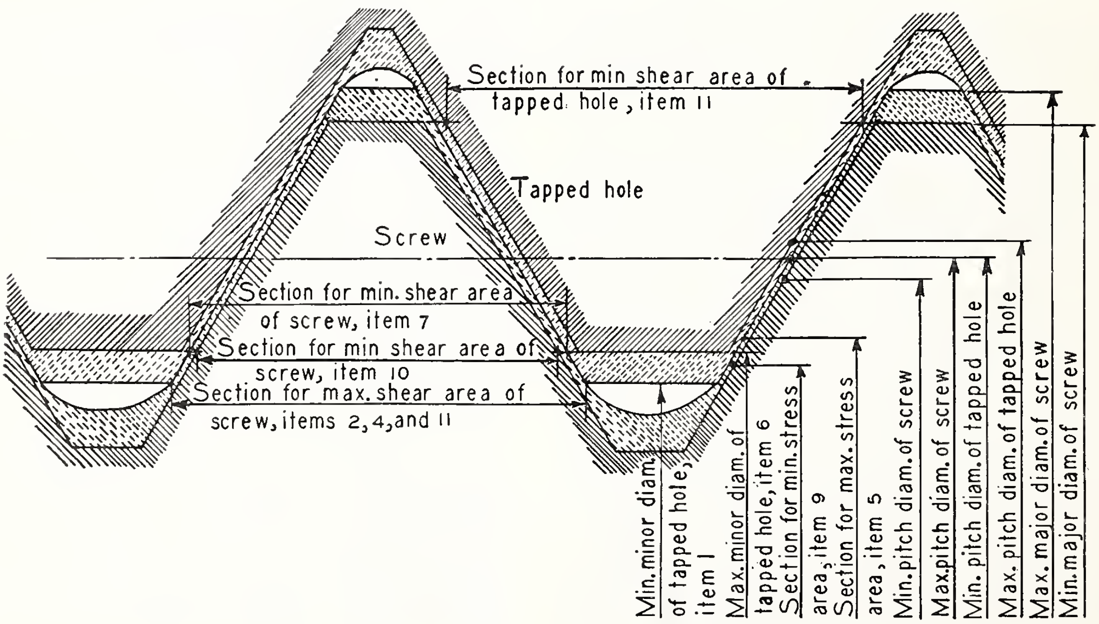

Figure XVI.3.—*Critical sections in a thread assembly.*

obtained is sufficient for a permanently fastened connection. If, however, the screw is an adjusting or lead screw, or if the connection will be frequently unscrewed, L_e should be increased to allow for the expected wear on the flanks of the threads during the useful life of the components.

For tapped holes in sheet metal, the maximum size of the screw to be specified should be such that the thickness of sheet equals the L_e required to develop full strength. In order to use the largest possible screw, it is necessary that the tolerance, T_{Kn}, on the minor diameter of the hole should be the practical minimum. If it should prove to be impracticable to reduce the minor diameter tolerance to such a value, it may be necessary to decrease the minimum minor diameter of the internal thread and to increase the minor diameter tolerance by the same amount. If this is done, the maximum minor diameter of the screw must be reduced by the same amount to prevent interference, and the minor diameter of the "Go" thread ring gage must likewise be decreased as this is the only control of the minor diameter of the screw. In all such cases, where dimensions are altered from those calculated according to this standard, the word "modified" with an asterisk (*) should be placed beside the thread designation. An asterisk should be placed beside each dimension that does not comply with the standard.

The factor 2 used in the numerator of formula 8 and the denominator of formula 5 means that it is assumed that the area in shear must be twice the tensile stress area to develop the full strength of the screw. This assumption is based on experiments made by the National Bureau of Standards in 1929, in which it was found that for hot-rolled and cold-rolled steel, and brass screws and nuts, this factor varied from 1.7 to 2.0. Taking the factor as 2 provides in general a small factor of safety against stripping of the threads.

(*b*) *Length of engagement determined by shear area of nut.*—The ratio of the area in shear in the screw and the area in shear in the tapped hole is given by formula 12, table XVI.10. This ratio, R_1, will usually be less than 1 and the strength of the material of the tapped hole can be less than the strength of the material of the screw by this ratio with no indicated increase in L_e by formula 8. If, however, the ratio

$$R_2=\frac{\text{tensile strength of the material of the tapped hole}}{\text{tensile strength of the material of the screw}}$$

is less than R_1, then L_e should be multiplied by R_1/R_2 to provide sufficient length of thread to prevent stripping of the threads in the tapped hole.

For retaining collars on shafts where the expected axial force resisted by the collar is appreciably less than the tensile force that the shaft itself is capable of resisting, L_e need only be long enough to withstand the expected axial force on the collar. If F_c is the axial force to be carried by the collar and *uts* is the tensile strength of the material of the shaft in pounds per square inch, then the length of thread engagement required on the shaft is equal to $2F_c/(uts\times S_s \text{ min})$, where S_s min is given by formula 7, when the strength of material of the collar is the same or slightly less than the strength of material of the shaft. Ratios R_1 and R_2 should be computed as previously explained to determine whether or not a greater length is required to prevent stripping of the threads in the collar.

(*c*) *Hollow externally threaded parts.*—For screws with through axial holes, the length of engagement required is of course less than if the screw is solid. For this condition, formula 8 becomes

$$L_e \text{ max}=\frac{2(A_s \text{ max}-A_n \text{ max})}{S_s \text{ min per inch}},$$

where A_n is the cross-sectional area of the hole.

However, as the wall thickness of either or both the internal and external members becomes thin, the tendency of the external member to enlarge and the internal member to neck down in the thread means that an L_e greater than given by the above formula must be used, also that the tolerances on minor diameter of the internal thread and major diameter of the external thread, T_{Kn} and T_{Ds}, must be small to obtain the maximum practicable depth of thread engagement. For components having threads on thin-wall tubing, tests under actual working conditions should be made to determine proper selection of wall thicknesses, length of engagement, and pitch of thread.

(*d*) *Control of tap breakage.*—The size of K_n is a factor in controlling tap breakage. Tap breakage is infrequent if the diameter of the tap is over ½ inch or if the length of thread to be tapped is less than ½D. For sizes less than ½ inch and length of thread over ½D, tap breakage can be minimized by use of a large K_n, that is T_{Kn} maximum. However, this means that L_e may have to be increased to develop the full strength of the screw.

5. Examples of Thread Design.—The design of special threads for particular purposes are illustrated by the following examples:

Example: A gun barrel is subjected to an internal explosive pressure that produces a tensile stress in the threaded end. The length of engagement of the threads should be sufficient to produce a minimum area in shear on the threads of the screw in line with the minor diameter of the tapped hole threads equal to twice the maximum stress area of the threaded portion of the barrel.

Assume that the thread on the barrel is 1.5–8N–2A and the minimum internal dimeter of the barrel at the threaded end is 0.792 inch.

In table XV.25 will be found the following maximum dimensions of the external thread:

$$D_s \text{ max}=1.4978 \text{ inch}$$
$$E_s \text{ max}=1.4166 \text{ inch}$$
$$K_s \text{ max}=1.3444 \text{ inch.}$$

From table XV.26, K_n min=1.3647 inch. If we select the tolerance for minor diameter of hole $T_{Kn}=0.0250$ inch, K_n max will equal $1.3647+0.0250=1.3897$, which will permit the use of a 1⅜ (1.375)-inch tap drill.

The minimum area in shear per inch can be computed, using formula 7, table XVI.10:

$$\begin{aligned} S_s \text{ min} &= K_n \text{ max } (C_1 - C_5 T_{Kn}) \\ &= 1.3897\ (2.356 - 14.51 \times 0.025) \\ &= 2.7700 \text{ sq in.} \end{aligned}$$

The maximum stress area of the external thread, if solid, using formula 5, table XVI.10, is

$$A_S \text{ max} = \frac{C_1 K_n \text{ min} \times \frac{L_e}{D} \times D_s \text{ max}}{2},$$

$$\frac{L_e}{D} \text{ from chart}=0.622,$$

$$=\frac{2.356 \times 1.3647 \times 0.622 \times 1.4978}{2}=1.4977$$

Area of minimum center hole
$$=(\pi/4)\times 0.792^2=0.4926$$

Max stress area of external threaded member
$$=1.0051$$

Length of thread engagement required

$$\begin{aligned} &= L_e = \frac{2 \times \text{max } A_s}{S_s \text{ min}} \\ &= \frac{2 \times 1.005}{2.7700} \\ &= 0.726 \text{ inch.} \end{aligned}$$

If a length of engagement of 0.73 inch cannot be obtained, the tolerance on minor diameter, T_{Kn}, of the internal thread should be reduced. If a space for a longer length of engagement is available, T_{Kn} can be increased.

Example: The dimension is required of the largest steel cap screw that can be used to hold a bracket on a cast iron body. The tensile strength of the steel is 60,000 lbs/in.², the tensile strength of the cast iron 20,000 lb./in.², and the thickness of the cast iron is such that the length of thread engagement cannot exceed 1 inch. The screws on the top side of the bracket will be in tension. From the ratio of the tensile strengths of the two materials, $R_2=20{,}000/60{,}000=0.333$, it is evident that the length of the tapped hole thread must be considerably longer than the length of thread engagement required to develop the full strength of the screw. R_1 will be of the order of 0.85 and the length of thread in the tapped hole will be approximately $R_1/R_2=\frac{0.85}{0.333}=2.55$ times as long as the length required to develop the full strength of the screw. L_e required to develop the full strength of the screw must be of the order of $1.000/2.55=0.392$ inch.

Inasmuch as the hole is tapped in cast iron, a relatively coarse thread would be required, that is UNC or coarser. For such threads L_e/D, as shown on the chart, figure XVI.2, varies between 0.54 and 0.59. Taking $L_e/D=0.57$, the approximate diameter required is $0.392/0.57=0.6877$. Try $D=11/16=0.6875$ inch. The selected pitch could be either 10 or 8 tpi with 8 tpi preferred. For a bracket screw, class 2A would be the preferred class. Thus, the screw is 11/16″–8UNS–2A and the hole 11/16″–8UNS–2B.

Next, compute the dimensions of the screw and hole to determine whether or not the above selection is correct.

Max major diameter of screw, D_s max, table **XVI.2**,
$=$basic $D-G=0.6875-0.0024=0.6851$

Min major diameter of screw, D_s min, table **XVI.2**,
$=D_s \text{ max}-T_{Ds}=0.6851-0.0150=0.6701$

Min minor diameter of tapped hole, K_n min, table XVI.1,
$=D-1\tfrac{1}{4}H=0.6875-0.1353=0.5522$

The number of 11/16–8 screws required will depend on the torque that may develop on the bracket that will produce tension in the screws. It should be possible to tighten these screws to the yield strength of the steel without stripping the cast iron threads.

The complete table of dimensions of the tapped hole and screw is

Tapped hole, 11/16–8UNS–2B

	Inch
Min major diameter	=0. 6875
Min pitch diameter, table 1,0.6875−0.0812	=0. 6063
Max pitch diameter, table 6,0.6063+0.0086	=0. 6149
Min minor diameter, table 1,0.6875−0.1353	=0. 5522
Max minor diameter, 0.5522+0.0492 (above)	=0. 6014

Screw, 11/16–8UNS–2A

	Inch
Max major diameter, table 2,0.6875−0.0024	=0. 6851
Min major diameter, table 2,0.6851−0.0150	=0. 6701
Max pitch diameter, table 1,0.6851−0.0812	=0. 6039
Min pitch diameter, table 5,0.6039−0.0066	=0. 5973
Max minor diameter, table 1,0.6851−0.1534	=0. 5317
Min length of thread engagement	=0. 951

Because of the length of the thread required in the tapped hole and the fact that the shear area of the hole thread is critical, which depends on min D_s and not on max K_n, the maximum tolerance, 0.0492, table XVI.2, has been used for minor diameter.

Thus, max minor diameter of tapped hole $=0.5522+0.0492=0.6014$.
This will permit the use of a 19/32 (0.5938)-inch tapdrill.

$$L_e/D \text{ from chart, figure XVI.2} = 0.5650$$

$$L_e \min = L_e/D \times D_s \max = 0.5650 \times 0.6851 = 0.3871$$

$$T_{En} \text{ (table XVI.6)} = 0.0086$$

$$R_1, \text{ table XVI.10, formula 12} = \frac{0.75\, K_n \min}{D_s \min\, [0.875 - C_4(T_{En} + T_{Ds} + G)]}$$

$$= \frac{0.75 \times 0.5522}{0.6701\, [0.875 - 4.619(0.0086 + 0.0150 + 0.0024)]}$$

$$= \frac{0.4142}{0.6701 \times 0.7549}$$

$$= 0.8188$$

$$L_e \text{ required in hole} = L_e \min \times \frac{R_1}{R_2} = 0.3871 \times 0.8188/0.3333 = 0.9509 \text{ inch,}$$

which is less than the L_e (1 in.) permitted.

Actually, in this case a 5/8–11UNC–2A screw with a length of thread engagement of 0.92 inch would be satisfactory, but a 3/4–10 would require a length of thread engagement longer than 1 inch.

8. GAGES

The specifications for gages beginning on pages 3 and 85 of this supplement and beginning on page 29 of Handbook H28 (1944) are applicable to special screw threads.

SECTION XVII. CROSS-RECESSED MACHINE SCREWS

These standards for two types of cross-recessed machine screws are intended for general use where cross-recessed heads are required.[1] [2] Type I recesses have a large center opening and a blunt bottom. Type II recesses have a smaller center opening and a more nearly sharp bottom. These types differ in other respects as shown in the illustrations and tables.

1. RECOMMENDED REQUIREMENTS

(*a*) Workmanship.—The workmanship shall be compatible with the type of product and class of thread specified. The product shall be free from fins, seams, or other defects, which may 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 shall be by chasing, milling, die cutting, or rolling.

(*b*) Thread Series and Classes.—The number of threads per inch shall be that specified for the Unified or American National coarse- or fine-thread series. Unless otherwise specified, machine screws shall be of the coarse-thread series, classes 2A or 2.

(*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. The length of machine screws shall not vary from that specified by more than the following: Up to 1 inch in length, +0, −1/32 in.; over 1 to 2 inches, inclusive, +0, −1/16 in.; and over 2 inches, +0, −3/32 in.

2. *Length of threads.*—The length of threaded portion of lengths up to and including 2 inches shall extend to within 2 threads from the bearing surface of the head. Longer screws shall have a minimum complete thread length of 1¾ inches.

3. *Body diameter.*—The diameters of the unthreaded portions shall not be less than the minimum pitch diameter nor more than the maximum major diameter of the thread.

4. *Bearing surface.*—The bearing surface of machine screw heads, except flat and oval countersunk heads, shall be at right angles to the axis of the body of the screw within a tolerance of 2°. The axis of the conical bearing surface of flat and oval countersunk heads shall be parallel with the axis of the body within 2°.

5. *Concentricity.*—The heads of all machine screws shall be concentric with the axis of the body within a tolerance of 3 percent of the specified maximum head diameter. On flat and oval countersunk heads, the eccentricity shall be measured at a distance equal to two-thirds of the head height, H, from the small end of the head.

[1] It is suggested that the type of cross-recessed screws used in equipment purchased under performance specifications be in accordance with the contractor's and/or equipment manufacturer's established practice.
[2] It is suggested that the established standard type of cross-recess of the agency or department concerned be ascertained before specifying the type. This is to obviate double stocking, tooling, and delays.

2. TABLES OF DIMENSIONS

Dimensions of round-head, flat-head, 100° flat-head, fillister-head, oval-head, truss-head, binding-head, and pan-head cross-recessed screws shall conform to tables XVII.1 to XVII.8, respectively.

All recess dimensions shall conform to table XVII.9 as controlled by the penetration, Q, of standard gage points specified in table XVII.10 and figures XVII.9 and XVII.11.

Gage dimensions shall conform to tables XVII.9 to XVII.13, inclusive, and figures XVII.9 to XVII.12, inclusive.

Driver dimensions shall conform to table XVII.14 and figure XVII.13.

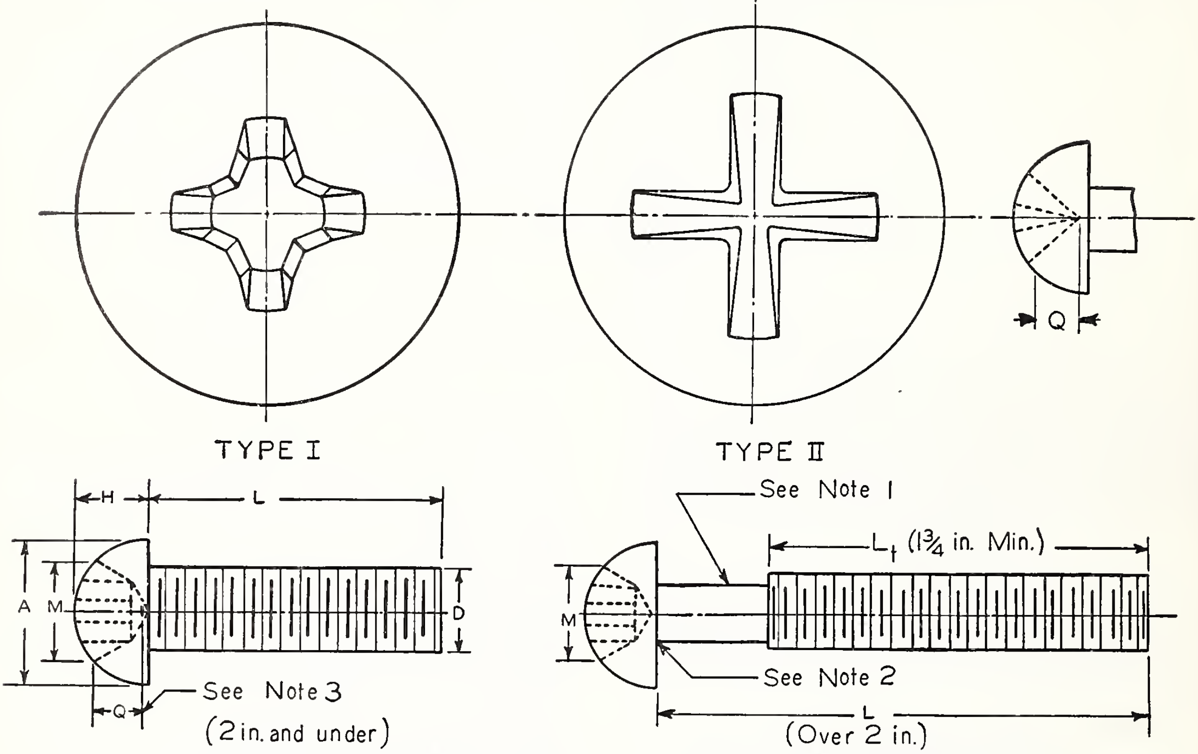

FIGURE XVII.1.—*Round-head cross-recessed machine screws (see table XVII.1).*

TABLE XVII.1.—*Dimensions of round-head, cross-recessed machine screws (see fig. XVII.1)*

Nominal size,[1] D	Threads per inch n		Dimensions of head[2]				Type I recess				Type II recess		
			A		H		Dimensions of recess			Recess number	Dimensions of recess		
			Diameter of head		Height of head		Q: Penetration[3]		M: Recess diameter, maximum		Q: Penetration		M: Recess diameter, maximum
	Coarse-thread series	Fine-thread series	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum			Maximum	Minimum	
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*		*in.*	*in.*	*in.*
2 0.086	56	64	0.162	0.146	0.069	0.059	0.043	0.027	0.097	1	0.048	0.034	0.105
3 .099	48	56	.187	.169	.078	.067	.052	.035	.106	1	.062	.047	.122
4 .112	40	48	.211	.193	.086	.075	.062	.046	.115	1	.076	.059	.137
5 .125	40	44	.236	.217	.095	.083	.060	.035	.151	2	.080	.063	.153
6 .138	32	40	.260	.240	.103	.091	.070	.045	.159	2	.093	.076	.169
8 .164	32	36	.309	.287	.120	.107	.087	.064	.175	2	.119	.098	.201
10 .190	24	32	.359	.334	.137	.123	.105	.082	.192	2	.146	.122	.233
12 .216	24	28	.408	.382	.153	.139	.105	.082	.246	3	.153	.129	.265
1/4	20	28	.472	.443	.175	.160	.127	.104	.265	3	.189	.162	.306
5/16	18	24	.590	.557	.216	.198	.167	.144	.305	3	.254	.224	.384
3/8	16	24	.708	.670	.256	.237	.205	.182	.384	4	.280	.248	.460
7/16	14	20	.750	.707	.328	.307	.218	.196	.399	4	.314	.279	.487
1/2	13	20	.813	.766	.355	.332	.233	.211	.413	4	.349	.313	.528

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread.
[2] The radius of the fillet under the head shall not exceed one-half the pitch of the thread. The application of an undercut instead of a radius is optional.
[3] All recess dimensions are controlled by the penetration, Q, of standard gage points as specified in table XVII.10 and figures XVII.9 and XVII.11.

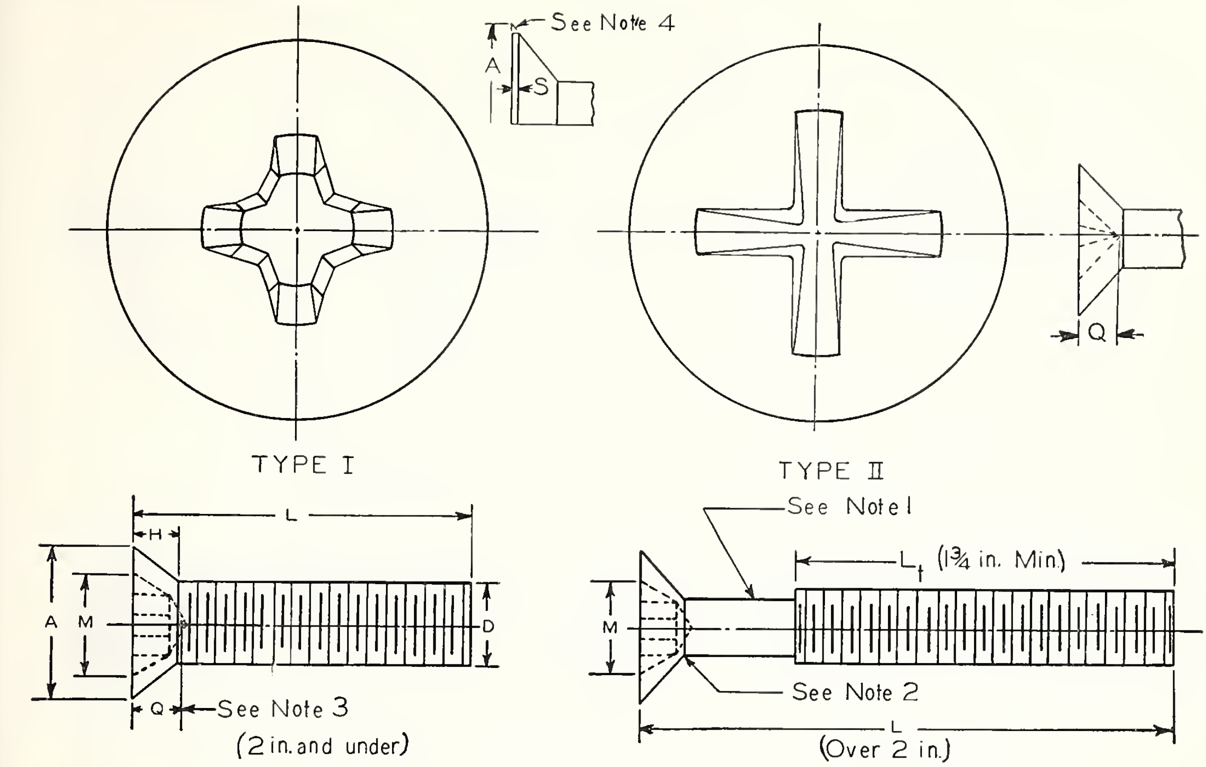

FIGURE XVII.2.—*Flat (countersunk) head cross-recessed machine screws (see table XVII.2).*

TABLE XVII.2.—*Dimensions of flat (countersunk) head, cross-recessed machine screws (see fig. XVII.2)*

Nominal size,[1] D		Threads per inch, n		Dimensions of head [2]						Type I recess				Type II recess		
				A			H		S [3]	Dimensions of rceess			Recess number	Dimensions of reeess		
				Diameter of head			Height of head		Flat on mini-mum serew	Q		M		Q		M
		Coarse-thread series	Fine-thread series	Maxi-mum sharp	Mini-mum sharp	Mini-mum with maxi-mum, S	Maxi-mum	Mini-mum		Penetration [4] Maxi-mum	Penetration [4] Mini-mum	Reeess diame-ter, maxi-mum		Penetration Maxi-mum	Penetration Mini-mum	Reeess diamc-ter, maxi-mum
No.	*in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*		*in.*	*in.*	*in.*
2	0.086	56	64	0.172	0.156	0.150	0.051	0.040	0.003	0.053	0.040	0.099	1	0.062	0.047	0.129
3	.099	48	56	.199	.181	.175	.059	.048	.004	.058	.045	.104	1	.075	.059	.150
4	.112	40	48	.225	.207	.200	.067	.055	.004	.079	.066	.125	1	.088	.072	.169
5	.125	40	44	.252	.232	.225	.075	.062	.005	.072	.052	.151	2	.101	.084	.189
6	.138	32	40	.279	.257	.249	.083	.069	.005	.092	.072	.171	2	.114	.097	.209
8	.164	32	36	.332	.308	.300	.100	.084	.006	.107	.087	.186	2	.139	.121	.249
10	.190	24	32	.385	.359	.348	.116	.098	.007	.122	.102	.201	2	.164	.146	.289
12	.216	24	28	.438	.410	.397	.132	.112	.008	.136	.116	.265	3	.190	.171	.329
	1/4	20	28	.507	.477	.462	.153	.131	.009	.151	.131	.280	3	.224	.204	.380
	5/16	18	24	.635	.600	.581	.191	.165	.011	.193	.174	.362	4	.285	.264	.476
	3/8	16	24	.762	.722	.700	.230	.200	.013	.222	.203	.390	4	.347	.324	.572
	7/16	14	20	.812	.771	.743	.223	.190	.016	.238	.219	.406	4	.371	.347	.609
	1/2	13	20	.875	.831	.802	.223	.186	.018	.253	.234	.421	4	.402	.377	.656

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread.
[2] The radius of the fillet under the head shall not exceed twice the piteh of the thread.
[3] All reeess dimensions are eontrolled by the penetration, Q, of standard gage points, as speeified in table XVII.10 and figures XVII.9 aud XVII.11.
[4] Edges of head may be rounded.

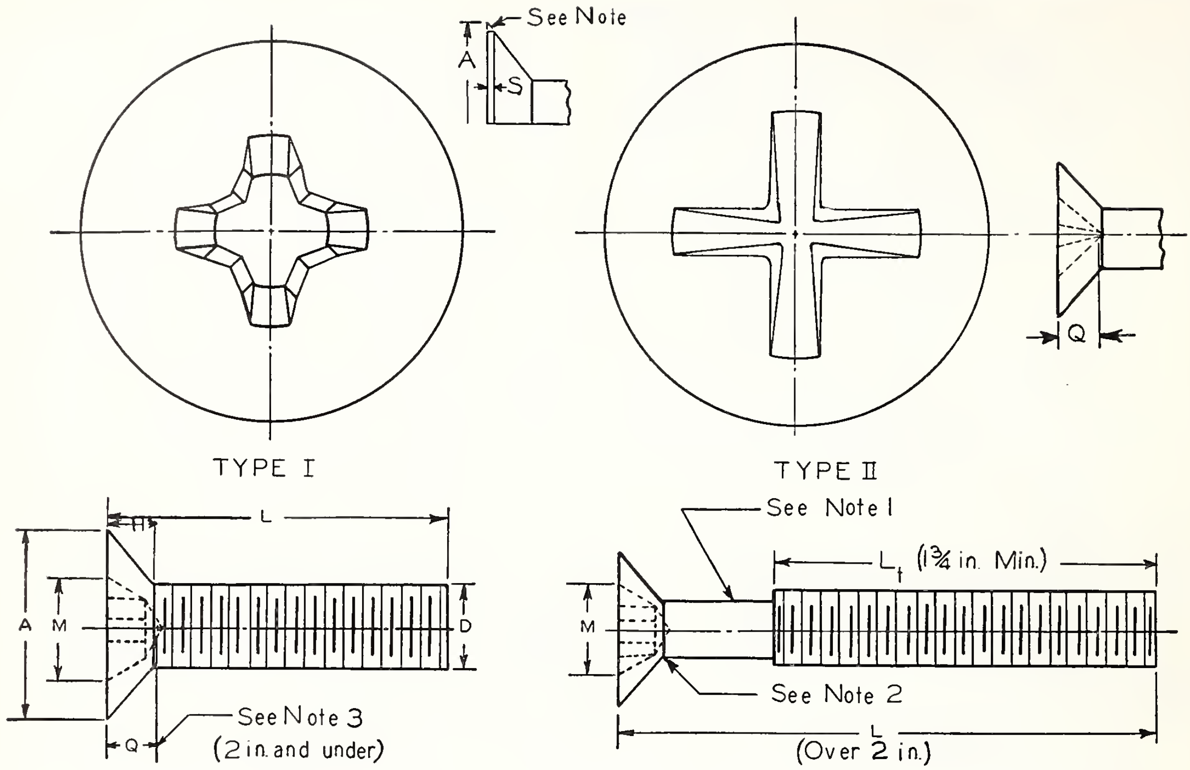

FIGURE XVII.3.—*Cross-recessed 100° flat (countersunk) head machine screws (see table XVII.3)*

TABLE XVII.3.—*Dimensions of cross-recessed 100° flat (countersunk) head machine screws (see fig. XVII.3).*

Nominal size,[1] D	Threads per inch, n		Dimensions of head [2]						Type I recess				Type II recess		
			A			*H*		*S*	Dimensions of recess			Recess number	Dimensions of recess		
			Diameter of head			Height of head		Flat on minimum screw	*Q*		*M*		*Q*		*M*
	Coarse-thread series	Fine-thread series	Maximum sharp	Minimum sharp	Minimum with maximum, *S*	Maximum	Minimum		Penetration [3] Maximum	Penetration [3] Minimum	Recess diameter, maximum		Penetration [3] Maximum	Penetration [3] Minimum	Recess diameter, maximum
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*		*in.*	*in.*	*in.*
4 0.112	40	48	0.225	0.207	0.200	0.048	0.040	0.003	0.068	0.055	0.114	1	0.069	0.054	0.145
6 .138	32	40	.279	.257	.249	.060	.051	.004	.072	.052	.151	2	.095	.080	.185
8 .164	32	36	.332	.308	.300	.072	.062	.004	.087	.067	.166	2	.112	.096	.205
10 .190	24	32	.385	.359	.348	.083	.072	.005	.102	.082	.188	2	.134	.117	.244
1/4	20	28	.507	.477	.462	.110	.097	.006	.115	.095	.244	3	.186	.166	.325
5/16	18	24	.635	.600	.581	.138	.123	.008	.145	.126	.314	4	.239	.218	.406
3/8	16	24	.762	.722	.700	.165	.148	.009	.170	.151	.339	4	.290	.267	.485

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread
[2] The radius of the fillet under the head shall not exceed twice the pitch of the thread.
[3] All recess dimensions are controlled by the penetration, *Q*, of standard gage points, as specified in table XVII.10 and figures XVII.9 and XVII.11.

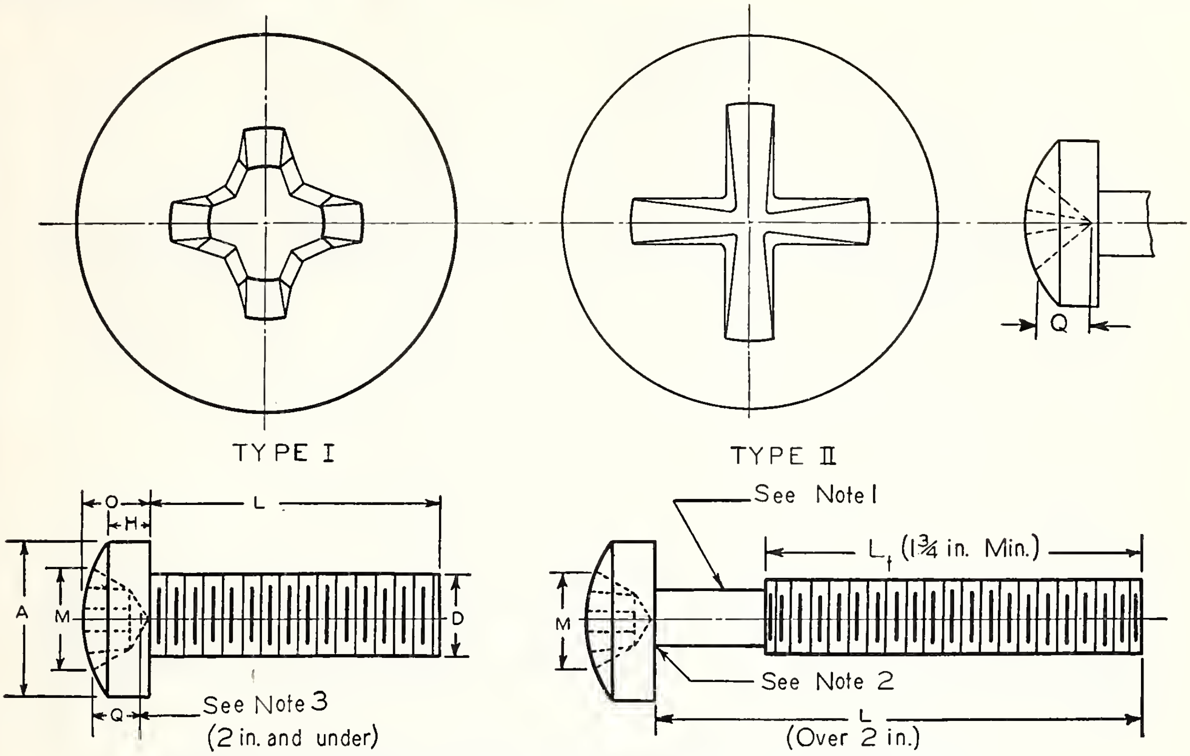

FIGURE XVII.4.—*Oval fillister head, cross-recessed machine screws (see table XVII.4)*

TABLE XVII.4.—*Dimensions of oval fillister head, cross-recessed machine screws (see fig. XVII.4)*

Nominal size,[1] *D*		Threads per inch		Dimensions of head[1]						Type I recess				Type II recess		
										Dimensions of recess			Recess number	Dimensions of recess		
		Coarse-thread series	Fine-thread series	*A*		*H*		*O*		*Q*		*M*		*Q*		*M*
				Diameter of head		Height of head		Total height of head		Penetration [3]		Recess diameter, maximum		Penetration [3]		Recess diameter, maximum
				Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum			Maximum	Minimum	
No.	*in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*		*in.*	*in.*	*in.*
2	0.086	56	64	0.140	0.124	0.062	0.053	0.083	0.066	0.049	0.033	0.103	1	0.045	0.031	0.105
3	.099	48	56	.161	.145	.070	.061	.095	.077	.060	.044	.113	1	.059	.044	.121
4	.112	40	48	.183	.166	.079	.069	.107	.088	.072	.057	.125	1	.073	.056	.137
5	.125	40	44	.205	.187	.088	.078	.120	.100	.069	.046	.158	2	.087	.069	.154
6	.138	32	40	.226	.208	.096	.086	.132	.111	.081	.058	.169	2	.090	.072	.169
8	.164	32	36	.270	.250	.113	.102	.156	.133	.104	.081	.191	2	.118	.099	.202
10	.190	24	32	.313	.292	.130	.118	.180	.156	.126	.103	.213	2	.145	.125	.235
12	.216	24	28	.357	.334	.148	.134	.205	.178	.131	.108	.271	3	.154	.132	.268
	1/4	20	28	.414	.389	.170	.155	.237	.207	.161	.139	.299	3	.190	.166	.310
	5/16	18	24	.518	.490	.211	.194	.295	.262	.215	.192	.352	3	.254	.228	.388
	3/8	16	24	.622	.590	.253	.233	.355	.315	.255	.233	.434	4	.285	.259	.466
	7/16	14	20	.625	.589	.265	.242	.368	.321	.266	.244	.443	4	.287	.260	.469
	1/2	13	20	.750	.710	.297	.273	.412	.362	.274	.252	.449	4	.366	.333	.562

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread.

[2] The radius of the fillet under the head shall not exceed one-half the pitch of the thread. The application of an undercut instead of a radius is optional.

[3] All recess dimensions are controlled by the penetration, *Q*, of standard gage points as specified in table XVII.10 and figures XVII.9 and XVII.11.

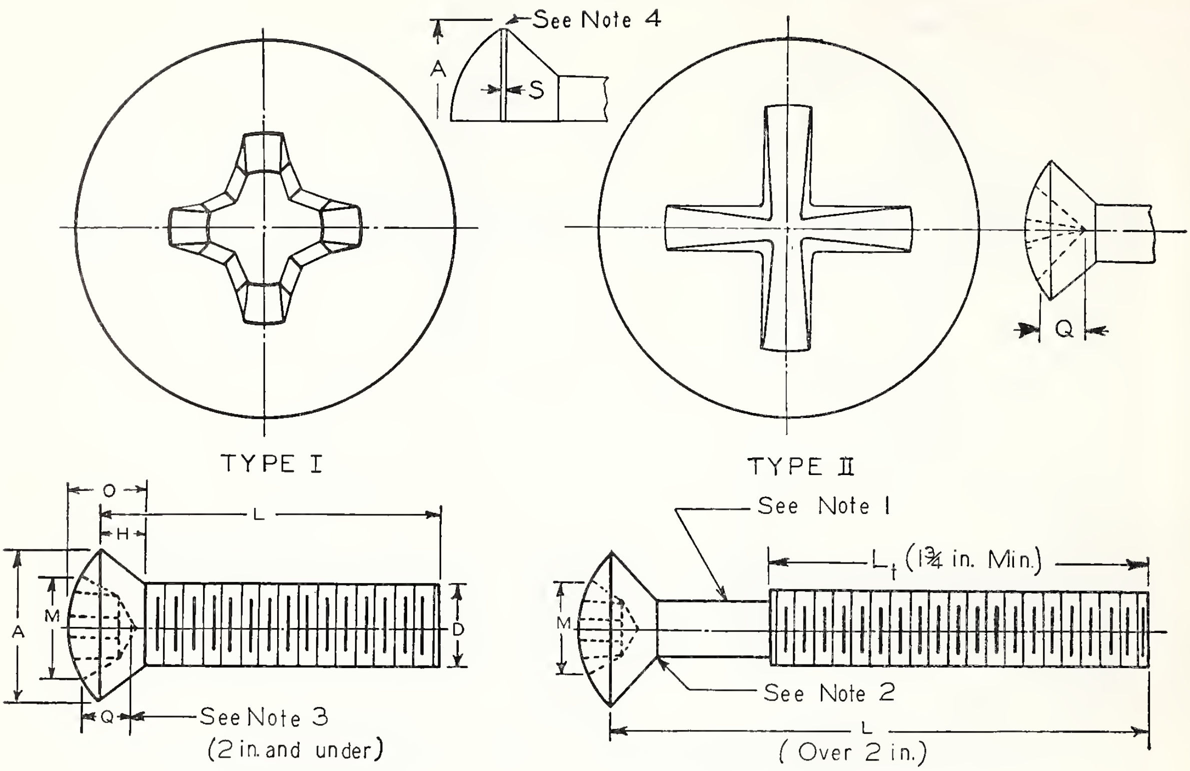

Figure XVII.5.—*Oval (countersunk) head, cross-recessed machine screws (see table XVII.5).*

Table XVII.5.—*Dimensions of oval (countersunk) head, cross-recessed machine screws (see fig. XVII.5)*

Nominal size,[1] D	Threads per inch, n: Coarse-thread series	Threads per inch, n: Fine-thread series	Dimensions of head[2]: A, Diameter of head: Maximum sharp	A, Diameter of head: Minimum sharp	A, Diameter of head: Minimum with maximum, S	H, Height of head: Maximum	H, Height of head: Minimum	S[3], Flat on minimum screw	O, Total height of head: Maximum	O, Total height of head: Minimum	Type I recess, Dimensions of recess: Q, Penetration[3]: Maximum	Type I recess: Q, Penetration[3]: Minimum	Type I recess: M, Recess diameter, maximum	Recess number	Type II recess, Dimensions of recess: Q, Penetration[3]: Maximum	Type II recess: Q, Penetration[3]: Minimum	Type II recess: M, Recess diameter, maximum
No. *in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*		*in.*	*in.*	*in.*
2 0.086	56	64	0.172	0.156	0.150	0.051	0.040	0.003	0.080	0.063	0.059	0.045	0.109	1	0.066	0.052	0.129
3 .099	48	56	.199	.181	.175	.059	.048	.004	.092	.073	.071	.057	.121	1	.082	.066	.150
4 .112	40	48	.225	.207	.200	.067	.055	.004	.104	.084	.084	.070	.133	1	.098	.081	.169
5 .125	40	44	.252	.232	.225	.075	.062	.005	.116	.095	.071	.050	.155	2	.107	.090	.189
6 .138	32	40	.279	.257	.249	.083	.069	.005	.128	.105	.091	.069	.175	2	.124	.105	.209
8 .164	32	36	.332	.308	.300	.100	.084	.006	.152	.126	.105	.084	.189	2	.156	.136	.249
10 .190	24	32	.385	.359	.348	.116	.098	.007	.176	.148	.123	.102	.206	2	.172	.148	.289
12 .216	24	28	.438	.410	.397	.132	.112	.008	.200	.169	.132	.111	.267	3	.205	.180	.329
1/4	20	28	.507	.477	.462	.153	.131	.009	.232	.197	.153	.131	.287	3	.247	.221	.380
5/16	18	24	.635	.600	.581	.191	.165	.011	.290	.249	.215	.194	.387	3	.295	.267	.476
3/8	16	24	.762	.722	.700	.230	.200	.013	.347	.300	.234	.213	.407	4	.374	.343	.572
7/16	14	20	.812	.771	.743	.223	.190	.016	.345	.295	.246	.225	.419	4	.404	.372	.609
1/2	13	20	.875	.831	.802	.223	.186	.018	.354	.299	.260	.239	.434	4	.442	.408	.656

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread.
[2] The radius of the fillet under the head shall not exceed twice the pitch of the thread.
[3] All recess dimensions are controlled by the penetration, Q, of standard gage points, as specified in table XVII.10 and figures XVII.9 and XVII.11.
[4] Edges of head may be rounded.

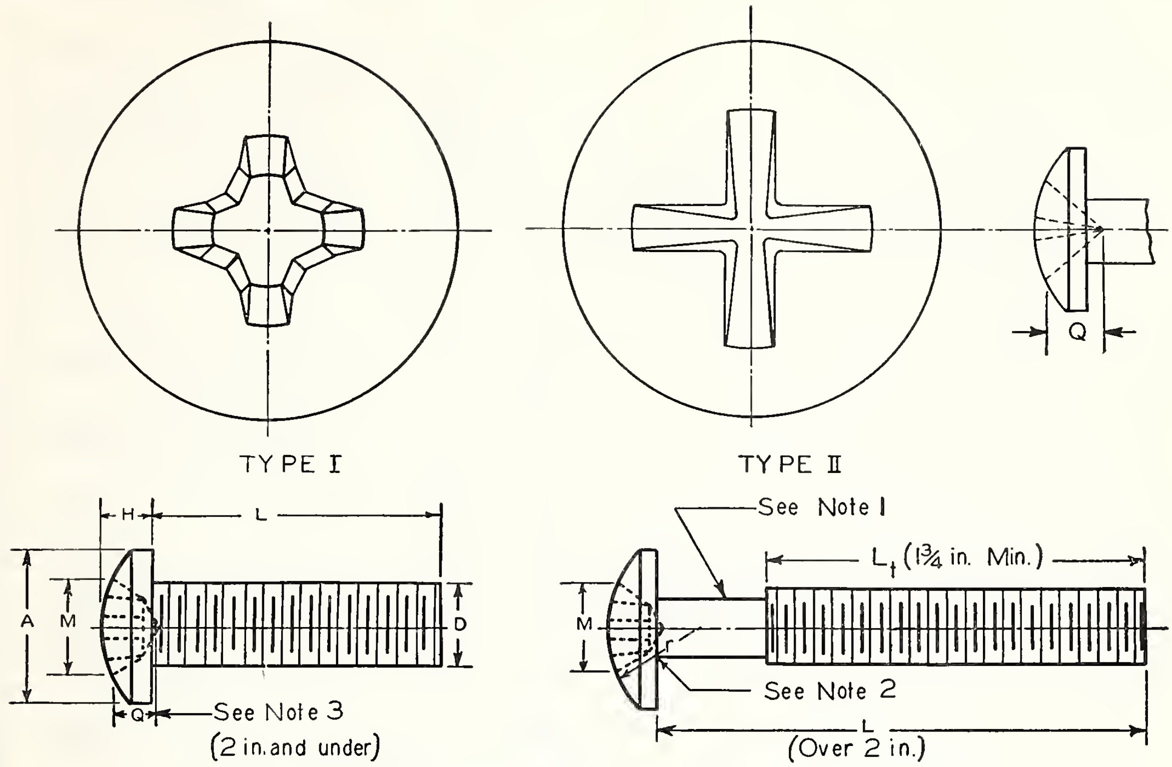

FIGURE XVII.6.—*Cross-recessed truss head machine screws (see table XVII.6).*

TABLE XVII.6.—*Dimensions of cross-recessed truss head machine screws (see fig. XVII.6)*

Nominal size,[1] D		Threads per inch, n		Dimensions of head[2]					Type I recess				Type II recess		
									Dimensions of recess			Recess number	Dimensions of recess		
				A		H		r	Q		M		Q		M
		Coarse-thread series	Fine-thread series	Diameter of head		Height of head		Radius of head	Penetration[3]		Recess diameter, maximum		Penetration[3]		Recess diameter, maximum
				Maximum	Minimum	Maximum	Minimum	Maximum	Maximum	Minimum			Maximum	Minimum	
No.	*in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*		*in.*	*in.*	*in.*
2	0.086	56	64	0.194	0.180	0.053	0.044	0.129	0.049	0.034	0.101	1	0.051	0.037	0.109
3	.099	48	56	.226	.211	.061	.051	.151	.056	.042	.107	1	.066	.051	.127
4	.112	40	48	.257	.241	.069	.059	.169	.059	.044	.109	1	.081	.064	.144
5	.125	40	44	.289	.272	.078	.066	.191	.075	.060	.125	1	.087	.070	.162
6	.138	32	40	.321	.303	.086	.074	.211	.070	.048	.155	2	.102	.084	.180
8	.164	32	36	.384	.364	.102	.088	.254	.085	.063	.170	2	.133	.112	.216
10	.190	24	32	.448	.425	.118	.103	.283	.101	.079	.185	2	.163	.139	.251
12	.216	24	28	.511	.487	.134	.118	.336	.108	.086	.245	3	.170	.145	.286
	1/4	20	28	.573	.546	.150	.133	.375	.123	.101	.260	3	.201	.175	.321
	5/16	18	24	.698	.666	.183	.162	.457	.170	.148	.349	4	.258	.230	.391
	3/8	16	24	.823	.787	.215	.191	.538	.216	.194	.380	4	.281	.251	.461
	7/16	14	20	.948	.907	.248	.221	.619	.234	.212	.411	4	.342	.310	.531
	1/2	12, 13	20	1.073	1.028	.280	.250	.701	.265	.243	.419	4	.404	.370	.601

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread.
[2] The radius of the fillet under the head shall not exceed one-half the pitch of the thread. The application of an undercut instead of a radius is optional.
[3] All recess dimensions are controlled by the penetration, Q, of standard gage points as specified in table XVII.10 and figures XVII.9 and XVII.11.

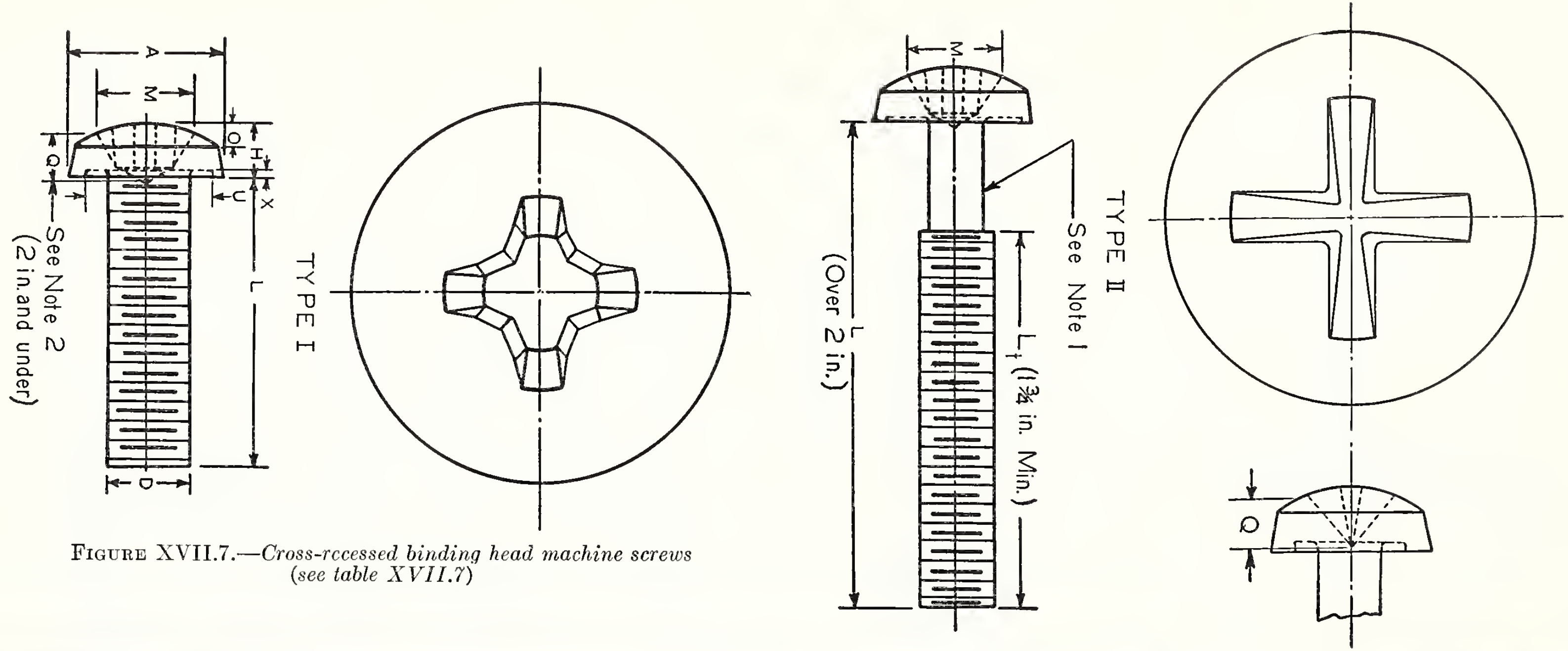

FIGURE XVII.7.—*Cross-recessed binding head machine screws (see table XVII.7)*

TABLE XVII.7.—*Dimensions of cross-recessed binding head machine screws (see fig. XVII.7)*

Nominal size,[1] D		Threads per inch, n		Dimensions of head										Type I recess				Type II recess		
				A		O		V		U		X		Dimensions of recess			Recess number	Dimensions of recess		
				Diameter of head		Total height of head		Height of oval		Diameter of undercut		Depth of undercut		Q		M		Q		M
		Coarse-thread series	Fine-thread series											Penetration [2]		Recess diameter, maximum		Penetration [2]		Recess diameter, maximum
				Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum			Maximum	Minimum	
No.	in.			in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.		in.	in.	in.
2	0.086	56	64	0.181	0.171	0.046	0.041	0.018	0.013	0.141	0.124	0.010	0.005	0.048	0.034	0.097	1	0.054	0.040	0.118
3	.099	48	56	.208	.197	.054	.048	.022	.016	.162	.143	.011	.006	.058	.044	.107	1	.067	.051	.135
4	.112	40	48	.235	.223	.063	.056	.025	.018	.184	.161	.012	.007	.067	.052	.115	1	.078	.062	.153
5	.125	40	44	.263	.249	.071	.064	.029	.021	.205	.180	.014	.009	.061	.040	.145	2	.090	.073	.171
6	.138	32	40	.290	.275	.080	.071	.032	.024	.226	.199	.015	.010	.074	.053	.157	2	.103	.084	.188
8	.164	32	36	.344	.326	.097	.087	.039	.029	.269	.236	.017	.012	.100	.079	.183	2	.128	.106	.224
10	.190	24	32	.399	.378	.114	.102	.045	.034	.312	.274	.020	.015	.120	.098	.202	2	.152	.128	.258
12	.216	24	28	.454	.430	.130	.117	.052	.039	.354	.311	.023	.018	.131	.109	.264	3	.177	.150	.295
	1/4	20	28	.513	.488	.153	.138	.061	.046	.410	.360	.026	.021	.144	.123	.278	3	.209	.179	.333
	5/16	18	24	.641	.609	.193	.174	.077	.059	.513	.450	.032	.027	.172	.152	.347	4	.268	.232	.417
	3/8	16	24	.769	.731	.234	.211	.094	.071	.615	.540	.039	.034	.224	.203	.397	4	.310	.264	.500

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread.
[2] All recess dimensions are controlled by the penetration, Q, of standard gage points, as specified in table XVII.10 and figures XVII.9 and XVII.11.

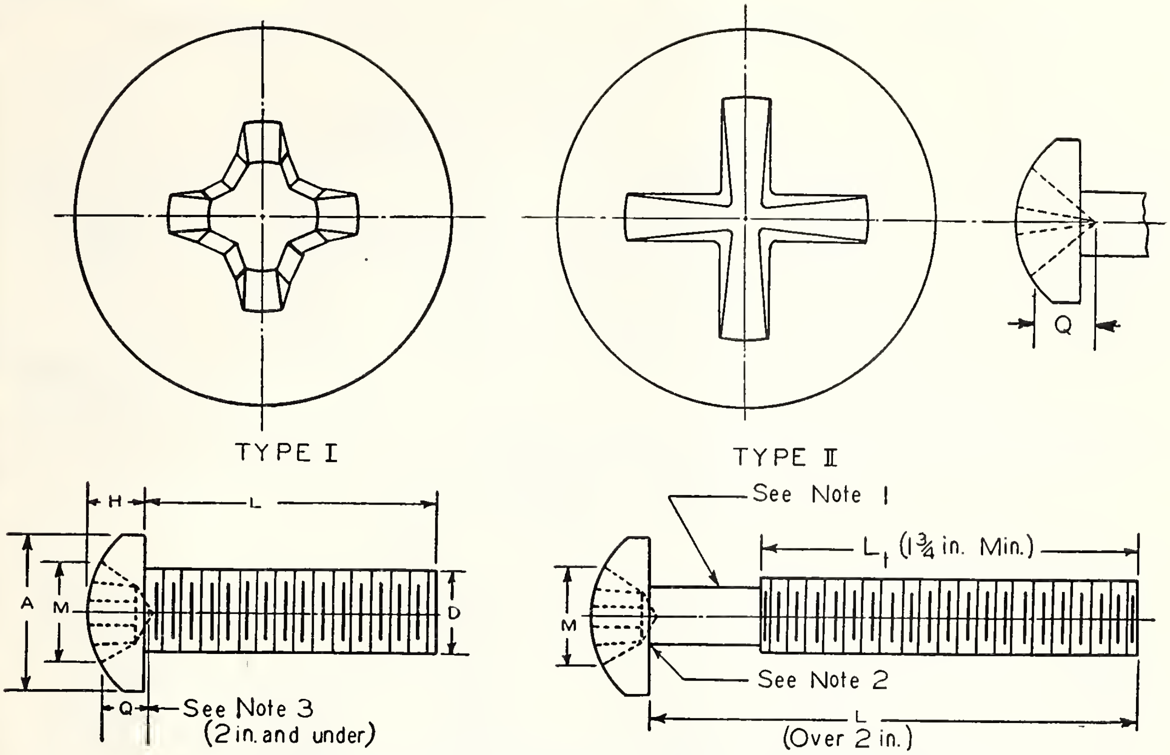

FIGURE XVII.8.—*Cross-recessed pan head machine screws (see table XVII.8).*

TABLE XVII.8.—*Dimensions of cross-recessed pan head machine screws (see fig. XVII.8)*

Nominal size, [1] D		Threads per inch		Dimensions of head [2]				Type I recess					Type II recess		
								Dimensions of recess							
				A		*H*		*Q*		*M*	Recess number		*Q*		*M*
				Diameter of head		Height of head		Penetration [3]		Recess diameter, maximum			Penetration [3]		Recess diameter, maximum
		Coarse-thread series	Fine-thread series	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum				Maximum	Minimum	
No.	*in.*			*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*			*in.*	*in.*	*in.*
2	0.086	56	64	0.167	0.155	0.062	0.053	0.049	0.034	0.101	1		0.053	0.037	0.109
3	.099	48	56	.193	.180	.071	.062	.058	.043	.109	1		.063	.047	.125
4	.112	40	48	.219	.205	.080	.070	.068	.053	.119	1		.074	.057	.142
5	.125	40	44	.245	.231	.089	.079	.069	.046	.155	2		.084	.067	.159
6	.138	32	40	.270	.256	.097	.087	.077	.055	.163	2		.095	.077	.176
8	.164	32	36	.322	.306	.115	.105	.094	.071	.179	2		.116	.098	.209
10	.190	24	32	.373	.357	.133	.122	.110	.089	.196	2		.137	.118	.242
12	.216	24	28	.425	.407	.151	.139	.121	.098	.256	3		.158	.138	.276
	1/4	20	28	.492	.473	.175	.162	.141	.118	.278	3		.186	.165	.320
	5/16	18	24	.615	.594	.218	.203	.170	.149	.347	4		.236	.214	.400
	3/8	16	24	.740	.716	.261	.244	.210	.190	.390	4		.287	.263	.481

[1] The diameter of the unthreaded portion shall be not less than the minimum pitch diameter nor more than the maximum major diameter of the thread.
[2] The radius of the fillet under the head shall not exceed one-half the pitch of the thread. The application of an undercut instead of a radius is optional.
[3] All recess dimensions are controlled by the penetration, *Q*, of standard gage points as specified in table XVII.10 and figures XVII.9 and XVII.11.

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TABLE XVII.9.—*Dimensions of cross recesses, types I and II (see figs. XVII.9 and XVII.11)*

Dimensions	Type I recess number				Type II recess
	1	2	3	4	
G, +0.002, −0.000	0.050 in.	0.090 in.	0.150 in.	0.200 in.	
B	0.0380 {+0.000 in. −0.001 in.}	0.0578±0.001 in.	0.0950±0.001 in.	0.1370±0.001 in.	0.0378 {+0.000 in. −0.002 in.}
Milling angle	7°+15′−0	5°45′+15′−0	5°45′+15′−0	7°+15′−0	9°+0′.−15.
Point angle	28°+0°−1	28°+0°−1	28°+0°−1	28°+0°−1	75°+1°−0.
Wing angle, +30′−0	26°30′	26°30′	26°30′	26°30′	
Base flute angle, +0, −15′	138°	140°	146°	153°	
Side flute angle	104°+0′−15	92°+0′−15	92°+0′−15	92°+0′−15	89°17′±15′.
Width of base flute, D {+0.000 −0.002}	0.018 in.	0.033 in.	0.080 in.	0.096 in.	
Wing thickness, F	{0.020 in. 0.024 in.}	0.035 in. 0.040 in.	0.033 in. 0.038 in.	0.056 in. 0.060 in.	
Radius, E					0.015 {+0.002 in. −0.000 in.}

TABLE XVII.10.—*Dimensions of gage points for types I and II cross recesses (see figs. XVII.9 and XVII.11)*

Dimensions	Type I recess number				Type II recess
	1	2	3	4	
G, +0.001, −0.000	0.050 in.	0.090 in.	0.150 in.	0.200 in.	
B	{0.0394+0.000 in. −0.001}	0.0606+0.000 in. −0.001	0.0983+0.000 in. −0.001	0.1407+0.000 in. −0.001	0.0180+0.001 in. −0.000.
Point angle	{18°+1° −0}	18°+1° −0	18°+1° −0	18°+1° −0	75°+0′ −30
Milling angle	{7°+0′ −15}	5°45′+0′ −15′	5°45′+0′ −15	7°+0′ −15′	8°45′+5′ −0
Flat on end	{0.015 in. 0.020 in.}	0.015 in. 0.020 in.	0.015 in. 0.020 in.	0.015 in. 0.020 in.	0.025 in. 0.030 in.
Wing angle, +0, −15′	26°30′	26°30′	26°30′	26°30′	
Angle E, +15′, −0	138°	140°	146°	153°	
Side flute angle, +15′, −0′	104°	92°	92°	92°	89°17′
Wing thickness, F	{0.018 in. 0.021 in.}	0.025 in. 0 028 in.	0.030 in. 0.033 in.	0.042 in. 0.045 in.	
Width of bottom of flute {+0.000 −0.001}	0.0202 in.	0.0434 in.	0.0826 in.	0.1078 in.	
Radius E					0.005 +0.000 in. −0.001

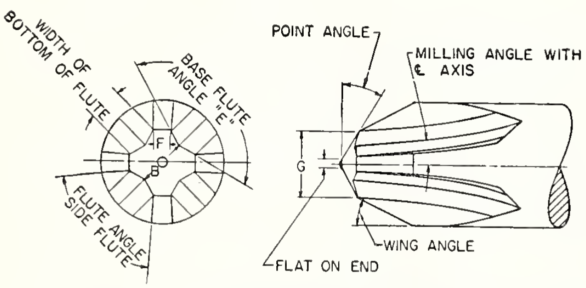


FIGURE XVII.9.—*Gage point and recess dimensions, type I recesses (see tables XVII.9 and XVII.10).*

TABLE XVII.11.—*Shank dimensions of gage points for type I cross recess penetration gage (see fig. XVII.10)*

Size of recess gage	A ±0.002	B ±0.003	C ±0.0001	D ±0.0001	E ±0.005	F ±0.005	G ±0.005
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
No. 1	0.012	0.020	0.0875	0.0871	5/32	11/16	13/16
No. 2	.018	.031	.1417	.1413	7/32	3/4	7/8
No. 3	.022	.037	.2097	.2093	1/4	25/32	29/32
No. 4	.031	.062	.3126	.3122	23/64	27/32	31/32

TABLE XVII.12.—*Dimensions for type II recess gage (see fig. XVII.12)*

A[1] ±0.0001	B ±0.005	C −0.002 −0.000	D ±0.005	E ±0.005	F ±0.0001	G ±0.005
in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
0.0930	11/32	0.376	1	7/8	0.0926	3/16
.1410	3/8	.376	1	7/8	.1406	1/4
.2460	1/2	.376	1 1/16	15/16	.2456	5/16
.4360	11/16	.500	1 1/4	1 1/8	.4356	15/32

[1] *A*=gage diameter.

TABLE XVII.13.—*Type II recess screw style and size for various penetration gage diameters*

Style of screw	Gage diameter, A			
	0.093	0.141	0.246	0.436
	Nominal size of screws			
Round head	2, 3, 4	5, 6, 8, 10	12, 1/4, 5/16	3/8, 7/16, 1/2
Flat head	2, 3, 4	5, 6, 8	10, 12, 1/4	5/16, 3/8, 7/16, 1/2
100° flat head	4	6, 8, 10	1/4, 5/16	3/8
Oval fillister	2, 3, 4, 5	6, 8, 10	12, 1/4, 5/16	3/8, 7/16, 1/2
Oval head	2, 3, 4	5, 6, 8	10, 12, 1/4	5/16, 3/8, 7/16, 1/2
Truss head	2, 3, 4	5, 6, 8, 10	12, 1/4, 5/16	3/8, 7/16, 1/2
Binding head	2, 3	4, 5, 6, 8	10, 12, 1/4, 5/16	3/8
Pan head	2, 3, 4	5, 6, 8, 10	12, 1/4, 5/16	3/8

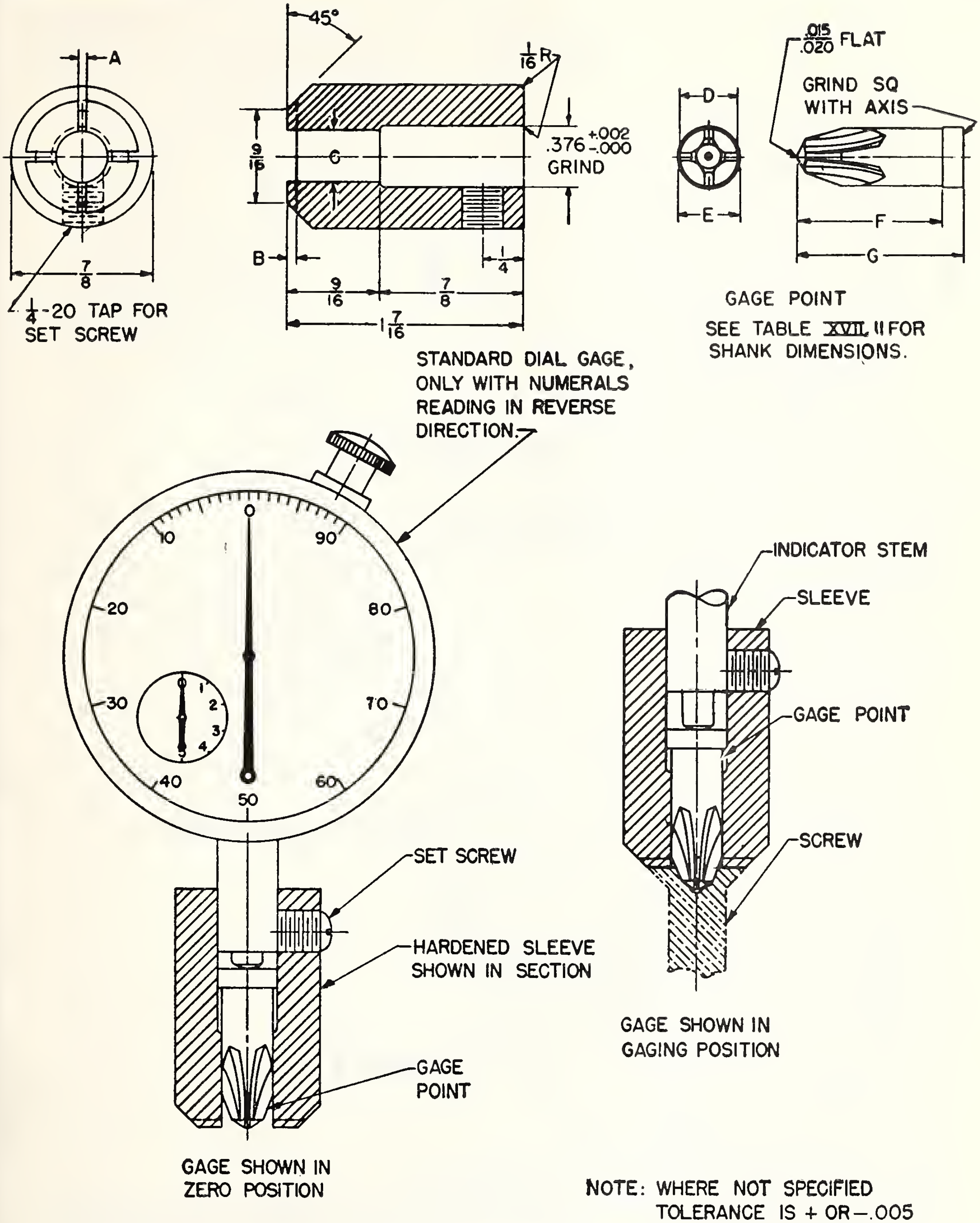


FIGURE XVII.10.—*Penetration gage for type I cross recesses (see fig. XVII.9 and table XVII.11).*

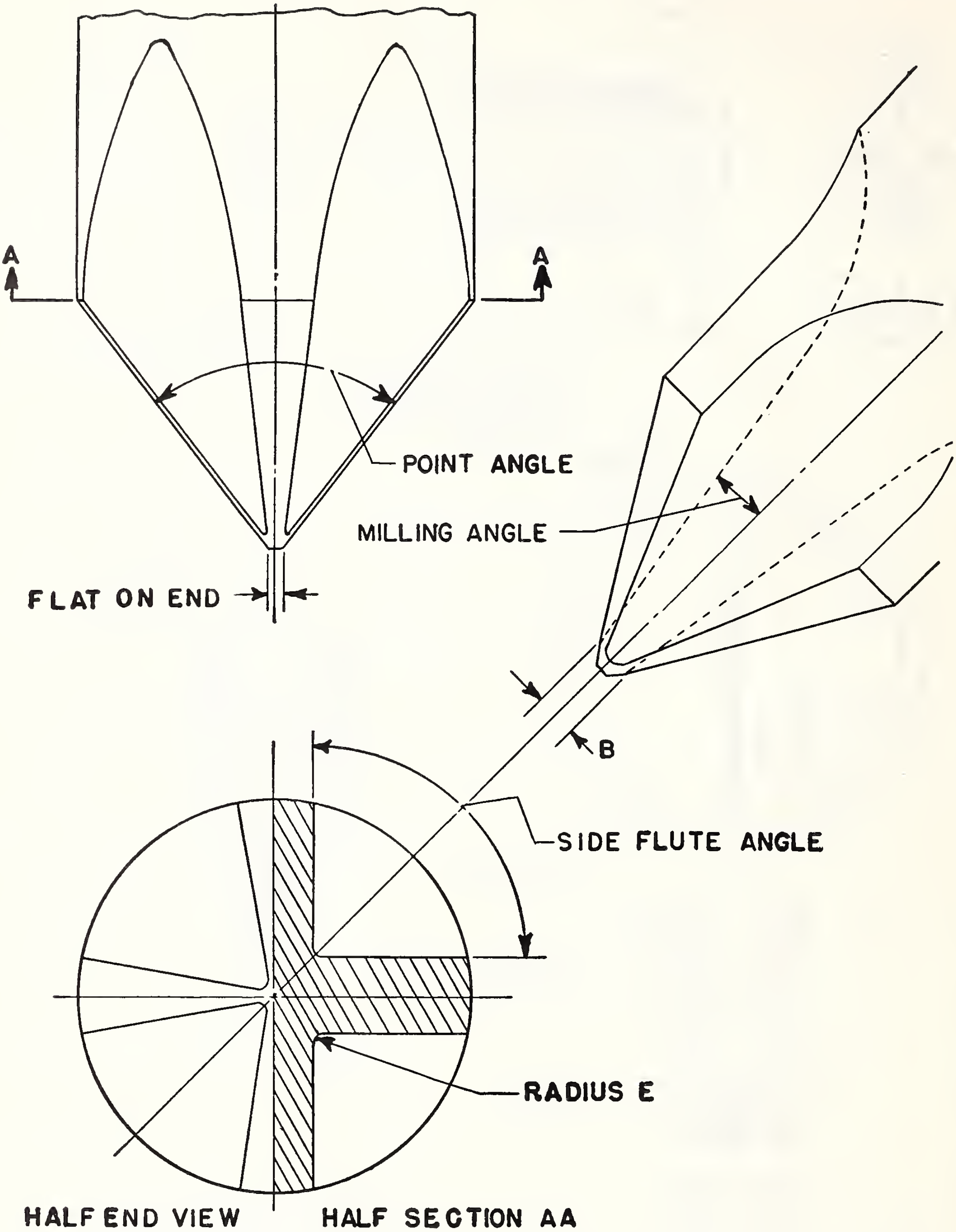


FIGURE XVII.11.—*Gage point and recess dimensions, type II recesses (see tables XVII.9 and XVII.10).*

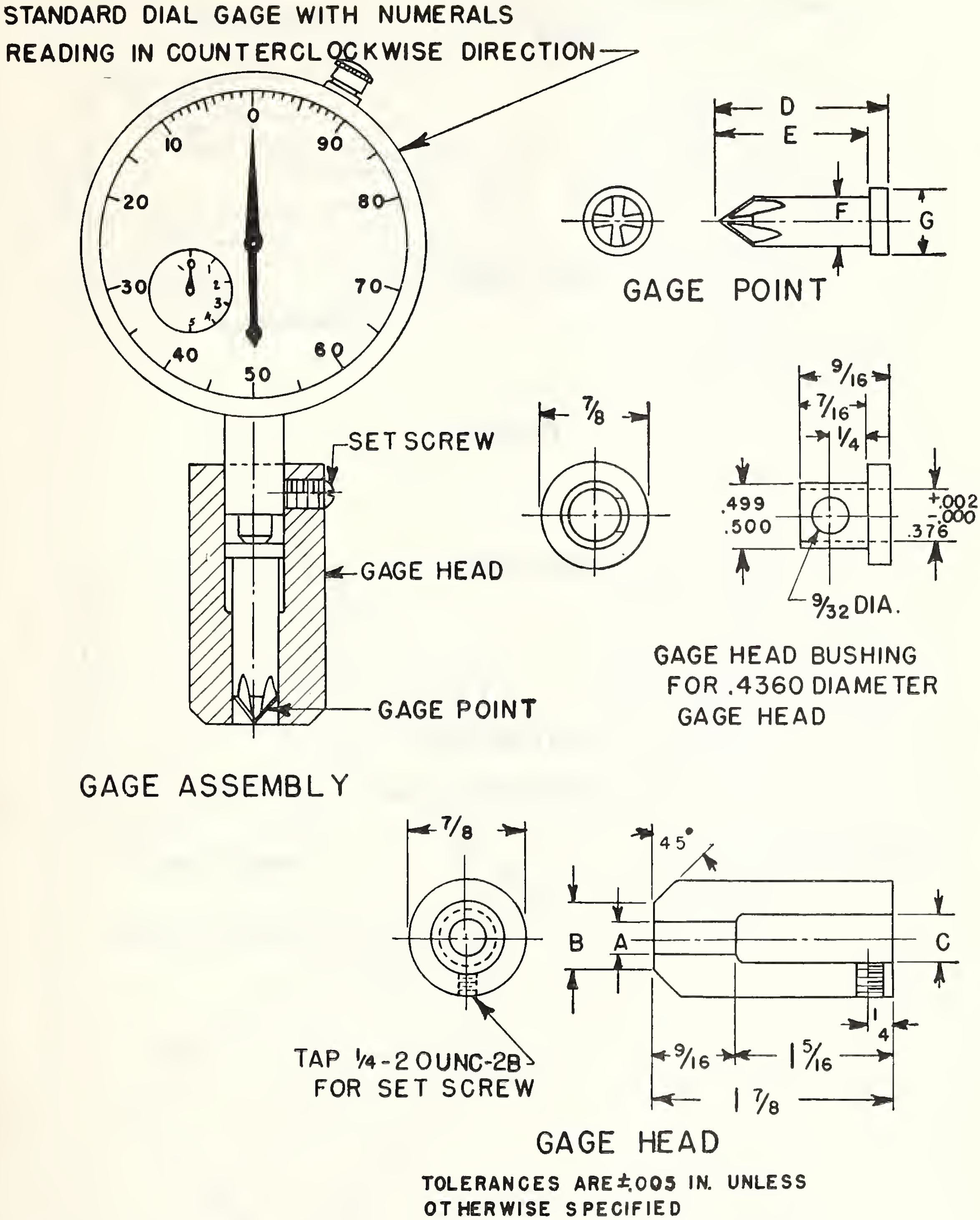
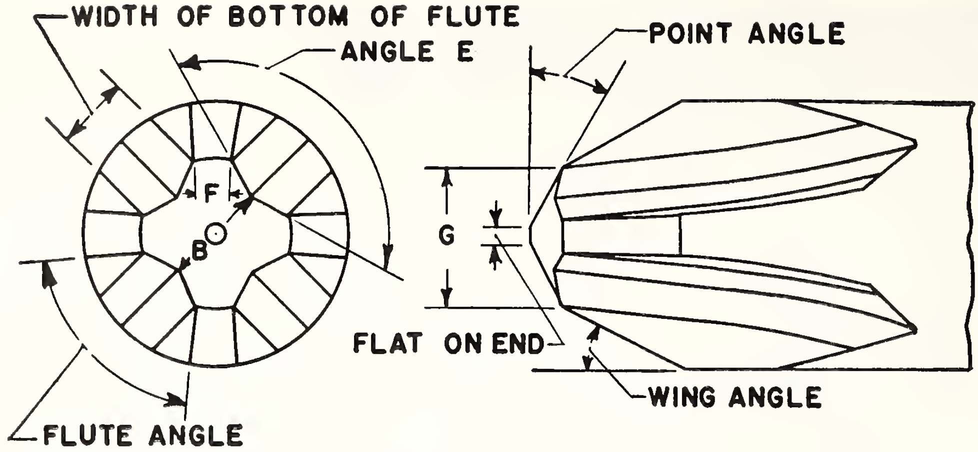
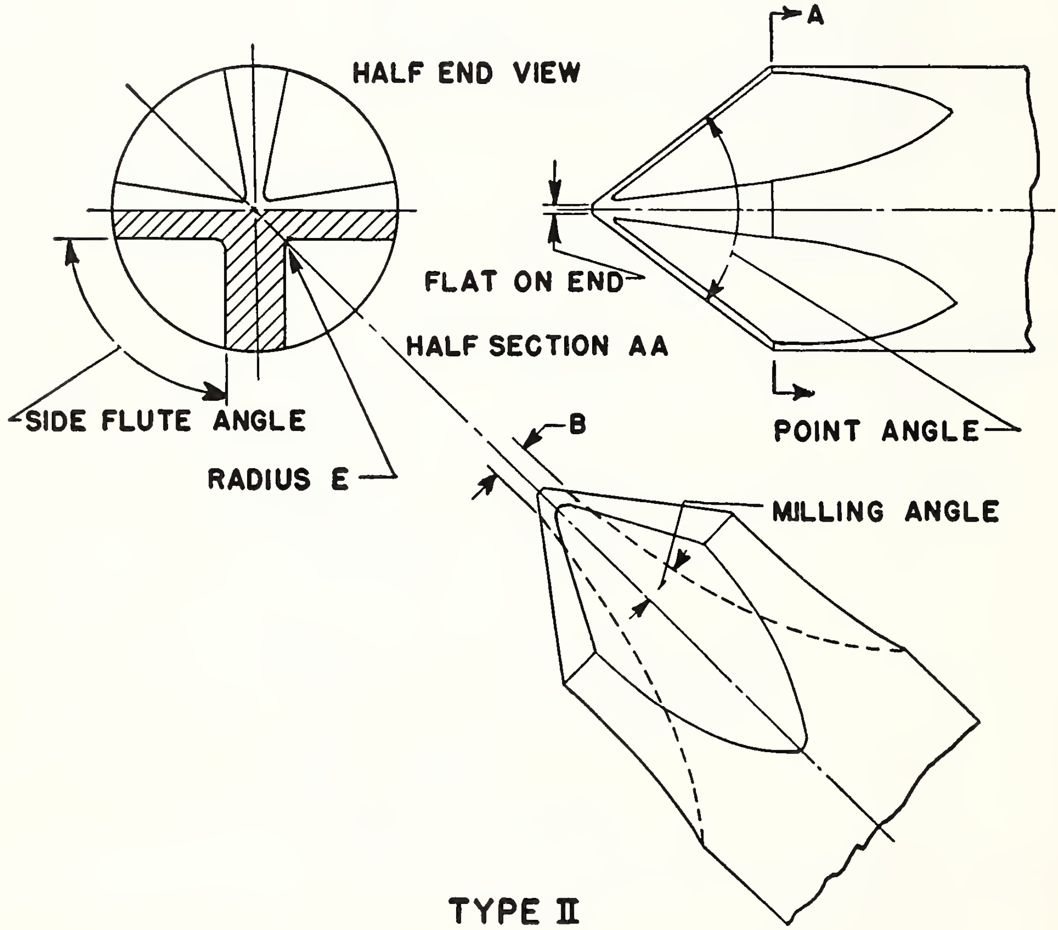


FIGURE XVII.12.—*Penetration gage for type II cross recesses (see fig. XVII.11 and tables XVII.12 and XVII.13).*



TYPE I



TYPE II

FIGURE XVII.13.—*Drivers for types I and II cross recesses (see table XVII.14).*

TABLE XVII.14.—*Dimensions of cross-recess drivers, types I and II (see fig. XVII.13)*

Dimensions	Type I recess number				Type II
	1	2	3	4	
$G, \pm 0.001$	0.050 in.	0.090 in.	0.150 in.	0.200 in.	
$B, \pm 0.001$	0.0394 in.	0.0606 in.	0.0983 in.	0.1407 in.	0.0305 in.
Milling angle $+0'-30'$	7°	5°45′	5°45′	7°	9°.
Point angle $+1°-0°$	18°	18°	18°	18°	75°.
Wing angle $+0'-30'$	26°30′	26°30′	26°30′	26°30′	
Base flute angle, E, $+30'-0'$	138°	140°	146°	153°	
Side flute angle $+30'-0'$	104°	92°	92°	92°	89°17′.
Width of bottom of flute ± 0.001	0.0202 in.	0.0434 in.	0.0826 in.	0.1078 in.	
Wing thickness, F	0.016 in. 0.020 in.	0.023 in. 0.028 in.	0.027 in. 0.033 in.	0.040 in. 0.045 in.	
Radius, E, ± 0.001					0.008 in.
Flat on end $\left\{\begin{matrix}+0.008\\-0.000\end{matrix}\right.$					0.015 in.