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METAL VACUUM SEALS FOR THE AGS

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AGS DIVISION TECHNICAL NOTE

No. 33

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METAL VACUUM SEALS FOR THE AGS

This report is intended to summarize the work done on developing metal vacuum seals for the AGS. In addition, a new seal material will be discussed as well as a method of electrically insulating vacuum chambers. Also, to facilitate the purchase of new size metal seals, drawings and specifications are being included.

After reviewing and testing many types of seals it became apparent that there is no one metal gasket that can be used as universally as the rubber O-ring. Therefore, one has to first consider the specific application and then the metal gasket which best suits the job. Fortunately, the majority of seals in the AGS have the same requirements and there are a few gaskets available which have proven to be reliable for this application.

In general, one cannot simple order a metal gasket from a seal manufacturer, as a direct replacement for a rubber O-ring, and expect to have a reliable vacuum seal. For example, a soft plating such as indium is a must for vacuum sealing. For the AGS where the gaskets are most often used in O-ring grooves, the basic seal design proposed is a gasket that stores energy when compressed in the groove and maintains sufficient sealing force on the soft plating to effect the seal.

Generally speaking, there are two basic types of gasket available, the machined seal and the mechanically formed seal. Examples of machined seals are the Lo-Load seal, "Vee" seal, "K" seal, "X" seal. Some formed gaskets are the hollow O-ring, C-ring, oval ring, etc. The formed gaskets have the advantage of being able to be shaped to fit designs such as elliptical or rectangular and they are generally less expensive, approximately by one-half to one-third. The machined seals are controlled very accurately and since they are machined from a ring or plate there is no chance of local distortion from welding which is an integral part of the manufacturing process of formed seals. We have used the Lo-Load seal, the C-ring and the hollow O-ring in the AGS with good success. However, because its basic design produces a uniform and controllable weld joint, the C-ring has been selected as the most practical and economical one to use in the AGS. Manufacturing techniques in the production of the hollow O-ring have made great strides and produced reliable seals and can be used as an alternate. Machined gaskets such as the Lo-Load work very well, but their high cost must be considered as their main disadvantage.

Table 1 is typical of the information which should be specified when ordering metal gaskets. Figures 1 and 2 are drawings of a typical C-ring and O-ring respectively listing dimensions to be used with our AGS standard O-ring grooves. This outline can also be used when ordering other gaskets, however, slight adaptations may be necessary to suit the application.

When one is not restricted to using an O-ring groove the metal seal can be used between flat flanges with a retaining ring to locate and limit compression of the seal.

Another seal design worth of mention is the aluminum foil seal.* This seal is recommended for laboratory systems, aluminum or stainless steel. Special machining of the flanges is required and nominal 1½ mil aluminum foil is used as the seal. This design can be modified and used with plain flat flanges, see AGS Division Technical Note No. 26 for details.

A duPont polyimide resin trademarked "Vespel" is a relatively new material which can also be considered for use as vacuum seals. It can be used where metal seals are impractical and where elastomer seals will not suffice. It has excellent radiation resistance, low outgassing rate, high dielectric strength, and good thermal and mechanical properties. A gasket (Fig. 3) was machined and tested in the laboratory. Sealing forces were comparable to those for the metal gaskets. Polyimide is also available in thin sheets under the trademark "Kapton" H-film. Tests at AGS have shown this material to remain flexible after irradiation in the graphite reactor to 5×10^9 rads. Mylar which recevied the same dose was brittle and fractured when flexed. H-film seems well suited for use as windows on beam pipes.

To electrically insulate vacuum chambers a ceramic-coated stainless steel flange will be used to replace the Mylar insulator between chamber flanges. The bolt insulators will continue to be used. Drawing D05-M-791-3A shows the insulator proposed for the AGS. For further details see AGSCD Technical Note No. 76.

For suppliers of metal seals see Machine Design Publication "Seals" 3rd Edition, March 9, 1967.

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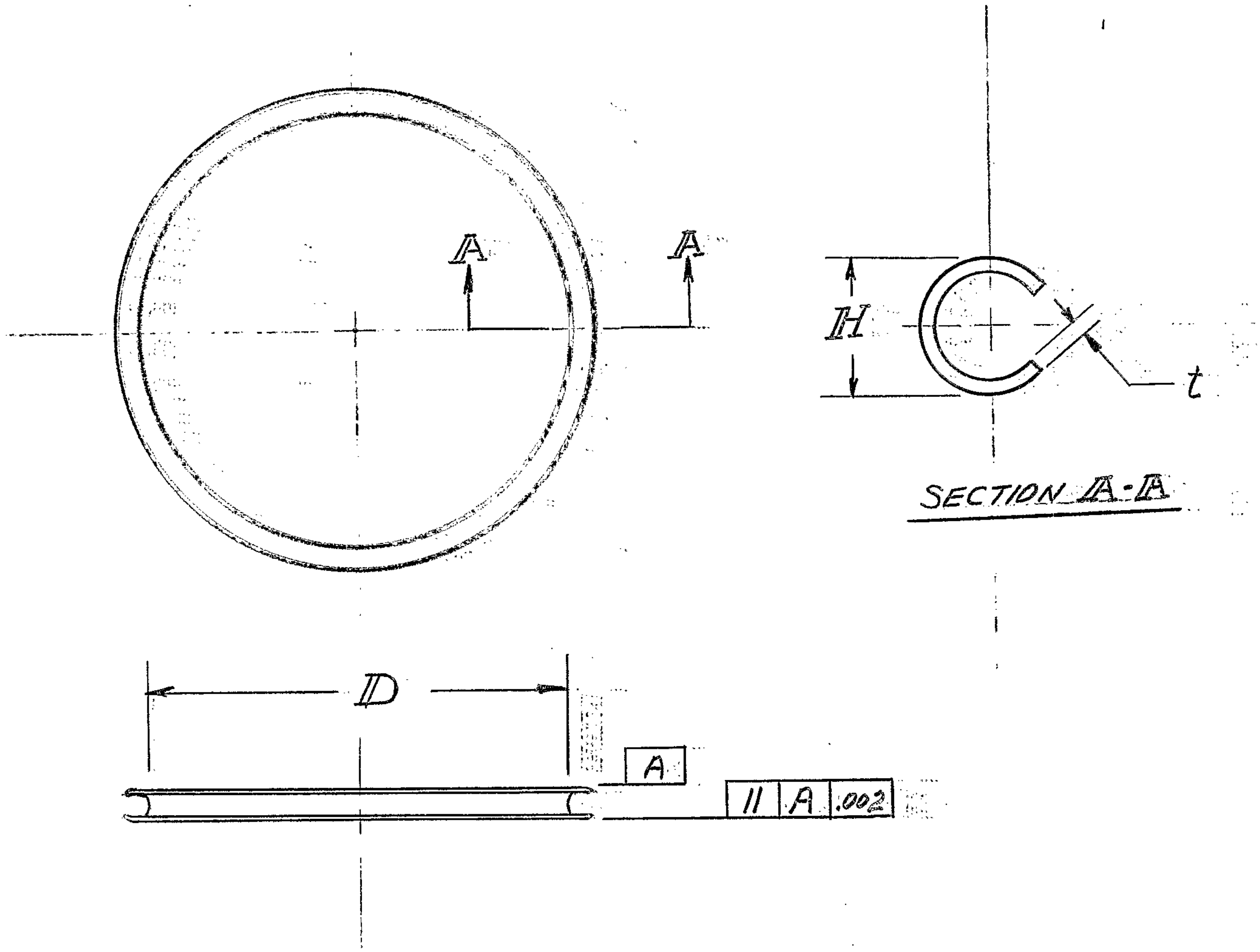
*, T.H. Batzer, Flange Design using Aluminum Foil for UHV Applications, UCRL-7393, ENA-129, Nov. 1963.

TABLE 1

Notes Common to All Metal Seals

1. All dimensions apply before plating.
2. Lap or hone sealing surfaces to a 32 micro-inch finish before plating. Lay of finish to be concentric with sealing line.
3. Irregularities in seal height resulting from welds, dents, scratches, etc., are not to exceed 0.0005".
4. If welded ring, weld to be vacuum leak tight.
5. Plating: nickel strike, lead plate 0.0015" thick, followed by indium plate 0.0005" thick.
6. No finishing treatment such as polishing after plating.
7. Seals to be suitably packaged for shipment and storage. No staples or clasps are to be used which may damage plating.
8. Certification required on material, dimensions and plating.

Distribution: AGS Mechanical Engineers

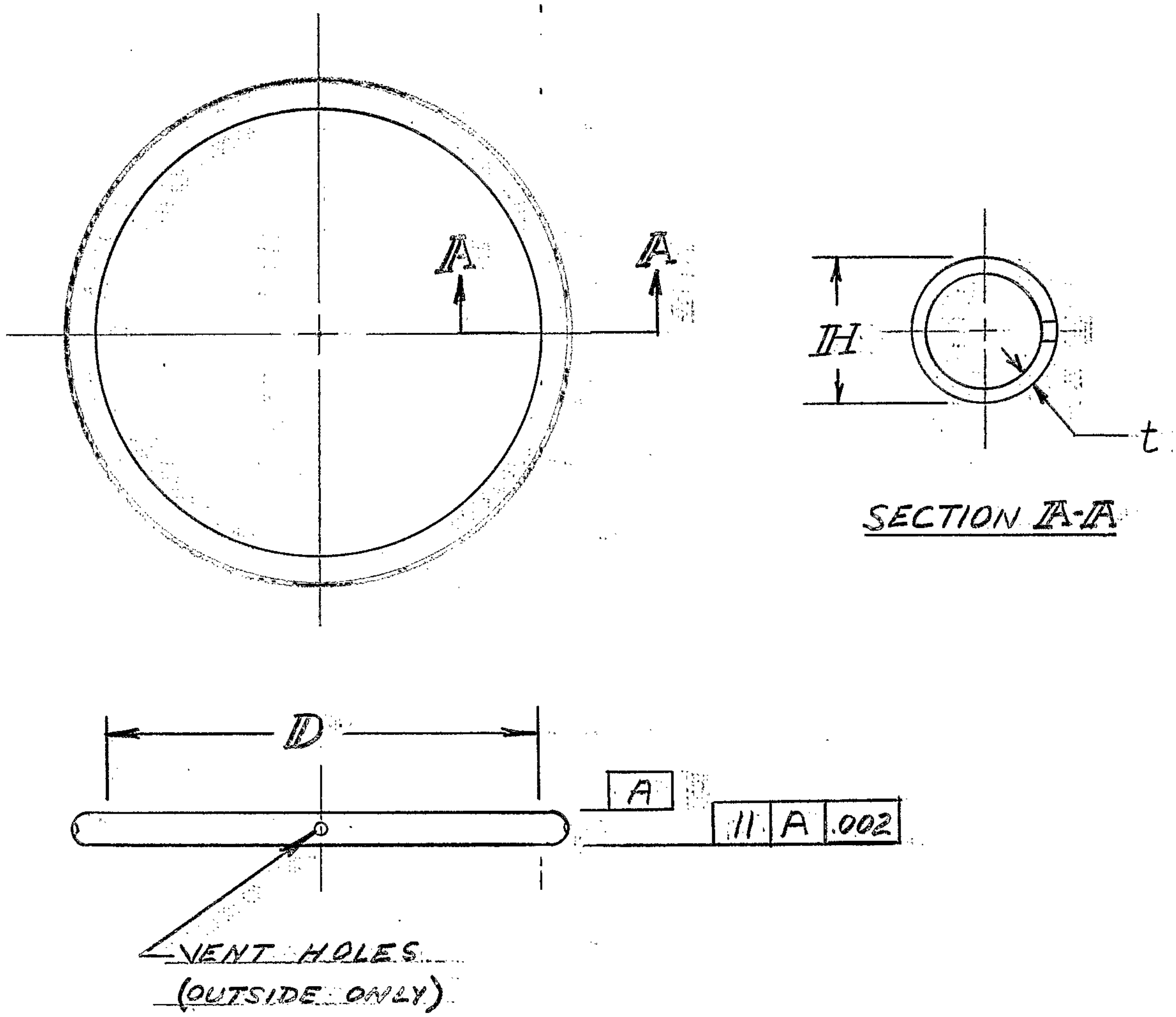


Material: Inconel alloy X-750

Nominal Size	Groove (AGS Std)		Seal	
	Depth ± .005	Width ± 1/64	H ± .003	t ± .001
1/4	.206	11/32	.225	.025
3/16	.156	9/32	.187	.025
1/8	.104	3/16	.125	.015
3/32	.077	5/32	.093	.015
1/16	.053	3/32	.062	.010

Diameter "D" equal to groove diameter plus 1/64.

Fig. 1 "C"-Ring

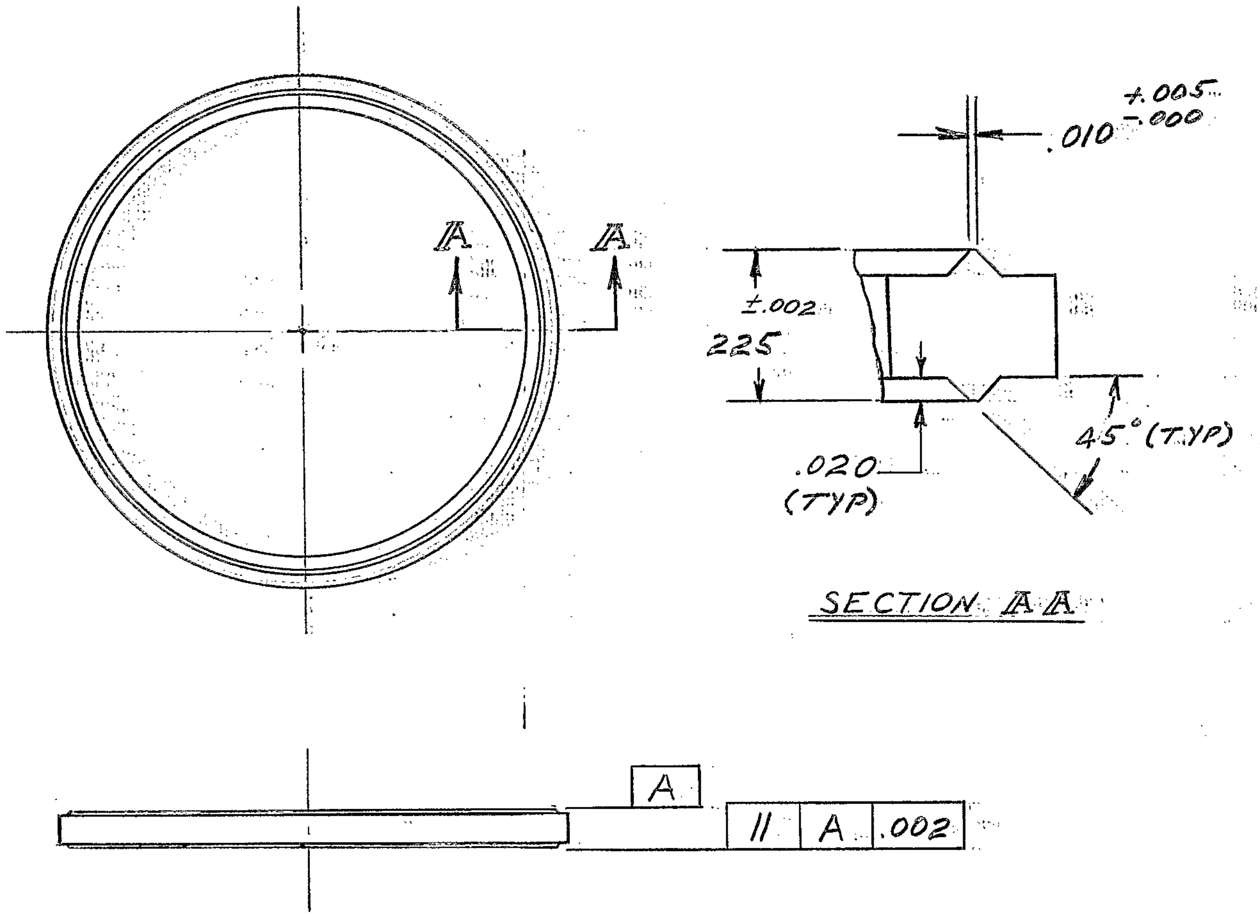


Material: Inconel alloy X-750

Nominal Size	Groove (AGS) Standard		Seal	
	Depth ±.005	Width ±1/64	H ±.003	t ±.001
1/4	.206	11/32	.225	.020
3/16	.156	9/32	.175	.020
3/32	.077	5/32	.093	.006

Diameter "D" equal to groove diameter plus 1/64

Fig. 2 O-Ring



Groove depth .206 ± .005

Material "Vespel" SP-1 annealed

Fig. 3 "Vespel" Seal