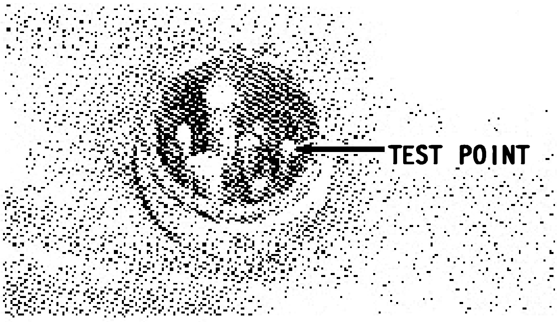



*The terminals of a side-mounted electrical connector should be inspected and cleaned each season. This connector is exposed and vulnerable to dampness and corrosion.*

**NEVER** connect the battery leads to the large terminals of the solenoid, or the meter will be damaged.

Using battery jumper leads, connect the positive lead from the positive terminal of the battery to the the small **"S"** terminal of the solenoid. Connect the negative lead to the negative battery terminal and the **"I"** terminal of the solenoid. If the meter pointer hand moves into the **OK** block, the solenoid is serviceable. If the pointer fails to reach the **OK** block, the solenoid must be replaced.

## 2-10 INTERNAL WIRING HARNESS

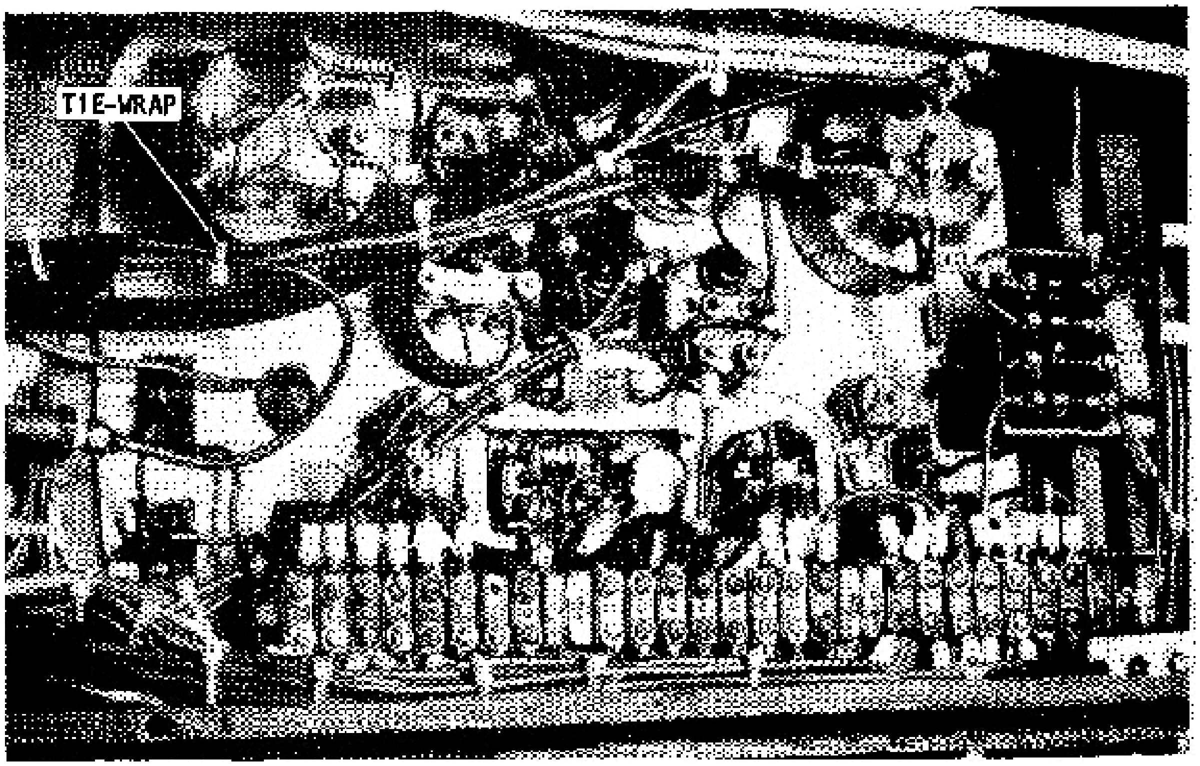
Check the internal wiring harness if problems have been encountered with any of the electrical components. Check for frayed or chafed insulation and/or loose connections between wires and terminal connections.

Check the harness connector for signs of corrosion. Inspect the electrical "prongs" to be sure they are not bent or broken. If the harness shows any evidence of the foregoing problems, the problem must be corrected before proceeding with any harness testing.

Verify that the "prongs" of the harness connector are clean and free of corrosion. Convince yourself that a good electrical connection is being made between the harness connector and the remote control harness.

**Short Test** (See the Wiring Diagram in the Appendix)

Disconnect the internal wiring harness from the electrical components. Use a magneto analyzer, set on Scale No. 3 and check for continuity between any of the wires in the harness. Use Scale No. 3 and




*Many electrical problems can be traced to poor connections, faulty wiring, or corroded terminals. Wiring at the dashboard should be "neat and tidy". Wires should be routed to permit the making of bundles and then secured with "tie-wraps", as shown. The wires should not be allowed to move as the boat is subjected to violent maneuvers in the water. A properly installed dashboard will permit efficient troubleshooting. Sometimes a malfunction, such as a loose connection, can be detected by visual inspection or simply checking the wire at the terminal.*

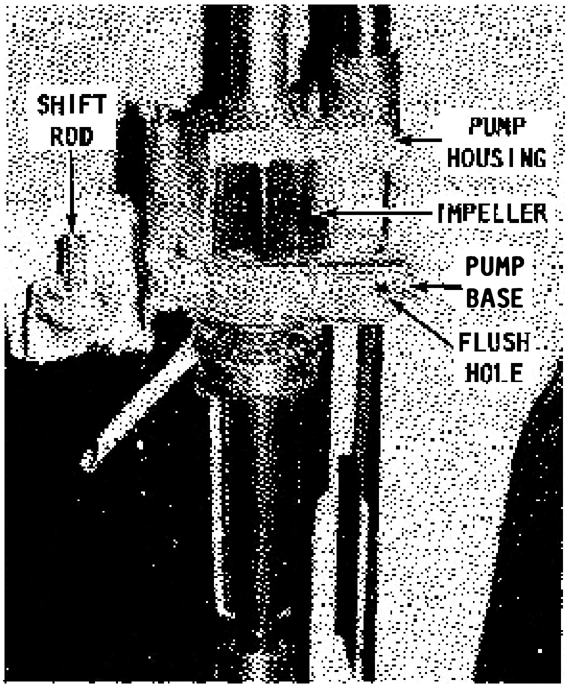
check for continuity between any wire and a good ground. If continuity exists, the harness **MUST** be repaired or replaced.

**Resistance Test** (See the Wiring Diagram in the Appendix.)

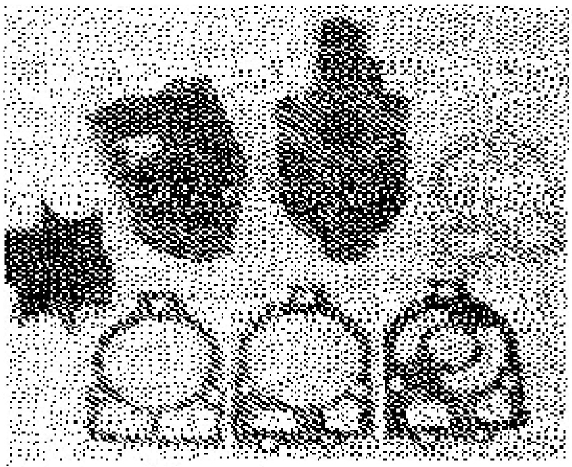
Use a magneto analyzer, set on Scale No. 2. Clip the small red and black leads together. Turn the meter adjustment knob for Scale No. 2 until the meter pointer aligns with the set position on the left side of the **"OK"** block on Scale No. 2. Separate the small red and black leads. Use the Wiring Diagram in the Appendix, and check each wire for resistance between the harness connection and the terminal ends. If resistance exists (meter reading outside the **"OK"** block) the harness **MUST** be repaired or replaced.

## 2-11 WATER PUMP CHECK

**FIRST A GOOD WORD:** The water pump **MUST** be in very good condition for the engine to deliver satisfactory service. The pump performs an extremely important function by supplying enough water to properly cool the engine. Therefore, in most cases, it is advisable to replace the complete water pump assembly at least once a year, or anytime the lower unit is disassembled for service.

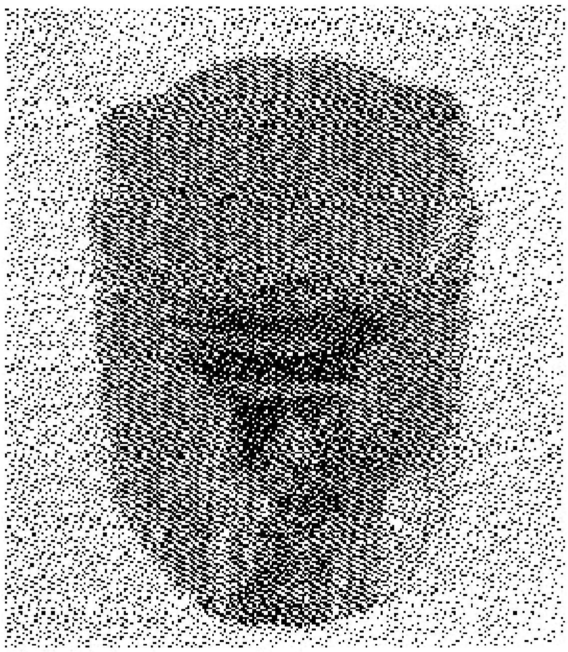



*Cutaway photographic view of a lower unit showing the various parts of the water pump installed.*

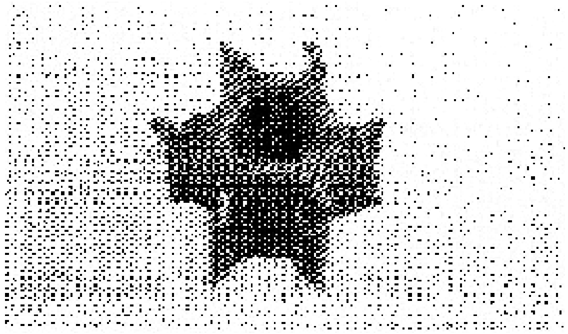


*Major parts included in a water pump kit, available at the local marine dealer at modest cost.*

Sometimes during adjustment procedures, it is necessary to run the engine with a flush device attached to the lower unit. **NEVER** operate the engine over 1000 rpm with a flush device attached, because the engine may **"RUNAWAY"** due to the no-load condition on the propeller. A "runaway" engine could be severely damaged. As the name implies, the flush device is primarily used to flush the engine after use in salt water or contaminated fresh water. Regular use of the flush device will prevent salt or silt deposits from accumulating in the water passage-way. During and immediately after flushing, keep the motor in an upright position until all of the water has



*Damaged piston caused from cylinder overheating when the cooling system failed to provide adequate coolant.*

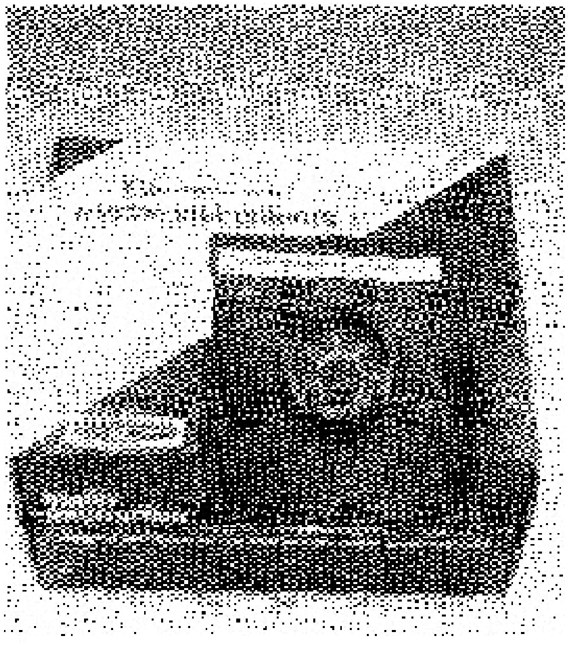


*Worn water pump impeller, unfit for service.*

drained from the drive shaft housing. This will prevent water from entering the power head by way of the drive shaft housing and the exhaust ports, during the flush. It will also prevent residual water from being trapped in the drive shaft housing and other passageways.

Most outboard engines have water exhaust ports which deliver a tattle-tale stream of water, if the water pump is functioning properly during engine operation. Water pressure at the cylinder block should be checked if an overheating condition is detected or suspected.

To test the water pump, the lower unit **MUST** be placed in a test tank or the boat moved into a body of water. The pump must now work to supply a volume to the engine. A tattle-tale stream of water should be visible from the ports.



*A water pressure gauge kit available from the local marine dealer. All necessary parts and fittings to complete the installation, are included in the package.*

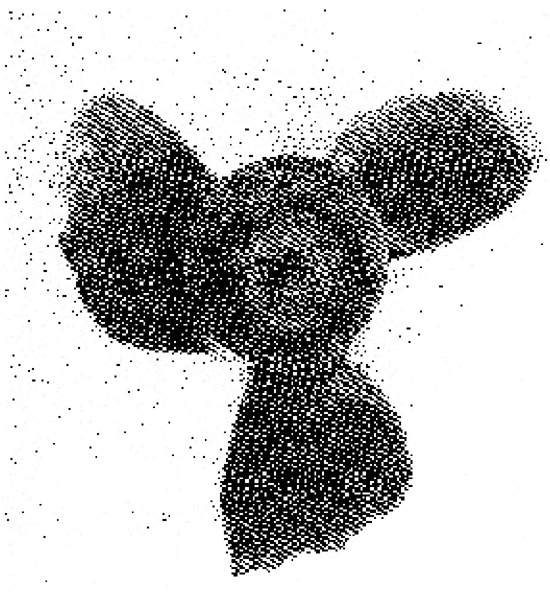
A water pressure kit is available from the local marine dealer for use with the larger horsepower engines. This kit will indicate the amount of water pressure the pump is delivering to the engine at all times. The first time the pressure indicator falls off, the pump should be serviced. To install the kit, simply connect the necessary fitting and water pressure hose onto the cylinder block. Place the water pressure gauge in a convenient position for viewing while operating the boat. Water pressure at full throttle under any boat operating condition, such as sharp turns, or other quick maneuvers, **MUST** be 5 psi or more.

Lack of adequate water supply from the water pump thru the engine will cause any number of power head failures, such as stuck rings, scored cylinder walls, burned pistons, etc.

## 2-12 PROPELLER

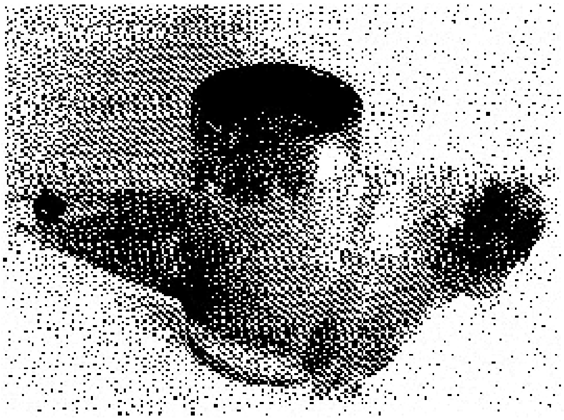
Inspect the propeller blades for nicks, cracks, or bent condition. If the propeller is damaged, the local marine dealer can make repairs or send it out to a shop specializing in such work.

Check with the local marine dealer, or a propeller shop for the recommended size and pitch for a particular size engine, boat, and intended operation. The correct propel-



*Example of a damaged propeller. This unit should have been replaced long before this much damage was sustained.*

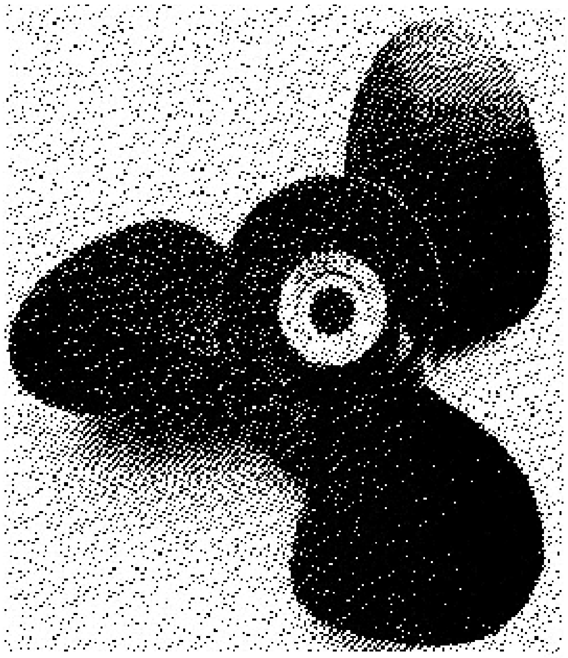
 



*Damage was caused to this unit when the propeller struck an underwater object. If the propeller should suffer this much abuse, the propeller shaft should be carefully checked.*

ler should be installed on the engine to enable operation at the upper end of the factory recommended rpm.

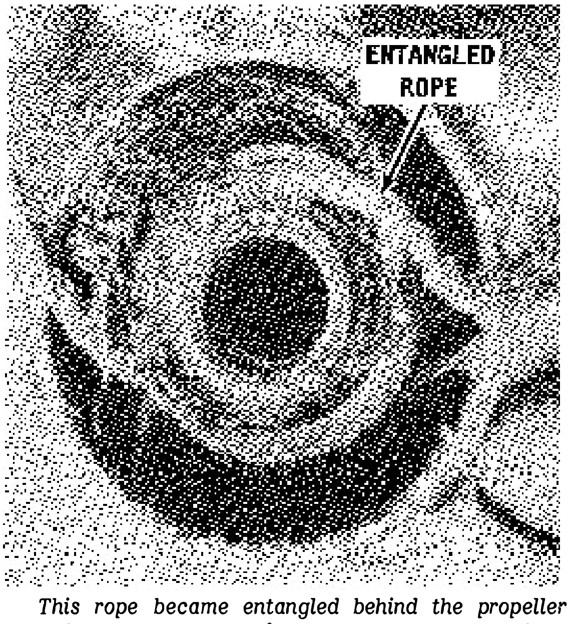
If the powerhead rpm is below the rated rpm range, use a smaller or less pitch propeller. The reason for adjusting to the "high" side of the rpm range is to compensate if a heavier load is carried in the boat, the wide open throttle (WOT) rpm will not drop substantially. If the powerhead rpm is above the recommended rpm, try a higher pitch propeller or the same pitch cupped. See Chapter 1 for explanation of propeller terms, pitch, diameter, cupped, etc. One size smaller propeller usually gives best performance for water skiing.



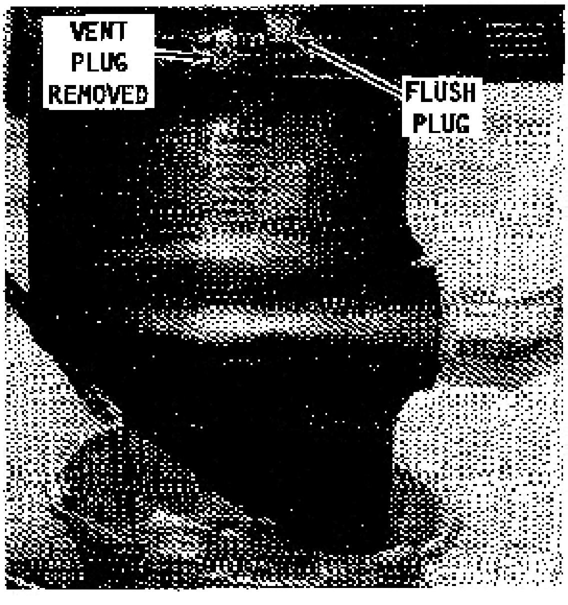
*New propeller ready for installation and service.*

For a dual engine installation, the next higher pitch propeller may prove the most satisfactory arrangement for water skiing.

Remove the propeller and the thrust hub. Check the propeller shaft seal to be sure it is not leaking. Check the area just forward of the seal to be sure a fish line is not wrapped around the shaft.




*This rope became entangled behind the propeller around the propeller shaft. The propeller should be removed periodically and this area checked for foreign material.*




*The amount of lubricant in the lower unit should be checked on a daily basis during the operating season. The lubricant should be drained and replenished every 100 hours of operation.*

## 2-13 LOWER UNIT

**NEVER** remove the vent or filler plugs when the lower unit is hot. Expanded lubricant would be released through the plug hole. Check the lubricant level after the unit has been allowed to cool. Add only Super-Duty Gear Lubricant. **NEVER** use regular automotive-type grease in the lower unit, because it expands and foams too much. Outboard lower units do not have provisions to accommodate such expansion.

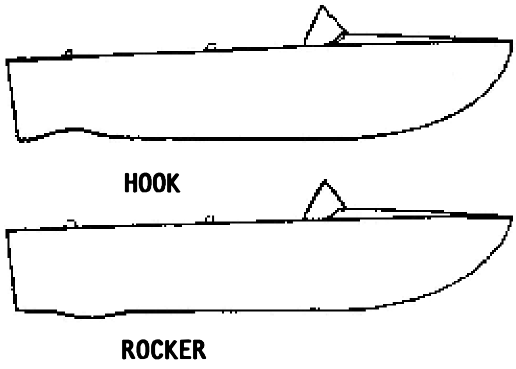
If the lubricant appears milky brown, or if large amounts of lubricant must be added to bring the lubricant up to the full mark, a thorough check should be made to determine the cause of the loss.

### Draining Lower Unit

Remove the **FILL** plug from the lower end of the gear housing on the port side and the **VENT** plug just above the anti-cavitation plate.

### Filling Lower Unit

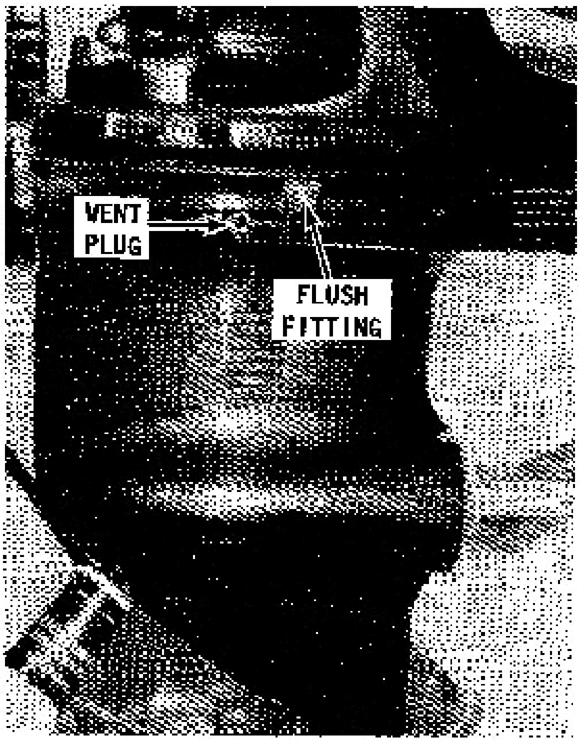
Position the drive unit approximately vertical and without a list to either port or starboard. Insert the lubricant tube into the **FILL/DRAIN** hole at the bottom plug hole,




*Boat performance will be drastically impaired, if the bottom is damaged by a dent (hook) or bulge (rocker).*

and inject lubricant until the excess begins to come out the **VENT** hole. Install the **VENT** plug first then replace the **FILL** plug with **NEW** gaskets. Check to be sure the gaskets are properly positioned to prevent water from entering the housing.

For detailed lower unit service procedures, see Chapter 9. For lower unit lubrication capacities, see the Appendix.




*Filling the lower unit with new lubricant. Notice the unit is filled through the lower plug, but the upper plug **MUST** be removed to allow trapped air to escape.*


*The manufacturer recommends the use of his brand name lubricant to service the lower unit.*

## 2-14 BOAT TESTING

Operation of the outboard unit, mounted on a boat with some type of load, is the ultimate test. Failure of the power unit or the boat under actual movement through the water may be detected much more quickly than operating the power unit in a test tank.

### Hook and Rocker

Before testing the boat, check the boat bottom carefully for marine growth or evidence of a "hook" or a "rocker" in the bottom. Either one of these conditions will greatly reduce performance.

### Performance

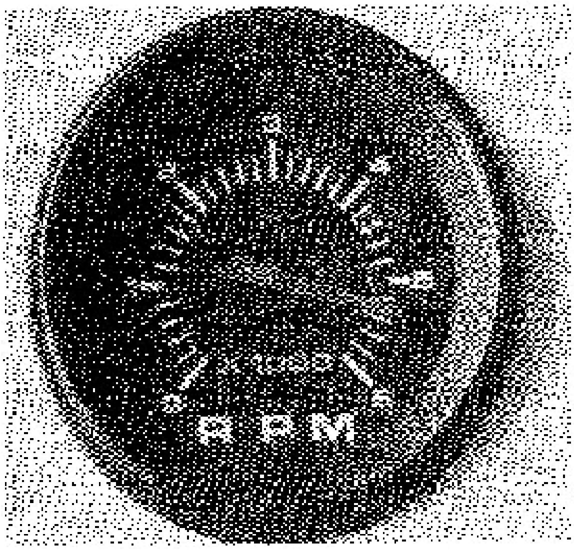
Mount the motor on the boat. Install the remote control cables and check for proper adjustment.

Make an effort to test the boat with what might be considered an average gross load. The boat should ride on an even keel, without a list to port or starboard. Adjust the motor tilt angle, if necessary, to permit the bow to ride slightly higher than the stern. If heavy supplies are stowed aft of the center, the bow will be light and the boat will "plane" more efficiently. For this test the boat must be operated in a body of water.

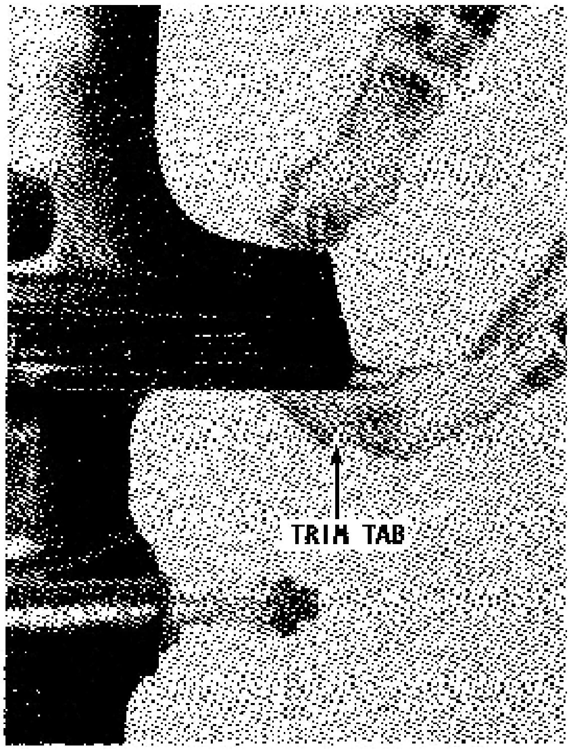
If the motor is equipped with an adjustable trim tab, the tab should be adjusted to permit boat steerage in either direction with equal ease.

Check the engine rpm at full throttle. The rpm should be within the Specifications in the Appendix. If the rpm is not within specified range, a propeller change may be in order. A higher pitch propeller will decrease rpm, and a lower pitch propeller will increase rpm.

For maximum low speed engine performance, the idle mixture and the idle rpm should be readjusted under actual operating conditions.




*Maximum engine performance can only be obtained through proper tuning using a tachometer.*



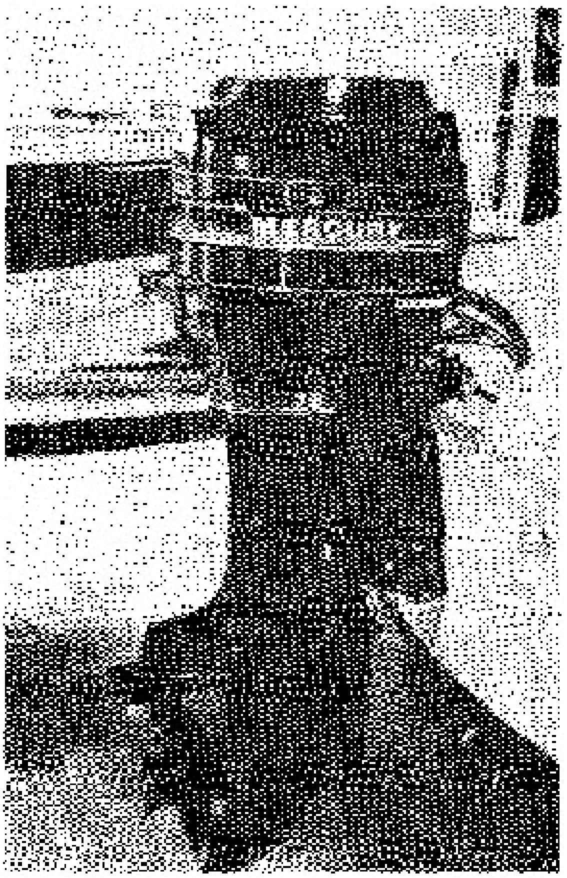

*Adjusting the trim tab to receive optimum performance from the boat and power unit.*

# 3 POWERHEAD

## 3-1 INTRODUCTION

The carburetion and ignition principles of two-cycle engine operation **MUST** be understood in order to perform a proper tune-up on an outboard motor or industrial engine.

The two-cycle engine differs in several ways from a conventional four-cycle (automobile) engine.



*The exterior and interior of the powerhead must be kept clean, well-lubricated, and properly tuned and adjusted, if the owner is to receive the maximum enjoyment from the unit.*

1- The method by which the air/fuel mixture is delivered to the combustion chamber.
2- The complete lubrication system.
3- In most cases, the ignition system.
4- The frequency of the power stroke.

These differences will be discussed briefly and compared with four-cycle engine operation.

### Intake/Exhaust

Two-cycle engines utilize an arrangement of port openings to admit fuel to the combustion chamber and to purge the exhaust gases after burning has been completed. The ports are located in a precise pattern in order for them to be opened and closed at an exact moment by the piston as it moves up and down in the cylinder. The exhaust port is located slightly higher than the fuel intake port. This arrangement opens the exhaust port first as the piston starts downward and therefore, the exhaust phase begins a fraction of a second before the intake phase.

Actually, the intake and exhaust ports are spaced so closely together that both open almost simultaneously. For this reason, the pistons of most two-cycle engines have a deflector-type top. This design of the piston top serves two purposes very effectively.

First, it creates turbulence when the incoming charge of fuel enters the combustion chamber. This turbulence results in more complete burning of the fuel than if the piston top were flat. The second effect of the deflector-type piston crown is to force the exhaust gases from the cylinder more rapidly.

This system of intake and exhaust is in marked contrast to individual valve arrangement employed on four-cycle engines.

**Lubrication**

A two-cycle engine is lubricated by mixing oil with the fuel. Therefore, various parts are lubricated as the fuel mixture passes through the crankcase and the cylinder. Four-cycle engines have a crankcase containing oil. This oil is pumped through a circulating system and returned to the crankcase to begin the routing again.

**Physical Laws**

The two-cycle engine is able to function because of two very simple physical laws.

One: Gases will flow from an area of high pressure to an area of lower pressure. A tire blowout is an example of this principle. The high-pressure air escapes rapidly if the tube is punctured.

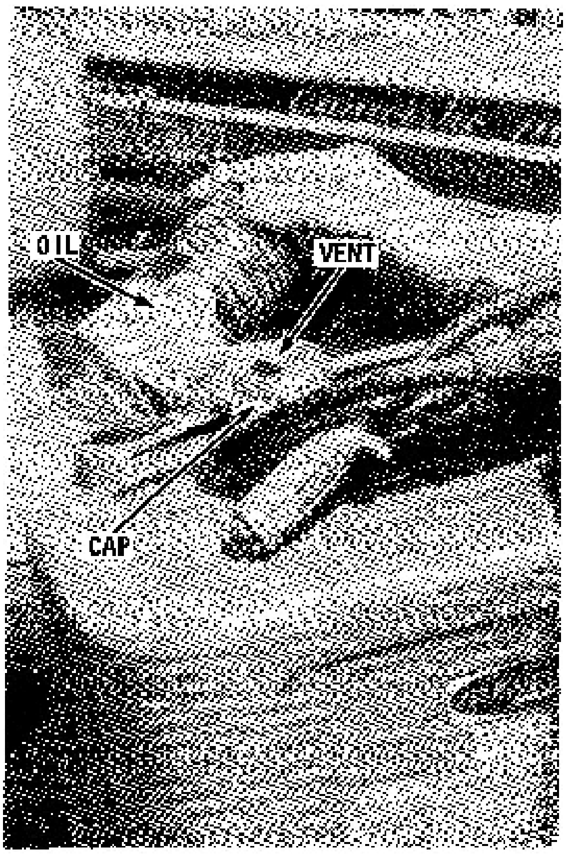
Two: If a gas is compressed into a smaller area, the pressure increases, and if a gas expands into a larger area, the pressure is decreased.

If these two laws are kept in mind, the operation of the two-cycle engine will be easier understood.

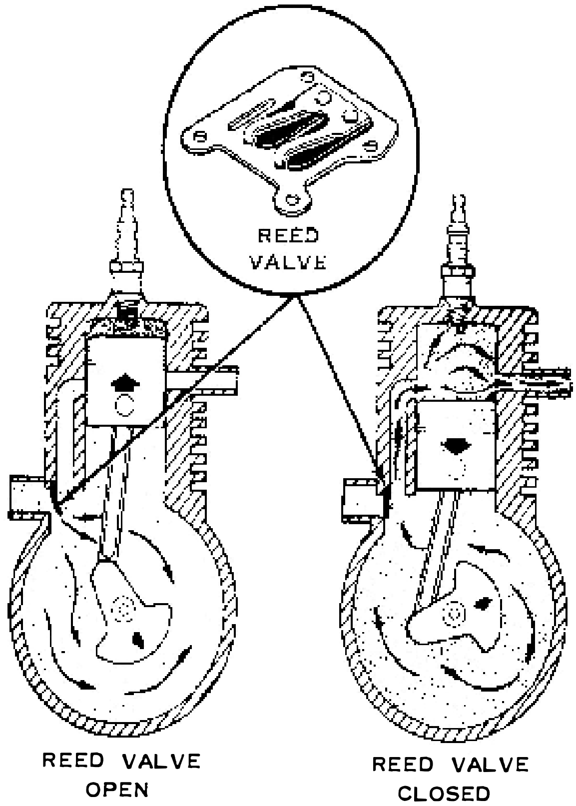
**Actual Operation**

Beginning with the piston approaching top dead center on the compression stroke: The intake and exhaust ports are closed by the piston; the reed valve is open; the spark plug fires; the compressed air/fuel mixture is ignited; and the power stroke begins. The reed valve was open because as the piston moved upward, the crankcase volume increased, which reduced the crankcase pressure to less than the outside atmosphere.

As the piston moves downward on the power stroke, the combustion chamber is filled with burning gases. As the exhaust port is uncovered, the gases, which are under great pressure, escape rapidly through the exhaust ports. The piston continues its downward movement. Pressure within the crankcase increases, closing the reed valves against their seats. The crankcase then becomes a sealed chamber. The air/fuel mixture is compressed ready for delivery to the combustion chamber. As the piston continues to move downward, the intake port is uncovered. A fresh air/fuel mixture




*Adding approved lubricant to the fuel tank at the time the tank is being filled. Some fuel must be in the tank to prevent the oil from sticking to a dry bottom.*




*Reed valves are used to control the flow of air/fuel into the crankcase and eventually into the cylinder. As the piston moves upward in the cylinder, the resulting suction in the crankcase overcomes the spring tension of the reed. The reed is pulled free from its seat and the air/fuel mixture is drawn into the crankcase.*

rushes through the intake port into the combustion chamber striking the top of the piston where it is deflected along the cylinder wall. The reed valve remains closed until the piston moves upward again.

When the piston begins to move upward on the compression stroke, the reed valve opens because the crankcase volume has been increased, reducing crankcase pressure to less than the outside atmosphere. The intake and exhaust ports are closed and the fresh fuel charge is compressed inside the combustion chamber.

Pressure in the crankcase decreases as the piston moves upward and a fresh charge of air flows through the carburetor picking up fuel. As the piston approaches top dead center, the spark plug ignites the air-fuel mixture, the power stroke begins and one complete cycle has been completed.

### Timing

The exact time of spark plug firing depends on engine speed. At low speed the spark is retarded, fires later than when the piston is at or beyond top dead center. Engine timing is built into the unit at the factory.

At high speed, the spark is advanced, fires earlier than when the piston is at top dead center. On some late models and larger engines, the timing can be changed in the field to meet advance and retard factory specifications.

### Summary

More than one phase of the cycle occurs simultaneously during operation of a two-cycle engine. On the downward stroke, power occurs above the piston while the ports are closed. When the ports open, exhaust begins and intake follows. Below the piston, fresh air-fuel mixture is compressed in the crankcase.

On the upward stroke, exhaust and intake continue as long as the ports are open. Compression begins when the ports are closed and continues until the spark plug ignites the air-fuel mixture. Below the piston, a fresh air-fuel mixture is drawn into the crankcase ready to be compressed during the next cycle.

## CHAPTER ORGANIZATION

This Chapter is divided into four working sections as follows:

Section 3-1 -- this section, includes chapter organization and general powerhead information.

Section 3-2 -- contains complete service procedures for original Mercury design 3-, and 4-cylinder powerheads, as follows:

| | | |
|---|---|---|
| 45hp | 4-cyl. | 1986 & On |
| Model 500 | 4-cyl. | 1965-79 |
| 50hp | 4-cyl. | 1980-85 |
| 50hp | 3-cyl. | 1986-90 |
| 60hp | 3-cyl. | 1984-90 |
| Model 650 | 4-cyl. | 1965-71 |
| Model 700 | 3-cyl. | 1977-79 |
| 70hp | 3-cyl. | 1980-83 |
| 75hp | 4-cyl. | 1984-86 |
| Model 800 | 4-cyl. | 1969-72 |
| Model 800 | 4-cyl. | 1978-79 |
| 80hp | 4-cyl. | 1980-83 |
| Model 850 | 4-cyl. | 1973-77 |

Section 3-3 -- contains complete service procedures for redesigned Mercury 3- and 4-cylinder powerheads, as follows:

| | | |
|---|---|---|
| 50hp | 3-cyl. | 1991 & On |
| 60hp | 3-cyl. | 1991 & On |
| 70hp | 3-cyl. | 1987-89 |
| 75hp | 3-cyl. | 1990 & On |
| 80hp | 3-cyl. | 1987-89 |
| 90hp | 3-cyl. | 1987 & On |
| 100hp | 4-cyl. | 1988 & On |
| 115hp | 4-cyl. | 1989 & On |

Section 3-4 -- provides detailed instructions for the cleaning and inspection of powerhead components for all models.

The redesign of the original inline block became available in 1987 on a few selected models. The reeds were relocated to a reed block housing behind the carburetors. The original design powerhead has reeds arranged around the crankshaft. The shape of the reeds on these new powerheads are also modified. Traditionally, reeds mounted behind the carburetors have horizontally or vertically mounted blocks of reeds. The new 3- and 4-cylinder reed blocks have reed petals arranged in a circle and are called the "rose petal design" by the manufacturer. This type design affords better fuel distribution and provides a smoother operating powerhead. The reeds on these models can now be serviced without removal and disassembly of the powerhead.

Other differences between the original and redesigned block are in the cylinder head area. The redesigned block and cylinder head are a one-piece casting. Only the