SAE Aerospace
An SAE International Group

AEROSPACE INFORMATION REPORT

SAE AIR6079

Issued 2010-12

Selection of Metallic Spring Energized Seals for Aerospace

RATIONALE

A document was needed to review the basics of spring energized seals. This AIR serves to fulfill that need.

1. SCOPE

The purpose of this report is to provide design, application and maintenance engineers with basic information on the use of metallic Spring Energized sealing devices when used as piston (OD) and rod (ID) seals in aircraft fluid power components such as actuators, valves, and swivel glands.

The Spring Energized seal is defined and the basic types in current use are described. Guidelines for selecting the type of Spring Energized seal for a given design requirement are covered in terms of friction, leakage, service life, installation characteristics, and interchangeability.

Spring Energized seals can also be made in various forms and types, including face seals (internal and external pressure sealing types), and rotary variants too. These further types will not be discussed in this document, but many of the same principles apply for them as well.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this standard to the extent specified herein. The latest issue of the SAE documents shall apply. The applicable issue of the other documents shall be the issue in effect at the date of the purchase order. In the event of conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Tel: 877 606 7323 (inside USA and Canada) or 724 776 4970 (Outside USA), www.sae.org.

ARP1281 Actuators: Aircraft Flight Controls, Power Operated, Hydraulics, General Specification for

AS568 Aerospace Size Standard for O-rings

AMS3678 Polytetrafluoroethylene (PTFE) Moldings and Extrusions Unfilled, Pigmented, and Filled Components

AS4716 Gland Design, O-Ring and Other Elastomeric Seals

AS5857 Gland Design, O-ring and Other Elastomeric Seals, Static Applications

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
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http://www.sae.org/technical/standards/AIR6079

2.1.2 US Government Publications

Available from the Document Automation and Production Service (DAPS) DODSSP, subscription Service desk, Building 4/D, 700 Robinson Avenue, Philadelphia, PA 19111 5094, Tel: 215 697 6257, http://assist.daps.dla.mil/quicksearch/.

MIL-PRF-5503 Actuators, Aeronautical Actuating Linear Actuating, General Specifications for

3. GENERAL INFORMATION

3.1 Features of Spring Energized Seals

A Spring Energized seal is a circumferential band of polymer material energized by a metal spring energizer. The cross section of the Spring Energized seal configuration can be a variety of symmetrical or asymmetrical shapes (See Figure 1), and these can be manufactured in different sizes to suit AS4716 and AS5857 “Inch” or metric size housings.

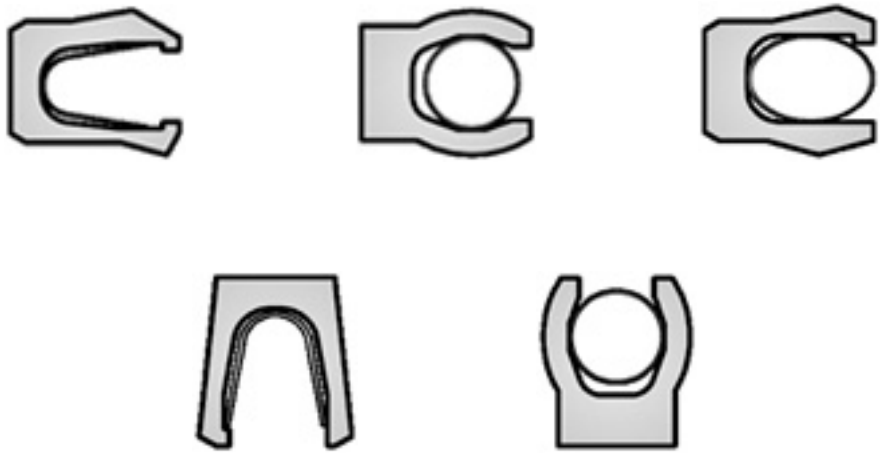
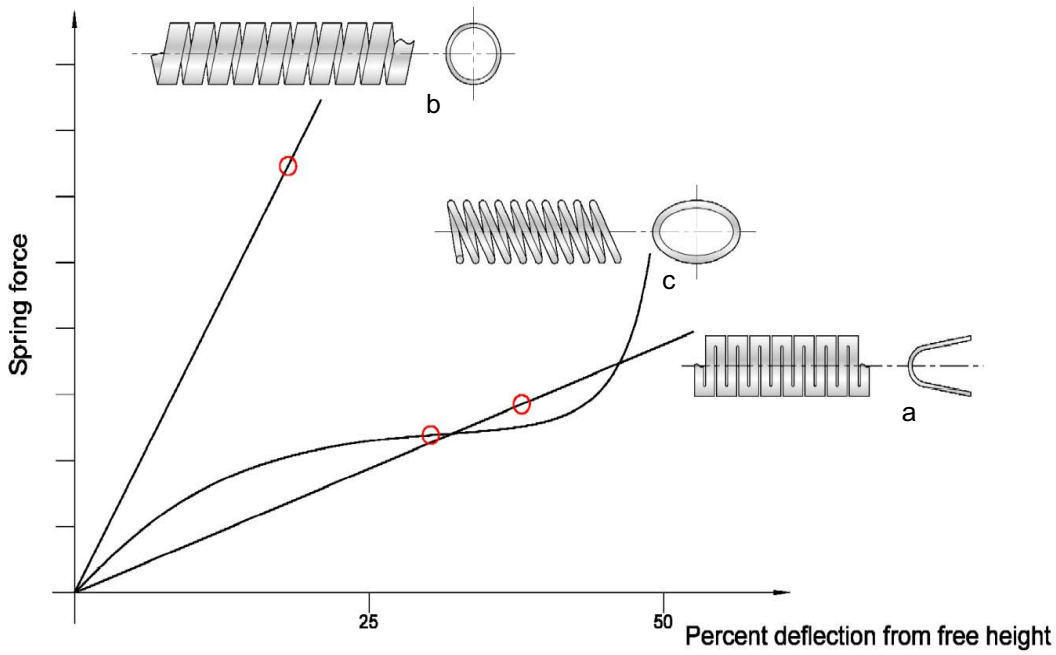


FIGURE 1 – TYPICAL SPRING ENERGIZED SEALS

Spring Energized seals are normally comprised of a machined polymer material body (or jacket), containing a spring energizer. The polymer most commonly used is Polytetrafluoroethylene (PTFE), as this provides excellent characteristics in terms of high and low temperature capability, low friction, long life, and wide chemical resistance. Other materials can be used for the seal jacket according to the application requirements.

The seal relies on the elastic characteristics of the spring to provide sealing force during low pressure (and vacuum) situations and to compensate for any seal material wear. Also the “U” shaped seal jacket can be energized by the system media pressure applied to the chamber to be sealed, and these further increase the sealing force that the seal provides. There are various types of metal spring energizers that can be used with the spring energized seals. These are shown in the seal images in Figure 1 above. The three main types of springs are shown in fig 2



a. Cantilever / V spring. (Good dynamic performance, medium to high deflection, medium spring force.)

b. Helical spring (Good static performance, high spring force, low deflection)

c. Wire / Coil Spring (Good dynamic performance, high deflection, low/medium spring force and easier for installation purposes.)

FIGURE 2 - SPRING TYPES

Each of these spring types provide different compression and load deflection characteristics, which combined with the appropriate seal jacket body design, can be used to optimize sealing performance for different circumstances. It is imperative to select the optimum seal and spring design, for any given application, and for the sealing performance characteristics desired. Consult the seal manufacturer for more information in this respect.

The metal Spring Energizer elements are often made in a stainless steel material, but other (more corrosion resistant) alloys are also commonly available.

The combination of a metallic spring and a machined PTFE jacket, when fitted in a gland, acts to control fluid leakage. When used in a dynamic application metallic Spring Energized seals generally, but not always, reduce breakout and running friction and enhance extrusion and wear resistance when compared to PTFE slipper seals.

The first PTFE spring energized seals were used successfully in the “nineteen fifties”. PTFE is a chemically-inert, temperature-resistant (from cryogenic limits to 500ºF (260 C)), low-friction, fluorocarbon thermoplastic, compatible with all industrial and military fuels and hydraulic fluids in military and commercial use.

Although PTFE is not elastic in the same sense as an elastomeric material, it is deformable for good sealing and can be stretched for ease of installation. Because PTFE is a relatively soft plastic, sealing surfaces must be protected from scratches and nicks during handling and installation. Installation tools for both OD and ID metallic Spring Energized seals are generally recommended for use where a (solid) one-piece gland is involved. Installation tools are not always necessary, depending upon the diameter and cross section sizes used, and upon the exact seal design used. Metallic Spring Energized seals can be limited in installation capability due to the inability of some springs to stretch (for O.D installation) and collapse (for I.D. installation). The metal spring can suffer due to permanent deformation or yielding when applied outside design parameters. This characteristic can vary by spring type and seal design. Consult the manufacturer for design limits.