



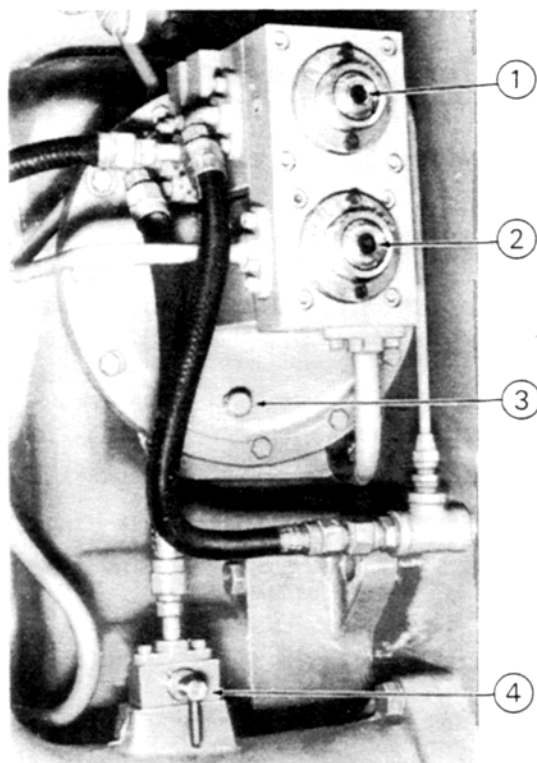
MAINTENANCE INSTRUCTION

DIFFERENTIAL PRESSURE (DELTA P) COMBINATION ENGINE PROTECTOR

DESCRIPTION

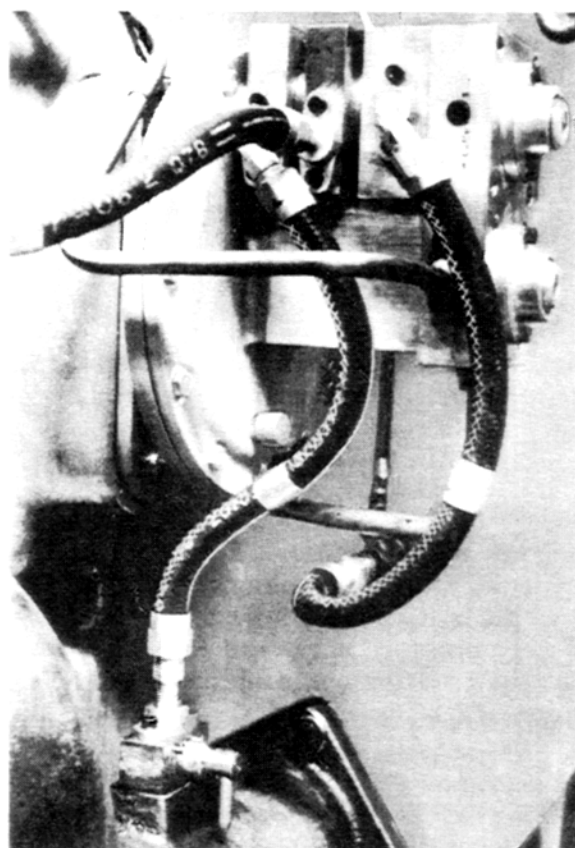
The differential pressure (Delta [Δ] P) combination engine protector, Fig. 1, is a mechanically operated, pressure sensitive device used to determine abnormal engine conditions and pressures. If potentially harmful conditions exist, this protective device will cause engine shutdown.

The Δ P engine protector configuration has the water portion located on the top of the crankcase portion. Fig. 2, shows the easily discernible housing profile of the Δ P protector. This arrangement enables the pump inlet chambers of the device to drain when the cooling system is drained in order to prevent the possibility of trapped water which could result in freeze damage.



- 1 Low Water Reset
- 2 Crankcase Pressure Reset
- 3 Vent And Test Fitting
- 4 Test Cock

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■ Fig.1 - Differential Pressure (Delta P)
Combination Engine Protector

■ Fig.2 - Side View Δ Protector

*This bulletin is revised and supersedes previous issues of this number.
Areas of change are indicated by vertical bars .

The ΔP water portion provides protection from conditions which cause the engine water pump input and discharge differential pressure to drop below the air box pressure, and also protects against the loss of the engine coolant.

The crankcase pressure portion senses malfunctions resulting in positive crankcase pressure which will cause the detector to trip; thereby shutting down the engine.

Operational and functional differences between the ΔP water and crankcase pressure detectors are explained below.

OPERATION

ΔP WATER DETECTOR

The ΔP water safety device is a spring loaded, normally closed, two way oil valve piloted by a latching mechanism mounted on a diaphragm stack. There are four diaphragms in the stack, Fig. 3. A piston located between the water pump inlet and high pressure (water discharge) diaphragms senses loss of differential pressure and moves with the diaphragms to allow latching mechanism release.

On turbocharged application differential pressure ratio between pressures is 1:1:1 (air box: pump inlet: pump discharge), and for blower aspirated (Roots) applications, the ratio is 3:1:1.

Under normal operating conditions, pump differential pressure exceeds air box pressure, and the diaphragm stack positions a latch to hold the two-way oil relief valve closed.

During low water conditions, Fig. 4, or conditions of cavitation caused by cooling system overheat or exhaust gas in the cooling system, the water pump discharge pressure *may*, and the water pump differential pressure *will*, drop below the air box pressure. When this occurs, the diaphragm stack positions the latch mechanism to disengage the spring loaded oil relief valve, dumping oil from the low oil pressure sensing device in the governor, causing an engine shutdown.

Bleed holes are provided between the pump inlet and outlet diaphragms and the pump inlet and air box diaphragms to visually indicate a leak.

DIFFERENTIAL WATER PRESSURE SHUTDOWN AND RESET

When a water shutdown occurs, the low water button pops out, Fig. 4, the low oil plunger on governor protrudes, and governor shutdown light on the engine control panel comes on.

NOTE

Since the ΔP water detector compares pump differential with air box pressure, it cannot be tested on a non-operating engine. The engine *must* be running, and the cooling system vented in order to permit latching the low water reset button.

The low water reset button will trip whenever differential pressure drops below air box pressure when the engine is running. However, the low water detector may or may not trip when the engine is drained dead.

CAUTION

A serious problem exists when the water pumps are not delivering coolant to the engine, and when the crankcase becomes pressurized. Both of these conditions are either the result of engine damage or an indication that engine damage is imminent. The Delta P protector *uses water pump cavitation as the signal that the cooling system is in trouble.*

The following conditions will cause the detector to trip:

1. Loss of engine coolant.
2. Pump cavitation due to air entrainment (particularly during engine start.)
3. Water pump failure on a single-water-pump engine, or a failed *left bank* water pump on a dual-pump engine.

Because this device is not affected by cooling system pressurization, it also provides engine protection against:

1. Exhaust gas in cooling system which:
 - a. Causes pump cavitation.
 - b. Results in cracked heads.
 - c. Can result in hydraulic locks.
 - d. Results in head-to-liner seal damage.
2. Engine overheat (especially below 6th throttle position), and pump cavitation due to water temperature approaching boiling point.

The ΔP water portion provides protection from conditions which cause the engine water pump input and discharge differential pressure to drop below the air box pressure, and also protects against the loss of the engine coolant.

The crankcase pressure portion senses malfunctions resulting in positive crankcase pressure which will cause the detector to trip; thereby shutting down the engine.

Operational and functional differences between the ΔP water and crankcase pressure detectors are explained below.

OPERATION

ΔP WATER DETECTOR

The ΔP water safety device is a spring loaded, normally closed, two way oil valve piloted by a latching mechanism mounted on a diaphragm stack. There are four diaphragms in the stack, Fig. 3. A piston located between the water pump inlet and high pressure (water discharge) diaphragms senses loss of differential pressure and moves with the diaphragms to allow latching mechanism release.

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During low water conditions, Fig. 4, or conditions of cavitation caused by cooling system overheat or exhaust gas in the cooling system, the water pump discharge pressure *may*, and the water pump differential pressure *will*, drop below the air box pressure. When this occurs, the diaphragm stack positions the latch mechanism to disengage the spring loaded oil relief valve, dumping oil from the low oil pressure sensing device in the governor, causing an engine shutdown.

Bleed holes are provided between the pump inlet and outlet diaphragms and the pump inlet and air box diaphragms to visually indicate a leak.

DIFFERENTIAL WATER PRESSURE SHUTDOWN AND RESET

When a water shutdown occurs, the low water button pops out, Fig. 4, the low oil plunger on governor protrudes, and governor shutdown light on the engine control panel comes on.

NOTE

Since the ΔP water detector compares pump differential with air box pressure, it cannot be tested on a non-operating engine. The engine *must* be running, and the cooling system vented in order to permit latching the low water reset button.

The low water reset button will trip whenever differential pressure drops below air box pressure when the engine is running. However, the low water detector may or may not trip when the engine is drained dead.

CAUTION

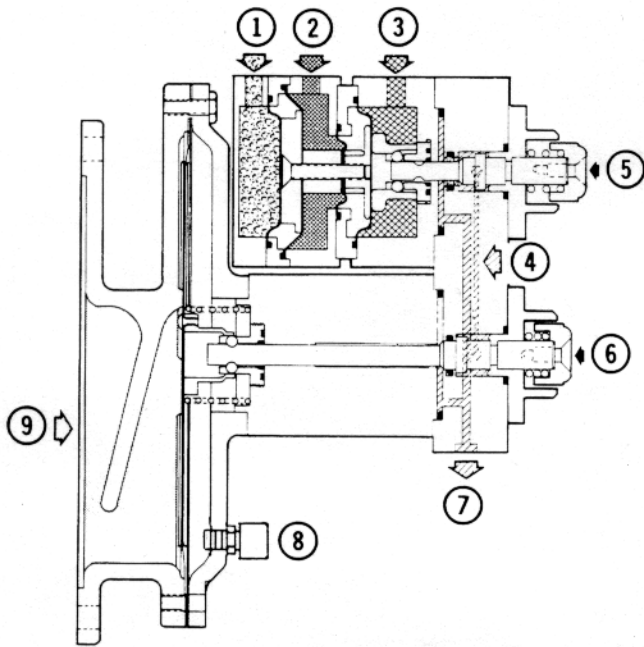
A serious problem exists when the water pumps are not delivering coolant to the engine, and when the crankcase becomes pressurized. Both of these conditions are either the result of engine damage or an indication that engine damage is imminent. The Delta P protector *uses water pump cavitation as the signal that the cooling system is in trouble.*

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1. Loss of engine coolant.
2. Pump cavitation due to air entrainment (particularly during engine start.)
3. Water pump failure on a single-water-pump engine, or a failed *left bank* water pump on a dual-pump engine.

Because this device is not affected by cooling system pressurization, it also provides engine protection against:

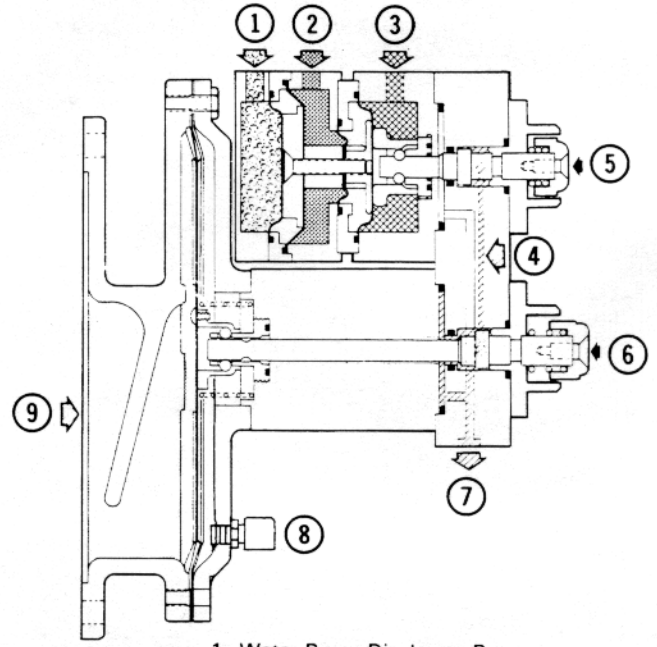
1. Exhaust gas in cooling system which:
 - a. Causes pump cavitation.
 - b. Results in cracked heads.
 - c. Can result in hydraulic locks.
 - d. Results in head-to-liner seal damage.
2. Engine overheat (especially below 6th throttle position), and pump cavitation due to water temperature approaching boiling point.



1. Water Pump Discharge Pressure
2. Water Pump Inlet Pressure
3. Air Box Pressure
4. Oil In From Governor
5. Trip Position
6. Latch Position
7. Oil Return To Crankcase
8. Vent Fitting
9. Crankcase Pressure Negative

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Fig. 4 - Low Water Pressure Condition



1. Water Pump Discharge Pressure
2. Water Pump Inlet Pressure
3. Air Box Pressure
4. Oil In From Governor
5. Latch Position
6. Trip Position
7. Oil Return To Crankcase
8. Vent Fitting
9. Crankcase Pressure Positive

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Fig. 5 - Positive Crankcase Pressure Condition

CRANKCASE PRESSURE DETECTOR

The crankcase pressure detector has a large diaphragm that is held in position by spring force. When pressure on the diaphragm exceeds spring force, the diaphragm moves. This movement results in tripping of an oil valve latch, Fig. 5, or tripping of a latch that operates a switch. Engine shutdown is through governor sensing of low oil pressure or by means of governor shutdown solenoid.

Crankcase ventilating equipment normally maintains a negative pressure in the crankcase. Malfunction, whether plugging of crankcase ventilating system, excessive blowby, faulty seals or damaged components, or crankcase explosion will result in positive pressure and crankcase pressure detector trip.

CAUTION

Automatic engine shutdown is NOT provided on marine applications unless specially equipped.

Crankcase pressure detectors installed on marine applications are equipped with a crankcase pressure switch (CPS). This switch

closes contacts when the crankcase pressure detector reset stem trips, and provides a signal to the alarm system. After the alarm is sounded, the engine should be shut down as soon as possible.

Units equipped with an optional shutdown selector switch provide selection of two different responses to an excessive crankcase pressure. In the NORMAL SHUTDOWN position, an excessive crankcase pressure will shut down the diesel engine. In the EMERGENCY ALARM position, an excessive crankcase pressure causes only the alarm system to be activated.

The following conditions will cause the detector to trip:

1. Blockage of oil separator or aspirator tube in exhaust.
2. Cylinder compression leak into oil pan.
3. Overheated part causing ignition of oil vapor.
4. Incorrectly applied lube oil relief valve in accessory gear train. Oil splash reaches the diaphragm of detector.

5. Excessive oil level in crankcase, resulting in blockage of oil separator.
6. Air box leak to crankcase.

WARNING

Following an engine shutdown because of crankcase pressure detector trip, do NOT open any handhole or top deck covers to make an inspection until the engine has been stopped and allowed to cool off for at least two hours. Do NOT attempt to restart the engine until it has been determined that the cause of the trip has not been a crankcase explosion. Crankcase pressure detector trip indicates a potentially explosive condition within the engine. The possibility exists that an overheated bearing may ignite the hot oil vapors if air is allowed to enter. If the shutdown was the result of a crankcase explosion, do NOT operate the engine until the pressure detector has been replaced, since the diaphragm backup plates may be damaged.

The crankcase pressure portion is designed to detect very low pressure. Therefore, application of pressure appreciably above the normal 0 mm-127 mm (0"-5") of water may permanently damage backup plates on the diaphragm. A detector with damaged backup plates cannot be reset.

Manual operation of crankcase pressure diaphragm through crankcase opening must be done carefully to avoid distorting aluminum backup plates. Do not exert too much force. Damaged detectors will not latch properly, if at all.

NOTE

Replace or qualify the device any time that a true crankcase pressure trip has occurred.

The rate at which the large diaphragm moves from trip to latch position on the crankcase pressure portion is dependent on pressures involved and the freeness with which air can enter the vent fitting at bottom of detector body.

When pressing the crankcase pressure detector reset button on a dead engine, the air pressure on the diaphragm is the same on both sides and only the light spring force is available to move diaphragm to a latched position. With the reset button held in to release the diaphragm, air must enter at the front of the diaphragm through the vent fitting to permit the spring to move the diaphragm until the valve stem and reset button remain latched. This takes several seconds when detector is cold. The reset button must therefore be depressed for several seconds to ensure complete latching.

"O" RING SEALS

Both reset buttons actuate lube oil valves which are sealed with "O" rings. To ensure lubrication and free movement of the valves, the "O" rings and retaining grooves are designed to seal only when normal oil pressure is present.

MAINTENANCE

The maintenance of these detectors is very important and requires the use of special tools and a properly maintained test panel to ensure correct functioning of the protector at the time of assembly. In order to ensure proper operation, the detectors should be dismantled, cleaned, and inspected at intervals indicated in the applicable Scheduled Maintenance Program.

DISASSEMBLY

1. Remove two hex socket head cap screws from oil drain line flange, using an Allen wrench.
2. Remove the four hex socket head cap screws holding the reset button enclosures to the oil valve block. Remove low water valve stem and "O" ring from oil block.
3. Loosen all eight hex socket head cap screws from oil valve block using an Allen wrench.
4. Remove the top four hex socket head retaining cap screws from the oil valve block. Slide out air housing, low pressure housing, and high pressure housing as an assembly.
5. Remove the crankcase reset valve stem and "O" ring from oil block.

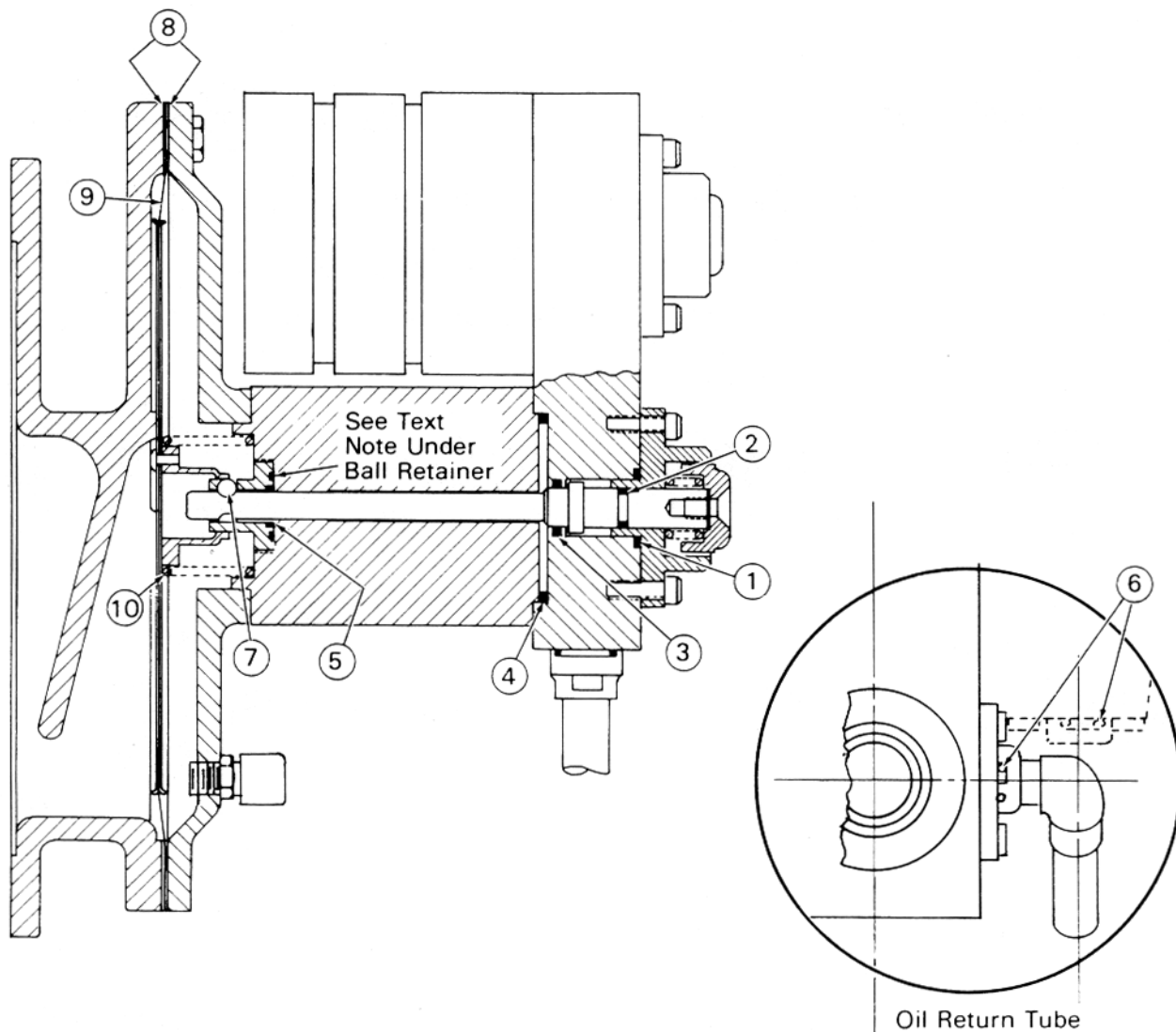
CAUTION

If it is necessary to manually trip the crankcase pressure diaphragm, avoid distorting aluminum backup plates. Gentle finger pressure will suffice.

6. Remove the bottom four 1/4"-20 x 4-1/4" hex socket head cap screws securing the oil valve block to crankcase housing assembly.
7. Remove oil valve block and replace all "O" rings, Fig. 6.
8. Remove crankcase housing assembly and spring.

NOTE

Do not lose balls.



ITEM	DESCRIPTION	NO. REQ'D.
1	Viton "O" Ring	1
2	" "	1
3	" "	1
4	" "	1
5	" "	1
6	" "	2
7	4.75 mm (.187") Dia. Ball Bearing	3
8	Gasket	2
9	Diaphragm & Plate Assy.	1
10	Spring	1

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Fig.6 - Crankcase Repair Kit

9. Remove the cover plate from the mounting plate housing by removing the twelve 1/4"-20 socket head bolts around the outer edge of the assembly. It is not necessary to remove the vent fitting.
10. Remove aluminum backup plate and apply new diaphragm, Fig. 6.
11. Invert the air and water pressure assembly.
12. Remove the four hex socket head cap screws from the high pressure block and remove from assembly with diaphragm facing upwards.
13. Separate circular brass spacer from low pressure block assembly.

14. Loosen 1/4"-20 x 1-3/8" flat head screw approximately 3/8".
15. Lift out screw, piston, diaphragm and spacer as a unit in that order.
16. Disassemble low pressure block assembly.
17. Separate circular brass spacer from air housing assembly.
18. Remove sleeve, piston, diaphragm and gasket assembly. To separate, remove three nylon screws.

INSPECTION

Clean all parts with a NON-CAUSTIC solution to remove foreign material. Do not wire brush or use abrasives that may scratch or alter finish on valve shafts or surfaces mating the "O" rings or diaphragms. Remove and scrap all "O" rings including those in bores. Inspect parts as follows:

VALVE SHAFTS

Sliding surfaces must be free of scratches and tool marks. Ball groove must be free of brinell marks.

BALL CUP

Free of pit marks.

NOTE

The use of ball cups with chrome plating is recommended. These ball cups tend to brinell less than hardened steel ball cups.

BALL RETAINER

NOTE

Do not remove ball retainer from crankcase pressure or low water block unless inspection proves it to be defective. Rebuild kits do not include the retainer-to-block "O" ring. Therefore, if reusable ball retainers are removed, the possibility of reassembling ball retainer without "O" ring exists. This would result in an oil leak or loss of sensitivity of the device.

Ball passages must be free of tool marks and dents and provide free movement of balls. Ball retainer must be checked for flush engagement of face into aluminum housing. If loose, tighten and secure with single punch mark at intersection of threads.

If it is necessary to remove ball retainer, see Service Data for removal tool.

Replace the three steel balls in the crankcase and low water portion of the detector with those furnished in the replacement kit.

LOW WATER BLOCK (CONTAINING WATER CAVITIES)

Check that the button controlling water pressure diaphragm travel is located 2.3 mm (.090") from the gasket face. Gasket face must be smooth and free of nicks.

CAUTION

All surfaces contacting red water diaphragm must have radius and be free of nicks, pits, or deposits because diaphragm is sensitive to abrasion.

If the low water block is not pitted severely, the block may be reused by refacing with fine grade emery. If refacing is done, a flat surface must be maintained.

If block is not fit to be reused, replace with new brass block. Replacement parts are available through EMD Parts Centers.

OIL VALVE BLOCK

Mounting face must be flat and square with bore within 0.07 mm (.003").

RESET BUTTON ENCLOSURE

Sliding "O" ring surface must show a high polish and be free of tool marks, scratches, and pits.

SPACERS

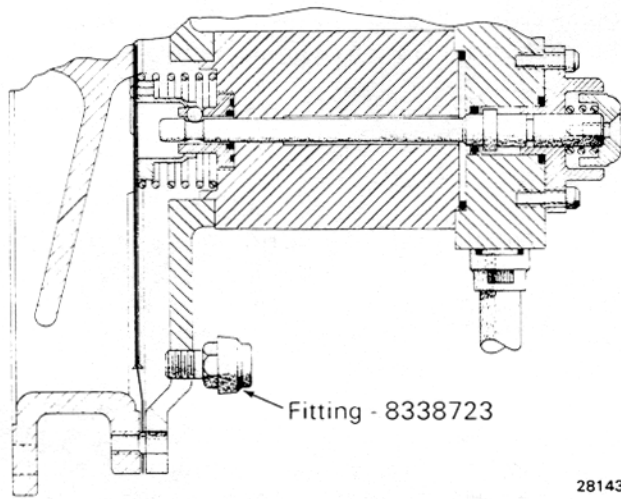
Spacers separating water and air box diaphragms or water chamber must be free of nicks, pits, and deposits in all areas which contact the red water diaphragm. If a spacer is not fit to be reused, replace with new spacer.

VENT FITTING

Effective July 1, 1982, the elbow vent fitting was replaced with a straight vent cap, Fig. 7, to prevent excess accumulation of oil on the front side of the crankcase diaphragm. This modification can be performed simply by disassembling the two-piece fitting, discarding the elbow portion, and threading only the straight, capped portion into the vent opening provided.

REASSEMBLY

Reassemble as follows using the equipment as listed in Service Data.



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Fig. 7 - Vent Fitting Applied To Engine Protector

LOW WATER SECTION

Use replacement kit parts where required, Fig. 8, and reassemble as follows:

1. Ensure steel balls are installed using a small amount of petroleum jelly.

NOTE

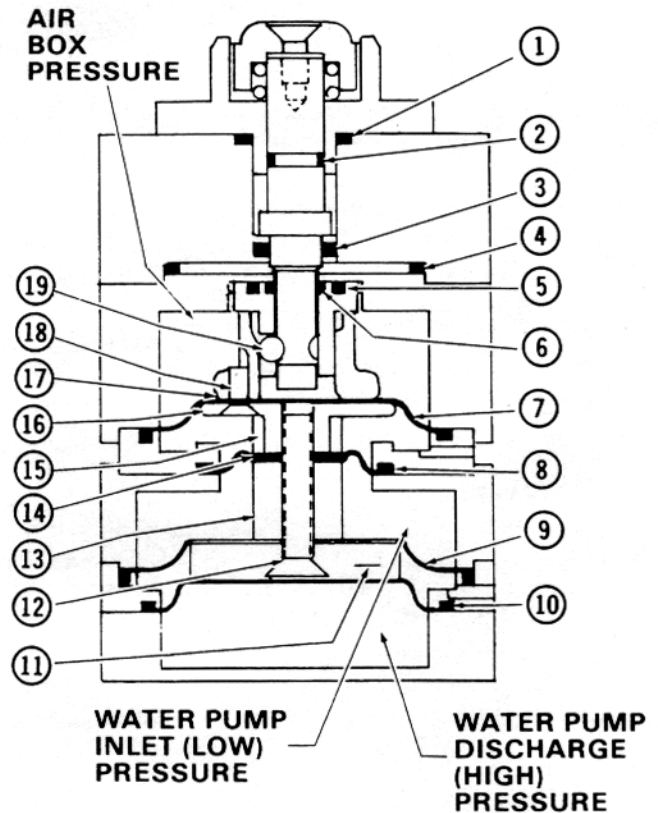
Ensure all three housing openings are located on the same side and that the diaphragms are properly seated when reassembling. (When viewing the protector from the front, Fig. 1, with the low water assembly positioned properly under oil block, these openings will be to the viewer's left.)

2. Reassemble gasket, air box diaphragm, piston and sleeve assembly. Apply silastic to screw threads during assembly. Torque to 0.91 N·m (8 in.-lbs).
3. Return circular brass spacer to air housing assembly.

NOTE

To ensure proper orientation of the two vent holes, it is necessary to position one hole 180° from the housing openings, with the second vent hole 90° counterclockwise from the 180° vent hole.

4. Install 1.52 mm (.060") spacer between small diaphragm and circular brass spacer, and position over air housing assembly.
5. Place low pressure block over diaphragm.



ITEM	DESCRIPTION	NO. REQ.
1	"O" Ring	1
2	"O" Ring	1
3	"O" Ring	1
4	"O" Ring	1
5	Not Included In Kit (See Ball Retainer Note)	1
6	"O" Ring	1
7	Diaphragm	1
8	Diaphragm	1
9	Diaphragm	1
10	Diaphragm	1
11	Piston	1
*12	Screw 1/4"-20 x 1-1/4" Flat Hd.	1
13	Spacer	1
14	1.52 mm (.060") Spacer	1
15	Sleeve	1
16	Piston	1
17	Gasket	1
*18	Screw 8-32 x 3/8" (Nylon)	3
19	Ball	3

*Apply silicone rubber compound to threads during assembly. (Reference Service Data for part number.)

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Fig. 8 - Water Portion Repair Kit

6. Position airbox-to-pump inlet spacer, diaphragm, piston and screw in low pressure housing assembly.

NOTE

Apply silastic (or equivalent) to threads during assembly and torque to 6.78 N·m (60 in.-lbs).

7. Position circular brass spacer over low pressure block between inlet and outlet diaphragms. Ensure proper vent hole position.
 8. Install diaphragm in circular brass spacer.
 9. Assemble high pressure block to assembly using four hex socket head cap screws. Torque to 6.78 N·m (60 in.-lbs).
 10. Invert assembly and position over cover plate.
7. Depress and hold crankcase reset button to fully seat stem in ball cage. (It may be necessary to slightly lift crankcase block or wiggle crankcase block and oil block while inserting stem.)
 8. Once stem has seated, release button and tighten down cap screws.
 9. Reinstall the crankcase identification ring over button. Ensure button vent hole is facing "down" before reinstalling the two hex head cap screws securing button enclosures to oil valve block.

CRANKCASE SECTION

Use replacement kit parts when required, Fig. 6, and reassemble as follows:

1. Assemble new crankcase pressure diaphragm with aluminum backup plate on each side, to ball cup. Check I.D. of ball cup for brinell marks from previous service. Orient crankcase diaphragm with housing so in subsequent assembly, the balls will not engage the brinell marks. Tighten attaching screws to 0.91 N·m (8 in.-lbs) torque.
2. Assemble crankcase pressure diaphragm between mounting housing and cover, with gasket on each side. Start retaining bolts but do not tighten. Install diaphragm centering fixture into ball cup and secure before aligning pilot of fixture with cover opening. (See Service Data for part number of diaphragm centering fixture.) Release plunger to pull diaphragm beyond trip position; tighten retaining screws to 2.26 N·m (20 in.-lbs) torque before removing centering fixture.
3. Make sure "O" ring is in place in center block. Apply replacement steel balls (with petroleum jelly to hold them in place), in ball retainer. Place center block with crankcase pressure to diaphragm spring over ball cup in diaphragm.

NOTE

Do not substitute Lubriplate grease for petroleum jelly. Lubriplate has a tendency to harden slightly and may interfere with proper ball movement.

4. Install two new "O" rings to oil block.
5. Insert crankcase button stem through oil block and position oil block over crankcase pressure and water and airbox pressure assemblies.
6. Loosely reinstall the four 1/4"-20 x 4-1/4" hex socket head cap screws securing oil block to crankcase block.

FINISHING SEQUENCE

10. Align low water portion assembly (with alignment tool inserted in valve stem opening) to full engagement (See Service Data), to oil valve block and reinstall the four 1/4"-20 x 1-1/4" hex socket head retaining bolts. Tighten to 6.78 N·m (60 in.-lbs) torque. Alignment tool must be free of bind.
11. Insert valve stem and reset button into oil valve block with new "O" ring.
12. To seat stem, insert Allen wrench (or similar blunt object) into airbox block opening and press gently down while guiding stem down through ball cage.
13. Reinstall the low water identification ring over button. Ensure button vent hole is facing "down" before reinstalling the two hex head cap screws securing button enclosure to oil valve block.
14. Tighten retaining bolts to 1.7 N·m (15 in.-lbs).
15. Torque the four 1/4"-20 x 1-1/4" hex socket head retaining bolts securing the oil valve block to crankcase block to 6.78 N·m (60 in.-lbs).
16. Set both reset buttons and perform test procedures as required.

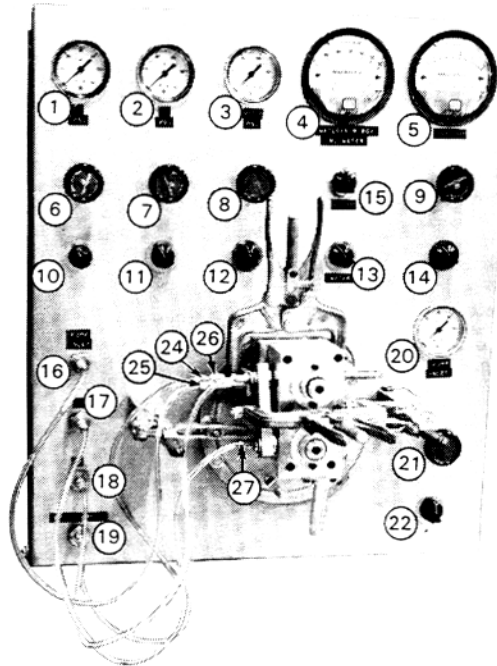
NOTE

Check to ensure proper vent hole positions. The two vent holes in each spacer should be oriented *down* (towards the crankcase portion of device) and to the viewer's *right* when viewed from the front as indicated in previous "Note".

TEST PROCEDURE

NOTE

Test panel, Fig. 9, uses air pressure only for all tests in place of oil or water. Prior to performing any test procedure, ensure all test panel valves are in the "off" position.



- | | |
|--|--|
| 1 Air PSI Gauge | 15 Air Box Gauge Valve |
| 2 Oil PSI Gauge | 16 Pump Inlet Connection |
| 3 Water PSI Gauge | 17 Oil Hose Connection |
| 4 Water/Air Box Pressure Gauge (Inches Of Water) | 18 Air Hose Connection |
| 5 Crankcase Pressure Gauge | 19 Water High Pressure Connection |
| 6 Air PSI Pressure Regulator | 20 Pump Inlet Gauge |
| 7 Oil PSI Regulator | 21 Pump Inlet Regulator |
| 8 Water PSI Pressure Regulator | 22 Pump Inlet Valve |
| 9 Crankcase Pressure Regulator | 23 Vent Elbow (Not Shown - Located On Rear Of Panel) |
| 10 Air PSI Valve | 24 Port No. 1 - (Pump Discharge Pressure) |
| 11 Oil PSI Valve | 25 Port No. 2 - (Pump Inlet Pressure) |
| 12 Water PSI Valve | 26 Port No. 3 - (Air Box Pressure) |
| 13 Water Gauge Valve | 27 Port No. 4 - (Oil) |
| 14 Crankcase Valve | |

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Fig.9 - A Δ Engine Protector Test Panel

DELTA P WATER DETECTOR PORTION

1. Visually check ports for plugging.
2. Connect test panel to a supply of clean, dry air at a minimum pressure of 190 kPa (100 psi).
3. Mount detector device on panel with Toggle clamps and fasten adapters to water (19), pump inlet (16), air (18), and oil hoses (17).
4. Fasten water high pressure line (19) to pump discharge pressure port, Port No. 1 (24) Fig. 9.
5. Fasten pump inlet line (16) to pump inlet pressure, Port No. 2 (25).

6. Fasten air line (18) to air box pressure port, Port No. 3 (26).
7. Fasten oil line (17) to port No. 4 (27).
8. Turn on water PSI valve (12).
9. Turn water PSI pressure regulator (8) to attain 69 kPa (10 psi) pressure. Latch low water button, then raise pressure to 690 kPa (100 psi).
10. Latch crankcase button if necessary.
11. Turn on air PSI valve (10).
12. Turn air PSI pressure regulator (6) to attain 138 kPa (20 psi) pressure (Turbo Device); 35 kPa (5 psi) Roots Device.
13. Turn on pump inlet valve (22).
14. Turn pump inlet regulator (21) to attain 207 kPa (30 psi) pressure.
15. Turn on oil PSI valve (11).
16. Turn oil PSI regulator (7) to attain 552 kPa (80 psi) pressure.
17. Check joints for leaks, using soap and water solution.
18. Check oil return port for leak. If panel has flowrator, maximum allowable leak is 0.283 m³/hr. (10 SCFH.)
19. Reduce oil PSI, water PSI, pump inlet, and air and water pressures to 0 psi using regulators (7), (8), (21), and (6).

CAUTION

To avoid damage to low pressure meter, always reduce water or air box pressure to 7 kPa (1 psi) or less before switching panel valve to water/air box meter readout. Make sure button is tripped by adding air box pressure.

20. Open water gauge valve (13) to read *water pressure* in inches of water on water/air box pressure gauge (4).
 21. Turbocharged Applications:
Raise water pressure to 20" H₂O by adjusting water PSI pressure regulator (8). Reset button must latch when depressed.
- Roots Blown Applications:
Raise water pressure to 30" H₂O by adjusting water PSI pressure regulator (8). Reset button must latch when depressed.

22. Close water gauge valve (13).
23. Raise water PSI gauge pressure (3) to 21 kPa (3 psig) minimum, using water PSI pressure regulator (8) and depress reset button two or three times to ensure positive latching.
24. Check low water button for minimum of 0.38 mm (.015") overtravel in latched position.
25. Reduce water pressure slowly to zero, and open air box gauge valve (15) to read *air box pressure* on water/air box gauge (4). Raise air box pressure slowly by adjusting air pressure regulator (6) until low water reset button trips.

Button must trip before pressure reaches 20" H₂O on a new device; 30" on used device.
26. Reduce air pressure to zero and close air box gauge valve (15).
27. Repeat Steps 20 through 26.
5. Reduce pressure to zero by adjusting crankcase pressure regulator (9).
6. Relatch crankcase button when pressure drops to zero.
7. Repeat Steps 4 through 6 two times.
8. Close crankcase valve (14).
9. Close oil PSI, pump inlet valve, air PSI, and water PSI valves (11), (22), (10), and (12) in that order.
10. Disconnect supply lines from device.

TESTING AND SERVICING

The following are some conditions and probable causes which may be encountered in testing and servicing these detectors. The single causes given below are not necessarily the only causative factors involved in a certain condition, but should be considered the most likely.

CRANKCASE PRESSURE TEST

1. Set crankcase pressure gauge (5) on zero pressure. If crankcase pressure regulator (9) is not effective in reducing the pressure to zero, air may be trapped in back of the detector. Loosen Toggle clamps slightly to relieve trapped air. Tighten clamps when trapped air has been relieved.
2. Crankcase pressure button must be in latched position. This may require holding button in until crankcase pressure gauge (5) reads zero. Check reset button for overtravel in latched position (must be 0.38 mm [.015"] minimum.)

CAUTION

Be sure crankcase pressure regulator (9) is turned to minimum position or is turned until crankcase pressure gauge (5) registers 0".

3. Turn crankcase valve (14) to ON position.
4. Turn crankcase pressure regulator (9) to raise pressure slowly until crankcase button trips. A new device should trip between 0.8" and 1.8" H₂O on crankcase pressure gauge (5) and a used device should trip between 0.8" and 3" H₂O.

NOTE

A used device is one that has been in service 3 months or more since it was new or rebuilt.

- | | |
|------------|---|
| Condition: | Low water button latches and trips in area of latch pressure. |
| Cause: | Steel balls are not all in place in ball retainer. |
| Condition: | Low water button latch point OK, trip point low. |
| Cause: | Alignment of air box diaphragm incorrect or, convolution in diaphragm is reversed. |
| Condition: | Low water button latch point OK, trip point high. |
| Cause: | Valve stem only partially latched. |
| Condition: | Low water button fails to trip with air box pressure and no water pressure. |
| Cause: | Lack of pretravel in diaphragm. Lack of overtravel in valve stem. Misaligned valve stem passages. Incorrect or broken reset button spring. Reset button spring missing. |
| Condition: | Engine oil pressure fails to build up with reset button latched. |
| Cause: | "O" ring in valve body missing or damaged. |

Condition: Air box pressure portion full of oil and carbon.

Cause: Small "O" ring at valve stem in the ball retainer is damaged or missing.

Condition: Water leaking from bleed hole in diaphragm spacer.

Cause: Water diaphragm faulty or improperly applied.

Condition: Oil and air leaking from bleed hole in diaphragm spacer. (Pressure applied only at air box port.)

Cause: Air box pressure diaphragm faulty.

Condition: Crankcase pressure button trips at too high a pressure.

Cause: Incorrect diaphragm spring. Diaphragm applied taut.

Condition: Crankcase pressure button trips at too low a pressure.

Cause: Incorrect diaphragm spring. Valve stem only partially latched.

Condition: Tripping of low water portion trips crankcase button, when testing on test panel.

Cause: Transfer seal on test panel for exhausting oil dump line, leaking.

Condition: Crankcase pressure button refuses to latch.

Cause: Positive pressure not being relieved from test panel. Vent on device is plugged. Diaphragm backing plate bent. Balls missing from ball retainer.

SERVICE DATA

DEVICES

1:1:1	(Turbo) New	9320130
	(Turbo) Utex	9332828
3:1:1	(Roots) New	9505867
	(Roots) Utex	9506013

EQUIPMENT LIST

Test Panel	9339066
Alignment Tool	8361214
Crankcase Diaphragm Centering Fixture	8361217
Torque And T-Bar Wrench Kit	8361215
Ball Retainer Removal Tool	8488380
Straight Vent Cap	8338723

KIT INFORMATION

Test Panel Conversion Kit	9339067
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Turbocharged application:

Complete Rebuild Kit for 9320130 device	9535869
Low Water Repair Kit	9339065
*Crankcase Repair Kit	8379503

Roots Application:

Complete Rebuild Kit for 9505867 device	9535870
Low Water Repair Kit	9505990
*Crankcase Repair Kit	8379503

*Same for both applications.

MATERIAL

Silicone Rubber Compound - 5 oz. tube	8453256
Silicone Rubber Compound - 12 oz. cartridge	8366747
Petroleum Jelly	

TEST LIMITS

NOTE

During pressure testing, test pump inlet port at 207 kPa (30 psi).

1:1:1 DEVICE (NEW AND UTEX)

LOW WATER PORTION:

- Should latch at a pump discharge pressure of 20" H₂O. (Used devices must latch at 30" H₂O maximum.)
- Must trip when all pressures are zero, and the airbox pressure is 20" H₂O maximum.)

CRANKCASE PORTION:

- (New) Trip at a pressure of 0.8" to 1.8" H₂O.
 (Used) Trip at a pressure of 0.8" to 3.0" H₂O.

3:1:1 DEVICE (NEW AND UTEX)

LOW WATER PORTION:

- a. Should latch at a pump discharge pressure of 30" H₂O.
- b. Must trip when all pressures are zero, and the airbox pressure is 30" H₂O maximum.

CRANKCASE PORTION:

- (New) Trip at a pressure of 0.8" to 1.8" H₂O.
(Used) Trip at a pressure of 0.8" to 3.0" H₂O.

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Electro-Motive Division Of General Motors La Grange, Illinois 60525