ADMIRALTY ENGINEERING LABORATORY

WORK OF HYDRAULICS SECTION, 1961

This report reviews the work of the Hydraulic Section of the Admiralty Engineering Laboratory in 1961. It is intended for the information and, it is hoped, the interest of those who may not be fully aware of the activities of this Section. Reference is made to the A.E.L. Reports and Internal Memoranda. The latter are the normal immediate reporting means to inform the sponsor Section at Admiralty of results of trials, states of progress, etc., and are produced only in small numbers. Should any reader wish to obtain copies of particular Internal Memos, he should address his request to the Superintendent, Admiralty Engineering Laboratory, West Drayton, Middlesex. A.E.L. Reports are obtainable through the Admiralty Centre of Scientific Information and Liaison, (A.C.S.I.L.) London.

BEARINGS

Engineering practice in high speed plain bearings, particularly the pinion bearings of warship double-reduction gear trains, has outstripped design knowledge of the subject. To redress this situation an extensive programme of research and development testing is planned to be undertaken at the A.E.L. The programme requires a considerable test installation, at the heart of which is a bearing test unit that will permit data to be obtained on temperature distribution, oil flow, friction and journal attitude in bearings of 6 in. nominal bore, loaded up to 24,000 lb with shaft speeds up to 15,000 r.p.m. The test unit has been delivered and, in FIG. 1, it is shown lined up to its driving mechanism. As there is no steam available for a turbine drive, this comprises a variable speed d.c. motor with speed stepped up in two stages, viz. by toothed belt drive and speed-increasing gearbox respectively.

The bearing test unit is shown partially dismantled, revealing thermocouple leads in the top half inner bearing block. The shell type test bearing is contained within this. Not seen is the outer bearing block, to which is attached a friction torque measuring arm. Load is applied vertically downwards by tie rods from a hydraulic jack acting upon a hydrostatic bearing cap over the outer bearing block.

FILTERS

There has been no filter testing during 1961, but developments that will shortly result in a considerable test programme have been taking place elsewhere. Interest centres on a filter intended for the Diesel engine lubricating oil duty (especially A.S.R.1. engines), cleanable by backflow (reflux) or other flushing methods. Autoklean Strainers Ltd., have completed the development of a prototype reflux filter, which will be delivered to the A.E.L. for evaluation and assessment for the Diesel lubrication duty, in early 1962. The Perolator Filter Division of Automotive Products Ltd., have developed a refluxable element sized to replace the present standard Vokes filter element in A.S.R.1. engines. This too will be tested in similar fashion to the Autoklean prototype reflex filter. The 3000 g.p.h. test rig used for a number of filter tests in past years will be employed for this purpose. A different test technique is intended, however, with ' before and after ' particulate counts of contaminant, using a Millipore sampling kit. The main part of the test will employ a standard test contaminant for I.C. Engines, made up by the Motor Industries Research Association (M.I.R.A.).

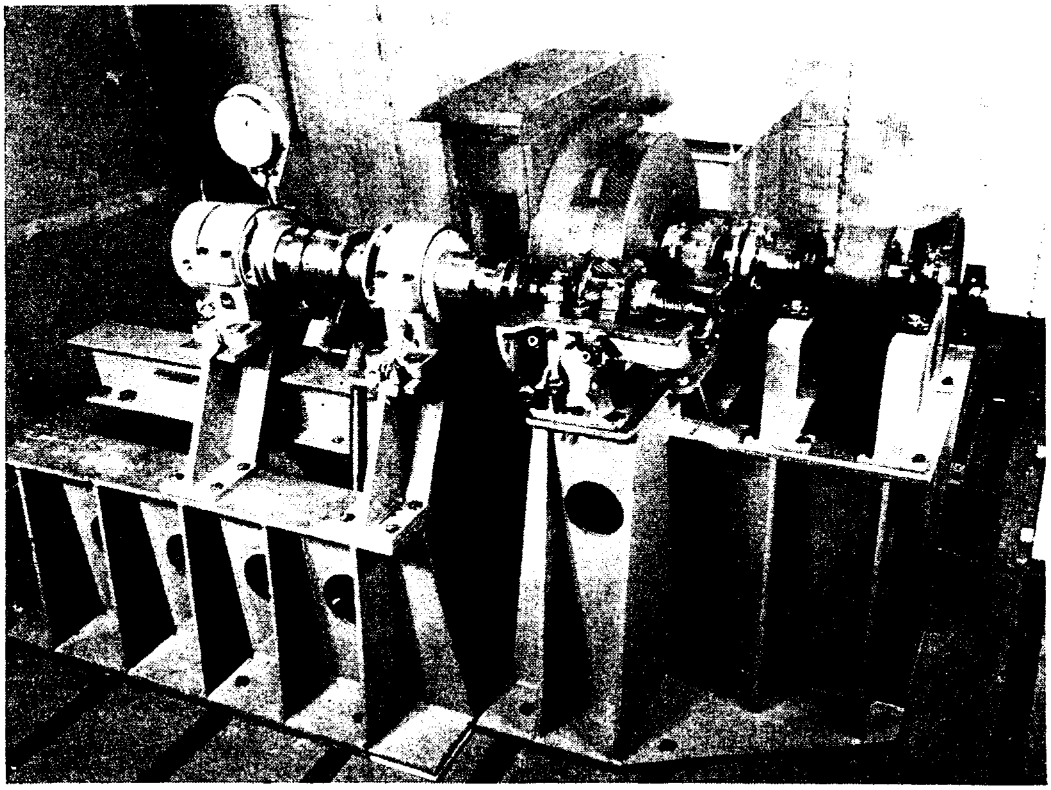

FIG. 1—BEARING TEST RIG

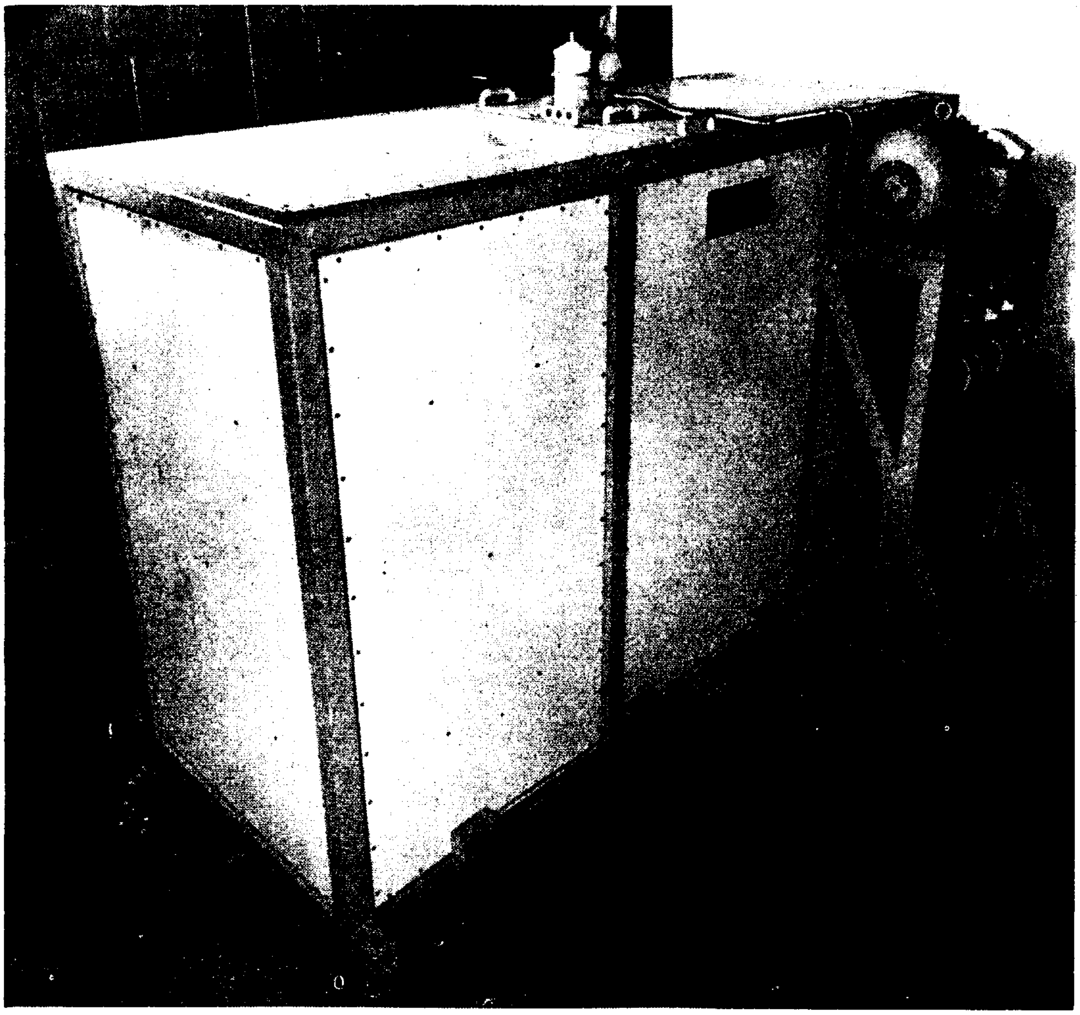

FIG. 2—HOSE VIBRATION ENDURANCE TEST RIG

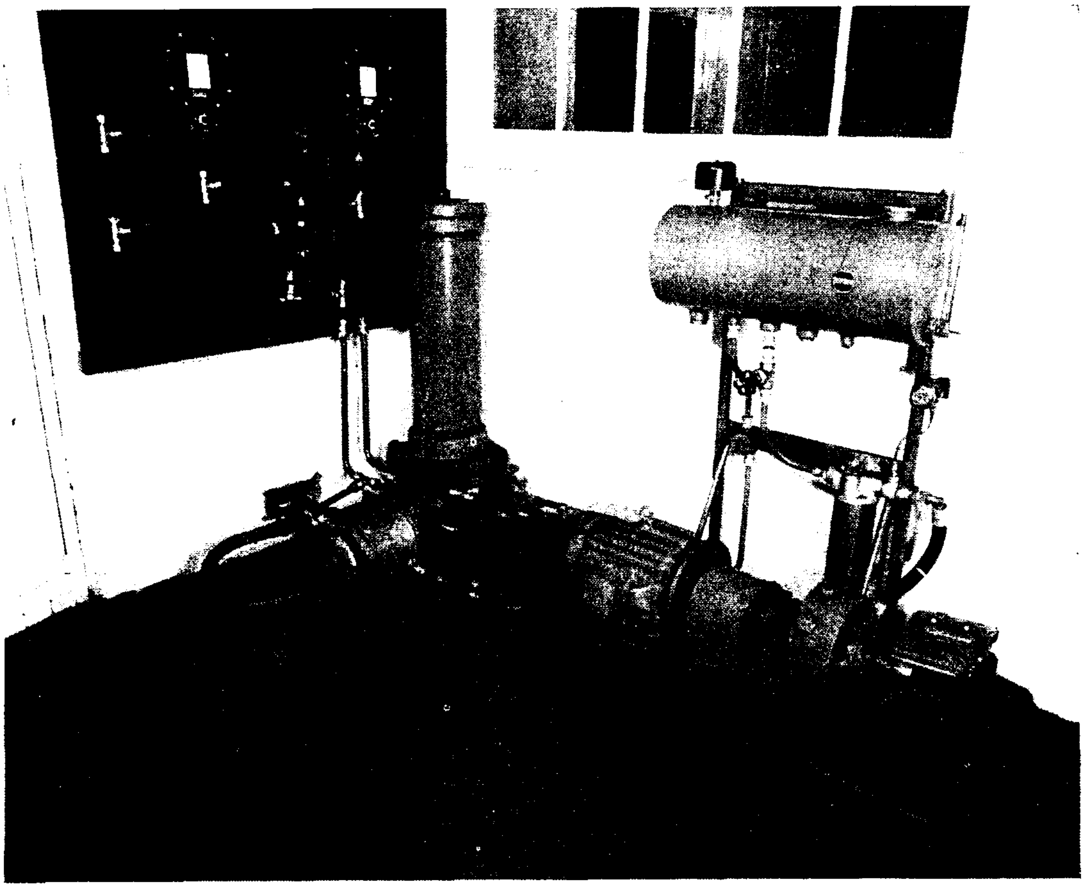

FIG. 3—HOSE PULSING RIG

HOSES

Vibro Rig

FIG. 2 shows a hose vibration endurance test rig, delivered in 1961. This comprises an insulated, heated cabinet, which can accommodate hoses up to 4 in. bore, bent at their minimum (test) radii. Up to six hoses of a given size can be tested under pressure simultaneously. The hoses are vibrated mechanically at 3,000 c.p.m., with a linear amplitude of 0·050 in. applied at one end of the hose, perpendicular to the plane containing the hose. A smoke detector is fitted, which will shut off heaters and vibration drive motor in the event of hose failure spraying hydraulic fluid inside the heated cabinet. The rig has not been operated in service yet, it being intended as a test facility capable of meeting hose specification type tests.

Pulse Rig

FIG. 3 shows a pressure impulsing endurance rig being installed from parts delivered in 1961. This is another hose test facility designed to cope with type testing. It caters for ' over-peaking ' pressure pulse cycles, as called for in hydraulic hose specifications. The shape and duration of the pulse cycles can be selected with a wide freedom of choice.

Submarine Hoses

A lengthy series of tests on hoses used in submarines was completed in 1961. The tests included static pressure tests, ability to be bent when chilled down to —40 degrees C, and endurance tests on an oscillating rig. New hose samples were run in comparison with hoses removed after a commission in H.M. submarines. The results were reported in A.E.L. Internal Memo. No. 453/HYD.

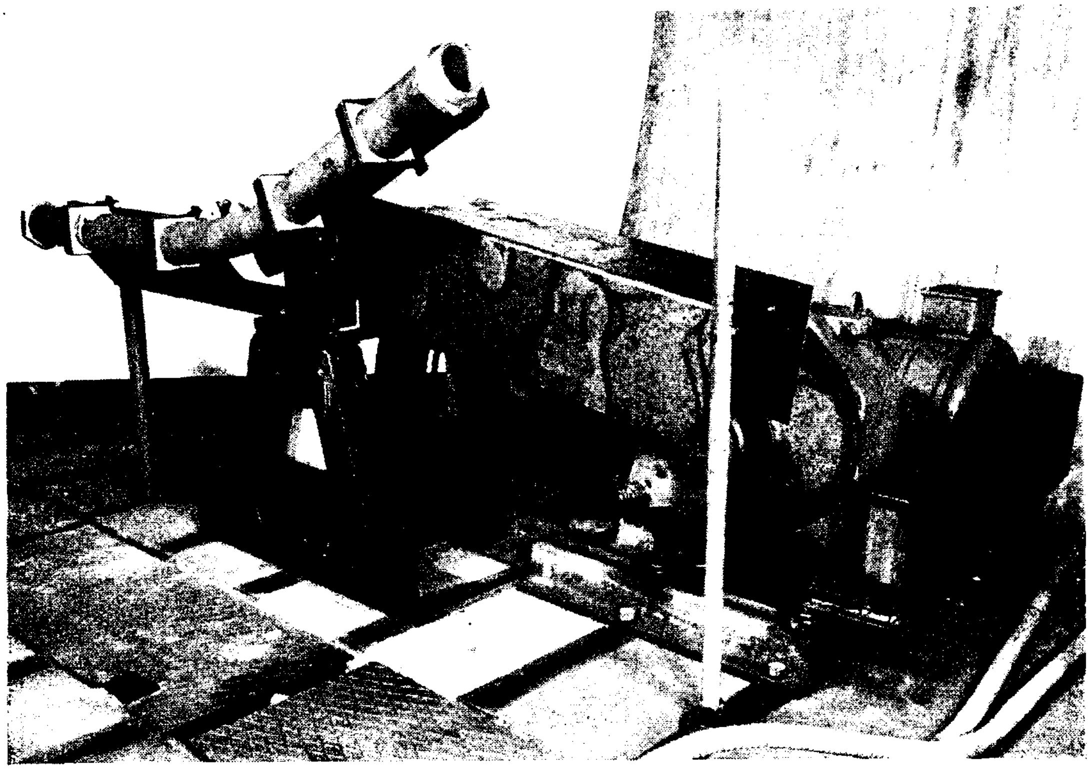

FIG. 4—AVFUEL HOSE FLEXING RIG

70. With the exception of those discussed in the next paragraph the hoses showed remarkably little deterioration in service.

Lockheed 2 in. Bore Type 8 Hoses

All the hoses mentioned above were of Lockheed Avery manufacture. One particular group, viz., 2 in. bore type 8, which had been used for sea water circulation, showed serious deterioration in service, and tests on a total of 36 of this type, size and service location were run. The results were reported initially in A.E.L. Internal Memo. No. 448/HYD.68, subsequently reissued as A.E.L. Report No. 362. It was concluded that some hoses deteriorated by corrosion of the wire braid reinforcement occasioned by small leaks through the inner lining, but that the majority suffered by corrosion of the braiding due to external condensation at the end connexions.

AVFUEL Hoses

Type testing to a provisional Admiralty specification of various makes of collapsible hose for flight deck refuelling of aircraft was commenced. As well as static pressure and bonding tests, flexing and pulsing tests were carried out. The rig used for the flexing test is shown in FIG. 4. The series is not yet completed, and no report has been issued. The hoses so fai tested (B.T.R. and Goodyear) have met the specified requirements.

Telemotor Hoses

Two samples of spiral-wrapped hose, intended for submarine telemotor service, were tested. Dimensional changes under static pressure were measured, and endurance tests of 100 hours pulsing and 100 hours vibration at 2,400 c.p.m. and 0.050 in. amplitude were carried out, followed by proof pressure tests and bursting. The hose stipulated burst pressures were not achieved, both hoses failing due to poor welding of the satinless steel elbow fittings. These tests were reported in A.E.L. Internal Memo. No. 400/HYD.56.

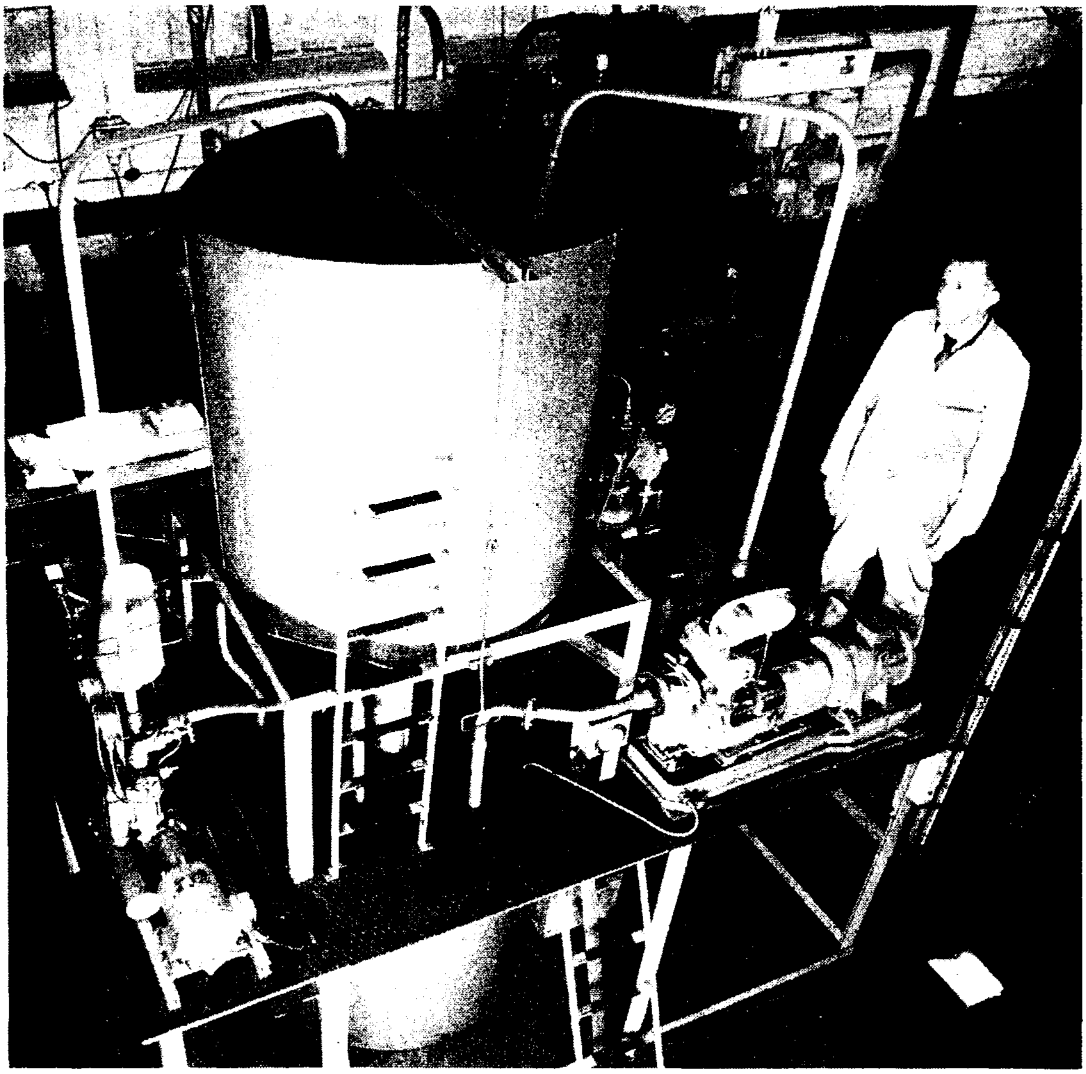

FIG. 5—BILGE PUMP TEST RIG

MISCELLANEOUS

Pressure Gauges

Further type testing of pressure gauges was conducted, with the aim of extending the list of manufacturers capable of supplying gauges to comply with ADSPEC 1001. This specification is virtually B.S. 1780 with permitted additional special gauges, and with shock and pulsation endurance tests added. It is of note that it is by no means an unusual experience to find that gauges frequently do not meet the basic requirements of B.S.1780, in respect of accuracy and construction. Samples treated in 1961 included the products of C. and A. Stewart, I.V. Pressure Controllers, Tomey Industries and Gauges Bourdon (Great Britain). Tests were reported respectively in A.E.L. Internal Memos. Nos. 360/HYD.52, 401/HYD.57, 443/HYD.66 and 452/HYD.69. Although not one of the 17 gauges tested completely met the specification, there is every reason to believe that the specification is sound and that manufacturers can improve their product without any great expense, to conform with it. The present state of success of manufacturers in progress towards clearance to supply gauges to ADSPEC 1001 thus remains as reported in Table 2 of A.E.L. Report No. 357.

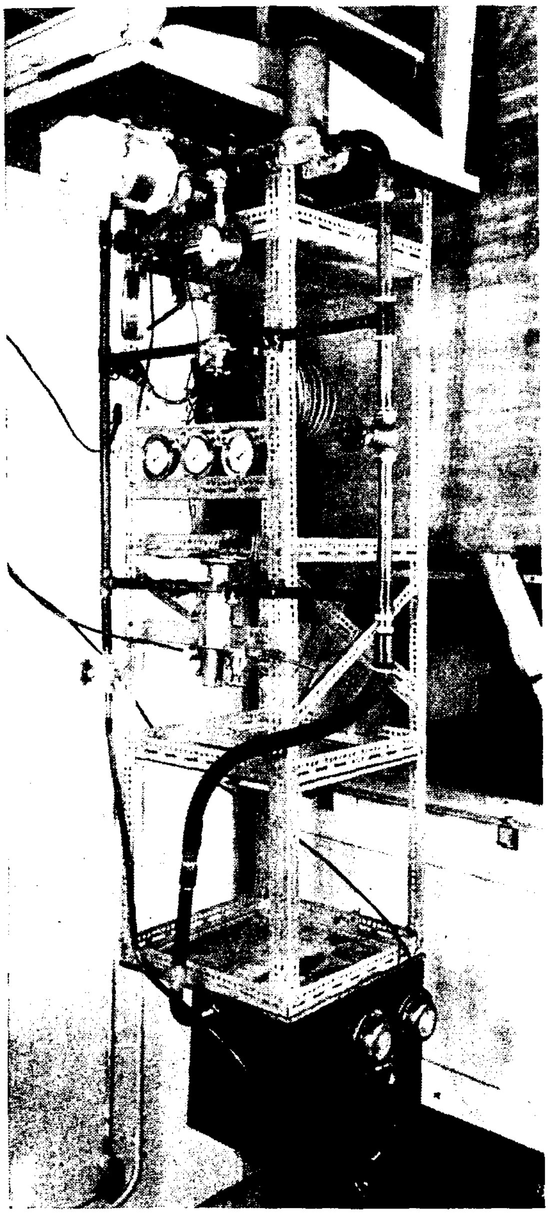

FIG. 6—TURRET RELAY PUMP SEAL RIG

AVFUEL/Water Probe

A rig is being manufactured, but is not yet commissioned, to test the efficacy and reliability of conductivity probes to sense the build-up of separated water in the sump of an AVFUEL filter-separator. The use of such probes would be to operate an automatic drain system to dump separated water.

PUMPS

Goodyear B7

This interesting design of screw type pump operated for a total of 1,710 hours on an endurance cycle to simulate that of an occasionally surfacing submarine. The pumped fluid was sea water, generally under a pressure of 200 lb/sq in. The duty in respect of pumping rate and pressure differential was light for the size of pump. Nevertheless, having made allowance for this, the performance of the pump left little to criticize. The tests were reported in A.E.L. Internal Memo. No. 423/HYD.61.

Bilge Pumps

Five pumps have been operated together on the rig illustrated in FIG. 5, on a test schedule to determine which ones would be suitable for machinery space bilge clearance duty in H.M. ships. Two of the pumps are already in service, and the others were new contenders. The tests, which included periods of dry running, were conducted with sea water contaminated with sand and other materials that might find their way into bilges. An interim report of the tests, viz. A.E.L. Internal Memo. No. 466/HYD.72, was issued at about 600 hours' running, which indicated that the two 'established' types, both positive displacement machines, are unsatisfactory, and that another positive displacement contender is also unsatisfactory, all being susceptible to wear. The remaining two contenders are self-priming centrifugals. One, the LaBour 10 UHL is very successful, and shows no diminution of output. The other is not so successful, being a slow primer and having an Achilles heel in the form of a wear-prone carbon type face seal.

SEALS

Turret Relay Pump Face Seal

The rig shown in FIG. 6 was put together to evaluate a prototype carbon face seal fitted to a turret relay pump, vis-a-vis the standard twin lip seal arrange-

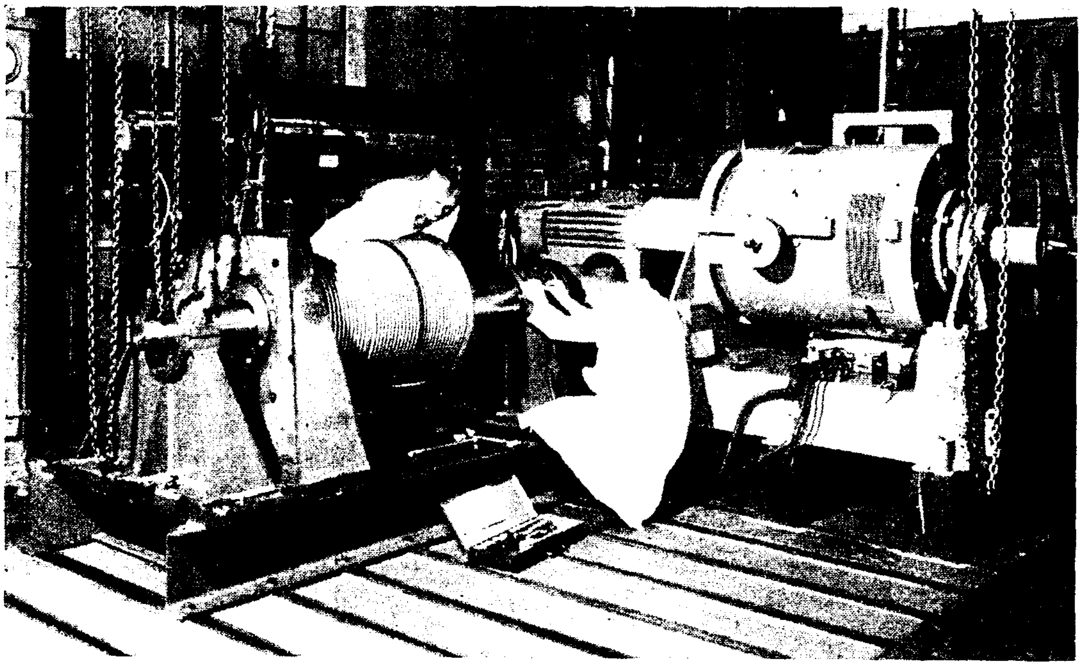

FIG. 7—FLEXIBLE BULKHEAD GLAND RIG

ment. The latter was shown to permit air in-leakage if the pump suction is at 5 in. Hg vacuum or more. The prototype face seal allowed considerable outward oil leakage under normal suction conditions, apparently due to uncertain axial location. A report was made in A.E.L. Internal Memo. No. 427/HYD.62. Subsequently the face seal has been modified to essay an improvement in axial fixing, and tests will be resumed.

Propeller Shaft Face Seal Test Rig

Drawing office work was largely completed, and the manufacture is well in hand of a rig designed to test face seals for submarines and surface ships. The shaft size selected is $17\frac{5}{8}$ in. diameter, and the test capability is for sealed pressures up to 500 lb/sq in., and shaft speeds up to 267 r.p.m. Axial movements corresponding to shaft movement when going from ahead to astern, and axial vibration can be imposed, as can also athwartship movements to simulate shaft bearing wear-down, and to apply angular misalignment. Sea water will be used as the test medium.

Flexible Bulkhead Gland

FIG. 7 shows the test set-up used to test the capabilities of a prototype flexible bulkhead gland, which can be seen in the picture. The drive motor, gearbox, bedplate and bearing pedestals will be used in the shaft seal test rig mentioned in the previous paragraph. The gland was not a success, the main snag being the very heavy twisting load imposed on the gland bearing by the bellows face when the bulkhead was placed in the ' distorted ' position. This load caused rapid failure of the whitemetal bearing. The tests are reported in A.E.L. Internal Memo. No. 407/HYD.59.

Face Seal Triple Test Rig

A rig comprising three pairs of carbon face seals, each pair arranged back to back to seal a pressure chamber, was delivered in 1961. It can be seen in FIG. 8. Each pressure chamber is mounted so as to permit torque measurements to be made. The object of the rig is to enable simultaneous testing of up to six seal

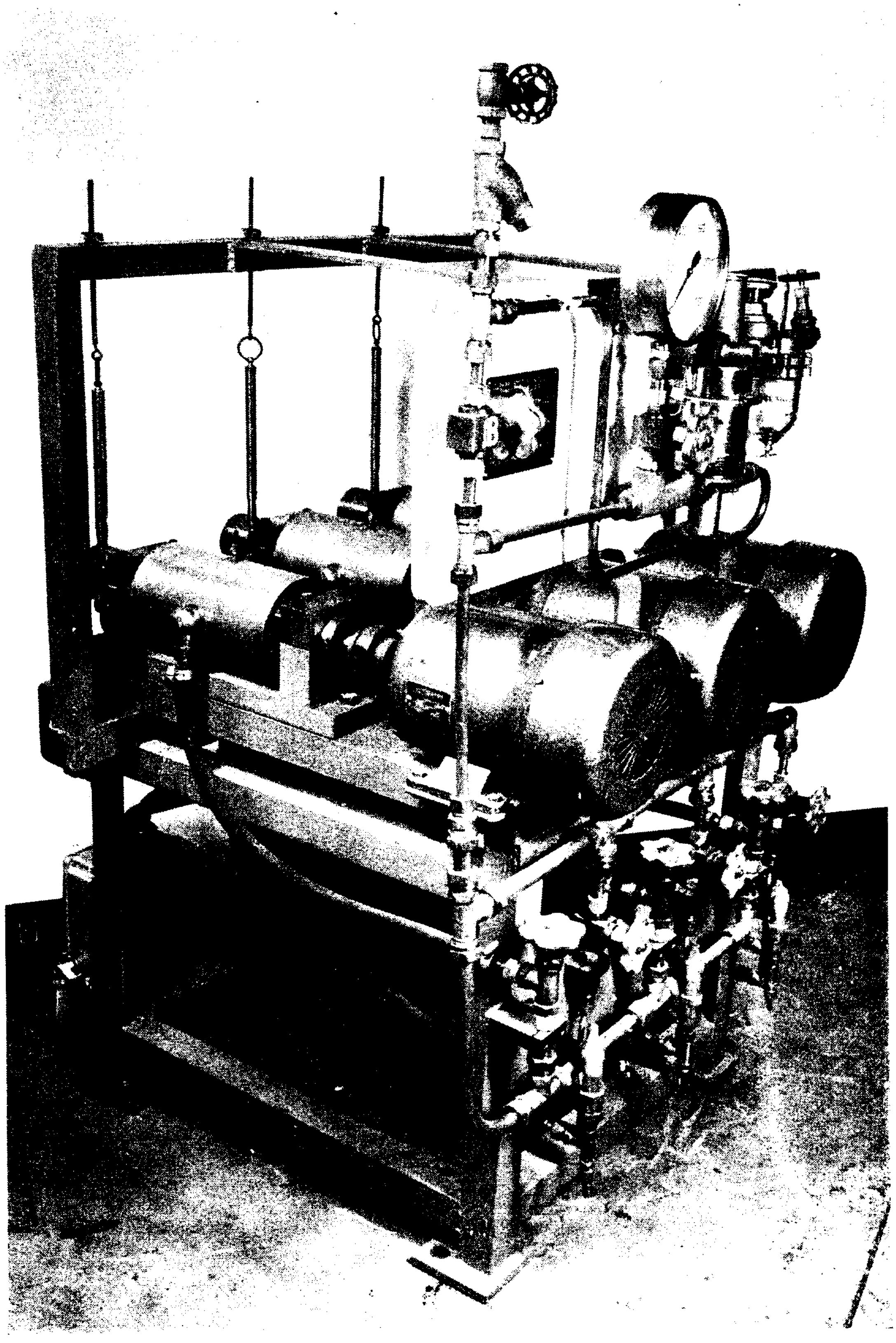

FIG. 8—TRIPLE FACE SEAL MATERIALS RIG

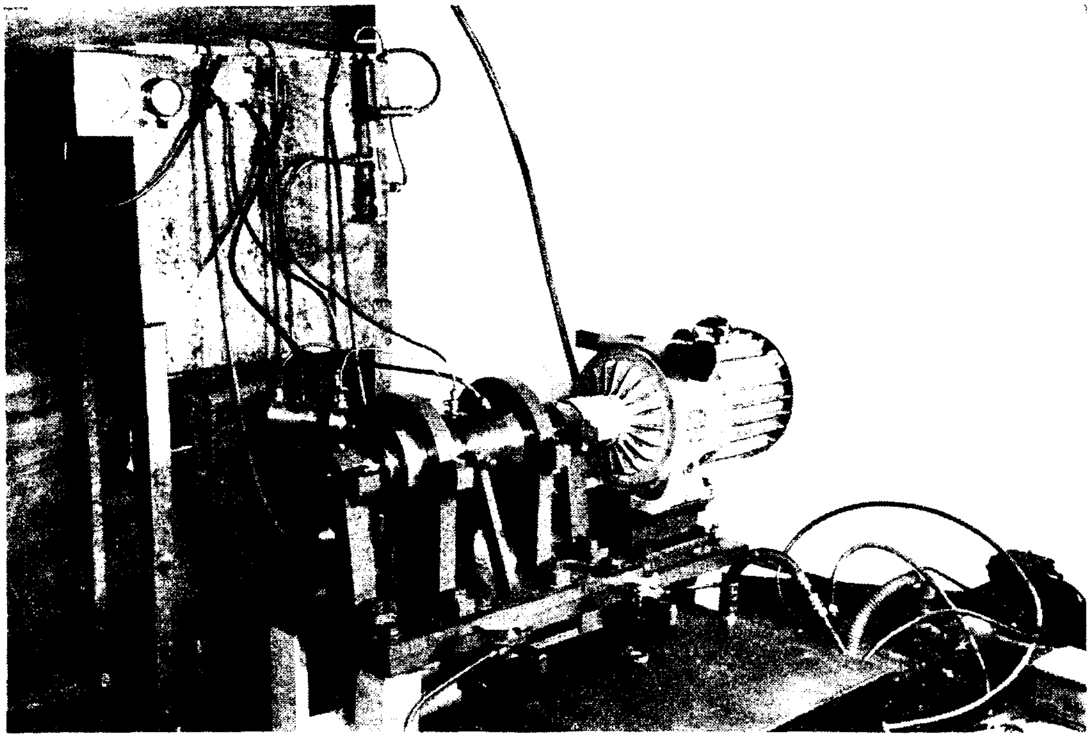

FIG. 9—2-INCH RING SEAL RIG

'ace material combinations to be conducted, the experimental combinations aking the place of the materials used in the standard face seals supplied with he rig. Test pressures up to 1,000 lb/sq in. are applicable, with sliding speeds ıt the sealing faces of 950 f.p.m.

Ring Seal R. and D.

With the submarine shaft seal problem most in mind, some experimental vork has been carried out on ring seals, i.e. seals which press around the shaft ircumference, as opposed to face seals, which press against the flat surface of . collar. A small rig inherited from earlier sealing investigations was used, and an be seen in FIG. 9. The oil-buffered floating bush was the first type tried, .nd its characteristics were sufficiently well established to enable large versions o be designed to suit the propeller shaft face seal test rig. In this rig a dummy ›iston and floating bush seal balances the thrust of the face seal under test. ˜he floating bush experiments are briefly reported in A.E.L. Internal Memo. No. 445/HYD.67. A matter considered at this time was the deflection of the ›ush under the axially varying pressure differential, and this focussed attention ›n the feasibility of a self-regulating annulus, i.e. a ring which would be squeezed ı as pressure increased, until it finally would cut off leakage between itself and he shaft. A brass seal of this type demonstrated the action, but was dropped ›ecause of excessive wear. A nylon-lined brass ring worked quite well at first ›ut failed after a time when the sealed fluid got between the ring and the nylon, nd caused partial collapse of the latter. At present two forms of self-regulating nnulus are under investigation which utilize soft packing. One of these is a rease-buffered seal, the grease being automatically pressurized by the sealed uid by means of the hydraulic intensifier that can be seen at the free end of he rig in FIG. 9.

Spiral Wound Gaskets

A new specification for flanged joint gaskets D.G.S. No. 8851 has been intro-

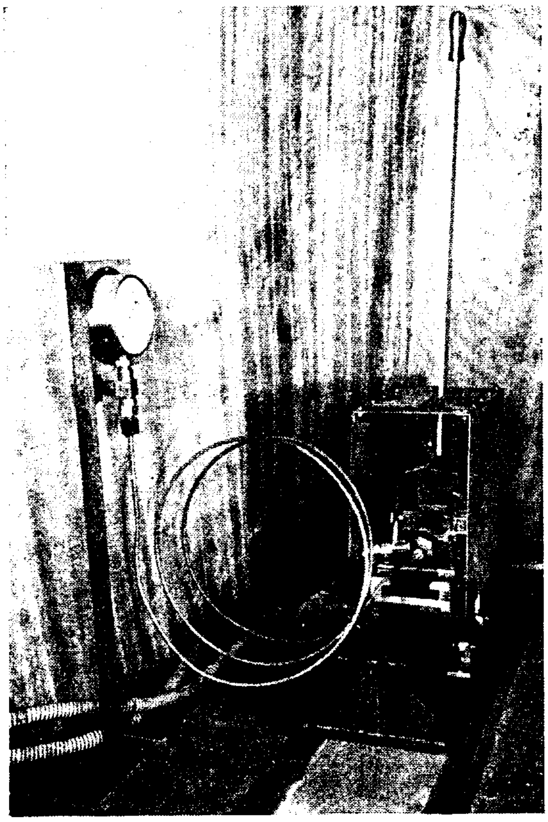

FIG. 10—H.P. AIR SELF-SEALING COUPLING RIG

duced, and type approval tests to this specification were conducted with successful outcome on James Walker Metaflex gaskets. The results are reported in A.E.L. Internal Memo. No. 441/HYD.65.

VALVES

H.P. Air Self-Sealing Coupling

A prototype self-sealing coupling, designed and made by Hale Hamilton Valves, Ltd., for use in guided missile handling systems was tested for expected reliability in service, in the rig shown in FIG. 10. This enabled repeated engagements and disengagements to be performed. After being twice modified the coupling was deemed to be satisfactory. The trials of the original prototype and its successive modifications are reported in A.E.L. Internal Memos. Nos. 415/HYD.60, 430/HYD.63 and 454/HYD.71.