

M AINTENANCE I NSTRUCTION

LOW WATER AND CRANKCASE PRESSURE DETECTORS

INTRODUCTION

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

The combination device has proven itself, and is available for all locomotive engine applications (from 567BC engines on). Many units have had this protective device added after delivery, however, 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 detector assemblies. 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, 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 devices, specific instructions will be given pertaining to each model.

DESCRIPTION

The combination low water and crankcase pressure detector, Fig. 1, is a mechanically operated,

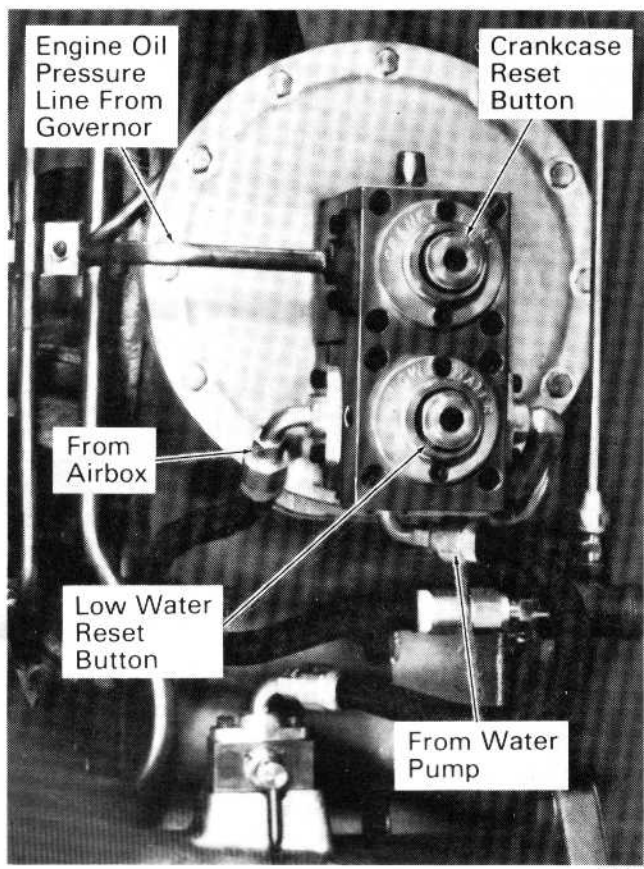


Fig.1 - Low Water And Crankcase Pressure Detector Installation

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.

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

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

OPERATION

LOW WATER DETECTOR

The low water safety device is a spring loaded, normally closed, 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 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 890 or 1524 mm (35" or 60") 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 1 minute and again within 2 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 reduced to approximately that of air box. The following conditions will cause the detector to trip:

1. Loss of water.
2. Pump cavitation due to air entrainment (particularly during engine start).
3. Pump cavitation due to water temperature approaching boiling point. (Application 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

The 1:1 detector design is equipped with a blue colored diaphragm spring. A gold colored diaphragm spring, Fig. 3, was 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.")

Water pressure must exceed air box pressure plus the force of a light spring, under normal operating conditions. Cross-sectional views of the 1:1 and 3:1 detector configurations are shown in both latched and tripped positions in Figs. 4 and 5 respectively.

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.

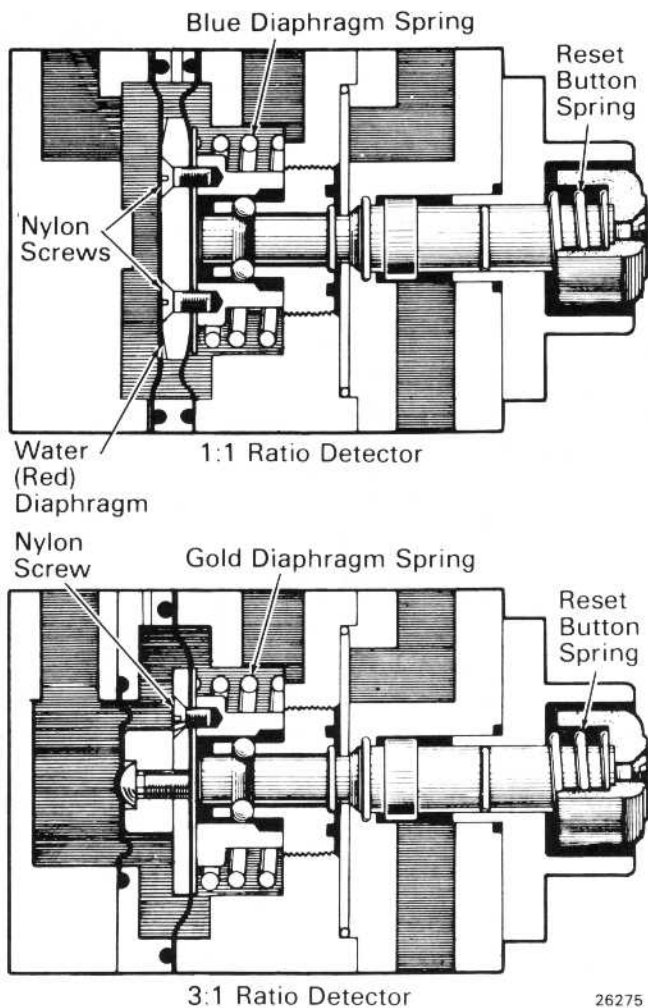


Fig.3 - Location Of Nylon Screws, Reset Button Spring, And Colored Diaphragm Springs

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 and 5, 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 2 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 0-120 mm (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, thin backing plates are used.

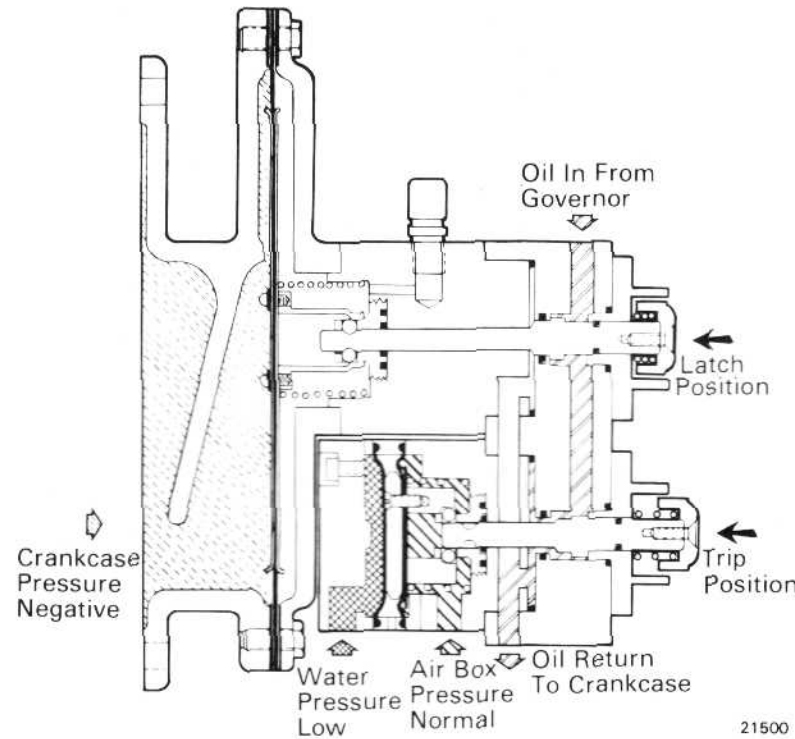
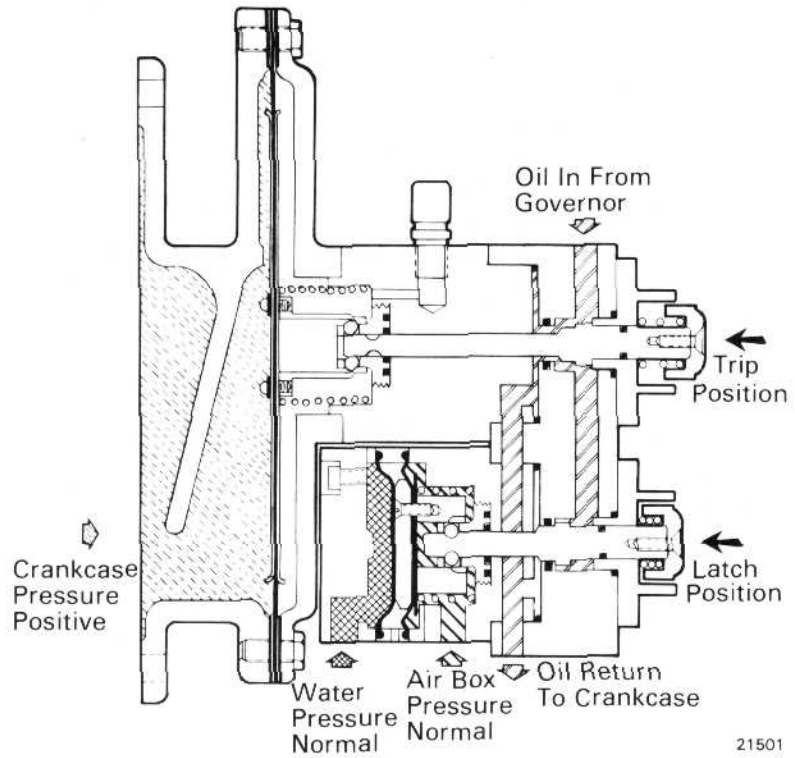


Fig.4 - 1:1 (Turbo Device) Schematic

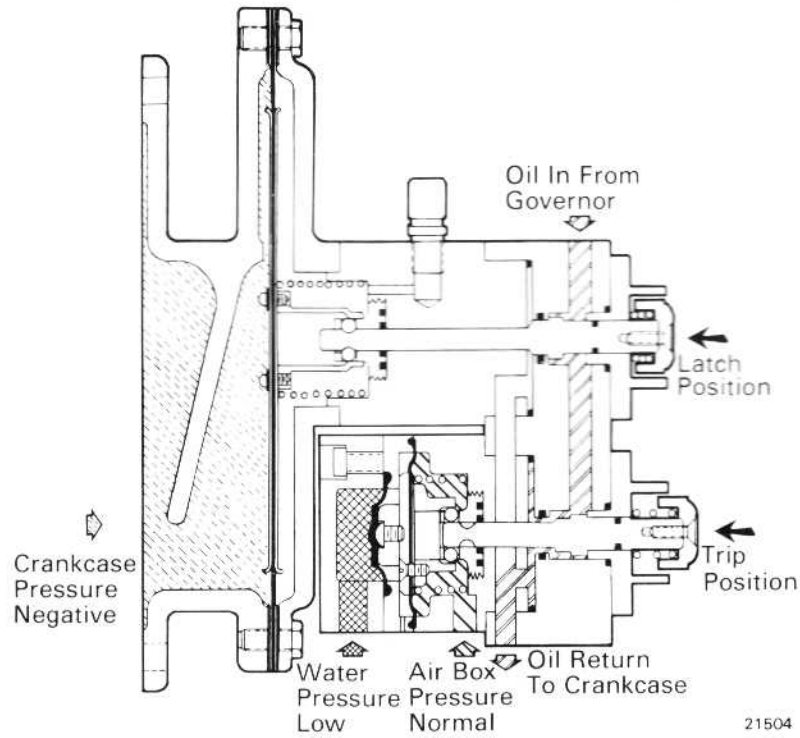
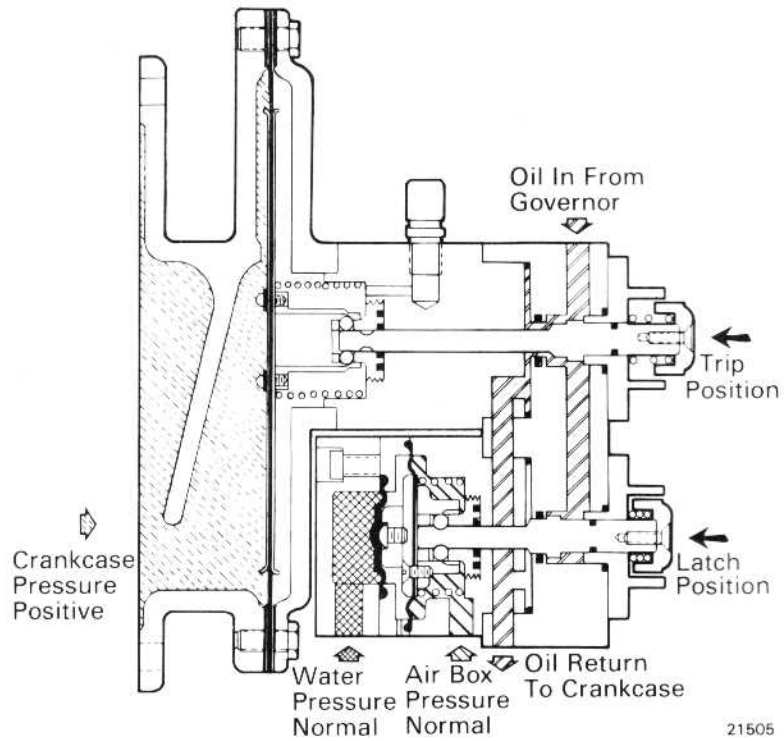


Fig.5 - 3:1 (Roots Device) Schematic

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 excessive 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 latch the device, 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 and 5. 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. 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. Discard three steel balls from low water portion.
7. Remove the cover plate from the mounting plate housing by removing the 12 1/4"-20 socket head bolts around the outer edge of the assembly. Do not remove the vent cap.
8. Remove diaphragm assembly from mounting plate housing.
9. Remove the three cage mounting screws holding the ball cup to the diaphragm and plate assembly. Discard three steel balls from the crankcase portion.
10. Disassemble both valve stem assemblies by clamping the stem major diameter in a suitable

clamping device to prevent damaging the stem finish. Remove Allen head screw securing button to stem. Remove button, spring and stem from guide housing.

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.

LOW WATER BLOCK

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. 6.



13559

Fig.6 - Tool Kit

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 three nylon retaining screw heads and install retaining screws. Torque to 1.36 N·m (12 in.-lbs).

CAUTION

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

2. Place assembly containing the four 1/4"-20 x 1" socket head screws through low water block, water pressure diaphragm (with convolution pointing away from block), spacer ring (with vent hole position at same side as water connection on block), and air box pressure diaphragm assembly.
3. Install new "O" ring 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 block with pressure connection 90° clockwise of water connection. Invert assembly and thread cap screws into air box block and tighten to 6.78 N·m (60 in.-lbs) torque.
5. Apply two new "O" rings to oil valve block bores, and check fit with valve stem to ensure seating of "O" ring without twisting.
6. Apply new "O" ring to valve stem and lubricate with petroleum jelly. Insert stem guide housing and slide back and forth to ensure seating of "O" 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 8430364, 8467306, 8469590, 8469591, 8379503, and 9535868.

7. Place oil valve block over low water pressure portion with new "O" ring between assemblies. Apply four 1/4"-20 x 1-1/4" retaining screws and tighten to 6.78 N·m (60 in.-lbs) torque.
8. Install new "O" ring into recess in oil valve block and install valve stem assembly into oil valve block. 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. 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 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. Install new "O" ring in bore of crankcase pressure block assembly. Apply replacement steel balls (with petroleum jelly to hold them in place), to ball retainer in crankcase pressure block. Place crankcase diaphragm spring over ball cup on crankcase diaphragm assembly. Position crankcase pressure block over diaphragm spring with vent fitting 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. 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.
5. Apply new "O" ring to valve stem and lubricate with petroleum jelly. Insert stem guide housing and slide back and forth to ensure seating of "O" 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 8430364, 8467306, 8469590, 8469591, 8379503, and 9535868.

6. Check vent cap (on top of reset button block) for freeness (must be loose).
7. Install new 'O' ring into recess in oil valve block and install valve stem assembly into oil valve block. Insert finger through opening in mounting face, and apply sufficient pressure to diaphragm backup plate 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 backup plate with finger 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 test panel configurations in use in the field. Figs. 7, 8, and 9 illustrate the test panel configurations being used.

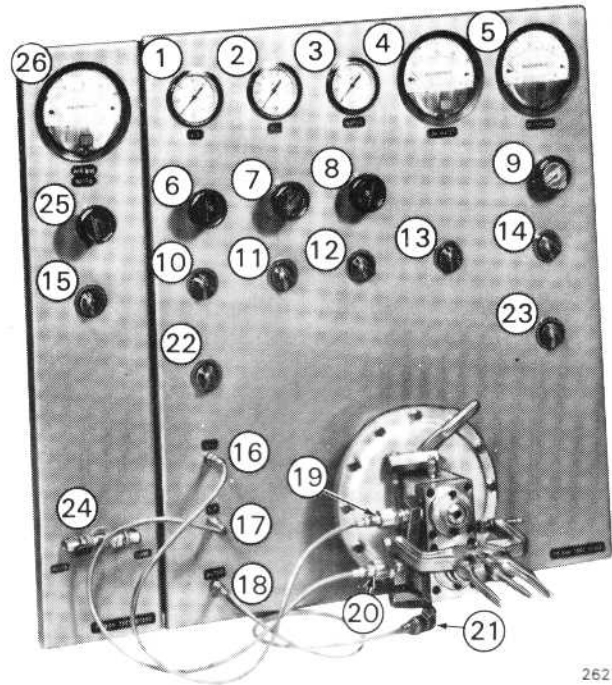
Test panels 8468433 or 8349133 with added panel 8468434 constructed prior to August 1, 1973, Fig. 7, were equipped with 60 psi gauges and regulators. These panels can be reworked by replacing the 60 psi gauge and regulator with 100 psi gauge 8382496 and 100 psi regulator 8382500.

Original design engine protector test panel 8349133 was equipped with a 0-40" H₂O low water pressure gauge. To test new 3:1 engine protectors equipped with gold diaphragm spring, a new 0-60" H₂O gauge is required, Fig. 8. Conversion kit 9098930 and 0-60" gauge assembly 9098659 are available through Electro-Motive Parts Centers.

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.

Modified test panel 8349133, Fig. 8, replaces test panel 8468433.



26272

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

Fig. 7 - Type A Test Panel (8468433 Or Original 8349133 With Added Panel 8468434)

TROUBLESHOOTING

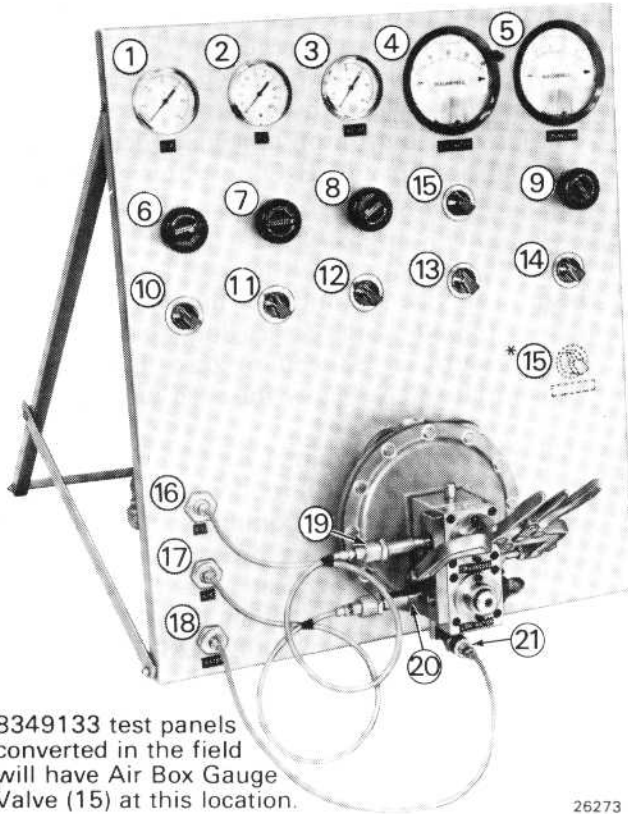
Qualified detectors have been unnecessarily removed and returned for warranty. Engine conditions may exist which make the detector *appear* faulty. To avoid premature detector changeout, check the following possibilities:

LOW WATER BUTTON WILL NOT RESET

1. Cooling system not filled to the proper level.
2. Cooling system not 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).



*8349133 test panels converted in the field will have Air Box Gauge Valve (15) at this location.

26273

- | | |
|---------------------------------------|----------------------------------|
| 1. Air Gauge (psi) | 10. Air Valve (psi) |
| 2. Oil Gauge (psi) | 11. Oil Valve (psi) |
| 3. Water Gauge (psi) | 12. Water Valve (psi) |
| 4. Water/Air Box Gauge (in. of water) | 13. Water Valve - (in. of water) |
| 5. Crankcase Gauge - (in. of water) | 14. Crankcase Valve |
| 6. Air Pressure Regulator | 15. Air Box Gauge Valve |
| 7. Oil Pressure Regulator | 16. Oil Hose Connection |
| 8. Water Pressure Regulator | 17. Air Hose Connection |
| 9. Crankcase Pressure Regulator | 18. Water Hose Connection |
| | 19. Port No. 1 - (Oil) |
| | 20. Port No. 2 - (Air) |
| | 21. Port No. 3 - (Water) |

Fig. 8 - Type B Test Panel (8349133 Modified)

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

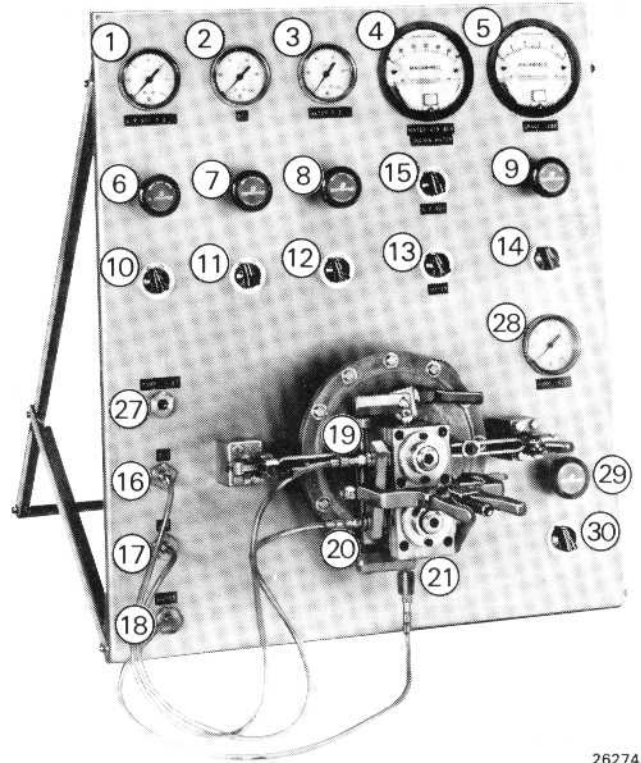
1. Marginal crankcase suction.
2. Excessive oil in crankcase.
3. Relief valve improperly applied.

NOTE

Oil relief valve must point downward 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 not functioning properly.



26274

- | | |
|--|-----------------------------------|
| 1. Air Gauge | 12. Water Valve (psi) |
| 2. Oil Gauge | 13. Water Valve (inches of water) |
| 3. Water Gauge (psi) | 14. Crankcase Valve |
| 4. Water/Air Box Gauge (inches of water) | 15. Air Box Gauge Valve |
| 5. Crankcase Gauge (inches of water) | 16. Oil Hose Connection |
| 6. Air Pressure Regulator | 17. Air Hose Connection |
| 7. Oil Pressure Regulator | 18. Water Hose Connection |
| 8. Water Pressure Regulator | 19. Port No. 1 (Oil) |
| 9. Crankcase Pressure Regulator | 20. Port No. 2 (Air) |
| 10. Air Valve (psi) | 21. Port No. 3 (Water) |
| 11. Oil Valve (psi) | 27. Pump Inlet Connection |
| | 28. Pump Inlet Gauge (psi) |
| | 29. Pump Inlet Pressure Regulator |
| | 30. Pump Inlet Valve (psi) |

Fig. 9 - Type C Test Panel (9339066 - Differential Pressure)

TESTING

The "Test Procedures" have been developed specifically as a step-by-step guide for determining the applicable engine detector and test panel combination test instructions. Refer to Figs. 7, 8, and 9 for item number references contained in the test instructions.

LOW WATER DETECTOR PORTION TEST PROCEDURES

ROOTS DEVICES (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 four nuts at top and bottom corners or using toggle clamps and fasten adapters to water, air, and oil hoses.
4. Fasten water line to port No. 3 (21).
5. Fasten air line to port No. 2 (20).
6. Fasten oil line to port No. 1 (19).
7. Set water psi valve (12) to ON position and turn water pressure regulator (8) to attain 10 psi pressure on water psi gauge (3). Latch low water button, then raise pressure to 100 psi.
8. Latch crankcase button if necessary.
9. Set air psi valve (10) to ON position and turn air pressure regulator (6) to attain 5 psi pressure on air psi gauge (1).
10. Set oil psi valve (11) to ON position and turn oil pressure regulator (7) to attain 80 psi pressure on oil psi gauge (2).
11. Check joints for leaks using soap and water solution.
12. Check oil return port for leaks. If panel has flowrator, maximum allowable leak is 10 SCFH.
13. Reduce oil, water and air pressure to 0 psi. Turn valves (10), (11), and (12) to OFF position.
14. *On type A test panel only, turn Roots-Turbo valve (24) to ROOTS position.*
15. Switch water gauge valves (12) and (13) to ON position.
16. Using water pressure regulator (8), raise water pressure to 60" H₂O on water gauge (4). Reset button must latch when depressed.

CAUTION

Water valve (13) must be switched to OFF position at this point since pressure may exceed gauge (4) limit.

17. Using water pressure regulator (8), raise water pressure to 3 psi on water gauge (3). Depress reset button two or three times to ensure positive latching. Check low water reset button for minimum of 0.38 mm (.015") overtravel while in latched position.

18. Reduce water pressure to approximately 1 psi, using water pressure regulator (8). 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" H₂O on water gauge (4).

NOTE

When testing a used 3:1 detector (one that has been in service 3 months or more since it was new or rebuilt), if the device does not trip when air pressure is reduced to zero, follow the appropriate steps below for each panel type.

- a. On type A test panel, turn air box valve (15) and air valve (10) to ON position. Turn air regulator (6) to maximum clockwise position and adjust air box pressure regulator (25) slowly until low water reset button trips. Button must trip at or before 5" H₂O, as shown on air box gauge (26).
 - b. On type B or C test panel, turn low water valve (13) to OFF position and air box valve (15) and air valve (10) to ON position. Adjust air box regulator (6) slowly until low water reset button trips. Button must trip at or before 5" H₂O, as shown on air box gauge (4).
19. Repeat Steps 16, 17, and 18.
 20. If test is satisfactory, turn all regulators fully counterclockwise and all valves to OFF position.

TURBO DEVICES (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 four nuts at top and bottom corners or using toggle clamps, and fasten adapters to water, air, and oil hoses.
4. Fasten water line to port No. 3 (21).
5. Fasten air line to port No. 2 (20).
6. Fasten oil line to port No. 1 (19).
7. Set water psi valve (12) to ON position and turn water pressure regulator (8) to attain 10 psi pressure on water psi gauge (3). Latch low water button, then raise pressure to 100 psi.

8. Latch crankcase button if necessary.
9. Set air psi valve (10) to ON position and turn air pressure regulator (6) to attain 20 psi pressure on air psi gauge (1).
10. Set oil psi valve (11) to ON position and turn oil pressure regulator (7) to attain 80 psi pressure on oil psi gauge (2).
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. Turn valves (10), (11), and (12) to OFF position.
14. On type A test panel only, turn Roots-Turbo valve (24) to TURBO position.
15. Switch water gauge valves (12) and (13) to ON position.
16. Using water pressure regulator (8), raise water pressure to 35" H₂O on water gauge (4). Reset button must latch when depressed.

CAUTION

Water valve (13) must be switched to OFF position at this point since pressure may exceed gauge (4) limit.

17. Raise water pressure to 3 psi on water gauge (4), and depress reset button two or three times to ensure positive latching. Check low water reset button for minimum of 0.38 mm (.015") overtravel while in latched position.
18. Reduce water pressure to approximately 1 psi using water pressure regulator (8). Turn water valve (13) to ON position and reduce water pressure slowly with water regulator (8). Low water reset button must trip at or above 10" H₂O on a new device and 4" H₂O on a used device (one that has been in service 3 months or more since it was new or rebuilt), as shown on water gauge (4).
19. Repeat Steps 16, 17, and 18.
20. If test is satisfactory, turn all regulators fully counterclockwise and all valves to OFF position.

CRANKCASE PRESSURE TEST PROCEDURE - ALL DEVICES

1. Mount detector device on panel with four nuts at top and bottom corners or using toggle clamps.
2. Set crankcase pressure gauge (5) on zero pressure using pressure regulator (9). If regulator (9) is not effective in reducing the pressure to zero, air may be trapped in back of the detector. Loosen mounting nuts or clamps slightly to relieve trapped air. Retighten nuts or toggle clamps when trapped air has been relieved.
3. 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).

NOTE

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

4. Turn crankcase valve (14) to ON position.
5. 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 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.

6. Reduce crankcase pressure to zero using regulator (9) and turn crankcase valve (14) to OFF position.
7. Relatch crankcase button when pressure drops to zero.
8. Repeat Steps 4 through 7 two times.

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" H₂O 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 vent hole in diaphragm spacer. (Pressure applied only at water port.)

CAUSE: Water diaphragm faulty.

CONDITION: Oil and air leaking from vent 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.
Crankcase diaphragm plate bent or damaged.

SERVICE DATA

ENGINE MODEL/ENGINE PROTECTOR APPLICATION DATA

<u>ENGINE MODEL</u>	<u>ENGINE PROTECTOR APPLICATION</u>
8-567-BC	8385288*
8-567-C	8385288*
8-567-CR	8385288*
8-645-E	8385288
8-645E3	9081663
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-D1	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.

REBUILD AND KIT INFORMATION TABLE

GENERAL INFORMATION

PART NO.	DESCRIPTION	REBUILD INSTRUCTION
8362040	Crankcase pressure detector switch.	Rebuild with kit 8379503.
8370362	Crankcase pressure detector valve.	Rebuild with kit 8379503.
8444042	Utex Number for above.	
8428395	Turbo combination low water and crankcase pressure detector (1:1).	Rebuild low water portion with kit 8430364 and crankcase portion with kit 8379503. Combination rebuild kit for low water and crankcase portions - 8467306.
8446372	Utex number for above.	
8447342	Turbo low water valve - flanged connection.	Rebuild with kit 8430364.
8446593	Turbo low water valve - threaded connection.	
8464678	Roots blown combination. Low water and crankcase pressure detector (3:1).	Rebuild low water portion with kit 8469590 and crankcase portion with kit 8379503. Combination rebuild kit for low water and crankcase portions - 9535868.
8474255	Utex number for above.	
8469592	Roots blown low water valve - flanged connection.	Rebuild with kit 8469590.

KIT IDENTIFICATION

PART NO.	DESCRIPTION
9535868	All parts needed to rebuild 8464678 and 8474255.
8467306	All parts needed to rebuild 8428395 and 8446372.
8430364	Rebuild 8446593, 8447342 and low water portion of 8428395 and 8446372.
8379503	Rebuild 8362040, 8370362, 8444042 and crankcase portion of 8428395, 8446372, 8464678 and 8474255.
8469590	Rebuild 8469592 and low water portion of 8464678 and 8474255.
8469591	Conversion of low water portion to 3:1 - use on 8428395 and 8447342.

SPECIFICATIONS

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

CONNECTIONS

- Port No. 1, Oil Inlet Connection (100 psi maximum).
- Port No. 2, Air Box Connection (0 to 20 psi).
- Port No. 3, Engine Cooling Water Connection (0 to 60 psi).
- Port No. 4, Oil Return To Crankcase.

PERFORMANCE

- Port No. 1 normally blocked from Port No. 4
- Port No. 1 connected to Port No. 4 if:
 - a. Port No. 3 pressure does not exceed Port No. 2 pressure by 10" to 35" of H₂O.
 - b. Crankcase pressure exceeds .8" to 1.8" H₂O (new device).

RESET INFORMATION

Low Water Detector - Manually resetable when Port No. 3 pressure exceeds Port No. 2 pressure by 35" H₂O on a 1:1 (turbo) device and by 60" H₂O on a 3:1 (Roots) device.
 Crankcase Detector - Manually resetable when crankcase pressure does not exceed 0 psi.

TEST LIMITS

Device	RESET (Rising Pressure)	TRIP			
		(Dropping Pressure)		(Rising Pressure)	
		New*	Used	New*	Used
Low Water (1:1)	35"	10"	4"		
Low Water (3:1)	60"	0"			5" H ₂ O**
Crankcase	0"			.8" to 1.8" H ₂ O	.8" to 3.0" H ₂ O

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

EQUIPMENT LIST

TEST PANELS

Test Panels (with 100 psi gauge and regulator)	8468433 or 8349133 With Added Panel 8468434
Modified Test Panel (replaces panel 8468433)	8349133
Differential Pressure Test Panel	9339066
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
Modernization Recommendation – Application of Low Water and Crankcase Pressure Detector	9544

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