WADC TECHNICAL REPORT 55-163

TESTING OF METAL BOSS SEALS

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Aircraft Equipment Testing Company

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Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

FOREWORD

The work described in this report was accomplished by the Aircraft Equipment Testing Company, Baltimore, Maryland for the Wright Air Development Center, Wright Patterson Air Force Base, Ohio as authorized by Contract No. AF 33(600)-26548, Metal Boss Seals, Project No. 1371, Aircraft Hydraulic Systems, Task No. 13495, Hydraulic Seal Development, dated 22 December 1953. This contract was administered under the direction of Mr. C. B. Yount of the Aircraft Laboratory, Directorate of Laboratories, WADC.

Chief responsibility for the conduct of this program was assigned to Mr. Harry P. Kupiec. Others who contributed to this project were Mr. Leo J. Skalinski and Mr. Irvin W. Knowles of the Aircraft Equipment Testing Company.

ABSTRACT

The metal boss seal was conceived by Wright Air Development Center to meet the requirements of hydraulic and pneumatic systems with operating pressures up to 5,000 psi, and temperatures as low as -100°F. and as high as 600°F. Basic development on the seal was accomplished by Wright Air Development Center. Further development work and testing of the seal were performed by the Aircraft Equipment Testing Company. The application of the metal boss seal involves the use of deformable metal ring in conjunction with standard AN hydraulic fittings with AND10056 or AND10057 fitting ends in standard AND10050 bosses. It is concluded that the metal boss seal possesses the desirable characteristics for a boss seal as indicated by tests conducted on size -5, -8, and -12. The metal boss seal is considered relatively simple and reliable. With proper choice of material, it is possible that this seal design may be suitable for operating temperatures above 600°F. This seal is being considered as a replacement for the current standard AN 6290 synthetic rubber gasket.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

for Carl A. Rechnitz

D. D. McKee
Colonel, USAF
Chief, Aircraft Laboratory
Directorate of Laboratories

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INTRODUCTION

Laboratory experience has indicated that the present AND10050 Boss, in combination with AND10057 or AND10056 fitting end and an AN gasket, is not satisfactory for use in high pressure pneumatic systems and at -65°F. It is anticipated that future requirements of the services will include a static seal suitable for the use at 5000 psi operating pressure and at temperatures lower than -65°F. and in excess of +160°F.

This testing program deals with the testing of a metallic seal, and is based on a contract received by the Aircraft Equipment Testing Company from the Department of Defense, United States Air Force, Headquarters, W.A.D.C., Wright-Patterson Air Force Base, Ohio. This contract is not classified and bears the number AF 33(600)-26548. The initiator was Mr. S. Prete, WCLSM-2 and the Buyer Mr. J. L. Moore, MCPPRF-1. The contract is dated 22 December 1953. This testing and research program started with a W.A.D.C. design which involves the use of a deformable metal packing in conjunction with present standard AN hydraulic fittings with AND10056 or AND10057 fitting ends in standard AND10050 bosses as outlined by W.A.D.C. drawings S53A50, S53A51, S3A52 and S53C47.

The contractor was to determine the most suitable material and the practical limit of tolerances which can be applied to the deformable metal packings proposed by W.A.D.C. and a practical manufacturing method which could be used on a production basis. This program covers fitting sizes -5, -8, and -12.

CONCLUSIONS

1. The rings of final design satisfactorily passed all tests specified by Exhibit A, and as described by this report.

2. The final design for the metallic seals is shown on Sketch #25 in the back part of this report.

3. The most suitable material for use in the manufacture of these rings was found to be cold rolled steel, bar stock, Grade 1020. Rings made of tube stock did not perform as well as those made from bar stock.

4. Seals made of stainless steel did not perform satisfactorily.

5. Lubrication was found to be necessary during the preforming of the metal seals before actual installation. Ordinary petroleum base mineral oil was found to be satisfactory for this purpose.

RECOMMENDATIONS

1. In view of the successful performance of the sizes covered by this report, it is recommended that sizes -4, -6, -10 and -16 be tested also.

2. It is recommended that materials other than those specified be investigated.

3. Although the surface finish is specified as 32 micro-inches on the final design, it is recommended that possible use of rougher finishes be explored.

4. It is recommended that use of the seals for other fluids, such as fuels and other hydraulic fluids be explored.

5. It is recommended that some investigations be made into the possibility of eliminating the presetting operation.

6. It is recommended that specific investigation be made into the minimum torques required for successful performance.

7. Although the presetting tools used in this investigation were not hardened, it is believed that hardening may increase the life of the tool.

8. The torque values for the presetting operation should be studied.

S E C T I O N I

DESCRIPTION OF TESTS AND TEST RESULTS

DESCRIPTION OF TESTS AND TEST RESULTS

1. SAMPLES

The three fitting sizes to be tested are -5, -8, and -12. Eight samples fabricated to maximum tolerances and eight samples fabricated to minimum tolerances of each size were tested with air and hydraulic fluids. The samples of the WADC design included both AND10056 and AND10057 fitting ends.

All designs were tested in test manifolds with maximum and minimum tolerance bosses for operation at 5000 psi using hydraulic fluid MIL-O-5606 and air. Sixteen samples of each size were fabricated. Drawings of the samples used and the manifolds used during this test are shown on Pages 34 through 55.

2. PNEUMATIC TESTING OF SEALS

The seals were tested under a proof pressure of 10,000 psi using air for 5 minutes at room temperature. There was no leakage, failure, extrusion, or permanent distortion. Leakage is defined as air bubbles forming on or rising from the fitting assembly any time after the first 5 seconds of the air pressure application. There was no indication of bubbles during this test.

3. LOW TEMPERATURE TESTS

All the fitting assemblies were cold soaked at -65°F. for a period of 24 hours. The assemblies were cycled with dry air at -65°F. from zero to 5000 psi for 2500 cycles. Temperature of the air in the manifold was no higher then -65°F. during the cycling test.

The samples were tested for leakage at -65°F. for two minutes at the following pressures: 10, 100, 1000, 3000, and 10,000 psi. There was no leakage as defined by this report.

The room temperature proof pressure test was repeated, without any evidence of leakage.

4. POSITIONING TEST

The positioning test was conducted using an AND10057 end in the following manner:

a. Fitting was installed in the manifold according to standard procedure, as specified in presetting and installation instructions on Sketch #23 & 24

b. Five thousand psi minimum pressure was applied using air. No leakage was detected.

c. The test circuit was depressurized and the fitting was loosened and the position was changed so that the metal seal bit into the fitting at a new location approximately 1/32 inches from the original location.

d. The fitting was tightened and the pressure test was repeated. At least three position changes from the original location were selected. Pressure was applied at each position. This test was conducted on 6 maximum and 6 minimum tolerance assemblies of each size. The bosses and fittings were combined to provide the following tolerance combinations: Low to low, high to high, and high to low. The seals were selected at random.

5. HYDRAULIC TESTING

The assemblies were proof pressure tested using MIL-O-5606 hydraulic fluid for 5 minutes with 10,000 psi hydraulic pressure. There was no leakage, failure, extrusion, or permanent distortion of the seal as a result of this pressure test.

6. IMPULSE TEST (AND10056 and AND10057)

The impulse test was conducted at room temperature maintaining fluid temperature between 70 and 100°F. Two hundred thousand impulse cycles were

applied through the assemblies at the rate of 60 cycles per minute. Each impulse cycle was composed of a rise in pressure of zero to 5000 psi with a 7500 psi pressure peak and dropping pressure to zero. There was no leakage during the impulse test. During the impulse test the fittings were vibrated at a rate of 1750 cycles per minute with a total amplitude of 1/4 inch during the first 86,400 cycles, and a total amplitude of 1/8 inch during the last 115,200 cycles of the test. Vibratory motion was circular. (Sketch # 26) The data for the vibration and impulse test are shown on Data Sheet #18.

7. LOW TEMPERATURE TEST (AND10056 and AND10057)

All the fitting assemblies were cold soaked at -65°F. for a period of 24 hours using MIL-O-5606 hydraulic fluid. The samples were impulse tested using a cycling rate of 40 cycles per minute for 8 hours at -65°F. The temperature of the fluid in the manifold was at no time higher than -60°F. during the cycling. There was no evidence of leakage.

The samples were then tested for leakage at -65°F. for two minutes at following hydraulic pressures: 10, 100, 1000, 3000, and 10,000 psi. There was no leakage at any time during this test.

This same proof pressure test was repeated at room temperature. There was no leakage. Data for these tests are shown on Data Sheet #1, #2 and #3.

8. REPEATED ASSEMBLY TEST

The assembly test outlined in Specification MIL-F-5506 was used to conduct the repeated assembly test. The fitting assemblies were tightened 15 successive times using the minimum tightening torque recommended for the fittings being tested. In this case the fittings, bosses, and rings were made of steel, therefor the following torques were used:

Seal Size	Minimum Torque Inch Pounds	Maximum Torque Inch Pounds	Overtightening Torque Inch Pounds
-5-	180	200	240
-8	450	500	600
-12	900	1000	1200

These maximum and minimum torques were obtained from Data Sheet AND10064 bearing the latest change date of June 14, 1951. The overtightening value was obtained from Specification MIL-F-5506A dated October 15, 1952 which specifies overtightening values to be 1 1/3 times the minimum value listed. Each tightening operation included a complete removal of the fitting from the boss. After each third tightening operation, fitting assemblies were subjected to a fluid pressure of two times the working pressure and held for five minutes.

This test was conducted using hydraulic fluid MIL-O-5606. There was no leakage of the fitting assemblies when subjected to these pressures. At no Time during the 15 tightening operations were the assemblies difficult to assemble or disassemble. After the 15 tightening operations there was no leakage or blowoff of the fitting assemblies up to the value of 10,000 psi.

There was no evidence of leakage when the minimum or overtightening torque values were used.

9. HIGH TEMPERATURE TEST

The static leakage test was then applied at 5000 psi at 400°F. for five minutes using MIL-O-5606 hydraulic fluid. There was no evidence of leakage. At the completion of this test 50% of the fittings were subjected to 550°F. without showing any evidence of leakage. The torque values used for this test were 20 foot pounds for the -5 size, 50 foot pounds for the -8 size, and 100 foot pounds for the -12 size. These torque values shall not be construed as recommended or required torques for high temperature. They simply represent the actual values used in this particular test.

10. BURST TEST

Fifty per cent of the samples were subjected to a burst test consisting of the application of 20,000 psi hydraulic burst pressure at room temperature at a maximum rate of 25,000 psi per minute. There was no rupture of parts or blowout of the metal seal.

TEST EQUIPMENT USED

1. Pump: Denison, 5000 psi, 14.5 gpm, driven by 40 hp electric motor.
2. Reservoir: 100 gallon tank, water-cooled.
3. Fluid: MIL-O-5606 Hydraulic Fluid
4. Hydrauliscope: Aeroquip
5. Solenoid Valve: double solenoid, closed center, 3/4" size, Denison.
6. Timer: Wilson, electronic with adjustable "on" and "off" time to produce necessary speed and impulse peaks for cycling.
7. Vibrator: Designed and built by Aetco. Shown in Photograph #8.
8. Temperature Cabinet: Capacity 550°F.
9. Temperature Cabinet: Capacity - 90°f. - shown in Photograph #8.
10. Gauges: Calibrated before start of test.
11. Thermocouple: Tag Celectray - 1/4 of 1% accuracy.
12. Miscellaneous: Tubing, fittings, handpumps. needle valves, unloader.

DATA SHEET #1

AIR LEAKAGE TEST AT -65°F.

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time
1	High	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min
2	High	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
3	High	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
4	High	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
5	Low	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
6	Low	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
7	Low	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
8	Low	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
25	Low	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
26	Low	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
27	Low	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
28	Low	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
29	High	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
30	High	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
31	High	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "
32	High	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 "

All of the samples listed above are -5 fittings and were tested at -65°F and at the pressures and time listed above with no signs of leakage.
These rings were made of 1020 bar stock.
Torque value used for this test was 20 ft. lbs.

DATA SHEET #2

AIR LEAKAGE TEST AT -65°F.

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time
9	High	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
10	High	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
11	High	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
12	High	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
13	Low	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
14	Low	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
15	Low	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
16	Low	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
33	Low	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
34	Low	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
35	Low	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
36	Low	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
37	High	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
38	High	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
39	High	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
40	High	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.

All of the samples listed above are -8 fittings and were tested at -65°F. and at the pressures and time listed above with no signs of leakage.

These rings were made of 1020 bar stock. Torque value used for this test was 50 ft. lbs.

DATA SHEET #3

AIR LEAKAGE TEST AT -65°F.

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time	Pressure PSI	Time
17	High	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min
18	High	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
19	High	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
20	High	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
21	Low	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
22	Low	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
23	Low	AND10056	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
24	Low	AND10056	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
41	High	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
42	High	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
43	High	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
44	High	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
45	Low	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
46	Low	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
47	Low	AND10057	High	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.
48	Low	AND10057	Low	10	5 min.	100	5 min.	1000	5 min.	3000	5 min.	10,000	5 min.

All of the samples listed above are -12 fittings and were tested at -65°F. and at the pressure and time listed above with no signs of leakage.

These rings were made of 1020 bar stock.

Torque value used for this test was 200 ft. lbs.

DATA SHEET #4

REPEAT PROOF PRESSURE AT ROOM TEMPERATURE WITH AIR

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Ring Inches	Torque In Ft. Lbs.	Air Press. PSI	Time	Fitting Size
1	High	AND10056	High	.100	20	10,000	5 min.	-5
2	High	AND10056	Low	.104	20	10,000	5 min.	-5
3	High	AND10056	Low	.105	20	10,000	5 min.	-5
4	High	AND10056	High	.108	20	10,000	5 min.	-5
5	Low	AND10056	Low	.104	20	10,000	5 min.	-5
6	Low	AND10056	Low	.100	20	10,000	5 min.	-5
7	Low	AND10056	High	.104	20	10,000	5 min.	-5
8	Low	AND10056	High	.102	20	10,000	5 min.	-5
25	Low	AND10057	Low	.104	20	10,000	5 min.	-5
26	Low	AND10057	Low	.102	20	10,000	5 min.	-5
27	Low	AND10057	High	.104	20	10,000	5 min.	-5
28	Low	AND10057	High	.104	20	10,000	5 min.	-5
29	High	AND10057	High	.100	20	10,000	5 min.	-5
30	High	AND10057	Low	.107	20	10,000	5 min.	-5
31	High	AND10057	Low	.112	20	10,000	5 min.	-5
32	High	AND10057	High	.108	20	10,000	5 min.	-5

The above samples were proof pressure tested in a manifold with 8 high tolerances and 8 low tolerance bosses as listed above.
No leakage was observed. These rings were made of 1020 bar stock.

DATA SHEET #5

REPEAT PROOF PRESSURE AT ROOM TEMPERATURE WITH AIR

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Ring Inches	Torque In Ft. Lbs.	Air Pressure PSI	Time	Fitting Size
9	High	AND10056	High	.130	50	10,000	5 min.	-8
10	High	AND10056	Low	.134	50	10,000	5 min.	-8
11	High	AND10056	Low	.129	50	10,000	5 min.	-8
12	High	AND10056	High	.128	50	10,000	5 min.	-8
13	Low	AND10056	Low	.128	50	10,000	5 min.	-8
14	Low	AND10056	High	.128	50	10,000	5 min.	-8
15	Low	AND10056	Low	.126	50	10,000	5 min.	-8
16	Low	AND10056	High	.130	50	10,000	5 min.	-8
33	Low	AND10057	Low	.127	50	10,000	5 min.	-8
34	Low	AND10057	High	.126	50	10,000	5 min.	-8
35	Low	AND10057	Low	.130	50	10,000	5 min.	-8
36	Low	AND10057	High	.127	50	10,000	5 min.	-8
37	High	AND10057	High	.123	50	10,000	5 min.	-8
38	High	AND10057	Low	.127	50	10,000	5 min.	-8
39	High	AND10057	Low	.128	50	10,000	5 min.	-8
40	High	AND10057	High	.129	50	10,000	5 min.	-8

The above samples were proof pressure tested in a manifold with 8 high tolerance and 8 low tolerance bosses as listed above.

These rings were made of 1020 bar stock. No leakage was observed.

DATA SHEET #6

REPEAT PROOF PRESSURE AT ROOM TEMPERATURE WITH AIR

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Ring Inches	Torque In Ft. Lbs.	Air Pressure PSI	Time	Fitting Size
17	High	AND10056	Low	.164	100	10,000	5 min.	-12
18	High	AND10056	High	.159	100	10,000	5 min.	-12
19	High	AND10056	Low	.159	100	10,000	5 min.	-12
20	High	AND10056	High	.157	100	10,000	5 min.	-12
21	Low	AND10056	High	.158	100	10,000	5 min.	-12
22	Low	AND10056	Low	.159	100	10,000	5 min.	-12
23	Low	AND10056	Low	.155	100	10,000	5 min.	-12
24	Low	AND10056	High	.158	100	10,000	5 min.	-12
41	High	AND10057	Low	.164	100	10,000	5 min.	-12
42	High	AND10057	High	.155	100	10,000	5 min.	-12
43	High	AND10057	Low	.165	100	10,000	5 min.	-12
44	High	AND10057	High	.156	100	10,000	5 min.	-12
45	Low	AND10057	High	.166	100	10,000	5 min.	-12
46	Low	AND10057	Low	.158	100	10,000	5 min.	-12
47	Low	AND10057	High	.158	100	10,000	5 min.	-12
48	Low	AND10057	Low	.163	100	10,000	5 min.	-12

The above samples were proof pressure tested in a manifold with 8 high tolerance and 8 low tolerance bosses as listed above.

These rings were made of 1020 bar stock. No leakage was observed.

DATA SHEET # 7

POSITIONING TEST

ROOM TEMPERATURE

Seal Sample No.	Fitting Tolerance	Fitting End	Boss Tolerance	Air Pressure PSI	Time	Fitting
25	Low	AND10057	Low	5000	5 min.	-5
26	Low	AND10057	Low	5000	5 "	-5
27	Low	AND10057	High	5000	5 "	-5
28	Low	AND10057	High	5000	5 "	-5
29	High	AND10057	High	5000	5 "	-5
30	High	AND10057	Low	5000	5 "	-5
31	High	AND10057	Low	5000	5 "	-5
32	High	AND10057	High	5000	5 "	-5
33	Low	AND10057	Low	5000	5 "	-8
34	Low	AND10057	High	5000	5 "	-8
35	Low	AND10057	Low	5000	5 "	-8
36	Low	AND10057	High	5000	5 "	-8
37	High	AND10057	High	5000	5 "	-8
38	High	AND10057	Low	5000	5 "	-8
39	High	AND10057	Low	5000	5 "	-8
40	High	AND10057	High	5000	5 "	-8
41	High	AND10057	Low	5000	5 "	-12
42	High	AND10057	High	5000	5 "	-12
43	High	AND10057	Low	5000	5 "	-12
44	High	AND10057	High	5000	5 "	-12
45	Low	AND10057	High	5000	5 "	-12
46	Low	AND10057	Low	5000	5 "	-12
47	Low	AND10057	High	5000	5 "	-12
48	Low	AND10057	Low	5000	5 "	-12

The above fittings were tried in 6 different positions.
These rings were made of 1020 bar stock.
No leakage was observed.

DATA SHEET #8

PROOF PRESSURE WITH HYDRAULIC FLUID

ROOM TEMPERATURE

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Rings Inches	Torque In Ft. Lb.	Hydraulic Pressure	Time	Fitting Size
29	High	AND10057	High	.100	20	10,000	5 min.	-5
28	Low	AND10057	High	.104	20	10,000	5 min.	-5
1	High	AND10056	High	.100	20	10,000	5 min.	-5
8	Low	AND10056	High	.102	20	10,000	5 min.	-5
26	Low	AND10057	Low	.102	20	10,000	5 min.	-5
6	Low	AND10056	Low	.100	20	10,000	5 min.	-5
2	High	AND10056	Low	.104	20	10,000	5 min.	-5
30	High	AND10057	Low	.107	20	10,000	5 min.	-5

The above samples were proof tested individually in a high and a low tolerance block as listed above.

Sample #8 and #6: The metallic ring did not clear allof the last thread on the fitting. The ring formed over the last part of the last thread.

7	Low	AND10056	High	.104	20	10,000	5 min.	-5
5	Low	AND10056	Low	.104	20	10,000	5 min.	-5
4	High	AND10056	High	.108	20	10,000	5 min.	-5
3	High	AND10056	Low	.105	20	10,000	5 min.	-5
25	Low	AND10057	Low	.104	20	10,000	5 min.	-5
27	Low	AND10057	High	.104	20	10,000	5 min.	-5
31	High	AND10057	Low	.112	20	10,000	5 min.	-5
32	High	AND10057	High	.108	20	10,000	5 min.	-5

The above samples were proof tested individually in a high and low tolerance block as listed above.

The thickness of the ring is the basic 0.108 dimension as shown on Sketch #4. These rings were made of 1020 bar stock.

SECTION II

INVESTIGATION OF

MATERIALS AND GEOMETRY

SECTION II

INVESTIGATION OF MATERIALS

Three materials were investigated during this program. They are as follows: (a) Stainless Steel, (b) 1020 Cold Drawn Steel Tubing, (c) 1020 Steel Bar Stock.

The stainless steel rings were found to be too hard to form properly and did not provide the satisfactory sealing arrangement even though the torques used were in excess of normal torque values as may be seen in the data shown on Data Sheet #8.

During the pneumatic proof pressure tests it was impossible to obtain pressures above 1300 psi due to excessive leakage.

After tightening the stainless steel rings, the fittings were removed and it was noted that the rings had flattened on one side more than on the other. The presetting was not uniform.

The rings made of 1020 steel tubing (cold drawn) were found to be unsatisfactory.

Early tests were conducted with the use of an eight-cavity manifold block using eight assemblies simultaneously. This procedure proved to be too complicated because it was difficult to determine the performance of each individual assembly. Therefore, single cavity blocks consisting of one standard boss in a block of steel were fabricated using both nominal dimensions as well as high and low tolerance dimensions. The tests performed on these different blocks are shown on the data sheets in Section II of this report.

When the rings made of 1020 steel bar stock were used satisfactory results were obtained. These rings were initially tested in individual single cavity blocks and then later in the multiple cavity manifolds. The successful tests showing performance of the multiple cavity manifolds are described in Section I of this report.

The contract specified that the contractor determine a suitable material. Inasmuch as 1020 bar stock was found to be satisfactory, no further investigation of materials was made.

GEOMETRY

When the first sample rings were made by Aetco, no special attention was given to the sharp edge. The rings with sharp edges worked satisfactorily on the AND10057 end of the sample fittings but did not work satisfactorily on the AND10056 end of the sample fittings. The rings were not presetting properly when used on the short end. After the sharp edge was broken as shown in the final design of the rings in Sketch #25, satisfactory operation was obtained on both the long and the short ends of the fitting.

During this investigation it was also found that lubrication was required in order to obtain uniform and proper presetting of the ring on the fitting. Consistent and satisfactory results were obtained after both the sharp edge was broken, and lubrication was added to the presetting procedure.

FABRICATION

The samples used during this testing program were manufactured on a South Bend Tool Room Precision Lathe. Each ring was machined separately from a piece of bar stock.

Early efforts using tubing proved unsuccessful. Discussions which were held with various representatives of several of the steel distributors in Baltimore did not reveal any significant reasons why 1020 cold drawn tubing did not produce as satisfactory a ring as did 1020 bar stock. The suggested explanation is the grain structure of the tubing, as a result of being drawn, is different than the grain structure of the 1020 bar stock.

Several discussions were also held with representatives of various machine shops both in Baltimore and in New York in regard to the methods used to fabricate these rings in quantities. It was generally agreed by everyone involved in these discussions that these parts should be made on automatic screw machines. The fact that bar stock has to be used in place of tubing does not exercise any particular hardship in setting up automatic screw machines. Some shops apparently prefer tubing but do not consider this a necessity. The use of bar stock apparently does not appreciably affect the price of the final product.

It was also generally agreed that the best procedure for breaking the sharp edge of the metal ring was to do this operation by placing the rings on a magnetic chuck and grinding the edges off. This process would also give excellent control for the thickness of the ring.

HEAT TREATMENT

Before any of the samples used in this testing and development program were heat-treated, it was discovered that satisfactory results were obtained without heat-treatment of the sharp edge. Therefore no investigation was made regarding methods of heat treatment. When the original design was formulated by Wright Air Development Center it was believed that heat treatment of the sharp edge would be required in order to obtain satisfactory results.

DATA SHEET #9

PROOF PRESSURE WITH AIR

ROOM TEMPERATURE

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Ring Inches	Torque Ft. Lbs.	Air Press.	Time	Fitting Size
37	High	AND10057	High	.123	50	10,000	5 min.	-8
38	High	AND10057	Low	.127	50	10,000	5 min.	-8
33	Low	AND10057	Low	.127	50	10,000	5 min.	-8
34	Low	AND10057	High	.126	50	10,000	5 min.	-8
9	High	AND10056	High	.130	50	10,000	5 min.	-8
10	High	AND10056	Low	.134	50	10,000	5 min.	-8
13	Low	AND10056	Low	.128	50	10,000	5 min.	-8
14	Low	AND10056	High	.128	50	10,000	5 min.	-8

The above samples were proof tested individually in a high and low tolerance block as listed above. No leakage was observed.

11	High	AND10056	Low	.129	50	10,000	5 min.	-8
12	High	AND10056	High	.128	50	10,000	5 min.	-8
15	Low	AND10056	Low	.126	50	10,000	5 min.	-8
16	Low	AND10056	High	.130	50	10,000	5 min.	-8
35	Low	AND10057	Low	.130	50	10,000	5 min.	-8
36	Low	AND10057	High	.127	50	10,000	5 min.	-8
39	High	AND10057	Low	.128	50	10,000	5 min.	-8
40	High	AND10057	High	.129	50	10,000	5 min.	-8

The above samples were proof tested individually in a high and low tolerance block as listed above. No leakage was observed. These seals were made of 1020 bar stock.

DATA SHEET #10

PROOF PRESSURE WITH AIR

ROOM TEMPERATURE

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Ring Inches	Torque Ft. Lbs.	Air Press.	Time	Fitting Size
21	Low	AND10056	High	.158	100	10,000	5 min.	-12
23	Low	AND10056	Low	.155	100	10,000	5 min.	-12
20	High	AND10056	High	.157	100	10,000	5 min.	-12
19	High	AND10056	Low	.159	100	10,000	5 min.	-12
47	Low	AND10057	High	.158	100	10,000	5 min.	-12
46	Low	AND10057	Low	.158	100	10,000	5 min.	-12
43	High	AND10057	Low	.165	100	10,000	5 min.	-12
42	High	AND10057	High	.155	100	10,000	5 min.	-12

The above samples were proof tested individually in a high and low tolerance (single cavity) block as listed above. No leakage was observed.

17	High	AND10056	Low	.164	100	10,000	5 min.	-12
18	High	AND10056	High	.159	100	10,000	5 min.	-12
22	Low	AND10056	Low	.159	100	10,000	5 min.	-12
24	Low	AND10056	High	.158	100	10,000	5 min.	-12
41	High	AND10057	Low	.164	100	10,000	5 min.	-12
44	Low	AND10057	High	.156	100	10,000	5 min.	-12
45	Low	AND10057	High	.166	100	10,000	5 min.	-12
48	Low	AND10057	Low	.163	100	10,000	5 min.	-12

The above samples were proof tested individually in a high and low tolerance (single cavity) block as listed above. No leakage was observed. All of the above rings were made of 1020 bar stock.

DATA SHEET #11

PROOF PRESSURE WITH HYDRAULIC FLUID

ROOM TEMPERATURE

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Rings Inches	Torque In Ft. Lb.	Hydraulic Pressure PSI	Time	Fitting Size
37	High	AND10057	High	.123	50	10,000	5 min.	-8
38	High	AND10057	Low	.127	50	10,000	5 min.	-8
33	Low	AND10057	Low	.127	50	10,000	5 min.	-8
34	Low	AND10057	High	.126	50	10,000	5 min.	-8
9	High	AND10056	High	.130	50	10,000	5 min.	-8
10	High	AND10056	Low	.134	50	10,000	5 min.	-8
13	Low	AND10056	Low	.128	50	10,000	5 min.	-8
14	Low	AND10056	High	.128	50	10,000	5 min.	-8

The above samples were proof **tested individually** in a high and low tolerance block as listed above.

11	High	AND10056	Low	.129	50	10,000	5 min.	-8
12	High	AND10056	High	.128	50	10,000	5 min.	-8
15	Low	AND10056	Low	.126	50	10,000	5 min.	-8
16	Low	AND10056	High	.130	50	10,000	5 min.	-8
35	Low	AND10057	Low	.130	50	10,000	5 min.	-8
36	Low	AND10057	High	.127	50	10,000	5 min.	-8
39	High	AND10057	Low	.128	50	10,000	5 min.	-8
40	High	AND10057	High	.129	50	10,000	5 min.	-8

The above samples were proof **tested individually** in a high and low tolerance block as listed above.

The thickness of the ring represents the basic 0.130 dimension as shown in Sketch #5.

These rings were made of 1020 bar stock.

DATA SHEET #12

PROOF PRESSURE WITH HYDRAULIC FLUID

ROOM TEMPERATURE

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Rings Inches	Torque In Ft. Lb.	Hydraulic Pressure PSI	Time	Fitting Size
21	Low	AND10056	High	.158	100	10,000	5 min.	-12
23	Low	AND10056	Low	.155	100	10,000	5 min.	-12
20	High	AND10056	High	.157	100	10,000	5 min.	-12
19	High	AND10056	Low	.159	100	10,000	5 min.	-12
47	Low	AND10057	High	.158	100	10,000	5 min.	-12
46	Low	AND10057	Low	.158	100	10,000	5 min.	-12
43	High	AND10057	Low	.165	100	10,000	5 min.	-12
42	High	AND10057	High	.155	100	10,000	5 min.	-12

The above samples were proof tested individually in a high and low tolerance block as listed above.

17	High	AND10056	Low	.164	100	10,000	5 min.	-12
18	High	AND10056	High	.159	100	10,000	5 min.	-12
22	Low	AND10056	Low	.159	100	10,000	5 min.	-12
24	Low	AND10056	High	.158	100	10,000	5 min.	-12
41	High	AND10057	Low	.164	100	10,000	5 min.	-12
44	High	AND10057	High	.156	100	10,000	5 min.	-12
45	Low	AND10057	High	.166	100	10,000	5 min.	-12
48	Low	AND10057	Low	.163	100	10,000	5 min.	-12

The above samples were proof tested individually in a high and low tolerance block as listed above.

The thickness represents the basic 0.161 dimension as shown on Sketch #6.

These rings were made of 1020 bar stock.

DATA SHEET #13

LIFE CYCLE TEST

Date	No. of Cycles Completed	Cyclic Rate	Fluid Temp.	Room Temp.	Vibration	Operating Pressure PSI	Pressure Peaks PSI
9/28/54	7200	60 cpm	100°F	75°F	1/4" amplitude	0 to 5000 psi	7500 psi
9/29	12,600	60 cpm	102	77	1/4" "	0 to 5000 psi	7500 psi
9/30	23,400	60 cpm	99	76	1/4" "	0 to 5000 psi	7500 psi
10/1	30,600	60 cpm	100	75	1/4" "	0 to 5000 psi	7500 psi
10/2	35,100	60 cpm	98	77	1/4" "	0 to 5000 psi	7500 psi
10/4	46,800	60 cpm	100	79	1/4" "	0 to 5000 psi	7500 psi
10/5	61,200	60 cpm	101	77	1/4" "	0 to 5000 psi	7500 psi
10/6	70,200	60 cpm	99	78	1/4" "	0 to 5000 psi	7500 psi
10/7	80,900	60 cpm	100	76	1/4" "	0 to 5000 psi	7500 psi
10/8	86,300	60 cpm	100	79	1/4" "	0 to 5000 psi	7500 psi
1/27/55	122,300	60 cpm	100	77	1/8" "	0 to 5000 psi	7500 psi
1/28	158,300	60 cpm	100	79	1/8" "	0 to 5000 psi	7500 psi
1/29	201,500	60 cpm	99	76	1/8" "	0 to 5000 psi	7500 psi

The change in the amplitude was made because the flares on the tubes were cracking. After a conference with Wright Field it was decided to change the amplitude to 1/8" instead of 1/4" and a heavier wall tubing was used.

The samples were installed in a manifold with eight high tolerance bosses and eight low tolerance bosses, with the same combinations of seals, fittings, and manifold as listed on data sheets #4, 5, and 6.

No leakage or failures were observed.

DATA SHEET #14

PROOF PRESSURE WITH AIR

ROOM TEMPERATURE

Seal Sample No.	Pressure PSI	Torque	Size	Tolerance Fitting	Tolerance Boss	Fitting End
3	1300	35 Foot Lbs.	-5	Max.	Min.	AND10057
4	1300	35 " "	-5	Max.	Max.	AND10057
5	1300	35 " "	-5	Min.	Min.	AND10057
6	1300	35 " "	-5	Min.	Min.	AND10057
8	1300	35 " "	-5	Min.	Max.	AND10057
9	1300	65 " "	-8	Max.	Max.	AND10057
12	1300	65 " "	-8	Max.	Max.	AND10057
16	1300	65 " "	-8	Min.	Max.	AND10057
17	1300	105 " "	-12	Max.	Min.	AND10057
21	1300	105 " "	-12	Min.	Max.	AND10057
22	1300	105 " "	-12	Min.	Min.	AND10057
23	1300	105 " "	-12	Min.	Min.	AND10057
35	1300	65 " "	-8	Min.	Min.	AND10056
36	1300	65 " "	-8	Min.	Max.	AND10056
37	1300	65 " "	-8	Max.	Max.	AND10056
38	1300	65 " "	-8	Max.	Min.	AND10056
41	1300	105 " "	-12	Max.	Min.	AND10056
44	1300	105 " "	-12	Max.	Max.	AND10056
46	1300	105 " "	-12	Min.	Min.	AND10056
48	1300	105 " "	-12	Min.	Min.	AND10056

Note: This test was conducted using stainless steel seals. These rings leaked so badly it was impossible to get pressure any higher than 1300 psi.

Chemical Analysis for Stainless Steel Tubing:

Heat	20284	Ni.	10.89
Carbon	.058		
Mang.	1.66		
Phos.	.025		
Sul.	.006		
Sil.	.35		
Cr.	18.66		

DATA SHEET #15

PROOF TEST (HYDRAULIC)

Seal Sample No.	Fitting Size	Tolerance Fitting	Fitting End	Pressure PSI	Time
1	5/16 Inches	Maximum	AND10057	10,000	5 min.
2	5/16 "	Maximum	AND10057	10,000	5 min.
3	5/16 "	Maximum	AND10057	10,000	5 min.
4	5/16 "	Maximum	AND10057	10,000	5 min.
5	5/16 "	Maximum	AND10057	10,000	5 min.
6	5/16 "	Minimum	AND10057	10,000	5 min.
7	5/16 "	Minimum	AND10057	10,000	5 min.
8	5/16 "	Minimum	AND10057	10,000	5 min.
9	1/2 "	Maximum	AND10057	10,000	5 min.
10	1/2 "	Maximum	AND10057	10,000	5 min.
11	1/2 "	Maximum	AND10057	10,000	5 min.
12	1/2 "	Maximum	AND10057	10,000	5 min.
13	1/2 "	Minimum	AND10057	10,000	5 min.
14	1/2 "	Minimum	AND10057	10,000	5 min.
15	1/2 "	Minimum	AND10057	10,000	5 min.
16	1/2 "	Minimum	AND10057	10,000	5 min.
17	3/4 "	Maximum	AND10057	10,000	5 min.
18	3/4 "	Maximum	AND10057	10,000	5 min.
19	3/4 "	Maximum	AND10057	10,000	5 min.
20	3/4 "	Maximum	AND10057	10,000	5 min.
21	3/4 "	Minimum	AND10057	10,000	5 min.
22	3/4 "	Minimum	AND10057	10,000	5 min.
23	3/4 "	Minimum	AND10057	10,000	5 min.
24	3/4 "	Minimum	AND10057	10,000	5 min.

Note: It will be seen that this data sheet covers the AND10057 fitting end only. At the time this test was conducted difficulty was encountered using the rings on the short end because of interference with the thread. This condition was cleared up later and satisfactory results were obtained on the short end as well as on the long end and the data for the short end are shown on Data Sheets # 8, 11, & 12.

These fittings were tested individually in single cavity blocks, with the bosses made to nominal (not high, not low) dimensions. Leakages were zero for all fittings and seals listed above. These rings were made of 1020 bar stock.

DATA SHEET #16

PROOF PRESSURE WITH AIR

ROOM TEMPERATURE

Seal Sample No.	Fitting Tol.	Fitting End	Boss Tol.	Thickness Of Ring Inches	Torque Ft. Lbs.	Air Press.	Time	Fitting Size
29	High	AND10057	High	.100	20	10,000	5 min.	-5
28	Low	AND10057	High	.104	20	10,000	5 min.	-5
1	High	AND10056	High	.100	20	10,000	5 min.	-5
8	Low	AND10056	High	.102	20	10,000	5 min.	-5
26	Low	AND10057	Low	.102	20	10,000	5 min.	-5
6	Low	AND10056	Low	.100	20	10,000	5 min.	-5
2	High	AND10056	Low	.104	20	10,000	5 min.	-5
30	High	AND10057	Low	.107	20	10,000	5 min.	-5

The above samples were tested individually in single cavity blocks. The bosses were made up to high and low tolerance dimensions.

Samples #8 and #6: The metallic ring did not clear all of the last thread on the fitting. The ring formed over the last part of the last thread.

7	Low	AND10056	High	.104	20	10,000	5 min.	-5
5	Low	AND10056	Low	.104	20	10,000	5 min.	-5
4	High	AND10056	High	.108	20	10, 000	5 min.	-5
3	High	AND10056	Low	.105	20	10,000	5 min.	-5
25	Low	AND10057	Low	.104	20	10,000	5 min.	-5
27	Low	AND10057	High	.104	20	10,000	5 min.	-5
31	High	AND10057	Low	.112	20	10,000	5 min.	-5
32	High	AND10057	High	.108	20	10,000	5 min.	-5

The above samples were tested individually in single cavity blocks. The bosses were made up to high and low tolerance dimensions. All rings listed were made of 1020 bar stock. No leakage was observed even though interferences were found after disassembly. Sharp edges were removed and lubricant was used on the preforming operation, thus clearing up the interference problem.

DATA SHEET #17

PROOF PRESSURE

AT

ROOM TEMPERATURE

Sample Fitting	Fitting End	Boss Tol.	Thickness Of Ring Inches	Torque	Hydraulic Pressure	Time	Air Press.	Time	Fitting
A	AND10056	Low	.102	20	10,000	5 min.	10,000	5 min.	-5
B	AND10056	High	.101	20	10,000	5 min.	10,000	5 min.	-5
C	AND10057	Low	.108	20	10,000	5 min.	10,000	5 min.	-5
D	AND10057	High	.104	20	10,000	5 min.	10,000	5 min.	-5
E	AND10056	Low	.125	50	10,000	5 min.	10,000	5 min.	-8
F	AND10056	High	.126	50	10,000	5 min.	10,000	5 min.	-8
G	AND10057	Low	.128	50	10,000	5 min.	10,000	5 min.	-8
H	AND10057	High	.130	50	10,000	5 min.	10,000	5 min.	-8
I	AND10056	Low	.156	100	10,000	5 min.	10,000	5 min.	-12
J	AND10056	High	.158	100	10,000	5 min.	10,000	5 min.	-12
K	AND10057	Low	.162	100	10,000	5 min.	10,000	5 min.	-12
L	AND10057	High	.160	100	10,000	5 min.	10,000	5 min.	-12

These rings were made of 1020 steel tubing.

The above samples were proof tested individually in a high and low tolerance single cavity block as listed above. The fittings used were regular AN bulkhead fittings. These rings did not form as well as the rings made of 1020 bar stock. They did not form into proper shape. Four rings were used on sample K fitting before it would hold pressure, and 3 rings were used on sample L fitting before it would hold pressure.

DATA SHEET #[illegible]

PROOF PRESSURE WITH HYDRAULIC FLUID

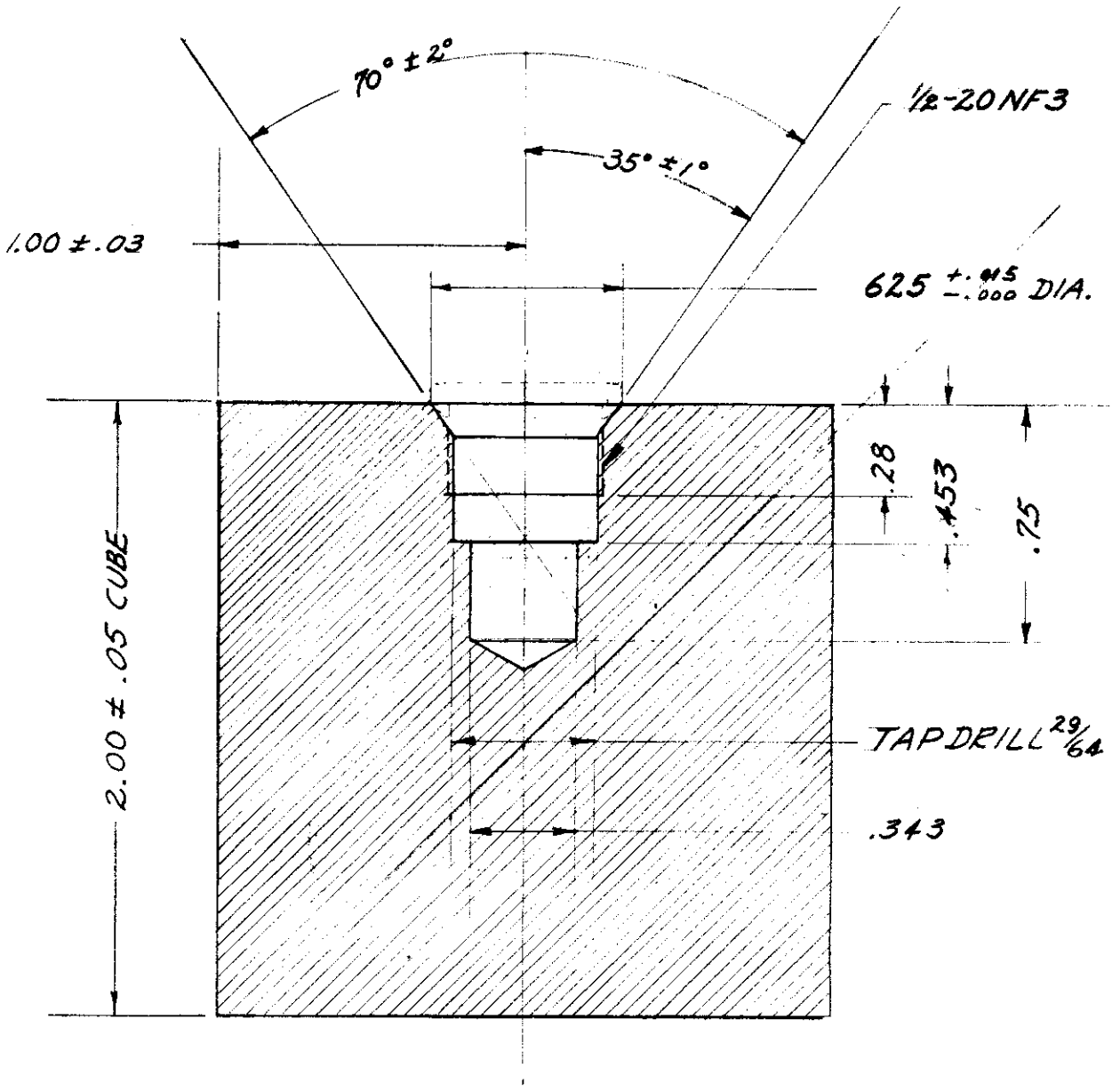
ROOM TEMPERATURE

Seal Sample No.	Pressure	Torque	Size	Tolerance	Fitting End
4	1000 PSI	35 Ft. Lb.	-5	Maximum	AND10057
12	1000 "	65 " "	-8	Maximum	AND10057
16	2000 "	65 " "	-8	Minimum	AND10057
17	5000 "	105 " "	-12	Maximum	AND10057
44	4000 "	105 " "	-12	Maximum	AND10056
48	6000 "	105 " "	-12	Minimum	AND10056

Leakage was excessive to raise pressure above 7000 psi.

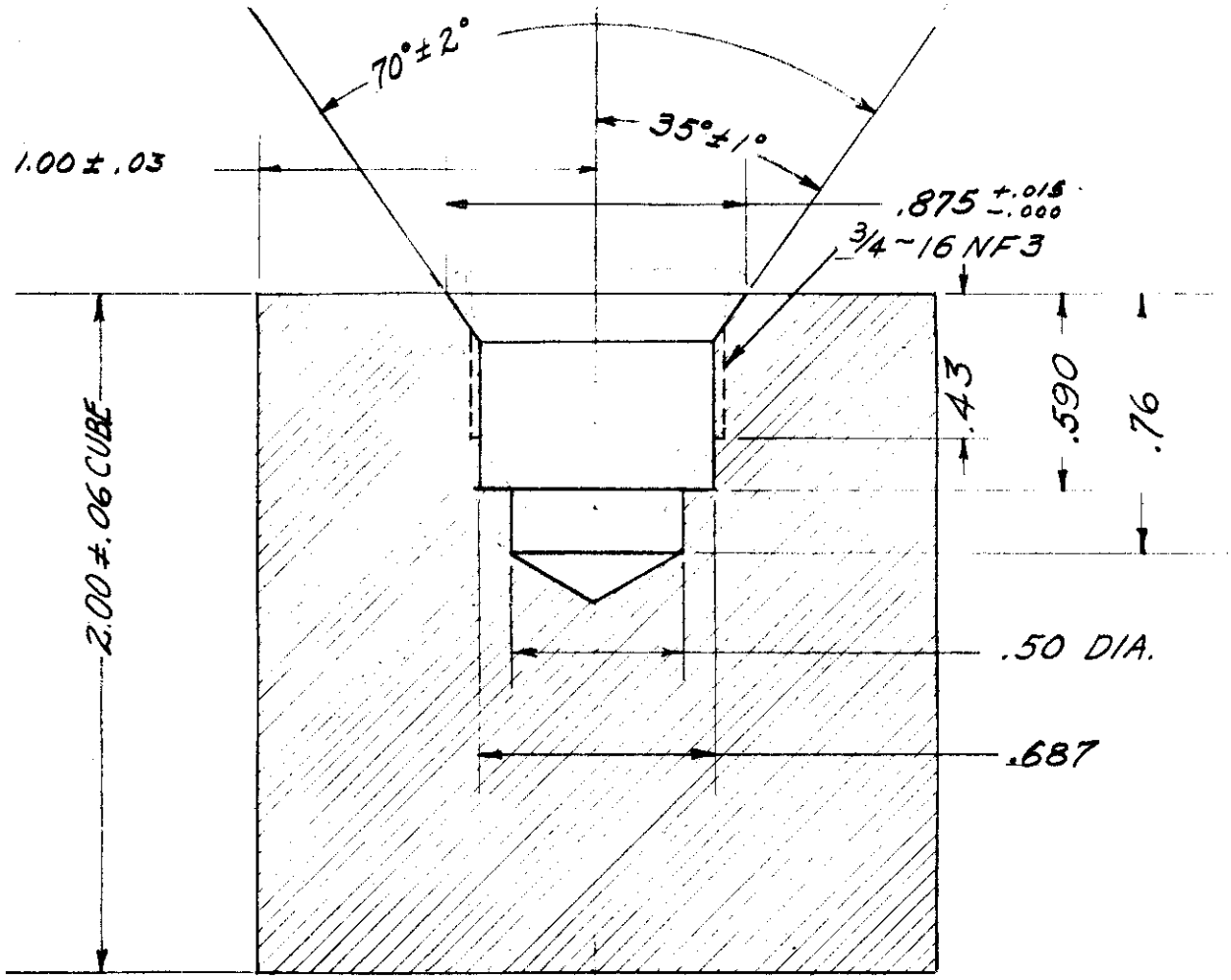
The above test was made with stainless steel rings. After changing to rings made of 1020 cold drawn bar stock the test was repeated with satisfactory results as shown on Data Sheets # 8 , #11, and #12.

Even with the use of the higher torque values, these assemblies leaked.



PRESETTING TOOL – 5/16 SIZE

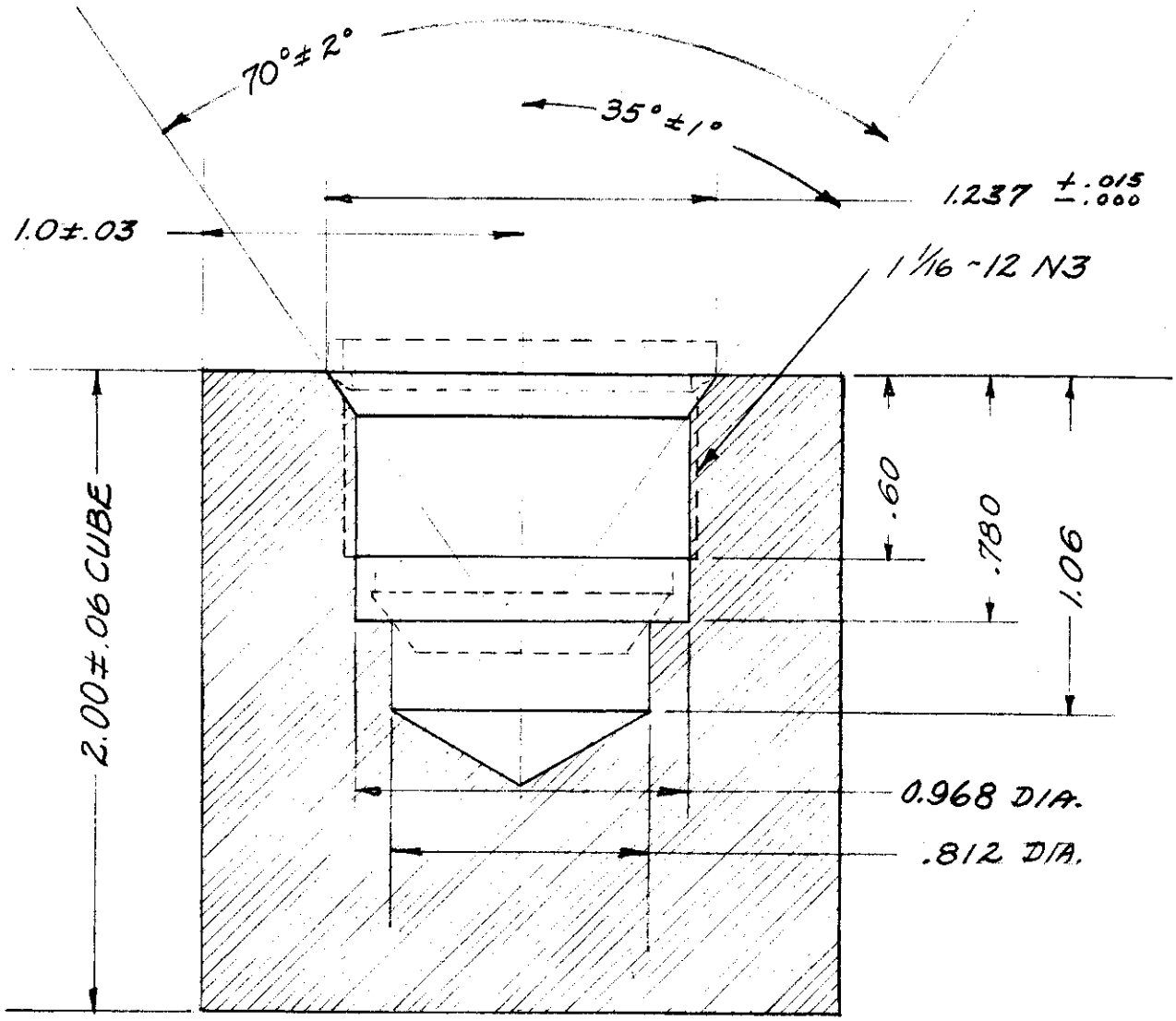
SCALE: DOUBLE SIZE
MTL. – KETOS TOOL STEEL
TOLERANCES: UNLESS SPECIFIED
.XX – ± .010
.XXX – ± .005



TOOL: PRESETTING - 1/2 SIZE

SCALE: DOUBLE SIZE
MTL: KETOS TOOL STEEL
TOLERANCES: UNLESS SPECIFIED
.XX - ± .010
.XXX - ± .005

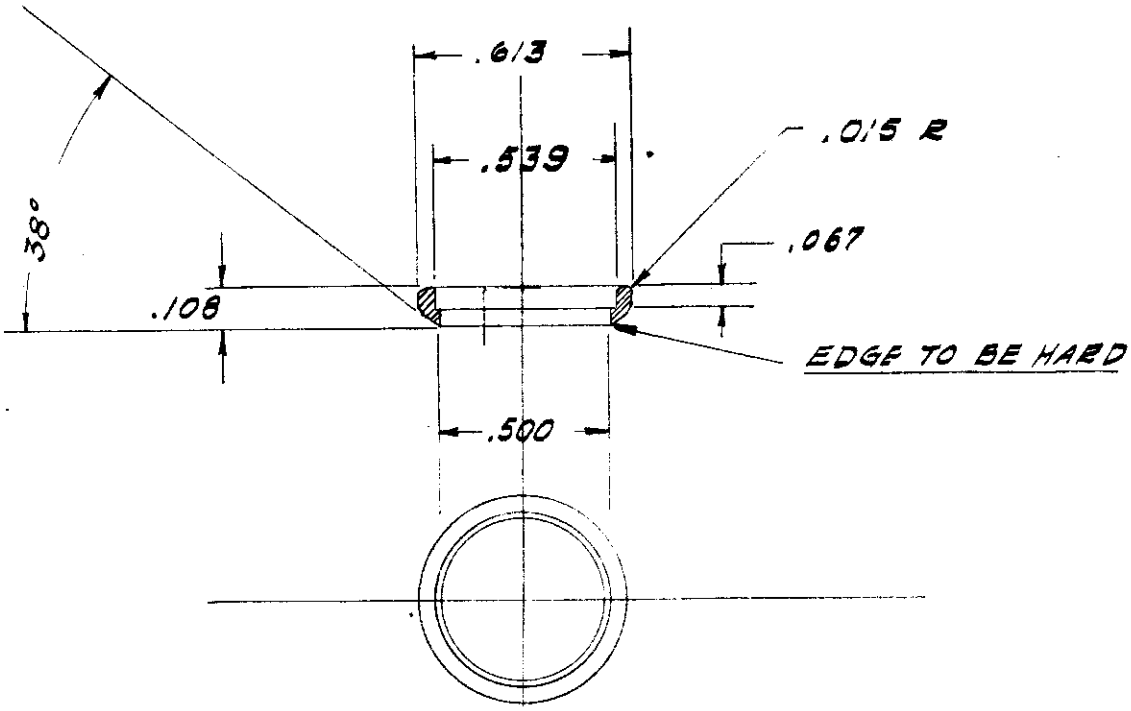
SKETCH #2



TOOL: PRESETTING - 3/4 SIZE

SCALE: DOUBLE SIZE
MATERIAL: KETOS TOOL STEEL
TOLERANCES: UNLESS SPECIFIED
.XX - ± .010
.XXX - ± .005

SKETCH #3

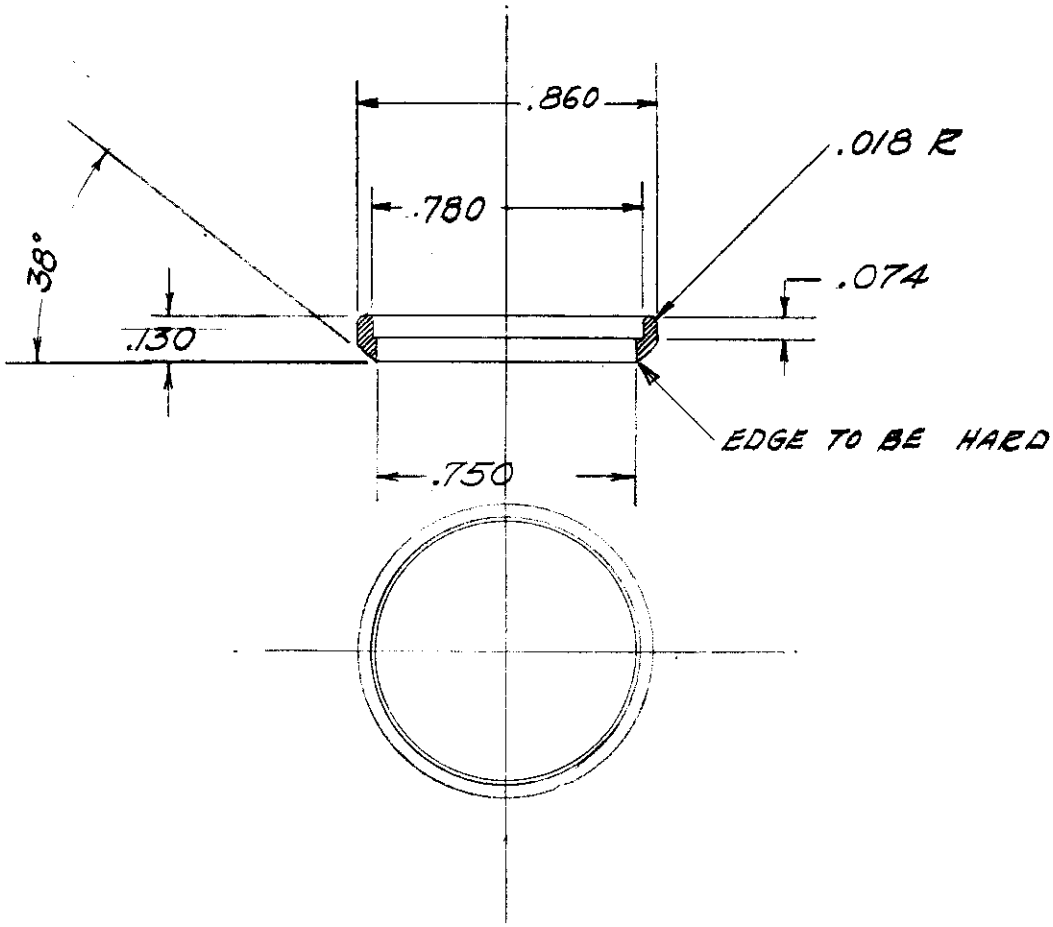


METAL SEAL - 5/16 SIZE

SCALE: DOUBLE SIZE

PRELIMINARY W. A. D. C. DESIGN

SKETCH #4

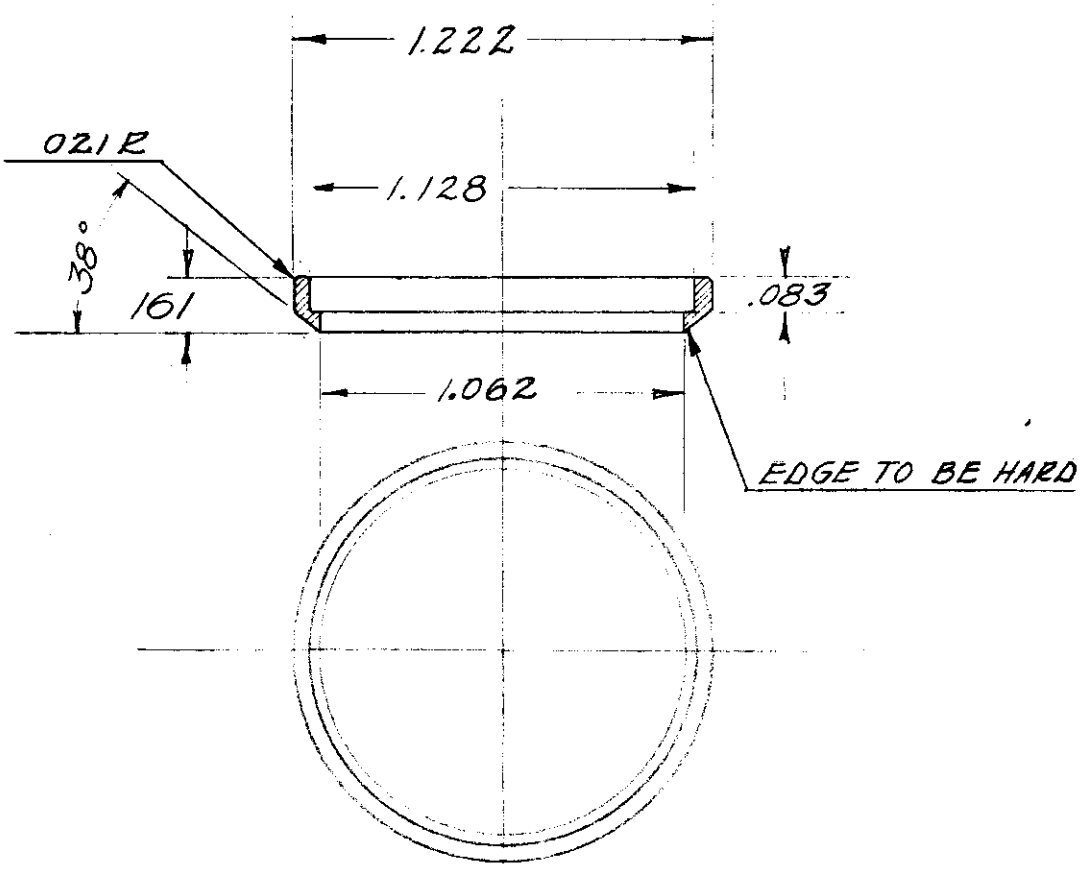


METAL SEAL 1/2 SIZE

SCALE: DOUBLE SIZE

PRELIMINARY W. A. D. C. DESIGN

SKETCH #5

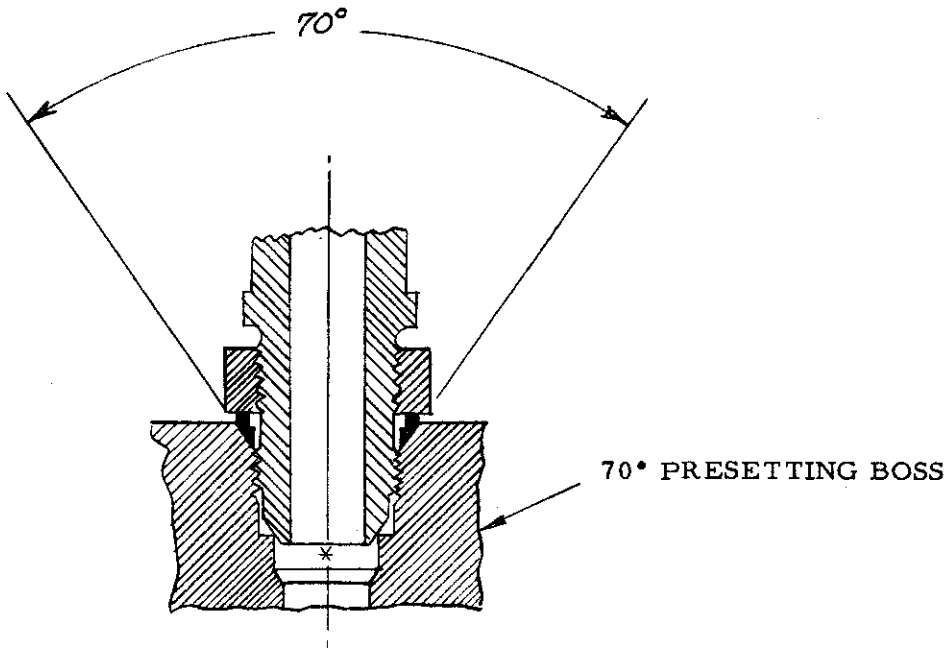


METAL SEAL - 3/4 SIZE

SCALE: DOUBLE SIZE

PRELIMINARY W. A. D. C. DESIGN

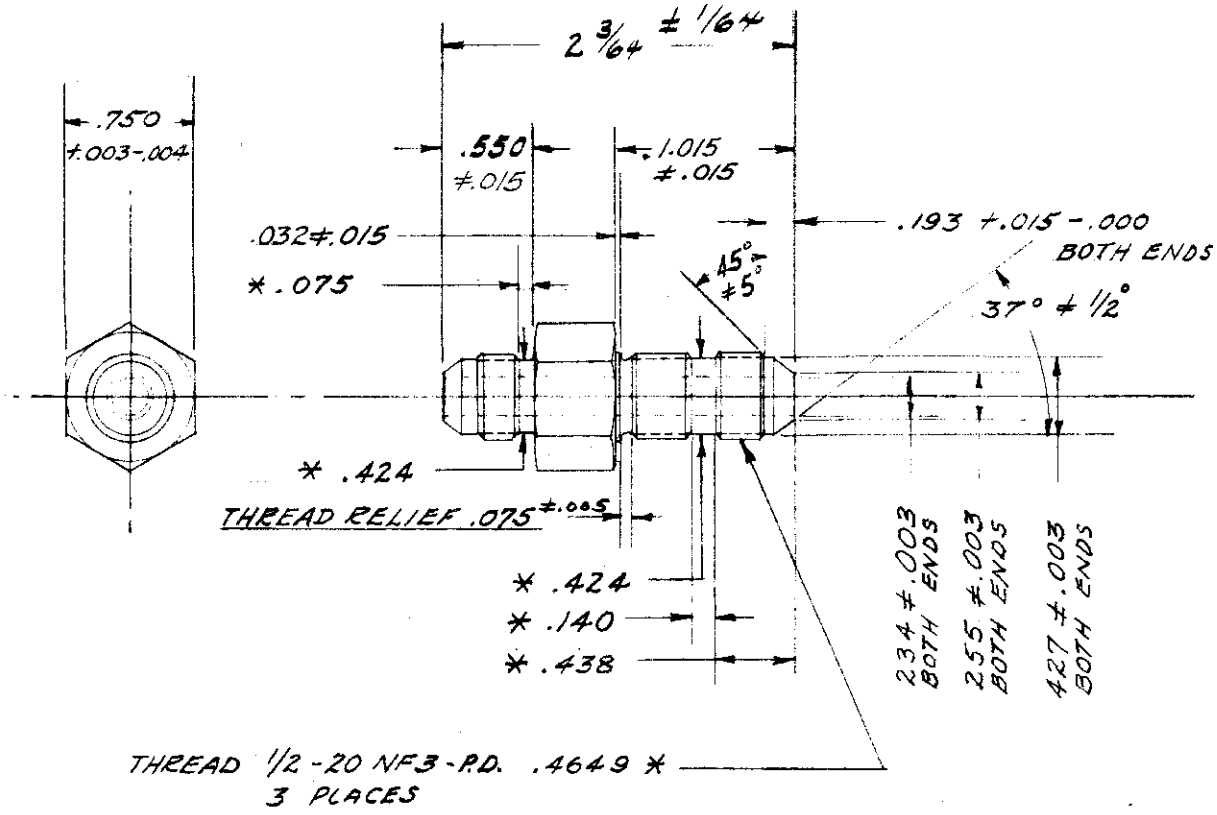
SKETCH #6



This shows a typical fitting and metal seal inserted into a presetting die for the presetting operation. Presetting is required before the metal seal and fitting are installed into a standard boss.

Note: Complete Presetting and Installation instructions are given on Sketches #23, #24.

SKETCH #7



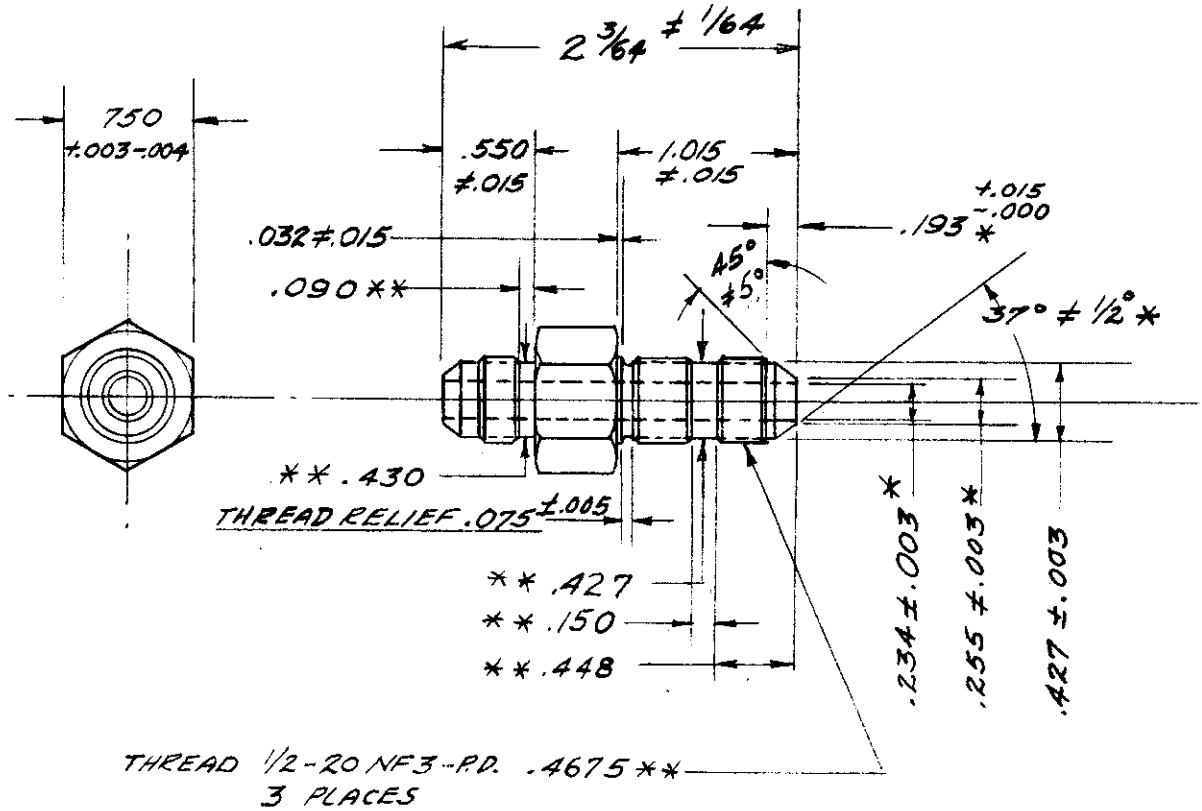
* LOW TOLERANCE DIMENSION

LOW TOLERANCE FITTING
-5 SIZE

M'T'L : SAE 4130 STEEL
SCALE: FULL SIZE

SKETCH #8

AND10056 & AND10057 ENDS



* BOTH ENDS

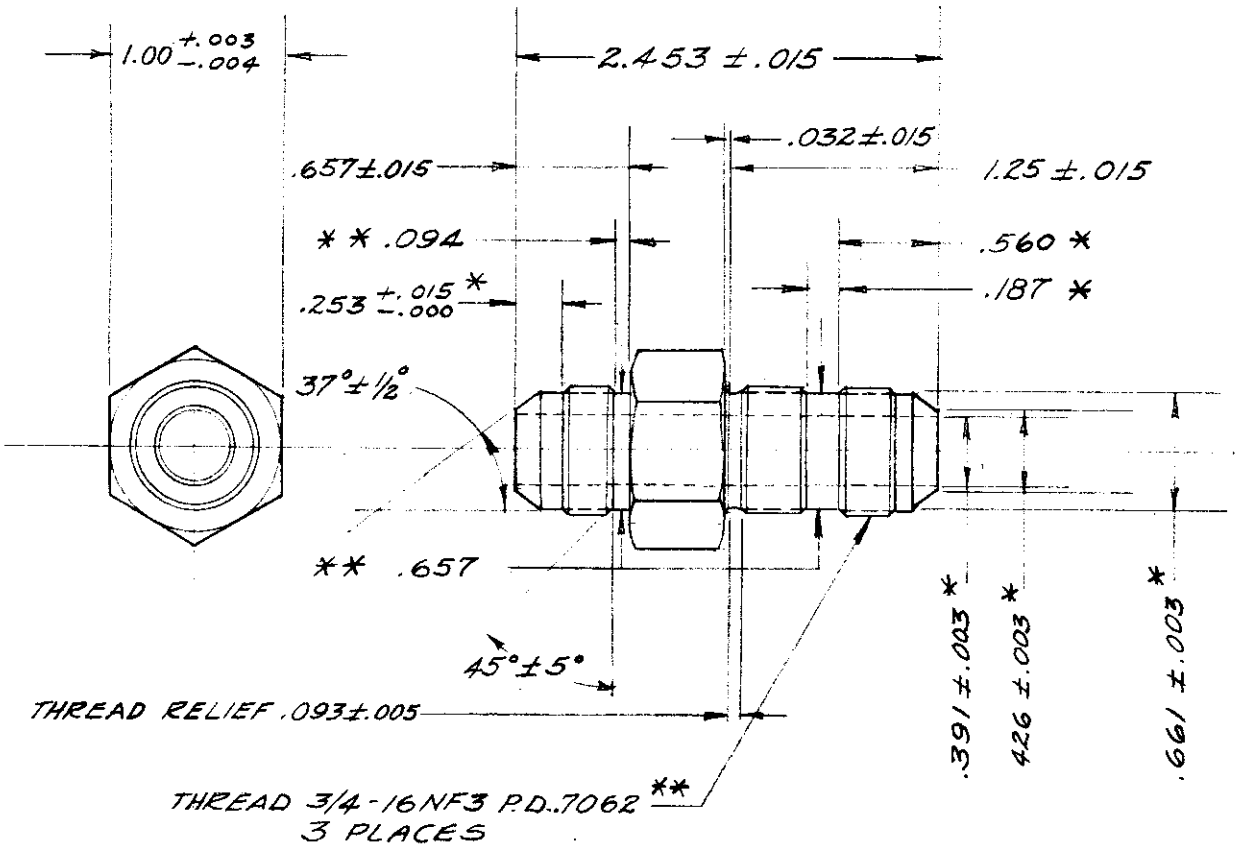
** HIGH TOLERANCE DIMENSION

HIGH TOLERANCE FITTING
-5 SIZE

M'T'L : SAE 4130 STEEL
SCALE: FULL SIZE

SKETCH #9

AND10056 & AND10057 ENDS

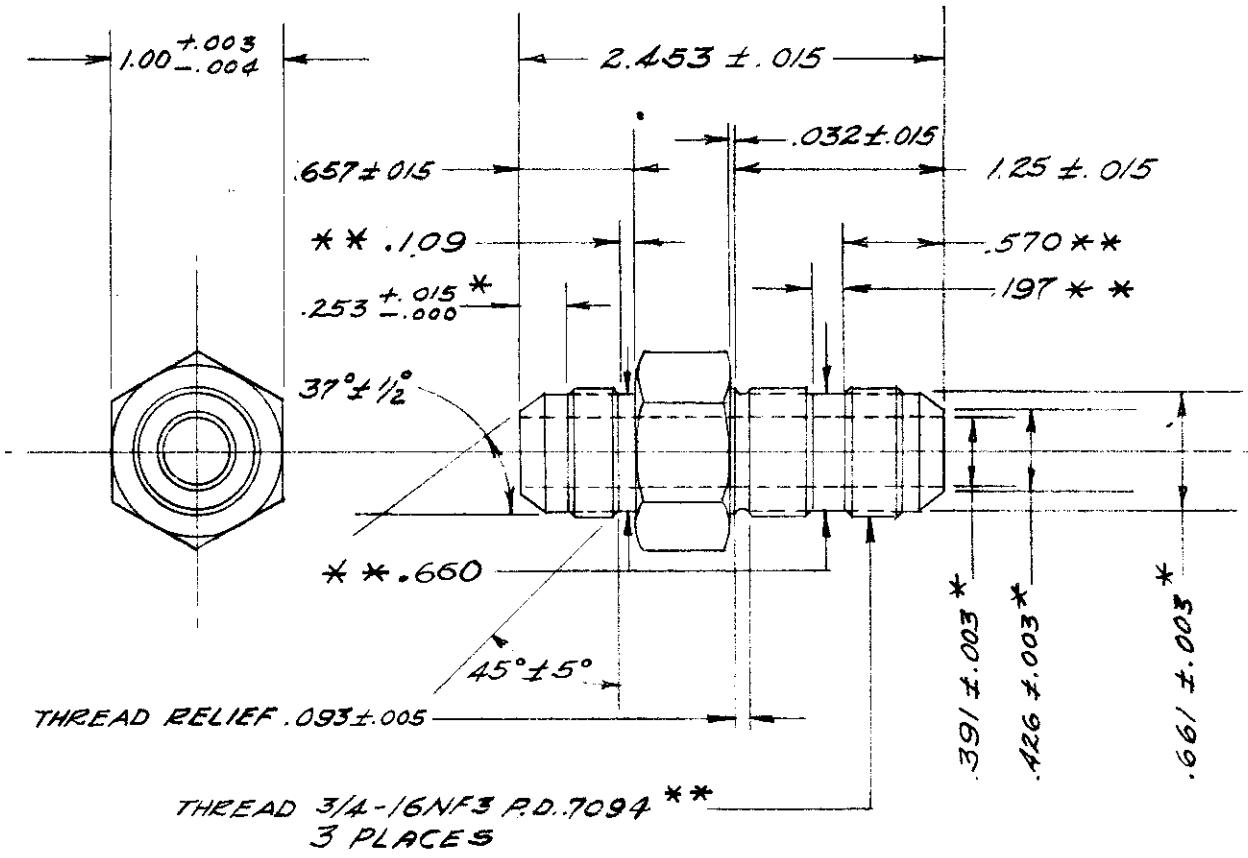


** LOW TOLERANCE DIMENSION

***BOTH ENDS**
LOW TOLERANCE FITTING
-8 SIZE

MTL: 4130 STEEL
SCALE: FULL SIZE
AND10056 & AND10057 ENDS

SKETCH #10

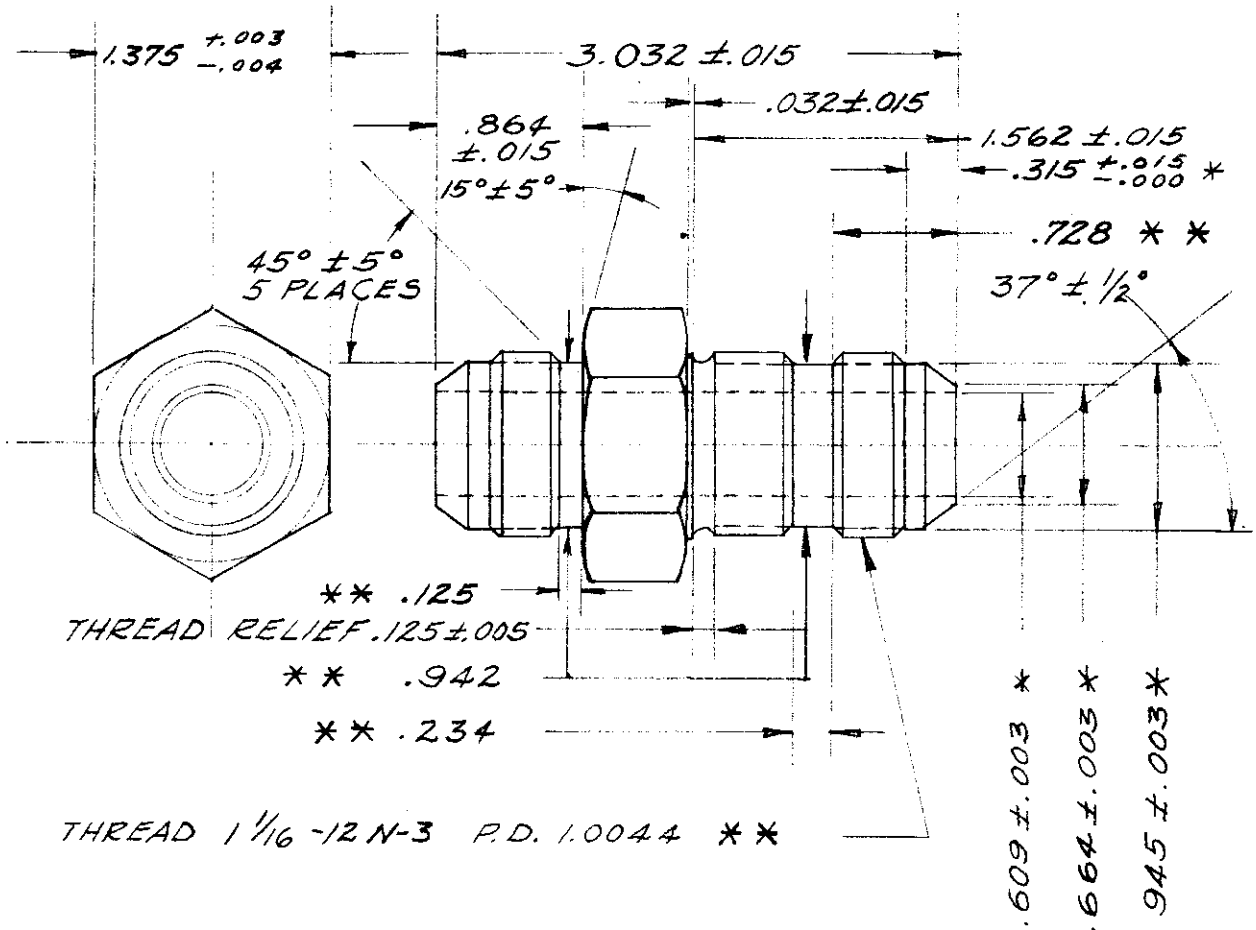


** HIGH TOLERANCE DIMENSION

*BOTH ENDS
HIGH TOLERANCE FITTING
-8 SIZE

MTL: 4130 STEEL
SCALE: FULL SIZE
AND10056 & AND10057 ENDS

SKETCH #11

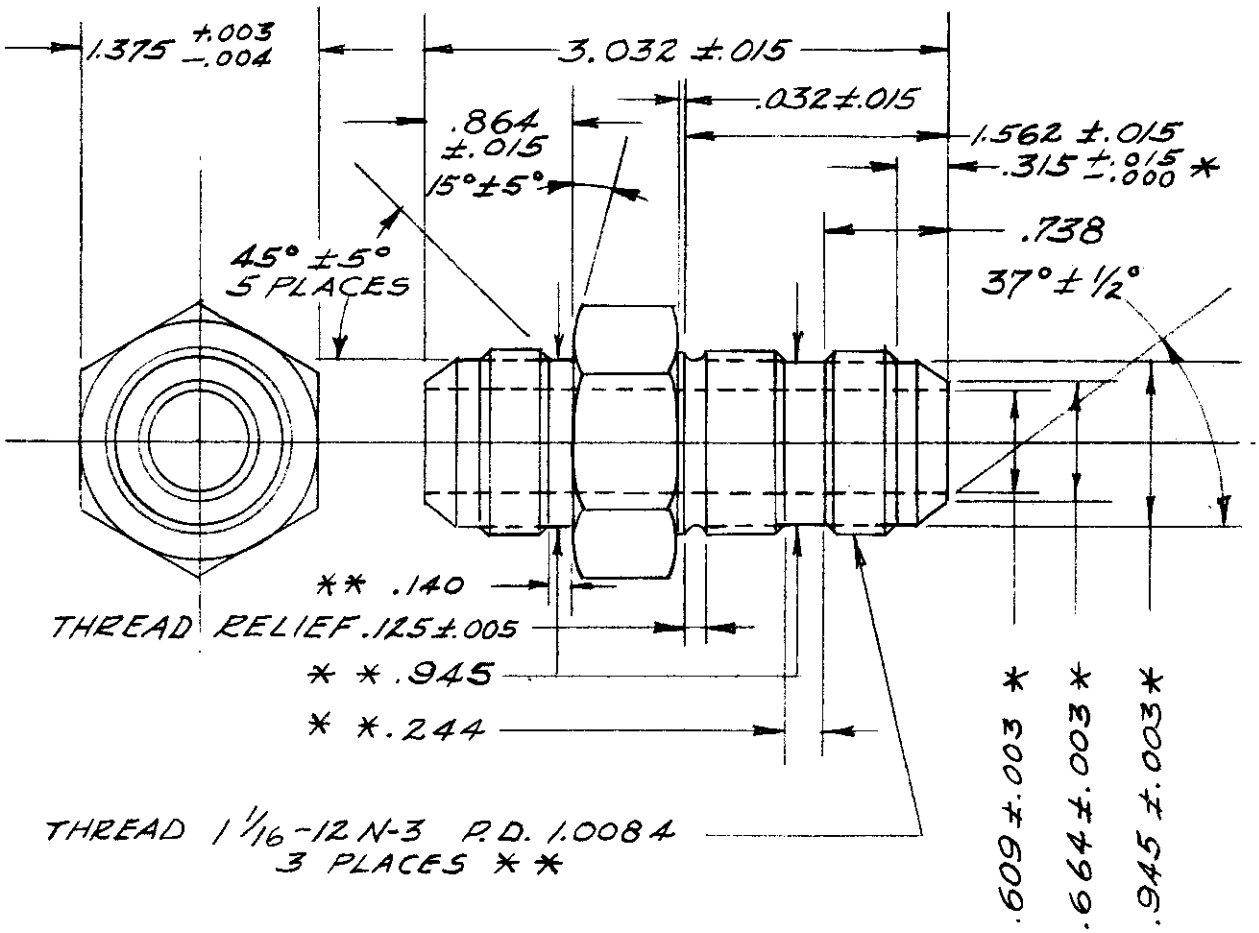


** LOW TOLERANCE DIMENSION

*BOTH ENDS
LOW TOLERANCE FITTING
-12 SIZE

MTL: 4130 STEEL
SCALE: FULL SIZE
AND10056 & AND10057 ENDS

SKETCH #12

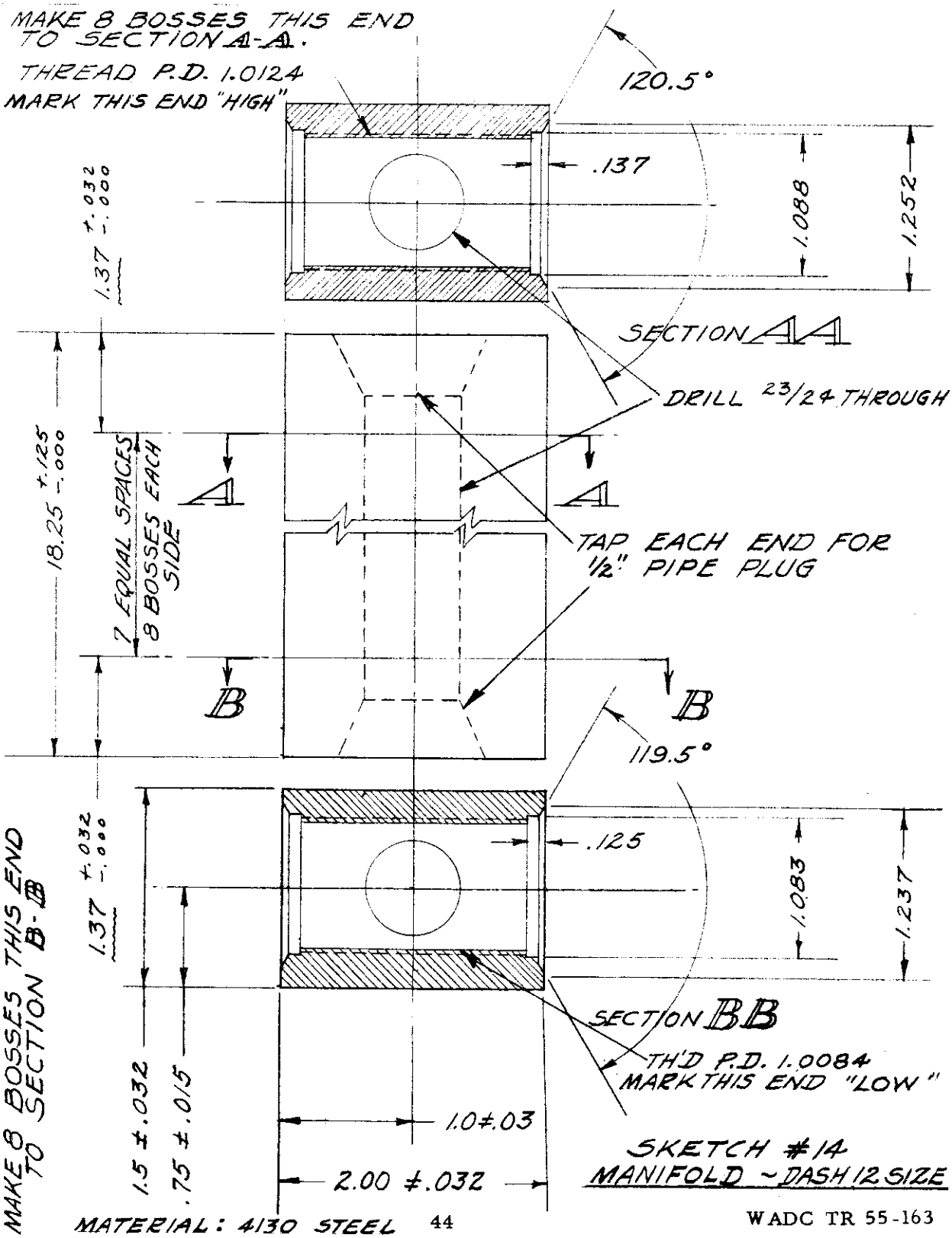


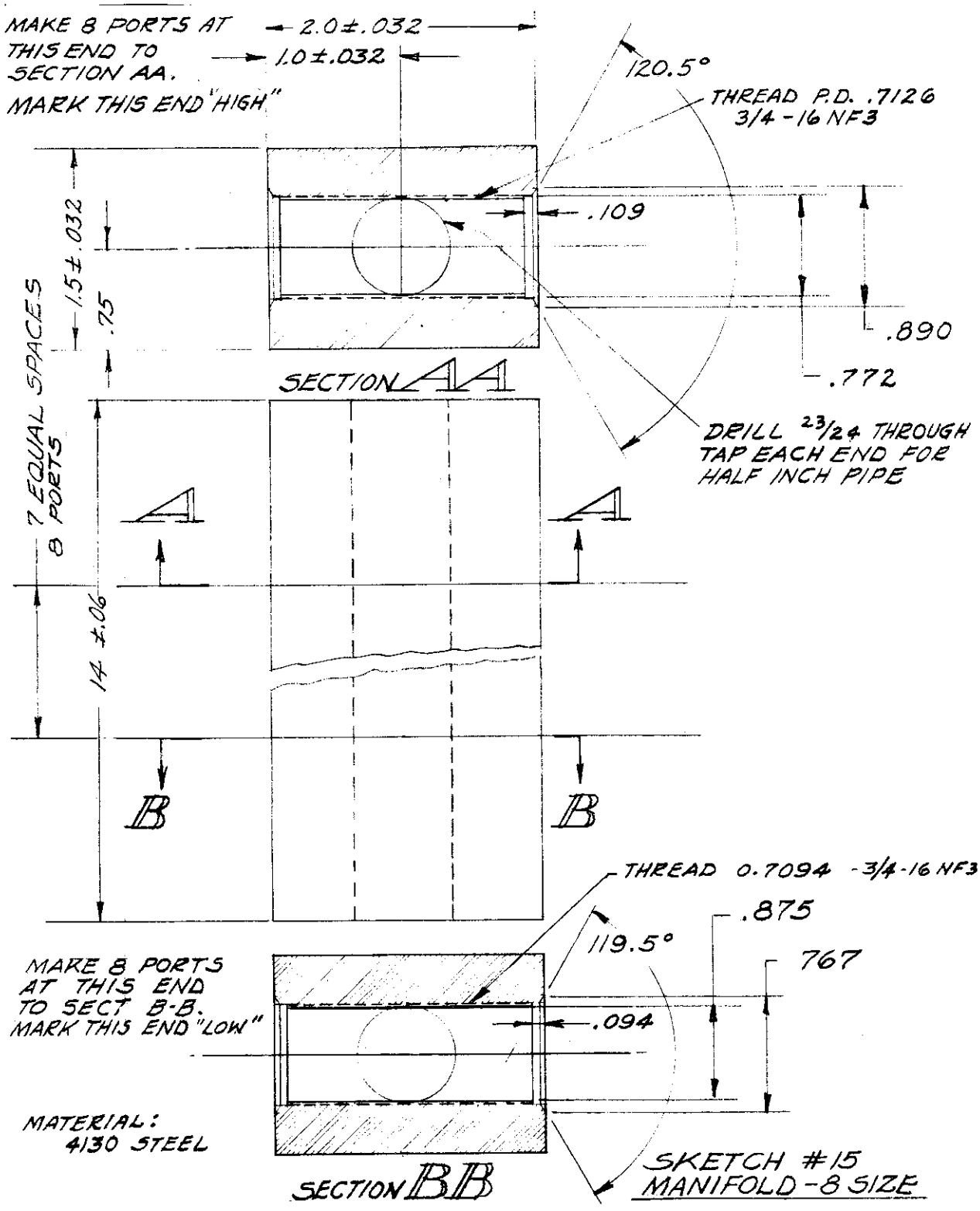
** HIGH TOLERANCE DIMENSION

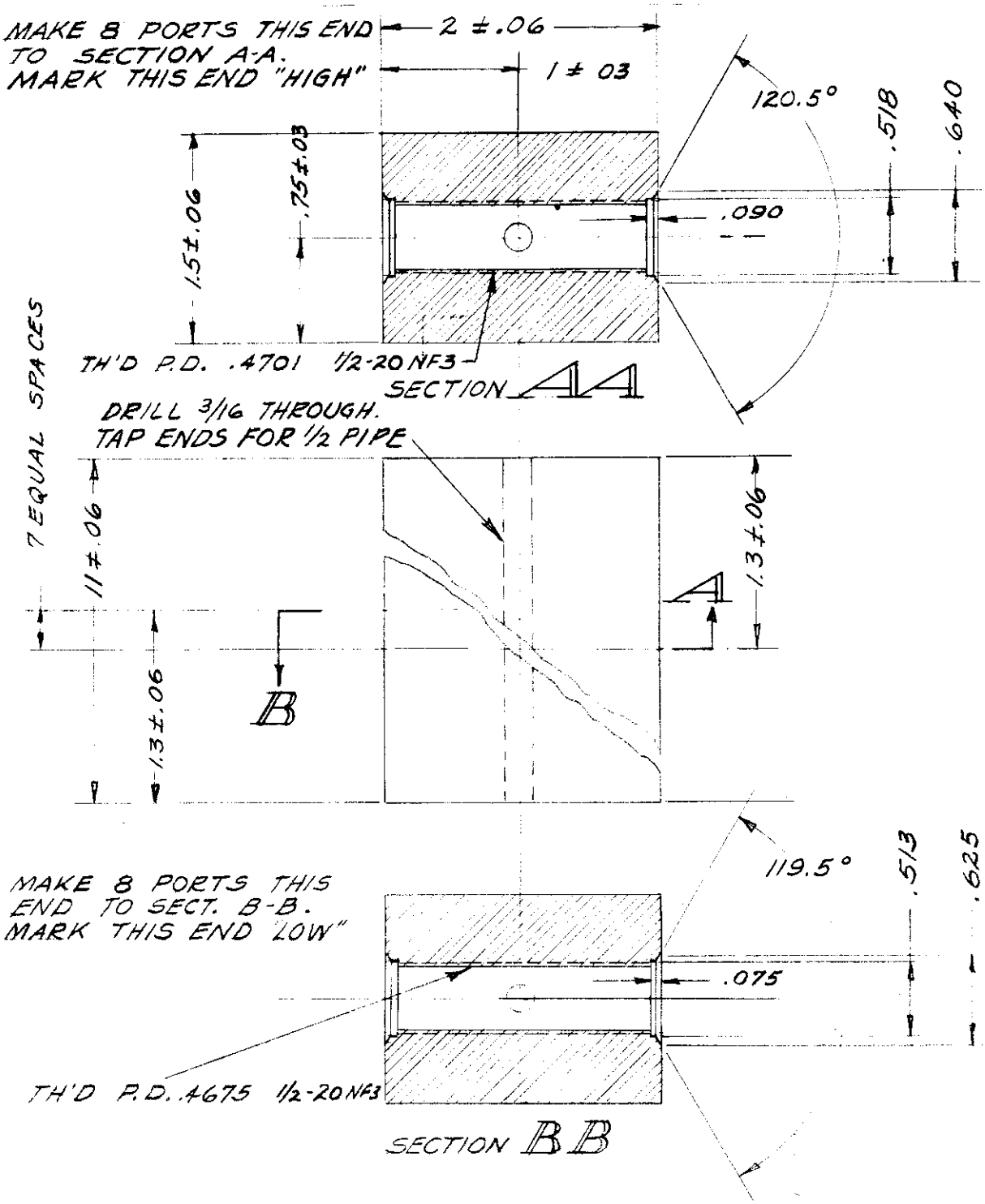
***Both Ends**
High Tolerance Fitting
-12 Size

MTL: 4130 STEEL
SCALE: FULL SIZE
AND 10056 & AND10057 ENDS

SKETCH #13

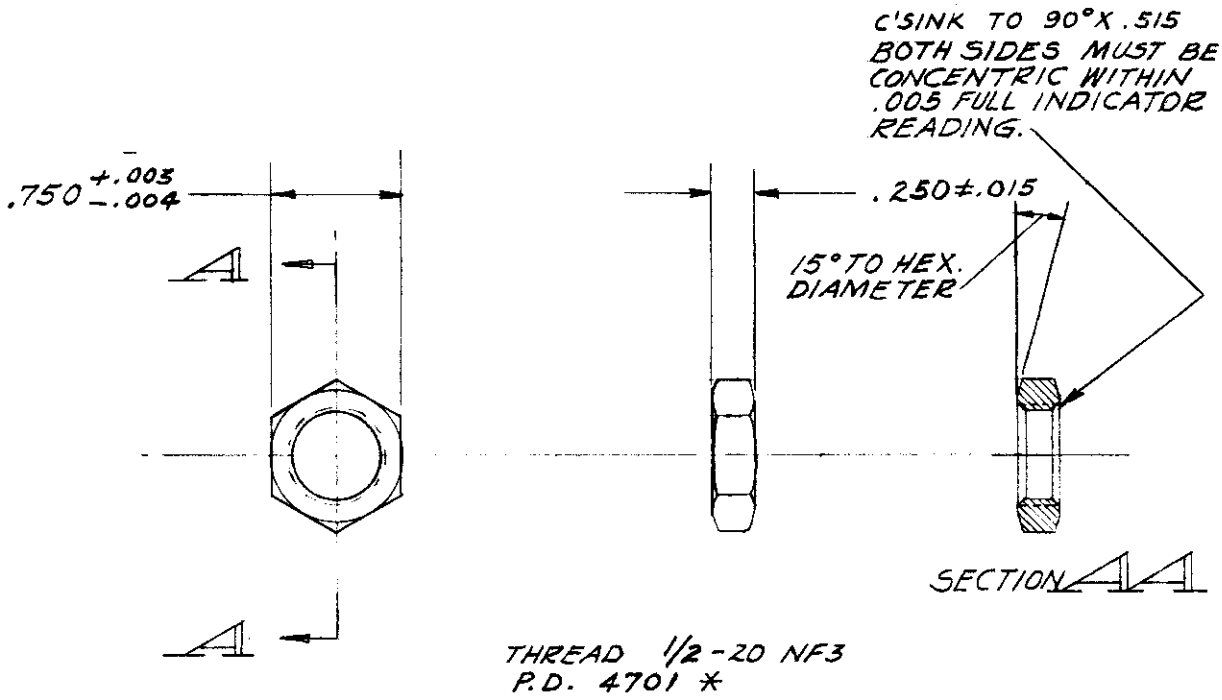






SKETCH #16
MANIFOLD -5 SIZE

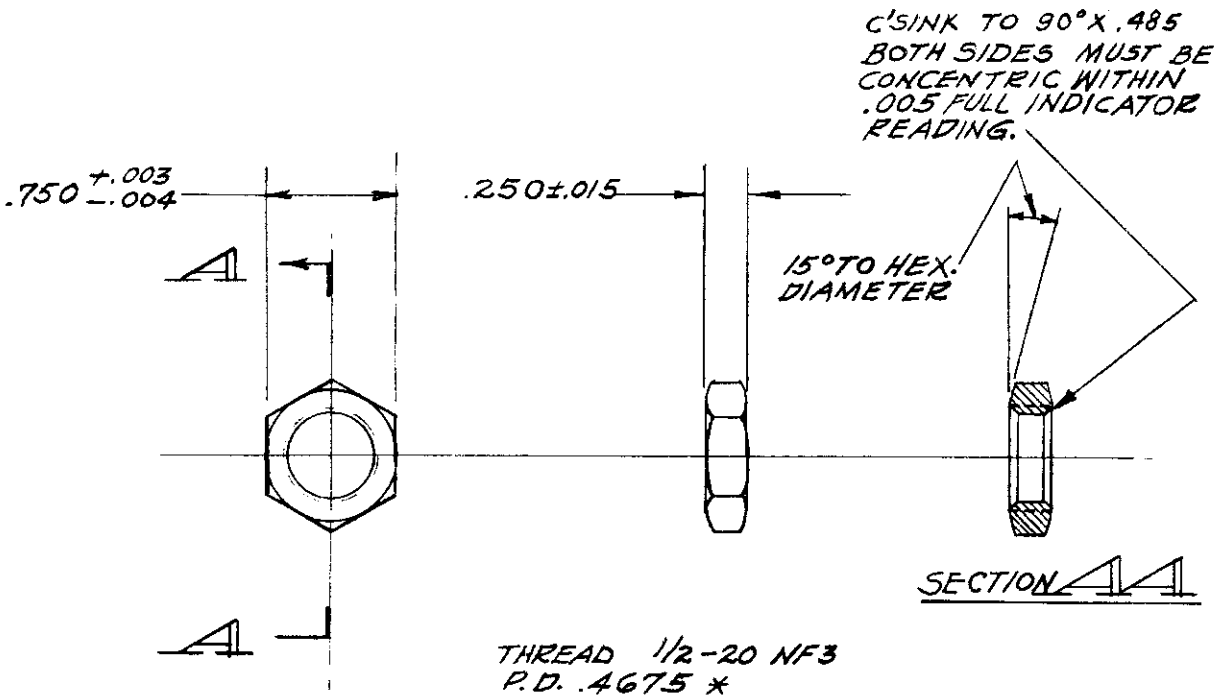
MATERIAL: 4130 STEEL



MATERIAL: 4130 STEEL

* HIGH TOLERANCE DIMENSION

NUT
HIGH TOLERANCE
-5 SIZE
AN 6289
SKETCH #17

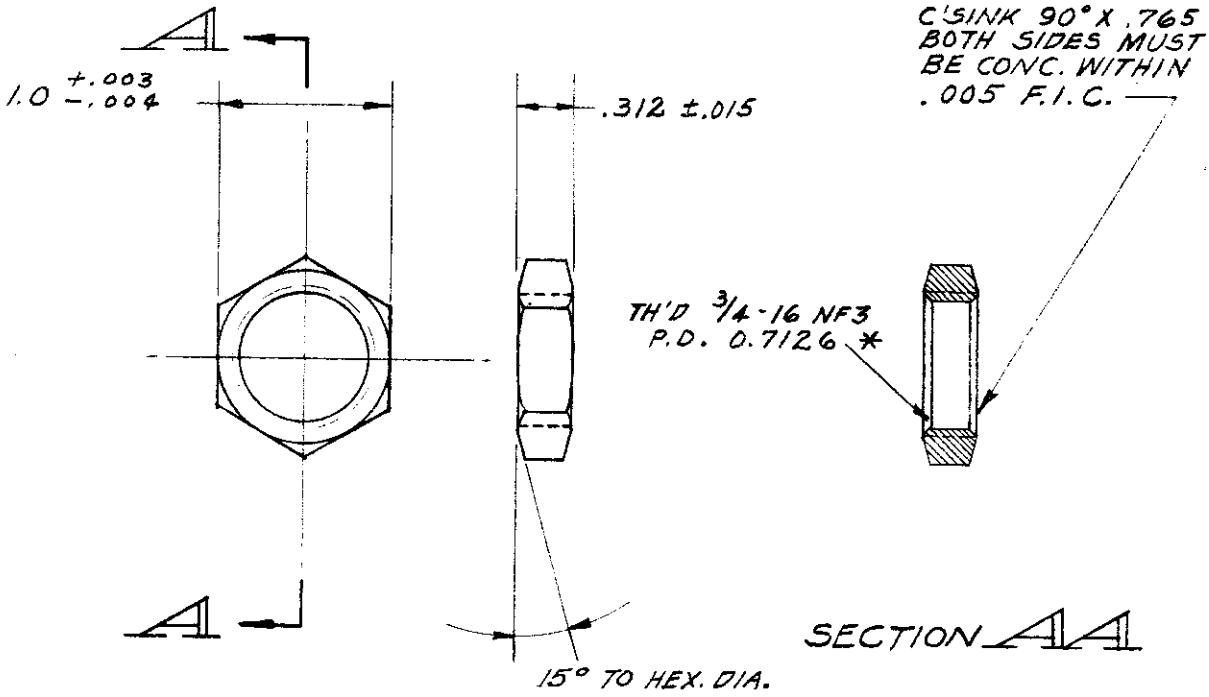


MATERIAL: 4130 STEEL

* LOW TOLERANCE DIMENSION

NUT
LOW TOLERANCE
-5 SIZE
AN 6289

SKETCH #18



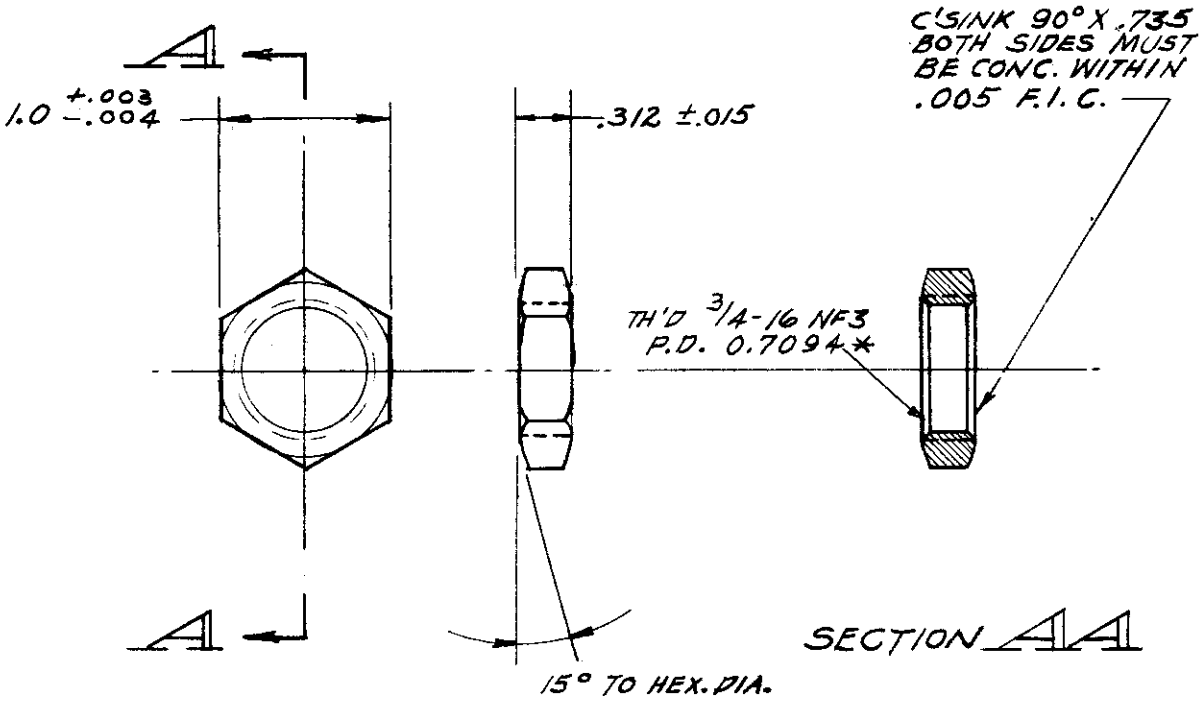
M'T'L: 4130 STEEL

* HIGH TOLERANCE DIMENSION

NUT
HIGH TOLERANCE
-8 SIZE

AN 6289

SKETCH #19

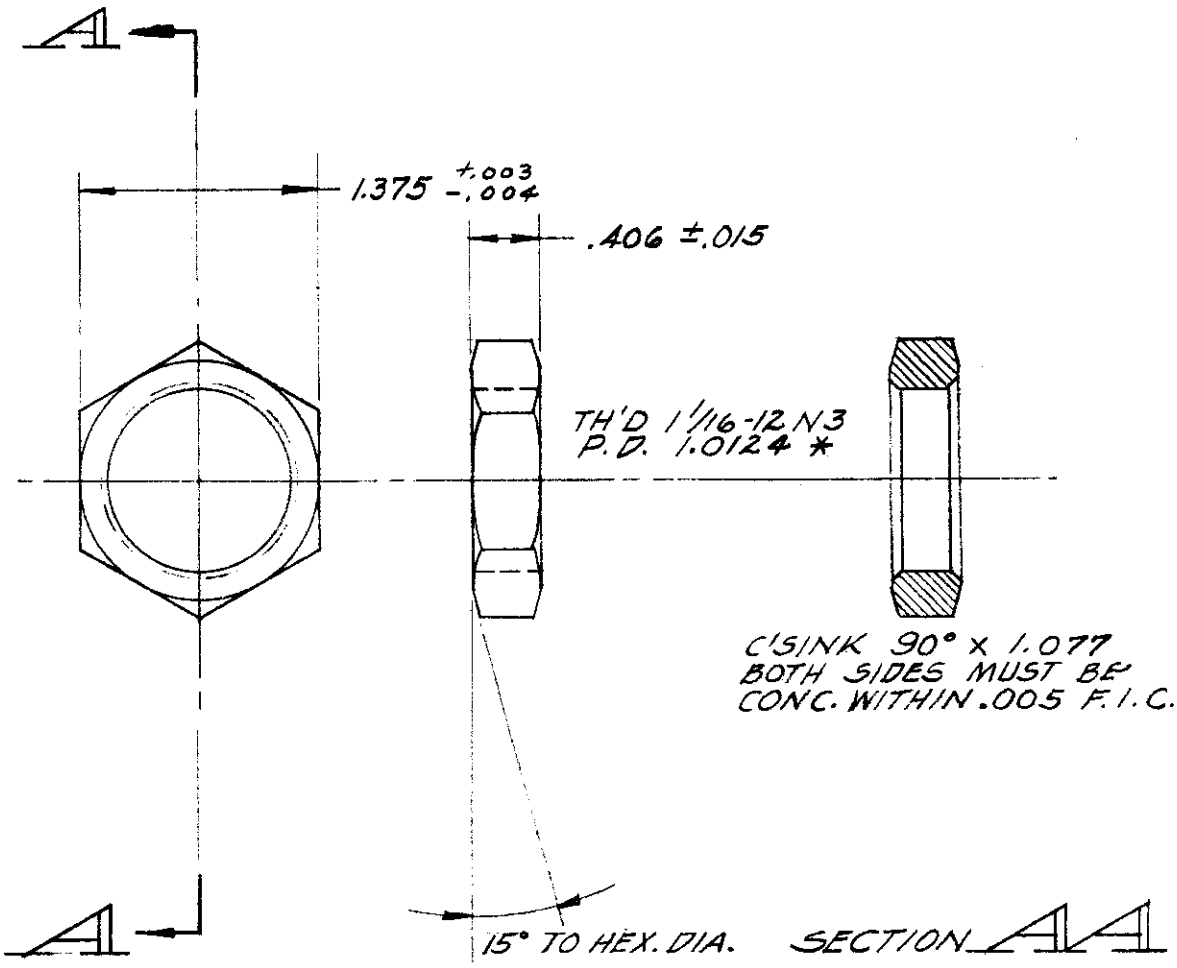


M'T'L: 4130 STEEL

* LOW TOLERANCE DIMENSION

NUT
LOW TOLERANCE
-8 SIZE
AN 6289

SKETCH #20

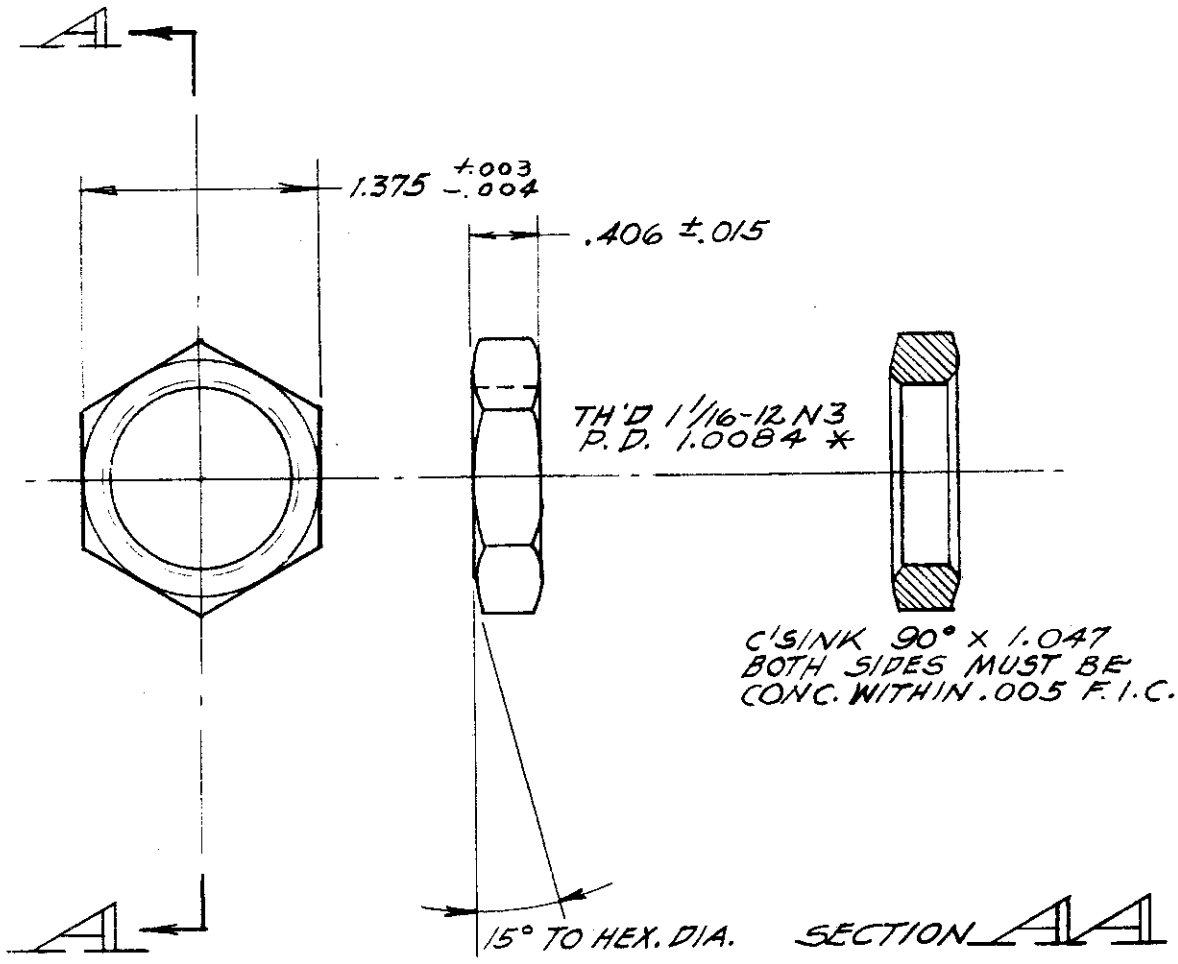


NUT
HIGH TOLERANCE
-12 SIZE
AN 6289

M'T'L: 4130 STEEL

SKETCH #21

* HIGH TOLERANCE DIMENSION



NUT
LOW TOLERANCE
-12 SIZE

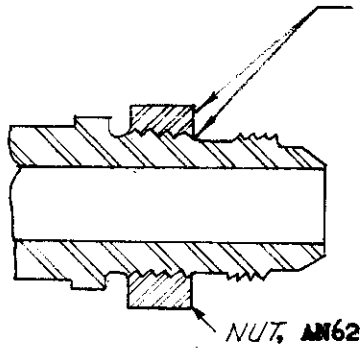
AN 6289

M'T'L: 4130 STEEL

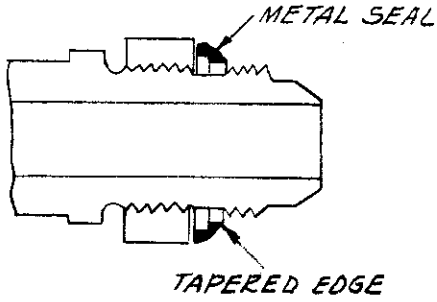
SKETCH #22

* LOW TOLERANCE DIMENSION

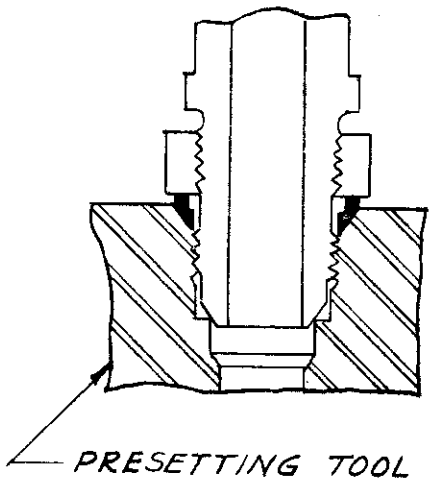
PRESETTING AND INSTALLATION INSTRUCTIONS



1. Place nut on fitting as shown.



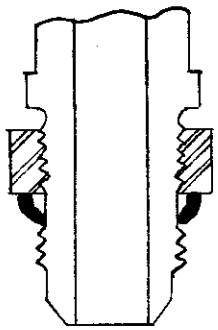
2. Place metal seal on fitting with tapered edge facing toward this end of fitting, as shown.



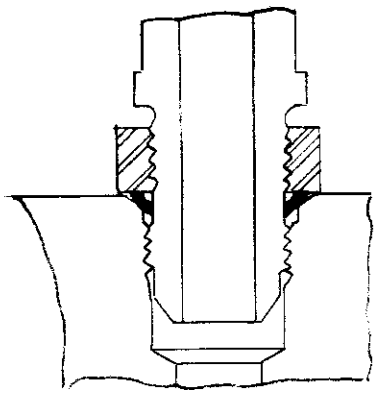
3. Screw assembly into presetting tool as shown. Have the fitting bottom in the tool as shown. Lubricate surface of tool where metal seal makes contact with surface of tool. Tighten nut with wrench until metal seal is preset around the neck of the fitting, and conical surface of seal matches conical surface of presetting tool.

SKETCH #23

PRESETTING AND INSTALLATION INSTRUCTIONS - Continued



4. Remove assembly from presetting tool. The metal seal should not slip off the fitting if the presetting operation has been performed properly.



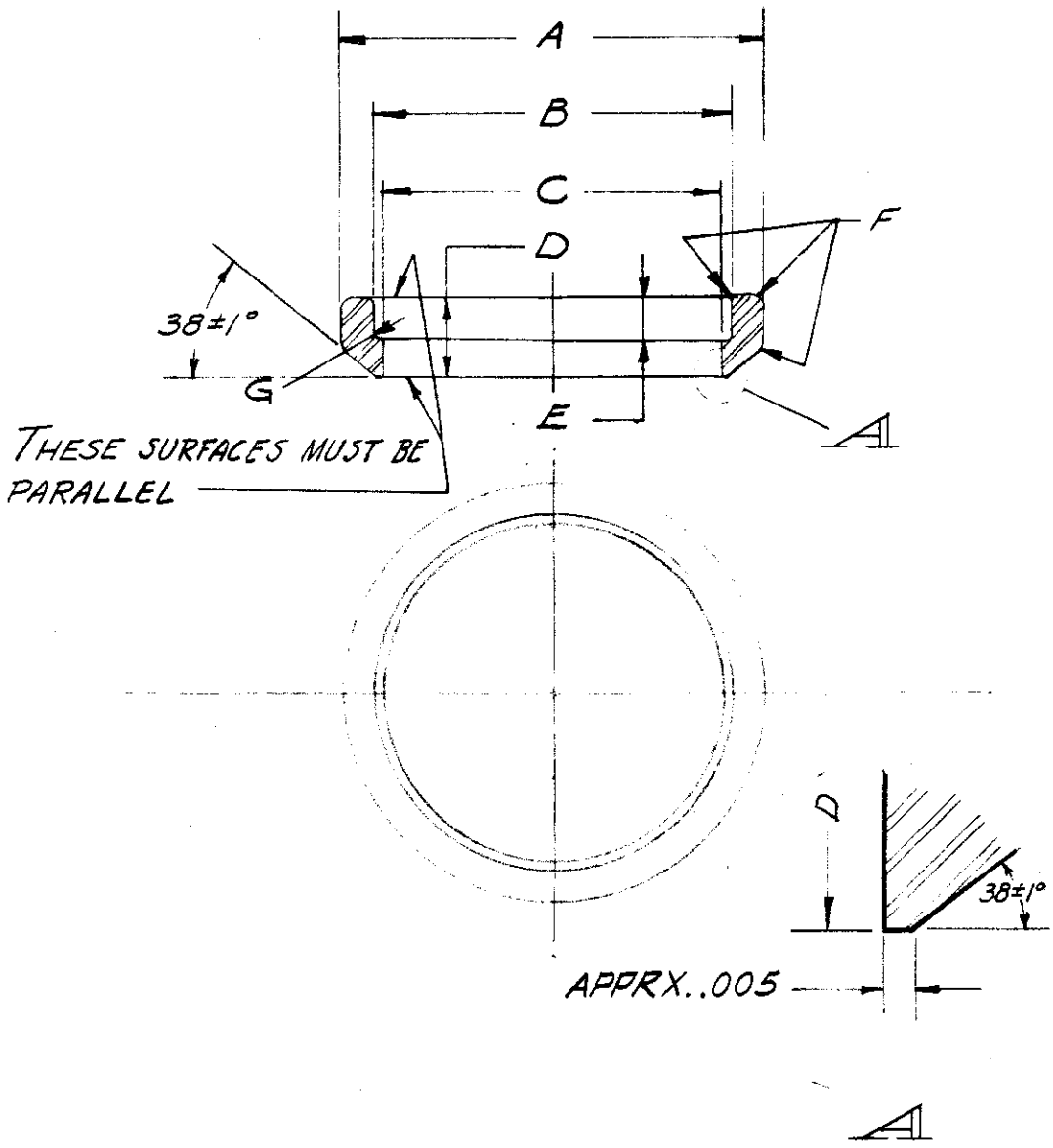
STANDARD AND 10050 BOSS

5. Screw assembly into standard boss. Tighten down nut with torque values as follows:

20 ft. lbs.	for -5 size
50 ft. lbs.	for -8 size
100 ft. lbs.	for -12 size

The same procedure may be used to preset and install a fitting with an AND10056 fitting end, **except that a AN6289 nut shall not be used and the AND10056 fitting will not bottom in the presetting tool.**

SKETCH #24



Size	A +.003 -.000	B ±.002	C +.003 -.000	D +.000 -.005	E ±.002	F ±.005	G
-5	.613	.539	.500	.108	.067	.015R	.005R
-8	.860	.780	.750	.130	.074	.018R	.005R
-12	1.222	1.128	1.062	.161	.083	.021R	.005R

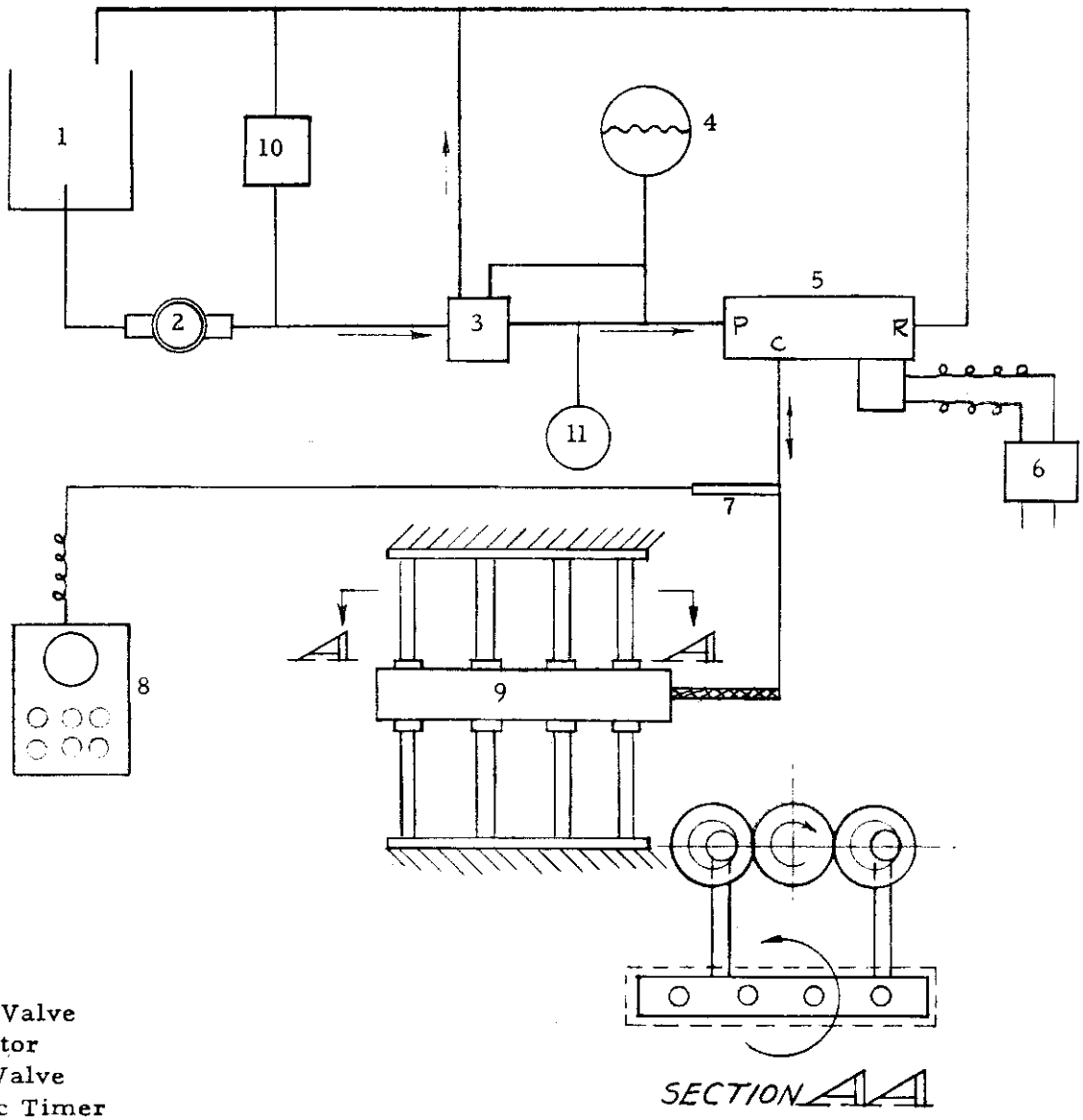
Concentricity between dimensions A, B, and C within .003 F.I.R.
Surface finish: 32 micro-inches RMS. maximum.

Scale: 4:1
Material: Cold Rolled Bar
1020 Steel
Break all edges .005 unless otherwise specified
Break all sharp edges and remove all hanging bures and slivers.

METAL SEAL
FINAL DESIGN
SIZES -5, -8, -12

SKETCH # 25

SCHEMATIC DIAGRAM - IMPULSE AND VIBRATION TEST

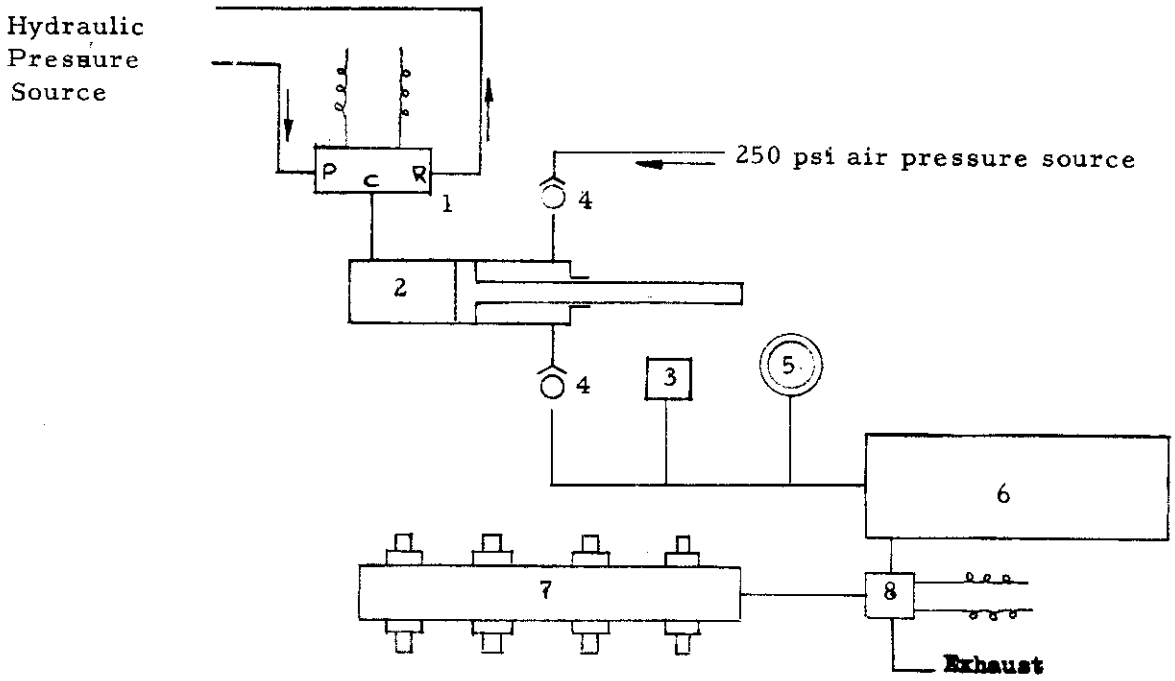


1. Reservoir
2. Pump
3. Unloader Valve
4. Accumulator
5. Solenoid Valve
6. Electronic Timer
7. Hydrauliscope Pick-up
8. Hydrauliscope
9. Manifold with samples under test.
10. Relief Valve
11. Gauge

Vibratory Motion was circular.

SKETCH #26

SCHEMATIC DIAGRAM OF PNEUMATIC CIRCUIT



1. Solenoid-operated hydraulic 4-way valve.
2. Hydraulic Actuating cylinder.
3. Relief Valve
4. Check Valve
5. Gauge
6. High Pressure Receiver
7. Manifold with samples under test.
8. Three-way control valve

SKETCH #27

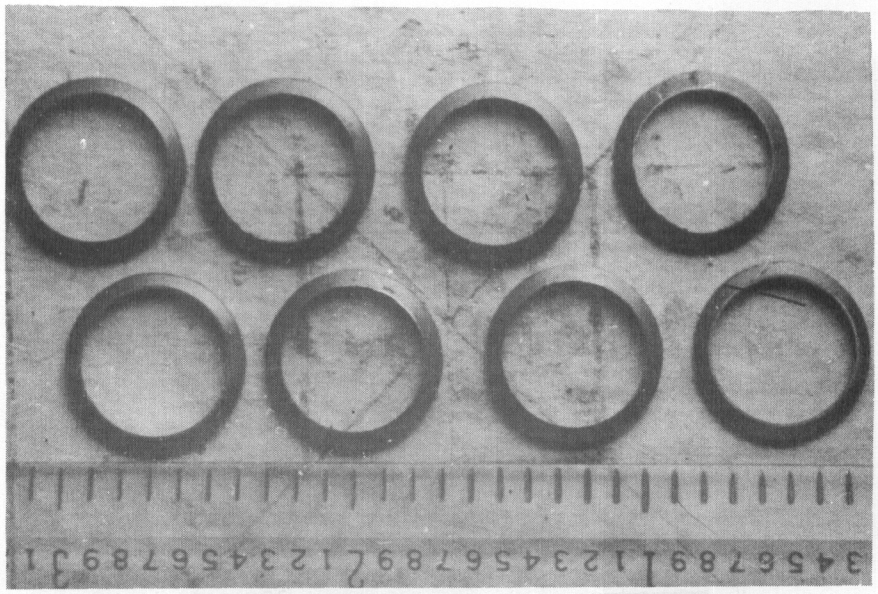


FIG. 1. THE DASH FIVE METAL RINGS USED IN THIS PROGRAM

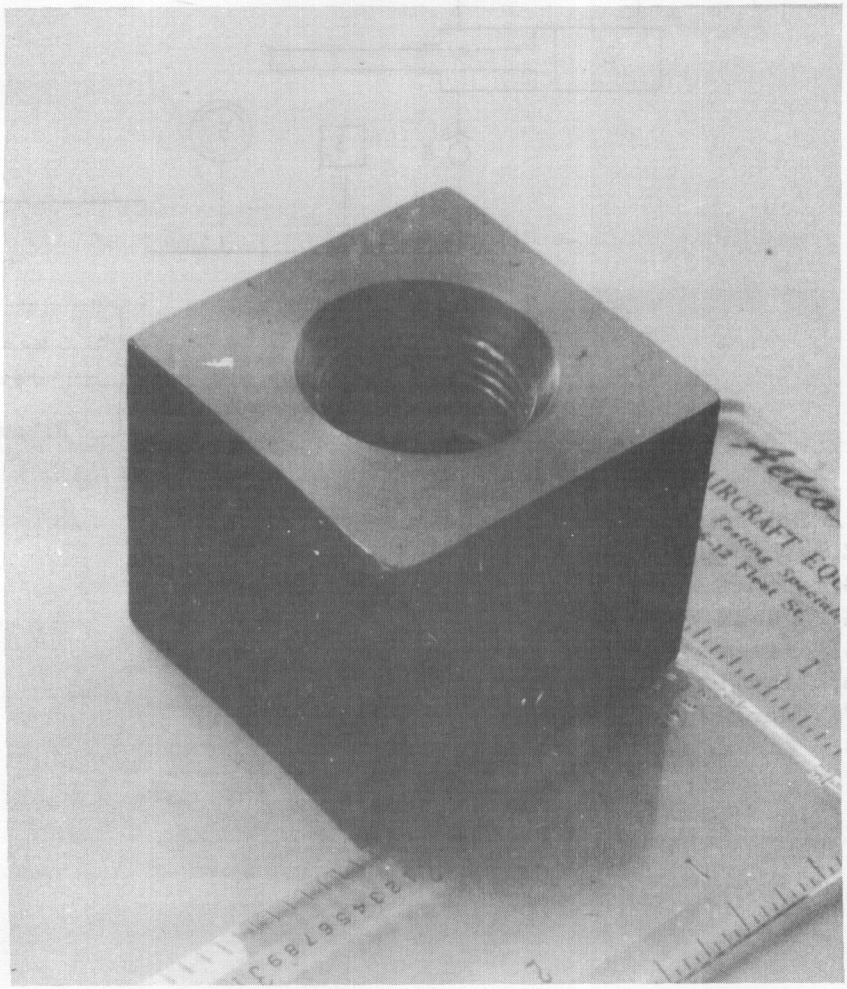


FIG. 2. TYPICAL PRESETTING DIE USED IN THIS PROGRAM

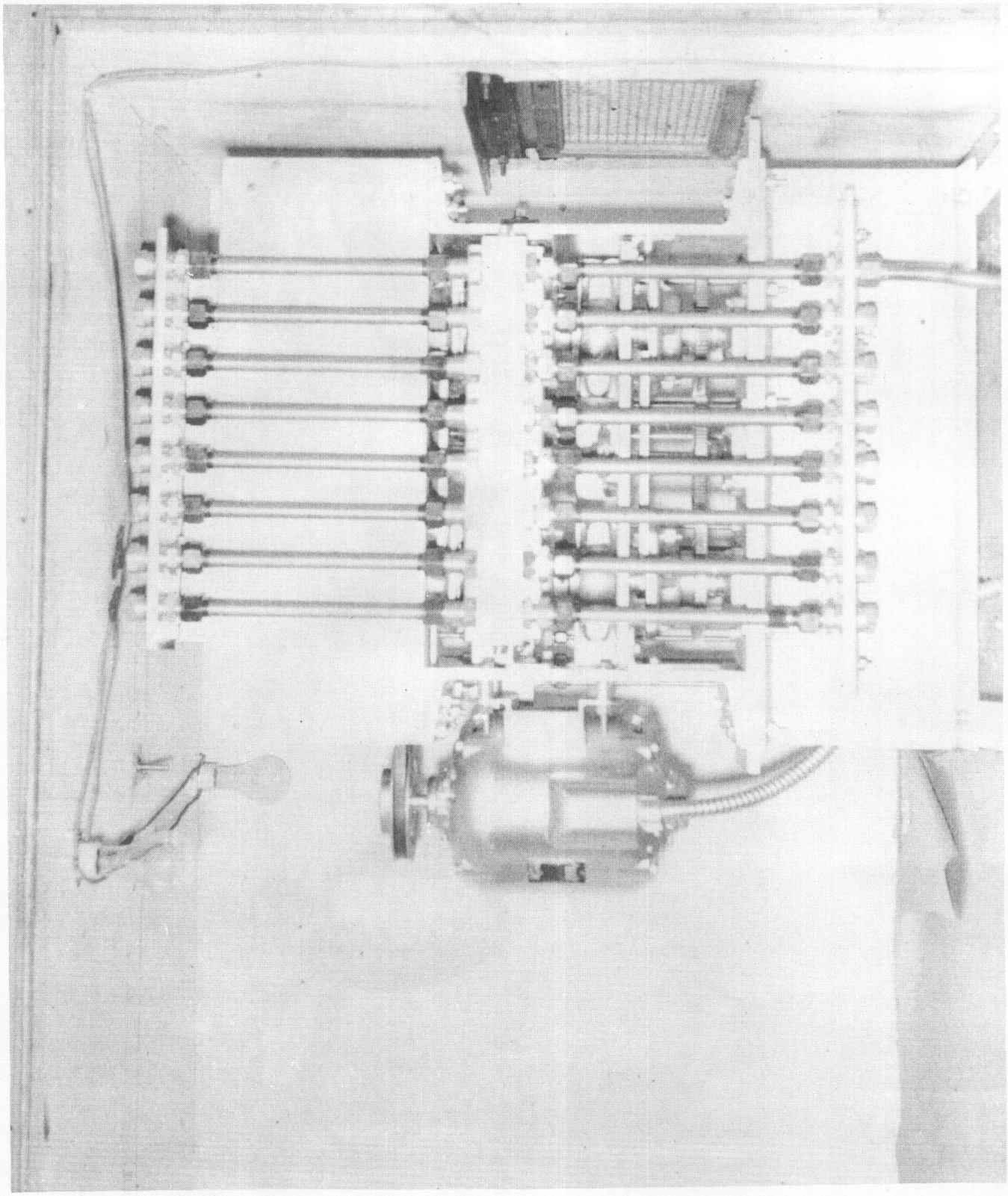


FIG. 3. THE VIBRATION SET UP USED IN THIS TEST PROGRAM

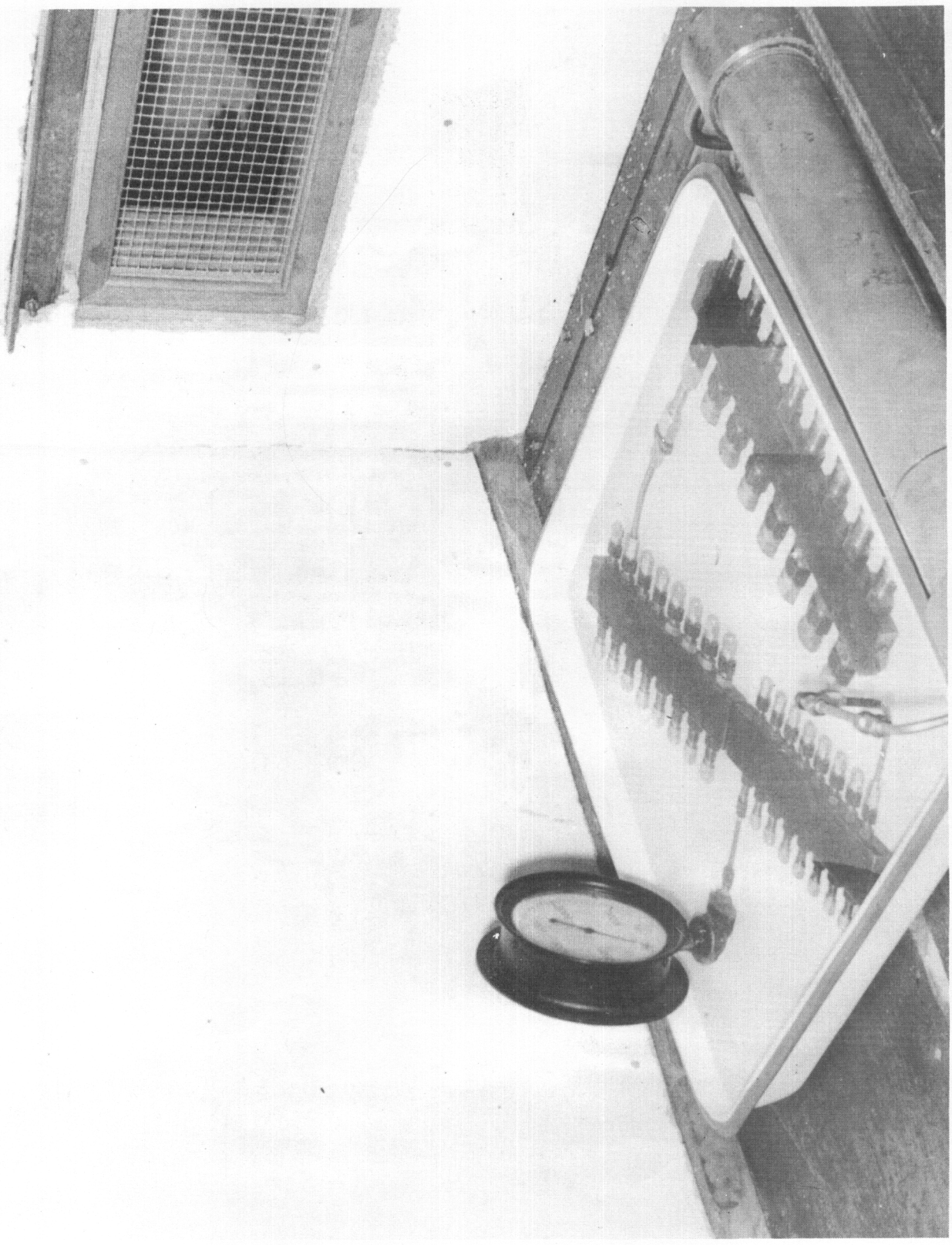


FIG. 4. AIR PRESSURE PROOF TEST PERFORMED IN THIS PROGRAM

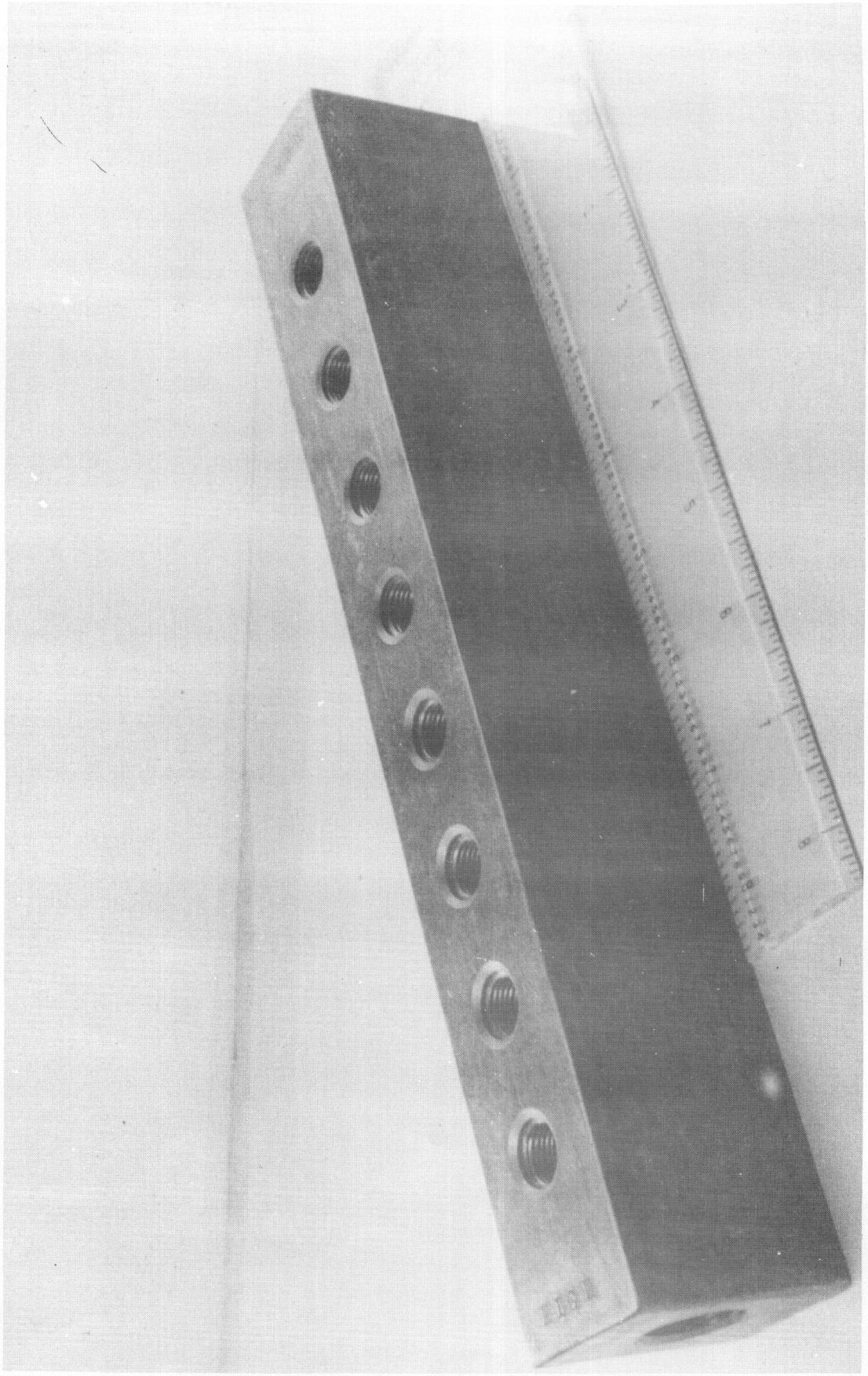


FIG. 5 TYPICAL MANIFOLD USED IN THIS TEST PROGRAM