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ASME B18.13.1M-1998
(Revision of ASME B18.13.1M-1991)

SCREW AND WASHER ASSEMBLIES: SEMS (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

SCREW AND WASHER ASSEMBLIES: SEMS (METRIC SERIES)

ASME B18.13.1M-1998

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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 also been assigned responsibility for standardization of washers and machine rings.) The Committee was reorganized in May 1928, at which time two subcommittees were established to carry on development work - Subcommittee 1[1] on plain washers and Subcommittee 2 on lock washers.

In 1940 the B27 Committee was reactivated and Subcommittee 2 proceeded to draft a proposal covering helical spring lock washers. It was further amended in 1943 and, following approval by the B27 Committee and sponsor organizations, accepted as an American Standard under the designation ASA B27.1-1994.

A draft proposal completed by Subcommittee 2 in September 1949 incorporated requirements applicable to helical spring lock washers made from materials other than carbon steel and included specifications for tooth lock washers, both helical spring and tooth lock washers, and machine screw assemblies. 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 1956, Subcommittee 2 considered numerous refinements to the coverage for helical spring lock washers and heat treated machine screw and lock washer assemblies. A formal draft dated June 1957 was approved by 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.

In 1961 a study group comprised of members of the B18 and B27 Committees recommended that the screw and washer assemblies, commonly known as *sems,* be published as a separate document under the jurisdiction of the B18 Committee, but subject to approval of both Sectional Committees and the affected subcommittees thereof. This recommendation was accepted by the B27 and B18 Committees, respectively, on the 28th and 30th of November 1961. Subcommittee 27[2] of Committee B18 was subsequently appointed.

At the initial meeting of Subcommittee 27 on February 1, 1962 a proposal was submitted consisting of pertinent data for lock washer sems extracted from ASA B27.1-1958 and for plain washer sems proposed for inclusion in ASA B27.2, plus information gleaned from SAE Standard J773, Conical Spring Washers. It was agreed that the proposal should be extended to include tapping screw sems. Consequently, additional meetings of the subcommittee were held at which new drafts incorporating data for these products were reviewed and

[1] As of April 1, 1966, Subcommittee 1 was redesignated Subcommittee 2 on plain washers; Subcommittee 2 was redesignated Subcommittee 1 on lock washers under American National Standards Committee B27. As of March 16, 1972, Subcommittees 1 and 2 became Subcommittees 22 and 21, respectively, of American National Standards Committee B18.

[2] As of April 1, 1966, Subcommittee 3 was redesignated Subcommittee 6; Subcommittee 9 was redesignated Subcommittee 3, and Subcommittee 27 was redesignated Subcommittee 13 of American National Standards Committee B18.

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further changes and corrections were recommended. On February 15, 1963, a formal proposal was circulated for comment to Subcommittees 3, 9, and 27 of the B18 Committee, and Subcommittees 1 and 2 of the B27 Committee. On November 15, 1963, a revised draft incorporating resolutions to the comments received and additional refinements was letter balloted to Sectional Committees B18 and B27. The resulting comments and disapprovals were resolved at a meeting of Sectional Committee B18 on June 4, 1964, and by circulation of the recommended dispositions to Sectional Committee B27 on February 12, 1965. Subsequent to approval by the sponsor organizations and the American Standards Association, the document was formally designated an American Standard, ASA B18.13-1965, on September 29, 1965.

Over the next 18 years attempts were made to update and refine the document. However, due to extended vacancies in the chairmanship and continual shifts in membership of Subcommittee 13, none of these efforts proved successful and the standard was reaffirmed for three review periods. At the December 5, 1984, meeting of Subcommittee 13, it was agreed the standard should be revised to incorporate those changes necessary to bring it into agreement with the latest versions of the referenced B18 document covering the screw and washer components and for possible additional refinements. Recommendations for changes were reviewed and discussed further at a meeting held on May 18, 1985, and task groups were established to prepare detailed proposals relative to specific product lines. A proposed revision was drafted that relegated the coverage for round and truss head sems and Type A and Type C tapping screw sems to appendices under "Not recommended for new design" status. The revision included dimensional coverage for smaller sizes where applicable, changes to the helical spring lock washer sections and hardness, plus other technical and editorial updating previously accepted. This proposal was reviewed at the December 3, 1985, meeting of Subcommittee 13. Numerous editorial refinements were considered and adopted.

A formal proposal dated February 1986 was circulated to Subcommittees 3, 6, 13, 21, and 22 of the B18 Committee. A revised proposal incorporating resolutions to the comments received was given letter ballot approval by Standards Committee B18 in March 1987. Following its acceptance by ASME and the American National Standards Institute, this revision was granted recognition as an American National Standard on January 12, 1996.

A metric equivalent to the standard was identified in 1988, thus B18 approved a metric series sems standard. The document was accepted by ASME and the American National Standards Institute granted approval on February 15, 1991.

With draft International Standards for screw and washer assemblies nearing completion in ISO/TC 2, and due to national or regional differences in production methods used, some revisions to this Standard, and addition of an explanation of the alternative manufacturing practices in Appendix A, became desirable. This revision was accepted by ASME, and was approved as an American National Standard on September 9, 1998.

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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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The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible: citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal including any pertinent documentation.

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The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his request in the following format:

Subject: Cite the applicable paragraph number(s) and a concise description.

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 general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings which are necessary to explain the question; however, they should not contain proprietary names or information.

Requests which 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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SCREW AND WASHER ASSEMBLIES: SEMS (Metric Series)

1 INTRODUCTORY NOTES

1.1 Scope

This Standard covers general and dimensional data pertinent to the various types of screw and captive washer assemblies, otherwise known as *sems*, which are recognized as an American National Standard. (The word sems is a generic term applicable to screw and washer assemblies.)

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.

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

1.2 Use and Application

The sems covered by this Standard are general purpose fasteners intended for mass production and other assembly operations where speed and convenience are paramount factors. Further attributes of the various washers, recognized herein, are given in detail for each type of sems.

1.3 Types of Sems

Included in these specifications are sems comprised of the following types of screws and washers.

(a) Helical Spring Lock Washers and
- *(1)* socket head cap screws (see Table 1)
- *(2)* hex cap screws (see Table 1)
- *(3)* machine screws (see Table 1)
- *(4)* tapping screws (see Tables 1 and 2)

(b) Tooth Lock Washers and
- *(1)* machine screws (see Tables 3 and 4)
- *(2)* tapping screws (see Tables 3 and 4)
- *(3)* hex cap screws (see Tables 3 and 4)

(c) Conical Spring Washers and
- *(1)* hex cap screws (see Table 5)
- *(2)* machine screws (see Table 5)
- *(3)* tapping screws (see Table 5)

(d) Plain Washers and
- *(1)* machine screws (see Table 6)
- *(2)* tapping screws (see Table 6)
- *(3)* hex cap screws (see Table 6)

(e) Hexagon sems may be supplied as hex cap screws or as formed hex heads at the option of the manufacturer.

(f) Products having washers of styles and shapes not shown in this Standard may be considered sems; however, these products must be covered by the purchaser's drawing or standard.

1.4 Screw Heads

The head styles applicable to the various types of sems shall be as depicted in the illustrations and designated in the tables for each type. Where only the slotted head sems are illustrated, it should be understood that this Standard also applies to the corresponding cross-recessed head sems.

1.5 Dimensions

All dimensions in this Standard are given in millimeters.

1.6 Options

Options, where specified, shall be at the discretion of the manufacturer unless otherwise agreed upon by the manufacturer and the purchaser.

1.7 Responsibility for Modification

The manufacturer shall not be held responsible for modifications, such as plating, when these modifications are not made under his control, nor shall any certification be issued by the party making the modification unless it is accompanied by a written statement noting the original lot number, disclosing the modification, and warning that such modification may affect the dimensional and/or physical characteristics of the fastener.

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1.8 Terminology

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

1.9 Designation

Sems products conforming to this Standard shall be designated by the following data, in the sequence shown: nominal size in millimeters preceded by the letter "M" for M profile thread, thread pitch, nominal length, point or screw type (tapping screw type or header point for machine screws), head style and driving provision, washer type, material and protective finish as required, or optionally by ASME B18.24.1, PIN Code. See examples below.

EXAMPLES:

(1) M6.3 × 1.81 × 35, Type AB, Slotted Pan Head Tapping Screw and Wide Plain Washer Sems, Steel, Zinc Plated

M131NJAJTMPD5155NNCE1

(2) M3.5 × 0.6 × 20 Type 1A Cross-Recessed Pan Head Machine Screw and Type H Regular Conical Spring Washer Sems, Steel, 9.8

M131NGACMMGC0325NNAA1

(3) M4 × 0.7 × 13 Type T Hex Head Tapping Screw and Helical Spring Lock Washer Sems, Carbon Steel

M131NG20MMHB3155NNAA1

1.10 Referenced Standards

(a) This Standard does not duplicate those general and dimensional data pertaining to components of sems as found in the following:

ASME B1.13M Metric Screw Threads—M Profile
ASME B18.2.3.1M Metric Hex Cap Screws
ASME B18.2.3.2M Metric Formed Hex Screws
ASME B18.3.1M Socket Head Cap Screws (Metric Series)
ASME B18.6.5M Metric Thread Forming and Thread Cutting Tapping Screws
ASME B18.6.7M Metric Machine Screws
ANSI 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 B18.21.2M Lock Washers (Metric Series)
ASME B18.22M Metric Plain Washers

(b) Copies of referenced standards may be obtained from the following: SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001; ANSI, 11 West 42nd Street, New York, NY 10036; ASTM, 1000 Barr Harbor Drive, West Conshohocken, PA 19428-2959; ASME, 22 Law Drive, P.O. Box 2300, Fairfield, NJ 07007-2300, (800) 843-2763.

1.11 Lot

For all inspections referenced in this Standard, the sems lot shall consist of screws of one type, grade, washer 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.

1.12 Quality Assurance

1.12.1 Characteristics. Products shall conform to the specifications of this Standard. The designated characteristics as defined below shall be inspected to the inspection levels shown in accordance with ASME B18.18.2M. For nondesignated characteristics the provisions of ASME B18.18.1M shall apply. Should a nondesignated dimension be determined to be outside of its specified limits, it shall be deemed conforming to this Standard if the user, who is the installer, accepts the dimension based on fit, form, and function considerations. If verifiable in-process inspection is used, inspection sample sizes and reporting shall be in accordance with the applicable ASME, ASTM, or SAE quality system consensus standard.

1.12.2 Coatings. One or both components are generally hardened. Should the purchaser specify an electroplated finish on hardened product then an embrittlement test is required and this test becomes a designated characteristic and ASME B18.18.2M will apply at inspection level C. The embrittlement test requires that a minimum of five samples from each lot shall be torqued to failure and the average failure torque determined. The samples to be tested shall then be torqued at 80% of the previously determined failure torque with the head against a 90 deg. surface. The fasteners shall then be retorqued after 24 h and then examined. No failure of either component is permitted.

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1.12.3 Designated Characteristics and Inspection Levels

(a) Machine Screws

Characteristic	Inspection Level
Thread Acceptance	C
Tensile Strength (Wedge Test for all hexagon configurations and Axial Test for slotted and recess heads)	B
Hardness	B
Washer Retention/Rotation	C

(b) Tapping Screws

Characteristic	Inspection Level
Torsional Strength	A
Washer Retention/Rotation	C

(c) Cap Screws

Characteristic	Inspection Level
Thread Acceptance	C
Tensile Test	B
Hardness	B
Washer Retention/Rotation	C

(d) Helical Spring Lock Washers

Characteristic	Inspection Level
Hardness	B

(e) Plain Washers

Characteristic	Inspection Level
Hardness only when specified	B

(f) Conical Washers

Characteristic	Inspection Level
Hardness	B
Thickness	B

2 GENERAL DATA

2.1 Machine Screws for Sems

2.1.1 General. The machine screw component of sems shall conform to the specifications for machine screws published in ASME B18.6.7M, except that:

(a) the maximum diameter of the unthreaded shank shall be less than the major diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screw;

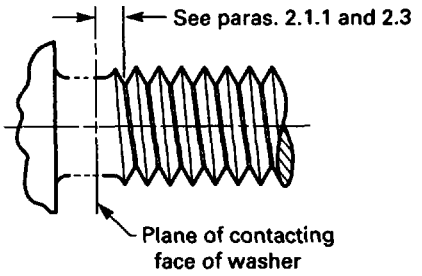


FIG. 1 UNTHREADED LENGTH ON SCREWS WITH MACHINE SCREW THREAD DIAMETER-PITCH COMBINATIONS

(b) on screws threaded full length, the unthreaded length is the distance measured parallel to the axis of the screw from the underside of the washer to the face of a nonchamfered or noncounterbored standard class 6h GO ring gage. The unthreaded length is a maximum of one thread pitch (see Fig. 1).

(c) the minimum underhead fillet radius shall be equivalent to 5% of the basic screw diameter on protruding head styles and 20% of the basic screw diameter for countersunk head styles;

(d) if so specified, the sems for greater strength shall be heat treated in accordance with para. 2.1.2 of this Standard.

2.1.2 Heat Treated Machine Screw Sems. Heat treated machine screw sems are available in two standard property classes. See para. 2.1.2(c) for details.

(a) Methods of Test. Tests for hardness and tensile strength shall conform with the tests specified in SAE J1216, Test Methods for Metric Threaded Fasteners, or ASTM F 606M, Standard Test Methods for Determining the Mechanical Properties of Externally Threaded Fasteners, Washers, and Rivets (Metric), except the wedge tensile tests shall be conducted using a 6 deg. wedge.

(b) Ductility Test. Whereas the wedge tensile test shall be considered the referee method, the following test for ductility of through-hardened screws may be used.

(1) The test for ductility of screws with protruding heads requires a test block with a hole approximately 5% larger in diameter than the basic diameter of the screw to be tested and having a top surface which is at an angle of 70 deg. to the axis of the hole. The hole shall be countersunk 100 deg. to 120 deg. included angle on the surface to a diameter 0.8 mm larger than

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the hole diameter. The screw and washer assembly shall be inserted into the hole and the head shall be hammered or pressed down until the underhead surface bears on the angular surface of the block. Washers may be removed prior to testing. For referee testing, washers shall be removed.

(2) Flat and oval countersunk head screws shall be held in a vise and shall be capable of taking a 20 deg. bend when the head is hammered to one side.

(3) The screws so tested shall exhibit no sign of failure.

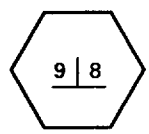
(c) Heat treated steel machine screw sems are available in two strength levels for sizes M3 through M12. The North American standard manufacturing practice for heat treating these products is identified in the following specifications. Alternative manufacturing practices are discussed in Appendix A.

Property Class 8.8 — All sizes. Must be heat treated before washer assembly. Minimum tempering temperature of the threaded component 425°C. For all material and mechanical properties refer to ISO 898-1

Property Class 9⊥8 — All sizes are heat treated after assembly. For all material and mechanical properties refer to SAE J1199. Sems are supplied using the low carbon steel option and the property class marking will be used in conjunction with an inverted T as shown below and the minimum tempering temperature shall be 340°C.

2.1.3 Identification. Unslotted hexagon and hexagon flange head sems shall be permanently and legibly marked on the top of the head for all sizes M5 or larger, with the manufacturer's identification, and heat treated sems must also have the appropriate property class marking which are shown below.





2.2 Tapping Screws for Sems

The tapping screw component of sems shall conform to the specifications for the respective types of tapping screws published in ASME B18.6.5M, except that:

(a) the maximum diameter of the unthreaded shank shall be less than the major diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screw;

(b) on screws threaded full length, the unthreaded length is the distance measured parallel to the axis of the screw from the underside of the washer to the point where the minor diameter is at the maximum dimension specified in ASME B18.6.5. The unthreaded length is a maximum of one pitch. See Fig. 2.

(c) the minimum underhead fillet radius shall be equivalent to 5% of the basic screw diameter on protruding head styles and 20% of the basic screw diameter on countersunk head styles.

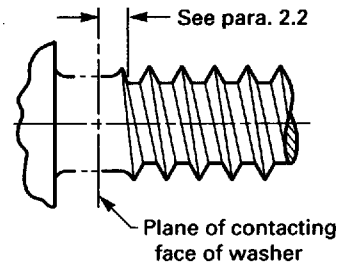


FIG. 2 UNTHREADED LENGTH ON TAPPING SCREWS WITH SPACED THREAD DIAMETER-PITCH COMBINATIONS

2.3 Heat Treated Cap Screws for Sems

Heat treated cap screws for sems are available in three strength levels for sizes M3 through M12. The North American standard manufacturing practice for heat treating these products is identified in the following specifications. Alternative manufacturing practices are discussed in Appendix A.

Property Class 8.8 — All sizes. Must be heat treated before washer assembly. Minimum tempering temperature of the threaded component 425°C. For all material and mechanical properties refer to ISO 898-1.

Property Class 9⊥8 — All sizes are heat treated after assembly. For all material and mechanical properties refer to SAE J1199. Sems are supplied using the low carbon steel option and the property class marking will be used in conjunction with an inverted T as shown below and the minimum tempering temperature shall be 340°C.

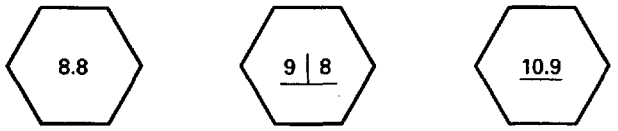
Property Class 10.9 — All sizes are heat treated after washer assembly. For all material and mechanical

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properties refer to SAE J1199. Sems are supplied using the low carbon steel option and the property class marking will be underlined as shown below and the minimum tempering temperature shall be 340°C.

(a) Identification. Unslotted hexagon and hexagon flange head sems shall be permanently and legibly marked on the top of the head for all sizes M5 or larger, with the manufacturer's indentification, and heat treated sems must also have the appropriate property class marking which are shown below.



(b) The cap screw component of sems shall conform with the specifications for cap screws published in ASME B18.3.1M or B18.2.3.1M, as applicable, except that: the diameter of the unthreaded shank shall be less than the maximum diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screw.

(c) On screws threaded full length, the unthreaded length is the distance measured parallel to the axis of the screw from the underside of the washer to the face of a nonchamfered or noncounterbored standard class 6h GO ring gage. The unthreaded length is a maximum of two thread pitches (see Fig. 1). Where required, threads extending closer than two pitches to the contacting face of the washer may be negotiated between the manufacturer and purchaser.

2.4 Washers for Sems

The washer components of sems shall conform with the dimensions and specifications given for the various types in this Standard. The compatibility of screw and washer materials shall be taken into account. It should be noted that the washers for sems differ dimensionally from the equivalent over-the-thread washers. Except for helical spring lock washers where the inside diameters are included for manufacturing purposes, the holes in the sems washers are not specified inasmuch as the washers shall be assembled onto the screw blanks before the threads are rolled. The edge contour of the hole on the head side of the washer and the size relationship between the inside diameter and the diameter of the unthreaded shank on the screw shall be such that the washer will be retained on the screw after the threads are rolled, and shall be free to rotate after assembly.

2.5 Processing

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

2.5.2 Coatings. The application of heavy coating deposits or supplemental treatments entailing organic compounds may result in a bonding of the sems components at points that abut. In such instances, the washers shall turn freely on the screw after breaking of the initial bond.

3 DATA FOR HELICAL SPRING LOCK WASHER SEMS

3.1 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.

3.2 Specifications

The washers shall conform to the specifications for helical spring washers published in ASME B18.21.2M, except for modifications contained herein.

3.3 Washer Components

3.3.1 Dimensions. The dimensions of helical spring lock washers shall be as specified in Tables 1 and 2. The corners at the outer and inner peripheries of the washer may be slightly rounded. However, the extent of the rounding shall be such that the bearing width of the washer section is not reduced to less than the equivalent of 70% of the specified minimum section width. See Fig. 3 for the check method.

3.3.2 Tests. After heat treatment of the sems, the washers shall be removed, undamaged, from the fastener for testing. They shall have a hardness of 38 to 48 HRC, or 372 to 484 HV, and shall meet all other test

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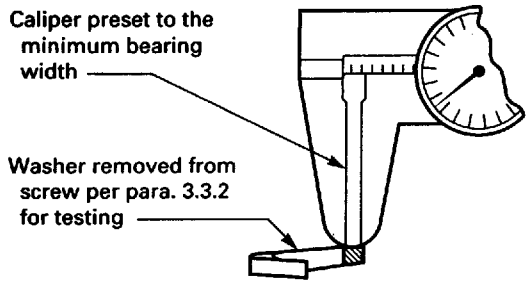


FIG. 3 VERIFICATION OF BEARING WIDTH ON HELICAL SPRING LOCK WASHERS

requirements for over-the-thread washers specified in ASME B18.21.2M.

3.4 Screw Components

3.4.1 Tapping screws and machine screws having machine thread diameter–pitch combinations, in the head styles indicated, shall be assembled with washers shown in Table 1.

3.4.2 Tapping screws having Type B spaced thread diameter–pitch combinations, in the head styles indicated, shall be assembled with washers shown in Table 2.

4 DATA FOR TOOTH LOCK WASHER SEMS

4.1 Application

The tooth lock washer sems covered herein are intended for general application. The tooth lock washers provide electrical continuity as well as serve to increase the friction between the screws and the assembly. Internal tooth lock washer sems are preferred where it is desirable to provide a smooth periphery.

4.2 Specifications

The washers shall conform to the specifications for toothed washers published in ASME B18.21.2M except for modifications contained herein.

4.3 Washer Components

4.3.1 Dimensions. The dimensions of internal tooth lock washers shall be as specified in Tables 4 and 5. Extrusion of a slight collar at the inside diameter of countersunk external tooth washers for use on flat or oval head screws shall be optional.

4.3.2 Tooth Design. Type A or Type B tooth design shall be optional. Refer to ASME B18.21.2M for details pertaining to tooth design.

4.3.3 Tests. After heat treatment of the sems, the washers shall be removed undamaged from the fastener for testing. They shall have a hardness of 40 to 50 HRC, or 392 to 513 HV, and shall meet all other tests for standard over-the-thread washers specified in ASME B18.21.2M.

4.4 Screw Components

Machine and tapping screws of the sizes and head styles shown in Tables 3 and 4 shall be assembled with the internal or external washers specified.

5 DATA FOR CONICAL SPRING WASHER SEMS

5.1 Application

The conical spring washer sems covered herein are intended for general application where it is desirable to:

(a) compensate for loss of screw tension due to such factors as smoothing out or wearing of parts, thermal expansion, or compression set of gaskets;

(b) distribute load over larger areas;

(c) span large or elongated clearance holes.

5.2 Washer Components

5.2.1 Dimensions. The dimensions of Type L and Type H conical washer components of sems are given in Table 5. Sizes generally conform to the specifications in SAE J773 converted to the metric equivalent, except that the crown height on some sizes is increased in order to facilitate the sems assembly operation.

5.2.2 Types. Conical spring washers are available in a light series (Type L) and heavy series (Type H) for use with screws as described in the following.

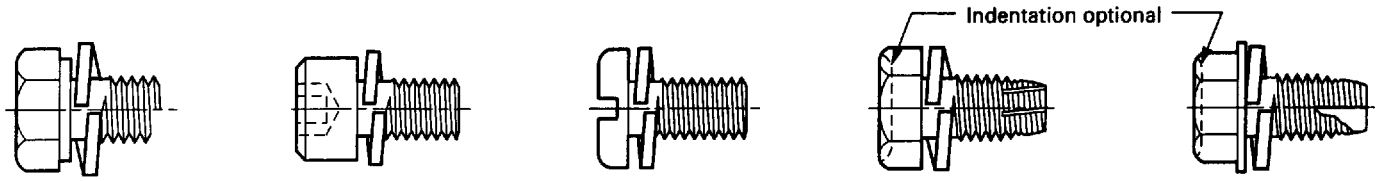
(a) Type L conical spring washers are intended for use on machine screw sems with screw components of materials having a specified minimum ultimate tensile strength of 520 MPa or less. They shall also be used on tapping screw sems capable of safely accommodating these tensile requirements.

(b) Type H conical spring washers are intended for use on heat treated sems with screw components of materials having a specified minimum ultimate tensile strength of 800 MPa or greater.

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Hex Cap Screw | Socket Head Cap Screw | Pan Head Machine Screw | Hex Head [Note (1)] Type F Tapping Screw | Hex Flange Head Type T Tapping Screw

Representative Examples of Helical Spring Lock Washer Sems

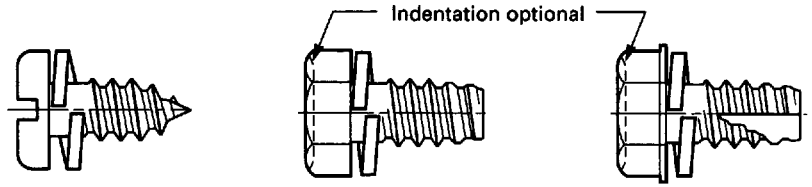
TABLE 1 DIMENSIONS OF HELICAL SPRING LOCK WASHERS FOR SEMS WITH MACHINE AND TAPPING SCREWS HAVING MACHINE SCREW THREAD DIAMETER–PITCH COMBINATIONS

Nominal Size or Basic Screw Diameter	Washer Inside Diameter		Pan Head Screw				Socket Head Cap Screw				Hex Head Screw				Hex Flange Head Screw			
			Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter	
			Width	Thick-ness			Width	Thick-ness			Width	Thick-ness			Width	Thick-ness		
	Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.
M2.5	2.35	2.22	1.19	0.79	4.81	4.60	0.86	0.73	4.15	3.94	1.02	0.64	4.47	4.26	1.19	0.79	4.81	4.60
M3	2.84	2.69	1.40	1.02	5.73	5.49	1.08	0.92	5.09	4.85	1.19	0.79	5.31	5.07	1.40	1.02	5.73	5.49
M3.5	3.30	3.15	1.40	1.02	6.19	5.95	...	...	...	...	1.19	0.79	5.77	5.53	1.40	1.02	6.19	5.95
M4	3.76	3.60	1.57	1.19	7.00	6.74	1.33	1.13	6.52	6.26	1.40	1.02	6.66	6.40	1.57	1.19	7.00	6.74
M5	4.67	4.52	1.78	1.42	8.34	8.08	1.57	1.33	7.92	7.66	1.57	1.19	7.92	7.66	1.78	1.42	8.34	8.08
M6	5.62	5.44	2.79	1.96	11.30	11.02	1.82	1.55	9.36	9.08	2.77	1.57	11.26	10.98	2.79	1.96	11.30	11.02
M8	5.75	7.36	3.30	2.46	14.29	13.96	2.32	1.97	12.33	12.00	3.18	1.98	14.05	13.72	3.30	2.46	14.29	13.96
M10	9.41	9.17	...	...	...	...	2.78	2.36	15.10	14.73	3.58	2.39	16.70	16.33	...	...	...	...
M12	11.33	11.08	...	...	...	...	2.76	2.36	17.05	16.64	4.34	3.18	20.17	19.76	...	...	...	...

NOTE:
(1) For additional requirements, refer to Sections 2 and 3.

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Pan Head Type AB Tapping Screw | Hex Head Type B Tapping Screw | Hex Flange Head Type BT Tapping Screw

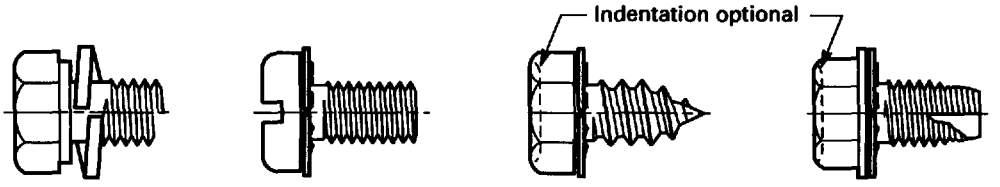
Representative Examples of Helical Spring Lock Washer Sems

TABLE 2 DIMENSIONS OF HELICAL SPRING LOCK WASHERS FOR SEMS WITH SCREWS HAVING TAPPING SCREW THREAD DIAMETER–PITCH COMBINATIONS

Nominal Size or Basic Screw Diameter	Washer Inside Diameter		Pan Head Screw				Hex Head Screw				Hex Flange Head Screw			
			Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter	
			Width	Thick-ness			Width	Thick-ness			Width	Thick-ness		
	Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.
2.9	2.57	2.44	1.19	0.79	5.10	4.83	1.02	0.64	4.75	4.48	1.19	0.79	5.10	4.83
3.5	3.08	2.95	1.57	0.86	6.43	6.09	1.19	0.79	5.66	5.33	1.57	0.86	6.43	6.09
4.2	3.66	3.50	1.98	0.79	7.82	7.47	1.40	1.02	6.65	6.30	1.98	0.79	7.82	7.47
4.8	4.11	3.96	2.05	1.42	8.43	8.07	1.57	1.19	7.47	7.10	2.05	1.42	8.43	8.08
5.5	4.78	4.60	2.05	1.42	9.09	8.71	1.78	1.42	8.54	8.16	2.05	1.42	9.09	8.71
6.3	5.52	5.31	3.05	1.57	11.82	11.41	2.77	1.57	11.26	10.85	3.05	1.57	11.82	11.41
8	7.06	6.86	3.17	1.98	13.61	13.21	3.18	1.98	13.63	13.22	3.17	1.98	13.61	13.21
9.5	8.59	8.38	3.58	2.39	15.95	15.54	3.58	2.39	15.95	15.54	3.58	2.38	15.95	15.54

GENERAL NOTE: For additional requirements, refer to Sections 2 and 3.

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Hex Cap Screw | Pan Head Machine Screw | Hex Head Type AB Tapping Screw | Hex Flange Head [Note (1)] Type T Tapping Screw

Representative Examples of Internal Tooth Lock Washer Sems

TABLE 3 DIMENSIONS OF INTERNAL TOOTH LOCK WASHERS FOR SEMS

Nominal Size or Basic Screw Diameter	Pan, Hex, and Hex Flange Head Screws			
	Washer Outside Diameter		Washer Thickness	
	Max.	Min.	Max.	Min.
2.9	7.00	8.50	0.45	0.30
3	7.36	6.85	0.45	0.30
3.5	7.50	7.00	0.55	0.40
4	8.75	8.25	0.60	0.45
4.2	8.75	8.25	0.60	0.45
4.8	9.70	9.20	0.60	0.45
5	10.50	10.00	0.65	0.50
5.5	10.50	10.00	0.65	0.50
6	12.15	11.65	0.75	0.75
6.3	12.15	11.85	0.75	0.60
8	15.50	14.75	0.85	0.70
9.5	17.70	16.95	1.00	0.80
10	17.70	16.95	1.00	0.80

GENERAL NOTE: For additional requirements, refer to Sections 2 and 5.

NOTE:
(1) Hex flange head sems are not available in sizes smaller than 3.5.

(c) Spur Tooth Conical Washers. Spur tooth conical washers having the same dimensions and characteristics as those defined above may also be used on sems for nonslip or positive electrical grounding purposes. Unless designated otherwise by the purchaser, when spur tooth conical washers are specified they shall be furnished with six sharp-edged teeth equally spaced about the outer periphery on the bottom face of the washer conforming with the dimensions shown in Fig. 4.

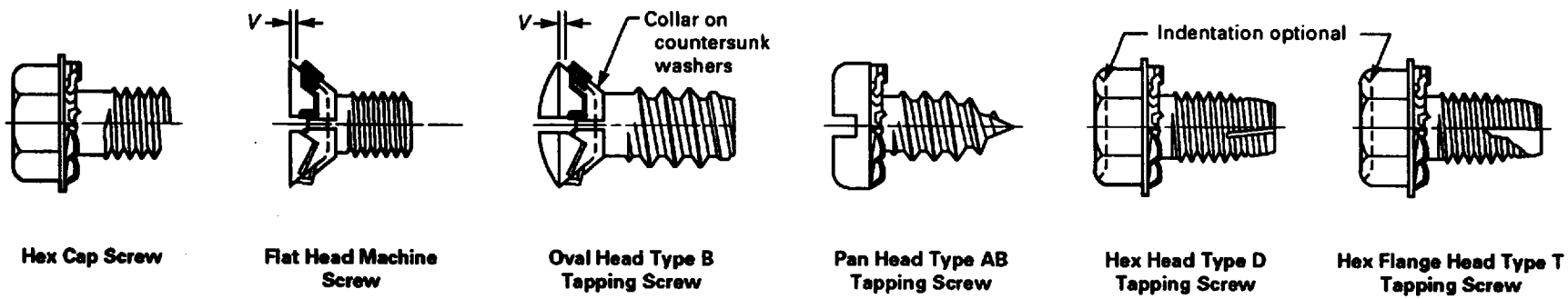
5.2.3 Series. Both the Type L and Type H conical spring washers for each screw size are specified in narrow, regular, and wide series having proportions designed to fulfill the purpose of distributing load over larger areas. Where used in conjunction with large clearance holes, it is recommended that the hole relationship be such as to permit washers to be in contact over at least 70% of their bearing area.

5.2.4 Tests for Washers on Heat Treated Sems. After heat treatment of sems, the washers shall be removed, undamaged, from the screws and subjected to the following tests.

(a) Hardness. The washers shall have a hardness of 40 HRC to 48 HRC (392 HV to 484 HV) or equivalent.

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Hex Cap Screw | Flat Head Machine Screw | Oval Head Type B Tapping Screw | Pan Head Type AB Tapping Screw | Hex Head Type D Tapping Screw | Hex Flange Head Type T Tapping Screw

Representative Examples of External Tooth Lock Washer Sems

TABLE 4 DIMENSIONS OF EXTERNAL TOOTH LOCK WASHERS FOR SEMS

Nominal Screw Size	Flat and Oval Head Screws			Pan Head and Hex Cap Screws				Hex Flange Head Screw			
	Washer Thickness		V Flush to Minus Tolerance	Washer Outside Diameter		Washer Thickness		Washer Outside Diameter		Washer Thickness	
	Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2.9	...	...	...	5.85	5.45	0.45	0.30	5.85	5.45	0.45	0.30
3	...	...	...	5.85	5.45	0.45	0.30	5.85	5.45	0.45	0.30
3.5	0.55	0.40	0.75	7.35	6.85	0.55	0.40	7.35	6.85	0.55	0.30
4	0.55	0.40	0.50	8.75	7.75	0.80	0.45	8.25	7.75	0.80	0.45
4.2	0.55	0.40	0.75	8.25	7.75	0.60	0.45	8.25	7.75	0.80	0.45
4.8	0.65	0.50	0.50	9.70	9.20	0.60	0.45	10.50	10.00	0.60	0.45
5	0.65	0.50	0.75	10.50	10.00	0.65	0.50	10.50	10.00	0.65	0.50
5.5	0.65	0.50	0.50	10.50	10.00	0.65	0.50	10.50	10.00	0.55	0.50
6	0.65	0.50	0.50	12.10	11.80	0.75	0.60	14.30	14.30	0.75	0.60
6.3	0.65	0.50	0.50	12.10	11.80	0.75	0.60	14.30	14.30	0.75	0.60
8	0.70	0.55	0.50	16.00	15.25	0.85	0.70	17.00	18.25	0.85	0.70
9.5	0.80	0.65	1.50	19.30	18.55	1.00	0.80	18.30	18.55	1.00	0.80
10	0.80	0.65	0.85	19.30	18.55	1.00	0.80	19.30	18.55	1.00	0.80

GENERAL NOTE: For additional requirements, refer to Sections 2 and 4.

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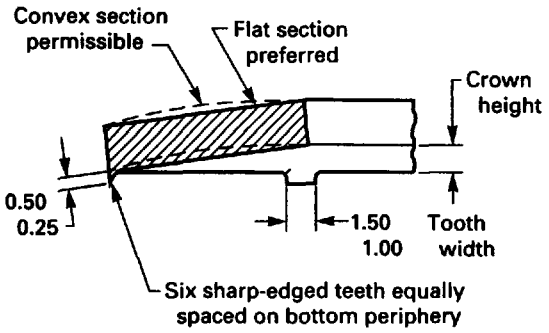


FIG. 4 ENLARGED CONICAL SPRING WASHER SECTION AND TOOTH WASHER DIMENSIONS

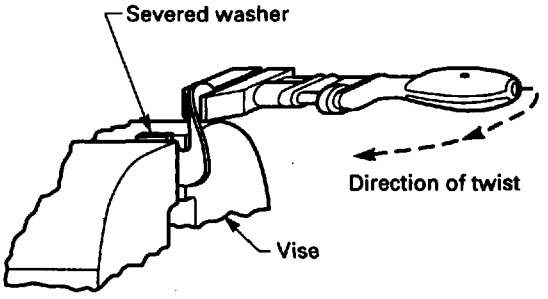


FIG. 5 CONICAL SPRING WASHER TWIST TEST

Hardness shall be checked by grinding or filing a flat spot on the top side of the washer to permit seating on an anvil with the reading to be taken on the undisturbed inner face of the washer. If the hardness as obtained above is not within specified limits, washers may be qualified by checking hardness on a cut-out section of the washer on which both sides have been ground flat. However, an excessively decarburized surface, especially on lighter gage materials, may be grounds for rejection if the performance of the washer is adversely affected.

(b) Twist Test. The rim of the washer shall be cut and the ends shall be gripped by pliers, vise and pliers, or wrench, whichever is most suitable for the washer section under test. Separation of the severed ends in the form of a helix to a distance equal to the inside diameter of the washer shall not result in fracture. (See Fig. 5.) When, at a greater degree of twist the washer fractures, the structure at the point of fracture shall exhibit a fine grain, and the washer up to the instant of fracture shall deliver a tough springy reaction.

(c) Embrittlement Test. See para. 1.12.2 for the test method.

(d) Recovery Test. Regular and wide series washers shall retain at least one-third of their original crown height after flattening between two hardened plates and then released. Narrow series washers may be expected to retain a minimum of 0.082 mm crown height.

5.3 Screw Components

Machine screws, hex cap screws, and tapping screws of the sizes and head styles indicated shall be assembled with the washers shown in Table 5. Care should be taken, however, to assure that mating materials will provide tensile requirements consistent with the selection of washer type.

5.4 Assembly Detail

The washers shall be assembled with the convex side adjacent to the screw head.

5.5 Assembly Considerations

5.5.1 Installation. The desired installed position shall be with the washer flat.

5.5.2 Load Conditions. Since it is intended that the washers in this Standard be loaded beyond the elastic limit of their material, they should not be used in applications involving dynamic loading of the washer.

6 DATA FOR PLAIN WASHER SEMS

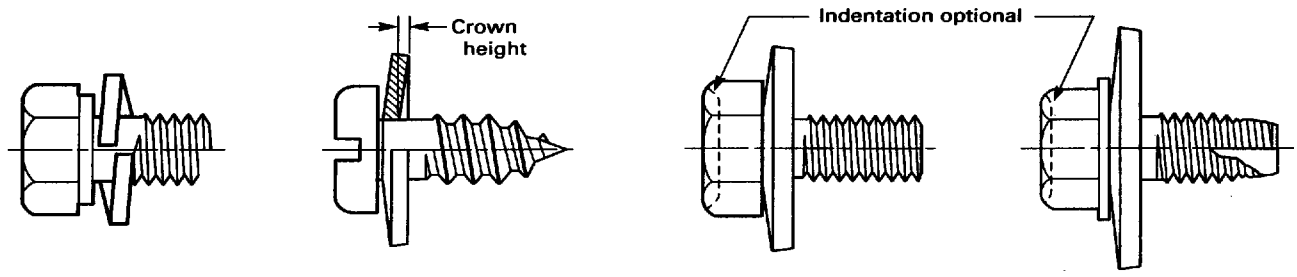
6.1 Application

The plain washer sems covered herein are intended for general application where it is desirable to increase the area of bearing under the head of the screw when used against soft materials such as aluminum, plastic, wood, etc.; span large or elongated clearance holes; and provide uniform bearing surfaces on rough workpiece surfaces.

6.2 Washer Components

6.2.1 Dimensions. The dimensions of plain washer components of sems are given in Table 6. The tolerances specified are intended to apply to metal washers but

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Hex Cap Screw

Pan Head Type AB Tapping Screw and Type L Regular Washer

Hex Head Machine Screw and Type H Regular Washer

Hex Flange Head Type T Tapping Screw and Type H Wide Washer

Representative Examples of Conical Spring Lock Washer Sems

TABLE 5 DIMENSIONS OF CONICAL SPRING WASHERS FOR SEMS

Nominal Size or Basic Screw Diameter	Pan, Hex, and Flange Head Screws										
	Washer Series	Washer Outside Diameter		Type L Washer				Type H Washer			
				Thickness		Crown Height		Thickness		Crown Height	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
3.5	Narrow	9.00	8.64	0.80	0.65	0.63	0.38	1.10	0.95	0.63	0.38
	Regular	10.00	9.64	0.85	0.70	0.63	0.38	1.10	0.95	0.63	0.38
	Wide	15.00	14.57	0.90	0.75	0.78	0.53	1.15	0.95	0.74	0.48
4	Narrow	10.00	9.64	1.15	0.95	0.63	0.38	1.25	1.05	0.63	0.38
	Regular	12.00	11.57	0.95	0.80	0.75	0.50	1.20	1.00	0.65	0.40
	Wide	16.00	15.57	0.95	0.80	0.95	0.70	1.20	1.00	1.04	0.78
4.2	Narrow	10.00	9.64	1.15	0.95	0.63	0.38	1.25	1.05	0.63	0.38
	Regular	12.00	11.57	0.95	0.80	0.75	0.50	1.20	1.00	0.65	0.40
	Wide	16.00	15.57	0.95	0.80	0.95	0.70	1.20	1.00	1.04	0.78
4.8	Narrow	11.00	10.57	1.05	0.85	0.63	0.38	1.50	1.30	0.63	0.38
	Regular	15.00	14.57	1.15	0.95	0.68	0.43	1.55	1.30	0.65	0.40
	Wide	20.00	19.48	1.20	1.00	0.92	0.67	1.50	1.30	0.88	0.63
5	Narrow	11.00	10.57	1.05	0.85	0.63	0.38	1.50	1.30	0.63	0.38
	Regular	15.00	14.57	1.15	0.95	0.68	0.43	1.55	1.30	0.65	0.40
	Wide	20.00	19.48	1.20	1.00	0.92	0.67	1.50	1.30	0.88	0.63
5.5	Narrow	11.00	10.57	1.15	0.95	0.63	0.38	1.60	1.35	0.63	0.38
	Regular	18.80	18.28	1.25	1.05	0.84	0.58	1.60	1.35	0.66	0.41
	Wide	22.00	21.48	1.25	1.05	1.10	0.84	1.80	1.50	0.84	0.58
6	Narrow	13.00	12.57	1.25	1.05	0.63	0.38	1.85	1.55	0.63	0.38
	Regular	18.80	18.28	1.50	1.30	0.82	0.56	2.25	1.90	0.79	0.54
	Wide	25.40	24.88	1.55	1.30	1.00	0.75	2.30	1.95	0.96	0.71
6.3	Narrow	13.00	12.57	1.25	1.05	0.63	0.38	1.85	1.55	0.63	0.38
	Regular	18.80	18.28	1.50	1.30	0.82	0.56	2.25	1.90	0.79	0.54
	Wide	25.40	24.88	1.55	1.30	1.00	0.75	2.30	1.95	0.96	0.71
8	Narrow	18.80	18.28	1.60	1.35	0.68	0.43	2.35	2.00	0.68	0.43
	Regular	25.40	24.88	1.85	1.55	1.05	0.80	2.75	2.40	0.75	0.48
	Wide	32.00	31.38	1.80	1.50	1.15	0.90	2.60	2.25	1.05	0.80

(continued)

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TABLE 5 DIMENSIONS OF CONICAL SPRING WASHERS FOR SEMS (CONT'D)

Nominal Size or Basic Screw Diameter	Pan, Hex, and Flange Head Screws										
	Washer Series	Washer Outside Diameter		Type L Washer				Type H Washer			
				Thickness		Crown Height		Thickness			
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Crown Height Max.	Crown Height Min.
9.5	Narrow	20.00	19.48	2.00	1.70	0.65	0.40	2.60	2.25	0.63	0.38
	Regular	28.00	27.48	2.00	1.70	1.08	0.83	3.15	2.80	0.83	0.58
	Wide	39.00	38.38	2.15	1.80	1.26	1.01	310	2.75	1.18	0.93
10	Narrow	20.00	19.48	2.00	1.70	0.65	0.40	2.60	2.25	0.63	0.38
	Regular	28.00	27.48	2.00	1.70	1.08	0.83	3.15	2.80	0.83	0.58
	Wide	39.00	38.38	2.15	1.80	1.26	1.01	3.10	2.75	1.18	0.93
12	Narrow	25.40	24.88	2.30	1.95	0.73	0.48	3.55	3.20	0.68	0.42
	Regular	34.00	33.38	2.65	2.30	1.09	0.84	3.50	3.15	1.01	0.75
	Wide	44.00	43.38	2.65	2.30	1.55	1.30	3.65	3.30	1.30	1.04

GENERAL NOTE: For additional requirements, refer to Sections 2 and 3.

do not preclude the use of other materials. Washers shall conform to specifications for plain washers published in ASME B18.22M, except for the modifications contained herein.

(a) Concentricity. The inside and outside diameters of the washers shall be concentric within 0.13 mm for M5 and smaller sizes, and within 0.25 mm for larger sizes.

(b) Flatness. The washers shall be flat within 0.13 mm for washers having outside diameters up to and including 22.6 mm and within 0.25 mm for washers having larger outside diameters.

6.2.2 Series. The plain washers for each screw size are specified in narrow, regular, and wide series having proportions designed to fulfill the purpose of distributing load over larger areas.

6.2.3 Materials. Plain washers for sems may be steel, soft or hardened; nonferrous metals; plastics; or other suitable materials as specified by the purchaser.

(a) Soft steel washers, where no hardness requirement is specified, shall normally be made from low carbon steel. Where incorporated in tapping screw sems and heat treated machine screw sems, the washers may be surface hardened at heat treatment of the screws, but must not be brittle so as to break on application.

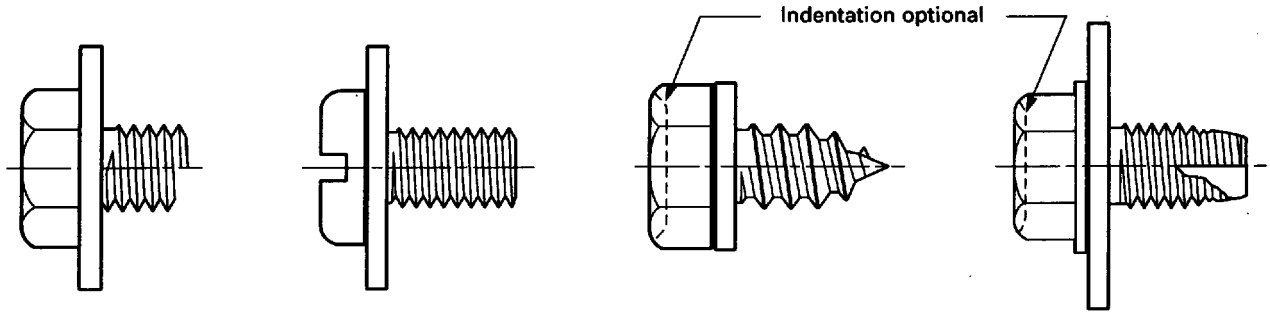
(b) Hardened steel washers, where specified by the purchaser, shall be quenched and tempered to a hardness of 40 to 50 HRC (392 to 513 HV) or equivalent.

6.3 Screw Components

Machine screws, hex cap screws, and tapping screws of the sizes and head styles indicated shall be assembled with washers specified in Table 6.

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Hex Cap Screw

Pan Head Machine Screw and Regular Washer

Hex Head Type AB Tapping Screw and Narrow Washer

Hex Flange Head Type T Tapping Screw and Wide Washer

Representative Examples of Plain Washer Sems

TABLE 6 DIMENSIONS OF PLAIN WASHERS FOR SEMS

Nominal Size or Basic Screw Diameter	Pan, Hex, and Hex Flange Head Screws					Nominal Size or Basic Screw Diameter	Pan, Hex, and Hex Flange Head Screws				
	Washer Series	Washer Outside Diameter		Washer Thickness			Washer Series	Washer Outside Diameter		Washer Thickness	
		Max.	Min.	Max.	Min.			Max.	Min.	Max.	Min.
2.2	Narrow	5.00	4.70	0.90	0.60	5	Narrow	11.00	10.57	1.40	1.00
	Regular	6.00	5.70	0.90	0.60		Regular	15.00	14.57	1.75	1.20
	Wide	8.00	7.64	0.90	0.60		Wide	20.00	19.48	2.30	1.60
2.5	Narrow	6.00	5.70	0.90	0.60	5.5	Narrow	11.00	10.57	1.40	1.00
	Regular	8.00	7.64	0.90	0.60		Regular	18.80	18.28	1.75	1.20
	Wide	10.00	9.64	1.20	0.80		Wide	22.00	21.48	2.30	1.60
2.9	Narrow	7.00	6.64	0.90	0.60	6	Narrow	13.00	12.57	1.75	1.20
	Regular	10.00	9.64	1.20	0.80		Regular	18.80	18.28	1.75	1.20
	Wide	12.00	11.57	1.40	1.00		Wide	25.40	24.88	2.30	1.60
3	Narrow	7.00	6.64	0.90	0.60	6.3	Narrow	13.00	12.57	1.75	1.20
	Regular	10.00	9.64	1.20	0.80		Regular	18.80	18.28	1.75	1.20
	Wide	12.00	11.57	1.40	1.00		Wide	25.40	24.88	2.30	1.60
3.5	Narrow	9.00	8.64	1.20	0.80	8	Narrow	18.80	18.28	2.30	1.60
	Regular	10.00	9.64	1.40	1.00		Regular	25.40	24.88	2.30	1.60
	Wide	15.00	14.57	1.75	1.20		Wide	32.00	31.38	2.80	2.00
4	Narrow	10.00	9.64	1.20	0.80	9.5	Narrow	20.00	19.48	2.30	1.60
	Regular	12.00	11.57	1.40	0.80		Regular	28.00	27.48	2.80	2.00
	Wide	16.00	15.57	2.30	1.60		Wide	39.00	38.38	3.50	2.50
4.2	Narrow	10.00	9.64	1.20	0.80	10	Narrow	20.00	19.48	2.30	1.60
	Regular	12.00	11.57	1.40	1.00		Regular	28.00	27.48	2.80	2.00
	Wide	16.00	15.57	2.30	1.60		Wide	39.00	38.38	3.50	2.50
4.8	Narrow	11.00	10.57	1.40	1.00	12	Narrow	25.40	24.88	2.80	2.00
	Regular	15.00	14.57	1.75	1.20		Regular	34.00	33.38	3.50	2.50
	Wide	20.00	19.48	2.30	1.60		Wide	44.00	43.38	3.50	2.50

GENERAL NOTE: For additional requirements, refer to Sections 2 and 6.

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APPENDIX A
ALTERNATIVE MANUFACTURING PRACTICES FOR PROPERTY CLASSES 9⊥8 AND 10.9

(This Appendix is not part of ASME B18.13.1M-1998, and is included here for information purposes only.)

North American sems production practice for Property Class 9⊥8 and 10.9 primarily utilizes the practice of assembling a low carbon steel screw blank with a medium carbon steel washer and thread rolling the assembly, subsequent heat-treating completes the process. This procedure is considered to be the most cost-effective method for producing this type of fastener. In certain critical applications the Design Engineer may require that the fastener manufacturer provide the medium carbon option provided in SAE J1199 for the threaded component. This option would require the manufacturer to utilize a minimum tempering temperature of 425°C and will require the minimum washer hardness to be adjusted to 36 HRC when heat-treated in the assembled condition. This option will void the washer recovery requirements shown in para. 5.2.4(d), and ASME B18.21.2M.

An alternative method of manufacturing sems with a medium carbon threaded component, and avoids reducing the specified washer hardness, utilizes a process where the fastener blank and the washer component are hardened and tempered independently. Assembly and thread rolling is subsequently completed in the hardened condition. The use of this manufacturing method is not standard and involves significant cost premiums. Sems will only be supplied using this manufacturing method when specified by the customer.

Unslotted hexagon and hexagon flange head sems which utilize either of the manufacturing methods discussed in this Appendix shall be permanently and legibly marked on top of the head for all sizes M5 or larger, with the manufacturer's identification and the appropriate Property Class marking which are shown below.

9.8 **10.9**

NOTE: No underline or inverted T required when product is manufactured as indicated in this Appendix.

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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(R1993)
Metric Hex Cap Screws ..... B18.2.3.1M-1979(R1995)
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(R1991)
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 ..... B18.4.4.4M-1982(R1993)
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)
Metric Round Head Short Square Neck Bolts B18.5.2.1M-1996
Metric Round Head Square Neck Bolts ..... B18.5.2.2M-1982(R1993)
Round Head Square Neck Bolts With Large Head (Metric Series) ..... B18.5.2.3M-1990(R1998)
Wood Screws (Inch Series) ..... B18.6.1-1981(R1997)
Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws B18.6.2-1998
Machine Screws and Machine Screw Nuts ..... B18.6.3-1972(R1997)
Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws (Inch Series) ..... B18.6.4-1981(R1997)
Metric Thread Forming and Thread Cutting Tapping Screws ..... B18.6.5M-1986(R1993)
Metric Machine Screws ..... B18.6.7M-1985(R1993)
General Purpose Semi-Tubular Rivets, Full Tubular Rivets, Split Rivets and Rivet Caps ..... B18.7-1972(R1992)
Metric General Purpose Semi-Tubular Rivets ..... B18.7.1M-1984(R1992)
Clevis Pins and Cotter Pins (Inch Series) B18.8.1-1994
Taper Pins, Dowel Pins, Straight Pins, Grooved Pins, and Spring Pins (Inch Series) B18.8.2-1995
Spring Pins — Coiled Type (Metric Series) B18.8.3M-1995
Spring Pins — Slotted (Metric Series) B18.8.4M-1994
Machine Dowel Pins — Hardened Ground (Metric Series) B18.8.5M-1994
Cotter Pins (Metric Series) B18.8.6M-1995
Headless Clevis Pins (Metric Series) B18.8.7M-1994
Headed Clevis Pins (Metric Series) B18.8.8M-1994
Grooved Pins (Metric Series) B18.8.9M-1998
Plow Bolts (Inch Series) B18.9-1996
Track Bolts and Nuts ..... B18.10-1982(R1992)
Miniature Screws ..... B18.11-1961(R1992)
Glossary of Terms for Mechanical Fasteners ..... B18.12-1962(R1991)
Screw and Washer Assemblies — Sems (Inch Series) B18.13-1996
Screw and Washer Assemblies: Sems (Metric Series) B18.13.1M-1998
Forged Eyebolts ..... B18.15-1985(R1995)
Metric Lifting Eyes B18.15M-1998
Mechanical and Performance Requirements for Prevailing-Torque Type Steel Metric Hex Nuts and Hex Flange Nuts ..... B18.16.1M-1979(R1995)
Torque-Tension Test Requirements for Prevailing-Torque Type Steel Metric Hex Nuts and Hex Flange Nuts ..... B18.16.2M-1979(R1995)

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Dimensional Requirements for Prevailing-Torque Type Steel
Metric Hex Nuts and Hex Flange Nuts B18.16.3M-1998
Inspection and Quality Assurance for General Purpose Fasteners ..... B18.18.1M-1987(R1993)
Inspection and Quality Assurance for High-Volume Machine Assembly Fasteners ..... B18.18.2M-1987(R1993)
Inspection and Quality Assurance for Special Purpose Fasteners ..... B18.18.3M-1987(R1993)
Inspection and Quality Assurance for Fasteners for Highly Specialized
Engineered Applications ..... B18.18.4M-1987(R1993)
Inspection and Quality Assurance Plan Requiring In-Process Inspection and Controls B18.18.5M-1998
Quality Assurance Plan for Fasteners Produced in a Third Party Accreditation System B18.18.6M-1998
Quality Assurance Plan for Fasteners Produced in a Customer Approved Control Plan B18.18.7M-1998
Lock Washers (Inch Series) B18.21.1-1994
Lock Washers (Metric Series) B18.21.2M-1994
Metric Plain Washers ..... B18.22M-1981(R1990)
Plain Washers ..... B18.22.1-1965(R1998)
Part Identifying Number (PIN) Code System Standard for B18 Externally
Threaded Products B18.24.1-1996
Part Identifying Number (PIN) Code System Standard for B18 Internally
Threaded Products B18.24.2-1998
Part Identifying Number (PIN) Code System Standard for B18 Nonthreaded Products B18.24.3-1998
Square and Rectangular Keys and Keyways B18.25.1M-1996
Woodruff Keys and Keyways B18.25.2M-1996
Square and Rectangular Keys and Keyways: Width Tolerances and
Deviations Greater Than Basic Size B18.25.3M-1998
Tapered and Reduced Cross Section Retaining Rings (Inch Series) B18.27-1998
Helical Coil Screw Thread Inserts (Inch Series) — Free Running and Screw Locking B18.29.1-1993

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