ELECTRO-MOTIVE DIVISION • GENERAL MOTORS CORPORATION

SERVICE DEPARTMENT

MAINTENANCE INSTRUCTION

LOW WATER AND CRANKCASE PRESSURE DETECTORS

INTRODUCTION

Low water and crankcase pressure (combination) detectors have been applied on locomotives since the GP35. Crankcase pressure detectors for Marine and Industrial applications have also been available since 1964.

The combination device has proven itself, and is recommended for all locomotive engine applications (from 567BC engines on). Many units have had this protective device added after delivery, however, many other units are operating without an engine protector. For "Engine Model-Engine Protector Application Data" see table in Service Data.

Years of research, development, and field tests have resulted in the integration of compounded improvements into the current production detector assemblies. Equally as many conversion kits have been made available to the field over the years to provide repair, rebuild, parts, and modernization information covering existing equipment. (Refer to "Rebuild and Kit Information Table.") Similarly, slight assembly and procedural differences have occurred. Therefore, it is the responsibility of the individual equipment owner to determine his requirements and carefully select equipment and follow procedures relative to his particular application.

Where variations occur among the 1:1, current 3:1, and previous 3:1 devices, specific instructions will be given. Information pertaining to all devices will be addressed generally in this Instruction.

DESCRIPTION

The combination low water and crankcase pressure detector, Fig. 1, is a mechanically operated, pressure-sensitive device used to determine abnormal conditions of engine coolant and crankcase pressures. If potentially harmful conditions exist, this protective device will cause engine shutdown.

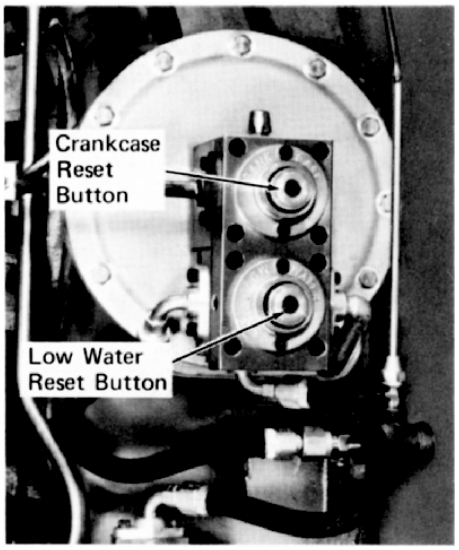

Fig. 1 - Low Water And Crankcase Pressure Detector Installation

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

OPERATION

LOW WATER DETECTOR

The low water safety device is a spring loaded, normally open, two-way valve piloted by a latching mechanism mounted on a diaphragm stack. There are two diaphragms in the stack -- one sensing water pressure into the engine, and the other sensing engine air box pressure.

The air box-to-water diaphragm area ratio for turbocharged application is 1:1, and for blower aspirated (Roots) application, the ratio is 3:1. Under normal operating conditions, water 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. 2, the diaphragm stack positions the latch to open the oil relief valve, dumping oil from the

*This bulletin is revised and supersedes previous issues of this number.

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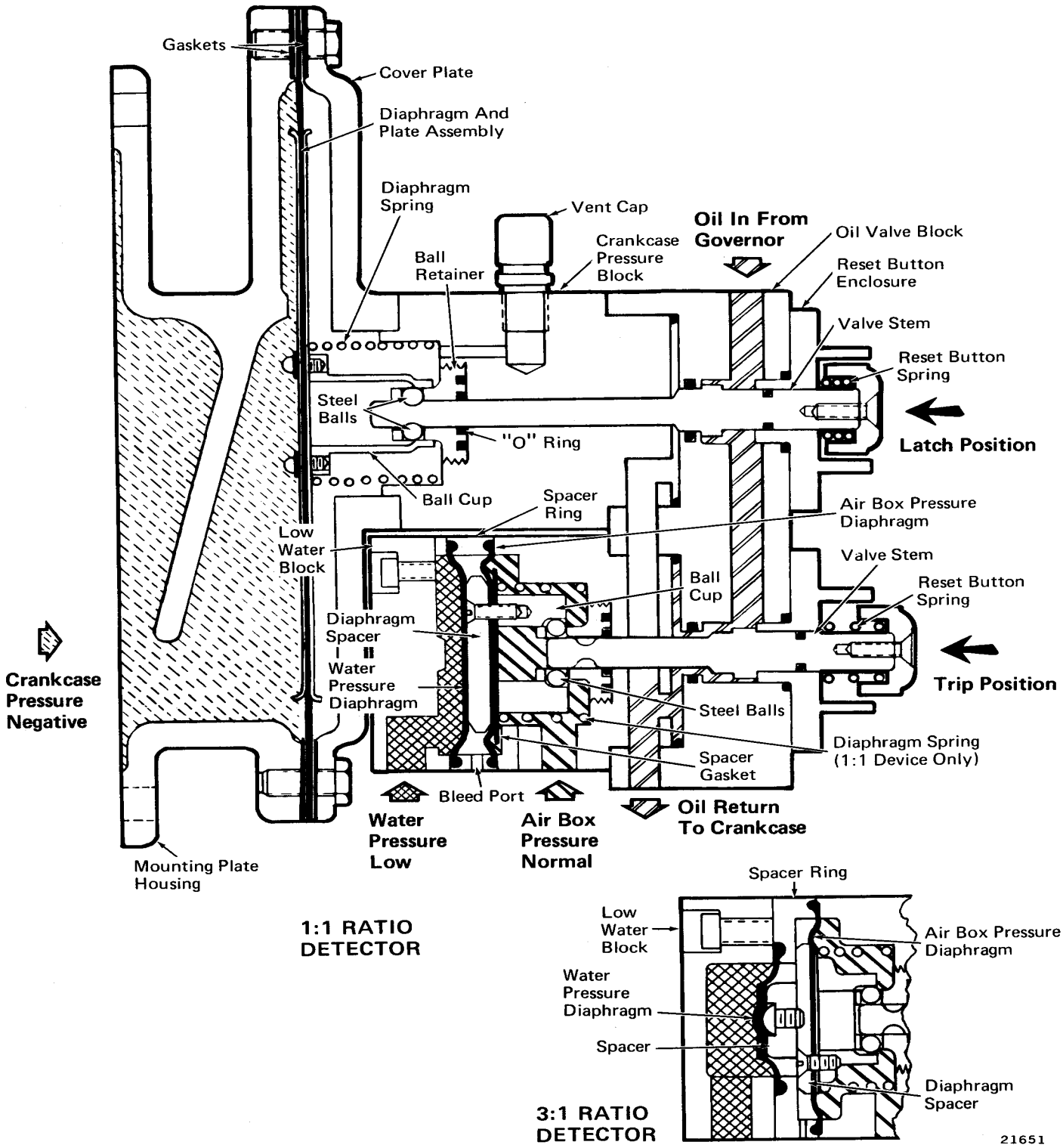


Fig. 2 - Low Water And Crankcase Pressure Detector Schematic

low oil pressure sensing device in the governor, causing an engine shutdown.

Spring bias is applied as required on the air box side to ensure the requisite functions of the valve.

LOW WATER SHUTDOWN AND RESET

When a low water shutdown occurs, the low water button pops out, Fig. 2, low oil plunger on governor protrudes, and governor shutdown light on the engine control panel comes on. Manual latching (resetting) of the valve may be accomplished at this time by depressing the low water reset button, Fig. 1.

The latching point of the low water reset button with engine shut down is a function of spring force at the diaphragm. This spring pressure must be compensated by water pressure to keep the device latched in. The low water reset button is more difficult to latch and keep latched on a dead engine and when starting an engine. Depending on the application, either a 32" or 50" head of water is required in a dead engine to enable latching of the reset button.

Even though the system is full, the possibility exists that the low water reset button may trip on initially starting the engine (particularly the 645 engine). Press the reset button within one minute and again within two minutes after engine start. This procedure will ensure positive latching of the relief valve.

NOTE: The cooling system should be fully vented (no entrained air) to ensure latching. This can be determined by checking coolant level on gauge while the engine is stopped and while the engine is running.

The low water reset button will trip when water pressure is within 3.448 kPa (1/2 psi) of air box pressure. The following conditions will cause the detector to trip:

1. Loss of water level.

2. Pump cavitation due to air entrainment (particularly during engine start.)

3. Pump cavitation due to water temperature approaching boiling point. (Applicable to installations without pressurized cooling system.)

4. Excessive air box pressure due to turbine surging at low throttle speeds. (Turbocharged engines only.)

DIAPHRAGM SPRING APPLICATION

Engines equipped with fuel-saving low idle engine speed feature have had a gold colored diaphragm spring, Fig. 3, added to the low water portion of all 3:1 ratio detectors and applicable rebuild and conversion kits supplied since May 1, 1975. This diaphragm spring provides the additional force required to trip the low water portion of the detector when a low water pressure fault exists and the engine is operating at low idle speed. (Refer to "Rebuild And Kit Information.")

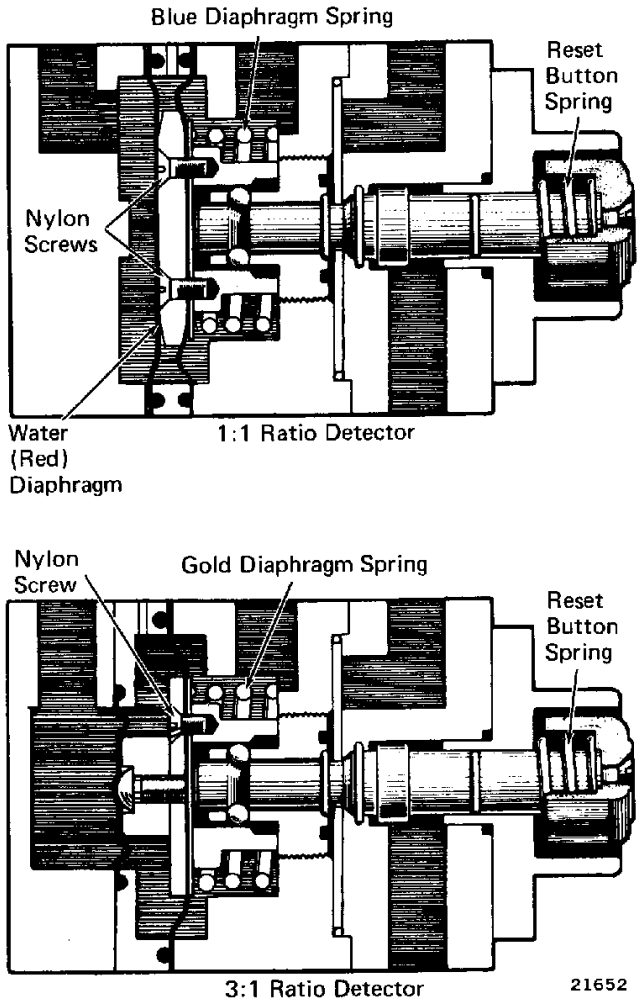


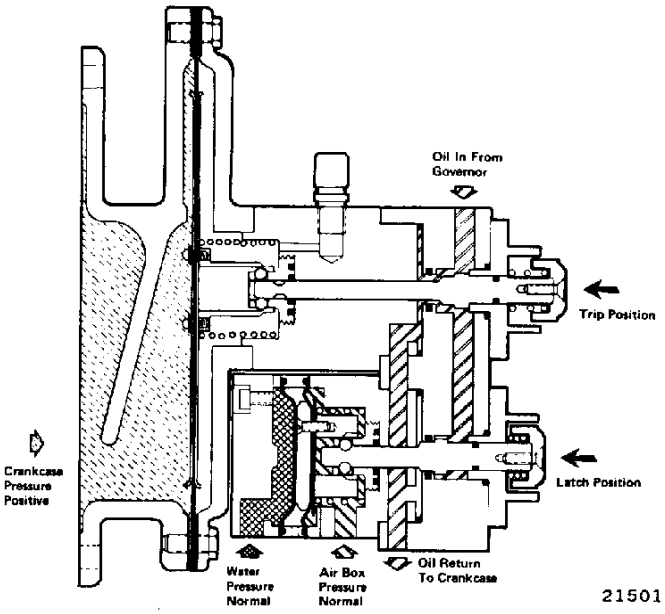
Fig. 3 - Location Of Nylon Screws, Reset Button Spring, And Colored Diaphragm Springs

On devices equipped with diaphragm springs, water pressure must exceed air box pressure PLUS THE FORCE OF A LIGHT SPRING, under normal operating conditions. Two different diaphragm springs are used. Since they are not interchangeable, care must be exercised in determining proper application. For convenience, the springs are color differentiated. Cross-sectional views of the 1:1, current 3:1, and previous 3:1 detector configurations are shown in both latched and tripped positions in Figs. 4, 5, and 6, respectively.

1:1 (Turbocharged) -- The diaphragm spring on this device is blue, Fig. 4.

3:1 (Current Roots) -- The diaphragm spring on this device is gold, Fig. 5.

3:1 (Previous Roots) - Detectors built prior to May 1975 were not spring equipped, Fig. 6.



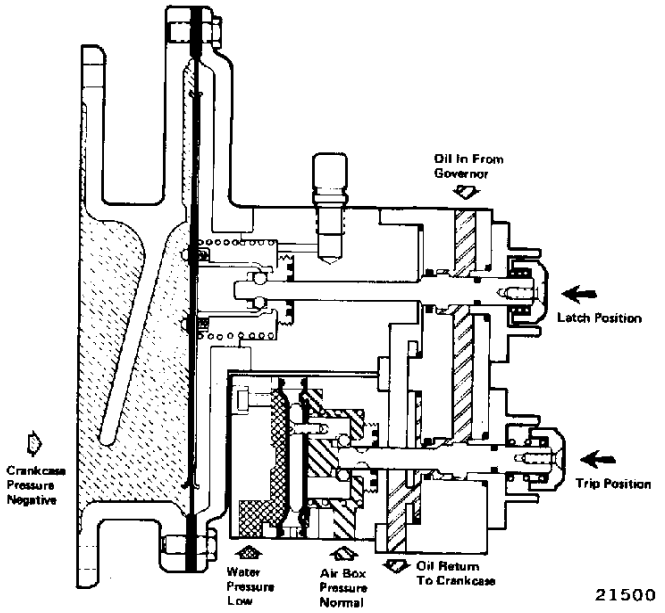
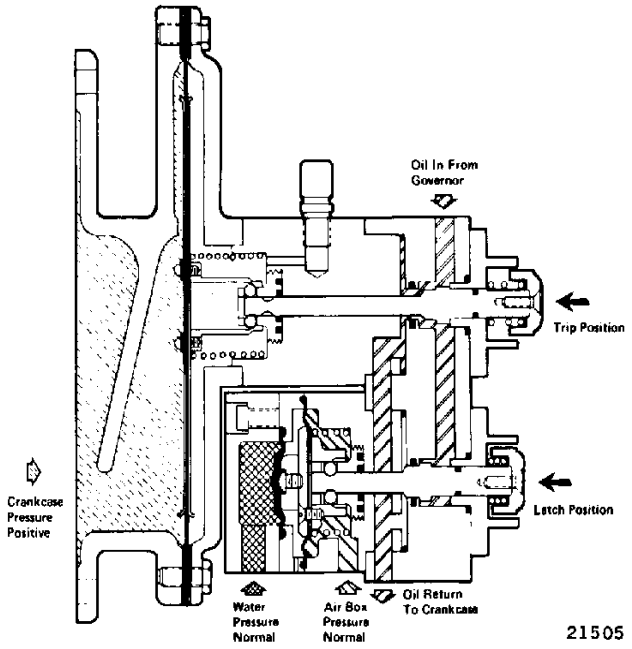


Fig. 4 - 1:1 (Turbo Device) Schematic



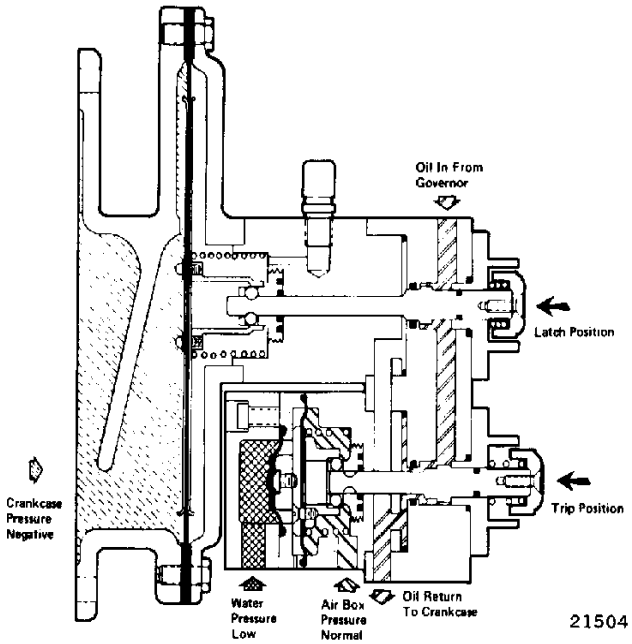


Fig. 5 - 3:1 (Current Device) Schematic

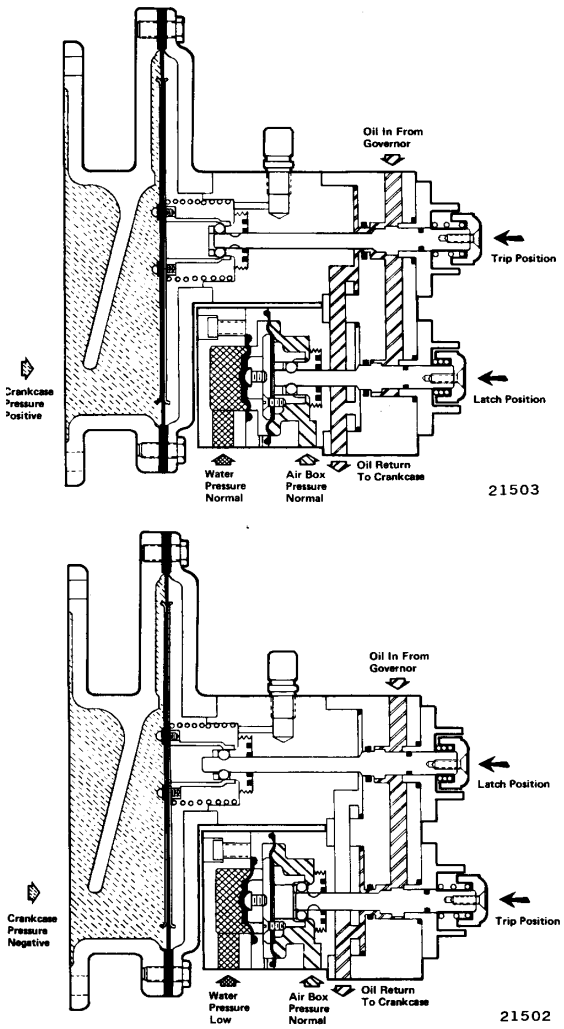


Fig. 6 - 3:1 (Previous Design) Schematic

In addition, nylon screws have replaced metal screws which hold the air box pressure diaphragm and spacer to the ball cup, Fig. 3. Therefore, the need to rework the metal screws has been eliminated. Nylon screws are included in rebuild kits. Refer to "Rebuild And Kit Information" or the EMD Parts Catalog for applicable kit part numbers.

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 (comparable to the action of the low water device), Figs. 4, 5, & 6, or tripping of a latch that operates a switch. Engine shutdown is through governor sensing of low oil pressure or by means of a 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.

NOTE: Crankcase pressure detectors installed on marine applications DO NOT initiate automatic engine shutdown. Instead, during a positive crankcase pressure condition, the outward movement of the stem causes a switch lever to close contacts in the switch and activate an alarm system. After the alarm is sounded, the engine should be shut down as soon as possible.

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.
5. Excessive oil level in crankcase.
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 the cause of the trip has been determined and corrected. 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. Do NOT operate

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 pressures appreciably above the normal 0"-5" of water may permanently damage backup plates on the diaphragm. A detector with damaged backup plates cannot be reset.

To reduce the ball to ball cup wear and backing plate wear at the housing stops, thinner (0.51 mm [0.020"] thick) backing plates are used. Reduced ball to ball cup wear results in less loss of sensitivity of the crankcase portion of the detector, and also reduces the overhung mass of the diaphragm assembly.

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 top 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.

When engine is being started or stopped and oil pressure falls below 138 kPa (20 psi), the "O" rings will seep oil momentarily and thereby lubricate "O" ring, valve stem, and guide, Figs. 4, 5, and 6. No leakage should occur when oil pressure is above 138 kPa (20 psi).

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 detector 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. Detach oil drain line by removing four 10-24 x 1/2" hex socket head cap screws from oil drain line flanges, using a 5/32' Allen wrench.

2. Remove the four 10-24 x 5/8" hex socket head cap screws holding the reset button enclosures to the oil valve block.

3. Loosen all eight 1/4" hex socket head cap screws from oil valve block using a 3/16' Allen wrench.

4. Remove the top four 1/4"-20 x 3-1/4" hex socket head retaining cap screws from the oil valve block. Remove the valve stems, the oil valve block, and low water detector assembly from the remaining crankcase pressure assembly.

NOTE: Both devices must be tripped to remove the oil valve block or the valve stems will be held in place by the steel balls.

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

5. Remove the bottom four 1/4"-20 x 1-1/4" hex socket head cap screws holding the low water assembly to the oil valve block and separate these assemblies.

6. Remove the three cage mounting screws holding the ball cup and ball retainer to the diaphragm and plate assembly.

7. Disassemble the low water block from the diaphragm assembly by removing the four 1/4"- 20 x 1 " hex socket head screws, and separate the diaphragms, diaphragm spacer, spacer ring, and ball cup.

8. 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. Do not remove the vent cap.

9. Remove aluminum backup plate and apply new diaphragm.

NOTE: Reuse only aluminum backup plates. Composition backup plates must be replaced.

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 with "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 pits and brinell marks.

BALL RETAINER

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.

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.

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

Remove the "O" ring in the ball retainer bore by spearing it with a sharp, pointed instrument such as a scribe, and pulling it from the groove. Be extremely careful not to scratch the bore. Install a new "O" ring by inserting it in the bore and using the stem shaft to work it into place in the groove.

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

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: The water (red) diaphragm is very sensitive to abrasion. The low water block, diaphragm spacer, and spacer ring should be free of corrosion deposits, nicks, pits, and deep machine marks in areas that contact the diaphragm.

If the low water block is brass, and the surface that contacts the diaphragm 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. Replacement parts of brass 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.

ASSEMBLY

Reassemble as follows using the equipment as listed in Service Data. See Tool Kit, Fig. 7.

LOW WATER PRESSURE SECTION

1. Assemble diaphragm spacer, air box pressure diaphragm, spacer gasket, and ball cup in that order with diaphragm positioned so that diaphragm spacer fits within cavity formed by diaphragm convolution. Apply silastic to underside of retaining screw heads and install retaining screws. Torque to 1.36 N-m (12 in.-lbs).

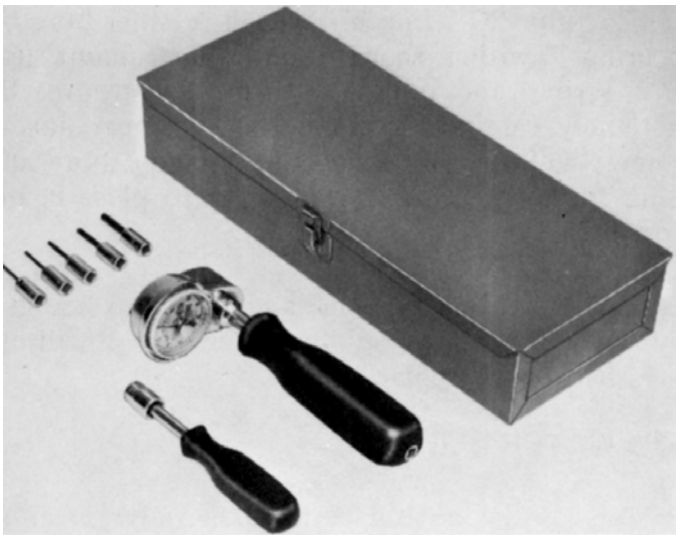


Fig. 7 - Tool Kit

NOTE: Previous design 3:1 ratio detector has an additional spacer between the diaphragm spacer and water pressure diaphragm.

Position assembly in centering fixture (see Service Data for part number) with ball cup over center pilot and diaphragm positioned over four 6.4 mm (1/4") dowels. Lock ball cup from rotating with clamp screw in fixture. Tighten retaining screws in assembly to 1.36 N-m (12 in.-Ibs) torque and remove centering fixture.

CAUTION: When nylon retaining screws are used, care must be exercised to ensure against overtorquing.

2. Place four 1/4"-20 x1" socket head screws through low water block, water pressure diaphragm (with convolution pointing away from block), spacer ring (with vent opening position at same side as water connection on block), and air box pressure diaphragm assembly.

3. Make sure "0" ring is in bore of air box block and ball retainer assembly. Place three steel balls in ball passages of ball retainer using petroleum jelly to hold in place.

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

4. Position diaphragm spring over ball cup of air box pressure diaphragm assembly. Position air box pressure connection 90° counterclockwise of water connection, when facing low water block. Thread cap screws into low water block and tighten to 6.78 N-m (60 in.-Ibs) torque.

NOTE: The 3:1 ratio detector produced prior to May 1975, is not equipped with diaphragm spring. Ensure insertion of proper colored spring where applicable.

5. Apply new "O" rings to oil valve block, and check fit with valve stem to ensure seating of 0" ring without twisting.

6. Apply new "O"rings to valve stem and lubricate with Lubriplate grease. Insert stem guide housing and slide back and forth to ensure seating of "0" ring without twisting. Clamp stem at major diameter in manner that will not damage valve stem. Apply reset button spring, reset button, and retaining screw. Tighten retaining screw to 1.7 N-m (15 in.-lbs) torque.

NOTE: Unless damaged, the red reset button spring should be reused. This spring is no longer included in repair kits 8467305, 8430364, 8467306, 8469590, 8469591, and 8379503.

7. Place oil valve block over low water pressure portion with new "0" ring between assemblies.

Align assembly through valve stem opening with alignment tool inserted to full engagement. (Refer to Service Data for part number.) Apply four 1/4"-20 x 1-1/4" retaining screws and tighten to 6.78 N-m (60 in.-lbs) torque. Alignment tool must be free of bind.

8. Install low water valve stem assembly into valve body with new "0" ring. Apply retaining screws finger tight. Depress reset button for full engagement and hold while tightening retaining screws to 1.7 N-m (15 in.-lbs) torque. Valve stem must move freely without binding.

CRANKCASE PRESSURE SECTION

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. Backup plates must have raised edge facing away from diaphragm. Tighten attaching

screws facing away from diaphragm. Tighten attaching screws to 0.91 N-m (8 in.-lbs.) torque.

NOTE: Reuse only aluminum backup plates. Composition backup plates must be replaced.

2. Assemble crankcase pressure diaphragm between mounting housing and cover, with gasket on each side. Start retaining screws but do not tighten. Install diaphragm centering fixture into ball cup and secure before aligning pilot of fixture with cover opening. (Refer to Service Data page 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. Apply replacement steel balls (with petroleum jelly to hold them in place), to ball retainer in crankcase pressure block. Place crankcase pressure block with crankcase pressure diaphragm spring over ball cup in diaphragm. Position block so vent fitting is at top of assembly.

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

4. Apply low water detector assembly to the crankcase pressure assembly with new "O" ring between oil valve block and crankcase pressure block. Align with alignment tool inserted in valve stem opening to full engagement. (Refer Service Data for part number.) Apply four 1/4"-20 x 3-1/4" hex socket head retaining screws, and tighten to 6.78 N-m (60 in.-lbs) torque. Alignment tool must be free of bind.

5. Insert valve stem and reset button into oil valve block with new "O" ring. Depress crankcase pressure diaphragm spring with pressure of finger inserted through opening in mounting face, against backup plate on diaphragm, until valve stem drops into ball latch assembly.

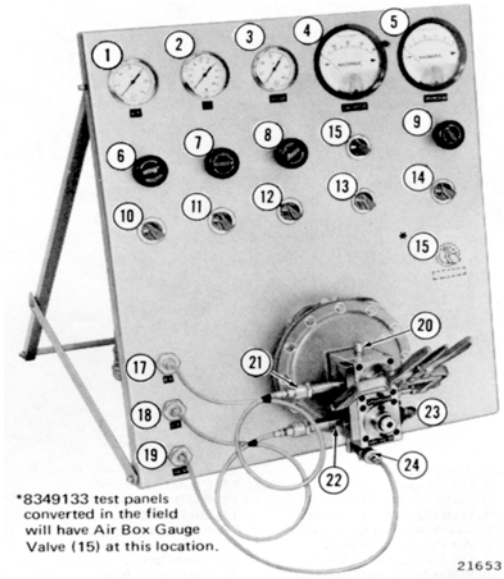
NOTE: Care should be exercised when manually depressing crankcase pressure diaphragm to ensure against distortion of aluminum backup plates.

Release diaphragm and depress reset button, and hold until diaphragm moves to latch position to hold button depressed. Apply retaining screws and torque to 1.7 N-m (15 in.-lbs). Depress crankcase pressure diaphragm spring to release valve stem and reset button. Quickly depressing and releasing reset button should not reveal any binding during movement.

TEST PANELS

There are various configuration test panels in use in the field. The following sequential test panel outline is for reference purposes. Instructions, as they relate to equipment ownership, should be followed.

1. Original design engine protector test panel 8349133 was equipped with a 0-40" H_2O low water pressure gauge. To test new 3:1 engine protectors equipped with gold diaphragm spring, a new 0-60" H_2O gauge is required, Fig. 8. Conversion kit 9098930 and 0-60" gauge assembly 9098659 are available through Electro-Motive Parts Centers.

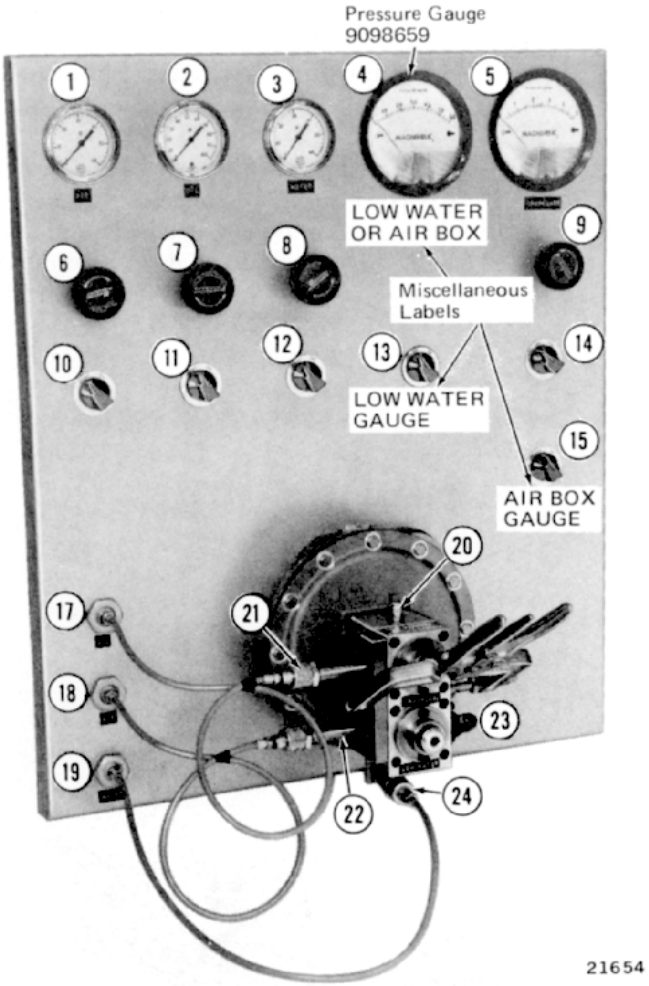


1. Air Gauge
2. Oil Gauge
3. Water Gauge - lbs per sq. in.
4. Low Water Or Air Box Gauge (inches of water)
5. Crankcase Gauge - in. of water
6. Air Pressure Regulator
7. Oil Pressure Regulator
8. Water Pressure Regulator
9. Crankcase Pressure Regulator
10. Air Valve
11. Oil Valve
12. Water Valve - lbs per sq. in.
13. Water Valve - inches of water
14. Crankcase Valve
15. Air Box Gauge Valve
17. Oil Hose Connection
18. Air Hose Connection
19. Water Hose Connection
20. Vent Cap
21. Port No. 1 - (Oil)
22. Port No. 3 - (Air)
23. Port No. 2 - (Oil Outlet)
24. Port No. 4 - (Water)

Fig. 8 - Revised Engine Protector Test Panel 8349133

NOTE: ANY test panel constructed prior to June 1, 1974 must be modified to be applicable for use with either 1:1 or 3:1 ratio engine protectors.

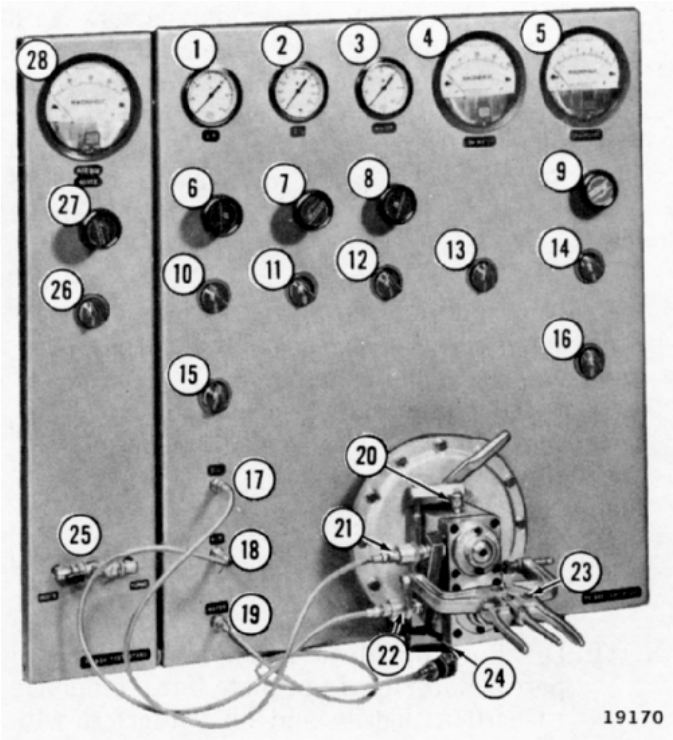
2. Modified test panel 8349133, Fig. 9, replaces test panel 8468433.



1. Air Gauge
2. Oil Gauge
3. Water Gauge - lbs per sq. in.
4. Water Gauge - in. of water
5. Crankcase Gauge - in. of water
6. Air Pressure Regulator
7. Oil Pressure Regulator
8. Water Pressure Regulator
9. Crankcase Pressure Regulator
10. Air Valve
11. Oil Valve
12. Water Valve - lbs per sq. in.
13. Water Valve - in. of water
14. Crankcase Valve
15. Air Box Gauge Valve
17. Oil Hose Connection
18. Air Hose Connection
19. Water Hose Connection
20. Vent Cap
21. Port No. 1 (Oil)
22. Port No. 3 - (Air)
23. Port No. 2 - (Oil Outlet)
24. Port No. 4 - (Water)

Fig. 9 - Modified Test Panel 8349133

3. Test panels 8468433 or 8349133 with added panel 8468434 constructed prior to August 1, 1973, Fig. 10, were equipped with 60 psi gauges and regulators. These panels can be reworked by replacing the 60 psi gauge and regulator with 100 psi gauge 8382496 and 100 psi regulator 8382500.



1. Air Gauge
2. Oil Gauge
3. Water Gauge - lbs per sq. in.
4. Water Gauge - in. of water
5. Crankcase Gauge - in. of water
6. Air Pressure Regulator
7. Oil Pressure Regulator
8. Water Pressure Regulator
9. Crankcase Pressure Regulator
10. Air Valve
11. Oil Valve
12. Water Valve - lbs per sq. in.
13. Water Valve - in. of water
14. Crankcase Valve
15. Surge Load Valve, (Not Used)
16. Surge Release Valve
17. Oil Hose Connection
18. Air Hose Connection
19. Water Hose Connection
20. Vent Cap
21. Port No. 1 - (Oil)
22. Port No. 3 - (Air)
23. Port No. 2 - (Oil Outlet)
24. Port No. 4 - (Water)
25. Roots-Turbo Valve
26. Air Box Valve - in. of water
27. Air Box Pressure Regulator
28. Air Box Gauge - in. of water

Fig. 10 - Engine Protector Test Panel 8468433 Or 8349133 With Added Panel 8468434

TESTING

The "Test Procedures" table, Fig. 11, has been developed specifically as a cross-reference and step-by-step guide for determining the applicable engine detector and test panel combination test instructions to follow. Though single detectors (crankcase pressure and low water pressure) are not discussed individually, information presented is applicable to the respective single portion.

"TEST PROCEDURES" TABLE INSTRUCTIONS (Fig. 11)

1. Locate the device to be tested in the left-hand column of the table.

2. Move across the page to locate the proper test panel column.

3. Read "down."

CODING

The Test Procedure Steps have been alphalogically coded for easy reference to correlate the device and test panel in use. It is important when performing a procedure to follow the EXACT reference Steps. Therefore, the applicable codes encountered in the Test Procedures are defined as follows:

LOW WATER DETECTOR PORTION

RR - The first "R" designates the blower aspirated "Current Roots" device; the second "R" designates the "Revised Panel" procedure.

PD - "Previous Design" blower aspirated (Roots) device.

RPD - "Revised (panel) Previous Design" procedure.

T - "Turbo" device.

RT - "Revised (panel) Turbo" procedure.

CRANKCASE PRESSURE TEST PORTION

P - "Previous" blower aspirated (Roots) device.

TROUBLESHOOTING

Recently, qualified detectors have been unnecessarily removed and returned for warranty. Engine conditions may exist which make the detector <u>appear</u> faulty. To avoid premature detector change-out, check the following possibilities:

LOW WATER BUTTON WILL NOT RESET

1. Cooling system filled to the proper level.

2. Cooling system fully vented.

NOTE: The cooling system is fully vented when water level in expansion tank drops from the FULL STOP level to the FULL RUN level (or equivalent).

CRANKCASE BUTTON CAN BE LATCHED, BUT TRIPS AT HIGHER THROTTLE POSITIONS

1. Marginal crankcase suction.

2. Excessive oil in crankcase.

3. Relief valve improperly applied.

NOTE: Oil relief valve <u>must</u> point toward the <u>center of the engine</u> to ensure against cold oil dumping into the detector.

DEVICE TRIPS, BUT DOES NOT SHUT ENGINE DOWN (LOCOMOTIVE APPLICATION ONLY)

1. Low oil pressure shutdown in governor functioning properly.

COMBINATION DETECTOR TEST PROCEDURES

NOTE: Test panels use air pressure only for all tests in place of oil or water.

LOW WATER DETECTOR PORTION

DEVICE	ALL PANELS	PANEL 8468433 OR 8349133 WITH ADDED PANEL 8468434, Fig. 10.	REVISED PANEL 8349133, Fig. 8.
CURRENT ROOTS *(3:1)	1. Visually check ports for plugging. 2. Connect test panel to a supply of clean, dry air at a minimum pressure of 100 psi. 3. Mount detector device on panel with two nuts at top and bottom corners and fasten adapter to water, air, and oil hoses. 4. Fasten water line to port No. 4 (24), Fig. 10. 5. Fasten air line to port No. 3 (22). 6. Fasten oil line to port No. 1 (21). 7. Turn water pressure regulator (8) to attain 10 psi pressure. Latch low water button, then raise pressure to 100 psi. 8. Latch crankcase button if necessary. 9 Turn air pressure regulator (6) to attain 5 psi pressure. 10. Turn oil pressure regulator (7) to attain 80 psi pressure. 11. Check joints for leaks using soap and water solution. 12. Check oil return port for leak. If panel has flowrator, maximum allowable leak is 10 SCFH. 13. Reduce oil, water and air pressure to 0 psi. Close valves (10), (11), and (12).	14. Turn Roots-Turbo valve (25), to ON position. 15. Switch water gauge valves (12) and (13) to ON position. 16. Using water pressure regulator (8), raise water pressure to 50" H_2O on water gauge (4). Reset button must latch when depressed. 17. Turn water valve (13) to OFF position and raise water pressure to 3 psi minimum on water gauge (3). Depress reset button two or three times to ensure positive latching. Check low water reset button for overtravel while in latched position. **CAUTION:** Water valve (13) is switched to OFF position since pressure may exceed gauge (4) limit. 18. Reduce water pressure to approximately 1 psi, turn water valve (13) to ON position and reduce water pressure slowly with water regulator (8). Low water reset button on a new 3:1 detector must trip at or above 0" H_2O on water gauge (4). When testing a used 3:1 detector, once the water pressure has been reduced to 0" H_2O, turn air box valve (26) and air valve (10) to ON position. Turn air regulator (6) to maximum clockwise position and adjust air box pressure (27) until 5" H_2O is shown on air box gauge (28). Low water reset button should trip. 19. Repeat Steps 16, 17, and 18. 20. Check crankcase and low water buttons for minimum of 0.38 mm (.015") overtravel in latched position. 21. If test is satisfactory, turn water valves (12) and (13), and valves (10) and (26) to OFF position.	RR14. Follow steps 1 through 13 as previously outlined. RR15. Perform Step 15. RR16. Perform Step 16. RR17. Perform Step 17. RR18. Reduce water pressure to approximately 1 psi, turn low water valve (13) to ON position, and reduce water pressure slowly with water regulator (8). Low water reset button on a new 3:1 detector must trip at or above 0" H_2O on water gauge (4). When testing a used 3:1 detector, once the water pressure has been reduced to 0" H_2O, turn low water valve (13) to OFF position and air box gauge (15) to ON position. Adjust air valve (10) until 5" H_2O is shown on gauge (4). Low water reset button should trip. RR19. Repeat Steps RR16, RR17, and RR18. RR20. Perform Step 20. RR21. If test is satisfactory, turn water valve (12), low water valve (13), and air box gauge valve (15), if applicable, to OFF position.
PREVIOUS DESIGN *ROOTS (3:1)		PD14. Turn Roots-Turbo valve (25), to ON position. PD15. Switch water gauge valves (12) and (13) to ON position. PD16. Using water pressure regulator (8), raise water pressure to 32" H_2O on water gauge (4). Reset button must latch when depressed. PD17. Raise water pressure to 40" H_2O on water gauge (4), and depress reset button two or three times to ensure positive latching.	RPD14. Follow Steps 1 through 13 as indicated under "All Panels." RPD15. Perform Steps PD14 and PD15. RPD16. Using water pressure regulator (8), raise water pressure to 40" H_2O on the water gauge (4). Reset button must latch when depressed. RPD17. Follow Step PD18. RPD18. Repeat Steps RPD16 and RPD17.

	CAUTION: To avoid damage to low pressure meters, always reduce water or air box pressure to 1 psi or less before switching panel valve to low pressure meter readout.	PD18. Turn water valves (12) and (13) to OFF position. PD19. Switch air box valve (26) to ON position. PD20. Using the air box pressure regulator (27), raise the pressure on the air box gauge (28) to 10" H_2O. Reset button must trip. PD21. Switch air box valve (26) to OFF position and valves (12) and (13) to ON position. PD22. Repeat Steps PD16, PD17, and PD18. PD23. Check crankcase and low water buttons for minimum of 0.38 mm (.015") overtravel in latched position. PD24. If test is satisfactory, switch air box valve (26) to OFF position.	RPD19. Perform Step PD23. RPD20. If test is satisfactory, turn valve (12), low water valve (13), and air box gauge valve (15), if applicable, to OFF position.
TURBO (1:1)	1. Visually check ports for plugging. 2. Connect test panel to a supply of clean, dry air at a minimum pressure of 100 psi. 3. Mount detector device on panel with two nuts at top and bottom corners and fasten adapter to water, air, and oil hoses. 4. Fasten water line to port No. 4 (24), Fig. 10. 5. Fasten air line to port No. 3 (22). 6. Fasten oil line to port No. 1 (21). 7. Turn water pressure regulator (8) to attain 10 psi pressure. Latch low water button, then raise pressure to 100 psi. 8. Latch crankcase button if necessary. 9. Turn air pressure regulator (6) to attain 20 psi pressure. 10. Turn oil pressure regulator (7) to attain 80 psi pressure. 11. Check joints for leaks using soap and water solution. 12. Check oil return port for leak. If panel has flowrator, maximum allowable leak is 10 SCFH. 13. Reduce oil, water, and air pressure to 0 psi. Close valves (10), (11), and (12). **CAUTION:** To avoid damage to low pressure meters, always reduce water or air box pressure to 1 psi or less before switching panel valve to low pressure meter readout.	T14. Turn Roots-Turbo valve (25), to TURBO position. T15. Switch water gauge valves (12) and (13) to ON position. T16. Using water pressure regulator (8), raise water pressure to 32" H_2O on water gauge (4). Reset button must latch when depressed. T17. Raise water pressure to 3 psi minimum H_2O on water gauge (4), and depress reset button two or three times to ensure positive latching. T18. Reduce water pressure slowly with water regulator (8). Low water reset button must trip at or above 10" H_2O on a new device and 4" H_2O on a used device. T19. Repeat Steps T16, T17, and T18. T20. Check crankcase and low water buttons for minimum of 0.38 mm (.015") overtravel in latched position. T21. If test is satisfactory, close water valves (12) and (13).	RT14. Follow Steps 1 through 13 as indicated under "All Panels." RT15. Perform Steps T14 and T15. RT16. Perform Step T16. RT17. Perform Steps T17 and T18. RT18. Repeat Steps RT16 and RT17. RT19. Perform Step T20. RT20. If test is satisfactory, turn valves (12) and (13), and air box gauge valve (15), if applicable, to OFF position.

*These devices should have a metal tag on water block with "ROOTS" embossed on tag.

Fig. 11 – Test Procedures

CRANKCASE PRESSURE TEST

DEVICE	ALL PANELS	PANEL 8468433 OR 8349133 WITH ADDED PANEL 8468434, Fig. 10.	REVISED PANEL 8349133, Fig. 8.
CURRENT ROOTS *(3:1) AND TURBO (1:1)	1. Set crankcase pressure gauge (5) on zero pressure. If pressure regulator (9) is not effective in reducing the pressure to zero, air may be trapped in back of the detector. Loosen mounting nuts slightly to relieve trapped air. Retighten nuts 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 gauge (5) registors 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" H_2O on crankcase gauge (5) and a used device should trip between 0.8" and 3" H_2O. **NOTE:** A used device is one that has been in service 3 months or more since it was new or rebuilt. 5. Turn crankcase valve (14) to OFF position. 6. Relatch crankcase button when pressure drops to zero. 7. Repeat Steps 3 through 7 two times. 8. Close oil, air, and water valves (11), (10), and (12) in that order.	9. Be sure all supply valves (10 through 14, and 26) are in OFF position before disconnecting supply lines from device.	9. Be sure all supply valves (10 through 15), are in OFF position before disconnecting supply lines from device.
PREVIOUS DESIGN *ROOTS (3:1)	1P. Perform Steps 1, 2, and 3 under CRANKCASE PRESSURE TEST, "All Panels." 2P. Turn crankcase pressure regulator (9) to raise pressure slowly until crankcase button trips. A new device should trip between 0.8" and 1.8" H_2O on crankcase gauge (5) and a used device should trip between 0.8" and 2.5" H_2O. 3P. Perform Step 5 under CRANKCASE PRESSURE TEST, "All panels." 4P. Relatch crankcase button when pressure drops to zero.		

	NOTE: It may be necessary to release trapped air by turning surge release valve (16) on and off several times. 5P. Perform Steps 7 and 8 under CRANKCASE PRESSURE TEST, "All panels." 6P. Perform Step 9 as indicated for the proper test panel under CRANKCASE PRESSURE TEST.		

GENERAL TESTS

DEVICE	ALL PANELS	PANEL 8468433 OR 8349133 WITH ADDED PANEL 8468434, Fig. 10.	REVISED PANEL 8349133, Fig. 8.
CURRENT ROOTS *(3:1); PREVIOUS DESIGN *ROOTS (3:1); TURBO (1:1)	1. Remove detector from test panel and lay on side with port No. 3 (22) up. 2. Turn water valve (12), Figs. 8, 9, and 10, to ON position. 3. Turn water pressure regulator (8) to provide 10 psi pressure on water gauge (3). 4. While turning water valve (12) on and off observe movement of ball latch cup within spring, through port No. 3 (22). Travel must be 1.27 mm (.050") minimum with low water valve button in tripped position. 5. Turn water pressure regulator (8) to zero reading on water gauge (3). 6. Turn water valve (12) to OFF position. 7. Remove water line from detector. 8. Position detector on spring tester (if not available use 3.6 kg [8 lbs] weight) with reset buttons upward. 9. Deflect water reset button with ram on spring tester, to bottom position and raise ram 0.81 mm (.032") and hold. Spring force to be 3.6 kg (8 lbs) minimum. 10. Deflect crankcase reset button with ram on spring tester, to bottom position and raise ram 0.81 mm (.032") and hold. Spring force to be 3.6 kg (8 lbs) minimum. 11. Check 10-24 NC-2B thread at six holes, depth 1/2" -- 1-1/4" center-to-center. 12. Check 11/32" drill through eight holes for size and location on mounting face. 13. Check vent cap (on top of reset button block) for freeness. (Must be loose.) 14. Replace closure caps at reset buttons and ports.		

*These devices should have a metal tag on water block with "ROOTS" embossed on tag.

Fig. 11 – Test Procedures

TESTING AND SERVICING

The following are some conditions and their causes which may be encountered in testing and servicing these detectors.

CONDITION: Low water button latches and trips in area of 30" H_2O 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.

CONDITION: Engine oil pressure fails to build up with reset buttons 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. (Pressure applied only at water port.)
CAUSE: Water diaphragm faulty.

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 top of device is plugged.

SERVICE DATA

ENGINE MODEL-ENGINE PROTECTOR APPLICATION DATA

ENGINE MODEL	ENGINE PROTECTOR APPLICATION
8-567-BC	8385288*
8-567-C	8385288*
8-567-CR	8385288*
8-645-E	8385288
12-567-BC	8340584
12-567-C	8340584
12-645-E	8368196 or 8454989**
12-645-E3	8428104**
16-567-BC	8340584
16-567-C	8340584
16-567-D 1	8340584
16-567-D2	8338016
16-567-D3	8338016
16-567-D3A	8338016
16-645-E	8368196 or 8454989**
16-645-E3	8348793 or 8428104**
16-645-E3A	8428104**
20-645-E3	8428104**

*Flange adapter 9093556 required. (Reference 8340584 for application.)
**Combination engine protector and hot oil valve application.

For field application order engine protector application kit 9096690. Eight cylinder engines will need tube assemblies 8385171, 8385172, and 8385173 in addition to the kit. Also order the engine protector (Roots or Turbo) that is compatible with the engine being equipped. (Reference above application drawings.)

NOTE: The application kit contains all necessary parts (and in some instances extraneous parts) to apply an engine protector to either a turbo or Roots engine.

SERVICE DATA (CONT'D)

REBUILD AND KIT INFORMATION TABLE

GENERAL INFORMATION

PART NO.	DESCRIPTION	REBUILD INSTRUCTION
8319666 8349491	Obsolete low water - threaded connection	Scrap - no salvage value - replace w/8446593
8344252	Obsolete low water valve - flanged connection	Scrap - no salvage value - replace w/8447342
8337245	Obsolete combination low water and crankcase pressure detector	Rebuild - parts that can be salvaged are those common to 8428395 and use kit 8447886
8358536	Low water valve - threaded connection	Rebuild w/kit 8467305 which upgrades device to 8446593
8358537	Low water valve - flanged connection	Rebuild w/kit 8467305 which upgrades device to 8447342
8358638	Combination low water and crankcase protector	Rebuild w/kit 8467306 which upgrades device to 8428395
8398174	Utex No. for 8358538	
8362040	Crankcase pressure detector switch	Rebuild w /kit 8379503
8370362	Crankcase pressure detector valve	Rebuild 8379503 w/kit
8444042	Utex No. for above	
8428395 WS 17082	New combination low water and crankcase pressure detector	Rebuild low water portion w/kit 8430364 and 8379503
8446372	Utex No. for above	crankcase portion w/kit
8447342	Low water valve - flanged connection	
8446593	Low water valve - threaded connection	Rebuild w/kit 8430364
8464678	Roots blown combination EP 3:1)	Rebuild w/kit 8469590 and 8379503
8474255	Utex. No. for above	
8469592	Roots blown low water valve (flanged)	Rebuild w/kit 8469590

KIT IDENTIFICATION

PART NO.	DESCRIPTION
8467306	All parts needed to upgrade and rebuild 8358538, 8398174 to standard of 8428395
8467305	All parts needed to upgrade and rebuild 8358536, 8358537 to standard of 8446593 and 8447342
8430364	Rebuild 8446593, 8447342 and low water portion of 8428395 and 8446372, WS 17082
8379503	Rebuild 8362040, 8370362, 8444042 and crankcase portion of 8358538, 8398174, 8428395, 8446372 WS 17082
8469590	Rebuild 8469592 and low water portion of 8464678 in kind
8469591	Conversion of low water portion to 3:1 - use on 8358538, WS 17082, 8428395, 8358536, 8358537,8447342,8464678

SERVICE DATA (CONT'D)

SPECIFICATIONS

1:1 (Turbo) Device -- (New) 8428395 and (Utex) 8446372 and 3:1 (Roots) Device - (New) 8464678 and (Utex) 8474255

CONNECTIONS

Port No. l, Oil Inlet Connection (100 psi max.)
Port No. 2, Oil Return To Crankcase
Port No. 3, Air Box Connection (0 to 20 psi)
Port No. 4, Engine Cooling Water Connection (0 to 60 psi)
Port No. 5, Breather And Test Connection
Port No. 6, Crankcase - Normally Negative Pressure

PERFORMANCE

Port No. 1 normally blocked from Port No. 2.
Port No. 1 connected to Port No. 2 if:

a) Port No. 4 pressure does not exceed Port No. 3 pressure by 10" to 32" of H_2O.
b) Crankcase pressure exceeds .8" to 1.8" H2O.

RESET INFORMATION

Low Water Detector - Manually resetable when Port No. 4 pressure exceeds Port No. 3 pressure by 32" H_2O.
Crankcase Detector - Manually resetable when crankcase pressure does not exceed 0 psi.

TEST LIMITS*

Device	Purpose	RESET (Rising Pressure)	(Dropping	Pressure)	TRIP (Rising	Pressure)
			New	Used	New	Used
(1:1)						
8428395	Low Water	32"	10"	4"		
8446372	Crankcase	0"	0"	0"	.8" to 1.8" H_2O	.8" to 3.0" H_2O
(3:1)						
8464678	Low Water	50"	0" or above	0"		5" H2O**
8474255	Crankcase	0"	0"	0"	.8" to 1.8" H_2O	.8" to 3.0" H_2O

*Limits applicable to all new or rebuilt devices with less than 3 months service. **Refers to air box pressure.

SERVICE DATA(CONT'D)

EQUIPMENT LIST

TEST PANELS

Revised Test Panel (with 0-60" H20 gauge)	8349133
Modified Test Panel (replaces panel 8468433)	8349133
Test Panels (with 100 psi gauge and regulator)	8468433 or 8349133 with Added Panel 8468434

Alignment Tool	8361214
Air Box Diaphragm Centering Fixture	8361216
Crankcase Diaphragm Centering Fixture	8361217
Torque and T-Bar Wrench Kit	8361215
Ball Retainer Removal Tool	8488380

REFERENCES

Modernization Recommendation-Conversion of Engine Protector Test Panels	9613-A