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Installation and Use of Equilateral Triangle Cross-Section Hydraulic O-Ring Seal Backup Rings (Dyna-Baks)

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

STABILIZED NOTICE

This document has been declared “Stabilized” by the A-6 Technical Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

1. INTRODUCTION:

The use of equilateral triangle cross-section hydraulic seal backup rings has been found to improve the life and reliability of high pressure O-ring seals especially for high temperature applications. This Aerospace Information Report (AIR) describes the design and operation of these backup rings, tabulates recommended seal groove and gland dimensions, offers recommendations and suggestions for their installation into hydraulic components, and outlines their advantages and limitations of their use.

2. DESCRIPTION:

2.1 Use:

The subject backup rings, sometimes called Delta backup rings and more commonly known as Dyna-Bak seal control rings, are used in both male and female configurations for piston type and rod gland type seals respectively. (See Fig. 1) They were developed specifically as anti-extrusion rings to protect elastomeric O-ring seals from extrusion into the clearance space between relatively moving or relatively stationary hydraulic component members where the elastomeric O-ring is used as either a static or dynamic fluid seal for any class of fluid service, but especially for use in high pressure hydraulic systems used in aircraft and aerospace vehicles. They also function to reduce O-ring wear and spiral failures in high pressure applications and leakage due to O-ring compression set in high temperature applications.

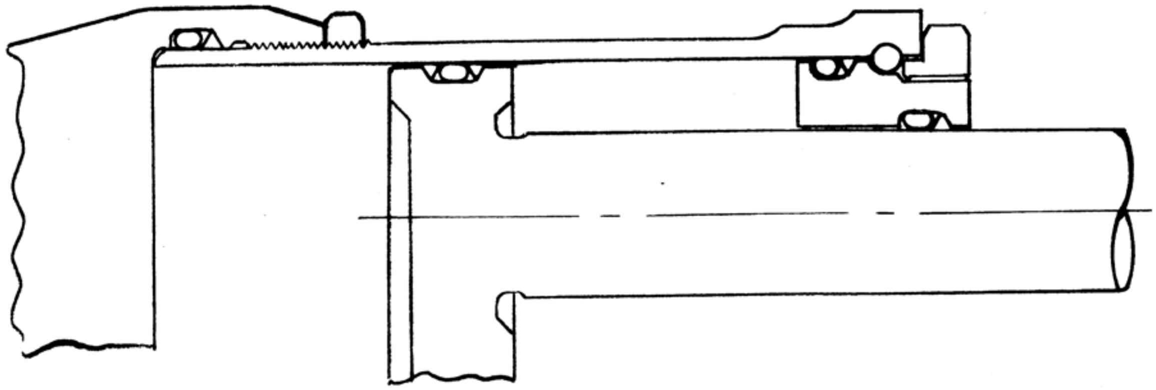

FIGURE 1 - TYPICAL DYNA-BAK INSTALLATIONS

2.2 Geometry:

The cross-sectional shape of the backup ring is in the form of a nearly perfect equilateral triangle with the base angles ø approximately matching the face angle θ of the seal groove. (See Fig. 2.) The sizes have been standardized for use with standard O-ring sizes per AS568, and part numbers correspond to the uniform dash number sizes. The standard groove diameters are per the dimensions of Table I of MIL-P-5514, and the rings are designed for use with the standard cylinder bore, piston rod, male gland bore, and female gland sleeve diameters contained therein.

The height of the backup ring is approximately 80 percent of the annular depth of the seal groove allowing generous radii at the bottom of the groove. Groove widths are sized to allow installation of O-ring and backup ring with relative ease without excessive side play and yet accommodate normal O-ring swell.

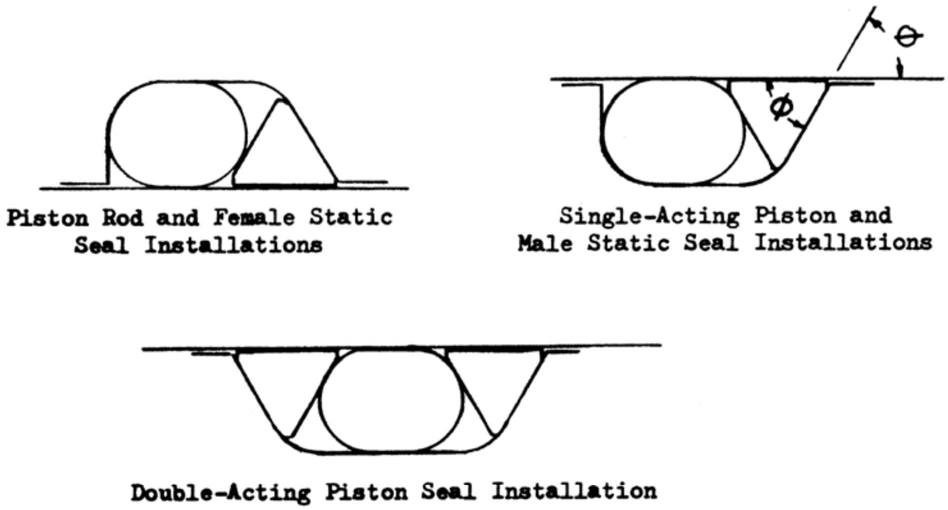

FIGURE 2 - BACKUP RING AND SEAL GROOVE GEOMETRY

2.3 Continuous or Scarf-Cut Rings:

The backup rings can be used either as continuous, uninterrupted rings or in a diagonally scarf-cut configuration. The scarf-cut rings are more easily installed in the seal grooves and will function satisfactorily in a great number of applications. For maximum seal protection, both during assembly of the hydraulic component and during operation, however, they should be used uncut. After a large number of cycles, the edges of the scarfed joint will eventually break down forming an extrusion gap where the O-ring will finally extrude and fail.

2.4 Materials:

The backup ring must be made of a material which is harder and substantially more resistant to extrusion than the O-ring it is designed to protect if it is to prevent O-ring extrusion without creating problems due to itself extruding into the clearance space between sealed members. On the other hand, the backup ring must be made of a relatively resilient stretchable material if it is to be installed in the non-cut configuration, in a normal one-piece seal groove. Pure Teflon TFE and various compounds of Teflon filled with materials such as graphite, bronze, and aluminum oxide fiber with molybdenum disulphide have all been tested with considerable success. Graphite-filled Teflon rings have demonstrated long life as rod seals at 400°F (204°C). The aluminum oxide fiber filled Teflon impregnated with molybdenum disulphide has proven satisfactory for piston rod seal backup rings at temperatures up to 550°F (288°C) but a very hard rod surface, such as flame plated tungsten carbide, must be used to prevent abrasive wear. For high temperature applications where extrusion resistance without abrasiveness is required, the polyimide resins, possibly modified with graphite, or other fortified polymers may have a more optimum combination of properties.