IFI
531
1982

METRIC SCREW AND WASHER ASSEMBLIES — SEMS

SEMS

IFI Notes:

1. *IFI-531 was originally published in 1976. In this 1982 edition the only technical change is the addition of the 6 mm sems size. Additionally, there are a few modest editorial improvements.*

2. *There are no ISO standards for metric sems nor are any contemplated at this time.*

3. *ASME Standards Committee B18 intends to develop an American National Standard on metric sems, however the project has not yet been initiated.*

1. Introductory Notes.

1.1 Scope.

1.1.1 This Standard covers general and dimensional data pertinent to the various types of screw and captive washer assemblies, otherwise known as sems. The word "sems" is recognized in the United States as a generic term for screw and washer assemblies. This Standard does not duplicate those general and dimensional data for components of sems. Such data may be found in other standards in this book, specifically, IFI-502, page F—1, SAE J1237, page F—27, IFI-504, page F—36, IFI-513, page F—44, and IFI-532, page I—18..

1.1.2 The inclusion of dimensional data in this Standard is not intended to imply that all of the products described herein are production items. Consumers are requested to consult with manufacturers concerning lists of stock production sizes.

1.2 Use and Application. The sems covered in this Standard are general purpose fasteners intended for use in mass production and other operations where speed and convenience are paramount factors. Further attributes of the various washers used are given in detail for each type of sems.

1.3 Types of Sems. Included in this Standard are sems composed of the following types of screws and washers:

1.3.1 Tooth Lock Washers and —
(a) Machine Screws (Tables 1 thru 3)
(b) Tapping Screws (Tables 1 thru 3)

1.3.2 Conical Spring Washers and —
(a) Machine Screws (Table 4)
(b) Tapping Screws (Table 4)

1.3.3 Plain Washers and —
(a) Machine Screws (Table 5)
(b) Tapping Screws (Table 5)

1.4 Screw Heads.

1.4.1 Head Styles. The head styles applicable to the various types of sems are depicted in the illustrations and designated in the tables for each washer type. Where only the slotted head sems are illustrated, it should be understood that this Standard also applies to comparable cross recess head sems.

1.5 Dimensions. All dimensions in this Standard are given in millimeters unless otherwise stated.

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 Terminology. For definitions of terms relating to fasteners or components thereof used in this Standard, refer to the American National Standard Glossary of Terms for Mechanical Fasteners, ANSI B18.12, page J—5.

1.8 Responsibility for Modifications. The manufacturer 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 his control or direction.

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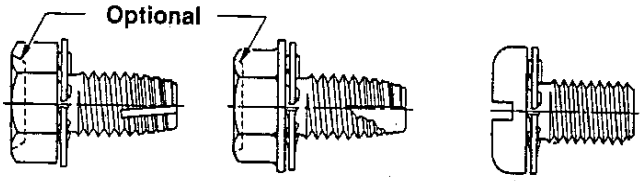

Hex head Type D tapping screw | Hex washer head Type T tapping screw | Pan head machine screw

Representative Examples of Internal Tooth Lock Washer Sems

Table 1 Dimensions of Washers on Internal Tooth Lock Washer Sems

Nom Screw Size (1)	Pan, Hex and Hex Washer Head Screws			
	Washer Outside Dia		Washer Thickness	
	Max	Min	Max	Min
2.9	7.00	6.50	0.45	0.30
3	7.35	6.85	0.45	0.30
3.5	7.50	7.00	0.55	0.40
4	8.75	8.25	0.55	0.40
4.2	8.75	8.25	0.60	0.45
4.8	9.70	9.20	0.65	0.50
5	10.50	10.00	0.65	0.50
5.5	10.50	10.00	0.65	0.50
6	12.15	11.65	0.70	0.55
6.3	12.15	11.65	0.70	0.55
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

NOTE: See Note 2.3 of General Data.

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 given in IFI-513, except (1) that the maximum diameter of the unthreaded shank shall be less than the maximum major diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screw; (2) that on screws having nominal lengths of 50 mm and shorter, the complete (full form) threads shall extend to within two pitches (threads) of the contacting face of the washer or closer if practicable (where so specified, the thread shall be made to extend to within one pitch of the contacting face of washer as shown in Figure 1); and (3) that, if so specified, the sems for greater strength shall be heat treated in accordance with paragraph 2.1.2 of this Standard.

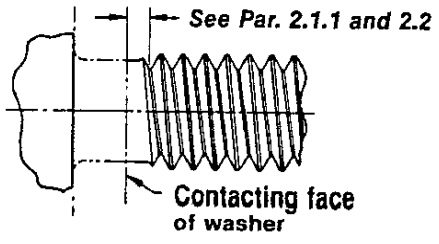

FIG. 1 UNTHREADED LENGTH FOR SCREWS

2.1.2 Hardened Machine Screws. Hardened screws for sems shall conform to the requirements for property class 9.8 as covered in ASTM F568, page B—1.

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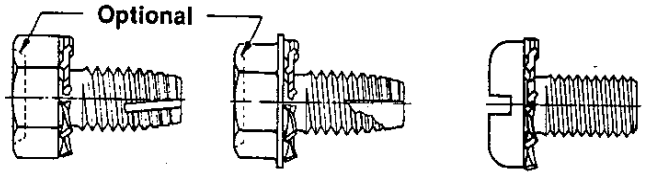

Representative Examples of
External Tooth Lock Washer Sems

Table 2 Dimensions of Washers on External Tooth Lock Washer Sems

Nom Screw Size (1)	Pan Head and Hex Head Screws				Hex Washer Head Screws			
	Washer Outside Dia		Washer Thickness		Washer Outside Dia		Washer Thickness	
	Max	Min	Max	Min	Max	Min	Max	Min
2.9	5.85	5.45	0.50	0.35	5.85	5.45	0.50	0.35
3	5.85	5.45	0.50	0.35	5.85	5.45	0.50	0.35
3.5	7.35	6.85	0.50	0.35	7.35	6.85	0.50	0.35
4	8.25	7.75	0.60	0.45	8.25	7.75	0.60	0.45
4.2	8.25	7.75	0.60	0.45	8.25	7.75	0.60	0.45
4.8	9.70	9.20	0.60	0.45	10.50	10.00	0.65	0.50
5	10.50	10.00	0.65	0.50	10.50	10.00	0.65	0.50
5.5	10.50	10.00	0.65	0.50	10.50	10.00	0.65	0.50
6	12.10	11.60	0.70	0.55	14.80	14.30	0.70	0.55
6.3	12.10	11.60	0.70	0.55	14.80	14.30	0.70	0.55
8	16.00	15.25	1.00	0.80	17.00	16.25	0.85	0.70
9.5	19.30	18.55	1.00	0.80	19.30	18.55	1.00	0.80
10	19.30	18.55	1.00	0.80	19.30	18.55	1.00	0.80

NOTE: See Note 2.3 of General Data.

2.1.2.1 Heat treated sems may be made by heat treating the assembly after assembling the washers on the screws or the screws and washers may be heat treated separately prior to assembly. They must meet all specifications after completion.

2.1.2.2 Identification. Heat treated (class 9.8) hex head sems of nominal thread diameters M5 and larger shall be marked to identify the property class and the manufacturer as specified in ASTM F568.

2.1.2.3 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:

The test for ductility of screws with protruding heads requires a test block with a hole approximately 5 percent larger in diameter than the nominal size of the screw to be tested and with a top surface which is at an angle of 70 deg to the axis of the hole. The hole shall be countersunk 100 to 120 deg included angle on the top surface to a diameter 0.8 mm larger than the hole diameter. The screw (with washer removed) shall be inserted in the hole and the head hammered or pressed down until the underneath surface of the head bears on the angular surface of the block.

Flat and oval head screws shall be held in a vise and shall be capable of taking a 20 deg bend when the head is hammered.

The screw shall show no sign of failure.

2.1.3 Points. The standard point on sems machine screws shall be the headed chamfer point which on the screw blank is 40 to 45 deg included angle to the approximate root diameter of the thread. Where specified, header points are obtainable.

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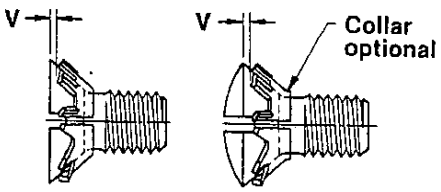
Table 3 Dimensions of Washers on External Tooth Lock Washer Sems

Nom Screw Size (1)	Flat and Oval Head Screws		
	Washer Thickness		V
	Max	Min	Flush To Minus Tolerance
3.5	0.55	0.40	0.75
4	0.55	0.40	0.50
4.2	0.55	0.40	0.75
4.8	0.65	0.50	0.50
5	0.65	0.50	0.75
5.5	0.65	0.50	0.50
6	0.65	0.50	0.50
6.3	0.65	0.50	0.50
8	0.70	0.55	0.50
9.5	0.80	0.65	1.50
10	0.80	0.65	0.65

NOTE: See Note 2.3 of General Data.



Flat head machine screw — Oval head machine screw

Representative Examples of External Tooth Lock Washer Sems

2.2 Tapping Screws for Sems. The tapping screw component of sems shall conform to the specifications for tapping screws given in IFI-502 and SAE J1237, except (1) that the maximum diameter of the unthreaded shank shall be less than the maximum major diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screw; and (2) that on screws of lengths equal to 8 diameters and shorter, the full form threads shall, for screws having machine screw diameter-pitch combinations, extend to within one pitch (thread) of the contacting face of washer or closer if practicable; and for screws having spaced threads, extend close to the washer such that the specified minor diameter limits are maintained to within one pitch of the contacting face of washer or nearer if practicable. See Figures 1 and 2, respectively.

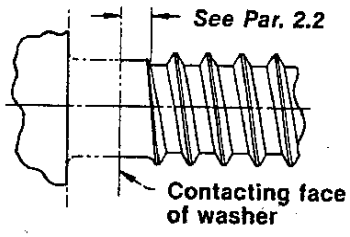


FIG. 2 UNTHREADED LENGTH FOR TAPPING SCREWS WITH SPACED THREAD DIAMETER-PITCH COMBINATIONS

2.3 Applicability of Screw Sizes. Nominal screw sizes 2.9, 4.2, 4.8, 5.5, 6.3 and 9.5 mm as listed in Tables 1 thru 5 apply only to Types AB, B, BF and BT tapping screws; sizes 3.5 and 8 mm apply to all machine and all tapping screws; sizes 3, 4, 5, 6 and 10 mm apply to all machine screws and all tapping screws except Types AB, B, BF and BT.

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. It should be noted that washers for sems may differ dimensionally from equivalent over-the-thread washers. The holes in sems washers are not specified inasmuch as the washers shall be assembled on the screw blanks before the threads are rolled. The inside diameter of washers shall be of a size which will permit them to rotate freely and yet prevent their disassembly from the screws.

2.5 Embrittlement. Plated or coated sems which are subject to hydrogen embrittlement shall be baked for a suitable time and at a suitable temperature to relieve possible embrittlement. Baking shall be accomplished as soon as possible after application of the plating or coating.

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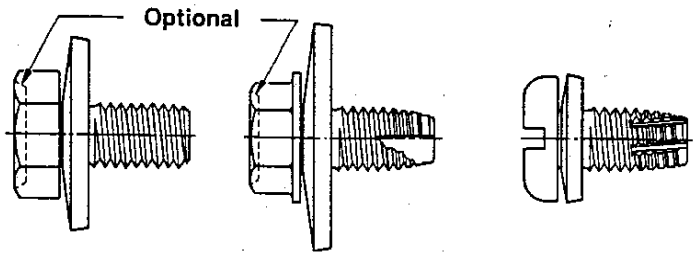


Hex head machine screw and Type H regular washer

Hex washer head Type T tapping screw and Type H wide washer

Pan head Type F tapping screw and Type H narrow washer

Representative Examples of Conical Spring Washer Sems

Table 4 Dimensions of Washers on Conical Spring Washer Sems

Nom Screw Size	Washer Series	Pan, Hex, and Hex Washer Head Screws											
		Washer Outside Dia		Type L Washer					Type H Washer				
				Washer Thickness			Crown Height		Washer Thickness			Crown Height	
		Max	Min	Basic	Max	Min	Max	Min	Basic	Max	Min	Max	Min

See Para. 4.2.1.

3. Data for Tooth Lock Washer Sems.

3.1 Application. Tooth lock washer sems covered in this Standard are intended for general industrial applications. Tooth lock washers serve to lock the screws to the component parts of an assembly, or increase the friction between the screws and the assembly. Internal tooth lock washer sems are preferred where it is desirable to provide a smooth contour or to avoid projecting teeth which may catch on clothing, etc.

3.2 Washer Components.

3.2.1 Dimensions. The dimensions of internal tooth and external tooth and lock washer components of sems are given in Tables 1 thru 3. Extrusion of a slight collar at the inside diameter of countersunk external tooth washers for flat and oval head screws shall be optional.

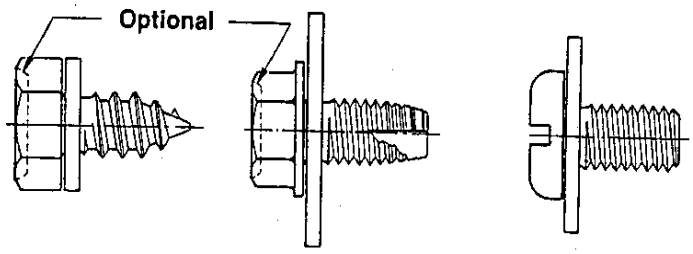
3.2.2 Tooth Design. The Type A tooth design shown below centerline and Type B tooth design shown above centerline of illustrations shall be optional. Refer to IFI-532 for detail of Types A and B designations.

3.2.3 Tests. After heat treatment of sems, the washers shall be removed, undamaged, from the screws for testing. They shall have a hardness of Rockwell C40 to 50, or equivalent, and shall meet all tests for standard over-the-thread washers as specified in IFI-532.

3.3 Screw Components. Machine and tapping screws of the sizes and head styles indicated shall be assembled with washers.

4. Data for Conical Spring Washer Sems.

4.1 Application. Conical spring washer sems covered in this Standard are intended for general applications where it is desirable to (1) compensate for loss of screw tension due to such factors as smoothing out or wearing of parts, thermal expansion, or compression set of gaskets; (2) distribute load over larger areas; and (3) span large or elongated clearance holes.



Hex head Type AB tapping screw and narrow washer

Hex washer head Type T tapping screw and wide washer

Pan head machine screw and regular washer

Representative Examples of Plain Washer Sems

Table 5 Dimensions of Washers on Plain Washer Sems

Nom Screw Size	Washer Series	Pan, Hex and Hex Washer Head Screws			
		Washer Outside Dia		Washer Thickness	
		Max	Min	Max	Min
See Para. 5.2.1.					

4.2 **Washer Components.**

4.2.1 **Dimensions.** The dimensions of Type L and Type H conical spring washer components of sems are given in Table 4.

(IFI Note: Because the values which will be included in Table 4 are still under development, this Table has been omitted from this Standard. Until dimensions are finalized it is recommended that purchasers consult with manufacturers of sems for guidance.)

4.2.2 **Types.**

4.2.2.1 Type L conical spring washers shall be used on machine screw sems with screws of materials having a specified minimum ultimate tensile strength equal to 420 MPa or lower (steel class 4.8 or lower). They shall also be used on tapping screw sems where the mating materials will safely develop these tensile requirements.

4.2.2.2 Type H conical spring washers shall be used on heat treated sems with screws of materials having a specified minimum ultimate tensile strength equal to 900 MPa and greater (steel class 9.8 and greater).

4.2.2.3 Tooth type conical spring washers having dimensions and characteristics of the standard conical spring washers specified herein may also be used for sems. However, this Standard does not include any requirements for the number or configuration of the teeth.

4.2.3 **Series.** Both Type L and Type H conical spring washers for each screw size are specified in narrow, regular and wide series with the proportions of each 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 on at least 70 percent of their bearing area.

4.2.4 **Tests for Washers on Heat Treated Sems.** After heat treatment of sems, washers shall be removed, undamaged, from the screws and subjected to hardness testing.

4.2.4.1 **Hardness.** Washers shall have a hardness of Rockwell C40 to 48, or equivalent. 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 taken on the undisturbed inner face of the washer. If hardness 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 affected.

4.3 Screw Components. Machine and tapping screws of the sizes and head styles indicated in Table 4 shall be assembled with washers. Care should be taken, however, to assure that mating materials will provide tensile requirements consistent with the selection of washer type.

4.4 Assembly Detail. The washer shall be assembled on headed screw blanks with the convex side adjacent to the screw head.

4.5 Assembly Considerations.

4.5.1 Installation. The desired installed position shall be with the washer as near flat as possible.

4.5.2 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.

5. Data for Plain Washer Sems.

5.1 Application. Plain washer sems covered in this Standard are intended for general applications where it is desirable to (1) increase the area of bearing under the head of the screw, where used against soft materials, such as aluminum, wood, etc.; (2) span large or elongated clearance holes; and (3) provide better bearing surfaces on rough work piece surfaces.

5.2 Washer Components.

5.2.1 Dimensions. The dimensions of plain washer components of sems are given in Table 5. The tolerances specified are intended to apply to metal washers but do not preclude the use of other materials.

(IFI Note: Because the values which will be included in Table 5 are still under development, this Table has been omitted from this Standard. Until dimensions are finalized it is recommended that purchasers consult with manufacturers of sems for guidance.)

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

5.2.3 Materials. Plain washers for sems may be steel, soft or hardened; non-ferrous metals; plastics; or other suitable materials as specified by user.

5.2.3.1 Soft steel washers, where no hardness requirement is specified, shall normally be made from low carbon steel. Where incorporated in tapping screw sems and hardened 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.

5.2.3.2 Hardened steel washers, where specified, shall have the properties of AISI 1050 steel, or equivalent, and a hardness of Rockwell C40 to 50, or equivalent.

5.3 Screw Components. Machine and tapping screws of the sizes and head styles indicated in Table 5 shall be assembled with washers.

6. Inspection.

6.1 Inspection and Quality Assurance. Unless otherwise specified by the purchaser in the original inquiry and purchase order, acceptability shall be based on conformance with the requirements specified in ANSI B18.18.1M, page J—25.