NYLON PIPE JOINTS IN HYDRAULIC SERVICES

BY

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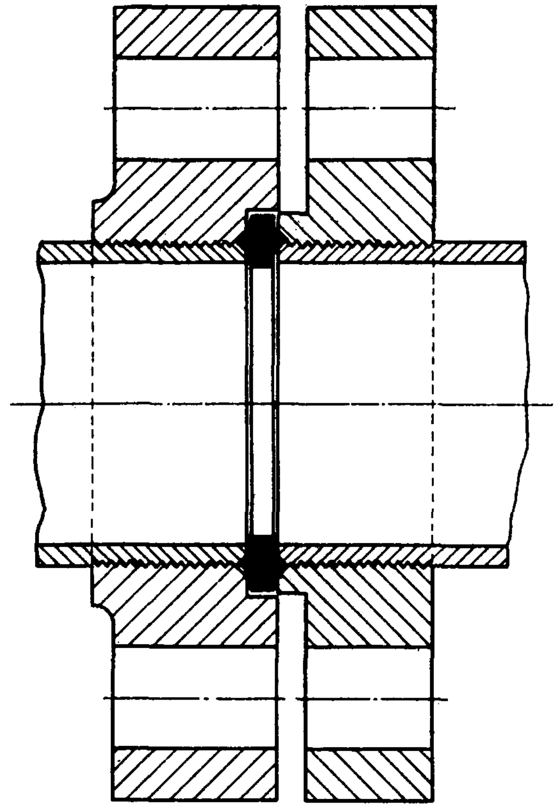


FIG. 1—3 IN. DIAMOND JOINT RING ASSEMBLED LIGHTLY IN A JOINT

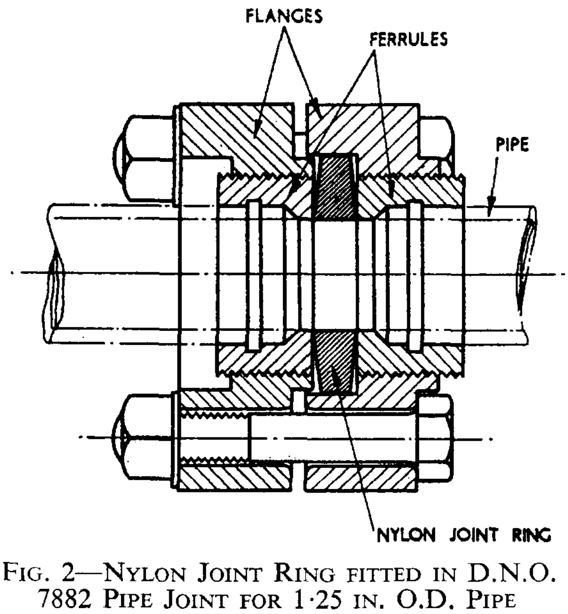


FIG. 2—NYLON JOINT RING FITTED IN D.N.O. 7882 PIPE JOINT FOR 1·25 IN. O.D. PIPE

Tests were carried out at the Admiralty Engineering Laboratory, West Drayton, on certain joint sealing rings designed with a view to replacing the copper diamond joint at present fitted in naval hydraulic systems, using O.M.13 oil (light mineral oil used on gun recoil systems) as a pressure medium.

Various forms of steel rings enclosing rubber joints were tested and, finally, trials were carried out using nylon joint rings.

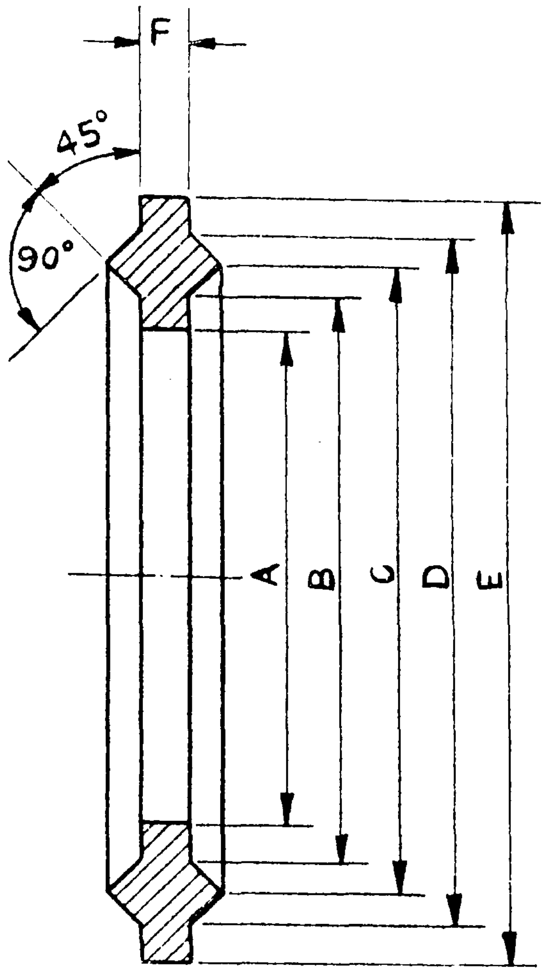
Details of Joint and Joint Rings

Two types of pipe joints were tested :—

(*a*) The existing pipe joints as fitted in the Service (FIG. 1) with nominal bore of 0·35, 0·75, 1·0625, 1·575, 1·9 and 3·0 inches

(*b*) D.N.O. flange joint No. 7882 with external diameters of pipes 1·25 and 2·0 inches.

Initial joint rings (FIG. 3) were nylon injection mouldings supplied by Messrs. Prestware Ltd. London, and it is believed that the nylon moulding powder was obtained from Imperial Chemical Industries. Rings of a modified design, i.e. tapered section as shown in FIGS. 4 and 5, were also tested, these being machined from extruded rods of Grade A 100 Maranyl and Grade M 2 Aculon to the sizes shown.



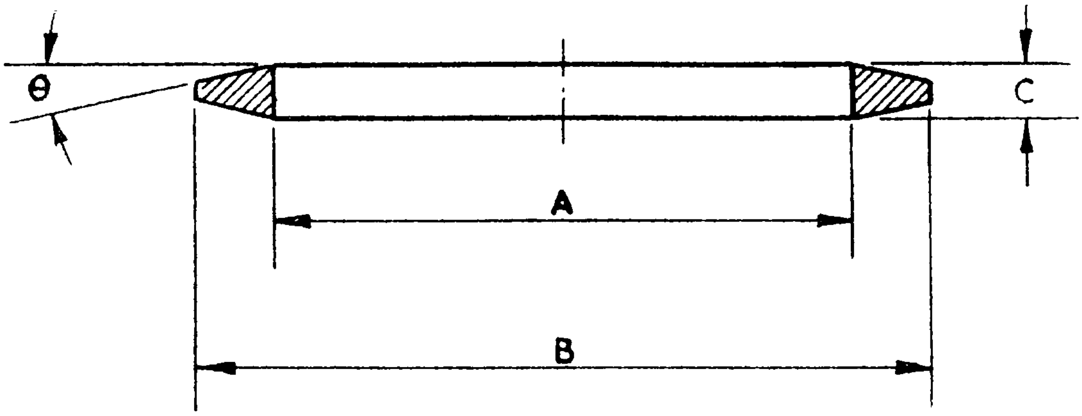
A (*inches*)	*B* (*inches*)	*C* (*inches*)	*D* (*inches*)	*E* (*inches*)	*F* (*inches*)
0·35	0·47	0·56	0·65	0·77	0·1
0·75	0·87	0·96	1·05	1·17	0·1
1·0625	1·16	1·27	1·38	1·52	0·12
1·575	1·71	1·83	1·95	2·11	0·12
3·0	3·16	3·37	3·58	3·74	0·25

FIG. 3—DIMENSIONS (NOMINAL) OF NYLON DIAMOND JOINT RINGS TESTED

Test Rig Details

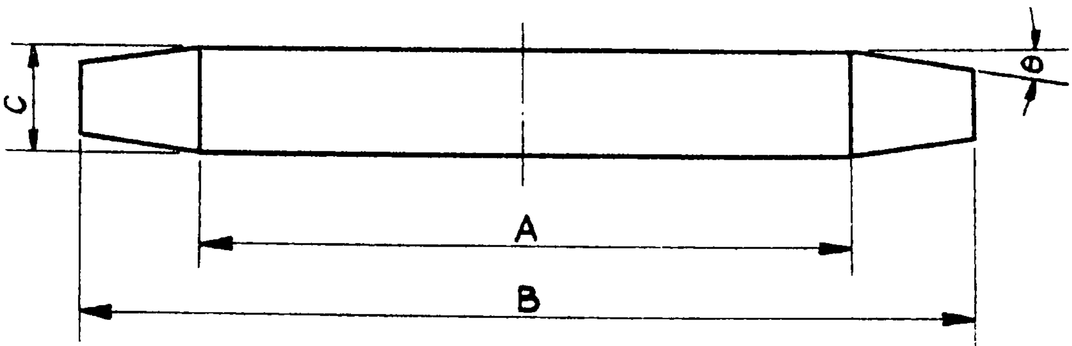
Bench tests were carried out with the apparatus shown in FIGS. 6 and 7 and investigations were carried out into the effects of bolt tightening and distortion of joint rings.

Final tests were made with the vibrator rig shown in FIG. 8. With this rig, fixed and pulsation pressures could be applied to the pipe assemblies which could also be vibrated by means of the connecting rods mounted on the eccentrics. The joint rings were subjected to the following tests :—



Nominal Size of Ring (inches)	*A (inches)*	*B (inches)*	*C (inches)*	θ *(degrees)*
3	3·000	3·830	0·260	9
1·9	1·890	2·510	0·260	7½
1·5	1·565	2·100	0·260	7½
1	1·053	1·510	0·260	6
0·75	0·740	1·160	0·160	6
0·35	0·340	0·760	0·110	6

FIG. 4—TAPERED JOINT RINGS—DIMENSIONS FOR FINAL TEST



Joints in Pipe No.	*Material*	*A (inches)*	*B (inches)*	*C (inches)*	θ *(degrees)*
1 (2 in.)	Aculon	1·790	3·092	0·440	4½
2 (2 in.)	Aculon	1·790	3·092	0·460	6
3 (2 in.)	Maranyl	1·790	3·092	0·440	4½
4 (1¼ in.)	Maranyl	1·120	2·092	0·400	3
5 (1¼ in.)	Maranyl	1·120	2·092	0·400	4½
6 (1¼ in.)	Aculon	1·120	2·092	0·400	3

FIG. 5—SIZES AND POSITIONS IN TEST RIG OF JOINT RINGS TESTED

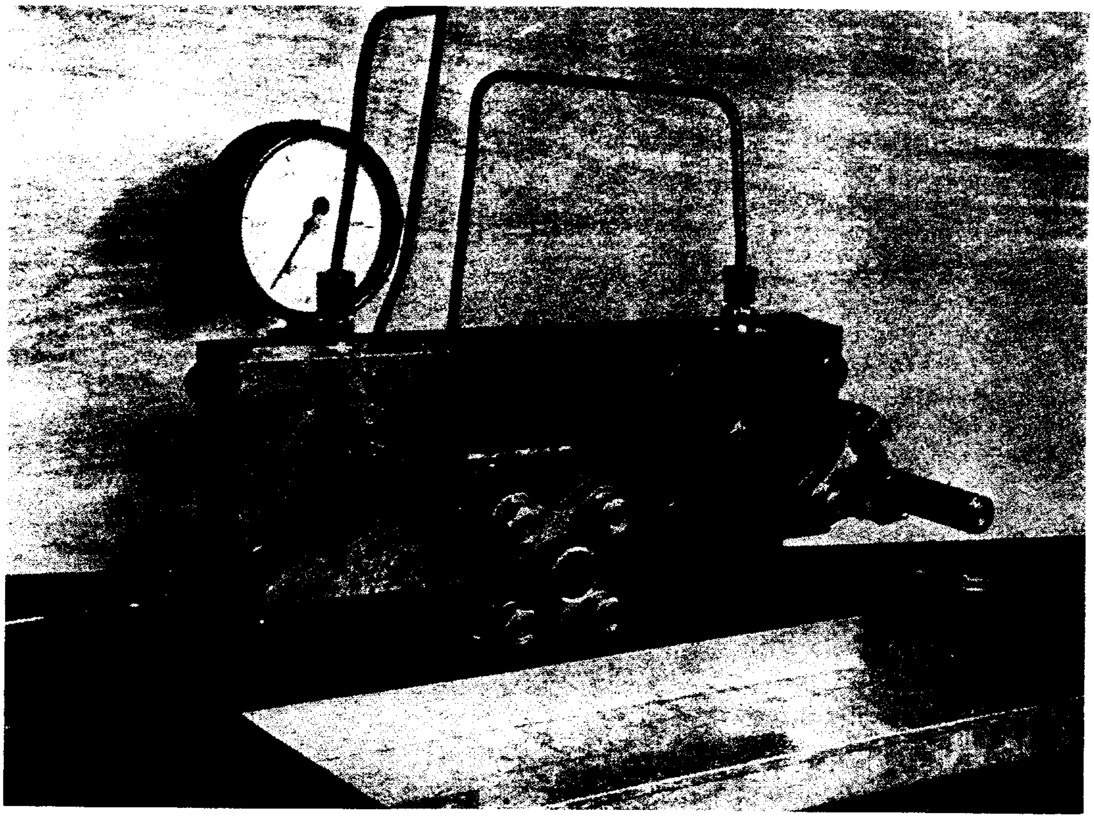


FIG. 6—BENCH TEST RIG

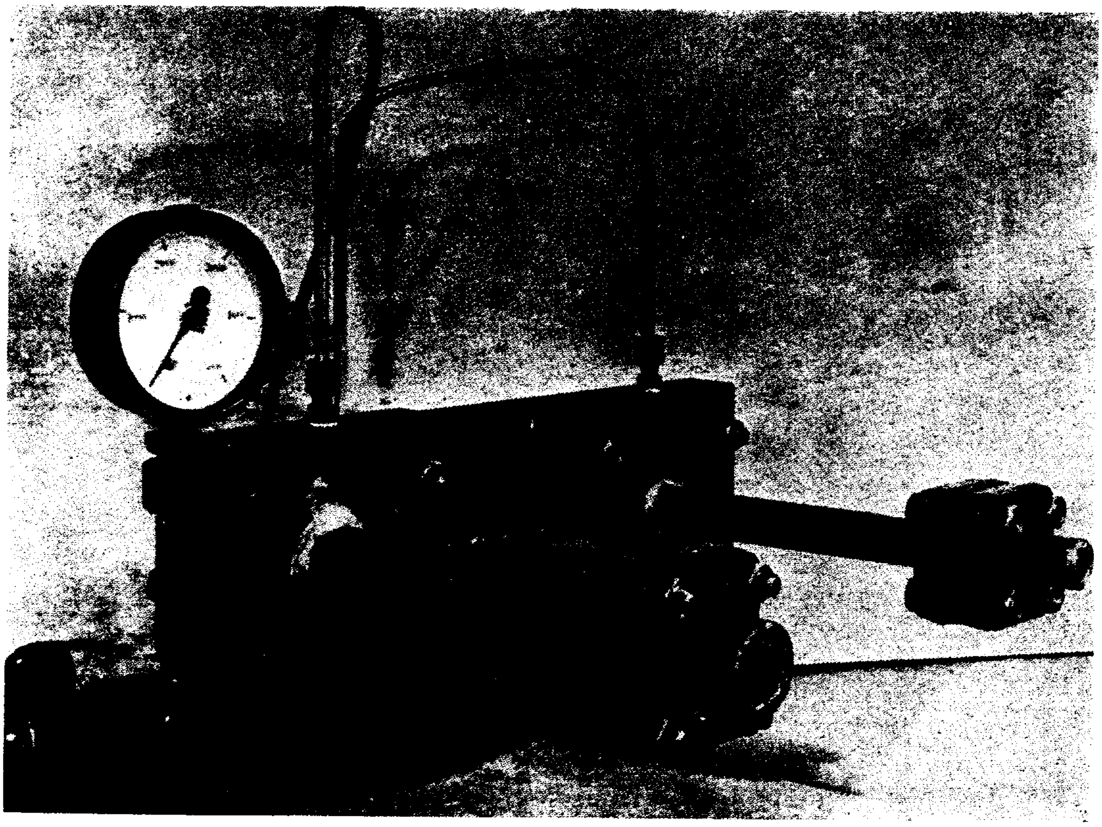


FIG. 7—BENCH TEST RIG

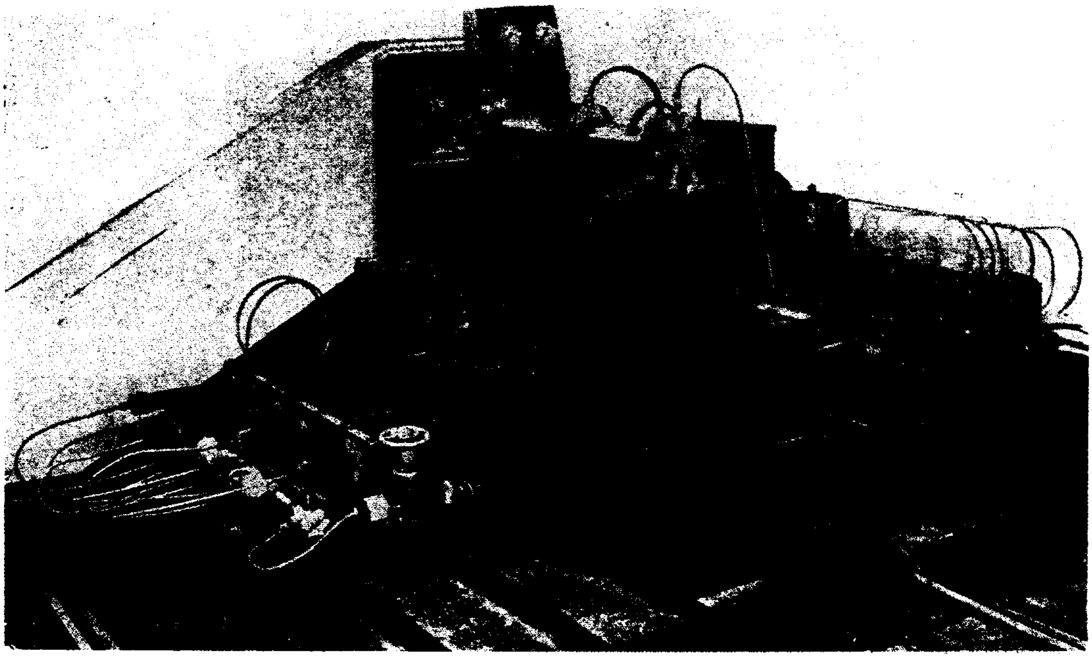


FIG. 8—VIBRATION TEST RIG

(*a*) Ten million vibrations, at various frequencies up to 1,000/min. and pressures up to 2,500 lb/sq in. in the pipes.

(*b*) 50,000 pulsations of pressure, between 200 and 1,500 lb/sq in. at the rate of 19/min., 30,000 pulsations with the pipes not vibrating and 20,000 vibrating as in (*a*).

(*c*) Misalignment tests with vibration and pressure, the misalignment applied in $\frac{1}{2}$-degree increments and the pipes subjected to 250,000 vibrations at each angle, with a pressure of 2,500 lb/sq in. in the pipes. Static pressures up to 5,000 lb/sq in. with no vibration were applied at intervals during the vibration tests.

(*d*) Shock tests were carried out by applying three blows of 40g, 80g and 120g to the system while an oil pressure of 1,500 lb/sq in. was maintained.

The bolt torque applied is shown in TABLE I.

TABLE I

Pipe Size (inches)	*Bolt Diam. (inches)*	*No. of Bolts*	*Bolt Torque (lb ft)*
3 (Bore)	$\frac{7}{8}$	4	100
1·9 ,,	$\frac{3}{4}$	4	75
1·5 ,,	$\frac{5}{8}$	4	60
1·0 ,,	$\frac{1}{2}$	4	50
0·75 ,,	$\frac{1}{2}$	3	50
2·0 (O.D.)	$\frac{1}{2}$	4	50
1·25 (O.D.)	$\frac{1}{2}$	4	50

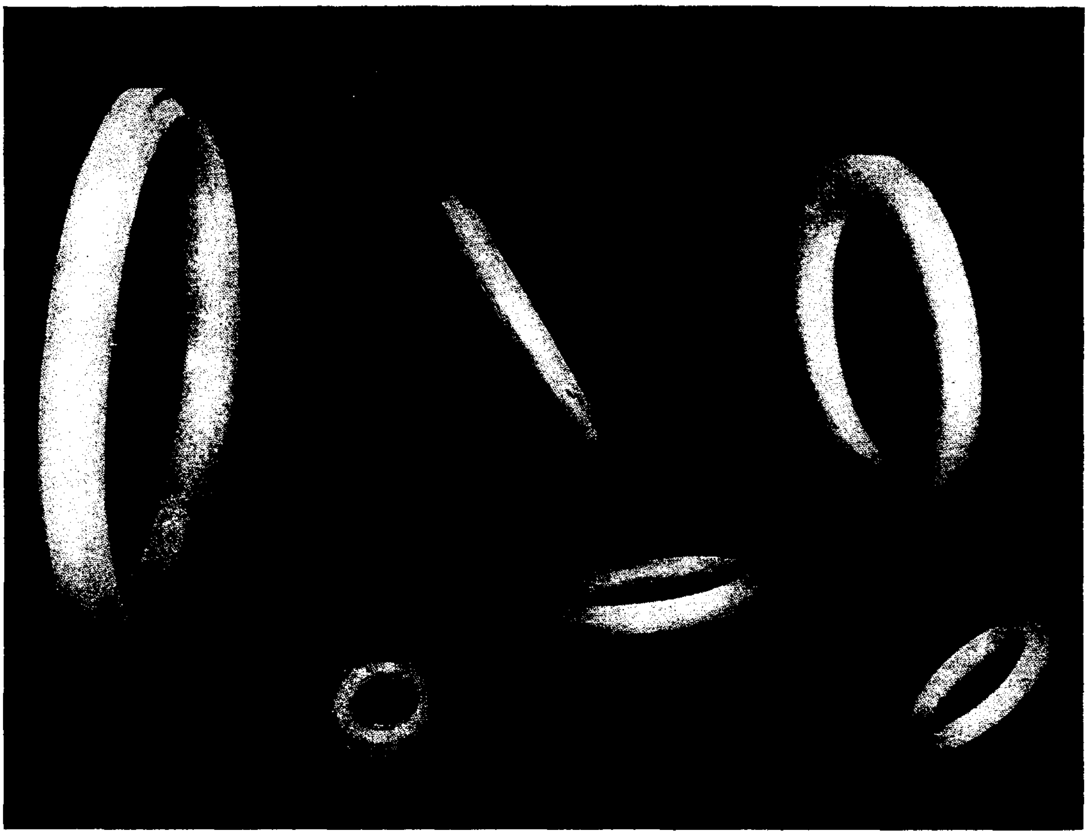


FIG. 9—NYLON RINGS

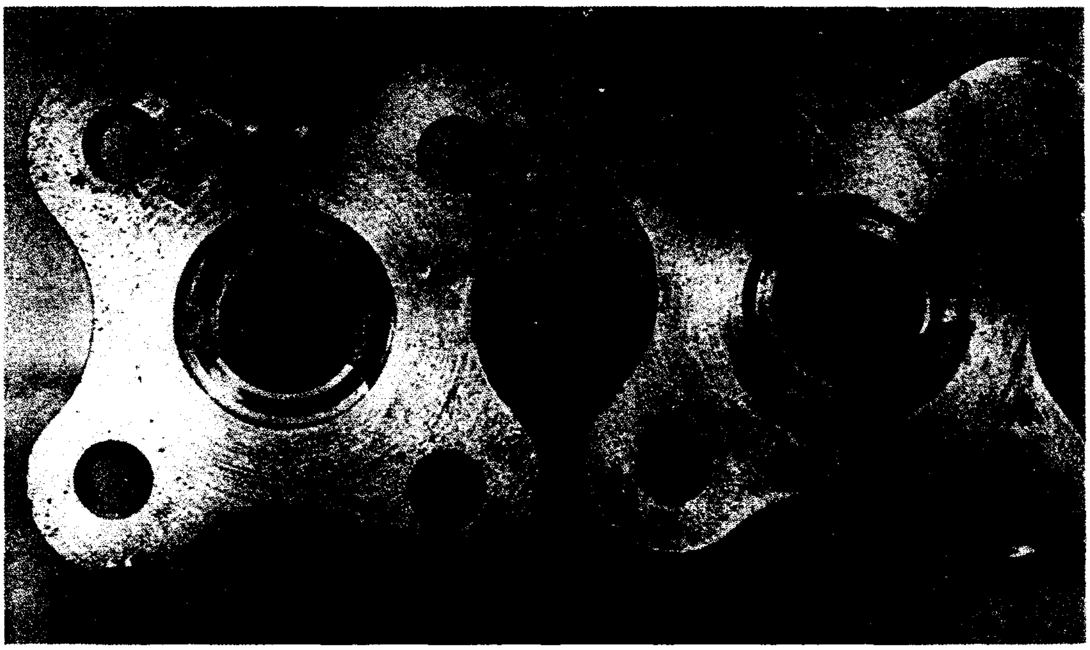


FIG. 10—DIAMOND NYLON JOINT RINGS AFTER TEST

Results of Test (Diamond Shaped Joints)

Joint rings were tested on the vibrating rig as shown in FIG. 8 and several leaked excessively and on examination of the pipe end of the flanges it was found that these were marked and required machining.

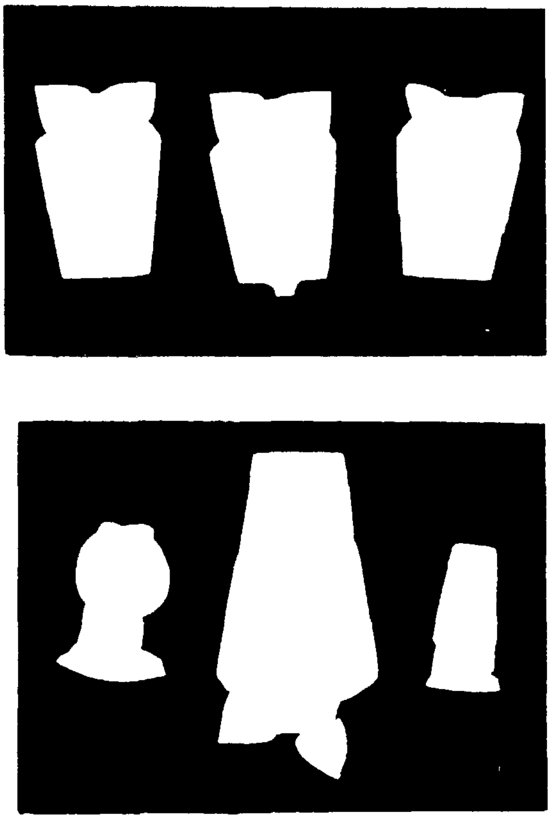


FIG. 11—NYLON JOINTS IMMEDIATELY AFTER TESTS

During the misalignment tests, several leaks occurred up to three degrees and on inspection after trial, the rings were found to be broken and embedded in the bottom of the ' Vs ' as shown in FIG. 10.

Results of Modified Design

Rings of the tapered section (FIG. 4) enabled initial local high stressing to occur only on the pipe ends.

The effect of the angle of taper on the sealing performance and also flange reduction were investigated and found to be as shown in TABLE II for the three-inch bore pipes.

TABLE II

Taper (degrees)	*Initial Flange Gap (inches)*	*Initial Spigot Entry (inches)*	*Flange Gap Reduction (inches)*	*Test Pressure (lb/sq in.)*
3	0·25	0·05	0·036	3,000
4½	0·28	0·02	0·054	3,000
6	0·25	0·05	0·055	3,000
7½	0·28	0·02	0·077	3,000
9	0·28	0·02	0·072	3,000
10½	0·25	0·05	0·193	3,000

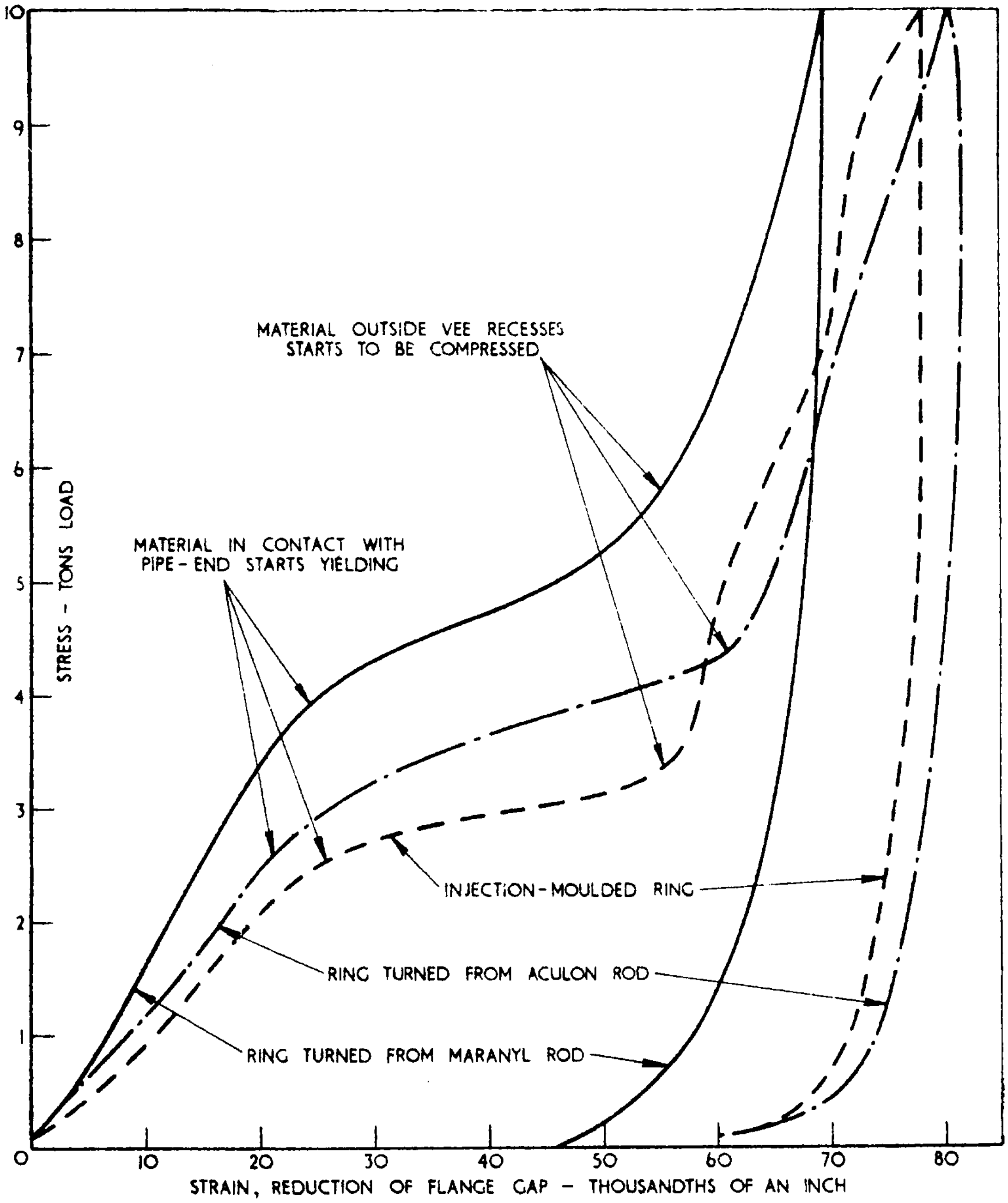


FIG. 12—STRESS-STRAIN DIAGRAM OF TAPERED JOINT RINGS FOR 1·9 IN. DIAMETER PIPES MADE OF THREE MATERIALS

No leakage occurred at any joint under test during vibration, pressure and shock tests. During the misalignment tests the 3 in. bore pipe joint leaked at $2\frac{1}{2}$ degrees misalignment and tightening the joint to 160 lb/ft did not stop it.

The remaining pipes were misaligned to three degrees and no leakage occurred. Distortion of the rings took place and this is shown in FIGS. 10 and 11.

Similar tests were carried out on D.N.O. flanges No. 7882 and no leakage occurred and the final condition of the rings was excellent.

No evidence, except that Maranyl Grade A 100 is harder material than Aculon Grade M 2, which means that any imperfections in the surface of the ferrules are less rapidly taken up by the former, suggests that of the two materials either is preferable to the other.

A stress-strain diagram of the top joint rings of the three materials used for the 1·9 in. bore pipe is shown in FIG. 12.