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STD.ASME B18.21.2M-ENGL 1999 0759670 0615657 2T0

ASME B18.21.2M-1999

(Revision of ASME B18.21.2M-1994)

LOCK WASHERS (METRIC SERIES)

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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The American Society of Mechanical Engineers

AN AMERICAN NATIONAL STANDARD

LOCK WASHERS (METRIC SERIES)

ASME B18.21.2M-1999

(Revision of ASME B18.21.2M-1994)

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FOREWORD

American National Standards Committee B27 for the standardization of plain and lock washers was organized in March 1926 as Sectional Committee B27 under the aegis of the American Standards Association (later the United States of America Standards Institute and, as of October 6, 1969, the American National Standards Institute, Inc.), with the Society of Automotive Engineers and the American Society of Mechanical Engineers as joint sponsors. Since 1950, this Committee has been designated responsibility for standardization of washers and machine rings.

In May of 1928, the B27 Committee established two subcommittees to carry on development work: Subcommittee 1[1] on plain washers and Subcommittee 2[1] on lock washers. A tentative standard for helical spring lock washers circulated for industry comment in November 1931 failed to achieve acceptance and Committee activity became dormant for some years.

In 1940, the B27 Committee was reorganized and Subcommittee 2 proceeded to draft a proposal covering three series of helical spring lock washers, designated light, medium, and heavy. In 1943, this proposal was amended to include the extra-heavy series washers and, following approval by the B27 Committee and sponsor organizations, was accepted as an American Standard under the designation ASA B27.1-1944.

During the ensuing years, minor refinements to the hardness requirements and methods of test were considered, and in December 1948, the B27 Committee accepted, in principle, expansion of the standard to cover helical spring lock washers made from materials other than carbon steel and inclusion of specifications for tooth lock washers, and both helical spring and tooth lock washer machine screw assemblies. A draft proposal incorporating requirements applicable to corrosion resistant steel, phosphor bronze, silicon bronze, aluminum-zinc alloy, and K-monel helical spring lock washers and the other new products was completed by Subcommittee 2 in September 1949. Subsequent to approval by the B27 Committee and sponsors, this proposal was forwarded to the American Standards Association and declared an American Standard on May 22, 1950.

During the years 1951 through 1958, Subcommittee 2 held five meetings, at which it was agreed to extend the light and heavy series helical spring lock washers to include sizes $1\frac{5}{8}$ in. through 3 in., establish tolerances on the nominal thickness of helical spring lock washers, and recognize hardened screw and lock washer assemblies. A format draft dated June 1957 was approved by the letter ballot of the B27 Committee and the sponsor organizations and submitted to the American Standards Association for designation as an American Standard. This was granted on November 3, 1958.

Throughout the period from 1959 through 1961, a number of changes were recommended by the Helical Washer Institute, which had undertaken a program to refine the helical spring lock washers to meet more exacting demands of consumer industries. Also, at a meeting held on November 28, 1961, the B27 Committee recognized the desirablity of publishing the screw and washer assemblies as a separate document under the jurisdiction of the B18 Committee, but subject to joint approval by the B27 Committee and affected subcommittees thereof. Subsequently, a draft proposal deleting the coverage on screw and washer assemblies

[1] As of April 1, 1966, Subcommittee 1 was redesignated Subcommittee 2 on plain washers, and Subcommittee 2 was redesignated Subcommittee 1 on lock washers.

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and incorporating revisions to the helical spring lock washers was prepared. The latter included changing designation of medium series to regular series and extra-heavy series to extra-duty series, and the addition of the hi-collar series for use with socket head cap screws. Following acceptance by the subcommittee, the proposal was letter balloted to the B27 Committee on November 18, 1963, then approved by the sponsors and the American Standards Association and officially granted recognition as an American Standard on September 20, 1965.

Continued studies conducted by the Helical Washer Institute resulted in this group submitting further recommendations for changes to the standard at a meeting of American National Standards Committee B27 in October 1969. Subcommittee 1 then undertook preparation of a proposal dated May 1970, incorporating changes to helical spring lock washers. These consisted of deleting coverage for the light series and Type 420 corrosion resistant steels, adding control on section corner radius, adjusting inside diameters, and relegating the heavy series to "Not Recommended for New Applications" status. Other minor corrections to dimensional data and extensive editorial refinements were also included. This draft was approved by letter ballot of Standards Committee B27, conducted on August 11, 1970. Subsequent to the inclusion of additional editorial refinements, the proposal was found acceptable by the sponsor organizations and submitted to the American National Standards Institute for designation as an American National Standard. After approval of this revision by American National Standards Committee B27, the washer activity was transferred to American National Standards Committee B18. Subcommittee 1 of B27 was redesignated as Subcommittee 21 of Standards Committee B18.

At the December 1986 American National Standards B18 main meeting, a request was made to have Subcommittee 21 draft an American National Standard for metric lock washers. On May 26, 1987, the first draft of the requested standard was completed. This draft was based on the inch series standard which was being reviewed and revised at the time by Subcommittee 21. Dimensional data and types of lock washers to be included in the tables were gathered from industry standards. Both standards were then updated as required during the May and December 1987 subcommittee meetings. At the December 1987 meeting, a motion to ballot the standard was made, and by the December 1988 meeting, all ballot comments were reviewed and editorial changes were made. At the May 1989 meeting, the completed draft dated May 6, 1989 was submitted for publication.

On December 9, 1992, a proposal to revise this Standard was made. This Standard has not been used with the dimensions in Table 2 or with the product listed in Table 3. This revision changes the dimensions in Table 2 to reflect active part dimensions and replaces Table 3, Metric Socket Head Helical Spring Lock Washers, with a new Table 3 for Metric Heavy Helical Spring Lock Washers. In addition, the trapezoid dimensions were replaced with the formula used in prior standards; several materials and hardness values were added; paragraphs covering lot size, inspection and quality assurance requirements, and inspection characteristics were added, and editorial changes were made. The proposal was sent out for balloting, and at the December 7, 1993 meeting, comments were reviewed and acted upon as needed.

On December 4, 1995, a proposal to clarify items in this Standard was made. For helical spring lock washers, the changes included, adding clearance to the washer inside diameter needing heavier coatings such as mechanically galvanizing, moving decarb measuring requirement into proper location, and correcting illustrations above tables. For the tooth lock washer, the changes include clarifying the wording in the measurement of the tooth projection from side to side, and removing the need for twist testing. In addition, the Standard was revised to conform with the standard formatting for B18 documents.

This Standard was approved as an American National Standard on November 3, 1999.

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Standardization of Bolts, Nuts, Rivets, Screws, Washers, and Similar Fasteners

(The following is the roster of the Committee at the time of approval of this Standard.)

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Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for genral understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include plans or drawings which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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LOCK WASHERS (METRIC SERIES)

1 INTRODUCTORY NOTES

1.1 Scope

1.1.1 This Standard covers the dimensions, physical properties, and methods of testing for helical spring and tooth lock washers.

1.1.2 The inclusion of dimensional data in this Standard is not intended to imply that all products described are stock production items. Consumers should consult with suppliers concerning the availability of products.

NOTE: The word *lock* appearing in the names of products in this Standard is a generic term historically associated with their identification and is not intended to imply an indefinite permanency of fixity in attachments where the fasteners are used.

1.2 Comparison with ISO

This Standard has no ISO counterpart.

1.3 Types

1.3.1 Helical Spring Lock Washers. This Standard covers helical spring lock washers of the following sections: regular and heavy.

1.3.2 Tooth Lock Washers. This Standard covers tooth lock washers of the following type: internal tooth, external tooth, internal-external tooth, of two constructions, designated Type A and Type B.

1.4 Dimensions

All dimensions in this Standard are given in millimeters (mm), and apply before any coating, unless otherwise specified.

1.5 Responsibility for Modifications

The washer manufacturers shall not be held responsible for malfunctions of product determined to be due to plating or other modifications when such plating or modification is not accomplished under the manufacturers' control or direction.

1.6 Terminology

For definitions of terms relating to washers or features thereof used in this Standard, refer to ASME B18.12, Glossary of Terms for Mechanical Fasteners.

1.7 Referenced Standards

Unless otherwise specified at the time the order is placed, the latest referenced standards shall be used.

ASME B18.12, Glossary of Terms for Mechanical Fasteners

ASME B18.18.1M, Inspection and Quality Assurance for General Purpose Fasteners

ASME B18.18.2M, Inspection and Quality Assurance for High-Volume Machine Assembly Fasteners

ASME B18.18.3M, Inspection and Quality Assurance for Special Purpose Fasteners

ASME B18.18.4M, Inspection and Quality Assurance for Fasteners for Highly Specialized Engineered Applications

ASME B18.24.3, Part Identifying Number (PIN) Code System Standard for B18 Nonthreaded Products

Publisher: The American Society of Mechanical Engineers (ASME), Order Department: 22 Law Drive, Box 2900, Fairfield, NJ 07007-2900

ASTM B 99, Standard Specification for Copper-Silicon Alloy Wire for General Applications

ASTM B 159, Standard Specifications for Phosphor Bronze Wire

ASTM B 211, Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire

ASTM B 591, Standard Specifications for Copper-Zinc-Tin Alloys Plate, Sheet, Strip, and Rolled Bar

ASTM E 140, Standard Hardness Conversion Tables for Metals (Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Rockwell Superficial Hardness, Knoop Hardness, and Scleroscope Hardness)

Publisher: The American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

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SAE J403, Chemical Compositions of Carbon Steels
SAE J404, Chemical Composition of Alloy Steels
SAE J405, Chemical Compositions of Wrought Stainless Steels
SAE J411, Carbon and Alloy Steels
SAE J419, Methods for Measuring Decarburization

Publisher: The Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA 15096

Federal Specification QQ-N-286, Nickel-Copper-Aluminum Alloy, Wrought

Publisher: Department of Defense Single Stock Point for Military Specifications and Standards (DODSSP) Defense Automated Printing Service, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19 11-5094

1.8 Lot

For all inspections referenced in this Standard, the lot shall consist of all washers of one type, grade, style, finish, and size fabricated by the same production process from the same heat number of metal as provided by the metal manufacturer and submitted for inspection and testing at the same time. The maximum lot size shall be restricted to one shift of production.

1.9 Inspection and Quality Assurance

Unless otherwise specified, acceptability to this Standard shall be determined in accordance with ASME B18.18.1M.

2 GENERAL DATA FOR HELICAL SPRING LOCK WASHERS

2.1 Application

The helical spring lock washers covered herein are intended for general applications. Helical spring lock washers compensate for developed looseness between component parts of an assembly, distribute the load over a larger area for some head styles, and provide a hardened bearing surface.

2.2 Dimensions

The dimensions of regular and heavy helical spring lock washers shall be as specified in Tables 2 and 3. Selection should be made from the regular or heavy series in Tables 2 and 3, respectively, to suit design requirements.

TABLE 1 DECARBURIZATION LIMITS

Diameters of Round Wire or Sections of Equivalent Area	Maximum Depth of Free Ferrite, mm	Maximum Total Affected Depth (Free Ferrite Plus Partial Decarburization), mm
Up to 4 mm, incl.	0.05	0.15
Over 4 mm to 6 mm, incl.	0.08	0.20
Over 6 mm to 10 mm, incl.	0.10	0.25
Over 10 mm to 12 mm, incl.	0.15	0.38

2.3 Material and Hardness

2.3.1 Material Composition. Washers shall be made from material meeting the chemical composition requirements of one of the following standards:

(a) Carbon Steel. SAE J403 1055 – 1065 (UNS G10550 – G10650).

(b) Boron Steel. SAE J411 10B55 – 10B65.

(c) Stainless Steel. SAE J405 302 – 305 (UNS S30200 – S30500) or SAE J405 316 (UNS S31600).

(d) Aluminum Alloy. ASTM B 211, 7075 (UNS A97075).

(e) Phosphor-Bronze. ASTM B 159 Copper Alloy No. 510 (UNS C51000).

(f) Silicon-Bronze. ASTM B 99, Copper Alloy No. 651 or 655 (UNS C65100 or C65500).

(g) Nickel-Copper-Aluminum. Federal Specification QQ-N-286 (UNS N05500).

(h) Alloy Steel. SAE J404 4037 (UNS G40370).

Other materials and grades shall be as agreed upon by manufacturer and purchaser.

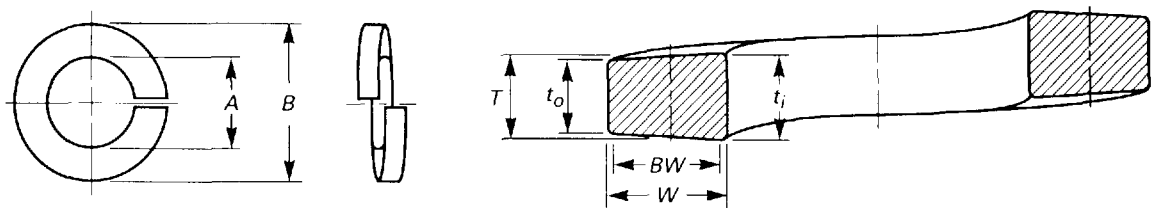
2.3.2 Hardness. All washers shall be prepared for checking the material hardness by cold (water) grinding or filing the sides sufficiently flat and parallel to assure correct readings. If applicable, be sure to remove the decarburized or plated surface. During this operation, care shall be exercised to prevent the surface temperature of the washer from exceeding 120°C. Hardness requirements applicable to washers of the respective materials shall be as follows. For hardness conversion, refer to ASTM E 140.

(a) Carbon Steel. 38 to 46 HRC, 372 to 458 HV.

(b) Boron Steel. 38 to 46 HRC, 372 to 458 HV.

(c) Stainless Steel. 35 to 43 HRC, 345 to 423 HV, for lock washers up to and including 16 mm, for larger sizes 32 to 43 HRC, 318 to 423 HV.

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Enlarged Section

TABLE 2 DIMENSIONS OF REGULAR METRIC HELICAL SPRING LOCK WASHERS

Nominal Washer Size, mm	Inside Diameter, *A*		Outside Diameter, *B*	Section Width, *W*	Mean Section Thickness $(T_i + T_o)/2$, *T*	Bearing Width, *BW*
	Max.	Min.	Max.	Min.	Min.	Min.
2	2.20	2.05	4.18	0.89	0.51	0.62
2.5	2.70	2.55	4.94	1.02	0.64	0.71
3	3.21	3.06	5.83	1.19	0.79	0.83
3.5	3.76	3.58	6.35	1.19	0.79	0.83
4	4.26	4.08	7.28	1.40	1.02	0.98
5	5.26	5.08	8.66	1.57	1.19	1.10
6	6.29	6.10	12.08	2.77	1.57	1.94
8	8.36	8.13	14.96	3.18	1.98	2.23
10	10.38	10.13	17.83	3.58	2.39	2.51
12	12.45	12.15	21.47	4.34	3.18	3.04
14	14.50	14.20	24.39	4.78	3.58	3.49
16	16.63	16.25	27.53	5.16	3.96	3.61
20	20.66	20.28	33.26	5.94	4.78	4.16
24	24.81	24.30	39.79	7.14	5.94	5.00
30	31.25	30.51	49.36	8.74	7.54	6.12
36	37.50	36.61	58.76	10.31	9.12	7.22

GENERAL NOTES:
(a) For additional requirements, refer to Section 2.
(b) Dimensions in millimeters (mm).

(d) Aluminum-Alloy. 75 to 97 HRB, 137 to 222 HV.

(e) Phosphor-Bronze. 90 HRB min., 185 HV min., or equivalent.

(f) Silicon-Bronze. 90 HRB min., 185 HV min., or equivalent.

(g) Nickel-Copper-Aluminum. 33 to 40 HRC, 327 to 392 HV.

(h) Alloy Steel. 38 to 46 HRC, 372 to 458 HV.

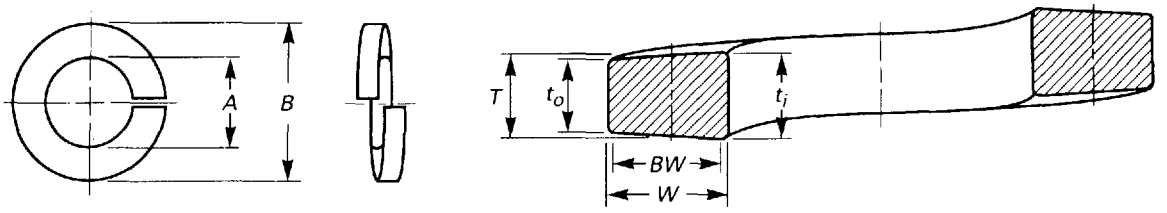
2.3.3 Decarburization. Carbon steel, boron steel, and alloy steel lock washers shall meet the limits for decarburization shown in Table 1. Methods for testing decarburization limits shall conform with SAE J419.

2.4 Designation

Nominal washer sizes are intended for use with comparable nominal screw or nut sizes. Fasteners conforming to this Standard shall be designated by the following data and sequence: product name and style, where applicable, ASME document number, nominal size, series, material, and surface protection, if necessary, or optionally by the ASME B18.24.3 PIN Code. See examples below:

EXAMPLES:
(1) Metric Helical Spring Lock Washer, B18.21.2M, 5 mm, Regular, Phosphor Bronze, W212NAA0050NN607NNAA1.

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Enlarged Section

TABLE 3 DIMENSIONS OF HEAVY METRIC HELICAL SPRING LOCK WASHERS

Nominal Washer Size, mm	Inside Diameter, *A*		Outside Diameter, *B*	Section Width, *W*	Mean Section Thickness $(T_i + T_o)/2$, *T*	Bearing Width, *BW*
	Max.	Min.	Max.	Min.	Min.	Min.
2	2.20	2.05	4.44	1.02	0.64	0.71
2.5	2.70	2.55	5.29	1.19	0.79	0.83
3	3.21	3.06	6.24	1.40	1.02	0.98
3.5	3.76	3.58	6.76	1.40	1.02	0.98
4	4.26	4.08	7.64	1.57	1.19	1.10
5	5.26	5.08	9.07	1.78	1.42	1.25
6	6.29	6.10	12.12	2.79	1.96	1.95
8	8.36	8.13	15.22	3.30	2.46	2.31
10	10.38	10.13	18.03	3.68	2.92	2.58
12	12.45	12.15	21.73	4.47	3.84	3.13
14	14.50	14.20	24.64	4.90	4.32	3.43
16	16.63	16.25	27.88	5.33	4.80	3.73
20	20.66	20.28	33.77	6.20	5.74	4.34
24	24.81	24.30	40.66	7.57	7.21	5.30
30	31.25	30.51	50.81	9.47	9.25	6.63
36	37.50	36.61	60.60	11.23	11.18	7.86

GENERAL NOTES:
(a) For additional requirements, refer to Section 2.
(b) Dimensions in millimeters (mm).

(2) Metric Helical Spring Lock Washer, B18.21.2M. 14 mm, Heavy, Carbon Steel, Phosphate Coated. W212NAB0140N-N155NNNE1.

2.5 Washer Section

The section of finished washers shall be slightly trapezoidal in shape with the thickness at the inner periphery greater than the thickness at the outer periphery by an amount varying from a minimum of 0.02 mm to a maximum of 0.04 mm per 0.62 mm of the section width. The minimum section thickness specified in the dimensional tables represents the nominal mean thickness *T* of the trapezoid. Reduced to formulas, the increase in thickness from the outer periphery to inner periphery is t_i minus t_o, or 0.032 *W* (minimum) to 0.064 *W* (maximum). The tolerance on the nominal mean thickness of the trapezoid shall be subject to a plus tolerance equal to the following:

Size	Tolerance, +
5 mm and Smaller	0.15 mm
6 mm to 20 mm	0.25 mm
24 mm to 36 mm	0.50 mm
42 mm to 72 mm	0.75 mm

The corners at the inner and outer peripheries of the washers shall be slightly rounded. However, the

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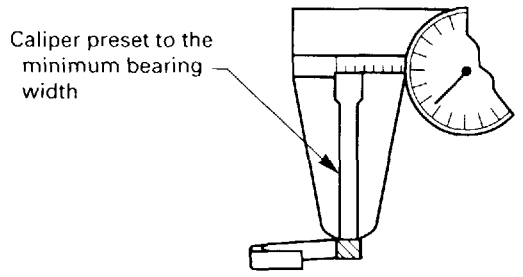


FIG. 1 VERIFYING MINIMUM BEARING WIDTH

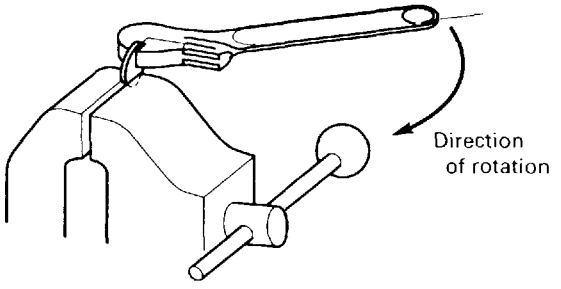


FIG. 2 WASHER TWIST TEST

extent of the rounding shall be such that the bearing width of the washer section is not reduced to less than the *BW* values shown in Tables 2 and 3. It is recommended that conformance to this limitation be determined by presetting a suitable caliper measuring device to the tabulated minimum bearing width dimension and comparing the setting to the flat bearing face on each side of the washer as shown in Fig. 1.

2.6 Coiling

Washers shall be coiled so that the free height is approximately equivalent to twice the thickness of the washer section. The gap and relationship of the severed ends shall be such as to prevent washers from tangling and ensure that washers compress flat.

2.7 Processing

2.7.1 Finishes. Unless otherwise specified by the purchaser, lock washers shall be supplied with a plain (as processed) finish, not plated or coated. Where corrosion preventative treatment is required, washers shall be plated or coated as specified by the purchaser. When helical spring lock washers are to be furnished with coatings over 0.0127 mm thick and are to be used with bolts or screws also having thicker coatings, they are to be coiled to limits 0.5 mm in excess of those specified in Tables 2 and 3 for minimum inside diameter and maximum outside diameter. Heavy coating of washers under 6 mm nominal size is not recommended.

2.7.2 Embrittlement. Carbon and Boron steel lock washers that are electroplated or coated may be subject to embrittlement; they shall be suitably treated to minimize such embrittlement. Plated washers shall not fracture after having been compressed flat for a minimum period of 48 hr.

2.8 Workmanship

The flat surfaces (faces) of helical spring lock washers shall be free from surface imperfections such as knurling, serrations, die marks, deep scratches, loose scale, burrs, or other irregularities which would affect serviceability. Moderate feed roll marks shall be permissible on the outer periphery.

2.9 Twist Tests

The washer shall be gripped in vise jaws. The ends of the washer shall be free and an axis passing through the slot shall be parallel to and slightly above the top of the vise so that less than 50% of the washer is gripped. A 90-deg maximum segment of the free end of the washer shall be gripped in wrench jaws so that at least 25% of the washer is exposed when twisting as shown in Fig. 2. Edges of the wrench jaws shall be in a plane parallel to the vise. Movement of the wrench that increases the free height of the spring lock washer shall twist carbon steel, boron steel, and alloy steel washers through an angle approximating 90 deg and corrosion resistant steel and nonferrous washers through an angle approximating 45 deg with no sign of fracture.

3 GENERAL DATA FOR TOOTH LOCK WASHERS

3.1 Application

The tooth lock washers covered herein are intended for general application. The tooth lock washers serve to increase the friction between the screw and the assembly. Internal tooth lock washers are preferred where it is desirable to provide a smooth periphery.

3.2 Tooth Design

The Type A tooth design and the Type B tooth design shall be optional.

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3.3 Dimensions

Dimensions of internal tooth lock washers, heavy internal tooth lock washers, external tooth lock washers, and internal-external tooth lock washers shall be as specified in Tables 4 through 8.

3.4 Material and Hardness

3.4.1 Material Composition. Washers shall be made from material meeting the chemical composition requirements of one of the following standards.

(a) Carbon Steel. SAE J403 1050 – 1065 or equivalent (UNS G10500 – G10650).

(b) Stainless Steel. SAE J405 301 – 305 (UNS S30100 – S30500) and SAE J405 316 (UNS S31600).

(c) Stainless Steel. SAE J405 410 (UNS S41000).

(d) Copper Alloy. ASTM B 591 Type 425 (UNS C42500).

Other materials and grades shall be as agreed upon by manufacturer and purchaser.

3.4.2 Hardness. Washers that are manufactured from carbon steel which show evidence of decarburization, or parts which were plated, shall have these surface layers removed before checking. During this operation, care shall be exercised to prevent the surface temperature of the washer from exceeding 250°F. It is recommended that the lighter, more sensitive depth reading HRA scale be used in lieu of HRC when testing washers of a thin section. Hardness requirements applicable to washers of the respective materials shall be as follows. For hardness conversion refer to ASTM E 140.

(a) Carbon Steel. 40 to 50 HRC, 392 to 513 HV.

(b) Stainless Steel 301 – 305. Annealed 88 HRB min., ¼ hard through full hard 20 to 45 HRC, 198 to 448 HV.

(c) Stainless Steel 410. 40 to 50 HRC, 392 to 513 HV.

(d) Copper Alloy. Temper H06 min.

3.5 Designation

Nominal washer sizes are intended for use with comparable nominal screw or nut sizes. Fasteners conforming to this Standard shall be designated by the following data, in the sequence shown: product name and style, where applicable, ASME document number, nominal size, maximum washer outside diameter (internal-external tooth washers only), type, material, and surface protective finish, if necessary.

EXAMPLES:

(1) Metric Internal Tooth Lock Washer, ASME B18.21.2M, 6 mm, Type A, Carbon Steel, Zinc Plated.

(2) Metric External-Internal Tooth Lock Washer, ASME B18.21.2M 4 mm, (19.30 O.D) Type A, Stainless Steel.

3.6 Manufacturing Detail

The number of teeth, the length of the teeth, the width of the rim and the thickness of the washer over the teeth (free height) shall be optional with the manufacturer with the provision, however, that the projection of the teeth on both sides of the washer shall be relatively uniform but the teeth on the side with the minimum projection must be at least 50% of the side with the maximum projection.

3.7 Processing

3.7.1 Finishes. Unless otherwise specified by the purchaser, lock washers shall be supplied with a plain (as processed) finish, not plated or coated. Where corrosion preventative treatment is required, washers shall be plated or coated as specified by the purchaser.

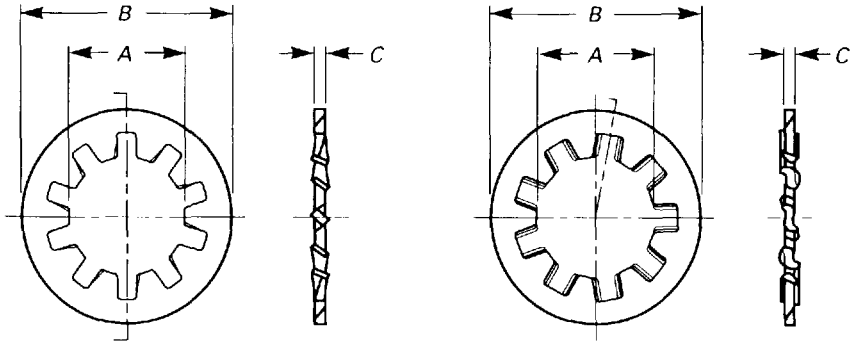
3.7.2 Embrittlement. Carbon Steel lock washers that are electroplated or coated may be subject to embrittlement. They shall be suitably treated to minimize such embrittlement. Plated washers shall not fracture after having been compressed to a height equal to the actual material thickness for a minimum period of 48 hr. Compression shall be accomplished between parallel flat surfaces for flat varieties of tooth washers and between mating countersunk holes and cones for countersunk tooth washers.

3.7.3 Compression Test. Washers, after being compressed to a height equal to the actual material thickness and then released, shall have a free height greater than the compressed height. Compression shall be accomplished between parallel flat surfaces for flat varieties of tooth washers and between mating countersunk holes and cones for countersunk tooth washers.

3.8 Workmanship

Washers shall be symmetrical in shape, free from surface imperfections such as loose scale or other irregularities which would affect serviceability.

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Type A Type B

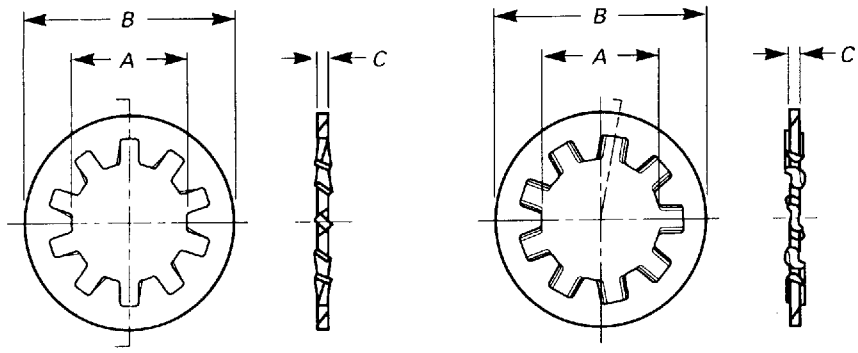
TABLE 4 DIMENSIONS OF INTERNAL TOOTH LOCK WASHERS

Nominal Washer Size [Note (1)]	Inside Diameter, *A*		Outside Diameter, *B*		Material Thickness, *C*	
	Max.	Min.	Max.	Min.	Max.	Min.
2.2*	2.40	2.25	4.70	4.40	0.35	0.25
2.5	2.80	2.65	5.85	5.45	0.35	0.25
2.9*	3.12	2.92	6.75	6.25	0.45	0.30
3	3.30	3.15	7.35	6.85	0.50	0.35
3.5	3.80	3.65	8.05	7.55	0.55	0.40
4	4.30	4.15	8.75	8.25	0.60	0.45
4.2*	4.47	4.27	8.75	8.25	0.60	0.45
4.8*	5.18	4.95	9.70	9.20	0.65	0.50
5	5.30	5.15	10.50	10.00	0.70	0.55
5.5*	5.87	5.61	10.50	10.00	0.70	0.55
6	6.50	6.20	12.95	12.20	0.70	0.55
6.3*	6.80	6.50	12.95	12.20	0.70	0.55
8	8.50	8.20	15.50	14.75	0.85	0.70
9.5*	10.11	9.75	17.60	16.85	1.00	0.80
10	10.60	10.20	17.60	16.85	1.00	0.80
12	12.70	12.30	20.25	19.50	1.00	0.80
14	14.80	14.30	22.90	21.90	1.15	0.95
16	17.00	16.40	27.20	26.20	1.25	1.05
20	21.20	20.50	32.00	31.00	1.40	1.20
24	25.30	24.50	35.30	34.50	1.50	1.30
30	31.40	30.60	46.30	45.10	1.70	1.50

GENERAL NOTES:
(a) For additional requirements, refer to Section 3.
(b) Dimensions in millimeters (mm).

NOTE:
(1) Nominal washer sizes are intended for use with comparable nominal screw, bolt, or nut sizes. Washer sizes identified by an asterisk (*) are suited for use with spaced thread tapping screw Types AB, B, BF, and BT.

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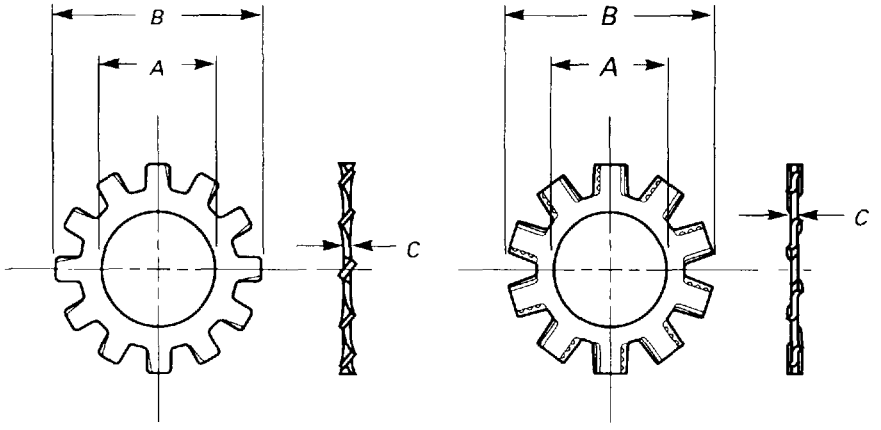
Type A Type B

TABLE 5 DIMENSIONS OF HEAVY INTERNAL TOOTH LOCK WASHERS

Nominal Washer Size	Inside Diameter, *A*		Outside Diameter, *B*		Material Thickness, *C*	
	Max.	Min.	Max.	Min.	Max.	Min.
6	6.50	6.20	13.5	12.5	1.15	0.90
8	8.50	8.20	15.5	14.5	1.25	1.05
10	10.60	10.20	19.0	18.0	1.30	1.10
12	12.70	12.30	25.0	24.0	1.70	1.50
14	14.80	14.30	29.0	28.0	1.80	1.60
16	17.00	16.40	32.0	31.0	2.20	1.80
20	21.20	20.50	42.0	41.0	2.60	2.20

GENERAL NOTES:
(a) For additional requirements, refer to Section 3.
(b) Dimensions in millimeters (mm).

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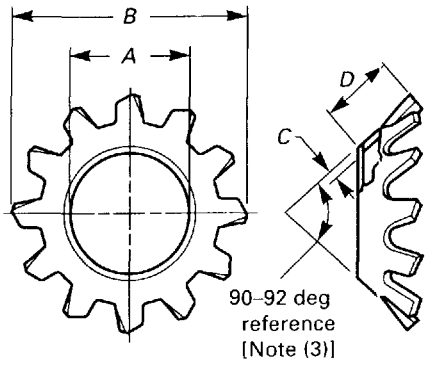
TABLE 6 DIMENSIONS OF EXTERNAL TOOTH LOCK WASHERS

Nominal Washer Size [Note (1)]	Inside Diameter, *A*		Outside Diameter, *B*		Material Thickness, *C*	
	Max.	Min.	Max.	Min.	Max.	Min.
2.2*	2.40	2.25	...	...	0.35	0.25
2.5	2.80	2.65	5.85	5.45	0.35	0.25
2.9*	3.12	2.92	6.60	6.20	0.45	0.30
3	3.30	3.15	7.35	6.85	0.50	0.35
3.5	3.80	3.65	8.05	7.55	0.55	0.40
4	4.30	4.15	9.00	8.50	0.60	0.45
4.2*	4.47	4.27	9.70	9.20	0.60	0.45
4.8*	5.18	4.95	10.30	9.80	0.65	0.50
5	5.35	5.15	10.50	10.00	0.65	0.50
5.5*	5.87	5.61	12.00	11.50	0.70	0.55
6	6.50	6.20	12.95	12.20	0.70	0.55
6.3*	6.80	6.50	12.95	12.20	0.70	0.55
8	8.50	8.20	15.50	14.75	0.85	0.70
9.5*	10.11	9.75	17.75	17.00	1.00	0.80
10	10.60	10.20	17.75	17.00	1.00	0.80
12	12.70	12.30	20.25	19.50	1.00	0.80
14	14.80	14.30	23.00	22.00	1.15	0.95
16	17.00	16.40	27.50	26.50	1.25	1.05
20	21.20	20.50	32.00	31.00	1.40	1.20
24	25.30	24.50	35.80	34.50	1.50	1.30
30	31.40	30.60	46.80	45.10	1.70	1.50

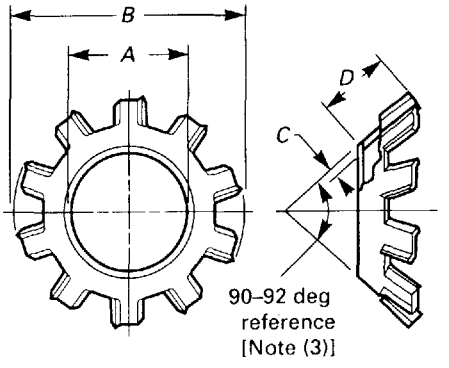
GENERAL NOTES:
(a) For additional requirements, refer to Section 3.
(b) Dimensions in millimeters (mm).

NOTE:
(1) Nominal washer sizes are intended for use with comparable nominal screw, bolt, or nut sizes. Washer sizes identified by an asterisk (*) are suited for use with spaced thread tapping screw Types AB, B, BF, and BT.

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Type A



Type B

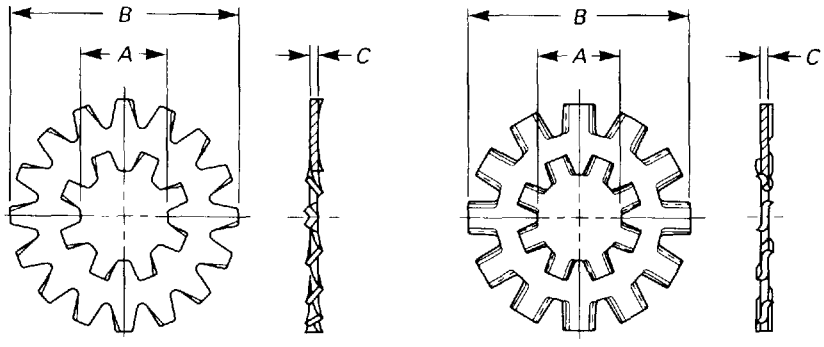
TABLE 7 DIMENSIONS OF COUNTERSUNK EXTERNAL TOOTH LOCK WASHERS

Nominal Washer Size [Note (1)]	Inside Diameter, *A*		Outside Diameter, *B* [Note (2)]	Material Thickness, *C*		Length, *D*	
	Max.	Min.	Ref.	Max.	Min.	Max.	Min.
2 and 2.2*	2.40	2.25	3.75	0.25	0.17	1.05	0.75
2.5	2.80	2.65	4.50	0.25	0.17	1.70	1.30
3 and 2.9*	3.30	3.15	5.85	0.45	0.30	2.10	1.70
3.5	3.80	3.65	6.60	0.45	0.30	2.30	1.80
4 and 4.2*	4.47	4.27	7.50	0.55	0.40	2.40	1.80
5 and 4.8*	5.30	5.15	9.60	0.65	0.50	3.40	2.80
5.5*	5.87	5.61	10.90	0.65	0.50	3.90	3.30
6	6.50	6.20	12.00	0.65	0.50	4.20	3.40
6.3*	6.80	6.50	12.00	0.65	0.50	4.20	3.40
8	8.50	8.20	15.60	0.70	0.55	5.50	4.75
10 and 9.5*	10.60	10.20	19.50	0.85	0.70	6.80	5.80
12	12.70	12.30	23.00	1.00	0.80	7.80	6.80

GENERAL NOTES:
(a) For additional requirements, refer to Section 3.
(b) Dimensions in millimeters (mm).

NOTES:
(1) Washer sizes are intended for use with comparable nominal screw sizes. Washer sizes identified by an asterisk (*) are suited for use with spaced thread tapping Screw Types AB, B, BF, and BT.
(2) For reference purposes only; not subject to inspection.
(3) Suggested angle for mating component is 90 deg to 92 deg.

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Type A Type B

TABLE 8 DIMENSIONS OF EXTERNAL-INTERNAL TOOTH LOCK WASHERS

Nominal Washer Size [Note (1)]	Inside Diameter, *A*		Outside Diameter, *B*		Material Thickness, *C*	
	Max.	Min.	Max.	Min.	Max.	Min.
2.9*	3.12	2.92	12.10	11.35	0.50	0.35
			13.00	12.25	0.55	0.40
			15.50	14.75	0.55	0.40
3	3.30	3.15	12.10	11.35	0.50	0.35
			13.00	12.25	0.55	0.40
			15.50	14.75	0.55	0.40
3.5	3.80	3.65	12.90	12.15	0.70	0.55
			15.50	14.75	0.70	0.55
			17.55	16.80	0.70	0.55
4	4.30	4.15	15.25	14.50	0.85	0.70
			17.70	17.05	0.85	0.70
			19.30	18.55	0.85	0.70
4.2*	4.47	4.27	15.25	14.50	0.85	0.70
			17.70	17.05	0.85	0.70
			19.30	18.55	0.85	0.70
4.8*	5.18	4.95	15.25	14.50	0.85	0.70
			17.75	17.05	1.00	0.80
			19.30	18.55	1.00	0.80
			22.90	21.90	1.00	0.80
5	5.35	5.15	15.25	14.50	0.85	0.70
			17.75	17.05	1.00	0.80
			19.30	18.55	1.00	0.80
			22.90	21.90	1.00	0.80

(continued)

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TABLE 8 DIMENSIONS OF EXTERNAL-INTERNAL TOOTH LOCK WASHERS (CONT'D)

Nominal Washer Size [Note (1)]	Inside Diameter, *A*		Outside Diameter, *B*		Material Thickness, *C*	
	Max.	Min.	Max.	Min.	Max.	Min.
5.5*	5.87	5.61	17.75	17.00	1.00	0.80
			19.30	18.55	1.00	0.80
			22.90	21.90	1.00	0.80
			25.00	24.00	1.00	0.80
6	6.50	6.20	19.30	18.55	1.00	0.80
			22.90	21.90	1.00	0.80
			25.00	24.00	1.15	0.95
			27.20	26.20	1.15	0.95
6.3*	6.80	6.50	19.30	18.55	1.00	0.80
			22.90	21.90	1.00	0.80
			25.00	24.00	1.15	0.95
			27.20	26.20	1.15	0.95
8	8.50	8.20	22.90	21.90	1.00	0.80
			25.00	24.00	1.15	0.95
			27.20	26.20	1.25	1.05
			29.35	28.05	1.25	1.05
9.5*	10.11	9.75	25.00	24.00	1.15	0.95
			27.20	26.20	1.25	1.05
			29.35	28.35	1.25	1.05
			32.00	30.70	1.25	1.05
10	10.60	10.20	25.00	24.00	1.15	0.95
			27.20	26.20	1.25	1.05
			29.35	28.35	1.25	1.05
			32.00	30.70	1.25	1.05
12	12.70	12.30	32.00	30.70	1.40	1.20
			33.50	32.20	1.40	1.20
			36.00	34.30	1.50	1.30
			41.35	39.65	1.70	1.50
14	14.80	14.30	33.50	32.20	1.40	1.20
			36.00	34.30	1.50	1.30
			41.35	39.65	1.70	1.50
			46.50	45.30	1.70	1.50
16	17.00	16.40	36.00	34.30	1.50	1.30
			41.35	39.65	1.70	1.50
			46.50	45.30	1.70	1.50
			50.20	48.50	1.70	1.50

GENERAL NOTES:
(a) For additional requirements, refer to Section 3
(b) Dimensions in millimeters (mm).

NOTE:
(1) Nominal washer sizes are intended for use with comparable nominal screw bolt, or nut sizes. Washer sizes identified by an asterisk (*) are suited for use with spaced thread tapping screw Types AB, B, BF, and BT.

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AMERICAN NATIONAL STANDARDS FOR BOLTS, NUTS, RIVETS, SCREWS WASHERS, AND SIMILAR FASTENERS

Small Solid Rivets ..... B18.1.1-1972(R1995)
Large Rivets ..... B18.1.2-1972(R1995)
Metric Small Solid Rivets ..... B18.1.3M-1983(R1995)
Square and Hex Bolts and Screws (Inch Series) B18.2.1-1996
Square and Hex Nuts (Inch Series) ..... B18.2.2-1987(R1999)
Metric Hex Cap Screws B18.2.3.1M-1999
Metric Formed Hex Screws ..... B18.2.3.2M-1979(R1995)
Metric Heavy Hex Screws ..... B18.2.3.3M-1979(R1995)
Metric Hex Flange Screws ..... B18.2.3.4M-1984(R1995)
Metric Hex Bolts ..... B18.2.3.5M-1979(R1995)
Metric Heavy Hex Bolts ..... B18.2.3.6M-1979(R1995)
Metric Heavy Hex Structural Bolts ..... B18.2.3.7M-1979(R1995)
Metric Hex Lag Screws ..... B18.2.3.8M-1981(R1999)
Metric Heavy Hex Flange Screws ..... B18.2.3.9M-1984(R1995)
Square Head Bolts (Metric Series) B18.2.3.10M-1996
Metric Hex Nuts, Style 1 ..... B18.2.4.1M-1996
Metric Hex Nuts, Style 2 ..... B18.2.4.2M-1979(R1995)
Metric Slotted Hex Nuts ..... B18.2.4.3M-1979(R1995)
Metric Hex Flange Nuts ..... B18.2.4.4M-1982(R1999)
Metric Hex Jam Nuts ..... B18.2.4.5M-1979(R1998)
Metric Heavy Hex Nuts ..... B18.2.4.6M-1979(R1998)
Fasteners for Use in Structural Applications B18.2.6-1996
Socket Cap, Shoulder, and Set Screws, Hex and Spline Keys (Inch Series) B18.3-1998
Socket Head Cap Screws (Metric Series) ..... B18.3.1M-1986(R1993)
Metric Series Hexagon Keys and Bits ..... B18.3.2M-1979(R1998)
Hexagon Socket Head Shoulder Screws (Metric Series) ..... B18.3.3M-1986(R1993)
Hexagon Socket Button Head Cap Screws (Metric Series) ..... B18.3.4M-1986(R1993)
Hexagon Socket Flat Countersunk Head Cap Screws (Metric Series) ..... B18.3.5M-1986(R1993)
Metric Series Socket Set Screws ..... B18.3.6M-1986(R1993)
Round Head Bolts (Inch Series) ..... B18.5-1990(R1998)
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