Designation: D 2882 – 00

An American National Standard

Standard Test Method for Indicating Wear Characteristics of Petroleum and Non-Petroleum Hydraulic Fluids in Constant Volume Vane Pump[1]

This standard is issued under the fixed designation D 2882; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a constant volume high-pressure vane pump test procedure for indicating the wear characteristics of petroleum and non-petroleum hydraulic fluids.

1.2 The values stated in SI units are to be regarded as standard. The values in parentheses are for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see 6.1.3, 7.1, 7.2, 7.3, 7.4, and Note 7.

2. Referenced Documents

2.1 *ISO Standards:*[2]

ISO 4021 Hydraulic Fluid Power—Particulate Contamination Analysis—Extraction of Fluid Samples from Lines of an Operating System

ISO 4406 Hydraulic Fluid Power—Fluids-Method for Coding Level of Contamination by Solids Particles

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *flushing, v*—the process of cleaning the test system before testing to prevent cross-contamination.

3.1.2 *torquing, v*—the process of tightening the pump head bolts to achieve a uniform clamping force.

4. Summary of Test Method

4.1 An amount of 18.9 ± 0.5 L (see Note 1) (5 ± 0.13 gal) of a hydraulic fluid are circulated through a rotary vane pump system for 100 h at a pump speed of 1200 ± 60 r/min and a pump outlet pressure of 13.8 ± 0.3 MPa (2000 ± 40 psi). Fluid temperature at the pump inlet is 66 ± 3°C (150 ± 5°F) for all water glycols, emulsions, and other water-containing fluids and for petroleum and synthetic fluids of ISO Grade 46 or lighter. A temperature of 80 ± 3°C (175 ± 5°F) is used for all other synthetic and petroleum fluids.

NOTE 1—To improve reproducibility, fluid volume has been standardized in this revision of Test Method D 2882.

4.2 The result obtained is the total mass loss from the cam ring and the twelve vanes during the test. Other reported values are fluid cleanliness before and after the test, initial flow rate, and final flow rate.

4.3 The total quantity of test oil required for a run is 26.5 L (7 gal).

5. Significance and Use

5.1 This test method is an indicator of the wear characteristics of petroleum and non-petroleum hydraulic fluids operating in a constant volume vane pump. Excessive wear in vane pumps could lead to malfunction of hydraulic systems in critical applications.

6. Apparatus

6.1 The basic system consists of the following (see Fig. 1):

6.1.1 *Twelve Hundred rpm AC Motor*, or other suitable drive, with 11 kW (15 hp) as suggested minimum power requirement (see Fig. 1, Item 5).

6.1.2 *Test Stand Base*, with appropriate, rigid mounting for the motor, pump, reservoir, and other components.

6.1.3 *Rotary Vane Pump*, replaceable cartridge type,[3,4] Vickers 104C or 105C rated at 28.4 L/min (7.5 gal/min) flow at 1200 r/min with ISO Grade 32 fluid at 49°C (120°F), and 6.9 MPa (1000 psi) (see Fig. 1, Item 4; Fig. 2; and Fig. 3). (**Warning**—The test pump is rated at 6.9 MPa (1000 psi) but is being operated at 13.8 MPa (2000 psi). A protective shield around the pump is therefore recommended.)

6.1.3.1 There are to be no modifications to the pump housing, such as plugging the drain hole in the pump body or drilling and tapping a hole in the head for an external drain.

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.N on Hydraulic Fluids.

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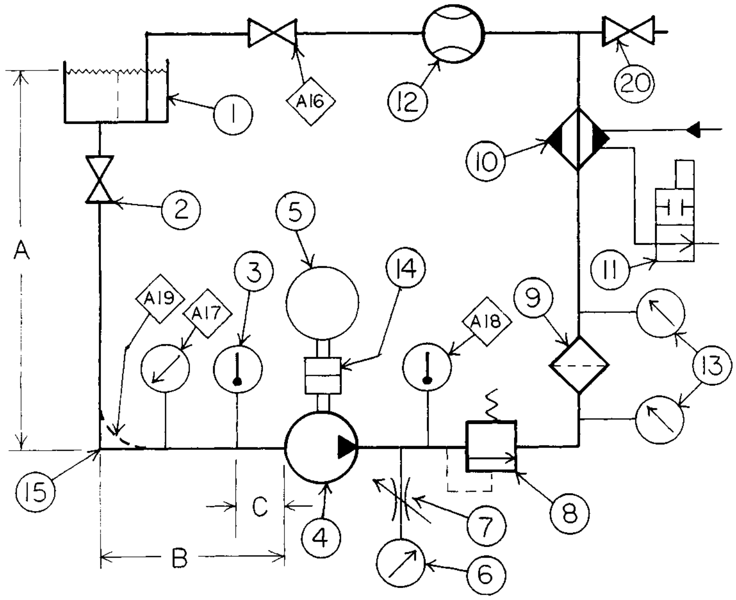
[2] Available from American National Standards Institute, 11 W 42nd St., 13th Floor, New York, NY 10017.

[3] The replaceable cartridge consists of the cam ring, the rotor, two bushings, a set of twelve vanes, and an alignment pin. Two different cartridges are available for this pump. Cartridge No. 429126 is intended to give better performance at 13.8 Mpa and uses Rotor No. 429446 and Cam Ring No. 574814. Cartridge No. 912014 uses Rotor No. 2008 and Cam Ring No. 2013. Some users report fewer pump failures when using Rotor No. 2008.

[4] The individual cartridge parts can be purchased separately, if desired. The Vickers part numbers for these items are Cam Ring No. 2013 or 574814, Pin No. 2020, Rotor No. 429446 or 2008, Bronze Bushings Nos. 2015 and 2016, and Vane Kit (twelve vanes) No. 912021.



ITEM DESCRIPTION
1. Reservoir
2. Pump inlet shut off valve
3. Pump inlet temperature sensor
4. Pump
5. Motor
6. Pressure gage for high pressure line
7. Snubber valve
8. Relief valve for pressure control
9. Return line filter
10. Heat exchanger
11. Temperature control valve
12. Flow meter
13. Pressure gages for return line filter
14. Flexible coupling
15. Inlet elbow
20. Fluid sampling port

Required Dimensions:
A. 61 - 66 cm (24 - 26 in)
B. 15.2 cm (6 in)
C. 10.2 cm (4 in)

Additional Non-required Items
A16. Return line shut off valve
A17. Pump inlet vacuum gage
A18. Pump outlet temperature sensor
A19. Radius bend at pump inlet

FIG. 1 System Schematic

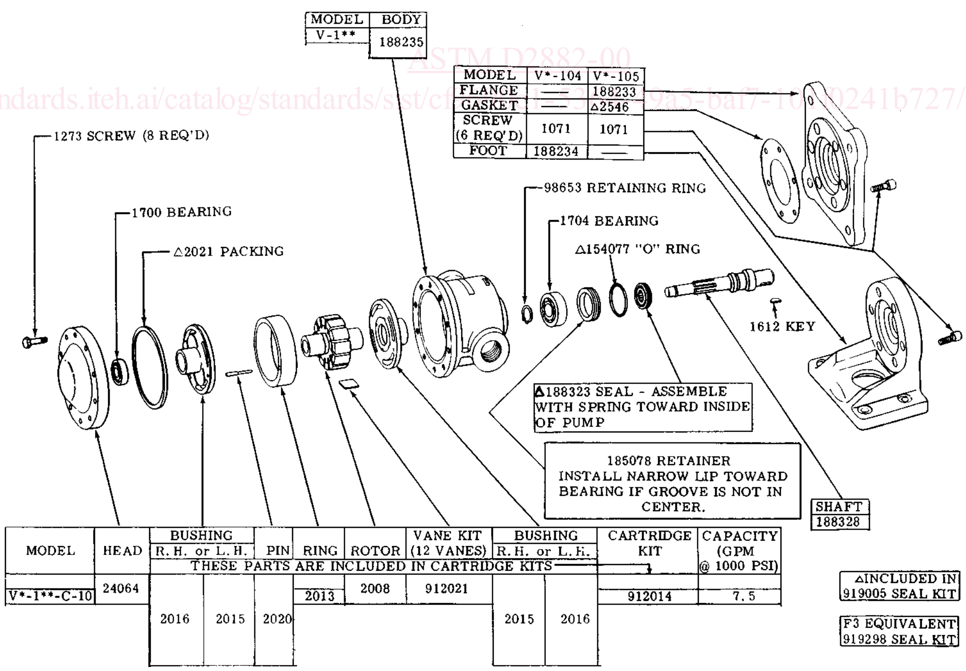


FIG. 2 Pump Components

6.1.4 *Reservoir*, (see Fig. 1, Item 1), equipped with a removable baffle and lid, all of stainless steel construction. The reservoir design is shown in Figs. 4-6.

6.1.4.1 Additional fluid ports may be added as required by the user to assist in measuring fluid level, reservoir temperature, and so forth.

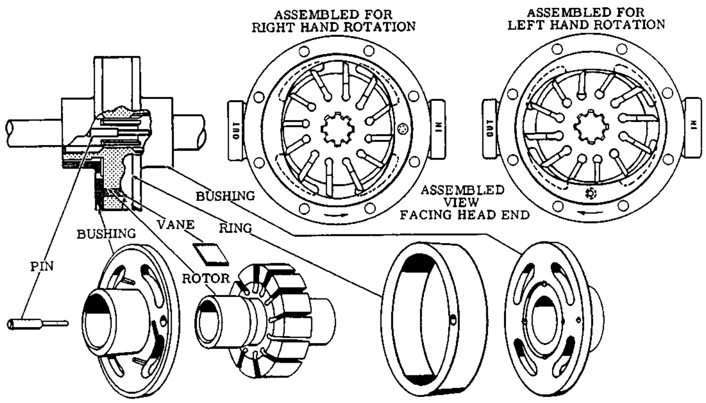


FIG. 3 Cartridge Kit

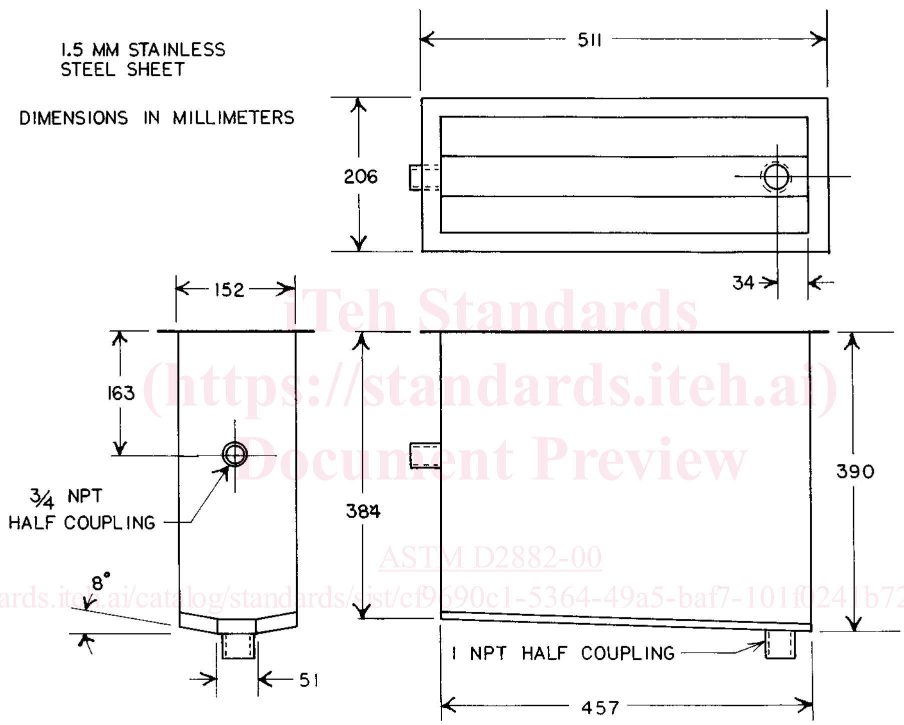


FIG. 4 Reservoir

6.1.4.2 If the reservoir is positioned so that the contents cannot be visually checked for aeration by removing the lid, a fluid-tight glass viewing port may be located in the side of the reservoir.

6.1.5 *Outlet Pressure Control Valve*, Vickers pressure relief valve (CT-06-C/500-2000 psi) with either manual or remote control (see Fig. 1, Item 8, and Fig. 7).

6.1.6 *Temperature-Control Device*, suitable for controlling coolant flow to the heat exchanger to maintain test fluid at the specified temperature (see Fig. 1, Item 11).

6.1.7 *Temperature Indicator* (see Fig. 1, Item 3) shall have an accuracy of ± 1°C and shall have an appropriate sensor to monitor pump inlet temperature.

6.1.7.1 To prevent a flow restriction near the pump inlet port, the temperature probe shall have a diameter of not more than 6 mm (0.25 in.).

6.1.7.2 The test fluid temperature shall be measured within 10.2 cm (4 in.) of the pump inlet (see Fig. 1, Dimension C). The sensing probe shall be inserted into the midpoint of flow.

NOTE 2—Some users have found the addition of a pump outlet temperature sensor to be a useful diagnostic tool. If used, it shall be suitable for 13.8 MPa duty and should be placed in the high pressure line between the pump and the relief valve (see Fig. 1, Item A18).

6.1.8 *Heat-Exchanger* (see Fig. 1, Item 10)—The heat exchanger should be of adequate size and design to remove the excess heat from the test system when utilizing the available coolant supply.

NOTE 3—It is suggested that a shell-and-tube type heat exchanger, if used, should be connected in reverse (the hydraulic fluid is passed through the tubes and not around them) so that the interior of the heat exchanger can be effectively cleaned between tests.

6.1.9 *Pressure Indicator* (see Fig. 1, Item 6), to measure pump discharge pressure shall have an accuracy of at least ± 0.3 MPa (± 40 psi). The pressure indicator should be snubbed (see Fig. 1, Item 7) to prevent damage from pulsations or

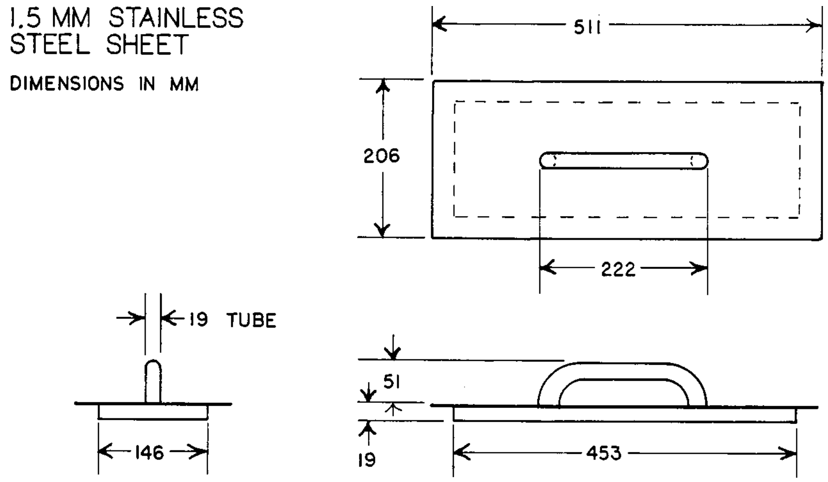


FIG. 5 Reservoir Lid

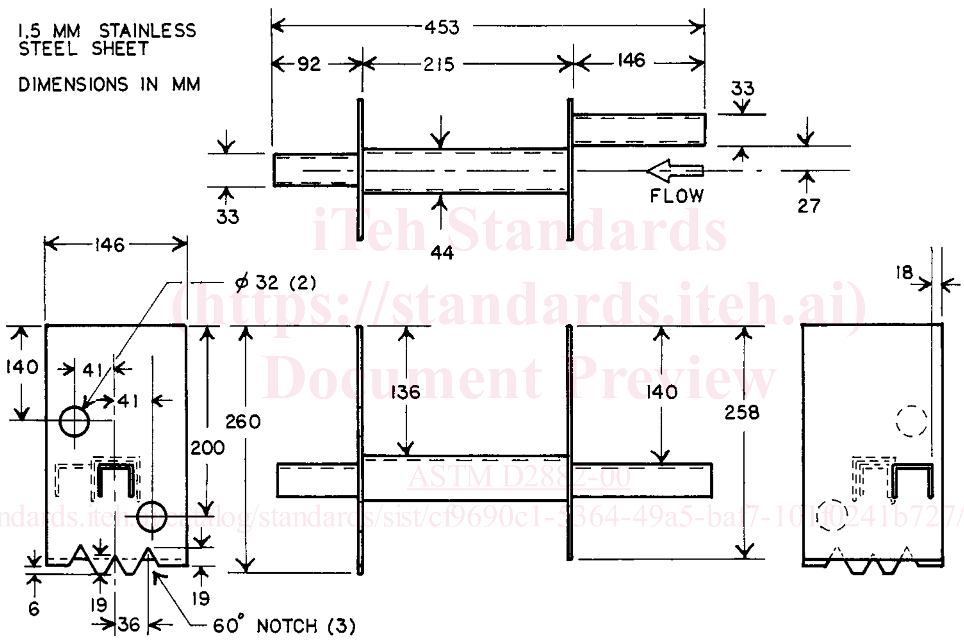


FIG. 6 Reservoir Baffle

sudden fluctuations of system pressure.

6.1.10 *Filter Unit* (see Fig. 1, Item 9), 3 µm (minimum Beta 3 ratio of 100) replaceable fiberglass element with housing. Two new filter elements are required for each test.

6.1.10.1 The filter housing shall be nonbypassing and shall be provided with dual pressure gages (see Fig. 1, Item 13) or another suitable indicator to monitor pressure across the filter to warn of impending collapse of the element.

6.1.10.2 If dual pressure gages are used to monitor filter pressure, the rated collapse pressure of the filter element should be known.

6.1.11 *Flow-Measuring Device* (see Fig. 1, Item 12), with an accuracy of at least ± 0.4 L/min (0.1 gpm).

6.1.12 While not required, it is suggested that low-level, high pressure, high temperature and low flow safety switches be incorporated into the system.

6.1.13 A check should be made to ensure that the flush and test fluid are not incompatible with seals or any other materials in the system.

NOTE 4—The use of galvanized iron, aluminum, zinc, and cadmium should be avoided due to their high potential for corrosion in the presence of many non-petroleum hydraulic fluids.

6.1.14 *Flexible Motor Coupling* (see Fig. 1, Item 14).

6.1.15 *Fluid Sampling Port*, in accordance with ISO 4021 (see Fig. 1, Item 16).

6.2 The various components of the test system shall be placed in the system as indicated in Fig. 1.

6.2.1 The test system shall be arranged and provided with necessary drain valves so that complete draining is possible with no fluid trap areas.

6.2.2 Good hydraulics piping practices should be used when constructing the test system to avoid air ingestment points and flow restrictions.

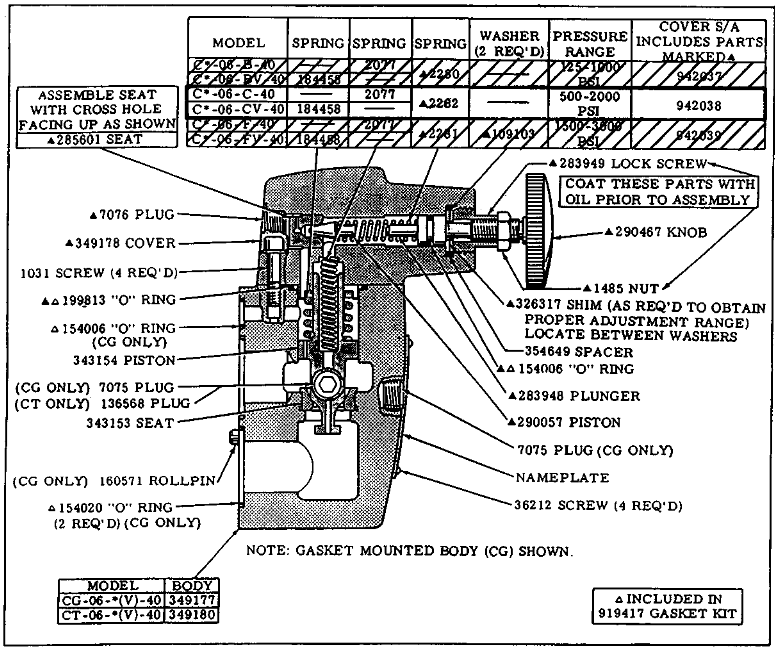


FIG. 7 Relief Valve

6.2.3 The pump should be mounted so that its internal surfaces can easily be inspected and cleaned, alignment can be checked, and the operator has comfortable access when torquing the head.

6.2.4 The reservoir shall be located above the pump so that the fluid level in the reservoir will be between 61 and 66 cm (24 to 26 in.) above the center line of the pump when the test system is fully charged with test fluid (see Fig. 1, Dimension A).

6.2.4.1 The reservoir should be mounted so that it can be cleaned and filled with ease and the contents may be readily inspected by removal of the reservoir lid.

6.2.5 The inlet line (from the reservoir to the pump intake) shall have an internal diameter of at least 25 mm (1 in.) and shall have a straight horizontal run of at least 15 cm (6 in.) between the inlet elbow (see Fig. 1, Item 15) and the pump inlet port (see Fig. 1, Dimension B).

NOTE 5—Some users have found the addition of a compound pressure gage near the pump inlet port to be a useful diagnostic tool (see Fig. 1, Item A17). However, care should be taken to ensure that any ports added to the inlet line do not become air ingestment points.

NOTE 6—Some users prefer to use a radius bend instead of an elbow at the pump inlet (see Fig. 1, Item A19 instead of Item 15). If used, the straight run described in 6.2.5, shall still be measured between the end of the bend and the pump inlet port.

6.2.6 The high pressure discharge line (from the pump to the pressure control valve) shall have an outer diameter of 26.7 mm and a wall thickness of 5.56 mm (¾in. Schedule 160) and be made from steel or stainless steel.

6.2.7 The fluid return line and fittings (from the pressure control valve to the filter, flow counter, heat exchanger, and reservoir) should have an inside diameter of at least 20.9 mm and a wall thickness of 2.87 mm (¾ in. Schedule 40).

NOTE 7—Some users find the addition of a shut-off valve on the return line (see Fig. 1, Item A16) to be a useful addition to the piping since it allows filter changes and other system maintenance to be performed without draining the reservoir. (**WARNING**—If a shut-off valve is installed in the fluid return line, the user shall take procedural steps to ensure that this valve has been opened before the pump is started. If the valve is not opened, low pressure system components may rupture.)

6.2.8 A shut-off valve shall be provided in the reservoir outlet line (see Fig. 1, Item 2). A "full flow" type of valve with an orifice of at least 25 mm (1 in.) is recommended.

7. Reagents and Materials

7.1 **Warning**—Use adequate safety provisions with all solvents.

7.2 *Aliphatic Naphtha*, Stoddard solvent or equivalent is satisfactory. (**Warning**—Combustible. Vapor harmful.)

7.3 *Precipitation Naphtha*. (**Warning**—Extremely flammable. Harmful if inhaled. Vapors can cause flash fire.)

7.4 *Isopropanol*. (**Warning**—Flammable.) (**Warning**—In instances when the solvents listed in Section 7 are not effective, alternative solvents may be used (see Notes 9 and 10 and 12.4.10). It is the responsibility of the user to determine the suitability of alternative solvents and any hazards associated with their use.

8. Test Stand Maintenance

8.1 Sensors and shut-off switches should be checked periodically for proper calibration and operation in accordance with good engineering practice, as determined by the user.

8.2 It is recommended that the pump shaft (see Fig. 2, Item 188328), seals (see Fig. 2, Items 188323, 154077, and 2021), and bearings (see Fig. 2, Items 1704 and 1700) be replaced after every five runs (or sooner if high weight loss, vibration, cavitation, or visual deterioration is encountered).

8.2.1 Special seals are required for testing with synthetic fluids. The different Vickers gasket kits that are available for the V-104C/105C pump are as follows: 919005 for water-glycols, water-in-oil emulsions, and petroleum; 919298 for water-in-oil emulsions, water-glycols, aryl phosphate esters, and phosphate ester-hydrocarbon blends; and 919038 for alkyl and aryl phosphate esters.

8.3 *Inspect the Pump Body and Head*:

8.3.1 Visually examine the pump head and the interior of the pump body (see Fig. 2, Items 24064 and 188235). Replace if evidence of deterioration is observed.

8.3.2 When the pump has been disassembled for seal and bearing replacement, carefully inspect the faces of the pump body and head, which seal against the bushing faces (see Fig. 8, Surfaces A and B) for high spots, warped condition, or other damage, which may interfere with a good fluid seal. Discard any unsuitable components.

8.3.3 Check that the head bearing (see Fig. 2, Item 1700) is a press fit into the head. If it is loose, discard the head.

8.3.4 Check that the shaft bearing (see Fig. 2, Item 1704) makes a close slip fit into the body. If loose, discard the body.

8.3.5 Check that the bore for the cartridge (76.2 mm) (see Fig. 8, Diameter E) is not oversized for the cam ring. If the bore is more than 0.05-mm (0.002-in.) larger than the ring diameter, the ring may crack. See Note 20 for remedial measures.

8.3.6 Check that the pump body ports align properly with the bushing ports, with no overlapping, which might restrict fluid flow.

NOTE 8—In some cases in which operational problems continue without apparent cause, a change of pump body or head, or both, have been known to alleviate the problem.

8.4 Inspect the shaft (see Fig. 8) (see Fig. 2, Item 188328).

8.4.1 Check that the splines of a new shaft are smoothly cut, have consistent width from the outer diameter to the root, and are parallel with the axis of the shaft. Avoid reusing shafts if the rotor has worn deep marks in the splines (see Fig. 9, Items 1, 2, 3, and 4).

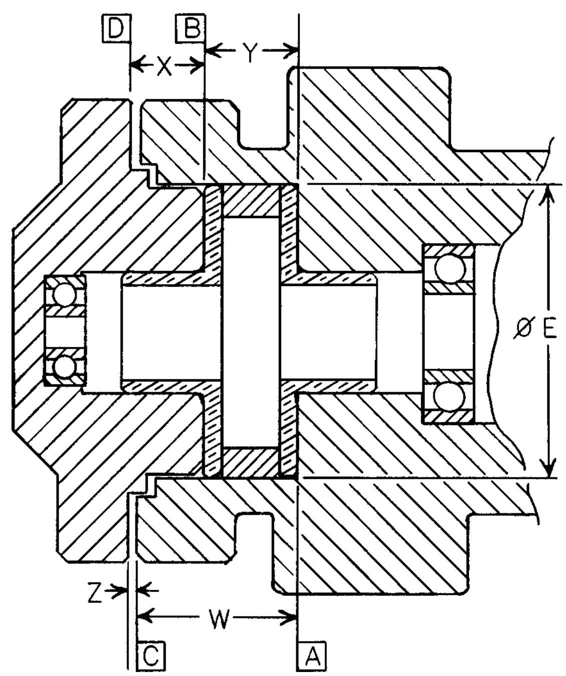


FIG. 8 Pump Housing

8.4.2 Check new shafts and used shafts that have been subjected to pump failure or overheating for bending, twist, or damage to the key seat or splines (see Fig. 9, Items 5, 7, and 8).

8.4.3 Check the surface where the shaft seal rides for conditions that may cause the seal to leak (see Fig. 9, Item 6).

8.5 Check alignment of the pump and motor shafts. Maximum values of 0.08-mm (0.003-in.) parallel misalignment and 0.3° angular misalignment are suggested limits.

8.5.1 Alignment checks should be made with a torqued cartridge in place.

8.5.2 Using a test indicator, inspect the shaft for a bent condition by rotating it by hand with the motor coupling removed (see Fig. 9, Item 7).

8.6 Periodically clean the eight tapped holes, which receive the pump head bolts (see Fig. 10) and the threads of the head bolts themselves (see Fig. 2, Item 1273). The threads may be coated with a light oil to prevent corrosion. To ensure even torquing of the cartridge, housings or head bolts with damaged threads should be discarded.

8.7 Periodic disassembly of the relief valve (see Fig. 1, Item 8, and Fig. 7) for cleaning and inspection is recommended.

9. Sampling

9.1 The sample of fluid shall be thoroughly representative of the material in question, and the portion used for the test shall be thoroughly representative of the sample itself.

10. Flushing

10.1 Proper cleaning and flushing of the entire system is extremely important in order to prevent cross-contamination of test fluids.

10.2 *Flushing Procedure for Petroleum and Synthetic Fluids*:

NOTE 9—This flushing sequence is not adequate when changing fluid types, such as from glycol to phosphate ester, oil to glycol, and so forth (**Warning**—In instances when the solvents listed in Section 7 are not effective, alternative solvents may be used (see Notes 9 and 10 and 12.4.10). It is the responsibility of the user to determine the suitability of alternative solvents and any hazards associated with their use.)

10.2.1 Drain all old fluid from the system, remove used test cartridge (if not already done), and remove and discard old filter. Wipe out pump and filter housings and the reservoir and baffle.

10.2.2 Install a flush cartridge (any good, previously used cartridge) and a new filter.

10.2.3 Close all drain valves, torque the pump head, and make sure that the pump inlet valve and any return line valves are open.

10.2.4 Charge the system with 7.6 L (2 gal) of flushing fluid. For petroleum and synthetic fluids, use either Stoddard solvent (**Warning**—see 7.2) or base stock, depending on the similarity of the old and new test fluids.

NOTE 10—One flush of this petroleum solvent is usually sufficient to clean a system in which an oil was run. Other solvents can be used when oxidized oil has coated the reservoir and lines (**Warning**—see 10.2.1). Repeat the flush if the first flush is cloudy or opaque.

10.2.5 If not already done, reduce the setting of the pressure control valve so that pressure will not be generated when flow starts.