

starts require a thin oil to reduce engine resistance, while high speed driving requires a thick oil which can lubricate vital engine parts at temperatures.

According to the Society of Automotive Engineers' (SAE) viscosity classification system, an oil with a high viscosity number (such as SAE 40 or SAE 50) will be thicker than one with a lower number (SAE 10W). The "W" in 10W indicates that the oil is desirable for use in winter operation, and does not stand for "weight". Through the use of special additives, multiple-viscosity oils are available to combine easy starting at cold temperatures with engine protection at high speeds. For example, a 10W40 oil is said to have the viscosity of a 10W oil when the engine is cold and that of a 40 oil when the engine is warm. The use of such an oil will decrease engine resistance and improve efficiency.

➔ **Yanmar does not approve synthetic oil for use in any of their engines.**

OIL LEVEL CHECK

➔ See Figures 13, 14, 15 and 16

** CAUTION

The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

When checking the oil level, it is best that the boat be level and the oil be at operating temperature. Checking the level immediately after stopping the engine will give a false reading.

It is normal for a diesel engine to naturally consume oil during the course of operation. You should not be alarmed if the oil level in your engine drops slightly between inspections. The color of the oil is usually a pitch black color. Smelling the oil is a poor indicator of oil condition than the color. If the oil smells burned, it should be replaced immediately.

➔ It takes a little while for fresh oil to reach the engine to reach the crankcase. Wait for about 3 minutes after adding oil to check the oil level again.

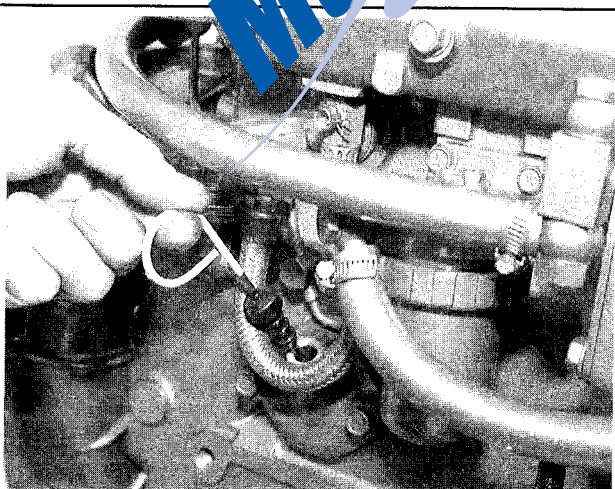


Fig. 13 To check the engine oil level, pull the dipstick from the tube, wipe it clean, then reinsert it to obtain a reading

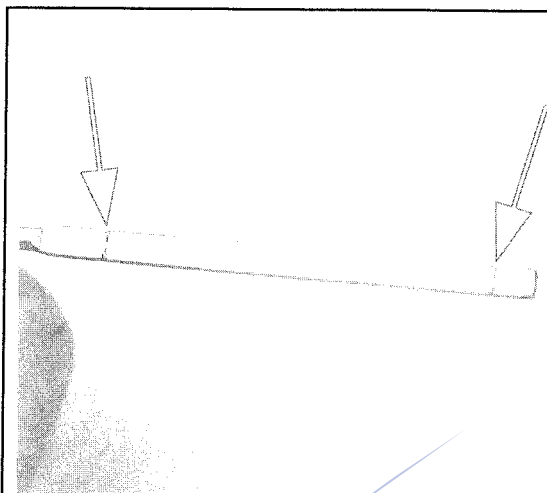


Fig. 14 The oil level on the dipstick should always be kept at the full mark on the dipstick

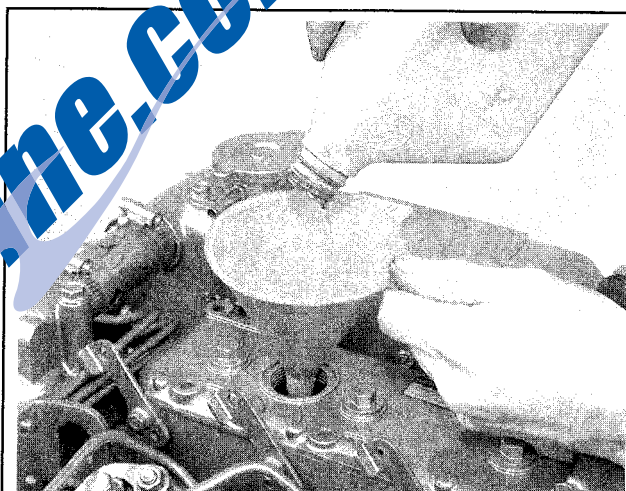


Fig. 15 If the oil level is low, add oil through the oil cap hole in the valve cover

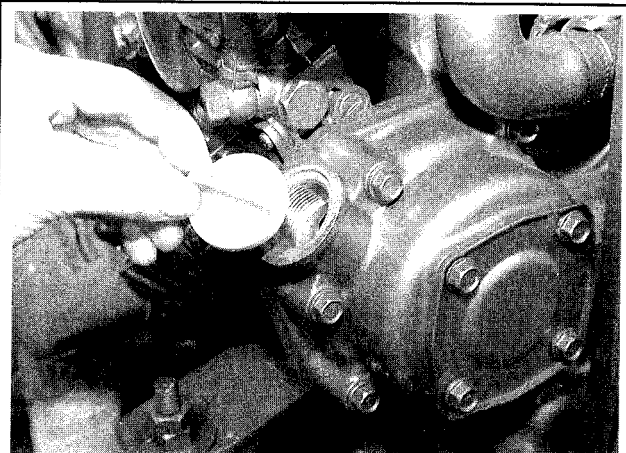


Fig. 16 On JH series engines, a secondary oil fill hole is added on the front of the engine cover if access to the valve cover is limited

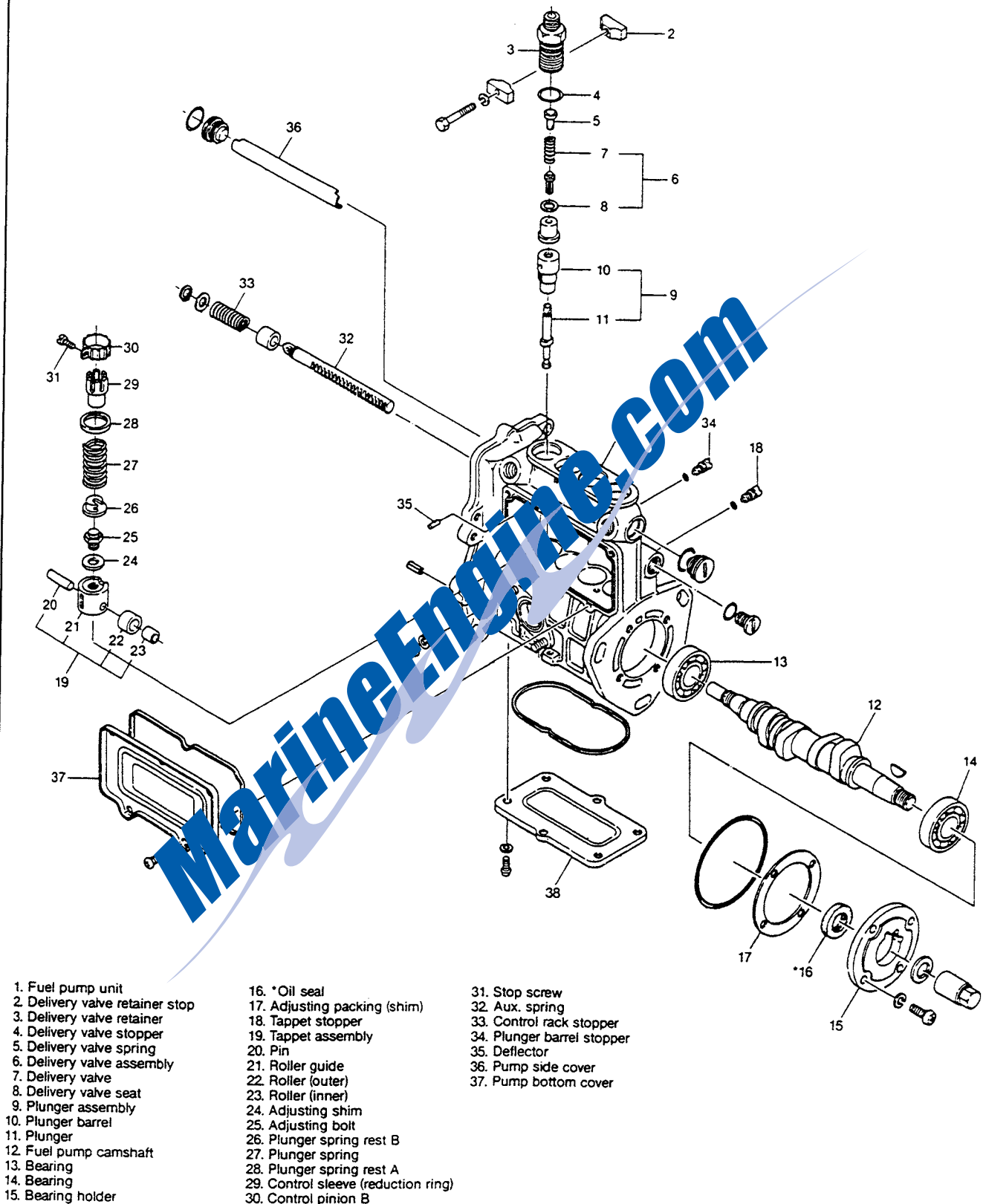


Fig. 13 Diesel injector pumps are made of highly precision parts, and should only be serviced by qualified technicians

To install:

6. Carefully scrape any gasket residue from the mating surfaces of the lift pump and injector pump.
7. Lightly grease the end of the lift pump piston where it rides on the cam.
8. Using a new gasket, install the lift pump to the injector pump.
9. Install the fuel lines to the lift pump in the proper direction.
10. Once the lines are attached, turn the fuel petcock to the **ON** position.
11. Loosen the air bleed screw on the secondary (between the lift pump and injector pump) fuel filter.
12. Operate the priming lever on the lift pump until fuel runs out of the air bleed screw opening, then tighten the screw.

Injector Pump

See Figure 13

The fuel injector pump is a highly precise, complex mechanical assembly that supplies the fuel injectors with the proper amount of pressurized fuel to be sprayed in the cylinders at the proper time.

On all engines, Yanmar stresses the importance of refraining from making adjustments to the injector pump. Many of the adjustment screws are sealed in place with lead-bound wire. These seals and other means of securing adjustments are placed on the injector pump at the factory, where the injector pump was properly adjusted on a testing machine. The adjustments on the injector pump and governor mechanism are set by the factory for optimum performance, and should not be changed.

*** WARNING

Do NOT attempt to disassemble the injector pump. The internal components of the pump are **EXTREMELY** close-fitting precision parts, and can fail quickly if contaminated with dirt and debris. Injector pumps should be serviced only by a professional diesel service facility equipped with the proper tools and equipment.

Due to the complex mechanical nature of the injector pump, no procedures for complete disassembly are given, although a procedure for adjusting the injector pump timing is given. It is recommended that only a qualified diesel engine mechanic with proper testing equipment perform any kind of adjustments or repairs to the injector pump. Foolish tampering with the injector pump can cause serious problems with engine operation.

TESTING

See Figures 14 and 15

Testing the injector pump for proper operation requires special equipment, and should be performed by an experienced diesel mechanic. If it has been determined that the injector pump is not functioning properly, the pump can be removed for testing at a qualified facility.

However, it is advisable that a qualified diesel mechanic verify that the injector pump is faulty **before** removal, since removal can be a lengthy task on some engines. Keep in mind that even if the injector pump is removed, taken to a shop and repaired, installation of the injector pump may require partial disassembly of the pump and other special tools to make timing adjustments. Unless you fully understand the operation of a diesel fuel injection system, and have the special tools and equipment, removal is not recommended.

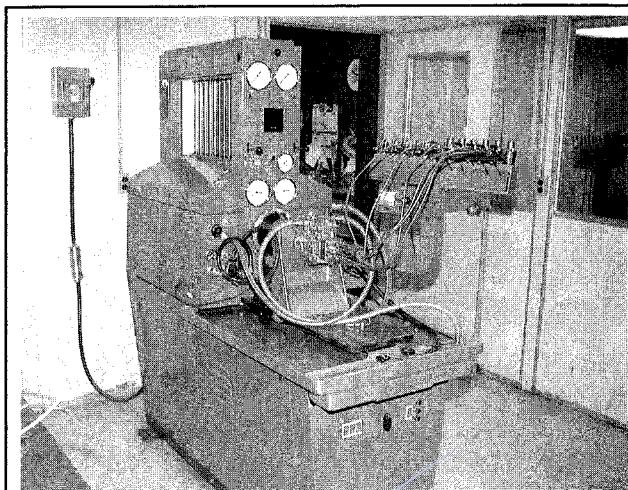


Fig. 14 Diesel injector pump must be tested and calibrated on special equipment for proper operation

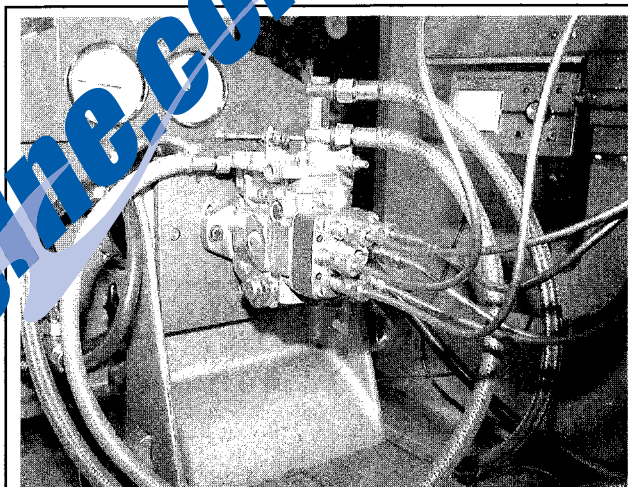


Fig. 15 The injector pump is fitted to a bracket on the calibration machine, and operated to simulate engine conditions

CHECKING & ADJUSTING TIMING

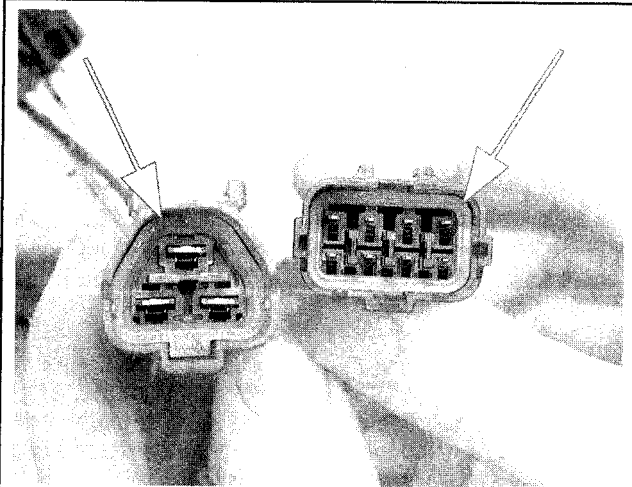
QM Series Engines

See Figures 16, 17, 18, 19 and 20

*** CAUTION

Observe all applicable safety precautions when working around fuel. Whenever servicing the fuel system, always work in a well ventilated area. Do not allow fuel spray or vapors to come in contact with a spark or open flame. Keep a dry chemical fire extinguisher near the work area. Always keep fuel in a container specifically designed for fuel storage; also, always properly seal fuel containers to avoid the possibility of fire or explosion.

1. Install a measuring pipe on each of the pump outputs for viewing of the fuel.
2. Bleed the air from the injector pump.
3. Set the control rack to the middle position. Pull the lever when setting the accelerator lever.



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Fig. 7 The seals on weatherproof connectors must be kept in good condition to prevent the terminals from corroding

- **Hard Shell**—unlike molded connectors, the terminal contacts in hard-shell connectors can be replaced. Replacement usually involves the use of a special terminal removal tool that depresses the locking tangs (barbs) on the connector terminal and allows the connector to be removed from the rear of the shell. The connector shell should be replaced if it shows any evidence of burning, melting, cracks, or breaks. Replace individual terminals that are burnt, corroded, distorted or loose.

Test Equipment

Pinpointing the exact cause of trouble in an electrical circuit is most times accomplished by the use of special test equipment. The following sections describe different types of commonly used test equipment and briefly explain how to use them for diagnosis. In addition to the information covered below, the manufacturer's instruction manual (provided with the test equipment) should be read and clearly understood before attempting any test procedures.

JUMPER WIRES

*** CAUTION

Never use jumper wires made from a thinner gauge wire than the circuit being tested. If the jumper wire is of too small a gauge, it may overheat and possibly melt. Never use jumpers to bypass high resistance loads in a circuit. Bypassing resistances, in effect, creates a short circuit. This may, in turn, cause damage and fire. Jumper wires should only be used to bypass lengths of wire or to simulate switches.

Jumper wires are simple, yet extremely valuable, pieces of test equipment. They are basically test wires which are used to bypass sections of a circuit. Although jumper wires can be purchased, they are usually fabricated from lengths of standard marine wire and whatever type of connector (alligator clip, spade connector or pin connector) that is required for the particular application being tested. In cramped, hard-to-reach areas, it is advisable to have insulated boots over the jumper wire terminals in order to prevent accidental grounding. It is also advisable to include a standard marine fuse in any jumper wire. This is commonly referred to as a

"fused jumper". By inserting an in-line fuse holder between a set of test leads, a fused jumper wire can be used for bypassing open circuits. Use a 5 amp fuse to provide protection against voltage spikes.

Jumper wires are used primarily to locate open electrical circuits, on either the ground (–) side of the circuit or on the power (+) side. If an electrical component fails to operate, connect the jumper wire between the component and a good ground. If the component operates only with the jumper installed, the ground circuit is open. If the ground circuit is good, but the component does not operate, the circuit between the power feed and component may be open. By moving the jumper wire successively back from the component toward the power source, you can isolate the area of the circuit where the open is located. When the component stops functioning, or the power is cut off, the open is in the segment of wire between the jumper and the point previously tested.

You can sometimes connect the jumper wire directly from the battery to the "hot" terminal of the component, but first make sure the component uses only low voltage for operation. Some electrical components, such as fuel injectors or sensors, are designed to operate on about 4 to 5 volts and applying 12 volts directly to these components will cause damage.

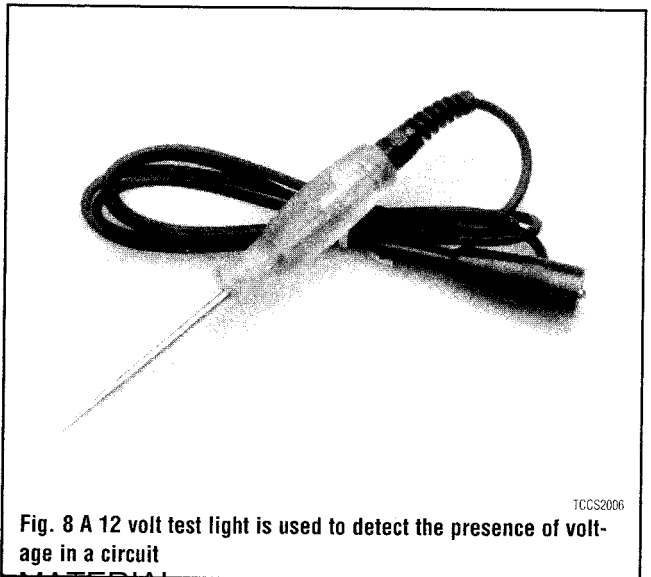
TEST LIGHTS

Simple Test Light

The test light is used to check circuits and components while current is flowing through them. It is used for voltage and ground tests. To use a 12 volt test light, connect the ground clip to a good ground and probe wherever necessary with the pick. The test light will illuminate when voltage is detected. This does not necessarily mean that 12 volts (or any particular amount of voltage) is present; it only means that some voltage is present. It is advisable before using the test light to touch its ground clip and probe across the battery posts or terminals to make sure the light is operating properly.

*** WARNING

Do not use a test light to probe electronic ignition, spark plug or coil wires. Never use a pick-type test light to probe wiring



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Fig. 8 A 12 volt test light is used to detect the presence of voltage in a circuit

on electronically controlled systems unless specifically instructed to do so. Any wire insulation that is pierced by the test light probe should be taped and sealed with silicone after testing.

Like the jumper wire, the 12 volt test light is used to isolate opens in circuits. But, whereas the jumper wire is used to bypass the open to operate the load, the 12 volt test light is used to locate the presence of voltage in a circuit. If the test light illuminates, there is power up to that point in the circuit; if the test light does not illuminate, there is an open circuit (no power). Move the test light in successive steps back toward the power source until the light in the handle illuminates. The open is between the probe and a point which was previously probed.

The self-powered test light is similar in design to the 12 volt test light, but contains a 1.5 volt penlight battery in the handle. It is most often used in place of a multimeter to check for open or short circuits when power is isolated from the circuit (continuity test).

The battery in a self-powered test light does not provide much current. A weak battery may not provide enough power to illuminate the test light even when a complete circuit is made (especially if there is high resistance in the circuit). Always make sure that the test battery is strong. To check the battery, briefly touch the ground clip to the probe; if the light glows brightly, the battery is strong enough for testing.

➔ **A self-powered test light should not be used on any electronically controlled system or component. The small amount of electricity transmitted by the test light is enough to damage many electronic marine components.**

MULTIMETERS

See Figure 9

Multimeters are an extremely useful tool for troubleshooting electrical problems. They can be purchased in either analog or digital form and have a price range to suit any budget. A multimeter is a voltmeter, ammeter and ohmmeter (also known as other features) com-

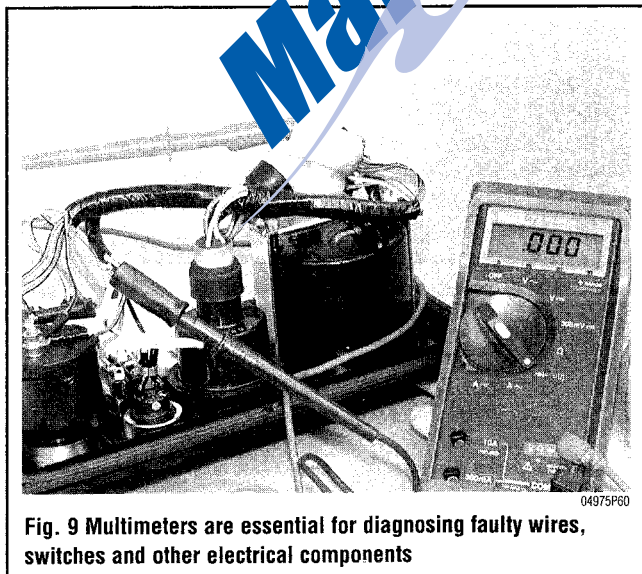


Fig. 9 Multimeters are essential for diagnosing faulty wires, switches and other electrical components

bined into one instrument. It is often used when testing solid state circuits because of its high input impedance (usually 10 megaohms or more). A brief description of the multimeter main test functions follows:

- **Voltmeter**—the voltmeter is used to measure voltage at any point in a circuit, or to measure the voltage drop across any part of a circuit. Voltmeters usually have various scales and a selector switch to allow the reading of different voltage ranges. The voltmeter has a positive and a negative lead. To avoid damage to the meter, always connect the negative lead to the negative (–) side of the circuit (to ground or nearest the ground side of the circuit) and connect the positive lead to the positive (+) side of the circuit (to the power source or the nearest power source). Note that the negative voltmeter lead will always be black and that the positive voltmeter will always be some color other than black (usually red).

- **Ohmmeter**—the ohmmeter is designed to read resistance (measured in ohms) in a circuit component. Most ohmmeters will have a selector switch which permits the measurement of different ranges of resistance. Usually the selector switch allows the multiplication of the meter reading by 10, 100, 1,000 and 10,000. Some ohmmeters are "auto-ranging" which means the meter itself will determine the scale to use. Since the meters are powered by an internal battery, the ohmmeter can be used like a self-powered test light. When the ohmmeter is connected, current from the battery flows through the circuit or component being tested. Since the ohmmeter's internal resistance and voltage are known, the amount of current flow through the meter depends on the resistance of the circuit or component being tested. The ohmmeter can also be used to perform a continuity test for suspected open circuits. In using the meter for making continuity checks, do not be concerned with the actual resistance readings. Zero resistance, or any ohm reading, indicates continuity in the circuit. Infinite resistance indicates an opening in the circuit. A high resistance reading where there should be none indicates a problem in the circuit. Checks for short circuits are made in the same manner as checks for open circuits, except that the circuit must be isolated from both power and normal ground. Infinite resistance indicates no continuity, while zero resistance indicates a dead short.

*** WARNING

Never use an ohmmeter to check the resistance of a component or wire while there is voltage applied to the circuit.

- **Ammeter**—an ammeter measures the amount of current flowing through a circuit in units called amperes or amps. At normal operating voltage, most circuits have a characteristic amount of amperes, called "current draw" which can be measured using an ammeter. By referring to a specified current draw rating, then measuring the amperes and comparing the two values, one can determine what is happening within the circuit to aid in diagnosis. An open circuit, for example, will not allow any current to flow, so the ammeter reading will be zero. A damaged component or circuit will have an increased current draw, so the reading will be high. The ammeter is always connected in series with the circuit being tested. All of the current that normally flows through the circuit must also flow through the ammeter; if there is any other path for the current to follow, the ammeter reading will not be accurate. The ammeter