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AEROSPACE INFORMATION REPORT

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ANTI-BLOW-BY DESIGN PRACTICE FOR CAP STRIP SEALS

1. PURPOSE

The purpose of this report is to provide information on anti-blow-by design practice for Cap Strip Seals.

2. SCOPE

Suggestions for piston Cap Strip Seal side-wall notch design and other anti-blow-by design details are described.

3. REFERENCES:

SEJPF Report 65-2	Issued By: Systems Engineering Group Research and Technology Division Air Force Systems Command Wright-Patterson Air Force Base Ohio "Warning Regarding the Use of Polytetrafluoroethylene Solid Ring And Elastomeric Ring Combinations As Piston Seals"
MIL-G-5514	Gland Design; Packings, Hydraulic, General Requirements For
ARP 1233	Gland Design, Elastomeric O-Ring Seals, Dynamic Radial, 1500 PSI Max
AS 568	Aerospace Size Standard For O-Rings

4. INTRODUCTION

It is assumed that the phenomenon of blow-by and its cause are familiar to the reader. The mechanism of blow-by (See Fig. 1) is described in SEJPF Report 65-2. The following recommendations and design details outline current practice to provide rapid pressure response of piston (O.D.) Cap Strip Seals, hence avoid piston blow-by.

Although the blow-by phenomenon is thought to be generally understood, information is fragmentary and documented service experience limited. Testing is recommended to confirm performance.

5. CONTROL DIAMETRAL CLEARANCE (See Fig. 1)

Excessive diametral clearance may cause deformation of the Cap Strip Seal, particularly with differential pressure loading. This deformation may close-off the seal side-wall clearance, hence reduce the pressure response of the seal assembly during rapid pressure reversals. It is recommended that seal diametral clearances per ARP 1233 and MIL-G-5514F be used.

Also the cylinder design should consider the increase in clearance due to cylinder pressures. A reinforced TFE Cap Strip Seal material is recommended to reduce seal deformation under conditions of long or repeated exposure to high temperature (over 275° F) (135° C) and pressure (over 2500 psi).

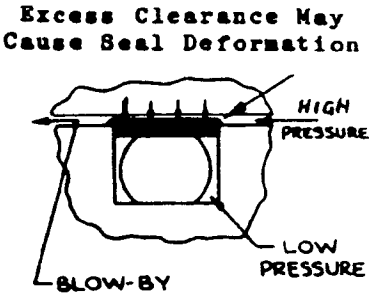

FIG. 1

6. USE CAP STRIP SEALS WITH ADEQUATE SIDE-WALL CLEARANCE (See Fig. 2)

The difference between the maximum axial length of the Cap Strip Seal and the minimum length of the groove should not be less than shown in the following Table I to ensure rapid pressure response.

Table I

O-RING CROSS-SECTION W	MINIMUM SIDE-WALL CLEARANCE A
.070	.010
.103	.010
.139	.012
.210	.014
.275	.016

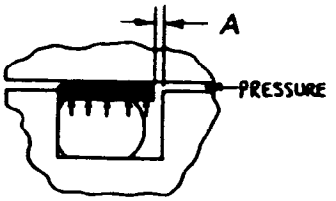

FIG. 2

7. USE OF SIDE-WALL NOTCHES ON PISTON (O.D.) CAP STRIP SEALS (See Figs. 5 & 6)

In addition to the recommended diametral clearance and side-wall clearance, notches in the seal side-walls should be used to provide rapid pressure response and prevent blow-by. Recommended notch detail is shown in Fig. 5.

Notches may not be practical on Cap Strip Seals with less than 0.30 in. (0.76 mm) radial thickness and less than .060 in. (1.52 mm) axial length. Anti-blow-by design recommendations for small cross-section seals are available from seal manufacturers and will vary with installation and service requirements. Procurement activity approval or testing is recommended.

Time in use, particularly at high temperature or high pressure or both, may cause distortion of the Cap Strip Seal sufficient to restrict the effectiveness of side-wall notches. Chamfers can be used to improve the effectiveness of notches and also to extend the service life of the notch (See 8).

8. USE OF CHAMFERS ON PISTON (O.D.) CAP STRIP SEALS (See Figs. 6 & 7)

The effective life of side-wall notches can be extended by incorporating chamfers in the Cap Strip Seal that reduce the tendency of the notches to close-off with seal use. The chamfers may be local at each notch on the outside diameter of the Cap Strip Seal, (Fig. 6), or circumferential chamfers may be used along the outside corners of the seals (Fig. 7). Circumferential chamfers are also effective in reducing the Cap Strip Seal deformation shown in Fig. 1 and Fig. 7.

9. USE OF HIGH-MODULUS MATERIAL BACK-UP RINGS WITH PISTON (O.D.) CAP STRIP SEALS (See Fig. 3)

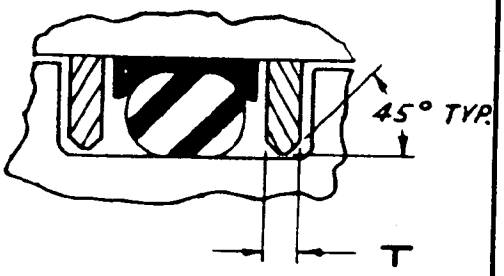

FIG. 3

Back-up rings made from high modulus material (such as Nylon Polyimide or Bronze filled TFE) may be located in the groove adjacent to the Cap Strip Seal to protect the seal against extrusion. Adequate side-wall clearance (.010 in. (0.25 mm) min.) will ensure rapid pressure response of the Cap Strip Seal. Notches in the back-up rings on the radial surface facing the groove side-wall can also be used advantageously to increase the fluid pressure response. Notch should be on both sides of back-up ring to prevent misassembly. Caution---the O-ring can be damaged in the gap below the high-modulus back-up ring. This can be minimized by 45° x T/4 chamfers on the back-up ring at both the edge that contacts the O-ring and the edge which tends to ride up on the groove radius (not necessary for filled TFE back-up rings). A TFE or filled TFE ring next to the O-ring with a higher modulus ring outboard will also provide the necessary O-ring protection.

10. USE OF PISTON HEAD CHANNELS AND DRILLED HOLES (See Fig. 4)

Channels in the piston head which admit fluid pressure into the seal groove will ensure rapid pressure response. A .010 in. (0.25 mm) wide channel is effective. Channel depth should not exceed the minimum side-wall height of the Cap Strip Seal to avoid extrusion of the elastomer into the channel. Two to four channels are recommended on each side of the seal groove.

Drilled holes through the piston head can be used as an alternative to the piston head channel. Holes must be located in the seal groove so that the Cap Strip Seal prevents O-ring extrusion into the hole. The number of holes and hole size will vary depending upon design requirements and limitations.

Caution---Experience with the design practice of using channel and drilled hole techniques to ensure rapid pressure response is limited. Testing is recommended.

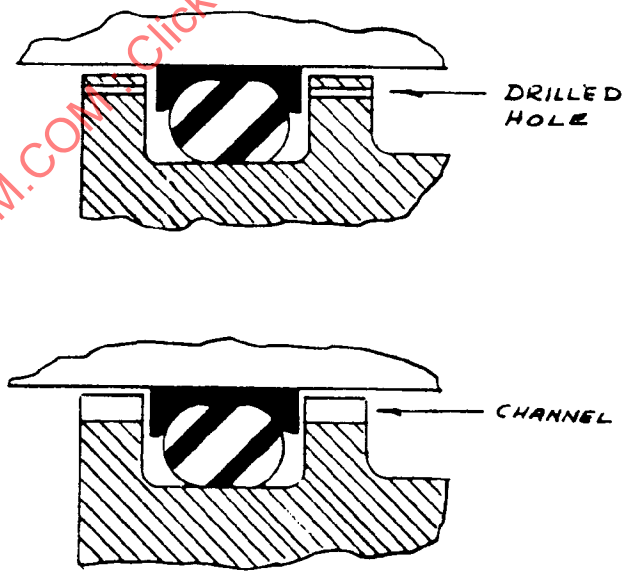

FIG. 4

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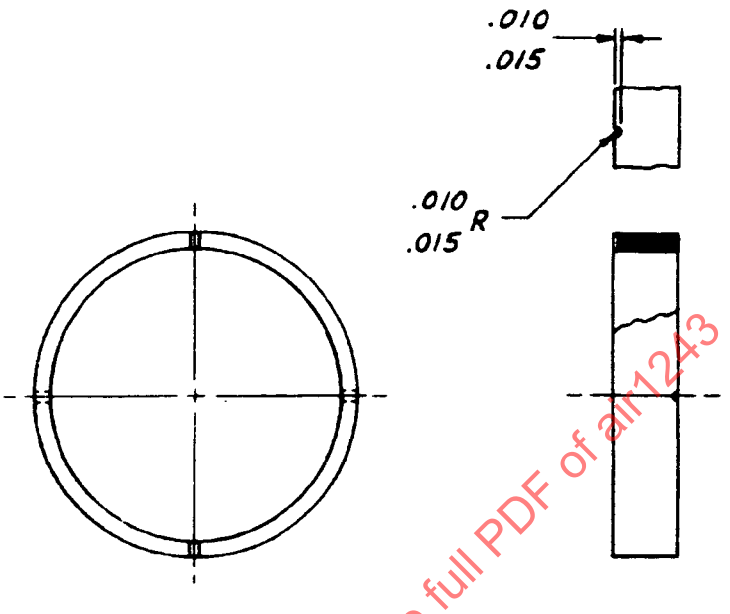
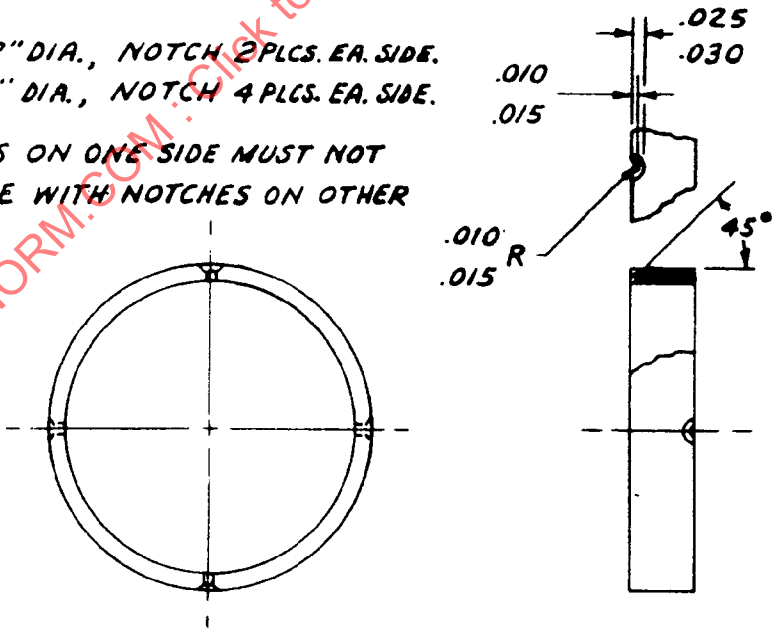


CAP STRIP WITH STRAIGHT NOTCH

FIG. 5

UP TO 2" DIA., NOTCH 2 PLCS. EA. SIDE.
OVER 2" DIA., NOTCH 4 PLCS. EA. SIDE.

NOTCHES ON ONE SIDE MUST NOT COINCIDE WITH NOTCHES ON OTHER SIDE.



CAP STRIP WITH CHAMFERED NOTCH

FIG. 6