- It acts as a dielectric insulator for the ignition system.

It is important to remember that spark plugs do not create heat, they help remove it. Anything that prevents a spark plug from removing the proper amount of heat can lead to pre-ignition, detonation, premature spark plug failure and even internal engine damage, especially in 2-stroke engines.

In the simplest of terms, the spark plug acts as the thermometer of the engine. Much like a doctor examining a patient, this "thermometer" can be used to effectively diagnose the amount of heat present in each combustion chamber.

Spark plugs are valuable tuning tools, when interpreted correctly. They will show symptoms of other problems and can reveal a great deal about the engine's overall condition. Evaluating the appearance of the spark plug's firing tip, gives visual cues to determine the engine's overall operating condition, get a feel for air/fuel ratios and even diagnose driveability problems.

As spark plugs grow older, they lose their sharp edges as material from the center and ground electrodes slowly erodes away. As the gap between these two points grows, the voltage required to bridge this gap increases proportionately. The ignition system must work harder to compensate for this higher voltage requirement and hence there is a greater rate of misfires or incomplete combustion cycles. Each misfire means lost horsepower, reduced fuel economy and higher emissions. Replacing worn out spark plugs with new ones (with sharp new edges) effectively restores the ignition system's efficiency and reduces the percentage of misfires, restoring power, economy and reducing emissions.

■ **Although spark plugs can typically be cleaned and re-gapped if they are not excessively worn, no amount of cleaning or re-gapping will return most spark plugs to original condition and it is usually best to just go ahead and replace them.**

How long spark plugs last will depend on a variety of factors, including engine compression, fuel used, gap, center/ground electrode material and the conditions in which the outboard is operated.

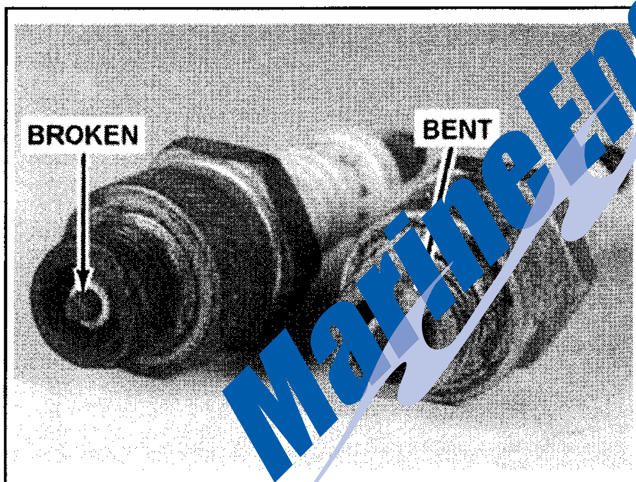

Fig. 110 Damaged spark plugs. Notice the broken electrode on the left plug. The electrode must be found and retrieved prior to returning the powerhead to service

SPARK PLUG HEAT RANGE

◆ **See Figures 111, 112 and 113**

Spark plug heat range is the ability of the plug to dissipate heat from the combustion chamber. The longer the insulator (or the farther it extends into the engine), the hotter the plug will operate; the shorter the insulator (the closer the electrode is to the engine's cooling passages) the cooler it will operate.

Selecting a spark plug with the proper heat range will ensure that the tip maintains a temperature high enough to prevent fouling, yet cool enough to prevent pre-ignition. A plug that absorbs little heat and remains too cool will quickly accumulate deposits of oil and carbon since it won't be able to burn them off. This leads to plug fouling and consequently to misfiring. A plug that absorbs too much heat will have no deposits but, due to the excessive heat, the electrodes will burn away quickly and might also lead to pre-ignition or other ignition problems.

Pre-ignition takes place when plug tips get so hot that they glow sufficiently to ignite the air/fuel mixture before the actual spark occurs. This early ignition will usually cause a pinging during heavy loads and if not corrected, will result in severe engine damage. While there are many other things that can cause pre-ignition, selecting the proper heat range spark plug will ensure that the spark plug itself is not a hot-spot source.

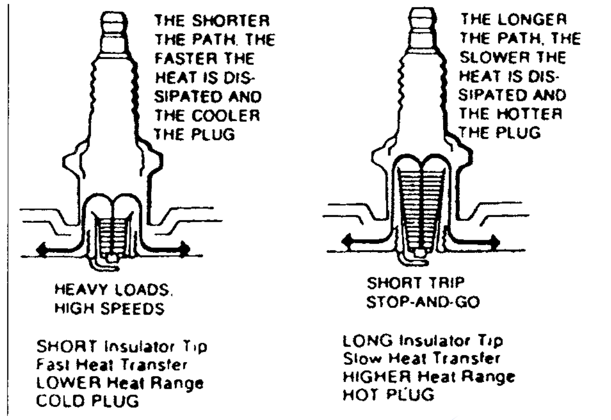

Fig. 111 Spark Plug heat range

■ **The manufacturer recommended spark plugs are listed in the Tune-Up Specifications chart. Recommendations may also be present on one of the labels affixed to your motor. When the label disagrees with the chart, we'd normally defer to the label as it may reflect a change that was made mid-production and not reflected in the Yamaha service literature.**

REMOVAL & INSTALLATION

◆ **See Figures 114 thru 119**

EASY

■ **New technologies in spark plug and ignition system design have greatly extended spark plug life over the years. But, spark plug life will still vary greatly with engine tuning, condition and usage. In general, 2-stroke motors are a little tougher on plugs, especially if great care is not taken to maintain proper oil/fuel mixtures on pre-mix motors.**

Typically spark plugs will require replacement once a season. The electrode on a new spark plug has a sharp edge but with use, this edge becomes rounded by wear, causing the plug gap to increase. As the gap increases, the plug's voltage requirement also increases. It requires a greater voltage to jump the wider gap and about two to three times as much voltage to fire a plug at high speeds than at idle.

■ **Fouled plugs can cause hard-starting, engine mis-firing or other problems. You don't want that happening on the water. Take time, at least once a month to remove and inspect the spark plugs. Early signs of other tuning or mechanical problems may be found on the plugs that could save you from becoming stranded or even allow you to address a problem before it ruins the motor.**

Tools needed for spark plug replacement include: a ratchet, short extension, spark plug socket (there are two types; either 13/16 inch or 5/8 inch, depending upon the type of plug), a combination spark plug gauge and gapping tool and a can of anti-seize type compound.

1. When removing spark plugs from multi-cylinder motors, work on one at a time. Don't start by removing the plug wires all at once, because unless you number them, they may become mixed up. Take a minute before you begin and number the wires with tape.
2. For safety, disconnect the negative battery cable or turn the battery switch **OFF**.
3. If the engine has been run recently, allow the engine to thoroughly cool (unless performing a compression check and then you should have already broken them loose once when cold and retightened them before

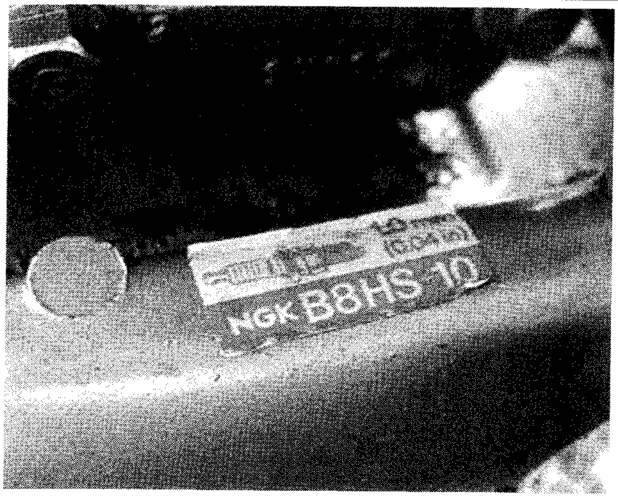

Fig. 112 Many Yamahas have a label which lists spark plug type and gap

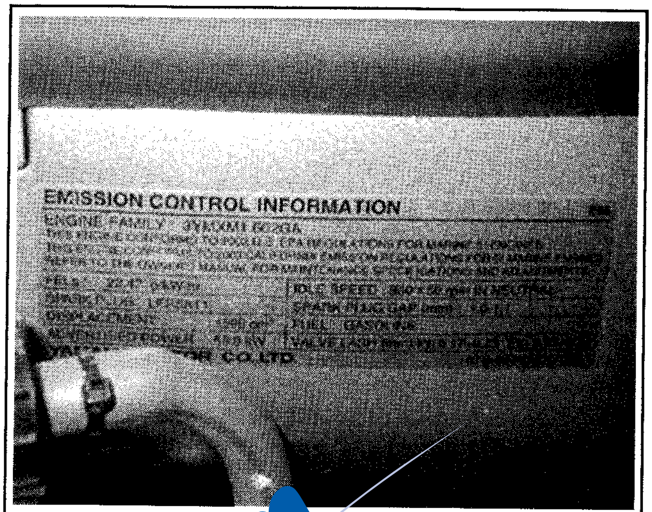

Fig. 113 Though these da[illegible]st in the US, most have an Emission Control label [illegible]ains that information

warming the motor, so they should have less of a tendency to stick). Attempting to remove plugs from a hot cylinder head could cause the plugs to seize and damage the threads in the cylinder head, especially on aluminum heads!

■ **To ensure an accurate reading during a compression check, the spark plugs must be removed from a hot engine. But, DO NOT force a plug if it feels like it is seized. Instead, wait until the engine has cooled, remove the plug and coat the threads lightly with anti-seize then reinstall and tighten the plug, then back off the tightened position a little less than 1/4 turn. With the plug(s) installed in this manner, re-warm the engine and conduct the compression check.**

4. Carefully twist the spark plug wire boot to loosen it, then pull the boot using a twisting motion to remove it from the plug. Be sure to pull on the boot and not on the wire, otherwise the connector located inside the boot may become separated from the high-tension wire.

■ **If removal is difficult (or on motors where the spark plug boot is hard to grip because of access) a spark plug wire removal tool is recommended as it will make removal easier and help prevent damage to the boot and wire assembly. Most tools have a wire loom that fits under the plug boot so the force of pulling upward is transmitted directly to the bottom of the boot.**

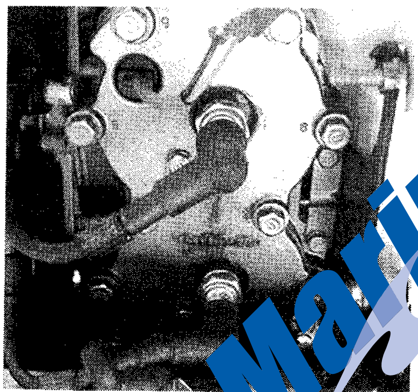

Fig. 114 The spark plugs are threaded into the center of the cylinder cover

Fig. 115 Gently grasp the boot and pull the wire from the plug

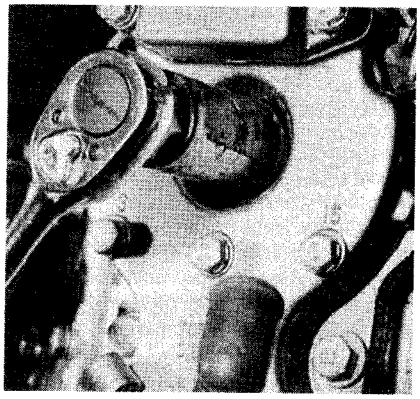

Fig. 116 Then unthread the plug using a ratchet and socket

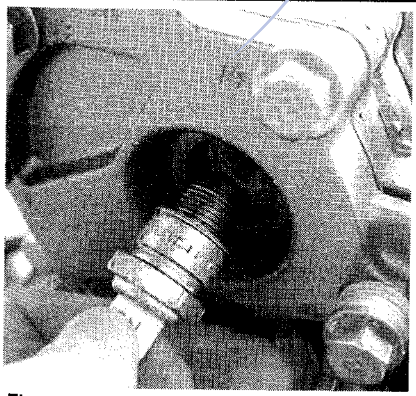

Fig. 117 ALWAYS thread plugs by hand to prevent cross-threading. . .

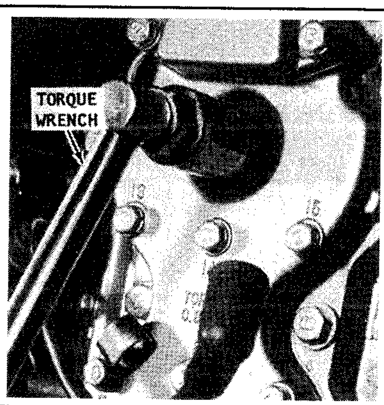

Fig. 118 . . . then use a torque wrench to tighten the plug to spec

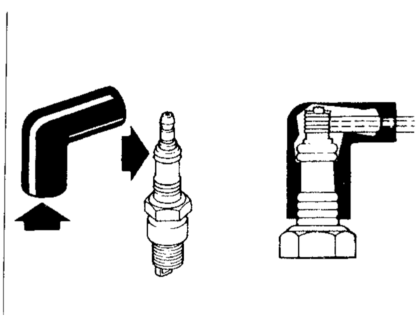

Fig. 119 To prevent corrosion, apply a small amount of grease to the plug and boot during installation

5. Using compressed air (and safety glasses), blow debris from the spark plug area to assure that no harmful contaminants are allowed to enter the combustion chamber when the spark plug is removed. If compressed air is not available, use a rag or a brush to clean the area. Compressed air is available from both an air compressor or from compressed air in cans available at photography stores. In a pinch, blow up a balloon and use the escaping air to blow debris from the spark plug port(s).

■ **Remove the spark plugs when the engine is cold, if possible, to prevent damage to the threads. If plug removal is difficult, apply a few drops of penetrating oil to the area around the base of the plug and allow it a few minutes to work.**

6. Using a spark plug socket that is equipped with a rubber insert to properly hold the plug, turn the spark plug counterclockwise to loosen and remove the spark plug from the bore.

✳✳ WARNING

Avoid the use of a flexible extension on the socket. Use of a flexible extension may allow a shear force to be applied to the plug. A shear force could break the plug off in the cylinder head, leading to costly and/or frustrating repairs. In addition, be sure to support the ratchet with your other hand - this will also help prevent the socket from damaging the plug.

7. Evaluate each cylinder's performance by comparing the spark condition. Check each spark plug to be sure they are from the same plug manufacturer and have the same heat range rating. Inspect the threads in the spark plug opening of the block and clean the threads before installing the plug.

8. When purchasing new spark plugs, always ask the dealer if there has been a spark plug change for the engine being serviced. Sometimes manufacturers will update the type of spark plug used in an engine to offer better efficiency or performance.

9. Always use a new gasket (if applicable). The gasket must be fully compressed on clean seats to complete the heat transfer process and to provide a gas tight seal in the cylinder.

10. Inspect the spark plug boot for tears or damage. If a damaged boot is found, the spark plug boot and possibly the entire wire will need replacement.

11. Check the spark plug gap prior to installing the plug. Many new plugs do not come gapped to the proper specification.

12. Apply a thin coating of anti-seize on the thread of the plugs. This is extremely important on aluminum head engines to prevent corrosion and heat from seizing the plug in the threads (which could lead to a damaged cylinder head upon removal).

13. Carefully thread the plug into the bore by hand. If resistance is felt before the plug completely bottoms, back the plug out and begin threading again.

✳✳ WARNING

Do not use the spark plug socket to thread the plugs. Always carefully thread the plug by hand or using an old plug wire/boot to prevent the possibility of cross-threading and damaging the cylinder head bore. An old plug wire/boot can be used to thread the plug if you turn the wire by hand. Should the plug begin to cross-thread the wire will twist before the cylinder head would be damaged. This trick is useful when accessories or a deep cylinder head design prevents you from easily keeping fingers on the plug while it is threaded by hand.

14. Carefully tighten the spark plug to specification using a torque wrench, as follows:

- 25/30 hp (496cc) 3-cylinder engines: 14 ft. lbs. (20 Nm)
- All other engines: 18 ft. lbs. (25 Nm)

■ **Whenever possible, spark plugs should be tightened to the factory torque specification. If a torque wrench is not available, and the plug you are installing is equipped with a crush washer, tighten the plug until the washer seats, then tighten it an additional 1/4 turn to crush the washer.**

15. Apply a small amount of a silicone dielectric grease or Yamaha All-Purpose Marine grease to the ribbed, ceramic portion of the spark plug lead and inside the spark plug boot to prevent sticking, then install the boot to the spark plug and push until it clicks into place. The click may be felt or heard. Gently pull back on the boot to assure proper contact.

16. If applicable, connect the negative battery cable or turn the battery switch **ON**.

17. Test run the outboard (using a test tank or flush fitting) and insure proper operation.

READING SPARK PLUGS

◆ **See Figures 120 thru 125**

Reading spark plugs can be a valuable tuning aid. By examining the insulator firing nose color, you can determine much about the engine's overall operating condition.

In general, a light tan/gray color tells you that the spark plug is at the optimum temperature and that the engine is in good operating condition.

Dark coloring, such as heavy black wet or dry deposits usually indicate a fouling problem. Heavy, dry deposits can indicate an overly rich condition, too cold a heat range spark plug, possible vacuum leak, low compression, overly retarded timing or too large a plug gap.

If the deposits are wet, it can be an indication of a breached head gasket or an extremely rich condition, depending on what liquid is present at the firing tip.

Also look for signs of detonation, such as silver specs, black specs or melting or breakage at the firing tip.

Compare your plugs to the illustrations shown to identify the most common plug conditions.

Fouled Spark Plugs

A spark plug is "fouled" when the insulator nose at the firing tip becomes coated with a foreign substance, such as fuel, oil or carbon. This coating makes it easier for the voltage to follow along the insulator nose and leach back down into the metal shell, grounding out, rather than bridging the gap normally.

Fuel, oil and carbon fouling can all be caused by different things but in any case, once a spark plug is fouled, it will not provide voltage to the firing tip and that cylinder will not fire properly. In many cases, the spark plug cannot be cleaned sufficiently to restore normal operation. It is therefore recommended that fouled plugs be replaced.

Signs of fouling or excessive heat must be traced quickly to prevent further deterioration of performance and to prevent possible engine damage.

Overheated Spark Plugs

When a spark plug tip shows signs of melting or is broken, it usually means that excessive heat and/or detonation was present in that particular combustion chamber or that the spark plug was suffering from thermal shock.

Since spark plugs do not create heat by themselves, one must use this visual clue to track down the root cause of the problem. In any case, damaged firing tips most often indicate that cylinder pressures or temperatures were too high. Left unresolved, this condition usually results in more serious engine damage.

Detonation refers to a type of abnormal combustion that is usually preceded by pre-ignition. It is most often caused by a hot spot formed in the combustion chamber.

As air and fuel is drawn into the combustion chamber during the intake stroke, this hot spot will "pre-ignite" the air fuel mixture without any spark from the spark plugs.

Detonation

Detonation exerts a great deal of downward force on the pistons as they are being forced upward by the mechanical action of the connecting rods. When this occurs, the resulting concussion, shock waves and heat can be severe. Spark plug tips can be broken or melted and other internal engine components such as the pistons or connecting rods themselves can be damaged.

Left unresolved, engine damage is almost certain to occur, with the spark plug usually suffering the first signs of damage.

■ **When signs of detonation or pre-ignition are observed, they are symptom of another problem. You must determine and correct the situation that caused the hot spot to form in the first place.**

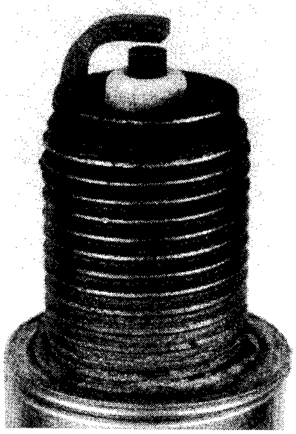

Fig. 120 A normally worn spark plug should have light tan or gray deposits on the firing tip (electrode)

Fig. 121 A carbon-fouled plug, identified by soft, sooty black deposits, may indicate an improperly tuned powerhead

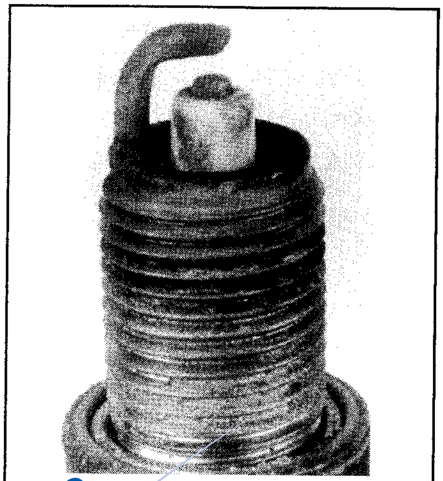

Fig. [illegible] This spark plug has been left in the p[illegible]d too long, as evidenced by the [illegible]p. Plugs with such an extreme g[illegible] cause misfiring and stumbling [illegible]mpanied by a noticeable lack of power

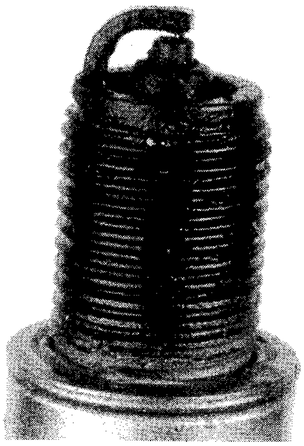

Fig.123 An oil-fouled spark plug indic[illegible]s a powerhead with worn piston ring[illegible] a malfunctioning oil injection [illegible] allows excessive oil to ent[illegible] chamber

Fi[illegible]. 124 A physically damaged spark plug [illegible]ay be evidence of severe detonation in that cylinder. Watch the cylinder carefully between services, as a continued detonation will not only damage the plug but will most likely damage the powerhead

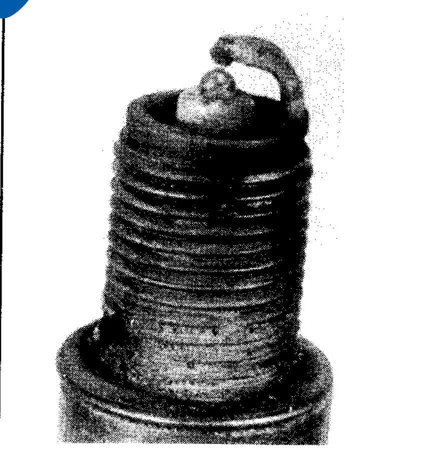

Fig. 125 A bridged or almost bridged spark plug, identified by the build-up between the electrodes caused by excessive carbon or oil build up on the plug

INSPECTION & GAPPI[illegible]

◆ **See Figures 126 and 127**

EASY

A particular spark plug might fit hundreds of powerheads and although the factory will typically set the gap to a pre-selected setting, this gap may not be the right one for your particular powerhead.

Insufficient spark plug gap can cause pre-ignition, detonation, even engine damage. Too much gap can result in a higher rate of misfires, noticeable loss of power, plug fouling and poor economy.

■ **Refer to the Tune-Up Specifications chart for spark plug gaps.**

Check spark plug gap before installation. The ground electrode (the L-shaped one connected to the body of the plug) must be parallel to the center electrode and the specified size wire gauge must pass between the electrodes with a slight drag.

Do not use a flat feeler gauge when measuring the gap on a used plug, because the reading may be inaccurate. A round-wire type gapping tool is the best way to check the gap. The correct gauge should pass through the electrode gap with a slight drag. If you're in doubt, try a wire that is one size

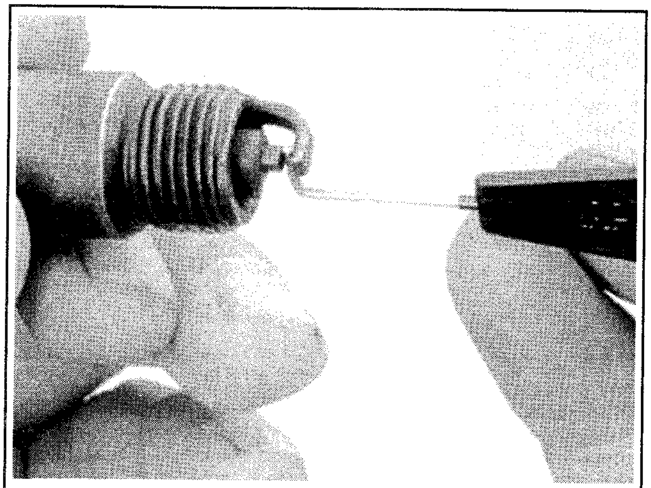

Fig. 126 Use a wire-type spark plug gapping tool to check the distance between center and ground electrodes

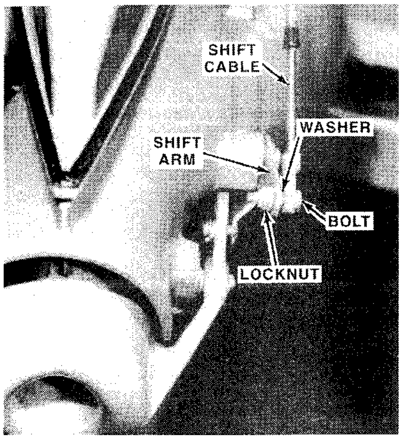

Fig. 256 . . .then disconnect the cable from the shift arm

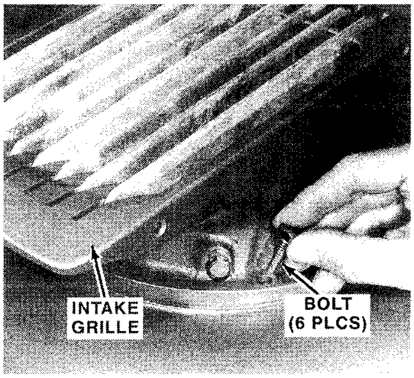

Fig. 257 Unbolt and remove the water intake grille for access to the impeller

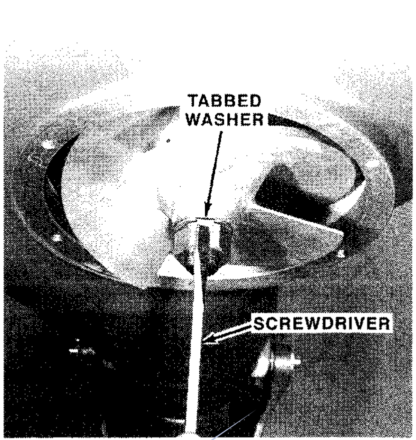

Fig. 258 To remove the impeller, bend back the locktab. . .

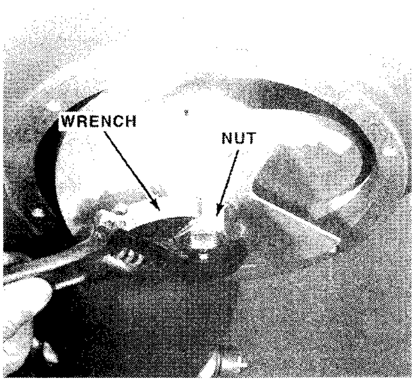

Fig. 259 . .then loosen and remove the nut

Fig. 260 Note the location of the tabbed washer and shims. . .

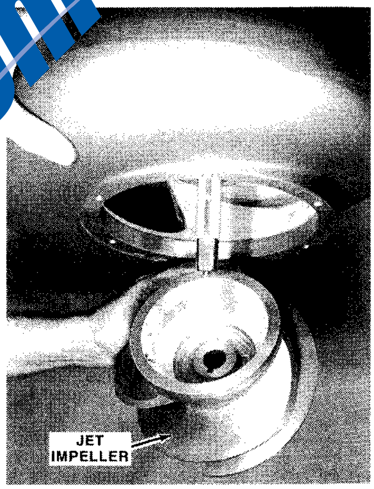

Fig. 261 . . .then lower the impeller from the drive

Fig. 262 Remove the nylon sleeve, shear key and any spacers which were above the impeller

CLEANING & INSPECTION

◆ **See Figures 269 and 270**

Wash all parts, except the driveshaft assembly, in solvent and blow them dry with compressed air. Rotate the bearing assembly on the driveshaft to inspect the bearings for rough spots, binding and signs of corrosion or damage.

Saturate a shop towel with solvent and wipe both extensions of the driveshaft.

Bearing Assembly

3 DIFFICULT

◆ **See Figures 270 and 271**

Lightly wipe the exterior of the bearing assembly with the same shop towel. Do not allow solvent to enter the three lubricant passages of the bearing assembly. The best way to clean these passages is not with solvent - because any solvent remaining in the assembly after installation will continue to dissolve good useful lubricant and leave bearings and seals dry. This condition will cause bearings to fail through friction and seals to dry up and shrink - losing their sealing qualities.

The only way to clean and lubricate the bearing assembly is after installation to the jet drive - via the exterior lubrication fitting.

If the old lubricant emerging from the hose coupling is a dark, dirty, gray color, the seals have already broken down and water is attacking the bearings. If such is the case, it is recommended the entire driveshaft bearing assembly be taken to the dealer for service of the bearings and seals.

Fig. 263 To unbolt the drive remove any external bolts (usually 1). . .

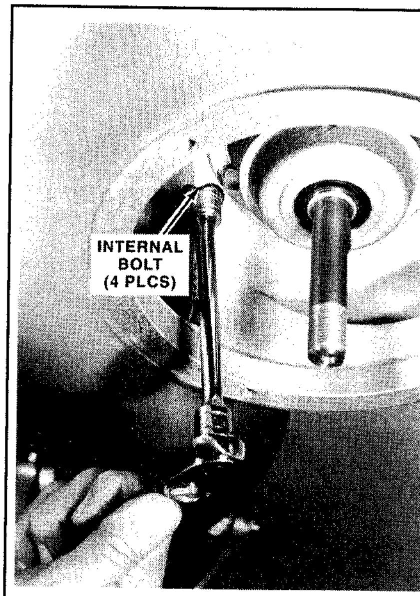

Fig. 264 . . .and any internal bolts (usually 4 around the outside of the impeller housing)

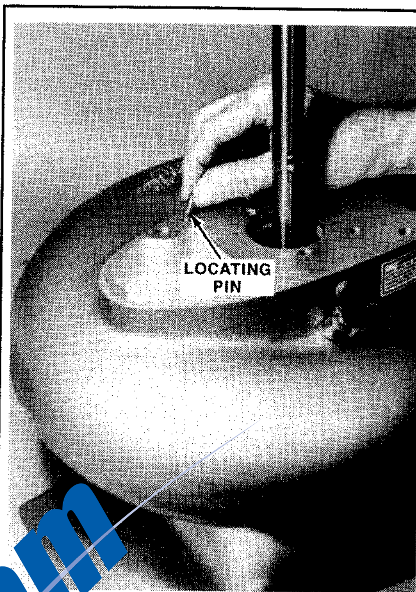

Fig. 265 When you lower the jet drive, check the dowel (locating) pins. . .

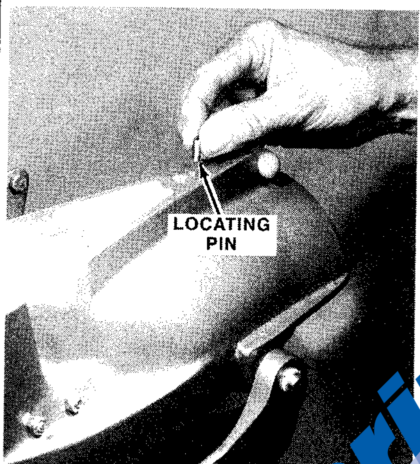

Fig. 266 . . .there is usually one at each end

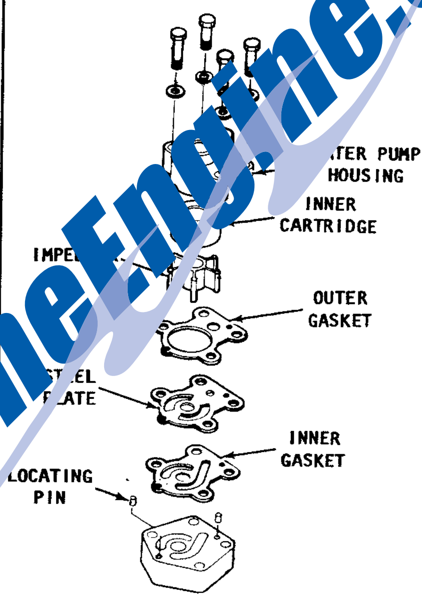

Fig. 267 Exploded view of a typical jet drive water pump assembly

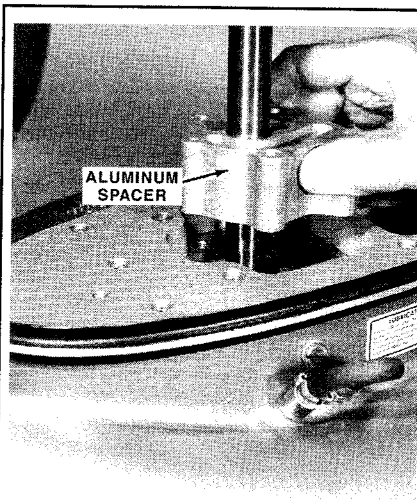

Fig. 268 If necessary, remove the pump shaped aluminum spacer

Disassembling the Bearing Carrier

OEM ③ DIFFICULT

◆ See Figures 272 and 273

A slightly involved procedure must be followed to dismantle the bearing carrier including "torching" off the bearing housing. Naturally, excessive heat will destroy the seals and possibly damage the bearings. Therefore, this procedure should be avoided unless you are planning (or at least open to the possibility) of a complete overhaul to the Jet Drive. Otherwise, use great care or leave this part of the service work to someone who is more familiar with Jet Drives.

However, if you have the experience and the shop tooling required to perform the torch heating and bearing press tasks, use the following procedures and illustrations to perform this work. Refer to the exploded view provided under the Cleaning & Inspecting heading in this section to help identify internal components, but remember that assemblies may vary slightly. A photographic exploded view is also provided in this section.

The following procedures pickup the work after the water pump assembly has been removed from

1. Remove the bolts (usually 4) securing the bearing carrier assembly in the jet pump housing. Lift out and discard the four small O-rings from the bolt holes on top of the bearing carrier flange.

✱✱ CAUTION

The retaining ring is under considerable force when installed. Use caution and wear eye protection when removing or installing this retaining ring.

TRIM & TILT SYSTEMS

Introduction

All outboard installations are equipped with some means of raising or lowering (pivoting), the complete unit for efficient operation under various load, boat design, water conditions, and for trailering to and from the water.

The correct trim angle ensures maximum performance and fuel economy as well as a more comfortable ride for the crew and passengers.

The most simple form of tilt is a mechanical tilt adjustment consisting of a series of holes in the transom mounting bracket through which an adjustment pin passes to secure the outboard unit at the desired angle.

Such a mechanical arrangement works quite well for the smaller units, but with larger (and heavier) outboard units some form of assist or power system is required. A simple hydraulic tilt assist system, known as the Yamaha Hydro Tilt system is used on larger motors that are NOT equipped with a power trim-tilt assembly. The main component of the Hydro Tilt system is a gas filled shock absorber that is used to both provide mechanical lift assistance as well as act to protect the outboard and transom from shock should the motor strike an underwater object.

For most 40 hp and larger motors (as well as a few smaller models such as some 25 or 30 hp motors) some form of a Power Trim/Tilt (PTT) system is used. The Yamaha power systems are hydraulically operated and electrically controlled from the helmsperson's position. There are basically 2 forms of the PTT system. The first uses a single trim/tilt rod to control all functions and provide shock absorption, while the second, found primarily on larger motors, uses a tilt rod for tilting and shock absorption, while using two dedicated trim cylinders for fine trim adjustment.

■ **The single tilt rod PTT system is normally found on smaller motors, including most medium sized motors (such as the 28J-50 hp, 698cc models). The large motor PTT system (with single tilt rod and dual trim rods) is normally found on most 60 hp and larger motors.**

All trim and tilt systems are installed between the two large clamp brackets. On power systems, the trim/tilt relay is usually mounted in the upper cowling pan where it is fairly well protected from moisture.

All power trim/tilt systems contain a manual release valve to permit movement of the outboard unit in the remote event the trim/tilt system develops a malfunction, either hydraulic or electrical (or in case the battery or power source fails), preventing use of power.

This section covers three different types of trim/tilt units which may be installed on Yamaha outboards. Each system is described in a separate section. Troubleshooting, filling the system with hydraulic fluid and purging (bleeding) procedures are included, as applicable.

HYDRO TILT LOCK SYSTEM

Description & Operation

◆ See Figure 1

The Hydro Tilt Lock system is a mechanical assist lift and lock system for tilting medium-to-large sized outboards that are NOT equipped with a PTT system. It consists of a single shock absorber and tilt lever assembly.

■ **The Hydro Tilt Lock system is normally found on medium-to-large sized commercial outboards or motors designed for high-reliability at a low price (lacking extra features such as electric start) for reasons of simplicity and low expense of production cost.**

The shock absorber contains a high pressure gas chamber located in the upper portion of the cylinder bore above the piston assembly. The piston contains a down relief valve and an absorber relief valve. Beneath the piston assembly, the lower cylinder bore contains an oil chamber. This lower chamber is connected to the upper chamber (above the piston) by a hydraulic line with a manual check valve. This check valve is located about half way down the hydraulic line.

This manual check valve is activated by the lever, when the lever is rotated from the lock (down) position to the tilt (up) position. The check valve cam rotates and pushes the manual check valve push rod against the check valve. This action opens the check valve and allows hydraulic fluid to flow from the lower chamber through the hydraulic line, past the open manual check valve and into the upper gas chamber.

■ **When the manual check is open, the valve will allow hydraulic fluid to flow in only. One direction - from the lower chamber to the upper chamber.**

RAISING OUTBOARD UNIT

When the outboard unit is tilted up, the volume below the piston decreases, and at the same time, the volume above the piston increases until the piston has reached the bottom of its stroke. In this position all fluid is contained above the piston.

The tilt lever is then rotated to the lock (down) position to engage with the clamp bracket. When the tilt lever is in the lock position, the manual valve push rod rests on a flat spot of the manual valve cam and releases pressure on the check valve. Releasing pressure on the check valve closes off the hydraulic line and the flow of hydraulic fluid. The outboard unit is now in the trailering position.

LOWERING OUTBOARD UNIT

To lower the outboard unit from the full up and locked position, the tilt lever is again rotated from the lock (down) position to the tilt (up) position. The manual check valve cam rotates and pushes the manual check valve push rod against the check valve and opens the valve.

As the outboard unit is tilted down, the piston moves up and compresses the fluid in the upper chamber. The fluid pressure overcomes the down relief valve spring and opens the relief valve. The valve in the open position allows hydraulic fluid to flow through the piston from the upper chamber to the lower chamber.

During normal cruising, the tilt lever is set in the lock (down) position. The manual check valve is closed to prevent the outboard unit from being tilted up by water pressure against the propeller when the unit is in reverse gear. When the unit is in forward gear, the outboard is held in position by the tilt pin through the swivel bracket.

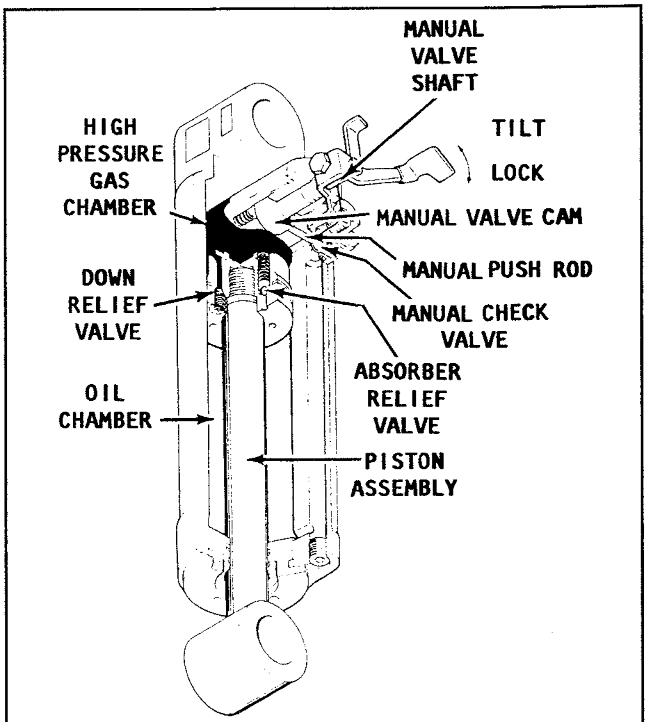

Fig. 1 Cutaway view of a hydro tilt lock system with major parts identified

UNDERWATER STRIKE

In the event the outboard lower unit should strike an underwater object while the boat is underway, the piston would be forced down. The hydraulic fluid below the piston would be under pressure with no escape because the manual check valve is closed. The valve is closed because the tilt lever is in the lock (down) position.

To prevent rupture of the hydraulic line, a safety relief valve is incorporated in the piston. This relief valve permits fluid to pass through the piston from the lower chamber to the upper chamber through the absorber relief valve. After the outboard has passed the obstacle, the fluid returns to the lower chamber through the piston and the down relief valve, because the piston is pushed up.

Servicing the Hydro Tilt System

◆ **See Figure 2**

Service procedures for the Hydro Tilt Lock system are normally confined to periodic inspection for signs of extreme corrosion (especially on the shock absorber rod) and signs of oil leaks. Although small amounts of corrosion MAY be polished away in some cases, extreme corrosion and/or oil leaks will normally require that the entire unit be replaced.

Although it is possible to remove the unit from the steering and clamp bracket assembly on a few motors, for MOST motors it will require disassembly of the clamp bracket itself, a potentially time consuming task.

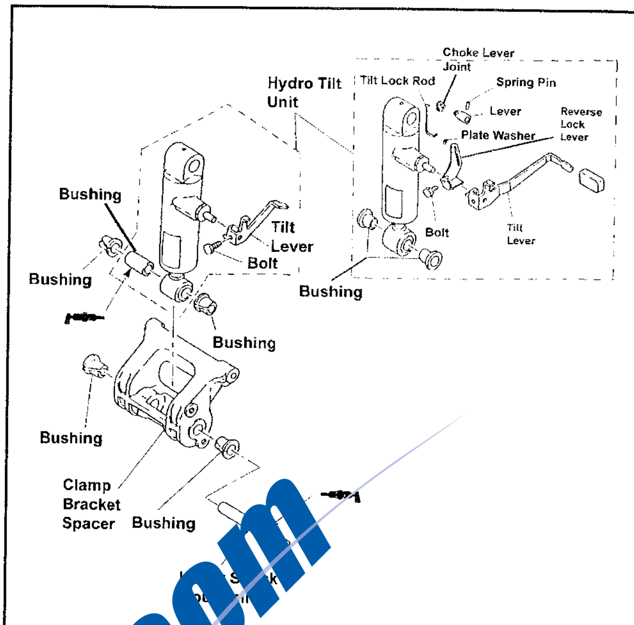

Fig. 2 Explo[illegible] vie[illegible] a typical hydro tilt lock system

SINGLE TILT RAM POWER TRIM/TILT SYSTEMS

Description & Operation

◆ **See Figures 3, 4 and 5**

■ **The single tilt rod PTT system is normally found on smaller motors including most medium sized motors (such as the 28J-50 hp, 698[illegible] models).**

The PTT system found on most medium sized Yamaha outbo[illegible] incorporates a single hydraulic cylinder and piston. Althou[illegible] s[illegible] olde[illegible] units this system was used only for tilt, on most modern Y[illegible]a[illegible] [illegible]tem allows for some trim adjustment of the motor once l[illegible]d [illegible] [illegible]pe[illegible]g position by the system. The system consists o[illegible] an [illegible]c[illegible] mo[illegible] m[illegible]nted on top of a gear driven hydraulic pump, a small fl[illegible]res[illegible]o[illegible] (which is an integral part of the pump) and a single hyd[illegible]c [illegible]o[illegible] and cylinder used to move the outboard unit up or down, as req[illegible]d.

■ **The positioning of the tilt [illegible]in[illegible] [illegible]ump are reversed on some models. That is to s[illegible] [illegible]und on either side (port or starboard) or th[illegible]ra[illegible]**

Unlike other power trim an[illegible] [illegible]its, all hydraulic circuits are routed inside the unit.

■ **Three safety relief valves are incorporated into the hydraulic passageways as protection against excessive pressurization. Each of these valves has a different pressure release factor. The valves are not interchangeable. The up relief valve and the down relief valve are normally located, one on each side of the pump. The third, main relief valve, is normally found above the main valve assembly.**

Each valve is secured in place with an Allen head screw accessible from the exterior of the pump. The distance the Allen head screws are sunk into the pump housing is critical. Therefore, do not remove and examine the valves without good cause. If a valve is accidentally removed, refer to Troubleshooting, in this section.

TILT UP OPERATION

When the up portion of the tilt switch on the remote control handle is depressed, the electric motor rotates (usually in a clockwise direction). The drive gear, on the end of the motor shaft, indexed with the driven gear act as [illegible]ou[illegible] [illegible]his action is very similar to the action in an automobile oil [illegible]u[illegible]n pump.

[illegible]e hyd[illegible]aulic fluid is forced through a series of valves into the lower [illegible]be[illegible] of the cylinder. The fluid fills the lower chamber and forces the [illegible]pward and the outboard unit rises. As the piston continues to extend, oi[illegible] the upper chamber is routed back through the suction side of the pump u[illegible] the tilt piston reaches the top of its stroke.

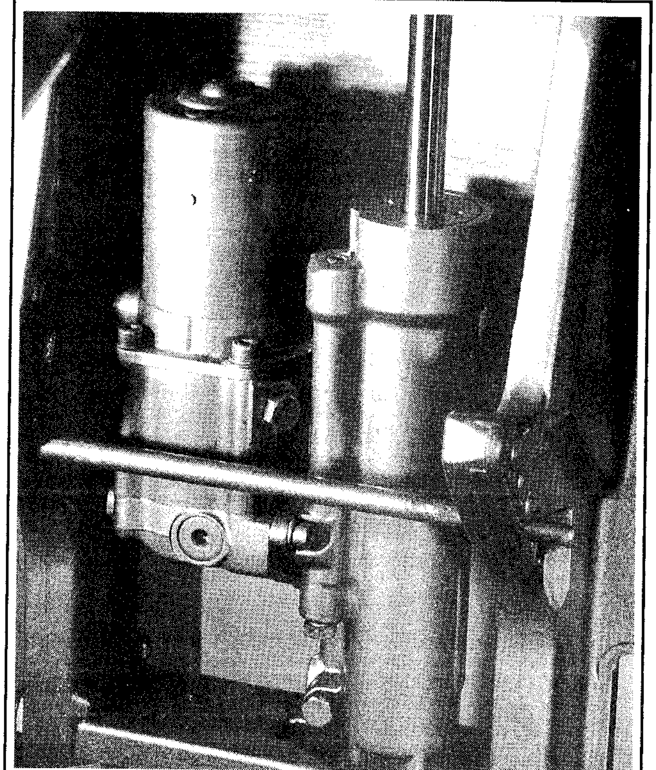

Fig. 3 Typical single tilt ram PTT unit installed on a 40 hp motor