SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

SAE ARP688 | REV. A

Issued 1962-07
Revised 2002-02
Reaffirmed 2012-10

Superseding ARP688

Reusable Lock for Spanner Nuts

RATIONALE

ARP688A has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

This aerospace recommended practice is applicable to the design of a reusable locking device for cylindrical nuts which are generally tightened with a spanner wrench. Nuts of this type are commonly used to pre-load, and/or position, anti-friction bearings.

1.1 Purpose:

To provide basic information relating to the design of a reusable lock for spanner and similar cylindrical nuts.

2. REFERENCES:

MS172321
MS172236
B.S. 2090-1954

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/ARP688A

3. INTRODUCTION:

The problem of locking a pre-loading nut to prevent loosening during operation has met with a wide variety of solutions.

Advantages of the design outlined herein are:

a. All the parts are basically reusable for an unlimited number of installation and removal cycles.
b. The design is basically unaffected by inertia loads which result when the nut is subjected to a gravitational field such as the rotating shaft application.
c. The locking design is positive and is applicable for severe vibratory environment applications.
d. Since the design does not require staking or deformation at the lock, there is no danger of inadvertently damaging the lock or the mating parts when setting the lock.
e. The installation of the lock is simple and requires no special skill or tools.
f. Since the lock is not in place during the torquing of the nut, the possibility of inadvertently damaging the lock during the torquing operation is eliminated.

4. DESCRIPTION OF THE DESIGN:

4.1 The components of the assembly are as shown in Figure 1.

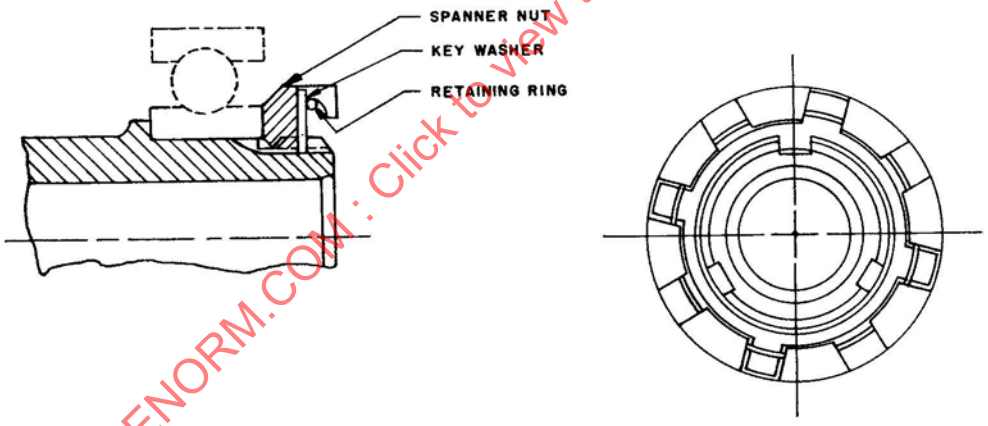

FIGURE 1

4.2 The shaft is provided with a multiplicity of equally spaced slots of basic width W. See Figure 2.

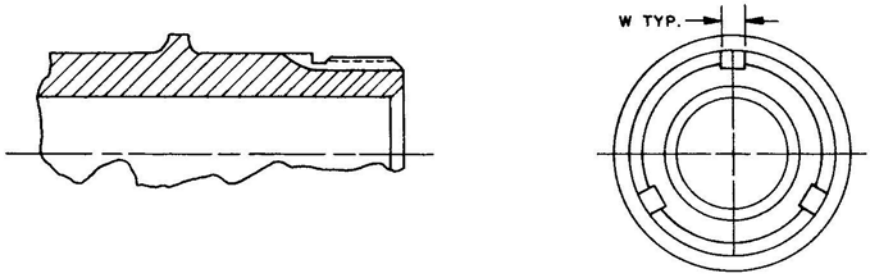

FIGURE 2

4.3 The nut is provided with a multiplicity of equally spaced slots of basic width B. In addition, the nut has a groove for the retaining ring. See Figure 3.

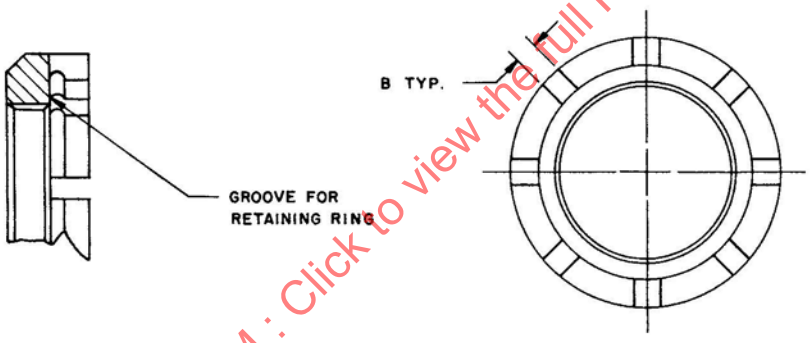

FIGURE 3

4.4 The key washer is a flat annular plate with a single key of basic width W on its inside diameter, and a multiplicity of equally spaced keys of basic width B on its outside diameter. See Figure 4.

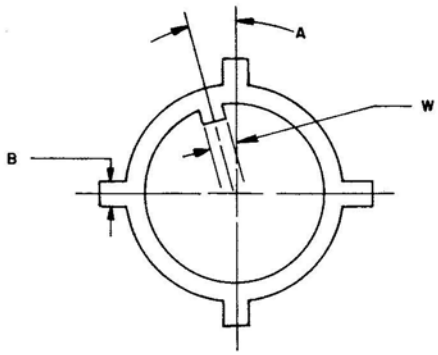

FIGURE 4

4.4.1 The single key on the inside diameter should be off-set from the outside diameter key by an angle equal to A.

4.4.2 The number of keys on the outside diameter should be as few as possible but not less than three and wholly divisible into the number of slots in the nut.

4.4.2.1 One outside diameter key is the actual locking key and should be closely fitted to the slots in the nut. For convenience, the locking key should be the closest one to the inside diameter key

4.4.2.2 The other outside diameter keys are for centrally locating the key washer in the nut and to provide a surface to bear against the retaining ring. The width of these keys should be less than the locking key to provide for slot-to-slot and key-to-key positioning tolerance.

4.5 The retaining ring can be a conventional split-ring designed to be under light compression when installed in the ring groove. Rings of this type are available commercially.

5. MAXIMUM POSSIBLE INDEXING ERROR:

5.1 After the nut is initially run down and torqued to the minimum value it is likely that it will not be possible to install the key washer because of a mis-match between the two sets of keys and slots.

5.2 The term "maximum indexing error" as used here is the maximum angle in degrees that the nut might have to be rotated relative to the shaft to install the key washer. The maximum indexing error is measured in the direction of increasing torque, only; correction of the nut position relative to the shaft will be considered as being possible only in direction of increasing torque. The maximum indexing error will be denoted by "I".

5.2.1 The maximum indexing error, with the optimum value for angle A (see paragraph 5.3.1), is given by the following:

$$I = \frac{180\ K}{GH} = 2A \qquad \text{(Eq. 1)}$$

where:

G = Number of slots in the shaft.
H = Number of slots in the nut.
K = Largest common integer factor of G and H.

5.3 The off-set angle "A" (see paragraph 4.4.1) when properly selected, can minimize the maximum indexing error because of the additional combinations provided by reversing the key washer.

5.3.1 The optimum value for angle A is given by the following:

$$A = \frac{90\ K}{GH} \qquad \text{(Eq. 2)}$$

6. INSTALLATION PROCEDURE:

6.1 The nut should be torqued to the minimum specified torque.

6.2 By making trial installations of the key washer using each of the shaft slots, and by reversing the key washer, the closest position for accomplishing the installation can be determined

6.3 The nut should then be rotated in the direction of increasing torque until the outside diameter locking key on the key washer lines up with the slot selected to accomplish the installation. If the correct torque allowance has been provided (see paragraph 8.4) the final torque should be equal to, or less than, the maximum specified torque.

6.4 The installation of the retaining ring in the nut groove completes the operation.

7. MAXIMUM NUMBER OF SLOTS:

7.1 The maximum indexing error can be reduced by increasing the number of slots in either the shaft, or nut, or both; within the limitations imposed by the factor K. (See paragraph 5.2.1 - equation)

7.2 The maximum number of slots in the shaft depends on the shaft diameter, and the width of the slots.

7.2.1 Generally, a slot width of .10 inches on a .40 inch circular pitch is found to be satisfactory.

7.3 The maximum number of slots in the nut depends on the basic nut size and the width of the slot.

7.3.1 It is desirable for manufacturing reasons to have an even number of nut slots.

7.3.2 The width of the slot is influenced by the strength requirements of the torquing wrench.

7.3.2.1 In order to avoid a special wrench for each nut design, the nut OD and the slot dimensions should conform to a standard. The preferred nut OD and slot dimensions are as used on the MS172321 and MS172236 series spanner nuts.

NOTE: The United Kingdom standard B.S. 2090 - 1954 covering the standardization of C (or hook) spanner wrenches is now being considered for adoption in the United States.

7.3.2.2 Generally, slot widths given by the MS nuts used with a circular pitch of about 2.5 times the slot width will be satisfactory.

7.4 As an example, Table 1 lists four nuts and the number of shaft and nut slots which result when the criteria given above are applied:

TABLE 1

NUT DATA

THREAD DIA.	NUT O.D.	NUMBER OF SHAFT SLOTS	NUMBER OF NUT SLOTS	OFF-SET ANGLE A	MAX. INDEX ERROR I
.500	1.05	3	10	3.0	6.0
1.00	1.72	7	10	1.3	2.6
1.50	2.25	11	10	0.8	1.6
2.00	2.78	13	12	0.6	1.2

8. THE EFFECT OF THE MAXIMUM INDEXING ERROR:

8.1 As previously mentioned, a sufficient range of tightening torque must be allowed to ensure that it will be possible to install the key washer. This range of torque will result in a corresponding variation in the pre-load which the nut provides and in the pre-stress imposed on the clamped parts.

8.2 The variation in the clamping load can be determined by the equation

$$F = \frac{I}{360\ Ne} \qquad \text{(Eq. 3)}$$

where:

F = Variation in clamping load in pounds due to I.
N = Number of threads per inch of length.
e = Total strain induced in inches per unit clamping force.