Some people replace zincs annually. This may or may not be necessary, depending on the type of waters in which you boat and depending on whether or not the boat is hauled with each use or left in for the season. Either way, it is a good idea to remove zincs at least annually in order to make sure the mounting surfaces are still clean and free of corrosion.

The first thing to remember is that zincs are electrical components and like all electrical components, they require good clean connections. So after you've undone the mounting hardware you want to get the zinc mounting sites clean and shiny.

Get a piece of coarse emery cloth or some 80-grit sandpaper. Thoroughly rough up the areas where the zincs attach (there's often a bit of corrosion residue in these spots). Make sure to remove every trace of corrosion.

Zincs are attached with stainless steel machine screws that thread into the mounting for the zincs. Over the course of a season, this mounting hardware is inclined to loosen. Mount the zincs and tighten the mounting hardware securely. Tap the zincs with a hammer hitting the mounting screws squarely. This process tightens the zincs and allows the mounting hardware to become a bit loose in the process. Now, do the final tightening. This will insure your zincs stay put for the entire season.

Timing Belt

INSPECTON

◆ **See Figures 100 and 101** ① EASY

All 4-stroke motors covered by this manual use a timing belt to synchronize the camshaft and crankshaft (for correct valve timing). The timing belt is a long life component that does not require much in the way or service, but we would recommend that you inspect it at least once every year. Also, although the manufacturer provides no recommended replacement interval, experience shows that it is wise to replace it every 4-5 years or anytime after about 500 hours of operation, whichever comes first. Keep in mind, a timing belt that breaks or even slips a tooth will likely disable the motor, possibly stranding the boat.

✳✳ WARNING

Warnings that the manufacturer give against rotating the crankshaft with the timing belt removed makes us believe that the 9.9 hp is an interference motor. This means that if the belt were to snap suddenly during service with the engine running, there is a good chance that one or more valves would be left in the open position and would be hit by a piston as it traveled upwards due to the remaining force of the spinning flywheel. This could destroy the piston, valves and/or cylinder head. So, periodic inspection and replacement of the timing belt is probably an even wiser investment on this motor.

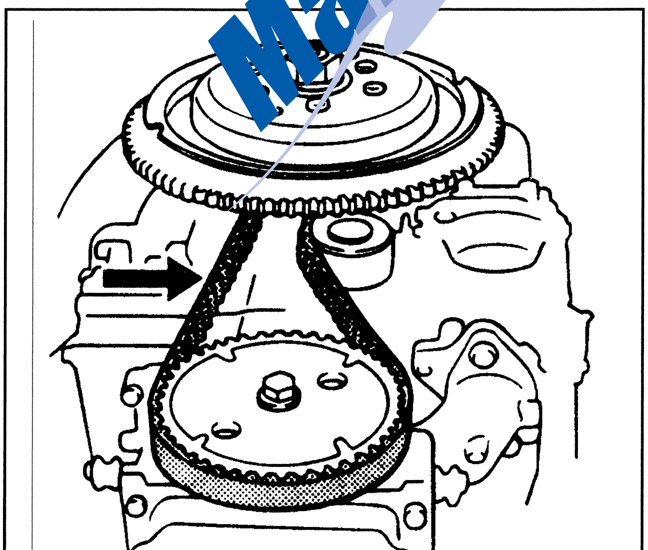

Fig. 100 Timing belt inspection on a late-model 9.9 hp motor (measure deflection)

■ **We did not find any references leading us to believe the 45/50 hp 4-stroke was an interference motor, but that doesn't mean it is definitely not, so use caution (and inspect the timing belt frequently).**

On some motors the timing belt may be partially visible at one point in the flywheel cover, but a thorough inspection is really only possible (and much easier) once the flywheel cover assembly is removed.

1. For safety when working around the flywheel, disconnect the negative battery cable and/or disconnect the leads from the spark plugs, then ground the leads on the powerhead.

■ **Although not absolutely necessary for this procedure, it is a good idea to remove the spark plugs at this time. Removing the spark plugs will relieve engine compression, making it easier to manually rotate the motor. Also, it presents a good opportunity to inspect, clean and/or replace the plugs.**

2. Remove the manual starter assembly or the flywheel cover, as applicable, for better access to the timing belt.
3. Use low-pressure compressed air to blow debris out from under the camshaft pulley, flywheel and timing belt.
4. Visually check the belt for worn, cracked or oil soaked surfaces. Slowly rotate the flywheel (clockwise) while inspecting all of the timing belt cogs.
5. Visually check the camshaft pulley and flywheel teeth for worn, cracked, chipped or otherwise damaged surfaces.
6. On 9.9 hp motors use light thumb pressure at the center of the longest span on the timing belt. It should deflect no more than 0.39 in. (10mm) or the belt requires attention. On some late model motors the pulley tension may be adjustable but it was not on all early-model motors (for more details please refer to the POWERHEAD section). If belt tension is out of specification and cannot be adjusted, the belt must be replaced.

■ **The 45/50 hp 4-stroke utilizes a spring-loaded belt tensioner that automatically applies the correct amount of tension to the belt. If the belt seems loose, refer to the timing belt replacement information under POWERHEAD. The tensioner mounting bolts may be loosened (allowing the spring to readjust tension) and then retightened to see if it takes care of the excess slack. If this doesn't do the trick the belt should usually be replaced.**

7. If the belt, pulleys or tensioner (on the 45/50 hp motor) are damaged, replace them as described under Powerhead in this manual.
8. If removed, install the manual starter assembly or flywheel cover to the powerhead.
9. Install the spark plugs, then connect the leads followed by the negative battery cable and the engine cover.

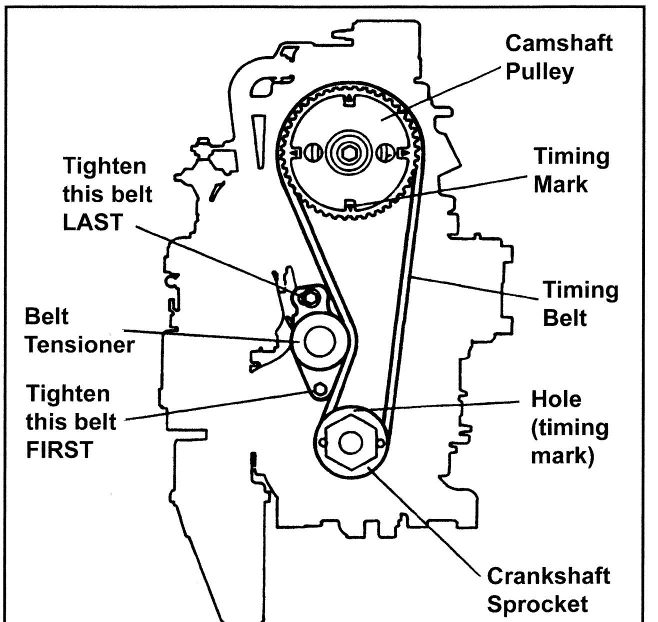

Fig. 101 Timing belt tension is set by the tensioner on 45/50 hp motors

BOAT MAINTENANCE

Batteries

◆ **See Figures 102 and 103**

Batteries require periodic servicing, so a definite maintenance program will help ensure extended life. A failure to maintain the battery in good order can prevent it from properly charging or properly performing its job even when fully charged. Low levels of electrolyte in the cells, loose or dirty cable connections at the battery terminals or possibly an excessively dirty battery top can all contribute to an improperly functioning battery. So battery maintenance, first and foremost, involves keeping the battery full of electrolyte, properly charged and keeping the casing/connections clean of corrosion or debris.

If a battery charges and tests satisfactorily but still fails to perform properly in service, one of three problems could be the cause.

1. An accessory left on overnight or for a long period of time can discharge a battery.
2. Using more electrical power than the stator assembly or lighting coil can replace would slowly drain the battery during motor operation, resulting in an undercharged condition.
3. A defect in the charging system. A faulty stator assembly or lighting coil, defective regulator or rectifier or high resistance somewhere in the system could cause the battery to become undercharged.

■ **For more information on marine batteries, please refer to BATTERY in the Ignition and Electrical Systems section.**

MAINTENANCE

◆ **See Figures 103, 104, 105 and 106**

EASY

Electrolyte Level

The most common and important procedure in battery maintenance is checking the electrolyte level. On most batteries, this is accomplished by removing the cell caps and visually observing the level in the cells. The bottom of each cell normally is equipped with a split vent which will cause the surface of the electrolyte to appear distorted when it makes contact. When the distortion first appears at the bottom of the split vent, the electrolyte level is correct. Smaller marine batteries are sometimes equipped with translucent cases that are printed or embossed with high and low level markings on the side. On some of these, shining a flashlight through the battery case will help make it easier to determine the electrolyte level.

During hot weather and periods of heavy use, the electrolyte level should be checked more often than during normal operation. Add distilled water to bring the level of electrolyte in each cell to the proper level. Take care not to overfill, because adding an excessive amount of water will cause loss of electrolyte and any loss will result in poor performance, short battery life and will contribute quickly to corrosion.

■ **Never add electrolyte from another battery. Use only distilled water. Even tap water may contain minerals or additives that will promote corrosion on the battery plates, so distilled water is always the best solution.**

Although less common in marine applications than other uses today, sealed maintenance-free batteries also require electrolyte level checks, through the window built into the top of the cases. The problem for marine applications is the tendency for deep cycle use to cause electrolyte evaporation and electrolyte cannot be replenished in a sealed battery. Although, more and more companies are producing maintenance-free batteries for marine applications and their success should be noted.

The second most important procedure in battery maintenance is periodically cleaning the battery terminals and case.

Cleaning

Dirt and corrosion should be cleaned from the battery as soon as it is discovered. Any accumulation of acid film or dirt will permit a small amount of current to flow between the terminals. Such a current flow will drain the battery over a period of time.

Clean the exterior of the battery with a solution of diluted ammonia or a paste made from baking soda and water. This is a base solution that will neutralize any acid that may be present. Flush the cleaning solution off with plenty of clean water.

✳✳ WARNING

Take care to prevent any of the neutralizing solution from entering the cells as it will quickly neutralize the electrolyte (ruining the battery).

Fig. 102 Explosive hydrogen gas is released from the batteries in a discharged state. This one exploded when something ignited the gas. Explosions can be caused by a spark from the battery terminals or jumper cables

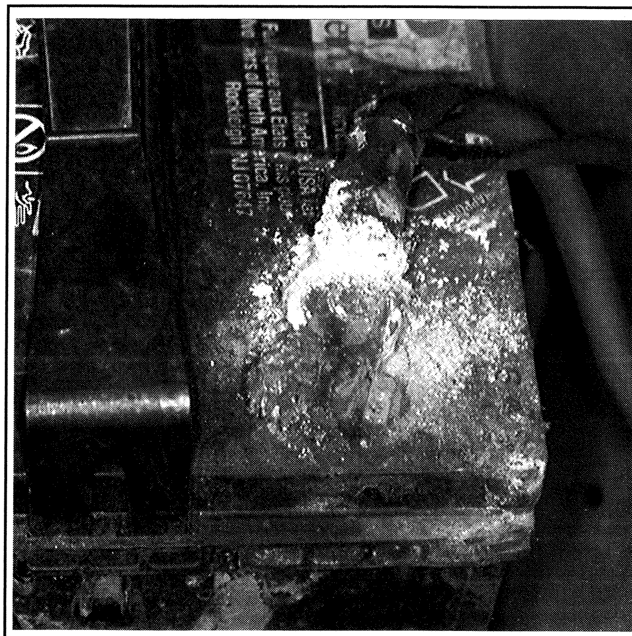

Fig. 103 Ignoring a battery (and corrosion) to this extent is asking for it to fail

Fig. 104 Place a battery terminal tool over posts, then rotate back and forth ...

Fig. 105 ... until the internal brushes expose a fresh, clean surface on the post

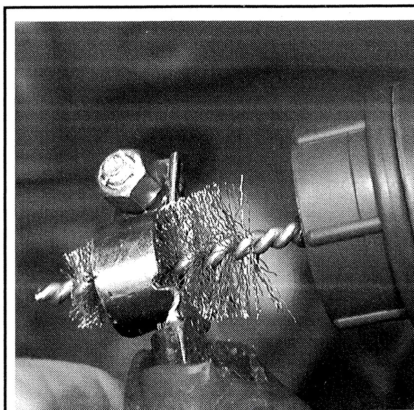

Fig. 106 Clean the insides of cable ring terminals using the tool's wire brush

Poor contact at the terminals will add resistance to the charging circuit. This resistance may cause the voltage regulator to register a fully charged battery and thus cut down on the stator assembly or lighting coil output adding to the low battery charge problem.

At least once a season, the battery terminals and cable clamps should be cleaned. Loosen the clamps and remove the cables, negative cable first. On batteries with top mounted posts, if the terminals appear stuck, use a puller specially made for this purpose to ensure the battery casing is not damaged. NEVER pry a terminal off a battery post. Battery terminal pullers are inexpensive and available in most parts stores.

Clean the cable clamps and the battery terminal with a wire brush until all corrosion, grease, etc., is removed and the metal is shiny. It is especially important to clean the inside of the clamp thoroughly (a wire brush or the part of a battery post cleaning tool is useful here), since a small deposit of foreign material or oxidation there will prevent a sound electrical connection and inhibit either starting or charging. It is also a good idea to apply some dielectric grease to the terminal, as this will aid in the prevention of corrosion.

After the clamps and terminals are clean, reinstall the cables, negative cable last, do not hammer the clamps onto battery posts. Tighten the clamps securely but do not distort them. To help slow or prevent corrosion, give the clamps and terminals a thin external coating of grease after installation.

Check the cables at the same time that the terminals are cleaned. If the insulation is cracked or broken, or if its ends are frayed, that cable should be replaced with a new one of the same length and gauge.

TESTING

OEM MODERATE

◆ **See Figure 107**

A quick check of the battery is to place a voltmeter across the terminals. Although this is by no means a clear indication, it gives you a starting point when trying to troubleshoot an electrical problem that could be battery related. Most marine batteries will be of the 12 volt DC variety. They are constructed of 6 cells, each of which is capable of producing slightly more than two volts, wired in series so that total voltage is 12 and a fraction. A fully charged battery will normally show more than 12 and slightly less than 13 volts across its terminals. But keep in mind that just because a battery reads 12.6 or 12.7 volts does NOT mean it is fully charged. It is possible for it to have only a surface charge with very little amperage behind it to maintain that voltage rating for long under load. A discharged battery will read some value less than 12 volts, but can normally be brought back to 12 volts through recharging. Of course a battery with one or more shorted or un-chargeable cells will also read less than 12, but it cannot be brought back to 12+ volts after charging. For this reason, the best method to check battery condition on most marine batteries is through a specific gravity check or a load test.

A hydrometer is a device that measures the density of a liquid when compared to water (specific gravity). Hydrometers are used to test batteries by measuring the percentage of sulfuric acid in the battery electrolyte in terms of specific gravity. When the condition of the battery drops from fully charged to discharged, the acid is converted to water as electrons leave the solution and enter the plates, causing the specific gravity of the electrolyte to drop.

It may not be common knowledge but hydrometer floats are calibrated for use at 80°F (27°C). If the hydrometer is used at any other temperature, hotter or colder, a correction factor must be applied.

■ **Remember, a liquid will expand if it is heated and will contract if cooled. Such expansion and contraction will cause a definite change in the specific gravity of the liquid, in this case the electrolyte.**

A quality hydrometer will have a thermometer/temperature correction table in the lower portion, as illustrated in the accompanying illustration. By measuring the air temperature around the battery and from the table, a correction factor may be applied to the specific gravity reading of the hydrometer float. In this manner, an accurate determination may be made as to the condition of the battery.

When using a hydrometer, pay careful attention to the following points:

1. Never attempt to take a reading immediately after adding water to the battery. Allow at least 1/4 hour of charging at a high rate to thoroughly mix the electrolyte with the new water. This time will also allow for the necessary gases to be created.
2. Always be sure the hydrometer is clean inside and out as a precaution against contaminating the electrolyte.
3. If a thermometer is an integral part of the hydrometer, draw liquid into it several times to ensure the correct temperature before taking a reading.
4. Be sure to hold the hydrometer vertically and suck up liquid only until the float is free and floating.
5. Always hold the hydrometer at eye level and take the reading at the surface of the liquid with the float free and floating.
6. Disregard the slight curvature appearing where the liquid rises against the float stem. This phenomenon is due to surface tension.
7. Do not drop any of the battery fluid on the boat or on your clothing, because it is extremely caustic. Use water and baking soda to neutralize any battery liquid that does accidentally drop.
8. After drawing electrolyte from the battery cell until the float is barely free, note the level of the liquid inside the hydrometer. If the level is within the charged (usually green) band range for all cells, the condition of the battery is satisfactory. If the level is within the discharged (usually white) band for all cells, the battery is in fair condition.
9. If the level is within the green or white band for all cells except one, which registers in the red, the cell is shorted internally. No amount of charging will bring the battery back to satisfactory condition.
10. If the level in all cells is about the same, even if it falls in the red band, the battery may be recharged and returned to service. If the level fails to rise above the red band after charging, the only solution is to replace the battery.

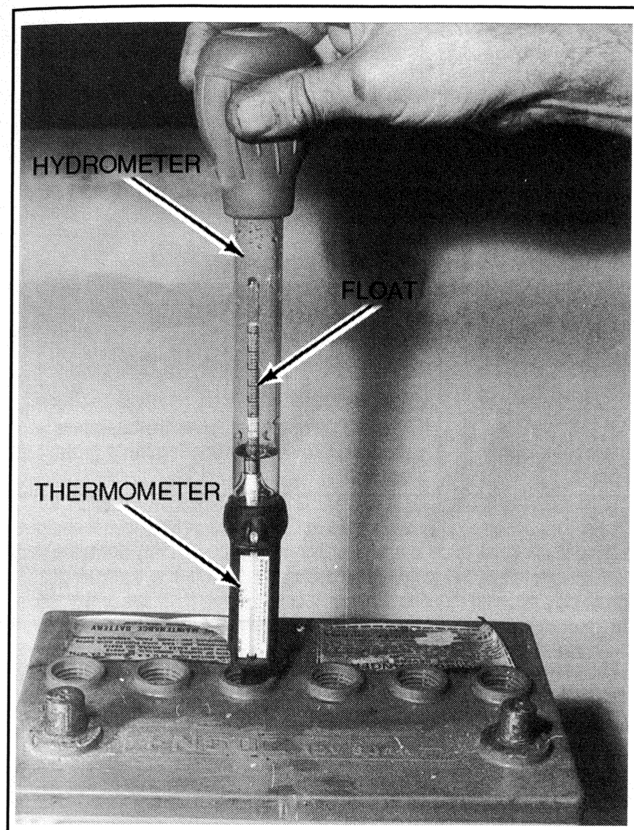

Fig. 107 A hydrometer is the best method for checking battery condition

■ **An alternate way of testing a battery is to perform a load test using a special Carbon-Pile Load Tester. These days most automotive and many marine parts stores contain a tester and will perform the check for free (hoping that your battery will fail and they can sell you another). Essentially a load test involves placing a specific load (current drain/draw) on a fully-charged battery and checking to see how it performs/recovers. This is the only way to test the condition of a sealed maintenance-free battery.**

STORAGE

① EASY

If the boat is to be laid up (placed into storage) for the winter or anytime it is not going to be used for more than a few weeks, special attention must be given to the battery. This is necessary to prevent complete discharge and/or possible damage to the terminals and wiring. Before putting the boat in storage, disconnect and remove the batteries. Clean them thoroughly of any dirt or corrosion and then charge them to full specific gravity readings. After they are fully charged, store them in a clean cool dry place where they will not be damaged or knocked over, preferably on a couple blocks of wood. Storing the battery up off the deck, will permit air to circulate freely around and under the battery and will help to prevent condensation.

Never store the battery with anything on top of it or cover the battery in such a manner as to prevent air from circulating around the filler caps. All batteries, both new and old, will discharge during periods of storage, more so if they are hot than if they remain cool. Therefore, the electrolyte level and the specific gravity should be checked at regular intervals. A drop in the specific gravity reading is cause to charge them back to a full reading.

In cold climates, care should be exercised in selecting the battery storage area. A fully-charged battery will freeze at about 60°F below zero. The electrolyte of a discharged battery, almost dead, will begin forming ice at about 19°F above zero.

■ **For more information on batteries and the engine electrical systems, please refer to the Ignition and Electrical section of this manual.**

Fiberglass Hull

INSPECTION AND CARE

◆ **See Figures 108, 109 and 110**

① EASY

Fiberglass reinforced plastic hulls are tough, durable and highly resistant to impact. However, like any other material they can be damaged. One of the advantages of this type of construction is the relative ease with which it may be repaired.

A fiberglass hull has almost no internal stresses. Therefore, when the hull is broken or stove-in, it retains its true form. It will not dent to take an out-of-shape set. When the hull sustains a severe blow, the impact will be either absorbed by deflection of the laminated panel or the blow will result in a definite, localized break. In addition to hull damage, bulkheads, stringers and other stiffening structures attached to the hull may also be affected and therefore, should be checked. Repairs are usually confined to the general area of the rupture.

■ **The best way to care for a fiberglass hull is to wash it thoroughly, immediately after hauling the boat while the hull is still wet. The next best way to care for your hull is to give it a waxing a couple of times per season. Your local marine or boat supply store should be able to help you find some high quality boat soaps and waxes.**

A foul bottom can seriously affect boat performance. This is one reason why racers, large and small, both powerboat and sail, are constantly giving attention to the condition of the hull below the waterline.

In areas where marine growth is prevalent, a coating of vinyl, anti-fouling bottom paint should be applied if the boat is going to be left in the water for extended periods of time such as all or a large part of the season. If growth has developed on the bottom, it can be removed with a diluted solution of Muriatic acid applied with a brush or swab and then rinsed with clear water. Always wear rubber gloves when working with Muriatic acid and take extra care to keep it away from your face and hands. The fumes are toxic. Therefore, work in a well-ventilated area or if outside, keep your face on the windward side of the work.

■ **If marine growth is not too severe you may avoid the unpleasantness of working with muriatic acid by trying a power washer instead. Most marine vegetation can be removed by pressurized water and a little bit of scrubbing using a rough sponge (don't use anything that will scratch or damage the surface).**

Barnacles have a nasty habit of making their home on the bottom of boats that have not been treated with anti-fouling paint. Actually they will not harm the fiberglass hull but can develop into a major nuisance.

If barnacles or other crustaceans have attached themselves to the hull, extra work will be required to bring the bottom back to a satisfactory condition. First, if practical, put the boat into a body of fresh water and allow it to remain for a few days. A large percentage of the growth can be removed in this manner. If this remedy is not possible, wash the bottom thoroughly with a high-pressure fresh water source and use a scraper. Small particles of hard shell may still hold fast. These can be removed with sandpaper.

Interior

INSPECTION AND CARE

① EASY

No one wants to walk around in bare feet on a boat whose deck or carpet is covered in fish guts right? It's not just a safety hazard, it's kind of nasty. Taking time to wash down and clean your boat's interior is just as important to the long term value of your boat as it is to your enjoyment. So take time, after every outing to make sure your baby is clean on the inside too.

Always try to find gentle cleaners for your vinyl and plastic seats. Harsh chemicals and abrasives will do more harm then good. Take care with guests aboard, as more than one brand of sun-tan lotion has been know to cause stains. Some people get carried away, forbidding things like cheesy coated chips/snacks or mustards on board. Don't let keeping your boat clean so much of an obsession that you forget to enjoy it, just keep a bottle of cleaner

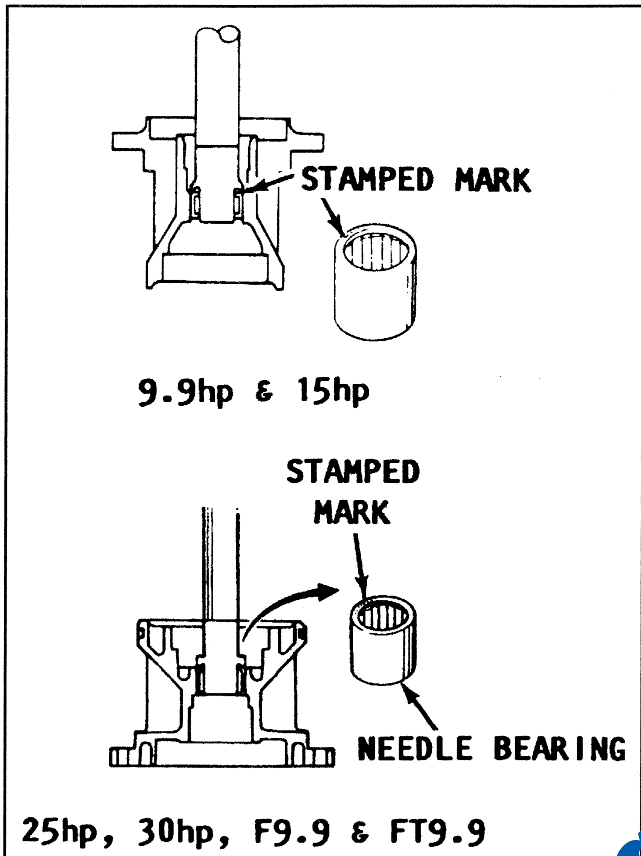

Fig. 114 Step 40

Fig. 115 Step 42

Reverse Gear Ball Bearing

◆ See Figures 116, 117, 118 and 119

The reverse gear ball bearing is pressed into the bearing carrier on some models. On other models the reverse gear is pressed onto the reverse gear. If the reverse gear is a press fit, do not forget to install any shim material removed from behind the reverse gear during disassembling. This shim material and, in some cases, a thrust washer must be installed between the reverse gear and the ball bearing assembly in order to ensure proper mesh between the reverse gear and the pinion gear.

On 4/5 hp, 6/8 hp models obtain a driver (#YB6016) and handle (#YB6071).

On 9.9 hp and 15 hp models, obtain a driver (#YB6105) and handle (#YB6071).

43. Install the ball bearing into the bearing carrier with the marks embossed on the bearing facing upward toward the driver. Install the same amount of shim material saved during disassembly. Install the reverse gear.

44. On 20 hp and larger models, position the reverse gear on a press with the gear teeth facing down. Place the same amount of shim material saved from disassembling, on the back of the gear. If applicable, install the thrust washer on top of the shim material.

45. Position the ball bearing assembly on top of the shim material, or the thrust washer, as the case may be, with the embossed marks on the bearing facing upward toward the press shaft.

46. Now, use a suitable mandrel and press against the inner bearing race.

■ **Take care to ensure the mandrel is pressing on the inner race and not on the outer race or the ball bearings. Such action would destroy the bearing.**

47. Continue to press the bearing into place until the bearing, thrust washer, shim material and back of the reverse gear are all seated against each other.

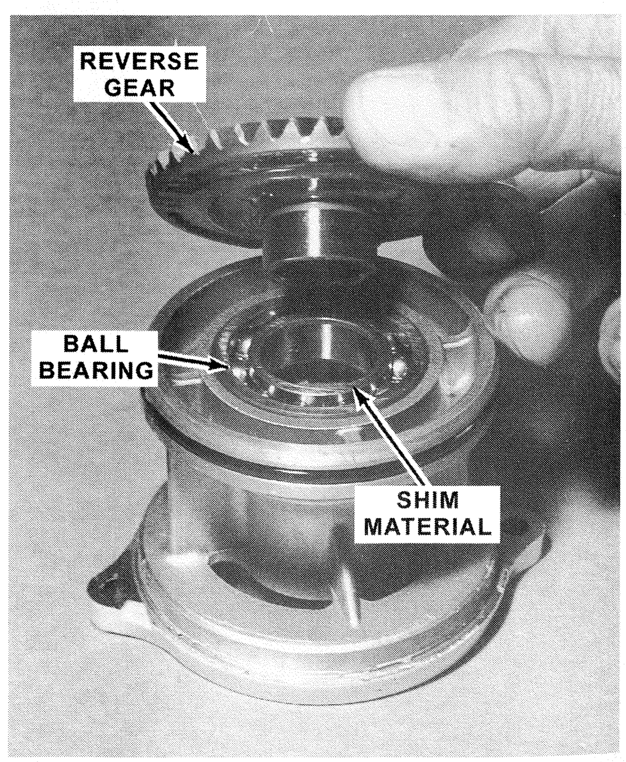

Fig. 116 Step 43

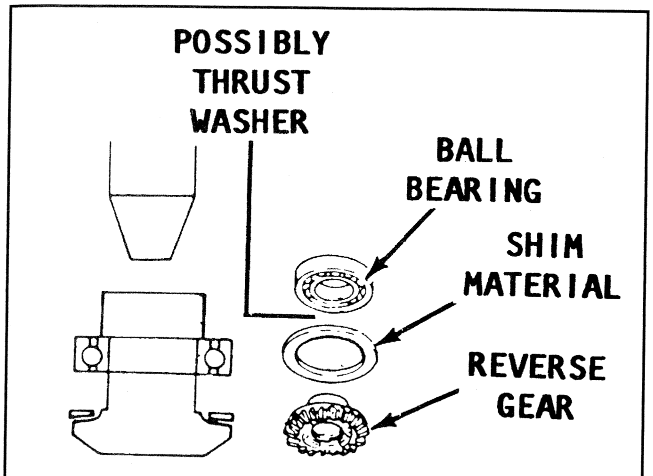

Fig. 117 Step 44

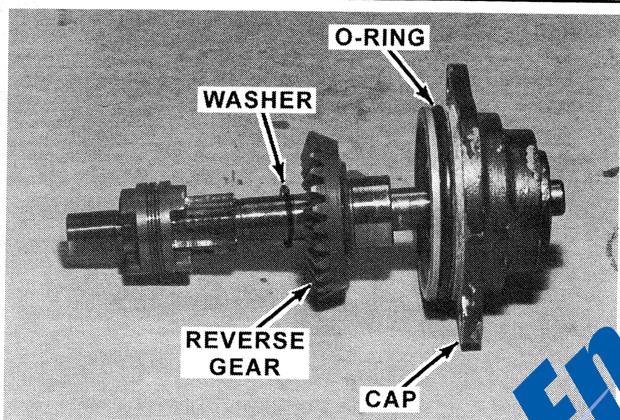

Fig. 118 Step 50

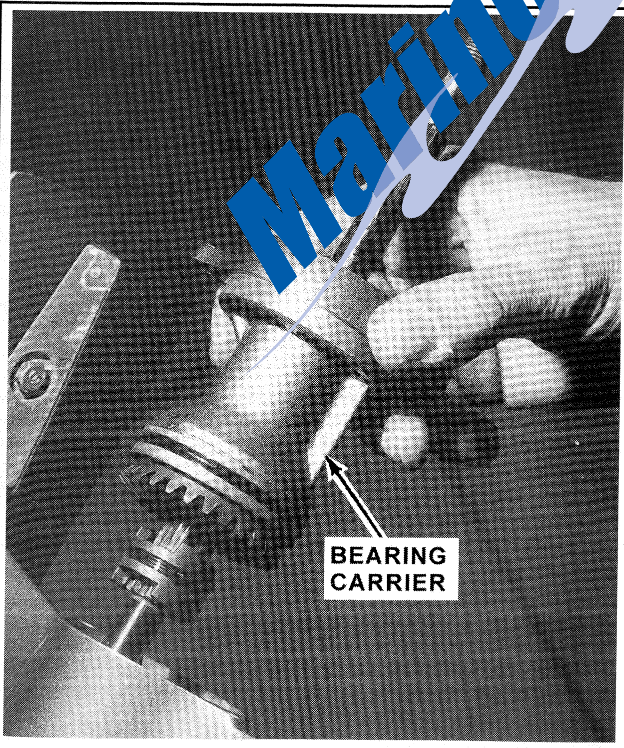

Fig. 119 Step 53

48. Leave the assembled unit in place on the press and install the bearing carrier over the ball bearing. This is accomplished by using a suitable mandrel which will contact the inner hub of the bearing carrier and does not apply pressure on the ribs.

49. Continue to press until the outer race of the bearing seats against the bearing carrier surface.

50. Install a new O-ring into the outer groove of the bearing carrier. Apply a coating of Yamabond #4 to the O-ring and to its mating surface.

51. Coat the teeth of the reverse gear with a fine spray of Desenex®, as instructed in the Plan Ahead paragraph prior to assembling. Handle the gear carefully to prevent disturbing the powder.

52. Place the washer over the reverse gear. Slide the threaded end of the assembled propeller shaft into the bearing carrier.

53. Install the propeller shaft and bearing carrier into the gearcase. On all except on 20 hp and larger models, install the two bolts and lockwashers. Tighten the bolts to 5.8 ft. lbs. (8 Nm).

■ **Assembling of parts at this time is not to be considered as final. The three gears are coated with the Desenex® powder, or equivalent, to determine a gear pattern. Therefore, the assemblies will be separated to check the pattern. During final installation the two mounting bolts will be coated with Loctite, or equivalent.**

54. If the assembler has omitted the application of the Desenex® powder and does not have plans to check the gear pattern, then this step may be considered as the final assembly of the bearing carrier. Loctite, or equivalent, should be applied to the threads of the bearing carrier attaching bolts.

55. On 20 hp and larger models, align the keyway in the lower unit housing with the keyway in the bearing carrier. Insert the key into both grooves, then push the bearing carrier into place in the lower unit housing. Install the ring nut with the embossed marks facing outward, away from the bearing carrier.

56. Obtain special bearing carrier holding tool (#YB6075). Tighten the ring nut, using the tool and a torque wrench, to 65 ft. lbs. (90 Nm) in the direction indicated by the embossed on mark.

■ **Assembling of parts at this time is not to be considered as final. The three gears are coated with the Desenex® powder, or equivalent, to determine a gear pattern. Therefore, the assemblies will be separated to check the pattern. During final installation, one or more of the lock washer tabs will be bent down over the locknut.**

57. If the assembler has omitted the application of Desenex® powder and does not have plans to check the gear pattern, then this step may be considered as the final assembly of the bearing carrier. If such is the case, bend one or more of the lock-washer tabs down over the locknut to secure it in place.

58. The propeller will be installed after the gear backlash measurements have been made, the water pump installed and the lower unit attached to the intermediate housing.

Backlash

◆ See Figure 120

59. The lower unit backlash is measured with the unit in the upright position for 6/8, and on 20 hp and larger models. The backlash is measured with the lower unit inverted (upside down) for the 9.9 hp and 15 hp models.

■ **The manufacturer does not give backlash specification for the 4/5 hp models. Therefore, the next lengthy and detailed section may be omitted for these two models.**

Backlash is the acceptable clearance between two meshing gears, in order to take into account possible errors in machining, deformation due to load, expansion due to heat generated in the lower unit and center-to-center distance tolerances. A no backlash condition is unacceptable, as such a condition would mean the gears are locked together or are too tight against each other which would cause phenomenal wear and generate excessive heat from the resulting friction.

Excessive backlash which cannot be corrected with shim material adjustment indicates worn gears. Such worn gears must be replaced. Excessive backlash is usually accompanied by a loud whine when the lower unit is operating in neutral gear.

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 a power system is required. The power system for these larger outboards is hydraulically operated and electrically controlled from the helmsperson's position.

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

All power trim/tilt systems use 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, 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.

HYDRO TILT LOCK SYSTEM

Description & Operation

◆ See Figure 1

The Hydro Tilt Lock system consists of a single shock absorber. 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. Below 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 tilt 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.

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. This means 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.

■ **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.**

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 permits 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.

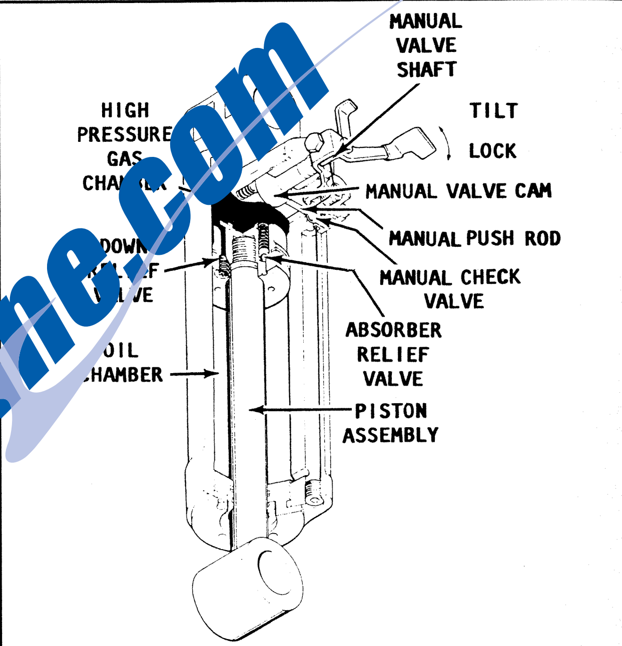

Fig. 1 Cutaway view of a hydro tilt lock system with major parts identified

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

Service procedures for the Hydro Tilt Lock system are confined to removal of the end cap, removing the piston and replacing the O-rings.

A spanner wrench is required to remove the end cap. Even with the tool, removal of the end cap is not a simple task. The elements, especially if the unit has been used in a salt water atmosphere, will have their corrosive affect on the threads. The attempt with the special tool to break the end cap loose may very likely elongate the two holes provided for the tool. Once the holes are damaged, all hope of removing the end are lost. The only solution in such a case is to replace the unit.

POWER TILT SYSTEM

Description & Operation

◆ **See Figures 2, 3 and 4**

The one-cylinder power tilt system incorporates a single tilt hydraulic cylinder and piston. This unit is used only for tilt purpose only. The system consists of an electric motor mounted on top of a gear driven hydraulic pump, a small fluid reservoir (which is an integral part of the pump) and a single hydraulic piston and cylinder used to move the outboard unit up or down, as required.

Unlike other power trim and tilt units, 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 located, one on each side of the pump. The third, main relief valve, is located 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 in a clockwise direction. The drive gear, on the end of the motor shaft, indexed with the driven gear act as an oil pump. This action is very similar to the action in an automobile oil circulation pump.

The hydraulic fluid is forced through a series of valves into the lower chamber of the cylinder. The fluid fills the lower chamber and forces the piston upward and the outboard unit rises. As the piston continues to travel oil in the upper chamber is routed back through the suction side of the pump until the tilt piston reaches the top of its stroke.

TILT DOWN OPERATION

When the down portion of the tilt switch on the remote control handle is depressed, the electric motor rotates counterclockwise. The drive gear on the end of the motor shaft indexed with the driven gear are now rotating in the opposite direction. This action forces the fluid into the upper cylinder chamber under pressure causing the piston to retract and the outboard unit is lowered. The fluid under pressure below the piston is routed back through a series of valves to the pump until the piston reaches the bottom of its stroke and the outboard unit is in the full down position.

MANUAL OPERATION

The outboard unit may be raised or lowered manually should the battery fail to provide sufficient current to operate the electric motor or should electric/hydraulic components of the PTT system fail for any other reason. A manual relief valve is provided to permit manual operation.

This manual relief valve is located on the lower end of the gear pump beneath the electric motor either facing aft (toward the motor/gearcase) or facing sideways (so that it is accessed through one of the clamp brackets). On most Yamaha motors the valve faced aft and contained an Allen (hex key) head. On these models the valve usually contains left-hand threads, meaning it is OPENED or LOOSENED by turning CLOCKWISE. However, on some late-model Yamaha outboards (where the valve faces to one side, and is accessed through a clamp bracket), the valve is equipped with a slotted head and contains normal right-hand threads, meaning it is OPENED or LOOSENED by turning COUNTERCLOCKWISE.

Either way, opening the valve releases pressure in both the upper and lower cylinder chambers. With a complete loss of pressure, the piston may be moved up or down in the cylinder without resistance.

After the outboard unit has been moved to the desired position, the valve should be rotated in the opposite direction (counterclockwise for Allen head valves, clockwise for slotted valves) to close the valve and lock the outboard against movement.

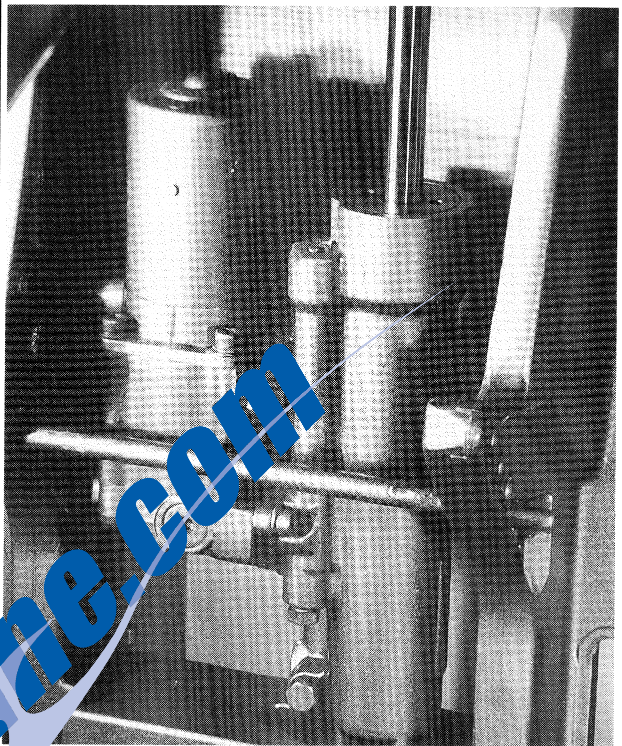

Fig. 2 Power tilt unit installed on a 40 hp outboard

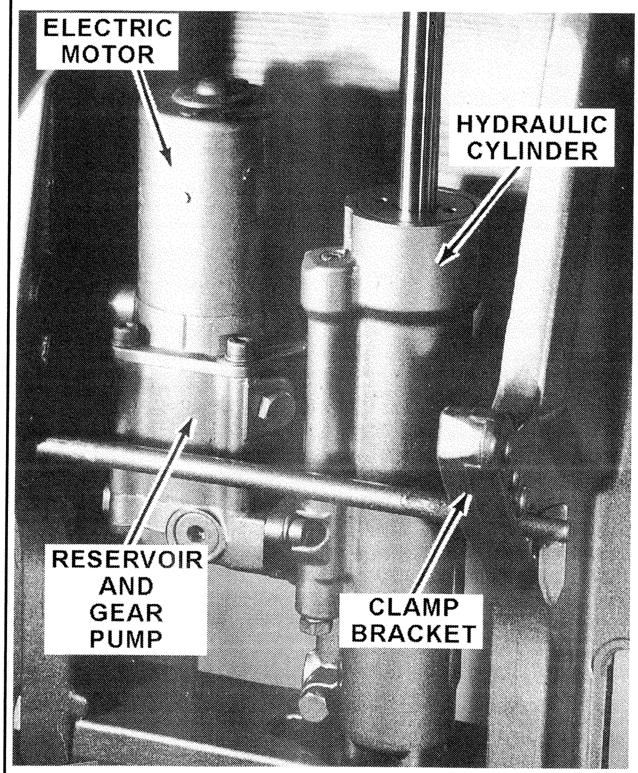

Fig. 3 Power tilt unit with major parts identified