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IMPROVED MECHANICAL SEAL FOR ALUMINUM VACUUM WINDOWS

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AGS Division Technical Note
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Summary

This Technical Note analyzes past problems associated with the vacuum windows on our secondary emission chambers, describes a new seal and its testing and performance to date.

Introduction

The proper operation of a secondary emission chamber generally requires vacuum levels of $10^{-9}/10^{-8}$ Torr. This in turn requires a bake-out at 300°C. The high vacuum and bake requirement placed stringent sealing demands on the particle windows of the unit. In the past, these windows were made of 0.002" thick stainless steel which was E.B. welded around its circumference. Once welded, they were generally leak tight. There were two problems, however; first, a high rate of rejects during the welding operation and second, the relatively high atomic number of stainless steel was in some cases objectionable. An aluminum window of 0.003" thick, 5052H35 was then tried making use of a mechanical seal as shown below.

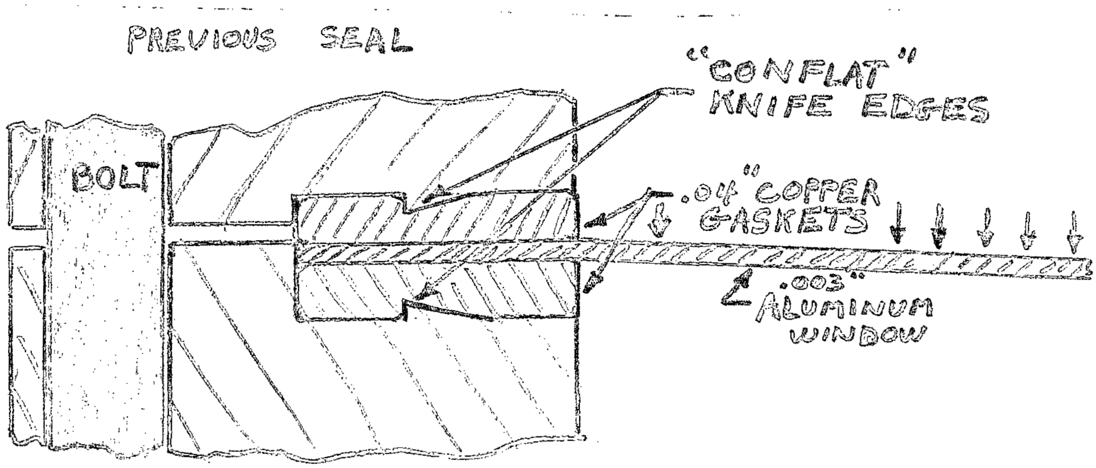

FIG. 1

This design proved troublesome for two reasons. First, the copper-to-aluminum seal was marginal because the high stress of the knife edge-to-copper contact was dissipated in traveling through the copper. This was evident by the fact that the minute surface scratches on the copper gasket were not completely obliterated by the window at the sealing area. Second, extensive copper-aluminum corrosion was observed across the seal area on a leaking unit. These observations lead to the design of a mechanical seal in which the stainless flange is clamped directly to the aluminum window as shown below.

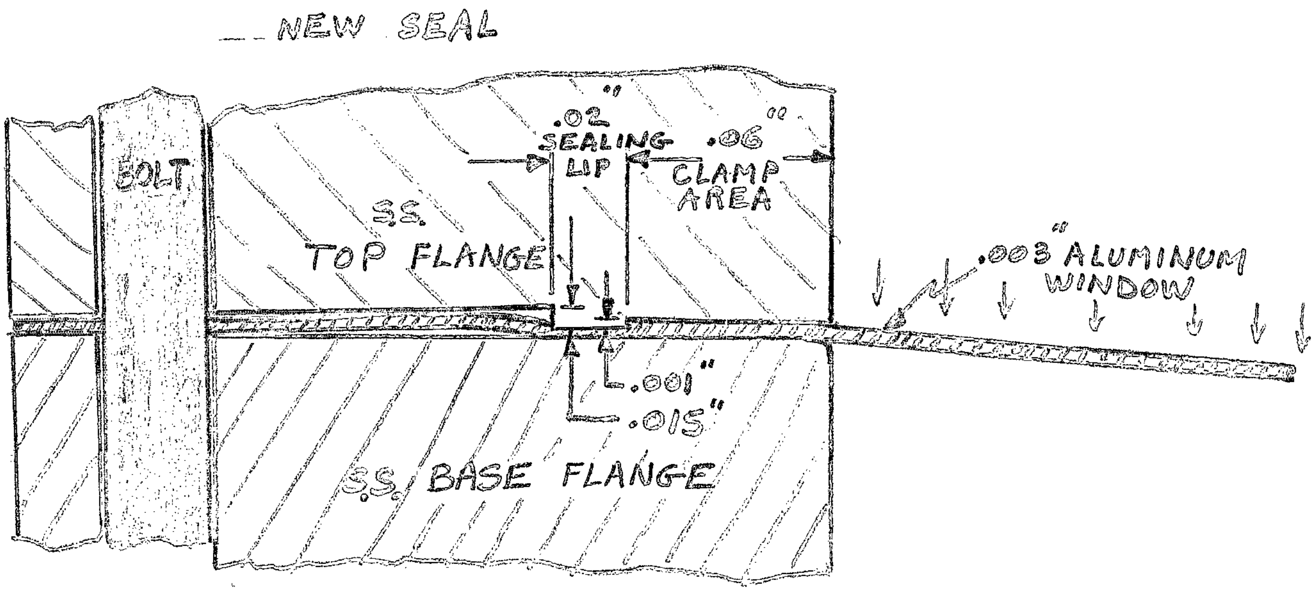

FIG. 2

This seal has three significant features:

1. Elasticity is built into the flange by the 0.015" relief in the bolt area. This causes the flange to take a slight cone shape under bolt tension. This maintains force on the sealing lip over temperature extremes and differential expansions.
2. The sealing lip is raised 0.001" ± 0.0005" above the clamping area and is 0.02" wide. The contact area of the lip with the aluminum is such that under 200 in-lbs. of bolt torque, the compressive yield of the aluminum window is exceed by a factor of about three. The lip thus sinks into the aluminum until the clamping area comes in contact.

3. The clamping area is compressed against the window with a stress which is approximately equal to the yield of the aluminum. This assures a good mechanical grip to resist the vacuum force.

Photographs taken at 38x of the seal areas of the flange and window are included. The machining marks on the stainless flange are readily observed embossed into the aluminum as well as the 0.001" depression left by the sealing lip (cross section photo). Also, note the microscopic grain and surface irregularities of the window material are obliterated in the seal and clamping areas.

Testing to date consists of five seals made with the same flange set. None showed any leak on the most sensitive scale of a helium mass spectrometer as shown below.

Test #	Condition	Results
1	As assembled (room temp.)	no leak
2	Assembled then baked @ 250°C	" "
3	Assembled, baked 2 hrs. at 250°C, cooled slowly to 100°C, sprayed with cold water	" "
4	Assembled, baked 2 hrs. at 300°C, cooled slowly to 200°C, sprayed with cold water	" "
5	Assembled, baked 2 hrs. at 300° C, sprayed with cold water	" "

An S.E.C. has been assembled using the new seal and is presently installed in the U Line for operational testing.

mn

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WINDOW UPPER SIDE (38X)

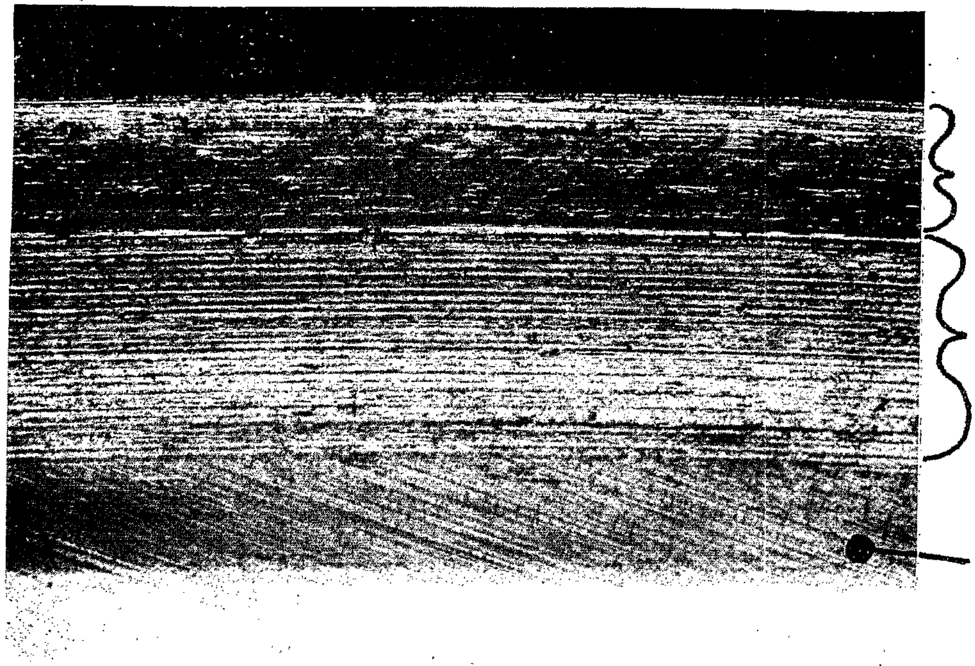


FIG. 3

TOP FLANGE
(MATES WITH FIG. 3) (38X)

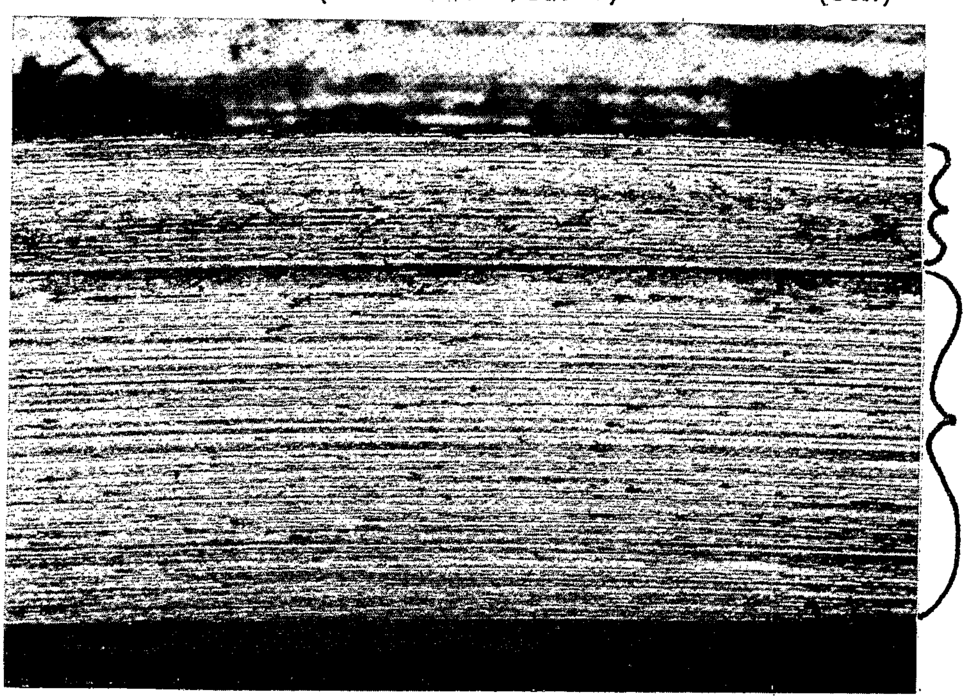
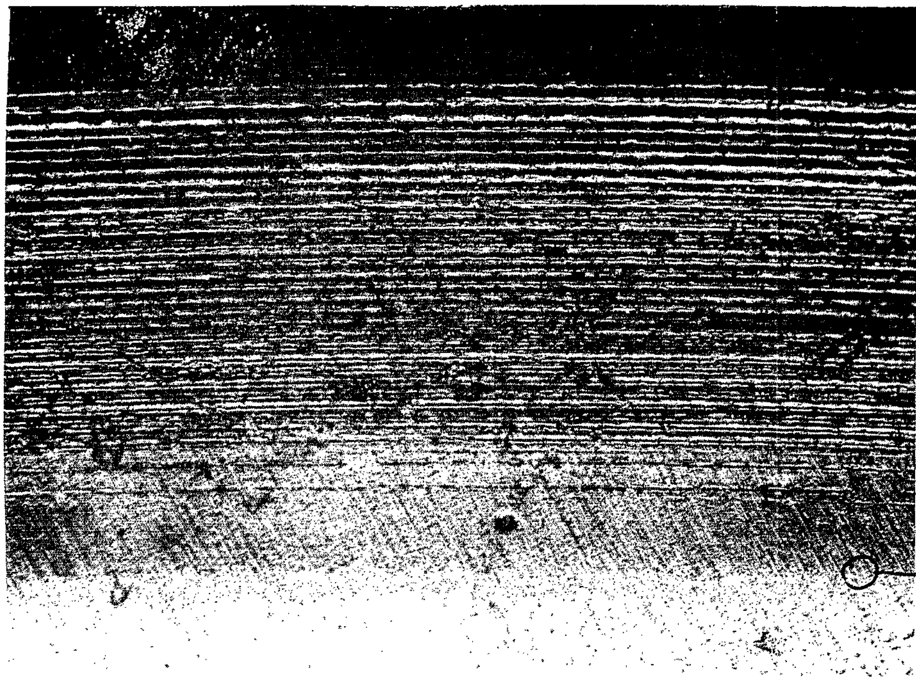


FIG. 4

WINDOW LOWER SIDE (38X)



UNDISTURBED GRAIN

FIG. 5

BASE FLANGE
(MATES WITH FIG. 5) (38X)

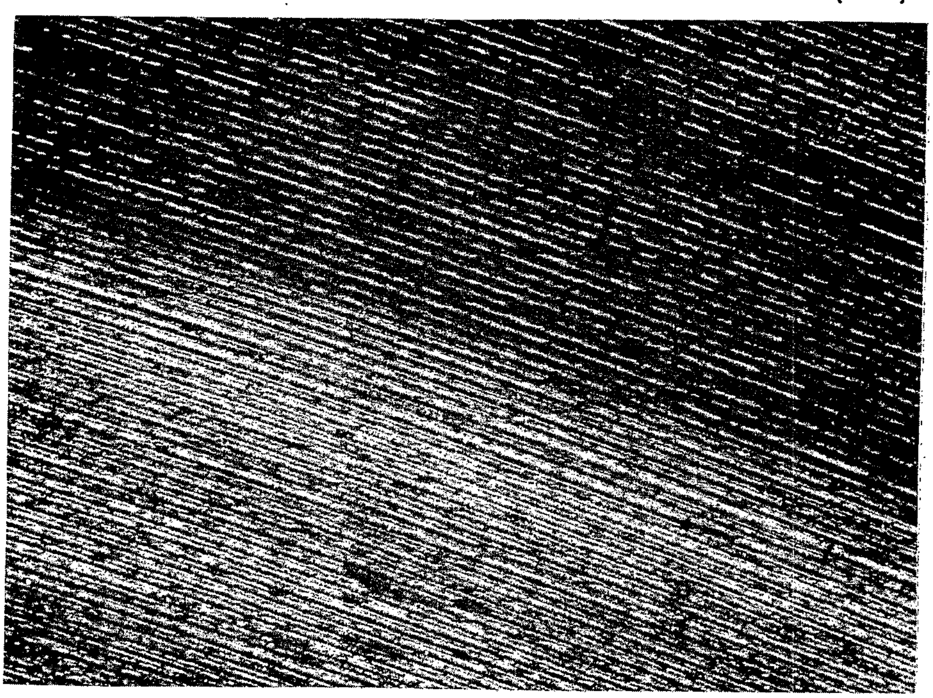


FIG. 6

CROSS SECTION OF WINDOW
SEAL/CLAMP AREAS (38X)

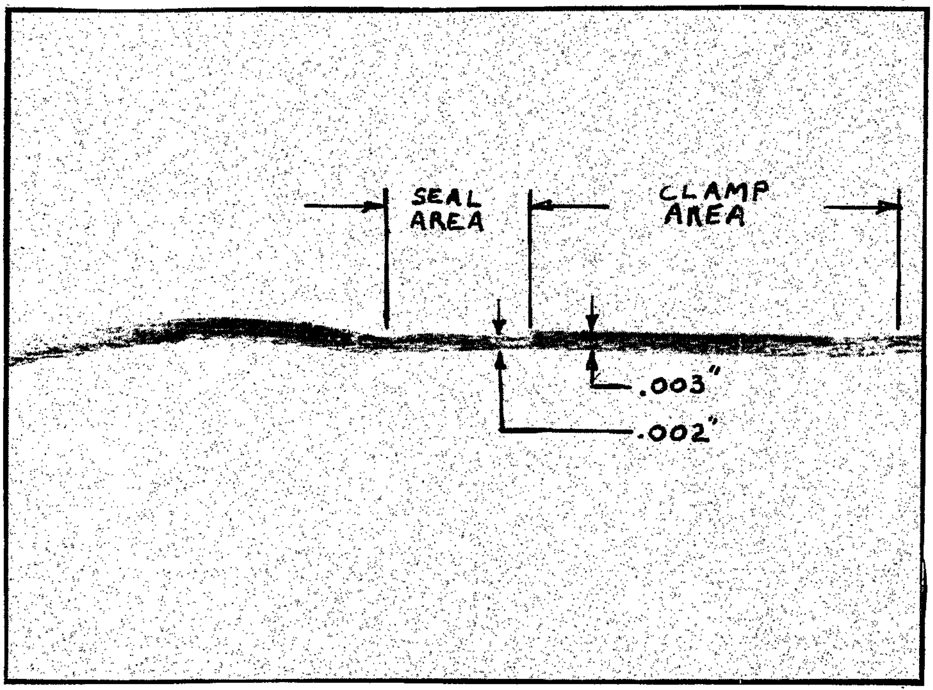


FIG. 7