UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

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HYDRAULIC LABORATORY REPORT NO. 63

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TEST TO DETERMINE THE BEHAVIOR OF RUBBER RINGS USED AS GASKETS IN VARIOUS GROOVES BETWEEN HEAVY HYDRAULIC FLANGES (HM-4)

By
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Denver, Colorado
August 21, 1939

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Branch of Design and Construction
Engineering and Geological Control
and Research Division
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Laboratory Report No. HYD-63
Hydraulic Laboratory

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Subject: Test to determine the behavior of rubber rings used as gaskets in various grooves between heavy hydraulic flanges (HM-4).

1. Introduction. Recently the use of a rubber ring, round in cross section, set in a groove between heavy hydraulic flanges to replace the flat gasket has become common practice. The main advantage of this type of gasket is that it permits the flanges to be drawn tightly together, thus eliminating the uncertain factor of gasket thickness. Also, in case of slightly warped flanges, a positive seal may be obtained without undue stressing of bolts.

While this method appears to be ideal for sealing under high pressures, some difficulty has been experienced in obtaining a positive seal. This is thought to be due to bad proportioning of the groove and improper ratio between the sectional area of the ring and that of the groove. The purpose of these tests was to study the behavior of rubber rings in grooves of various shapes and sectional areas when the flanges are drawn together.

2. Summary. Designs No. 1 and No. 2 were submitted by the electrical section. Designs No. 3 and No. 4 originated in the laboratory. The models of these various designs are shown in figure 1. In the course of the tests it was noted that as the initial load was applied to the gasket specimen, there would be symmetrical distortion which would continue until the shape of the groove forced unsymmetrical distortion. Further loading would distort the specimen toward the unoccupied portion of the groove. However, the friction between the rubber and the flanges hindered free adjustment such that a tendency to creep up over the steep side of the grooves was noted. This occurred particularly in the test of design No. 1 using specimen c, where the maximum load of 100 pounds per square inch was applied without the feeler gages indicating contact between the respective flange faces.

The use of two hardnesses of rubber showed little difference in distortion characteristics other than a greater unit load to compress to the same position, rubber of 65 durometer hardness requiring approximately twice the unit load as that for rubber of 45 durometer hardness.

3. Description of tests. The models were made of oak and pyralin, as shown in figure 1. The upper block represents a segment of a plain flange and the lower block represents a segment of a grooved flange. The cross-sectional dimensions of the various models tested are shown in table II, and the length of segment for all designs was 1-7/8 inches. A pyralin plate 1/4 inch thick, reinforced by an oak plate 13/16 inch thick, with a suitable hole for observation and photographing, was bolted onto each side of the model with machine bolts. The block representing the mating flange was guided by two oak dowels, in order that no relative lateral motion with respect to the grooved flange could take place.

The purpose of reinforcing plates was to hold the pyralin securely against the ends of the rubber test specimens and prevent extrusion between the plates and the model. In spite of this precaution, some extrusion did occur, as may be seen in the photographs.

The rubber gasket specimens tested are described in the following table:

TABLE I

Gasket specimen	Diameter inches	Durometer hardness No.	Hole diameter inches
a	0.730	45	0
b	0.730	65	0
c	0.910	45	0
d	0.910	45	0.25
e	0.910	45	0.50

Coordinate lines were drawn on each end of the test specimen before placing it in the model. This was done in order that the movement of the rubber might be studied when the flange segments were drawn together.

For photographing, the models were assembled without lubricating the grooves and test specimens, placed in the hydraulic press, and the flange segments brought together. These photographs are shown on plates 1, 2, 3, and 4. The distortion of the coordinage lines indicates the flow tendencies in the test specimens. In order to improve this condition, designs Nos. 3 and 4 were proposed. It was also expected that grooves of this type would better hold the rubber ring gasket in place during the assembling of the flanges.

In order to determine the force required to bring the mating flanges together, both the test specimens and the grooves were lubricated with vaseline. Column 7, table II, gives the load required to bring the mating flanges to within 0.005 inch of each other as determined by feeler gages.

Since rubber is considered to be incompressible for all practical purposes, the ratio between the sectional areas of the groove and the gasket is important. Columns 4 and 5 in table II give the respective sectional areas of the groove and gasket, while column 6 expresses the percentage of gasket area to groove area. In the case of designs No. 3 and No. 4 there was more gasket area than groove area. In compressing the test specimen, the excess rubber was evidently taken up by endwise distortion, as no binding on the sides took place. Column 7 gives the load required to bring the flanges to within 0.005 inch of each other. In the case of design No. 1, using the solid gasket, the largest load was required to bring the faces together. This was doubtless due to pinching of the gasket between the two flange segments on the steep side of the groove, as may be seen on plate 2.

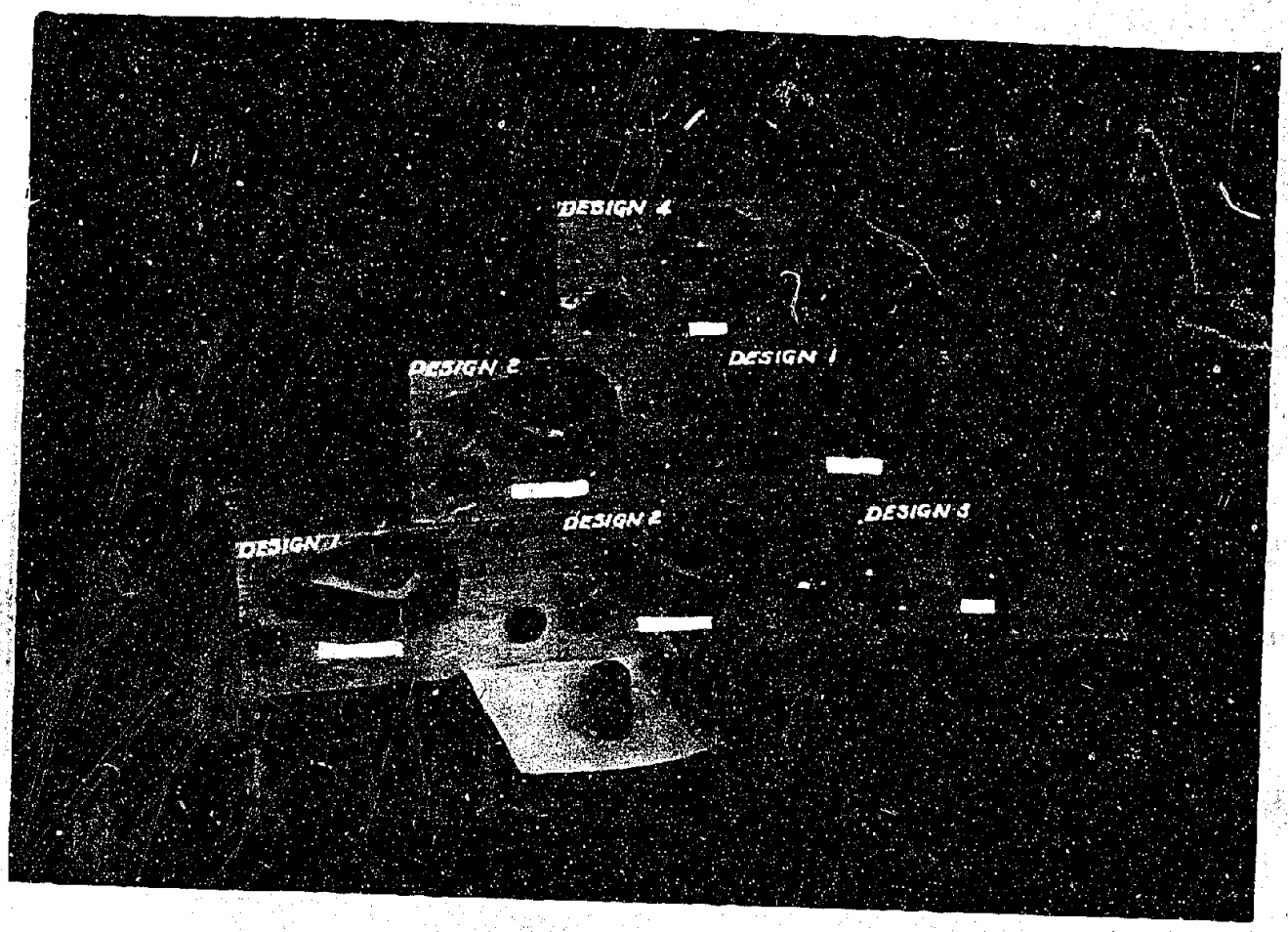
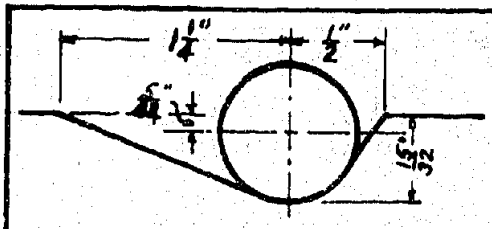
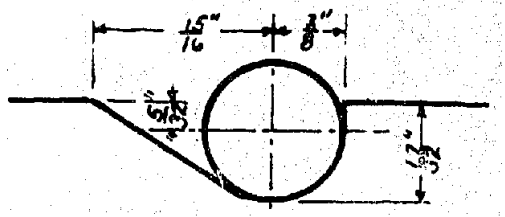
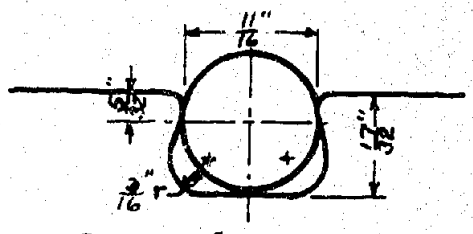
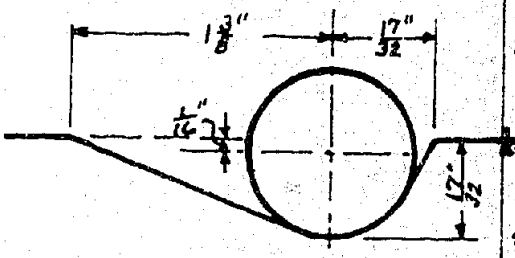
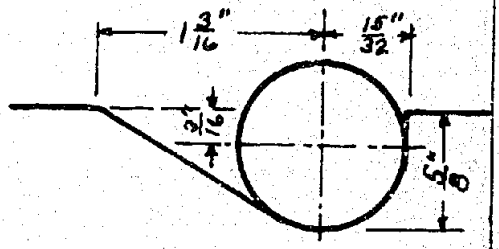
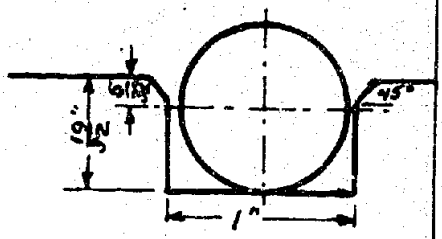


FIGURE 1 - GROOVE BLOCKS AND GASKET SPECIMEN USED IN TEST

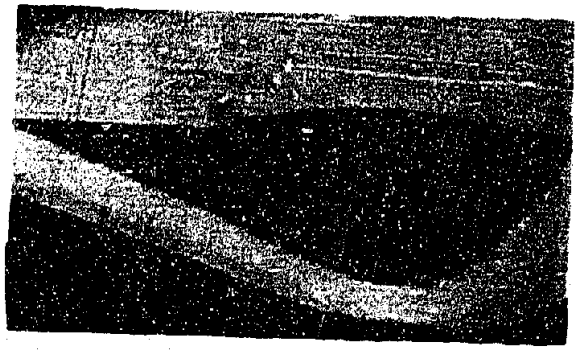
TABLE 2

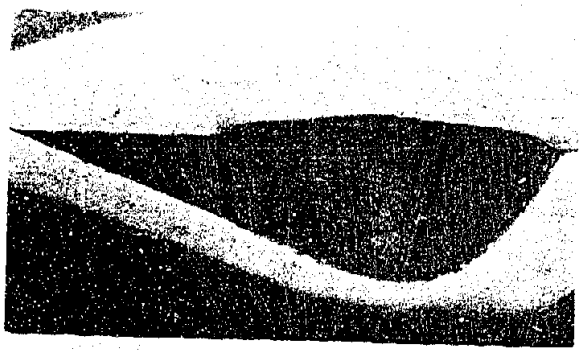
	(1) TYPE OF GASKET	(2) DURO. HARD. NO.	(3) GASKET DIA. IN INCHES	(4) AREA OF GROOVE	(5) AREA OF GASKET	(6) COL. 5/4 IN %	(7) LOAD LBS./ SQ. IN.
 DESIGN #1	(b) SOLID	65	.73	.439	.423	96.5	84
	(a) SOLID	45	.73	.439	.423	96.5	43
 DESIGN #2	(b) SOLID	65	.73	.457	.423	92.6	63
	(a) SOLID	45	.73	.457	.423	92.6	32
 DESIGN #3	(b) SOLID	65	.73	.397	.423	106.0	43
	(a) SOLID	45	.73	.397	.423	106.0	23
 DESIGN #1	(c) SOLID	45	.91	.668	.645	96.5	100
	(d) 1/4"HOLE	45	.91	.668	.596	89.2	50
	(e) 1/8"HOLE	45	.91	.668	.449	67.2	20
 DESIGN #2	(c) SOLID	45	.91	.697	.645	92.6	44
	(d) 1/4"HOLE	45	.91	.697	.596	85.5	20
	(e) 1/8"HOLE	45	.91	.697	.449	64.5	10
 DESIGN #4	(c) SOLID	45	.91	.609	.645	106.0	50
	(d) SOLID	45	.91	.609	.596	98.0	19
	(e) SOLID	45	.91	.609	.449	73.7	10

- PLATE 1 -

COMPRESSION OF SOLID RUBBER GASKETS
IN VARIOUS GROOVE DESIGNS

(.73" D.)

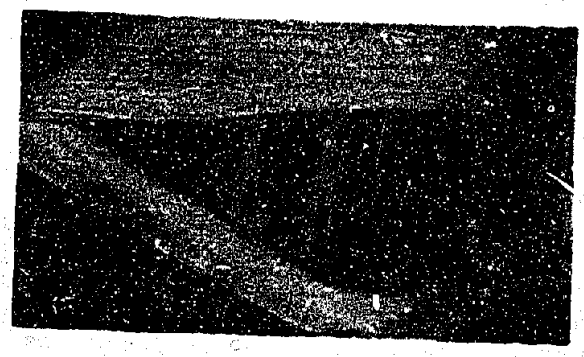


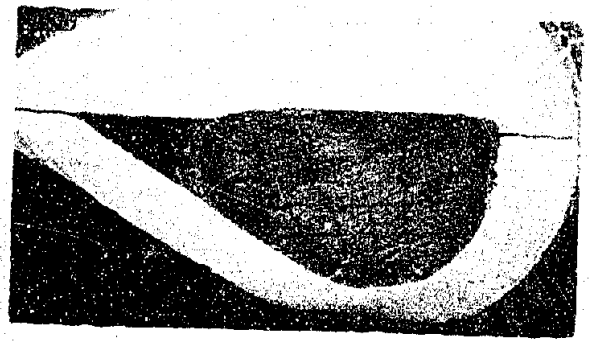


45 Duro. Hard. (a)

#1

65 Duro. Hard. (b)

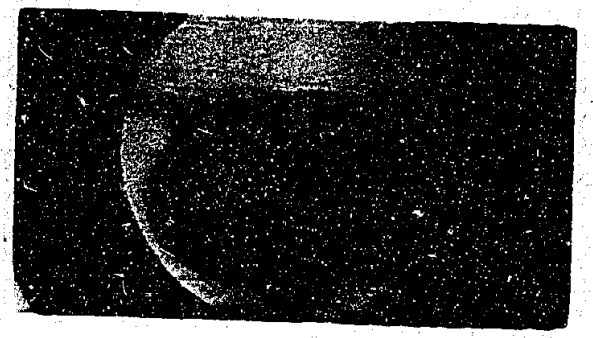


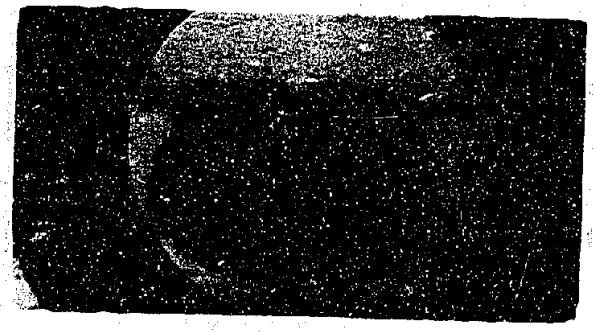


45 Duro. Hard. (a)

#2

65 Duro. Hard. (b)





45 Duro. Hard. (a)

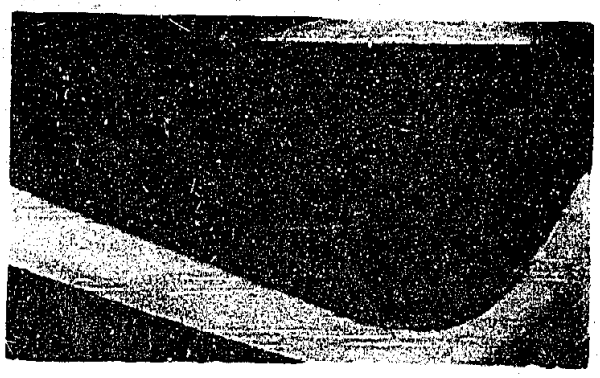
3

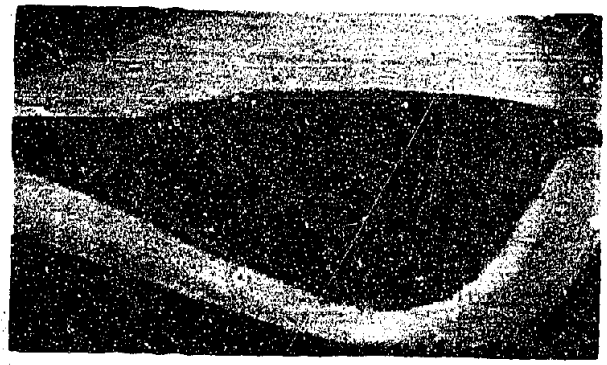
65 Duro. Hard. (b)

- PLATE 2 -

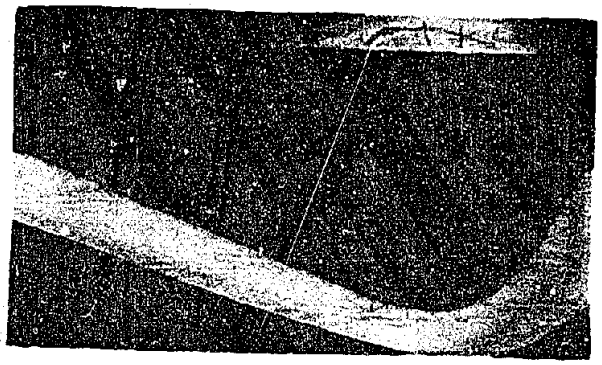
COMPRESSION OF VARIOUS TYPES GASKETS
IN GROOVE DESIGN - #1

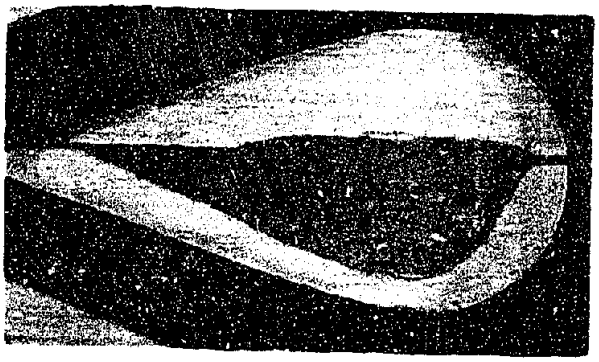
(45 Duro. Hardness .91"O.D.)



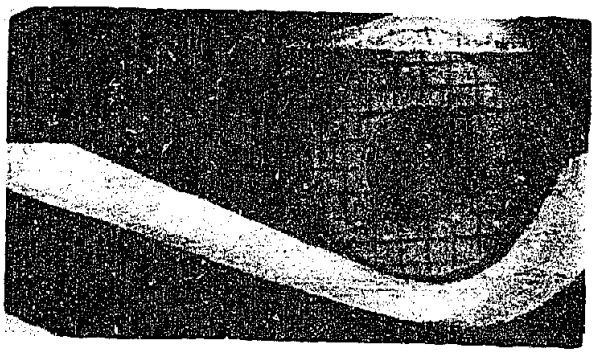


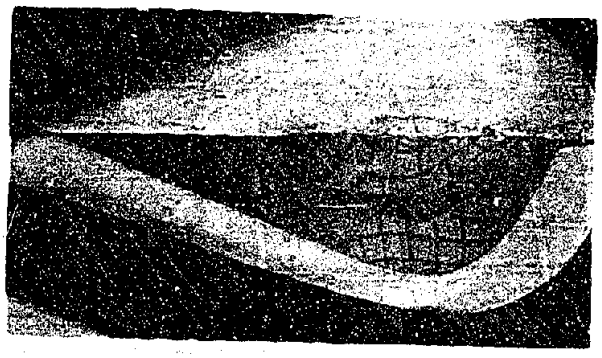
SOLID RUBBER GASKET (c)





$\frac{1}{4}$" HOLE CENTER OF GASKET(d)



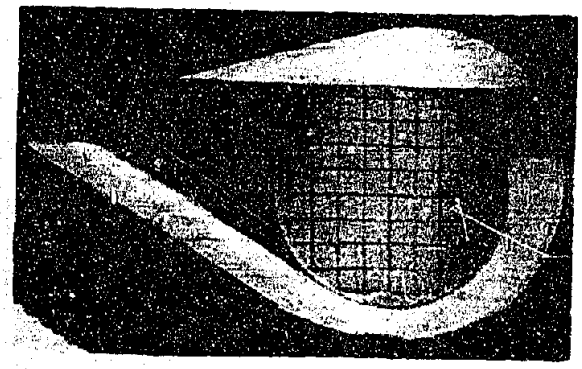


$\frac{1}{2}$" HOLE CENTER OF GASKET (e)

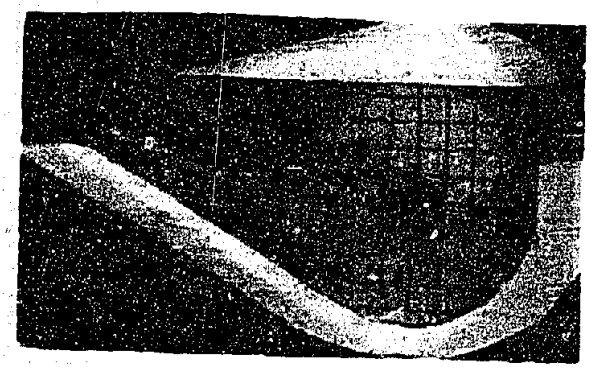
- PLATE 3 -

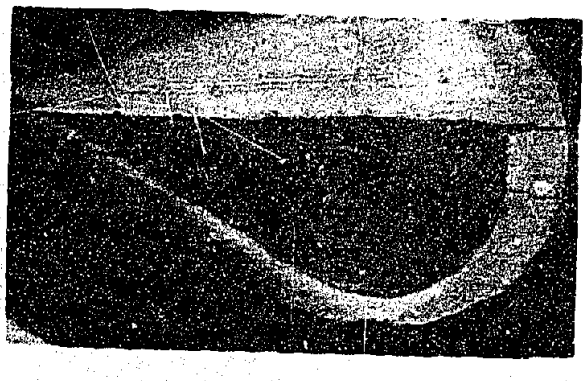
COMPRESSION OF VARIOUS TYPES GASKETS
IN GROOVE DESIGN - #2

(45 Duro. Hardness .91"O.D.)

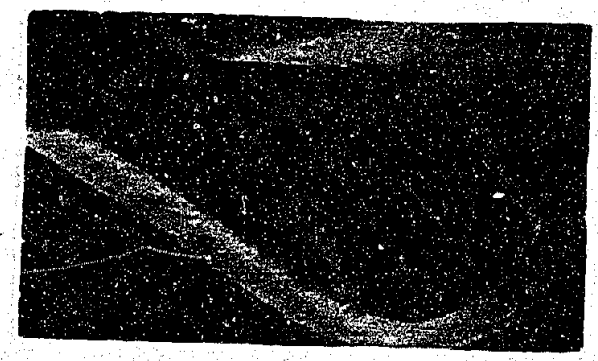


SOLID RUBBER GASKET (c)





$\frac{1}{4}$" HOLE CENTER OF GASKET (d)

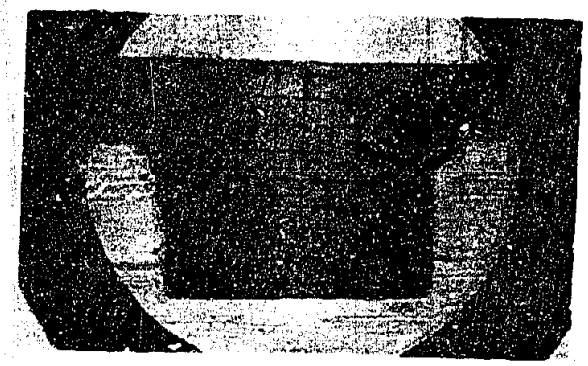


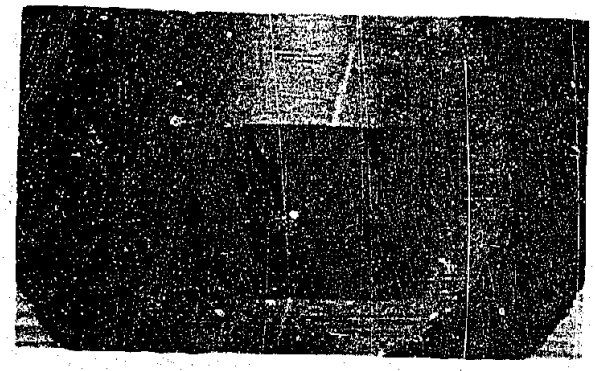
$\frac{1}{2}$" HOLE CENTER OF GASKET (e)

- PLATE 4 -

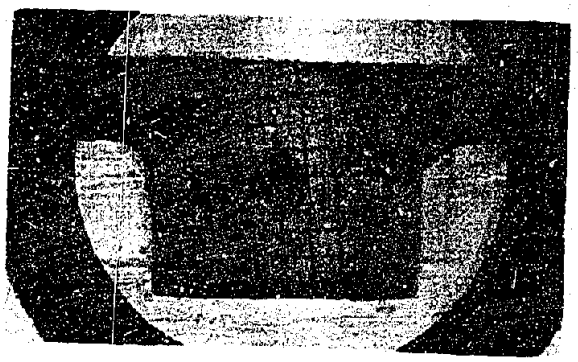
COMPRESSION OF VARIOUS TYPES GASKETS
IN GROOVE DESIGN - #4

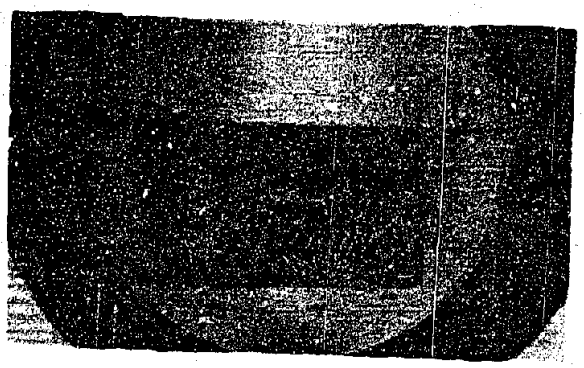
(45 Duro. Hardness .91"O.D.)



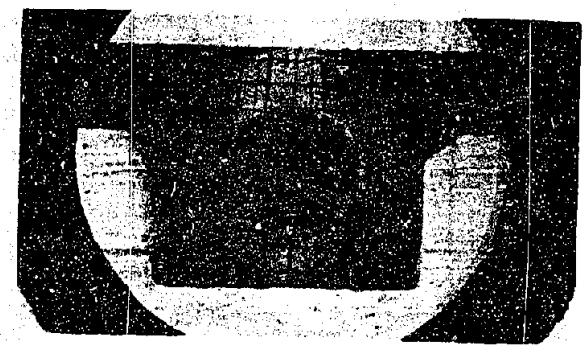


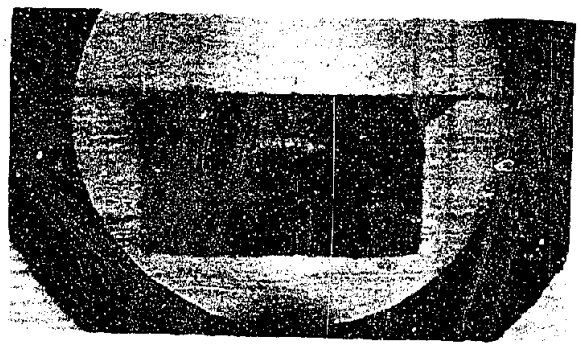
SOLID RUBBER GASKET (c)





$\frac{1}{4}$" HOLE CENTER OF GASKET (d)





$\frac{1}{2}$" HOLE CENTER OF GASKET (e)