7. If the belt, pulleys or tensioner (if applicable) are damaged, replace them as described under Powerhead.

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.

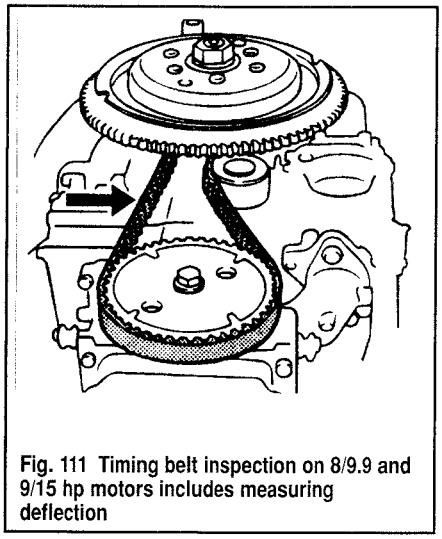

Fig. 111 Timing belt inspection on 8/9.9 and 9/15 hp motors includes measuring deflection

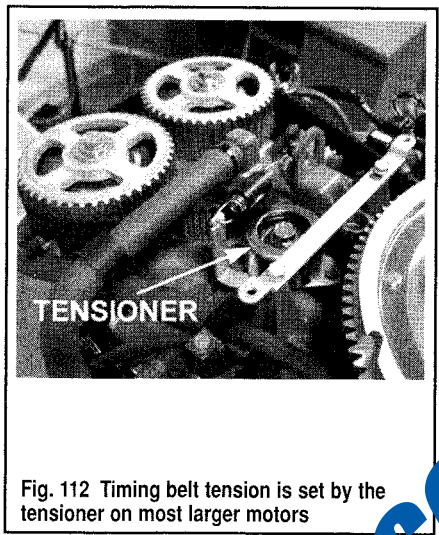

Fig. 112 Timing belt tension is set by the tensioner on most larger motors

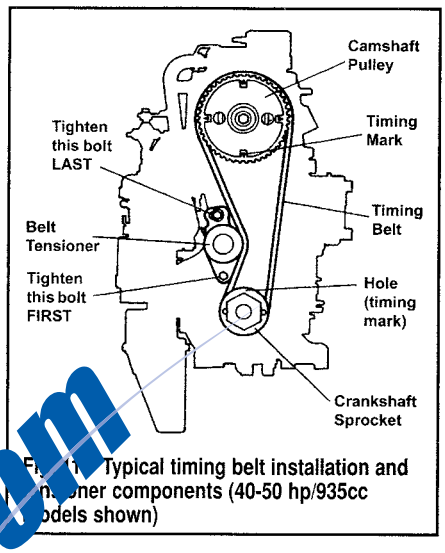

Fig. 113 Typical timing belt installation and tensioner components (40-50 hp/935cc models shown)

BOAT MAINTENANCE

Batteries

◆ See Figures 114 and 115

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 battery connections at the battery terminals or possibly an excessively dirty battery top can all contribute to an improperly functioning battery. So basic maintenance, first and foremost, involves keeping the battery cells full of electrolyte, properly charged and keeping the casing/connections clean and free of corrosion or debris.

If a battery charges and tests satisfactorily but fails to perform properly in service, one of three problems could be present:

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.

Fig. 114 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

3. A faulty component 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, Ignition and Electrical Systems section.

MAINTENANCE

EASY

◆ See Figures 115 thru 118

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.

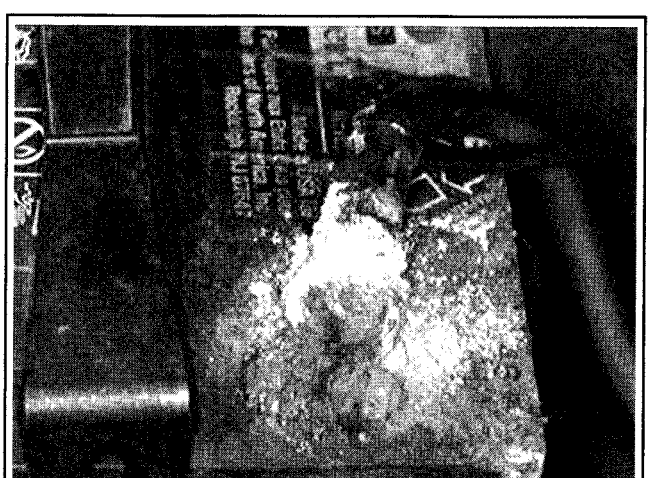

Fig. 115 Ignoring a battery (and corrosion) to this extent is asking for it to fail

Fiberglass Hull

INSPECTION AND CARE

EASY

◆ **See Figures 120, 121 and 122**

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 marina 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 use 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 [illegible] instead. Most marine vegetation can be removed [illegible] and a little bit of scrubbing using a rough sponge [illegible] 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. Fortunately 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

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 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 messy foods 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 handy for spill clean-ups. And keeping it handy will ensure you'll be more likely to wipe things down after a fun-filled outing.

Be sure to always test a cleaner on a hidden or unexposed area of your boat or vinyl before soaking things down with it. If it does not harm or fade the color of your finish, you're good to go.

When we trailer our boats, we sometimes find it more convenient to hit a spray-it-yourself car wash on the way home. This gives us a chance to spray down the boat hull, trailer and tow vehicle before we get home and turn our attention to engine flushing and wiping down/cleaning the interior.

If you're lucky enough to have snap out marine carpet, remove it and give it a good wash down once in a while. This allows you to spray down the deck as well. Hang the carpet to dry and reinstall once it is ready. If you've got permanently installed marine carpet, you can spray it down too, just make sure you can give it a chance to dry before putting the cover back on.

■ **For permanently installed marine carpet, try renting a rug steam-cleaner at least once a season and give it a good deep cleaning. We like to do it at the beginning and the end of each season!**

Fig. 120 The best way to care for a fiberglass hull is to wash it thoroughly

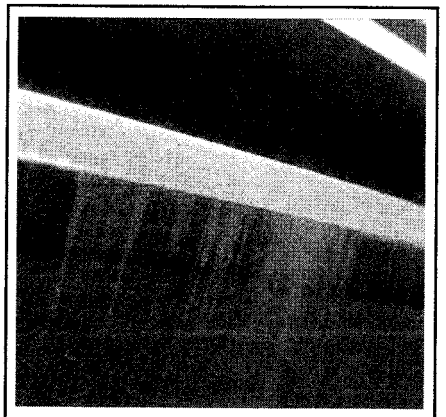

Fig. 121 If marine growth is a problem, apply a coating of anti-foul bottom paint

Fig. 122 Fiberglass, vinyl and rubber care products, like those from Meguiar's protect your boat

Driveshaft & Water Pump Base

1. Remove the Water Pump assembly as detailed in the Lubrication and Cooling System section.
2. Remove the bolt securing the shift shaft assembly to the top of the driveshaft and water pump base. Carefully pull upward to remove the shift shaft and bushing. Remove the shaft O-ring from the bore in the base.
3. Grasp the driveshaft, then lift up and remove the driveshaft and water pump base as an assembly from the lower unit housing. Remove and discard the gasket.
4. Reach inside the lower unit bearing carrier cavity and remove the pinion gear.

■ **Be alert for any shims behind the pinion gear. Save these shims, because they will be critical during the assembling work. Also be aware of any shims which may be installed on top of the driveshaft upper bearing.**

5. Slide the water pump base off the driveshaft bearing assembly.
6. Remove the seals, O-rings and gasket materials from the water pump base assembly. This base is normally equipped with a dual-lipped seal that is removed or installed from underneath the housing. Use a internal jawed seal puller to remove it from the bore in the underside of the base.

■ **If possible use the Mercury tool (#91-17351) for removal and installation of the driveshaft lower needle bearing. However, a suitable sized driver MAY be substituted.**

7. If the driveshaft lower needle bearing must be removed, double-check the installed height of the current bearing before disturbing it (as the replacement is driven in from the top to a certain depth using the specified tool, OR if the special tool is not available, using a suitable driver and the measurement). If the bearing is to be replaced, use a driver to tap it out of its bore and into the gearcase. Reach in and remove the bearing.

Forward Gear and Bearing

1. Tilt the lower unit. The forward gear will fall into your ha[illegible] fails to fall free, strike the open end of the lower unit on a blo[illegible] jar the gear free.
2. Although Mercury claims this gearcase, when inst[illegible] powerheads, is NOT adjustable when it comes to lash, w[illegible] any shim material (if any is found behind the forward [illegible] shim material is critical to obtaining the correc[illegible] The shim material will be located between the [illegible] the bearing.
3. The forward gear bearing is a one [illegible] and will not - or should not - just fall out of the lower unit ca[illegible] must be "pulled" from the lower unit only if it is unfit fo[illegible] vice.
4. Obtain a puller (#91-27[illegible] with a jaw expander attachment. Hook the jaws i[illegible] race and use the slide hammer to jar the race fr[illegible]

CLEANING & INSPECTI[illegible]

OEM ② MODERATE

◆ **See Figure 100**

1. Clean all water pump parts with solvent, and then dry them using compressed air.
2. Inspect the water pump cover and base for cracks and distortion. If possible always install a new water pump impeller while the lower unit is disassembled. A new impeller will insure extended satisfactory service. If the old impeller must be used, never install it in reverse to the original direction of rotation. Reverse installation could lead to premature impeller failure and subsequent powerhead damage.
3. Inspect the bearing surface of the propeller shaft.
4. Check the shaft surface of propeller shaft for pitting, scoring, grooving, imbedded particles, uneven wear and discoloration.
5. Check the straightness of the propeller shaft with a set of machinist V-blocks.
6. Clean the pinion gear and the propeller shaft with solvent and dry the components with compressed air.
7. Check the pinion gear and drive gear for abnormal wear.

ASSEMBLY

OEM ③ DIFFICULT

Sliding Clutch Assembly

1. Slide the spring down into the propeller shaft. Insert a narrow screwdriver into the slot and compress the spring until approximately 1/4 in. (12mm) is obtained between the top of the slot and the screwdriver.
2. Hold the spring compressed, and at the same time, guide the sliding clutch over the splines of the propeller shaft with the hole in the clutch aligned with the hole in the propeller shaft. The clutch may be installed either way, preferably the side with the least amount of wear should face the forward gear.
3. Insert the cross pin into the sliding clutch and through the space held open by the screwdriver.
4. Center the pin and then remove the screwdriver allowing the spring to pop back into place.
5. Install the guide into the [illegible] of the propeller shaft, followed by the cam follower. As both ends o[illegible] follower are equally rounded, it may be installed either way.

Forward Gear and B[illegible]

1. Obtain [illegible] special tools: Mandrel (#91-84532M) and Driver (#91-84529M). [illegible] the ball bearing assembly with the numbered side facing toward th[illegible] tool.

■ **If s[illegible] removed during disassembly, be sure to insert them [illegible] housing and bearing assembly,**

2. [illegible] oughly lubricate the bearing and gear with Mercury Super Duty [illegible] Lubricant, or equivalent. Insert any shim material saved during [illegible] bly (if present), onto the forward gear. The shim material should [illegible] the same amount of backlash between the pinion gear and the forward gear as before disassembly.
3. Insert the lubricated forward gear and shim material into the lower unit with the teeth of the gear facing outward.

Driveshaft Needle Bearing

The following steps apply only if the driveshaft needle bearing was removed.

1. Obtain the needle bearing removal and installation tool (#91-17351), or a suitable driver (however, if not using the factory tool you'll need the measurement taken during disassembly of how deep the needle bearing sits in the gearcase).
2. Slide the new needle bearing onto the end of the tool with the embossed numbers facing up.
3. Slide the tool and the bearing into the top of the driveshaft cavity. Take care to ensure the bearing does not tilt. Drive the bearing into place. The bearing will seat itself at the correct location when the head of the drive rod seats against the guide bushing. (When not using the factory tool you'll have to stop periodically and check installed depth. One trick is to mark the driver where it will be at the appropriate depth so you'll know as your tapping.)

■ **If the bearing position is not correct, both the upper and lower bearings will be reloaded by the water pump base and cause early bearing failure.**

Water Pump Base Plate

1. Obtain a driver or equivalent size socket and the appropriate driver handle.
2. Place the water pump plate on the workbench with the bottom side facing up.
3. Coat the seal lip with a good grade of water resistant lubricant.
4. Install the oil seal using the driver with the oil seal (spring side), lip facing up. Tap the seal down into the pump base until the seal bottoms in the bore.

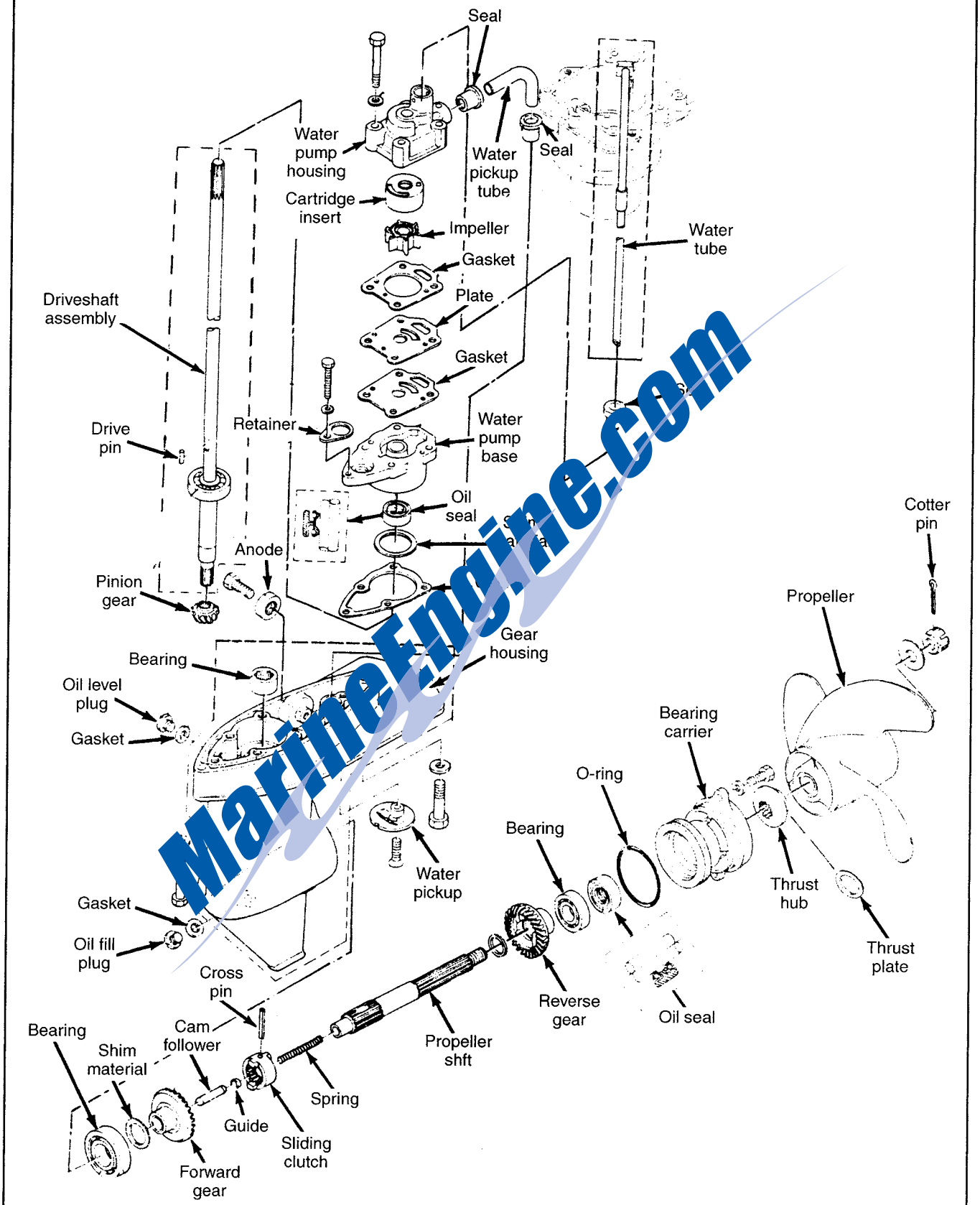

Fig. 100 Exploded view of the 4/5/6 hp lower units

Driveshaft, Pinion Gear and Water Pump Base

1. Slide any shim material saved during disassembly, over the driveshaft and down onto the bearing. If present, the shim material should give the same amount of backlash between the pinion gear and the other two gears as before disassembling.

2. Lubricate the seal in the pump base lightly with a good grade of water resistant lubricant. Slide the water pump base down the driveshaft and over the upper bearing.

■ **Mercury normally directs technicians to assemble the shifter shaft components AFTER the driveshaft and water pump base assembly has been installed to the gearcase, but from our experience we've found you can position the shifter before the assembly is installed. The choice is really yours.**

3. Place a new O-ring into the pump base opening for the shift shaft. Slide a new shift shaft bushing down onto the shift shaft.

4. Rotate the tapered side of the shift cam toward the pinion shaft.

5. Place a new water pump base gasket on top of the lower unit. Be sure the pins and bolt holes are correctly aligned.

6. Insert the pinion gear into the lower unit. Now, with the other hand, lower the driveshaft, shift shaft and pump base down into the lower unit with the shift cam going in first. Slowly rotate the driveshaft until the driveshaft splines index with the splines of the pinion gear.

7. Install the Water Pump assembly as detailed in the Lubrication and Cooling System section.

Bearing Carrier and Propeller Shaft

1. Place the bearing carrier on the workbench with the propeller end facing down.

2. Obtain a driver/installation tool (#91-83174M). Apply a coating of good grade water resistant lubricant to the lip of the seal, and then install the seal with the flat side down.

3. Place the bearing, numbered side up, into the bearing carrier. Obtain a driver (#91-84536M) and tap the bearing down into the bearing carrier.

4. Install a new O-ring around the bearing carrier. Apply a coating of water resistant lubricant to the O-ring.

■ **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.**

5. Slide the washer (if equipped), and reverse gear onto the end of the propeller shaft with the teeth of the gear facing away from the bearing carrier.

6. Slide the bearing carrier over the propeller shaft.

7. Apply a liberal amount of water resistant lubricant on the cam follower and insert the follower into the end of the propeller shaft.

8. Check to be sure the cam follower is on the end of the propeller shaft. This is a loose piece and easily forgotten. Insert the propeller shaft and bearing carrier into the lower unit until the end of the shaft indexes into the forward gear.

9. Using a soft head mallet, lightly tap around the circumference of the carrier until it is fully seated in place. Check to be sure the two bolt holes are aligned with the lower unit holes.

10. Install the two washers and bolts. Tighten the bolts alternately to 70 inch lbs. (8Nm).

SHIMMING

■ **The manufacturer gives no specific instructions for setting up the backlash on these units. As a matter of fact, Mercury claims this gearcase, when installed on these powerheads, is NOT adjustable when it comes to lash. However, IF any shim material found during disassembly was placed in its original locations, the backlash should be acceptable. The manufacturer states: "The amount of play between the gears is not critical, but no play is unacceptable." Therefore, if after the assembly work is complete, the gears are indeed locked, the unit must be disassembled and shim material removed from behind the forward or reverse gears, using a "trial and error" method. If the lower unit is allowed to operate without "some" backlash, very heavy wear on the three gears will take place almost immediately.**

Gearcase - 8-1[illegible] hp ([illegible]-Cylinder) Models

REMOVAL & INSTALLATION

② MODERATE

◆ **See Figures 101, 102 and 103**

1. For safety and to prevent accidental engine start, disconnect and ground the spark plug leads to the powerhead or for electric start models, and disconnect the battery cables.

2. If necessary for overhaul purposes, remove the Propeller, as detailed in the Maintenance and Tune-Up section.

3. If necessary for gearcase overhaul purposes, position a suitable clean container under the lower unit. Remove the FILL screw on the bottom of the lower unit, and then the VENT screw. The vent screw must be removed to allow air to enter the lower unit behind the lubricant. Allow the gear lubricant to drain into the container.

As the lubricant drains, catch some with your fingers from time-to-time and rub it between your thumb and finger to determine if there are any metal particles present. Examine the fill plug. A small magnet imbedded in the end of the plug will pickup any metal particles. If metal is detected in the lubricant, the unit must be completely disassembled, inspected, and the damaged parts replaced.

Check the color of the lubricant as it drains. A whitish or creamy color indicates the presence of water in the lubricant. Check the container for signs of water separation from the lubricant. The presence of any water in the lubricant is bad news. The unit must be completely disassembled; inspected; the cause of the problem determined; and then corrected.

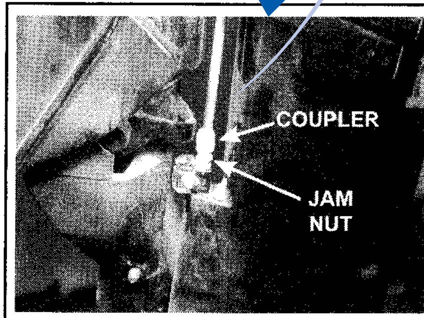

Fig. 101 Loosen the jam nut and coupler on the shift rod

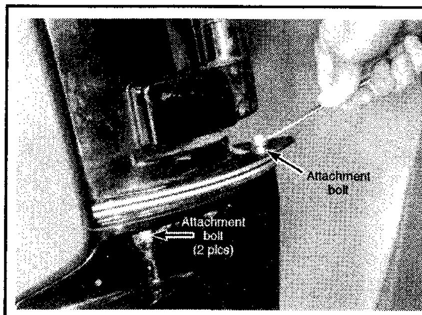

Fig. 102 Then unbolt the gearcase (non Bigfoot models shown)

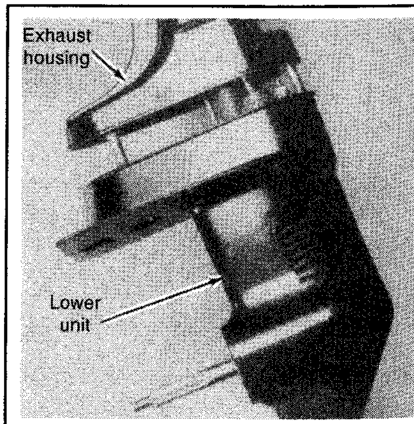

Fig. 103 Upon installation, guide the 2 shafts up into the housing as the lower unit is lifted into place

4. Rotate the outboard unit to the full UP position and engage the tilt lock pin.
5. Locate the shift shaft coupling on the exterior front of the motor, near the swivel housing (if the coupling is not readily visible, the motor MAY have a lower shroud which must first be removed for access).
6. Although the shift shaft coupling designs vary slightly, all should have a small jam nut located underneath a large coupler. Loosen the jam nut, then unthread the coupler to free the shift shaft.

■ **By measuring or marking the final coupler position on the threads you may save yourself some trouble when adjusting the shifter during installation.**

7. Remove the bolts and washers securing the lower unit to the exhaust housing. For non-Bigfoot models there should be 3 bolts, one threaded upward on each side and one threaded downward at the front of the gearcase. On Bigfoot models there should be 2 bolts threaded upward on either side of the gearcase.
8. Pull down on the lower unit gear housing and separate the lower unit from the exhaust housing.
9. Guide the shift rod and driveshaft out of the exhaust housing as the lower unit is removed.

To Install:

10. If not done already, swing the exhaust housing outward until the tilt lock lever can be actuated, and then engage the tilt lock.
11. Apply a liberal coating of 2-4-C Marine Lubricant With Teflon to the driveshaft splines (but NOT to the top of the shaft as it may prevent the shaft from fully seating in the crankshaft).
12. Position the driveshaft and shift shaft into the exhaust housing. Guide the two shafts up into the housing as the lower unit is lifted to meet the exhaust housing. Maintain the lower unit mating surface parallel with the exhaust housing mating surface.
13. As the lower unit approaches closer to the exhaust housing, align the water tube with the water pump tube guide.
14. If necessary rotate the flywheel slightly to permit the crankshaft splines to index with the driveshaft splines (alternately you COULD put the gearcase in gear and slowly turn the propeller shaft in the proper direction).
15. Secure the lower unit in place with the 3 or 4 attaching bolts. Tighten the bolts to 180 inch lbs./15 ft. lbs. (20 Nm) for non-Bigfoot models and 40 ft. lbs. (54 Nm) for Bigfoot models.
16. Bring the two halves of the shift shaft together and secure the coupler back into position to join them. Either match the old marks or adjust the shifter so that the gearcase properly engages and releases Forward and Reverse gears.
17. If the gearcase was drained refill it with recommended gear oil.
18. If the propeller was removed, install it.
19. Reconnect the spark plug wires and battery cables.

OVERHAUL

Propeller Shaft and Bearing Carrier

■ **For gearcase exploded views, please refer to Cleaning & Inspection in this section.**

⁂ CAUTION

The threads on the bearing carrier are LEFT HAND. Be sure to turn the bearing carrier tool in CLOCKWISE for removal and in the COUNTERCLOCKWISE for assembly.

1. For Bigfoot models, loosen and remove the 3 screws that secure the O-ring retainer plate and O-ring to the bearing carrier. Then, remove the plate and O-ring from the gear housing.
2. Obtain the appropriate bearing carrier tool (either #91-13664 for non-Bigfoot models or #91-93843—1 for Bigfoot models). Unscrew the bearing carrier by turning CLOCKWISE, then grasp the propeller shaft and pull to remove the bearing carrier and propeller shaft assembly from the lower unit gear housing.

■ **At this point the cam follower on the front (inner) end of the propeller shaft is free to slide out of the shaft. Recover the follower if it falls into the gearcase during removal.**

3. Remove and discard the O-ring on the bearing carrier.
4. Slide the reverse gear from the propeller shaft. Although Mercury claims most of these gearcases, when installed on these powerheads, are NOT adjustable when it comes to lash, watch for and save any shim material from the back side of the reverse gear. If present, the shim material is critical in obtaining the correct backlash during assembling.
5. On Bigfoot models, use a screwdriver or punch to carefully unwind the cross-pin retainer spring from the sliding clutch. To remove the cross-pin on thee models, insert the cam follower back into the end of the propeller shaft (with the flat end facing inward toward the cross-pin). Gently push the propeller shaft and cam follower against a flat surface then use a punch to push the cross-pin out of the sliding clutch.
6. For Non-Bigfoot models, use a punch to carefully tap the cross-pin out of the sliding clutch. Be sure to tap on the end of the cross-pin that is NOT grooved. Remove and discard the pin (which must be replaced during assembly).
7. When the cross pin is removed the sliding clutch should fall free of the propeller shaft. Examine the clutch on both ends for broken, chipped or rounded off teeth.
8. Check the cam follower for worn, flat or blunt end.
9. Remove the cam follower spring from inside the propeller shaft. Check the spring to be sure it is not broken or distorted.

⁂ WARNING

Perform the following work only if the seal/s have been damaged and are no longer fit for service. Removal of the seal/s destroys their sealing qualities. Therefore, the seal/s cannot be installed a second time. Be absolutely sure new seal/s are available before removing the seal/s.

Inspect the condition of the seals in the bearing carrier. If the seals appear to be damaged and replacement is required there are multiple methods available to remove them. In some cases, you can use a punch to drive the 2 seals from the rear (gearcase) side of the carrier, in other cases a seal remover or pry tool can be used to carefully extract them. If necessary a slide hammer and expanding jaw attachment will do the trick. However in all cases, it is usually easiest to proceed with the carrier carefully mounted in a soft-jawed vise for stability when removing the seal.

■ **Perform the following work only if the needle bearing is damaged and is no longer fit for further service. Removal of the bearing will distort it. Therefore, bearings with prior service cannot be installed a second time. Be absolutely sure a new part is available before removing the bearing. Unfortunately, the oil seals, good or bad, must be removed before the bearing can be driven out, and of course they must be replaced with new seals.**

11. Note the position of the bearing in relation to the carrier. Look for any embossed numbers or letters and which shoulder of the bearing is flush in the carrier. Remove the bearing using a punch and a hammer, or obtain a suitable sized socket and driver, and then drive the bearing from the carrier.

Driveshaft and Pinion Gear Removal

If not done already, remove the water pump assembly, as detailed in the Lubrication and Cooling section.

On non-Bigfoot models, pull upward on the driveshaft with one hand and with the other hand, reach into the lower unit cavity and grasp the pinion gear. As the driveshaft is removed the pinion gear and thrust washer will fall free in your hand. When removing the driveshaft watch for and save any shim material found on top of the pinion gear. Although Mercury claims most of these gearcases, when installed on these powerheads, are NOT adjustable when it comes to lash, if present, this shim material is critical to obtain the correct backlash during installation.

On Bigfoot models, clamp the driveshaft in a vise equipped with soft jaws and remove the bolt on the end of the driveshaft securing the pinion gear to the shaft. Pull the driveshaft out of the lower unit housing. Remove the pinion gear and tapered roller bearing.

YAMAHA 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.

Most 40 hp and larger motors (as well as a few smaller models such as high-thrust 15 hp 4-strokes and a few other 25 or 30 hp motors) use some form of a Power Trim/Tilt (PTT) system. 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 all inline 4-strokes, except the 115 and 150 hp motors. The large motor PTT system (with single tilt rod and dual trim rods) is normally on all 115 hp and larger Yamaha 4-strokes (including the V6 Mercury/Mariner 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 include[d] as applicable.

■ If you haven't figured it [out yet, the] 3.3L V6 4-stroke Mercury/Mariner motor IS a Yamaha, lock, [stock and] barrel. For this reason the trim & tilt system is covered u[nder the] Motor Power Trim/Tilt System (Yamaha), earlier in this sectio[n. The] Mercury/Mariner motors utilize a Mercury trim & [tilt] system and therefore are covered in separate sections.

YAMAHA 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[-]sized commercial outboards or motors designed for high-[...] low price (lacking extra features such as electric start) for re[...] simplicity and low expense of production cost.

The shock absorber contains a high pressure gas [...] upper portion of the cylinder bore above the pis[ton] contains a down relief valve and an absorber re[lief] assembly, the lower cylinder bore contains a[n] [...] lower

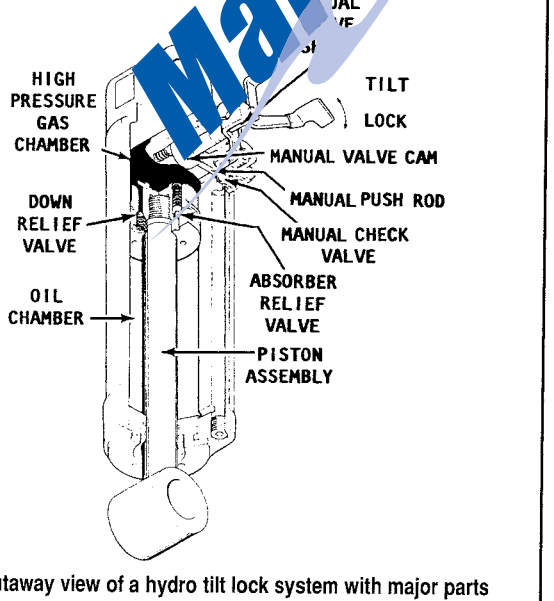

Fig. 1 Cutaway view of a hydro tilt lock system with major parts identified

[...] connected to the upper chamber above the piston by a hydraulic [...] manual check valve. This check valve is located about half way [...] hydraulic line.

[...] manual check valve is activated by the tilt lever, when the lever is [...] in the lock (down) position to the tilt (up) position. The check valve [...] cam lobes and pushes the manual check valve push rod against the check [...] This action opens the check valve and allows hydraulic fluid to flow [...] 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. 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.

■ 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.

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.

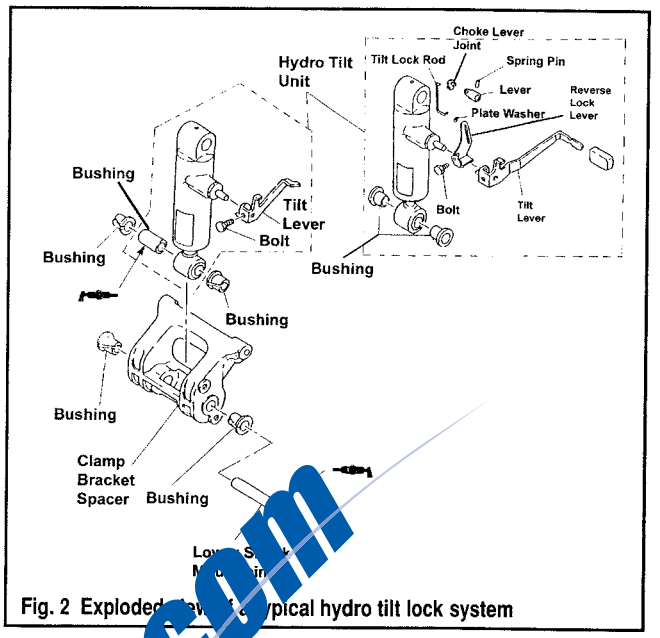

Fig. 2 Exploded view of a typical hydro tilt lock system

YAMAHA 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 all inline 4-strokes, except the 115 hp and 150 hp motors.**

The PTT system found on most medium sized Yamaha outboa incorporates a single hydraulic cylinder and piston. Although on the o units this system was used only for tilt, on most modern Yamahas allows for some trim adjustment of the motor once lowered position by the system. The system consists of an electric top of a gear driven hydraulic pump, a small fluid reser integral part of the pump) and a single hydraulic to move the outboard unit up or down, as required.

■ **The positioning of the tilt cylinder and pu are reversed on some models. That is to say the pum found on either side (port or starboard) or the hydra**

Unlike other power trim a ra circuits are routed inside the unit.

■ **Three safety relief valves ar corporated 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 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 up and the outboard unit rises. As the piston continues to extend, oil from the upper chamber is routed back through the suction side of the pump through the piston reaches the top of its stroke.

DOWN OPERATION

When the down portion of the tilt switch on the remote control handle is depressed, the electric motor rotates in the opposite direction (therefore normally 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, lowering the outboard. The fluid under pressure

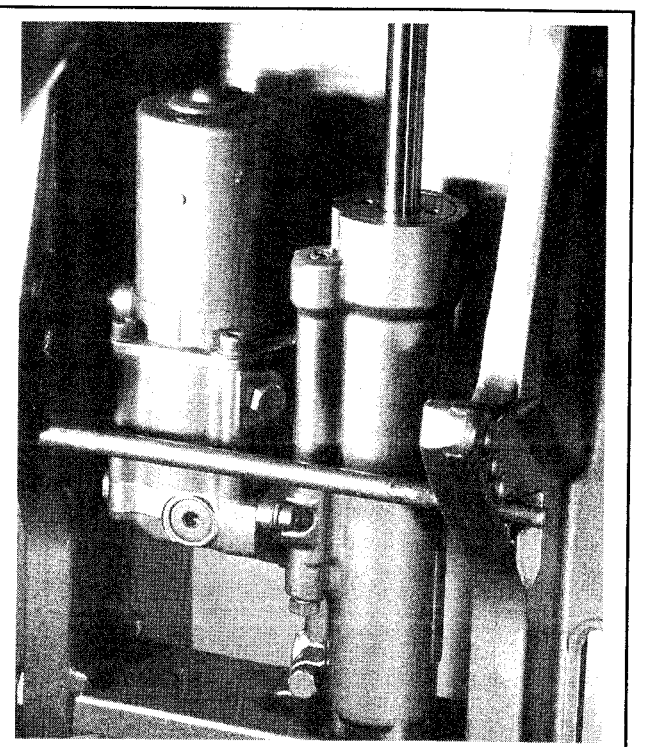

Fig. 3 Typical Yamaha single tilt ram PTT unit