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Superseding AS567H

**Safety Cable, Safety Wire, Key Washers, and Cotter Pins for
Propulsion Systems, General Practices for Use of**

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

1. SCOPE:

This SAE Aerospace Standard (AS) covers devices whose primary function is the retention of fasteners, except for such devices that are integral with the item being retained.

1.1 The practices cover the types of retaining devices described in the following sections:

- a. Section 3: Safety Cable and Safety Wire
- b. Section 4: Key Washers
- c. Section 5: Cotter Pins

1.2 Purpose:

The purpose of this document is to establish the requirements and basic principles for retaining fasteners and other parts in aerospace propulsion systems.

2. REFERENCES:

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 5687	Wire, Alloy, 74aNi 15.5Cr 8.0Fe, Annealed
AMS 5689	Wire, 18Cr 10.5Ni 0.40Ti, Solution Heat Treated
AMS 7210	Cotter Pins, 18Cr 9.5Ni, Corrosion Resistant Steel
AMS 7211	Cotter Pins, 18Cr 10.5Ni 0.40Ti, Corrosion and Heat Resistant Steel
AS4536	Safety Cable Kit, Procurement Specification and Requirements for Use of
AS123751-AS123850	Cotter Pin - Corrosion Resistant

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SAE AS567 Revision J

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MS9245 Pin, Cotter & CRES, AMS 7211

2.3 Definitions:

- 2.3.1 SAFETY CABLE/SAFETY WIRE: Safety cabling or wiring is the securing together of two or more parts with a cable or wire, which shall be installed so that any tendency for a part to loosen will cause an additional tightening of the safety cable or wire. Safety cable or wire is not a means of obtaining or maintaining torque, but a safety device used to prevent disengagement of the part (Figure 1 applies to safety wire only).
- 2.3.2 ABRASION: Material worn, ground, or rubbed away from surface by frictional means. There is no sharp notch present; however, surface finish may be smooth or rough, raised material may or may not be visible.
- 2.3.3 KINK: Permanent deformation in the wire having a sharp radius less than or equal to the wire diameter and locally forming an angle less than 160° (see Figure 2).
- 2.3.4 NICK: A surface impression that is greater than .003 inch in depth having a sharp notch at bottom.
- 2.3.5 PART: Parts or units that are bound by the safety cable or wire.
- 2.3.6 SCRATCH: A surface impression that is less than .003 inch in depth.
- 2.3.7 PIGTAIL: Termination point of safety wire.

3. SAFETY CABLE OR WIRE:

3.1 Basic Rules for Installation of Safety Wire:

For Safety Cable, see 3.4.

- 3.1.1 For general purpose safety wiring, use the preferred sizes shown in Table 1. Use smaller diameter wire where parts are too small to permit a hole diameter to accommodate the preferred sizes, or where space limitations preclude the use of the preferred sizes. The larger sizes are used where stronger wire is required. The proper wire shall be specified on the drawing by part number.

SAE AS567 Revision J

TABLE 1 - Safety Wire and Safety Wire Hole Data

Wire Diameter in	Wire Diameter mm	Recommended Twists per inch (25.4 mm)	Recommended Hole Diameter /1/ /2/ in	Recommended Hole Diameter /1/ /2/ mm	Recommended Chamfer Diameter (90° ± 5 incl) in Keep Edge Breaks Below .005 in	Recommended Chamfer Diameter (90° ± 5 incl) mm Keep Edge Breaks Below .005 in
0.015 - 0.017	0.381 - 0.431	10 - 15	0.037 - 0.057	0.94 - 1.44	0.070 - 0.090	1.78 - 2.28
0.019 - 0.021	0.483 - 0.533	8 - 14	0.037 - 0.057	0.94 - 1.44	0.070 - 0.090	1.78 - 2.28
0.024 - 0.026	0.610 - 0.660	8 - 14	0.060 - 0.080	1.53 - 2.03	0.090 - 0.110	2.29 - 2.79
0.030 - 0.034	0.770 - 0.860	6 - 11	0.060 - 0.080	1.53 - 2.03	0.090 - 0.110	2.29 - 2.79
0.038 - 0.042	0.970 - 1.070	6 - 11	0.060 - 0.080	1.53 - 2.03	0.090 - 0.110	2.29 - 2.79
0.049 - 0.053	1.250 - 1.340	4 - 9	0.060 - 0.080	1.53 - 2.03	0.090 - 0.110	2.29 - 2.79
0.061 - 0.065	1.550 - 1.650	4 - 9	0.070 - 0.090	1.78 - 2.28	0.100 - 0.120	2.54 - 3.04
0.089 - 0.093	2.270 - 2.360	4 - 8	0.100 - 0.120	2.54 - 3.04	0.140 - 0.160	3.56 - 4.06

/1/ Where safety wire is used to secure a castellated nut on a threaded item, selection of safety wire hole diameter for the item shall be based on cotter pin requirements.
/2/ Where parts cannot accommodate the recommended hole size, it is permissible to use a smaller hole provided a minimum diametral clearance of 0.003 in (0.08 mm) is maintained between the wire and the hole, except on the two largest wire sizes.

- 3.1.2 The safety wire material for use up to 1200 °F (649 °C) shall be corrosion resistant steel such as AMS 5689, and for use up to 1800 °F (982 °C), a corrosion and heat resistant alloy such as AMS 5687 shall be used. Where AMS or other material specifications are used, the specified diameter tolerances in Table 1 shall supersede those in the material specifications.
- 3.1.3 The common method of installing safety wire shall consist of two strands of wire twisted together (double twist method) where one twist is defined as being produced by twisting the wires through an arc of 180° and is equivalent to half of a complete turn. The single strand method of safety wiring may be used, when specified on the drawing, such as in a closely spaced, closed geometrical pattern (triangle, square, rectangle, circle, etc.), or parts in electrical systems, and in places that would make the single strand method more advisable. In such cases the single strand wire shall be limited to the pattern or group of similar parts.
- 3.1.4 The maximum span of safety wire (between tension points) shall be 6 in (152mm). The wire shall be taut within the requirements of 3.3.1.5.
- 3.1.5 Where multiple groups are safety wired by either the double twist or the single strand method, the maximum number in a series shall be determined by the number of units that can be safety wired by a 24 in (609 mm) length of wire.
- 3.1.6 Caution must be exercised during the twisting operation to keep the wire taut. Gripping surfaces of pliers shall have edges sufficiently rounded to preclude nicks. Abrasions and scratches are allowed; however, nicks are not allowed.
- 3.1.7 Exercise caution when installing safety wire on parts subject to relative movement such that the wire itself is not chafed, fatigued through vibration, installed over radii less than .005 in (0.13 mm) or given additional tension other than tension imposed on the wire to prevent loosening.

SAE AS567 Revision J

- 3.1.8 In all cases wiring must be done through the holes provided. In the event that no wire hole is provided, wiring should be to a convenient neighboring part in a manner so as not to interfere with the function of the parts and in accordance with the basic principles described herein (see Figures 20 and 24).
- 3.1.9 Safety wire shall be new upon each application.
- 3.1.10 Various examples of safety wiring are shown in Figures 5 through 32. Although not every possible combination is shown, any combination used must adhere to the basic rules outlined in this specification. Figure 16 shows the single strand method, while the other figures show the double twist method. Figures are for reference only.
- 3.1.11 When drawing specifies a safety wiring seal, it may be applied to the load bearing or pigtail portion of the wire and crimped to the safety wire as shown in Figures 17, 18, or 19. Figures 18 and 19 show the seal application at the end of a series, where the safety wire beyond seal is twisted and secured to safety wire between units and to an unused safety wire hole in the last unit. When sealing is required for the single strand method, apply and crimp the seal to the twisted wire at the end of the series as represented by Figure 18 except that twisted wire beyond seal is secured to single strand wire between units. Safety wire must go through and be twisted on both sides of a seal, the twisted wire direction shall be the same on both sides, so the seal cannot be turned in a manner to loosen the wire. The safety wire after the seal shall comply with the requirements of a pigtail.
- 3.1.12 Hose and electrical coupling nuts shall be wired in the same manner as tube coupling nuts.
- 3.2 Detail Instructions for Installation of Safety Wire:
- See 3.4 for Safety Cable.
- 3.2.1 Installation:
- 3.2.1.1 Prior to installation assure the units to be safety wired have been tightened to the correct torque. Undertorquing or overtorquing to obtain proper alignment of the holes is not permitted. If it is impossible to obtain a proper alignment within the specified torque limits, back off the unit and try it again, select another unit, or try another wire method.
- 3.2.1.2 In adjacent units, it is desirable that the holes be in approximately the same relationship to each other as shown in Figures 5 through 8 for right-hand threads, and the safety wire shall be installed in such a manner that the strand through the hole will have a tendency to pull the unit clockwise should the unit loosen. This should be reversed for left-hand threads.
- 3.2.1.3 For installation where the loop is not captured from movement and movement of the loop itself could cause the wire to loosen, the portion of the wire that exits the hole in the unit shall be twisted over the top of the wire that extends around the unit (see Figure 4).

SAE AS567 Revision J

- 3.2.1.4 For double twist method, twist the strands while taut (reference Table 1) until one of the strands is just short of a hole.
- 3.2.1.5 Insert the uppermost strand through the hole in the second unit and follow the rules in 3.2.1.3 (see center unit Figure 5). If there are more than two units in the series, repeat the above procedure. See also 3.2.1.7. Pigtail shall be regarded as a continuation of the safety wire and is subject to all requirements defined herein.
- 3.2.1.6 After wiring the last unit, continue twisting the wire to form a pigtail. Bend in toward any adjacent surface or place inside part to assure that the cut edges will not cause personal injury. Cut off the excess wire taking care to dispose of the excess wire so that it does not become a hazard (reference Figure 3).
- 3.2.1.7 As an alternative to wrapping wire around the unit, wire may be crossed through the unit as in Figures 9 through 12. Wire passing over the top of a bolt, as in Figures 7 and 18, is an acceptable alternative to the illustrated routing around the part.
- 3.2.1.8 The seal shall be installed around the wire per 3.1.11 and not positioned within one twist of the retaining part. Drawing shall specify seal requirement.

3.3 Details for Inspection:

Not applicable to Safety Cable.

3.3.1 Points of Inspection:

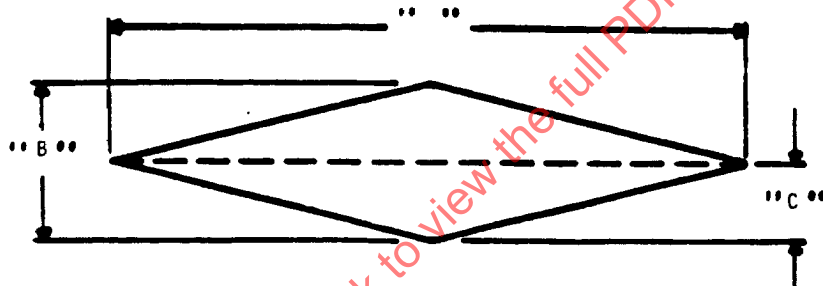
- 3.3.1.1 All external safety wire shall be inspected visually for drawing conformity prior to shipment. Specific areas of inspection are as follows:
 - a. Broken wire
 - b. Direction of strand
 - c. Total flex
 - d. Pigtail length
 - e. Pigtail position
 - f. Loose part(s) on or within safety wire
- 3.3.1.2 Strands of twisted or single wire between parts shall not be broken or violate the kink and nick criteria of 2.3.2, 2.3.3, and Figure 2.
- 3.3.1.3 Twist per inch shall conform to the requirements of Table 1. Untwisted voids or inconsistent twists within the wire are acceptable provided they do not violate tabulated criteria.
- 3.3.1.4 For right-hand threads, clockwise twist must retain part by rotating retained part clockwise. For left-hand threads, counterclockwise twist must retain part by rotating retained part counterclockwise.

SAE AS567 Revision J

- 3.3.1.5 Total flex for twisted wire may not exceed the limits of Table 2 when light finger pressure (approximately 2 lb) is applied at mid-span.

TABLE 2 - Safety Wire Flex Limits
(Units = Inches)

Minimum Assembly Length "A"	Maximum Flex at Center "B"	Half Flex at Center "C"
0.5 (12.70 mm)	.125 (3.16 mm)	.063 (1.60 mm)
1.0 (25.40 mm)	.250 (6.32 mm)	.125 (3.16 mm)
2.0 (50.80 mm)	.375 (9.53 mm)	.188 (4.78 mm)
3.0 (72.20 mm)	.500 (12.70 mm)	.250 (6.35 mm)
4.0 (101.60 mm)	.500 (12.70 mm)	.250 (6.35 mm)
5.0 (127.00 mm)	.625 (15.86 mm)	.313 (7.95 mm)
6.0 (152.40 mm)	.625 (15.86 mm)	.313 (7.95 mm)



- 3.3.1.6 Pigtail length shall be equal to or less than 0.75 in and a minimum of four turns. Twist requirement of Table 1 apply to pigtail. It shall be turned toward or placed inside the part. Likewise, pigtails with seals shall be wrapped or twisted around load bearing safety wire or fastened to a nearby part within constraints of 3.2.1.8. Open pigtails are allowed provided their termination is positioned so as not to cause injury or interfere with the operation of the part (reference Figure 3).
- 3.3.1.7 Relative movement of seals on the wire greater than 0.125 in is cause for rejection. Loose parts within the wire are also causes for rejection.

3.4 Basic Rules for Safety Cable:

- 3.4.1 Safety cable may be used as an alternate to safety wire when permitted by the design activity, applicable drawing, or other relevant documentation. When used, the cable shall be installed per AS4536.
- 3.4.2 Safety cable shall be per AS4536.

4. KEY WASHERS:

4.1 Locking With Key Washers:

- 4.1.1 Key washers are used to restrain relative motion between two parts by fitting the keys in keyways in adjacent parts or by bending the keys over parts after application.
- 4.1.2 Key washers with single bendable keys are not reusable and must be replaced with a new key washer after removal. Key washers with multiple bendable keys may be reused after previously used keys are removed and unused keys remain. Key washers must be discarded if cracks are present.

4.2 Locking Hex Nuts With Key Washers:

- 4.2.1 When single hole key washers are used, the key which is bent down against the stationary part shall be positioned as illustrated by key A in Figure 33 so that it will maintain the gap in a tightening direction.
- 4.2.2 Of the other keys, one that will provide the maximum contact with a single hex flat in the required area (key B in Figure 33) shall be bent up against a hex flat.
 - 4.2.2.1 Other keys which also happen to be aligned properly with a second hex flat (key C in Figure 33) may also be bent up at the option of the assembler and may be bent around corner of nut if desired.
- 4.2.3 Any excess key protrusion above the hex flat shall be bent over the nut to avoid becoming a snag.
- 4.2.4 Figure 34 shows keys located in unacceptable position for bending.

4.3 Drilled Holes for Washer Keys:

- 4.3.1 If there is no stationary part against which to retain the key as illustrated in Figure 33, a hole may be drilled to fulfill this function as shown in Figure 35.
 - 4.3.1.1 Key should not be allowed to move within the hole but should be braced against the side to prevent objectionable movement.

4.4 Use of Multiple Hole Key Washers:

- 4.4.1 When a multiple hole key washer is required, installation shall be as for the single hole key washer except key A provision of 4.2.1 does not apply (see Figure 36). When rotating parts are involved and a choice of keys is available, the key shall be bent that will utilize centrifugal force to aid in maintaining its bent position.

4.5 Locking Spanner Nuts With Key Washers:

- 4.5.1 Assemble key washer on shaft with washer key engaging keyway in shaft. When the nut has been torqued to the proper level, bend one of the tabs at the periphery of the washer into the corresponding slot in the nut. Use the tab and slot which are most favorably aligned. Only one tab needs to be bent to secure the nut. It is not necessary to bend the tabs into additional slots which may also be favorably aligned. Figures 37 and 38 show typical bearing retention applications. Note that the washer may engage shaft with a single key as in Figure 37 or with a double key as in Figure 38. The double key configuration provides better resistance to shear loads through the key.

- 4.5.1.1 Table 3 references recommended MS standard key washers and spanner nuts. See AS462 and AS919 for dimensions of shaft features.

TABLE 3 - Recommended MS Key Washers and Spanner Nuts

Application	Key Washer	Nut
Single keyway shaft		
Millimeter series bearings	MS172201 thru MS172235	MS172236 thru MS172270
Inch series bearings	MS172271 thru MS172320	MS172321 thru MS172370
Double keyway shaft		
Millimeter bearings	MS9081, MS9274	MS172236 thru MS172270

- 4.5.1.2 When clearance problems prohibit the use of spanner nuts with slots in the circumference, spanner nuts with the slots in the face may be used. Key washers for use with these spanner nuts are designed with keys on the ID. The keys are long enough to extend through the slot keyway and past the nut. The part of the key extending out of the keyway is bent up into the nut slot (see Figure 39) thereby creating a locked condition.

4.6 Elliptical Key Washers:

- 4.6.1 The installation of 180° ellipses shall be accomplished by bending up across one whole face of the hex as shown in Figure 40.

4.7 Cup-Type Key Washer:

- 4.7.1 Lock fastener by dimpling the washer as shown in Figure 41. Two dimples, placed 180° apart, are required. Form dimples with a spherically tipped tool. Radius of sphere must be such that it forms smooth, well formed dimples that are free of cracks and that engage scallops of the fastener to the depth shown in view A.

- 4.7.1.1 Table 4 gives dimple engagements for MS standard cup washers and fasteners.

TABLE 4 - Recommended Dimple Engagement for MS Standard Cup Washers and Fasteners

Nom Size in	Nom Size mm	Bolt	Nut	Cup Washer	Dimple Engagement (0.6 d min) /1/ in	Dimple Engagement (0.6 d min) /1/ mm
0.190	4.83	MS9676 MS9680	MS9766-09	MS9684-09	0.026	0.67
0.250	6.35	MS9677 MS9681	MS9766-10	MS9684-10	0.025	0.64
0.3125	7.94	MS9678 MS9682	MS9766-11	MS9684-11	0.024	0.61
0.375	9.52	MS9679 MS9683	MS9766-12	MS9684-12	0.023	0.59

/1/ See Figure 41.

4.7.2 To release fastener from lock, restrain the key and untorque fastener. As fastener turns, it will restore periphery of cup washer to virtually the predimpled state. This method of release is recommended in preference to prying out dimple with sharp tool because it is surer and less likely to produce burred surfaces.

5. COTTER PINS:

5.1 Locking With Cotter Pins:

5.1.1 Cotter pins are used to restrain relative motion between two parts by inserting the cotter pin through a hole in one part and slots in the other part and spreading the exposed ends.

5.1.2 Cotter pins are not reusable and must be replaced with a new cotter pin after removal.

5.1.3 Cotter pin material shall be a corrosion resistant steel, such as AMS 7210, for use up to 700 °F (371 °C); and a corrosion and heat-resistant material, such as AMS 7211, for use up to 1200 °F (649 °C). See AS123751 through AS123850 and MS9245, respectively; these cotter pins range in size from 0.031 in (0.79 mm) to 0.188 in (4.78 mm) diameter.

5.2 Locking Nuts With Cotter Pins:

5.2.1 The preferred method of cotter pin installation is illustrated in Figure 42. General rules for the installation of cotter pins are as follows:

5.2.1.1 Tighten the nut to the low side of the selected torque range, unless otherwise specified, and continue tightening until the slot aligns with the hole in the bolt shank (see Figure 45). Maximum applicable torque should not be exceeded.

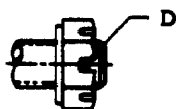
SAE AS567 Revision J

- 5.2.1.2 Install the cotter pin with the head seated firmly in the slot of the nut with the axis of the eye at right angles to the bolt shank as shown in Figure 42. Bend prongs so that the head and upper prongs are firmly seated against the bolt. Upper prong may be cut off at "A", if necessary, to provide clearance.
- 5.2.1.3 The alternative method of installation to be used in overcoming a clearance problem is shown in Figure 43. This will require longer pins than those outlined in Table 5.
- 5.2.1.4 Unsatisfactory conditions of locking with cotter pins are indicated in Figure 44. Excessive working of pin should be avoided to prevent breaking.
- 5.2.2 Alignment of Cotter Pin and Holes: Using mean dimensions of the parts to be clamped, select bolt so that the cotter pin hole is approximately midway into the slot of the nut (see Figure 45). If, during assembly, part tolerances accumulate to cause the cotter pin hole to extend more than 25% above the nut castellation, select a new nut or bolt, or place not more than two washers under the nut to obtain proper alignment.
- 5.2.3 Cotter Pin Size for Preferred Installation: Recommended cotter pin sizes for the preferred installation method are given in Table 4 for standard fastener applications. Longer or shorter cotter pins may be used when required.
- 5.3 Locking Clevis Pins, Rod End Bearings, etc.:
- 5.3.1 The proper method for installing cotter pins for use with clevis pins, rod end bearings, etc., is illustrated in Figure 46. General rules for this application are as follows:
 - 5.3.1.1 Install the cotter pin with the axis of the eye parallel to the shank of the clevis pin or rod end.
 - 5.3.1.2 Bend the prongs of the cotter pin around the shank of the pin or rod end as illustrated in Figure 46. A standard cotter pin should be chosen with a length approximately equal to twice the diameter of the clevis pin, rod end, etc.

SAE AS567 Revision J

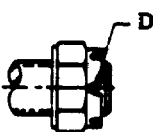
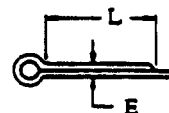
TABLE 5A - Inches
(U.S. Customary Units)

Cotter Pin and Cotter Pin Hole Data



AN150426 thru AN150450
MS9363 and MS9364

Slotted nut-type 1



AN121551 thru AN121575
MS9358 and MS9359

Castellated nut-type 2



12 point nut-type 3

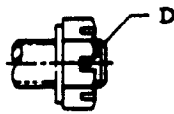
Fastener Size	Cotter Pin Hole Dia	Cotter Pin Hole Chamfer Dia (60° ± 2° incl)	Nut Type	Recommended Cotter Pin Length	Recommended Cotter Pin Dia	Recommended Cotter Pin 800 °F /1/ AMS 7210 Ref P/N	Recommended Cotter Pin 1200 °F /1/ AMS 7211 Ref P/N
0.190-32	0.065 - 0.072	0.090 - 0.110	1 2 3	0.312 0.375 0.312	0.0625 0.0625 0.0625	AS123770 AS123771 AS123770	MS9245-22 MS9245-23 MS9245-22
0.250-28	0.065 - 0.072	0.090 - 0.110	1 2 3	0.375 0.438 0.375	0.0625 0.0625 0.0625	AS123771 AS123772 AS123771	MS9245-23 MS9245-24 MS9245-23
0.3125-24	0.065 - 0.072	0.090 - 0.110	1 2 3	0.438 0.500 0.438	0.0625 0.0625 0.0625	AS123772 AS123773 AS123772	MS9245-24 MS9245-25 MS9245-24
0.375-24	0.094 - 0.101	0.140 - 0.160	1 2 3	0.500 0.562 0.500	0.0938 0.0938 0.0938	AS123788 AS123789 AS123788	MS9245-42 MS9245-43 MS9245-42
0.4375-20	0.094 - 0.101	0.140 - 0.160	1 2 3	0.562 0.625 0.562	0.0938 0.0938 0.0938	AS123789 AS123790 AS123789	MS9245-43 MS9245-44 MS9245-43
0.500-20	0.094 - 0.101	0.140 - 0.160	1 2 3	0.625 0.750 0.625	0.0938 0.0938 0.0938	AS123790 AS123791 AS123790	MS9245-44 MS9245-45 MS9245-44
0.5625-18	0.126 - 0.133	0.178 - 0.198	1 2 3	0.750 0.875 0.750	0.125 0.125 0.125	AS123805 AS123806 AS123805	MS9245-62 MS9245-63 MS9245-62
0.625-18	0.126 - 0.133	0.178 - 0.198	1 2 3	0.875 1.000 0.875	0.125 0.125 0.125	AS123806 AS123807 AS123806	MS9245-63 MS9245-64 MS9245-63
0.750-16	0.126 - 0.133	0.178 - 0.198	1 2	1.000 1.125	0.125 0.125	AS123807 AS123808	MS9245-64 MS9245-65
0.875-14	0.126 - 0.133	0.178 - 0.198	1 2	1.125 1.250	0.125 0.125	AS123808 AS123809	MS9245-65 MS9245-66
1.000-12	0.126 - 0.133	0.178 - 0.198	1 2	1.250 1.500	0.125 0.125	AS123809 AS123811	MS9245-66 MS9245-68

/1/ Maximum recommended temperature.

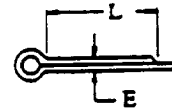
SAE AS567 Revision J

TABLE 5B - Millimeters
(Conversion of Inch Values)

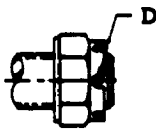
Cotter Pin and Cotter Pin Hole Data



AN150426 thru AN150450
MS9363 and MS9364



Slotted nut-type 1



AN121551 thru AN121575
MS9358 and MS9359

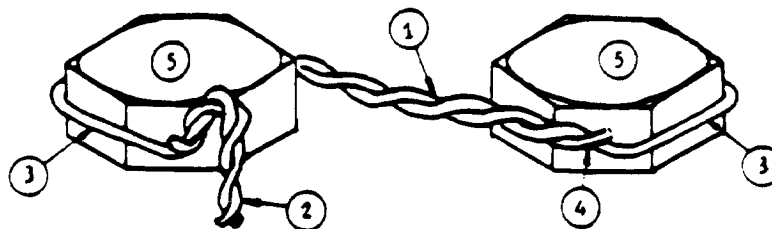


Castellated nut-type 2

12 point nut-type 3

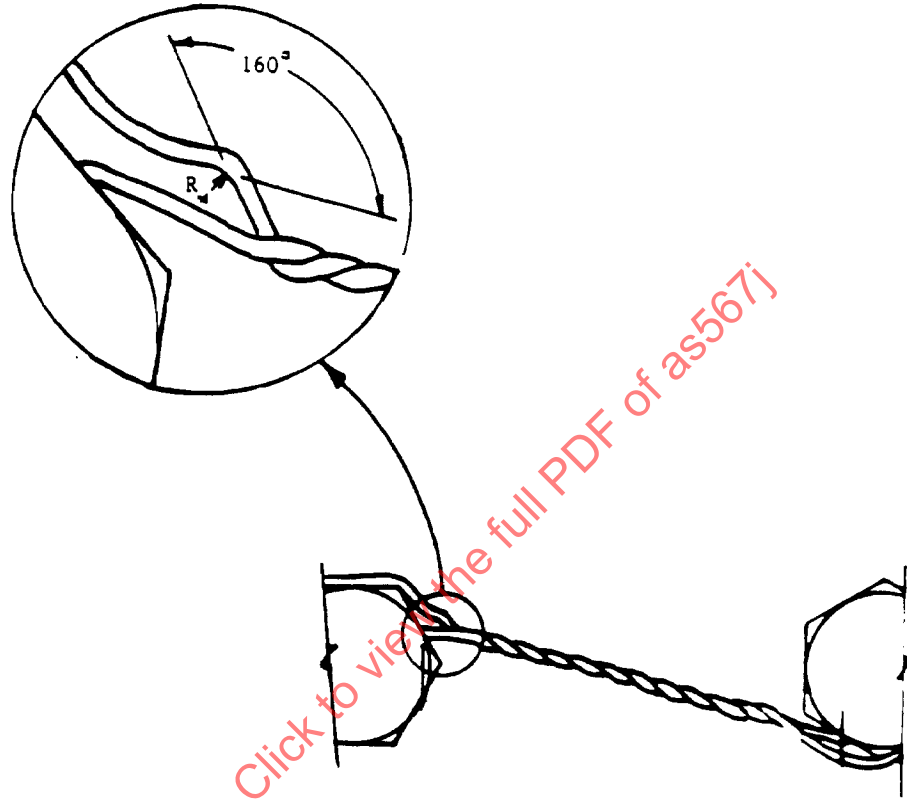
Fastener Size	Cotter Pin Hole Dia	Cotter Pin Hole Chamfer Dia (60° ± 2° incl)	Nut Type	Recommended Cotter Pin Length	Recommended Cotter Pin Dia	Recommended Cotter Pin 427 °C /1/ AMS 7210 Ref P/N	Recommended Cotter Pin 649 °C /1/ AMS 7211 Ref P/N
0.190-32	1.66 - 1.82	2.29 - 2.79	1 2 3	7.92 9.52 7.92	1.59 1.59 1.59	AS123770 AS123771 AS123770	MS9245-22 MS9245-23 MS9245-22
0.250-28	1.66 - 1.82	2.29 - 2.79	1 2 3	9.52 11.13 9.52	1.59 1.59 1.59	AS123771 AS123772 AS123771	MS9245-23 MS9245-24 MS9245-23
0.3125-24	1.66 - 1.82	2.29 - 2.79	1 2 3	11.13 12.70 11.13	1.59 1.59 1.59	AS123772 AS123773 AS123772	MS9245-24 MS9245-25 MS9245-24
0.375-24	2.39 - 2.56	3.56 - 4.06	1 2 3	12.70 14.27 12.70	2.38 2.38 2.38	AS123788 AS123789 AS123788	MS9245-42 MS9245-43 MS9245-42
0.4375-20	2.39 - 2.56	3.56 - 4.06	1 2 3	14.27 15.88 14.27	2.38 2.38 2.38	AS123789 AS123790 AS123789	MS9245-43 MS9245-44 MS9245-43
0.500-20	2.39 - 2.56	3.56 - 4.06	1 2 3	15.88 19.05 15.88	2.38 2.38 2.38	AS123790 AS123791 AS123790	MS9245-44 MS9245-45 MS9245-44
0.5625-18	3.21 - 3.37	4.53 - 5.02	1 2 3	19.05 22.22 19.05	3.18 3.18 3.18	AS123805 AS123806 AS123805	MS9245-62 MS9245-63 MS9245-62
0.625-18	3.21 - 3.37	4.53 - 5.02	1 2 3	22.22 25.40 22.22	3.18 3.18 3.18	AS123806 AS123807 AS123806	MS9245-63 MS9245-64 MS9245-63
0.750-16	3.21 - 3.37	4.53 - 5.02	1 2	25.40 28.58	3.18 3.18	AS123807 AS123808	MS9245-64 MS9245-65
0.875-14	3.21 - 3.37	4.53 - 5.02	1 2	28.58 31.75	3.18 3.18	AS123808 AS123809	MS9245-65 MS9245-66
1.000-12	3.21 - 3.37	4.53 - 5.02	1 2	31.75 38.10	3.18 3.18	AS123809 AS123811	MS9245-66 MS9245-68

/1/ Maximum recommended temperature.



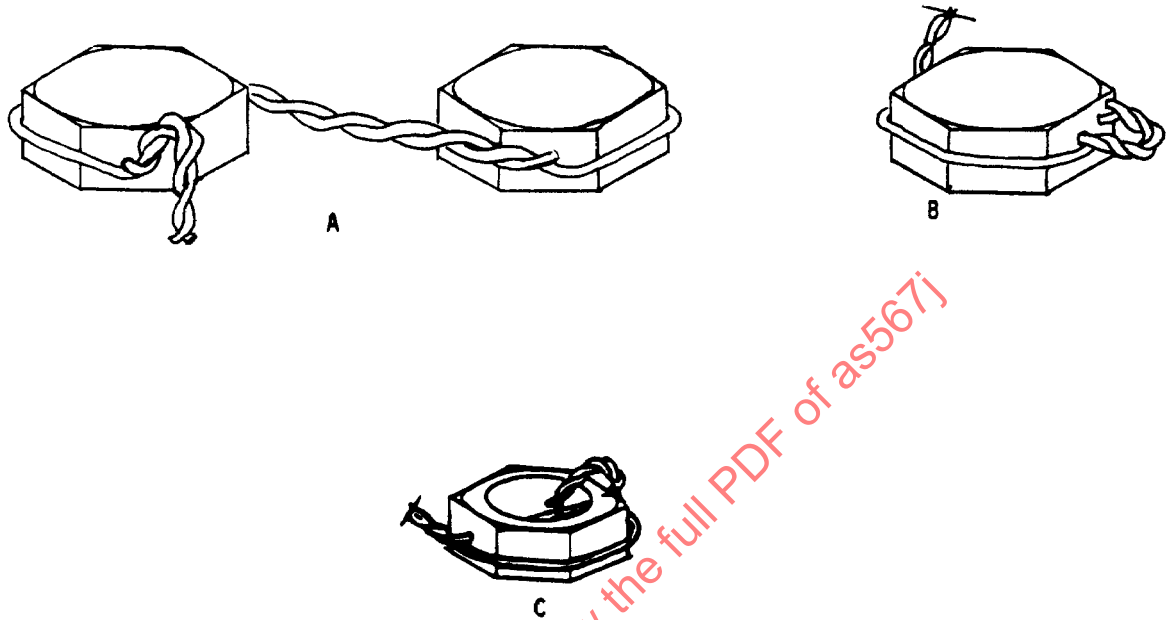
- 1 Double Twist Method - Common method where two strands of one continuous wire are twisted together over the installed length.
- 2 Pigtail - Termination point of safety wire.
- 3 Lower Loop or Strand - Portion of safety wire that extends around outside of fastener.
- 4 Uppermost Loop or Strand - Portion of safety wire that extends through the hole(s) in the fastener.
- 5 Fastener - There are multiple combinations of fasteners; shown is a hex head bolt with right hand threads (tightens clockwise). Safety wire is installed to apply tension in the wire should the fastener(s) loosen.

FIGURE 1 - Basic Safety Wire Configuration



- 1 Radius at deformation "R" to be equal-to or less-than wire radius.
- 2 Angle at deformation to be less-than 60° .

FIGURE 2 - Kink



- 1 Cut ends of pigtail shall be positioned toward any adjacent surface as Views A or B.
- 2 Pigtail may be horizontal, vertical, in any plane or combination within area(s) shown. Views A through C.
- 3 Cut end of pigtail may be turned in toward middle on hollow center fasteners, preferably below the top surface. View C.

FIGURE 3 - Pigtail Termination and Orientation

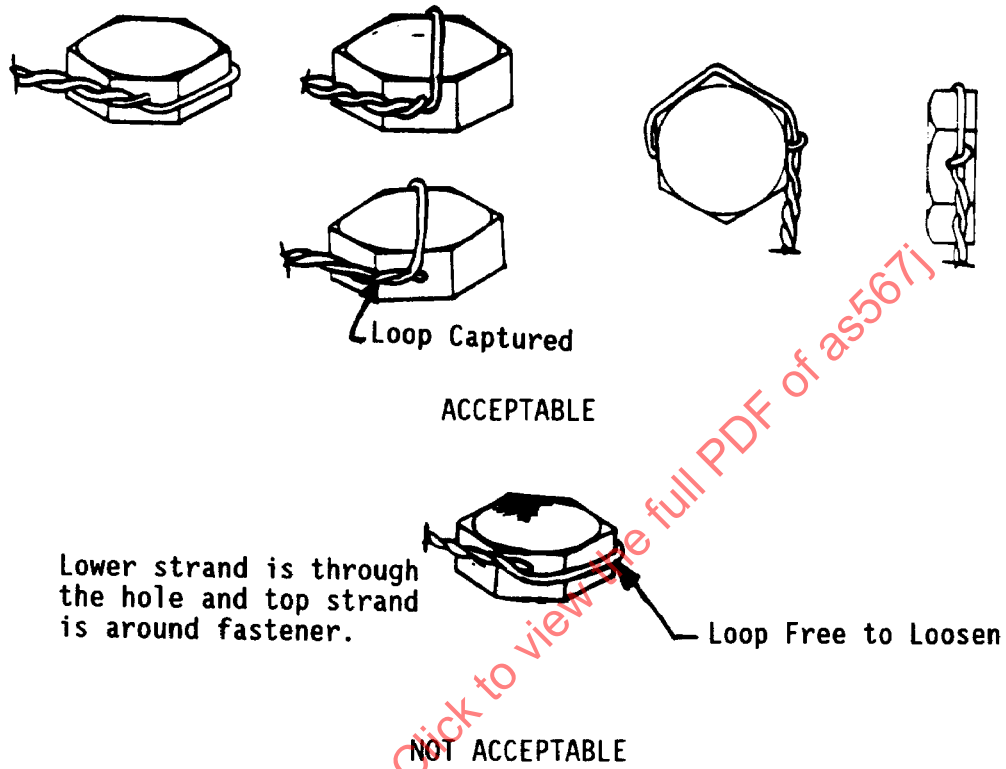


FIGURE 4 - Upper and Lower Strand Orientation

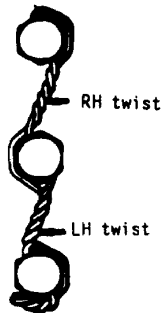


FIGURE 5

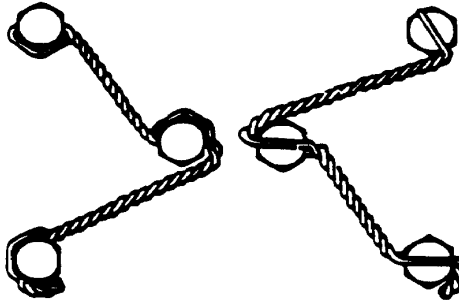


FIGURE 6

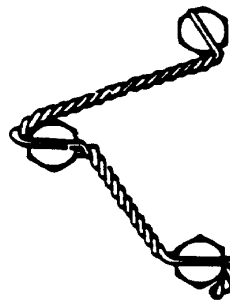


FIGURE 7



FIGURE 8

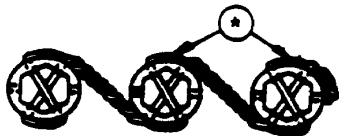


FIGURE 9



FIGURE 10



FIGURE 11

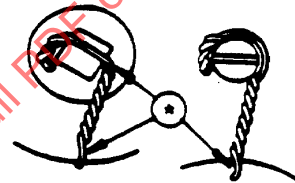


FIGURE 12

FIGURE 13

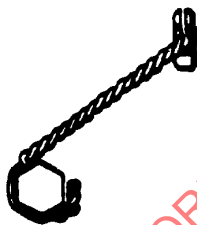


FIGURE 14 - Correct method for wiring bolts in different planes. Note that wire should always be applied so that tension is in the tightening direction.

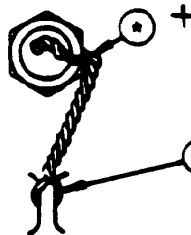


FIGURE 15 - When practicable, hollow head plugs shall be wired as shown with the pigtail bent inside the hole to avoid snags and possible injury to personnel.



FIGURE 16



FIGURE 17



FIGURE 18

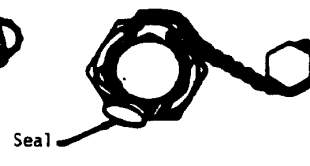


FIGURE 19

METHODS FOR ATTACHING SEAL TO PROTECT CRITICAL ADJUSTMENT

+ ⊙ See 3.3.1.3 and 3.3.1.5. Portions of these paragraphs do not apply with regard to upper and lower strand orientation.



FIGURE 20 - Bolt wire to a right angle bracket with the wire wrapped around the bracket.

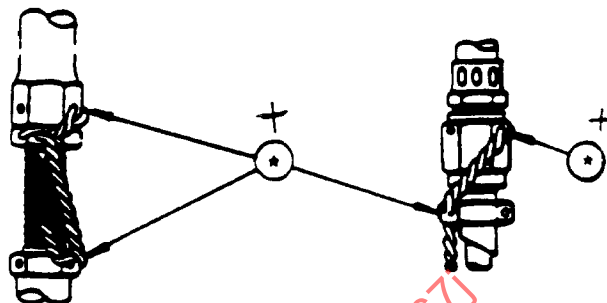


FIGURE 21 - Correct method for wiring adjustable connecting rod.

FIGURE 22 - Correct method for wiring the coupling nut on flexible line to the straight connector brazed on rigid tube.

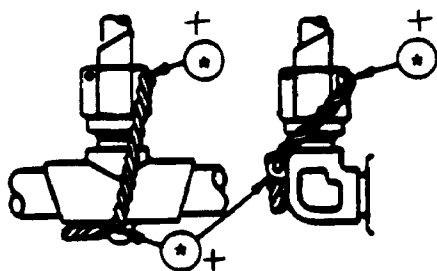


FIGURE 23 - Fittings incorporating wire lugs shall be wired as shown.

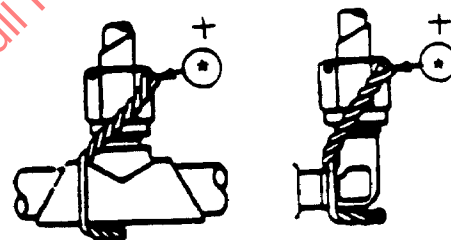
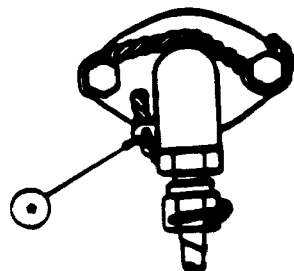


FIGURE 24 - When no safety wire lug is provided, wire should be applied as shown with caution being exercised to insure that wire is wrapped tightly around the fitting.



See 3.3.1.3 and 3.3.1.5. Portions of these paragraphs do not apply with regard to upper and lower strand orientation.



END VIEW
(enlarged)



FIGURE 25 - Small coupling nuts or those made of soft material may be wired as shown to lessen possibility of wire breaking or tearing out.

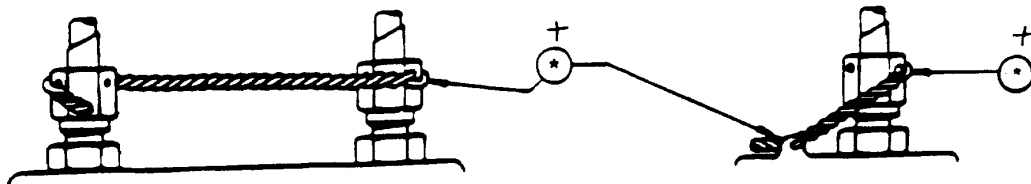


FIGURE 26 - Coupling nuts attached to straight connectors shall be wired as shown where unwired fitting is an integral part of the connector.

FIGURE 27 - See Figure 26

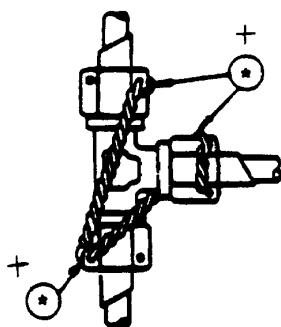


FIGURE 28 - Coupling nuts on a tee shall be wired as shown above so that tension is always in the tightening direction.

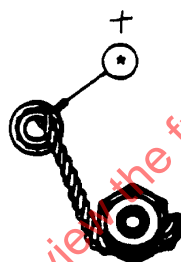


FIGURE 29 - Straight connector (bulkhead type)

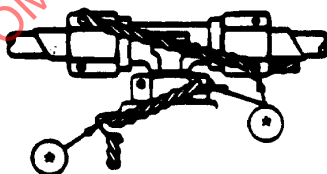


FIGURE 30



FIGURE 31 - The proper method for wiring a standard fitting with check nut wired independently so that it need not be disturbed when removing the coupling nut.

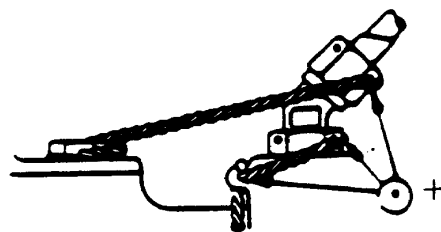


FIGURE 32 - See Figure 31



See 3.3.1.3 and 3.3.1.5. Portions of these paragraphs do not apply with regard to upper and lower strand orientation.

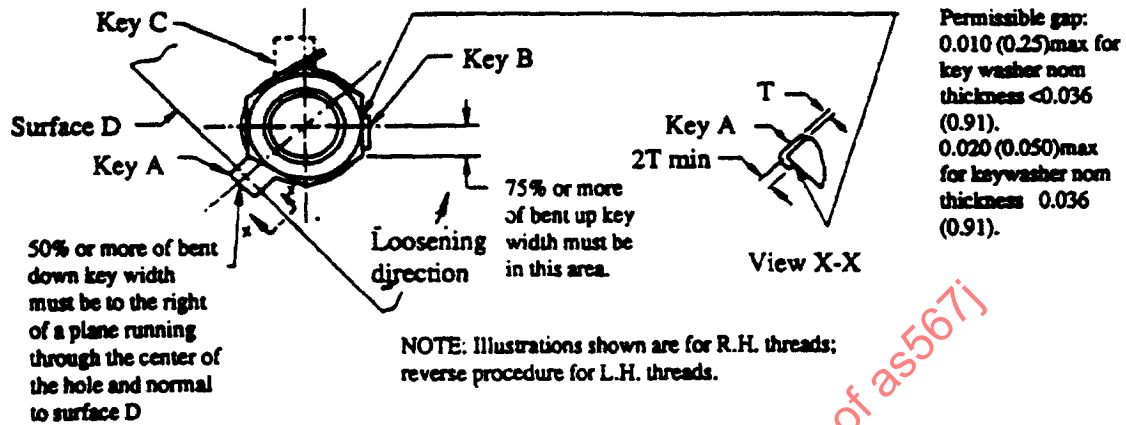


FIGURE 33 - Key Washer Stationary Surface Lock

NOTE: No technical changes to sections; key washers or cotter pins.

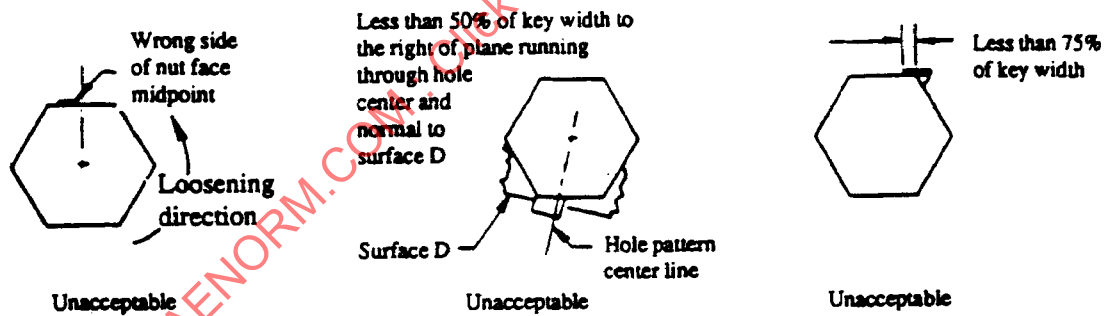


FIGURE 34 - Unacceptable Bent Key Locations