mercruiser

SERVICE MANUAL

Number 4

Stern Drive Units

MCM 120 - 260

Sections 1 thru 7

Printed in U.S.A.

90-86137 286

MODELS COVERED IN THIS MANUAL

TRANSOM ASSEMBLIES	
Model	**Serial Number**
MCM 120/140/165/ 470/485/898/228/260	4891650 - 6216686

MC 120 - 260 STERN DRIVE UNITS	
Ratio	**Serial Number**
1.98:1	4893635 - 6237860
1.84:1	4893835 - 6225576
1.65:1	4890460 - 6268064
1.50:1	4898730 - 6229157

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I-DRIVE
SERVICE MANUAL
OUTLINE

NOTICE TO USERS OF THIS MANUAL

This service manual has been written and published by the service department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. (Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

REPLACEMENT PARTS

⚠WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

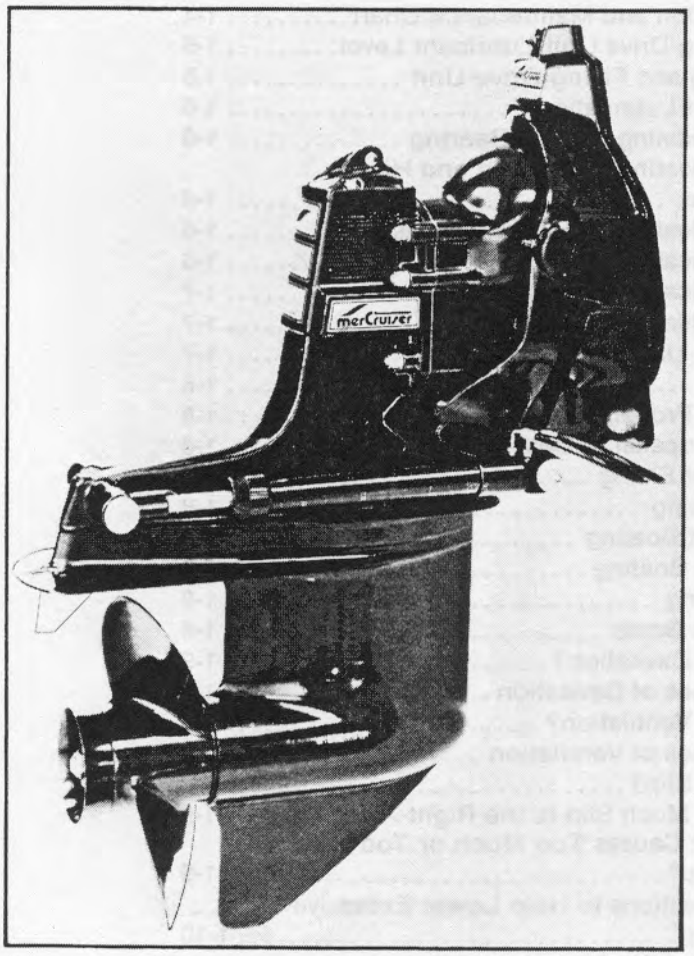
Failure to use recommended Quicksilver service replacement parts can result in poor performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts will void the warranty on those parts which are damaged as a result of the use of other than recommended parts.

SECTION 1

I-DRIVE

General Information



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IMPORTANT SAFETY NOTIFICATION

Correct service and repair is important for the safe, efficient operation of all mechanical products. The service procedures, that are recommended and described in this service manual, are effective methods for performing service operations.

Some repair procedures require special tools which should be used where specified and as recommended. Pay special attention to the "Safety Warnings" and/or "Cautions" (printed in bold type in this manual) which relate to a specific service procedure that can damage the product, render it unsafe or cause personal injury. Remember, however, that these "Safety Warnings" and/or "Cautions" are not all-inclusive.

We could not possibly know of and advise the service trade of all conceivable procedures in which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by us, first must completely satisfy oneself that neither one's nor the product's safety will be endangered by the service procedure selected.

ELECTRICAL REPLACEMENT PARTS

SAFETY WARNING: Electrical system components on MerCruiser Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical systems, it is extremely important that all components are properly installed and tightened. If not, any electrical component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

NOTICE

The following special information will alert you to possible dangers and to important information in this manual. Observe them carefully. "Safety Warnings" and "Cautions" (outlined in a border) alone do not eliminate the dangers that they signal. Your close attention to implement them, plus "common sense" operation are major accident prevention measures.

SAFETY WARNING	**Failure to follow a "Safety Warning" may result in bodily injury.**
CAUTION	**Non-compliance with "Caution" instructions may result in failure or damage to the product and/or equipment.**
IMPORTANT	**Is used to indicate required service procedure.**

NOTES: Are used to indicate preferred service procedures and/or exceptions.

GENERAL INFORMATION

Directional Reference

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this service manual, all directional reference are given as they appear when viewing boat from stern, looking toward bow. (Figure 1)

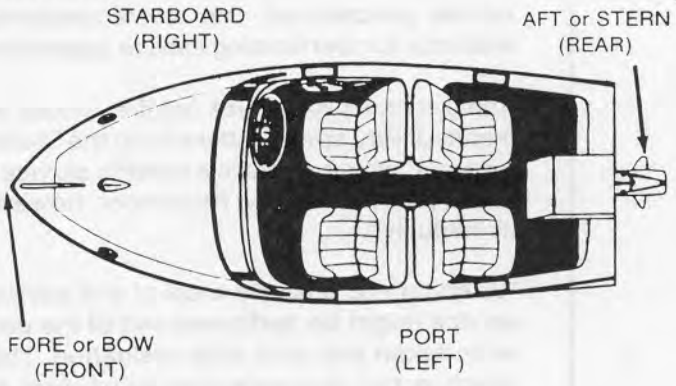


Figure 1. Directional Reference

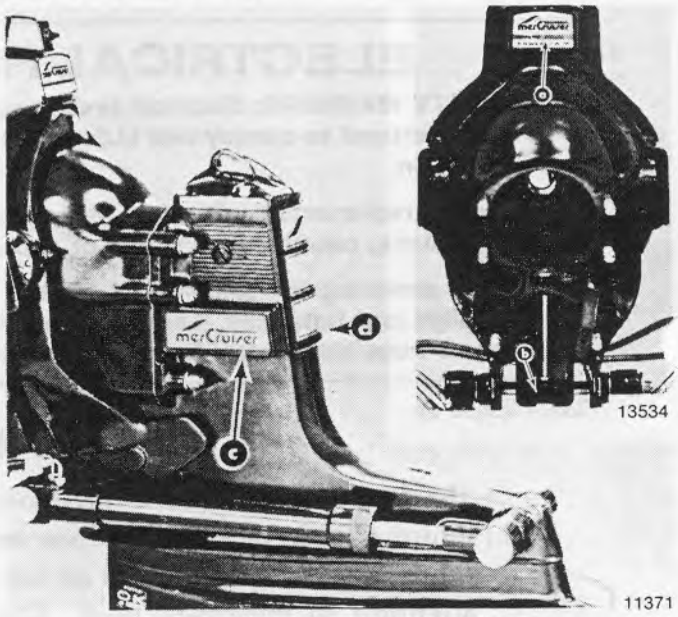
Serial Number Locations

IMPORTANT: Serial numbers are the manufacturer's key to numerous engineering details applicable to the unit. When ordering parts, accessories and tools, or when corresponding with the manufacturer or dealer in regard to service matters, always specify stern drive and/or transom assembly serial number.

The transom assembly serial number location is permanently stamped on the bell housing gasket surface. For quick reference, the serial number also will be located on gimbal housing decal. (Figure 2)

The stern drive unit serial number is stamped on the drive shaft housing under MerCruiser decal on left side of housing. Serial number also is on the decal on rear of drive shaft housing. (Figure 2)

Both transom assembly and stern drive unit serial numbers are stamped in a pressure sensitive decal (located on side of engine rocker arm cover).



a - Decal Location on Gimbal Housing
b - Bell Housing Gasket Surface
c - Serial Number under Side Decal
d - Serial Number on Rear Decal

Figure 2. Transom Assembly (Top Illustration) and Stern Drive Unit Serial Number Locations

STEERING and SHIFT CABLE REQUIREMENTS

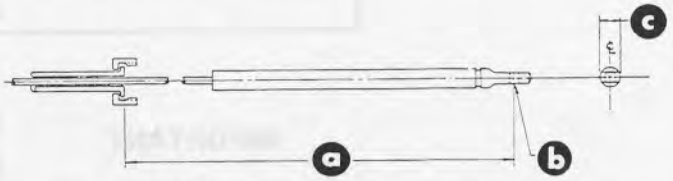
STEERING CABLE REQUIREMENT

CAUTION: If a steering cable with the wrong end dimensions is installed on a MerCruiser Power Steering System, severe damage to the steering system and the Power Steering pump will occur.

Total travel should be 8½" ± ½" (21.6cm + 12.7mm) minimum travel of 4" (10.2cm) each side of mid-travel position; maximum travel of 4½" (11.4cm) each side of mid-travel position. (Figure 3)

SHIFT CABLE REQUIREMENT

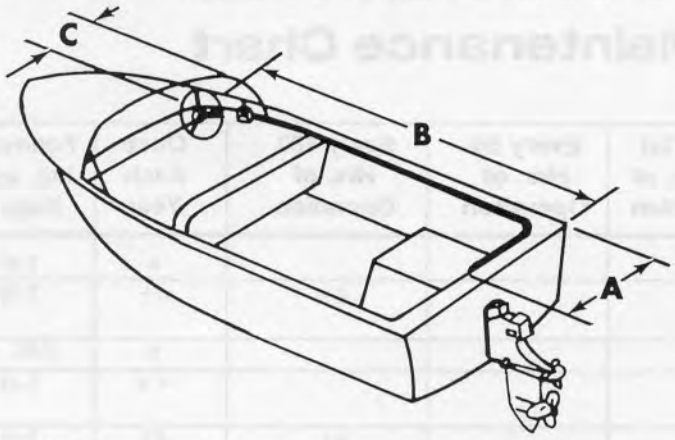
Total travel of remote control shift cable, that is used on MerCruiser I Stern Drives, should be 3¼" (83mm), 1⅝" (41.3mm) on each side of mid-travel point. If these dimensions are not complied with, the stern drive will not shift properly into both forward and reverse.



a - 16-7/8" (42.9cm) Mid-Travel Position
b - .385" ± .005" (9.8mm ± 0.13mm) Diameter Drill Thru
c - 5/8" (15.9mm) Maximum Diameter

Figure 3. Steering Cable Travel

DETERMINING STEERING CABLE LENGTH



NOTE: The following boat measurements are to be taken on the inside of boat.

1. Add boat measurements A-B-C, where

   A = Distance in inches (or centimeters) from the center of engine to the starboard side of boat.
   B = Distance (in inches) from transom to dashboard.
   C = Distance (in inches) from center of steering wheel (helm) to starboard side of boat.

   NOTE: For port (left) side cable routing, use the same measuring procedure, except take measurements "A" and "C" from opposite side of boat.

2. Subtract 6" for In-Line models with Power Steering. Add 6" for In-Line models without Power Steering and V-8 models.
3. Divide above measurement by 12".
4. This is the cable length in feet for ordering. After cable length in feet has been determined, order as follows:

   Example:
   Measured 15' - order 14'6" cable (C-76___A14)
   Measured 15' 1" - order 15' 6" cable (C-76___A15)

   NOTE: This cable measuring procedure allows for an 8" minimum radius at 2 cable bending points. On boats with unusual cable routing or considerable freeboard drop, it may be necessary to adjust cable length slightly.

Metric Scale: 1" (inch) = 2.54cm; 1' (ft.) = 30.5cm

DETERMINING SHIFT CABLE LENGTH

IMPORTANT: When selecting and installing shift and throttle cables (in the following steps), be sure to adhere to the following:

- Choose correct length cable. (A cable of improper length will cause hard shift and throttle operation.)
- Cable should follow the shortest route possible to the engine.
- Cable should be allowed to protrude down or out from remote control and should not be fastened to boat for at least 3' (91.4cm) from control. (This will prevent placing a load on cables when operating control.)
- Bends should be kept to a minimum and should not form less than a 12" (30.5cm) radius.
- Use only Quicksilver cables with Quicksilver Remote Controls.

Determine correct length shift and throttle cable (C-34555A ____) required, as follows:

1. Measure the route (in inches or centimeters) that each cable will follow. Measure from cable anchor point on control to shift lever fixed stud (for right-hand cable installation) or to anchor stud on shift plate (for left-hand cable installation). Be sure to allow sufficient cable length to allow cables to protrude straight down or out from control and to make gradual bends with not less than a 12" (30.5cm) radius.
2. Add 6" (15.2cm) to this measurement.
3. If measurement was taken in centimeters, divide total by 2.54 to convert total to inches. Round total off to nearest inch.
4. Divide total by 12 to obtain cable length in feet.
5. Select correct length cable. If measurement obtained contains a fraction of a foot, always select next highest length cable. Use the following examples if necessary.

   Measured 15' 0" - Use 15' cable (C-34555A15)
   Measured 15' 1" - Use 16' cable (C-34555A16)

LUBRICATION and MAINTENANCE

Lubrication and Maintenance Chart

Check the Following	After 1st 20 Hrs. of Operation	Every 50 Hrs. of Operation	Every 100 Hrs. of Operation	Once Each Year	Following, on Page
Bellows	Δ			•	1-6
Drive Unit Swivel Shaft and Swivel Pin Lubricate	4+		4+	4+	1-5
Drive Unit to Engine Alignment, Check				•	Sec. 3
Exterior, Clean and Check Drive Unit Painted Surface				+•	1-6
Gimbal Bearing, Lubricate	4+		4+	4+	1-5
Hinge Pins, Lubricate	4Δ	4Δ		4Δ	1-5
Power Steering Control Valve (if Equipped), Lubricate	4Δ	4Δ		4Δ	1-6
Power Steering Fluid Level (if Equipped), Check	2	2		2	1-6
Power Steering Extension Rod (on V-8's Only), Lubricate	7Δ	7Δ		7Δ	1-6
Power Trim Pump Oil Level, Check	6		6	6	1-6
Propeller, Check for Possible Damage §	•	•		•	1-6
Propeller Shaft Splines, Lubricate				5	1-6
Shift Control, Lubricate				4	
Shift Linkage, Lubricate				4	1-6
Steering Cable Exposed Portion, Lubricate		7		7	1-5
Steering Cable, Lubricate	4+	4Δ		4Δ	1-5
Steering Linkage, Lubricate	1+	1+			1-5
Steering Head, Lubricate				4	1-5
Steering System for Excessive Wear or Looseness			•	•	1-5
Stern Drive Oil Level, Check	3	3			1-4
Stern Drive Unit Oil, Change			3	3	1-4
Trim Cylinder Fasteners, Tighten	• +		•		1-6
Trim Tab and Anodic Plate, Check Condition		Every 30 days +			1-6
U-Joint Coupling Splines, Lubricate			4	4	1-5
U-Joint Cross Bearings, Lubricate			4	4	1-5
Water Pump Impeller, Check (Necessary to Separate Drive Shaft Hsg. from Gear Hsg.)				8	1-6

1 - Use Formula 4 Quicksilver Oil
2 - Use ATF Type "F" or Dexron
3 - Use Quicksilver Super-Duty Lubricant
4 - Use Universal Joint Lubricant
5 - Use Perfect Seal
6 - SAE 10W-30 or SAE 10W-40
7 - Use Special Lubricant 101
8 - On "V-8" models with Closed Cooling, inspect impeller inside water pump mounted on engine (refer to "Engine Installation Manual" by model).

+ If unit is operated in salt water, requires more frequent attention.
Δ Every 60 days in fresh water; every 30 days in salt water.
§ Check that nut is secure.

NOTE: Complete list of maintenance is not applicable to all models. The above chart is based on average operating conditions. Under severe operating conditions, continuous heavy duty or high speed operation, the inspection and maintenance intervals should be shortened.

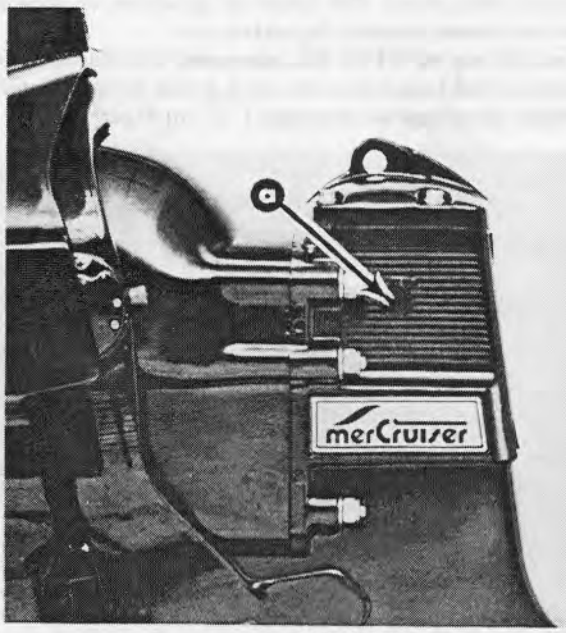
Checking Drive Unit Lubricant Level

SAFETY WARNING: DO NOT remove "Vent" or "Fill" plug when drive is hot from operation. Expanded hot gear lubricant would be released thru hole. Check only when stern drive unit is cool.

CAUTION: DO NOT use regular automotive grease in stern drive unit.

CAUTION: If lubricant appears milky brown, or if large amounts of lubricant must be added to fill stern drive unit, a leak is indicated, and drive unit should be checked promptly.

1. Remove "Vent" plug and gasket from side of drive shaft housing. (Figure 4) Lubricant must be even with bottom edge of threaded "Vent" hole when unit is level.
2. If level is low, add Super-Duty Gear Lubricant thru "Vent" hole. If more than 2 ounces (59ml) of lubricant are added to drive unit, then a leak is indicated, and it will be necessary to check the drive unit to determine the cause. After cause has been found, and lubricant level is more than 2 ounces low, fill drive unit according to "Draining and Filling Drive Unit" instructions, following.
3. After bringing lubricant level up to bottom of "Vent" hole, install "Vent" screw with new seal gasket.



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a - Vent Screw

Figure 4. Vent Screw Location

Draining and Filling Drive Unit

SAFETY WARNING: DO NOT remove "Vent" or "Fill" plug when drive unit is hot from operation. Expanded hot gear lubricant would be released thru plug hole. Check only when stern drive is cool.

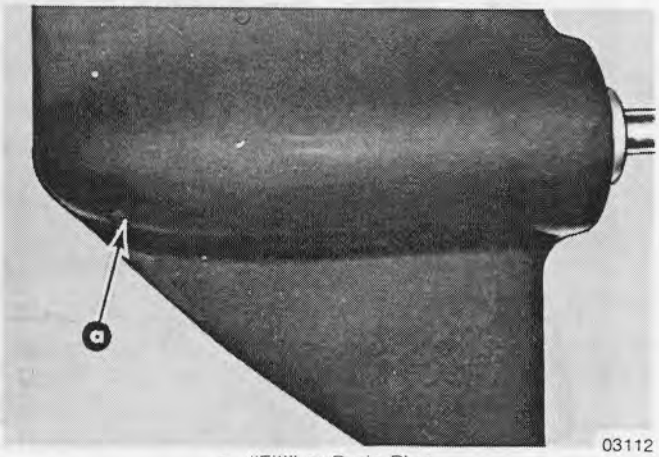
CAUTION: DO NOT use regular automotive grease in stern drive unit.

CAUTION: If more than one teaspoonful of water drains from the filler hole, or if lubricant appears milky brown, or if large amounts of lubricant must be added to fill the stern drive unit, it should be checked promptly to determine problem.

Use only Quicksilver Super-Duty Gear Lubricant. Lubricant should be changed once every 100 hours of operation or once each season. DO NOT attempt to fill drive unit with lubricant thru "Vent" hole, or air pockets will form and eventually cause drive unit failure.

1. Drain stern drive unit by removing drain plug from lower end of gear housing on left side (Figure 5) and "Vent" plug on upper drive shaft housing. (Figure 4)
2. To refill drive unit, insert lubricant tube into drain hole in lower unit (Figure 5) and inject lubricant until air-free excess fluid starts to flow out of "Vent" hole in upper drive shaft housing. (Figure 4)
3. Without removing lubricant tube from gear housing, install "Vent" screw, being sure that gasket is in position on screw and in good condition.
4. Remove lubricant tube, then quickly install "Fill" screw, being sure that gasket is in position on screw and in good condition.

NOTE: After filling a stern drive unit, that has been drained of all lubricants, the lubricant level must be rechecked after a "run-in" period of about one minute. This procedure assures that any air pockets, which may have developed during filling, will be eliminated. Additional lubricant may have to be added after rechecking to "top off" the oil level.



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a - "Fill" or Drain Plug

Figure 5. Filler or Drain Plug Location

Points of Lubrication

LUBRICATING GIMBAL BEARING

Lubricate once every 100 hours of operation or once each season or whenever servicing drive unit.

1. Gimbal bearing MUST BE lubricated with Universal Joint Grease and Lubricant Gun thru grease fitting located on right side of gimbal housing. ("C" in Figure 6)

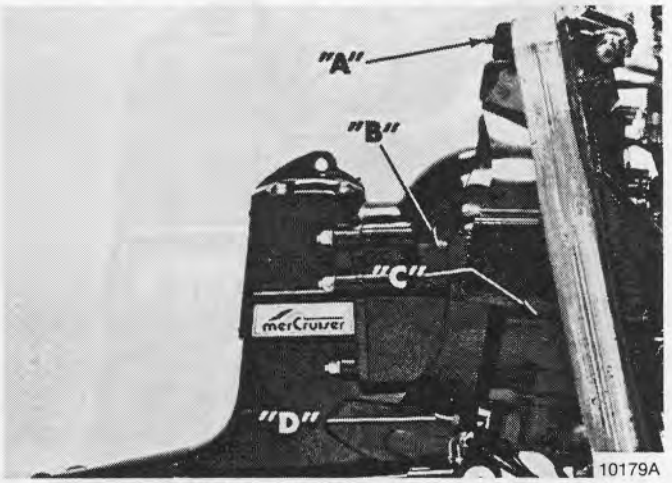
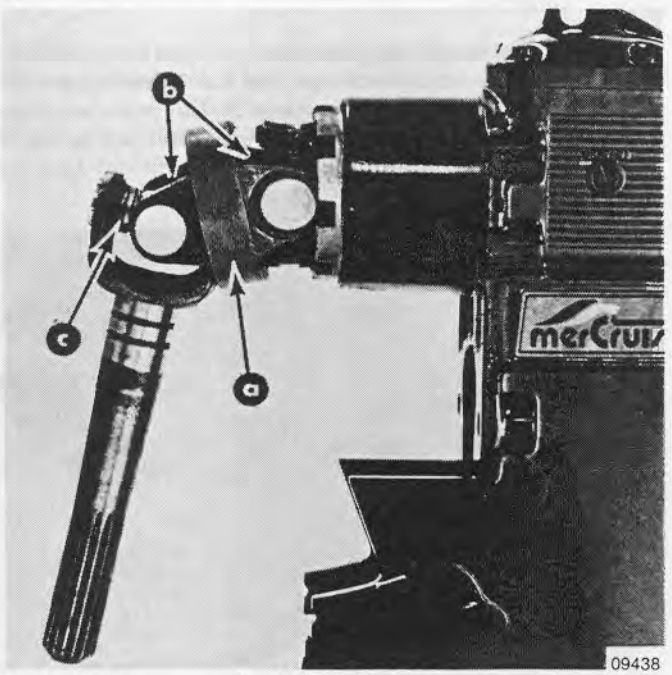


Figure 6. Points of Lubrication, Outside Boat

2. Remove protective cap and insert approximately one ounce (30ml) with lubricant gun.
3. Reinstall protective cap to grease fitting after lubricating gimbal bearing.

LUBRICATING SWIVEL PIN and HINGE PINS

Apply Universal Joint Grease to gimbal housing upper ("A") and lower ("D") swivel pins and to hinge pins ("B"). (Figure 6)



a - U-Joints b - Grease Fittings c - Seals (8)

Figure 7. Lubricating U-Joint Bearings

LUBRICATING U-JOINT BEARINGS

Lubricate stern drive universal joint bearings (and splines) at specified intervals with Universal Joint Lubricant.

1. Remove drive unit from gimbal housing (refer to "Drive Shaft Housing - Removal"; see "Index").
2. Inject Universal Joint Lubricant into both grease fittings (Figure 7) until new grease appears around seals.
3. Apply Universal Joint Lubricant to shaft splines before reinstalling drive unit.

LUBRICATING STEERING SYSTEM

1. Lubricate Ride-Guide Steering cable through grease fitting ("A" in Figure 8, 9 or 10) on transom end of cable with Universal Joint Grease only when cable is fully retracted. If cable is lubricated while extended, hydraulic lock could occur.

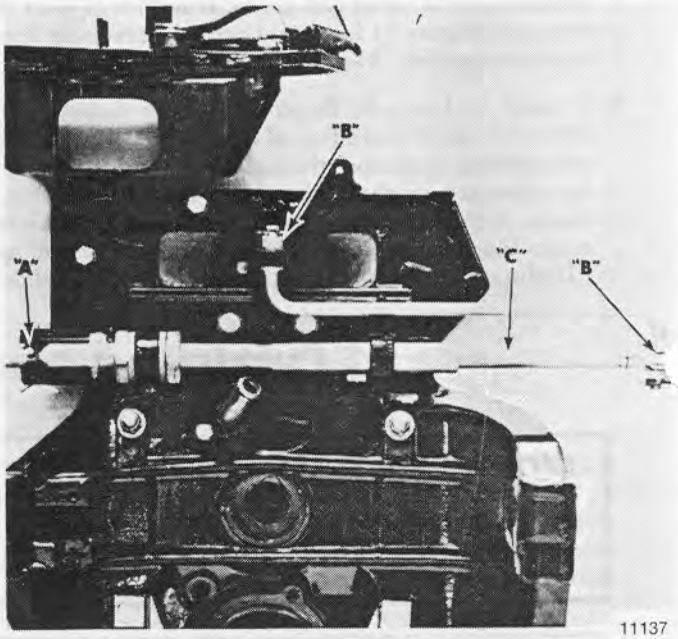


Figure 8. Lubrication Points Inside of Boat (In-Line with Manual Steering)

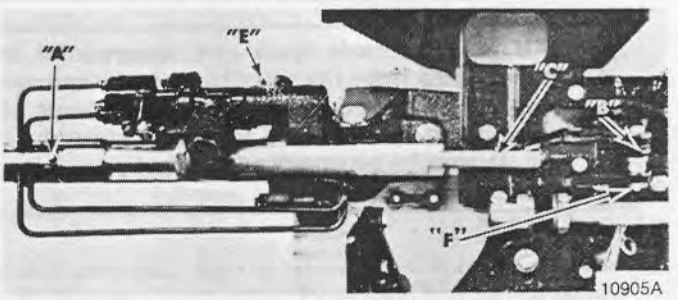


Figure 9. Lubrication Points Inside Boat (In-Line with Power Steering)

NOTE: Ride-Guide Steering cable is lubricated at the factory and requires no additional lubrication at initial installation.

2. Lubricate all pivot points ["B" and "D" (if equipped) with 20W engine oil] at intervals listed in "Lubrication and Maintenance Chart", preceding.
3. With steering cable fully extended, coat exposed portion of steering cable "C" with Special Lubricant 101 at intervals

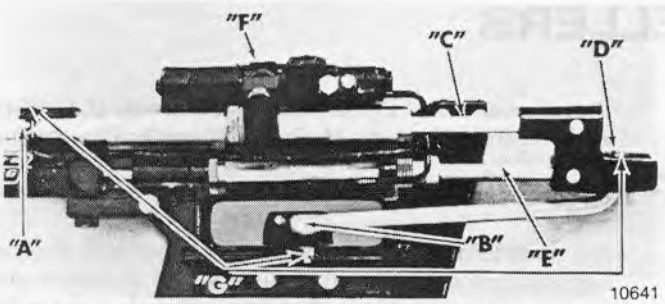


Figure 10. Lubrication Points Inside Boat ("V-8's")

listed under "Lubrication and Maintenance Chart", preceding.

4. Lubricate Power Steering control valve ("E" in Figure 9) or ("F" in Figure 10) thru grease fitting with Universal Joint Grease (until grease appears around rubber boot).
5. On "V-8" installations, lubricate extension rod ("E" in Fig. 10) when fully extended with Special Lubricant 101.
6. Check all connections for loose fasteners and/or wear while performing lubrication.

LUBRICATING PROPELLER SHAFT

SAFETY WARNING: To prevent accidental starting of engine while removing and installing propeller, be sure that the remote control is in neutral and that the ignition key is removed from switch.

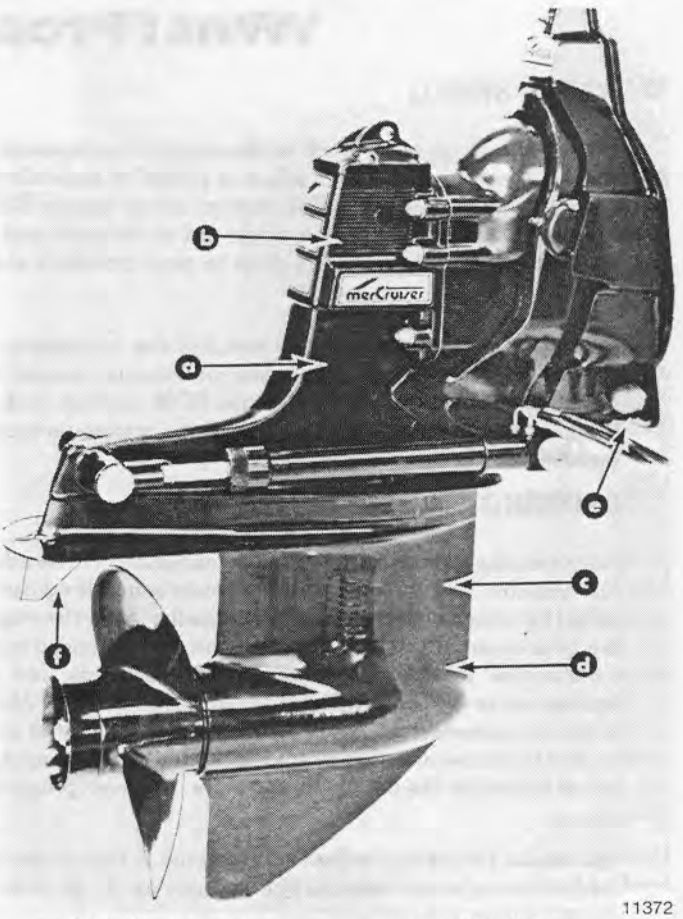
Periodically lubricate propeller shaft with Perfect Seal to prevent propeller from seizing to shaft. Remove propeller, coat propeller shaft with Perfect Seal and install propeller, as explained under "Stern Drive Unit - Installing Gear Housing" (see Service Manual "Outline" page in front of book).

LUBRICATING SHIFT LINKAGE

1. Remove nuts, washers and cotter pin which secure shift cables to shift bracket, then remove cables without disturbing adjustments.
2. Lubricate studs and recess with Universal Joint Lubricant and reinstall cables. Be sure to tighten nuts, then back off ½-turn.

STERN DRIVE UNIT STORAGE

1. Drain stern drive lubricant. (Refer to "Draining and Filling Drive Unit", preceding.)
2. Separate gear housing from drive shaft housing and check condition of water pump impeller. Replace if impeller is worn, hardened or set. Refer to "Drive Unit" Section 3.
3. Reassemble drive unit, then remove drive unit from gimbal housing and check drive unit to engine alignment. (Refer to "Drive Unit" Section 3.)
4. Lubricate universal joint bearings (2 grease fittings) with Universal Joint Lubricant.
5. Lubricate universal joint splined shaft and engine coupling with Universal Joint Lubricant.
6. Check condition of bellows and clamps.
7. Install drive unit back to gimbal housing and fill drive unit with Super-Duty Gear Lubricant. (Refer to "Draining and Filling Drive Unit", preceding.)
8. Perform all procedures according to instructions under "Points of Lubrication", preceding.
9. Check Power Steering fluid level, if applicable.
10. Check Power Trim pump oil level.
11. Check condition of drive unit painted surface. Clean and paint metal surfaces that have become exposed. Spray stern drive exterior with Corrosion and Rust Preventive.
12. Open water drain holes (one located in gear housing and 2 in drive shaft housing), using a piece of wire to check that they are open. (Figure 11)
13. Check all fasteners for tightness.
14. Check complete steering system for excessive wear or looseness.
15. Check condition of trim tab and anodic bolt heads. (Figure 11) Replace if necessary.
16. Store unit in full "down" position. The universal joint bellows may develop a "set", if unit is stored in a tilted-up position, and result in bellows failure when unit is returned to service. Drive unit may be stored OFF boat and installed prior to service.



a - Drive Shaft Housing
b - Water Drain (One Each Side)
c - Gear Housing
d - Water Drain
e - Anodic Bolt Heads
f - Trim Tab

Figure 11. Water Drain Locations

PROPELLERS

For complete information on propeller theory and boat performance read "What You Should Know About Quicksilver Propellers and Boat Performance Information" (C-90-86144), available from Mercury Marine Publications Department.

Correct Propeller

Diameter and pitch, the 2 most important propeller characteristics, are measured in inches. Propeller pitch usually is stamped on the hub. If diameter also is stamped on the propeller, this number would be listed first.

Example: 15-1/4 x 21 = Diameter x Pitch in Inches

Incorrectly propped, a boat can suffer reduced top speed, poor acceleration and poor fuel economy. It even can shorten engine and/or drive life by either overloading the engine or allowing excessive RPM. Correct propellers are found in prepared charts, catalogs or Boat House Bulletins. Here, the testing has been done for you, and correct propeller sizes are listed for typical boats of various weights and styles.

Check for the correct propeller by test running the boat, using an accurate tachometer. Basically, the correct propeller is one that turns RPM within the range recommended by the engine manufacturer at wide-open-throttle (WOT). If the tachometer reads too high, use a propeller of greater pitch. If the tachometer reads too low, use a propeller of lower pitch.

Under certain operating conditions, such as overloading of a boat or pulling water skiers, it may be necessary to reduce propeller pitch to again allow the engine to turn up to its recommended RPM. By doing this, better acceleration and overall performance will result.

CAUTION: If, at any time, operating conditions change to where a boat is no longer overloaded or water skiers are no longer pulled, the original propeller should be reinstalled to prevent engine damage caused by excessive RPM.

What Propeller(s) Is Best?

WATER SKIING

To take advantage of as much of the engine's horsepower as possible for pulling up water skiers, a propeller with a lower pitch should be selected. With higher initial engine RPM, more thrust is developed to pop skiers out of the water and get the boat on plane faster. Each drop in pitch provides about 10% more thrust.

It's important that the operator watches the tachometer to make sure that engine RPM does not continuously exceed the maximum recommended full throttle RPM without a skier. Propping the engine at or a little above the maximum recommended limit is called "under-propping".

CRUISING

Since cruising does not require top acceleration, a little added fuel economy, less engine wear and a lower sound level can be gained by selecting a higher pitched propeller. Here the engine can be propped out at the low end of the recommended maximum engine RPM range. Most engines burn less fuel per horsepower at this lower RPM end than at the higher RPM end of the recommended range. Here, again, the tachometer must be checked to be sure that with a maximum load the engine is not pulled below the bottom of the range, or "over-propping" occurs.

One reason for getting better fuel economy is that propellers tend to have a slight increase in efficiency as the pitch is increased within a given prop line.

SPORT BOATING

When a compromise between wide-open-throttle speed and acceleration is needed, propping out in the upper half of the recommended RPM range with a light load is suggested.

This should be the best prop, unless planing off with a heavy load is unsatisfactory, in which case dropping to the next lower pitch should solve the problem. But, again, it is important to watch top RPM.

BASS BOATING

Bass boats have become a very significant and very specialized breed. Designed to fit the every need of the serious fisherman, these boats tend to be narrow for their length, making them more difficult to plane off. This problem is further complicated by the considerable convenience equipment carried and the weight of one or 2 filled live wells on the trip home. The result is that careful propping at the top of the RPM range is essential for best over-all performance.

FISHING

Three-bladed props are smoother and perform better when the boat is carrying a larger load. If the slowest possible trolling speed is important, a very low pitch prop should be chosen.

Because of frequent operation in shallows, fishing props often become nicked. Better performance can be maintained if rough edges are kept filed. As a frequently filed prop becomes smaller, it eventually will struggle to plane off the boat, indicating time for a replacement.

WORK BOATS

This specialized class of boats - such as pontoon boats, and houseboats - use larger diameter, low pitch, lower rake propellers with large blade surface areas. Here durability generally is more significant than top speed.

With lower water velocity, it is important to keep the propeller low in the water to avoid ventilation of surface air around the anti-ventilation (anti-cavitation) plate via little whirlpools. I is imperative here to run the highest possible pitch that will satisfy all engine and usage requirements, since the basic efficiency of low pitch props is steadily dropping off as the pitch/diameter ratio declines.

What Is Cavitation?

Water boils at 212°F (100°C) at normal sea level atmospheric pressure. But water also boils at room temperature, if the atmospheric pressure is low enough.

As a shape passes through water at an increasing speed, the pressure, that holds the water to the sides and back of the shape, is lowered. Depending upon the water temperature, when the pressure reaches a sufficient low level, boiling will begin. This occurs most often on a propeller at the leading edge of the blade. When speed is reduced, and the pressure goes up, boiling will subside. As the water vapor bubbles move downstream into a higher pressure region that won't sustain boiling, they collapse (condense back to liquid). The collapsing action of the bubbles releases energy that chips away at the blades, causing a "cavitation burn" or erosion of the metal. (Figure 12)

The initial cause of the low pressure may be nicks in the leading edge, too much cup, sharp leading edge corners, improper polishing or sometimes poor blade design. Massive cavitation by itself is rare, and it usually is caused by a prop that is severely bent or far too small in diameter for the engine.

CAUSES of CAVITATION

1. A bent blade particularly at the leading edge.
2. Blade leading edges that have very square corners (round is best).
3. Too much cup.
4. Too small a propeller diameter for the engine size.
5. Increasing the gear reduction on an engine may raise the torque at the prop so high that the prop diameter becomes effectively too small.
6. Ventilation.

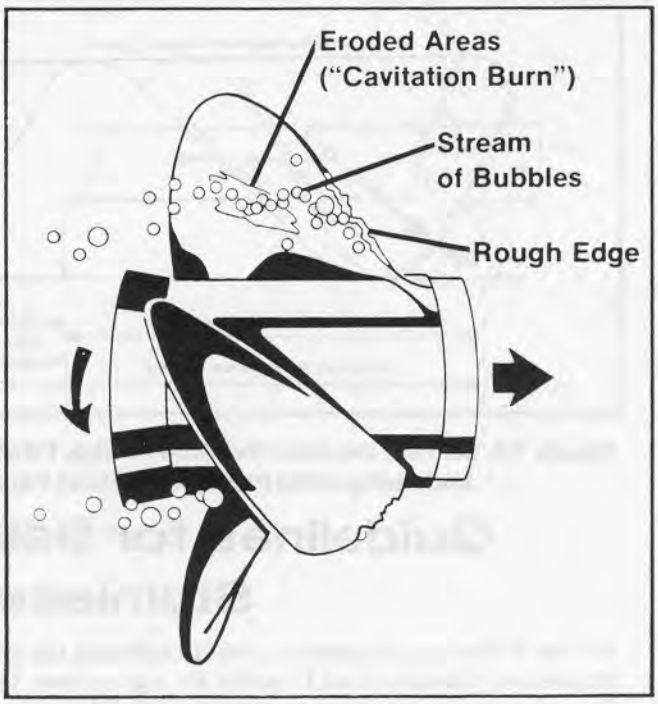


Figure 12. Cavitation Burn

What Is Ventilation?

Ventilation occurs when air from the water's surface or exhaust gases from the exhaust outlet are drawn into the propeller blades. The normal water load is reduced and the prop over-revs, losing much of its thrust; however, as the propeller momentarily over-revs, this brings on massive cavitation which can further "unload" the prop and kill all forward thrust. It continues until the prop is slowed down enough to allow the bubbles to surface. Ventilation most often occurs in turns, particularly when trying to plane in a sharp turn or with an excessive outward drive unit tilt.

CAUSES of VENTILATION

1. Running with the engine too high on the transom (prop is pulling in surface air).
2. Running with the engine trimmed out or up too far (prop is again pulling in surface air plus running at a less efficient angle through the water).
3. A missing or broken prop diffuser ring that can allow exhaust gas to be pulled back into the negative pressure or back side of blades, particularly while planing off or in turns.
4. Broken outer prop hub adjacent to the gearcase or a broken gearcase adjacent to the prop, either of which could allow exhaust gases to get directly into the prop blades.

What Is Slip?

"Slip" is the most misunderstood of all propeller terms, probably because the name sounds like something undesirable. The presence of slip does not necessarily mean propeller inefficiency. Slip is essential for a propeller to produce thrust -- to move a boat forward in the water; therefore, slip itself, is not bad. Too little or too much slip, however, makes for a less efficient propeller push than the right amount of slip. Slip is the percentage of the designated pitch that the prop does NOT successfully travel in one revolution.

HOW MUCH SLIP IS the "RIGHT AMOUNT"?

For typical planing pleasure boats, the most efficient amount of slip is in the area of 10% to 15%. With a well-selected propeller for a high-performance lightly-loaded boat, slip should remain around 10%. On a heavily-loaded, slower planing boat, proper slip increases to about 20% or 25%. A prop, that operates at zero slip, produces zero thrust, and zero slip will occur only when the propeller is windmilling while being towed or under rapid deceleration. Slip, in general, can be considered a measure of the load on the propeller. However, when slip rises to a critical point, the propeller will begin to cavitate.

WHAT CAUSES TOO MUCH or TOO LITTLE SLIP?

Too much slip will occur when the propeller diameter is too small for the engine and the boat load. It also can take place

when too much cavitation or ventilation begins to affect the propeller. These conditions have the effect of reducing the blade area in contact with the water. Too little slip occurs when the propeller diameter is too large for an engine/boat combination.

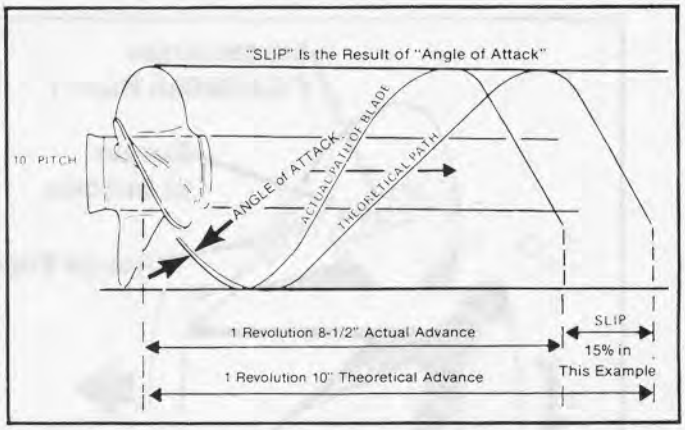


Figure 13. Shown, the Inter-Relation of Slip, Pitch and Ability of the Propeller to Move Forward

CORRECTIONS to HELP LOWER EXCESSIVE SLIP

1. Trim engine down or under a little.
2. If an older, uncupped prop is being used, either change to a newer, cupped prop or have the old one cupped.
3. If an older, lower rake prop is being used, switch to a newer, high rake stainless steel prop.
4. Check for a bent prop that could be causing extensive cavitation.
5. If prop is already cupped, have more cup added.
6. Check for a broken or missing prop diffuser ring.
7. Check for a broken outer prop hub adjacent to the gear housing or a broken gear housing adjacent to the prop, either of which could allow exhaust gases to get directly into the prop blades.
8. Lower the engine.
9. Check that prop diameter has not been significantly worn down.

A "Propeller Slip Calculator" (C-90-86147) is available thru Mercury Marine Publications Department.

Guidelines for Selection of Best Quicksilver Stainless Steel Propellers

Use the following guidelines to assist in selecting the correct Quicksilver Stainless Steel Propeller for a given boat. Guidelines are based on aluminum propeller which is known to provide best performance for that boat. Below is a chart to help determine whether an aluminum prop on a particular boat is considered large or small.

Large		Small	
Diameter	Pitch	Diameter	Pitch
14-1/2"	25"	13-1/4"	25"
15"	23"	13-1/2"	23"
15-1/4"	21"	13-1/4"	21"
15-1/2"	19"	14"	19"
15-3/4"	17"	14-1/4"	17"
16"	15"	14-1/2"	15"
16"	13"		

METRIC CONVERSION: 1" (Inch) = 2.54cm (Centimeters)

CONVENTIONAL QUICKSILVER STAINLESS STEEL PROPELLER SELECTION

1. For drives with the larger diameter cupped aluminum propeller, when running at full throttle and drive in trimmed position:
   a. If engine is operating within upper 2/3 of the maximum recommended RPM range, select the MerCruiser Quicksilver Stainless Steel prop of the SAME pitch.
   b. If the engine is operating in the lower 1/3 of the maximum recommended RPM range, select the MerCruiser Quicksilver Stainless Steel Propeller 2" LOWER in pitch.
2. For drives equipped with smaller diameter cupped aluminum propellers, when running at full throttle and with engine or drive in trimmed position:
   a. If engine is operating within upper 2/3 of the maximum recommended RPM, select the MerCruiser Quicksilver Stainless Steel prop of the next lower pitch.
   b. If engine is operating in the lower 1/3 of the maximum recommended RPM range, select the MerCruiser Quicksilver Stainless Steel prop 4" LOWER in pitch.

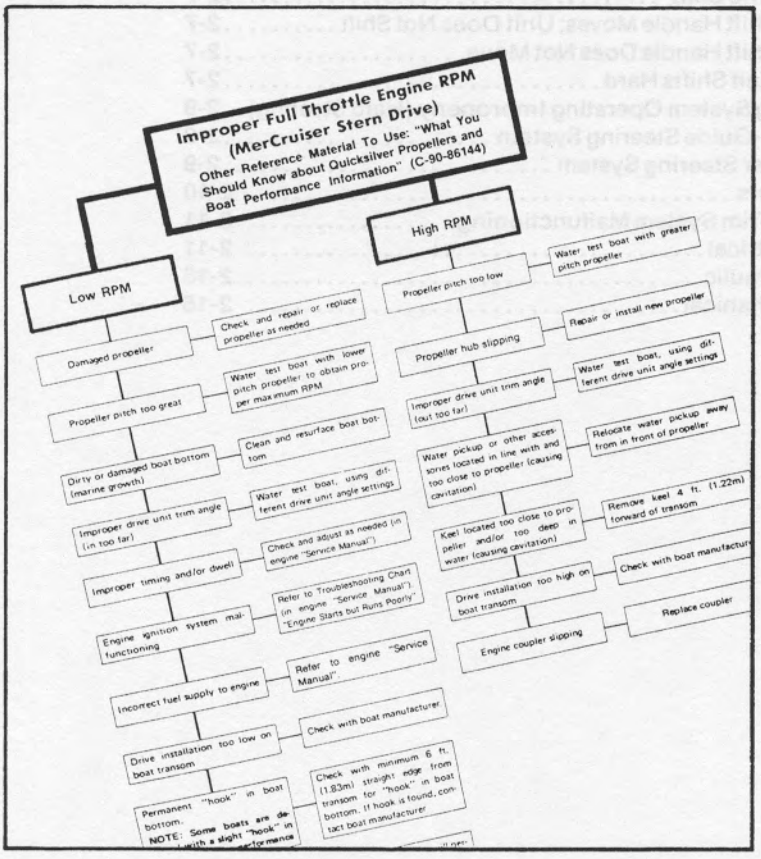
HI-PERFORMANCE (CLEAVER) PROPELLER SELECTION

1. For drives equipped with the larger diameter cupped aluminum propeller, when running at full throttle and with drive in trimmed position and, if:
   a. Stern drive is installed so that the anti-cavitation plate is above the bottom of the boat, and
   b. boat is capable of at least 50 MPH, and
   c. engine is operating within 200 RPM of the top end of the maximum recommended RPM range at full throttle, then . . .
   d. select the MerCruiser Quicksilver Stainless Steel (Cleaver) prop of the same pitch.
2. For drives equipped with the smaller diameter cupped aluminum propeller, when running at full throttle and with drive in trimmed position and, if all the above conditions in Step 1 apply, then select the MerCruiser Quicksilver Stainless Steel (Cleaver) prop of the next LOWER pitch.

I-DRIVE

Troubleshooting

SECTION 2



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Improper Full Throttle Engine RPM (MerCruiser Stern Drive)

Other Reference Material To Use: "What You Should Know about Quicksilver Propellers and Boat Performance Information" (C-90-86144)

Low RPM

Damaged propeller	Check and repair or replace propeller as needed
Propeller pitch too great	Water test boat with lower pitch propeller to obtain proper maximum RPM
Dirty or damaged boat bottom (marine growth)	Clean and resurface boat bottom
Improper drive unit trim angle (in too far)	Water test boat, using different drive unit angle settings
Improper timing and/or dwell	Check and adjust as needed (in engine "Service Manual")
Engine ignition system malfunctioning	Refer to Troubleshooting Chart (in engine "Service Manual"), "Engine Starts but Runs Poorly"
Incorrect fuel supply to engine	Refer to engine "Service Manual".
Drive installation too low on boat transom	Check with boat manufacturer
Permanent "hook" in boat bottom. **NOTE: Some boats are designed with a slight "hook" in boat for correct performance**	Check with minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If hook is found, contact boat manufacturer
"Power hook" in boat bottom (develops "hook" under power only; weak boat bottom)	Water test boat. Boat will perform normal until "hook" develops at high speed, then loss of RPM and speed will occur

High RPM

Propeller pitch too low	Water test boat with greater pitch propeller
Propeller hub slipping	Repair or install new propeller
Improper drive unit trim angle (out too far)	Water test boat, using different drive unit angle settings
Water pickup or other accessories located in line with and too close to propeller (causing cavitation)	Relocate water pickup away from in front of propeller
Keel located too close to propeller and/or too deep in water (causing cavitation)	Remove keel 4 ft. (1.22m) forward of transom
Drive installation too high on boat transom	Check with boat manufacturer
Engine coupler slipping	Replace coupler

Poor Boat Performance and/or Poor Maneuverability (MerCruiser Stern Drive)

Other Reference Material To Use: "What You Should Know about Quicksilver Propellers and Boat Performance Information" (C-90-86144)

Bow Too Low

- Improper drive unit trim angle
  - Water test boat, using different drive unit angle settings
- Weight distribution (heavy in bow [front] of boat)
  - Relocate stored gear from bow (front) of boat to stern (rear) and water test boat. If bow overweight is caused by permanently installed fuel tank(s) etc, contact boat manufacturer
- Under-powered
  - Check horsepower-to-boat weight ratio. Refer to boat manufacturer
- Permanent "hook" in boat bottom.
  NOTE: Some boats are designed with a slight "hook" in boat bottom for correct performance
  - Check with minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If hook is found, contact boat manufacturer
- "Power hook" in boat bottom (develops "hook" under power only; weak boat bottom)
  - Water test boat. Boat will perform normal until "hook" develops at high speed, then loss of RPM and speed will occur

Bow Too High

- Improper drive unit trim angle
  - Water test boat, using different drive unit angle settings
- Propeller pitch too great (also low RPM)
  - Water test boat with lower pitch propeller to obtain proper maximum RPM
- Dirty boat bottom (marine growth)
  - Clean boat bottom and retest boat
- Poor running engine
  - Refer to Troubleshooting Chart (in engine "Service Manual"), "Engine Starts but Runs Poorly"
- Weight distribution (heavy in stern [rear] of boat)
  - Relocate stored gear from stern (rear) to bow (front) of boat and water test. If stern overweight is caused by permanently installed fuel tank(s) etc, contact boat manufacturer
- "Rocker" in boat bottom
  - Check with minimum 6 ft. (1.83m) straight edge from transom for "rocker" in boat bottom. If "rocker" is found, contact boat manufacturer

Propeller Cavitating

- Drive unit installation too high on boat transom
  - Check with boat manufacturer
- Dirty or rough boat bottom (marine growth)
  - Clean and/or resurface boat bottom
- Damaged propeller
  - Repair or replace propeller as needed
- Keel located too close to propeller and/or too deep in water
  - Remove keel 4 ft. (1.22m) forward of transom
- Water pickup or other accessories located in line with and too close to propeller
  - Relocate water pickup away from in front of propeller
- Hook in bottom of boat
  - Check with minimum 6 ft. (1.83m) straight edge from transom for "hook" in boat bottom. If "hook" is found, contact boat manufacturer

Stern Drive Unit Noise

Noise in Gear Housing

Metal particles in drive unit lubricant	Disassemble drive unit, clean in solvent and dry with compressed air. Inspect gears and bearings (Section 3)
Propeller not correctly installed	Remove propeller and install correctly (Section 3B)
Propeller shaft bent	Replace propeller shaft (Section 3)
Gear alignment and/or shimming not correct	Check gear alignment and shimming. Repair as necessary (Section 3B)
Worn, damaged or loose parts in drive unit	Disassemble and inspect gears, bearings and shafts for wear, damage or loose fit (Section 3)

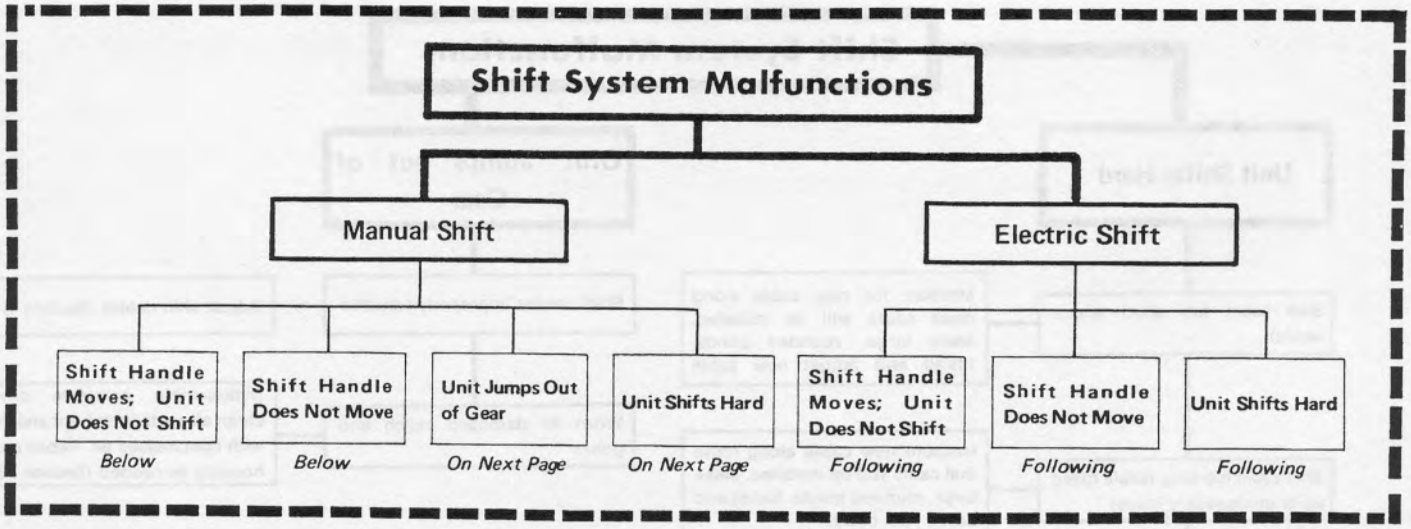
Noise in Drive Shaft Housing

Lubricant level low	Check lubricant level and add lubricant if necessary (Section 1)
Worn or dirty universal joint bearings	Check universal joint bearing and repair as necessary (Section 3A)
Worn or dirty gimbal bearing	Check bearing and repair as necessary (Section 4)
Metal particles in drive unit lubricant	Disassemble drive unit, clean in solvent and dry with compressed air. Inspect gears and bearings (Section 3)
Transom not thick enough	Check transom thickness. Shim transom plates if necessary
Gear alignment and/or shimming not correct	Check gear alignment and shimming. Repair as needed (Section 3A)
Worn, damaged or loose parts in drive unit	Disassemble and inspect gears, bearings and shafts for wear, damage or loose fit (Section 3)
Engine not aligned	Align engine with proper alignment tool (in engine "Service Manual")
Engine coupler worn	Replace engine coupler. Check engine alignment and lubricate coupler before drive installation (in engine "Service Manual")

Stern Drive Unit Will Not Slide into Bell Housing

MerCruiser I Drive

Universal joint shaft splines not aligned with engine coupling splines	**CAUTION: DO NOT rotate propeller shaft clockwise, or drive unit shift shaft will move out of forward gear position.** Rotate propeller shaft counter-clockwise until drive unit can be pushed into position (Section 3B)
Drive unit not in forward gear	Place drive unit shift shaft in straight forward (forward gear) position. It may be necessary to rotate propeller shaft counter-clockwise to obtain full forward position (Section 3B)
Shift shaft coupler in bell housing not aligned	Align shift shaft coupler in forward gear position (Section 3)
Engine not aligned	Align engine with proper alignment tool (in engine "Service Manual")
Bearing in gimbal housing not aligned	Align engine with proper alignment tool (in engine "Service Manual")
Damaged splines on shaft or coupling	Inspect splines and repair as needed (Section 3 and engine "Service Manual")



Shift System Malfunctions

Manual Shift

Shift Handle Moves; Unit Does Not Shift

Shift cables improperly adjusted	Adjust shift cables (Section 4)
Shift cables not connected	Install shift cables correctly (Section 4)
Inner core wire broken or loose	Reconnect or replace inner core wire (Section 4)
Outer shift cable broken	Replace shift cable (Section 4)
Shift crank (located in gear housing) improperly installed	Install shift crank properly (Section 3B)
Broken shift shaft coupler (located in bell housing)	Replace shift shaft assembly (Section 4)

Shift Handle Does Not Move

Control box not properly assembled	Reassemble control box properly
Broken or damaged linkage in control box	Repair control box as needed
Control box mounting screw(s) loose and backed out, restricting control handle movement (single lever control with hidden control box only)	Remove handle and install screws, using Loctite Type "A"
Shift shaft or shift shaft lever jammed	Check and repair as needed (Section 3)
Controls improperly adjusted (cable end guide hitting brass barrel)	Adjust shift cables (Section 4)

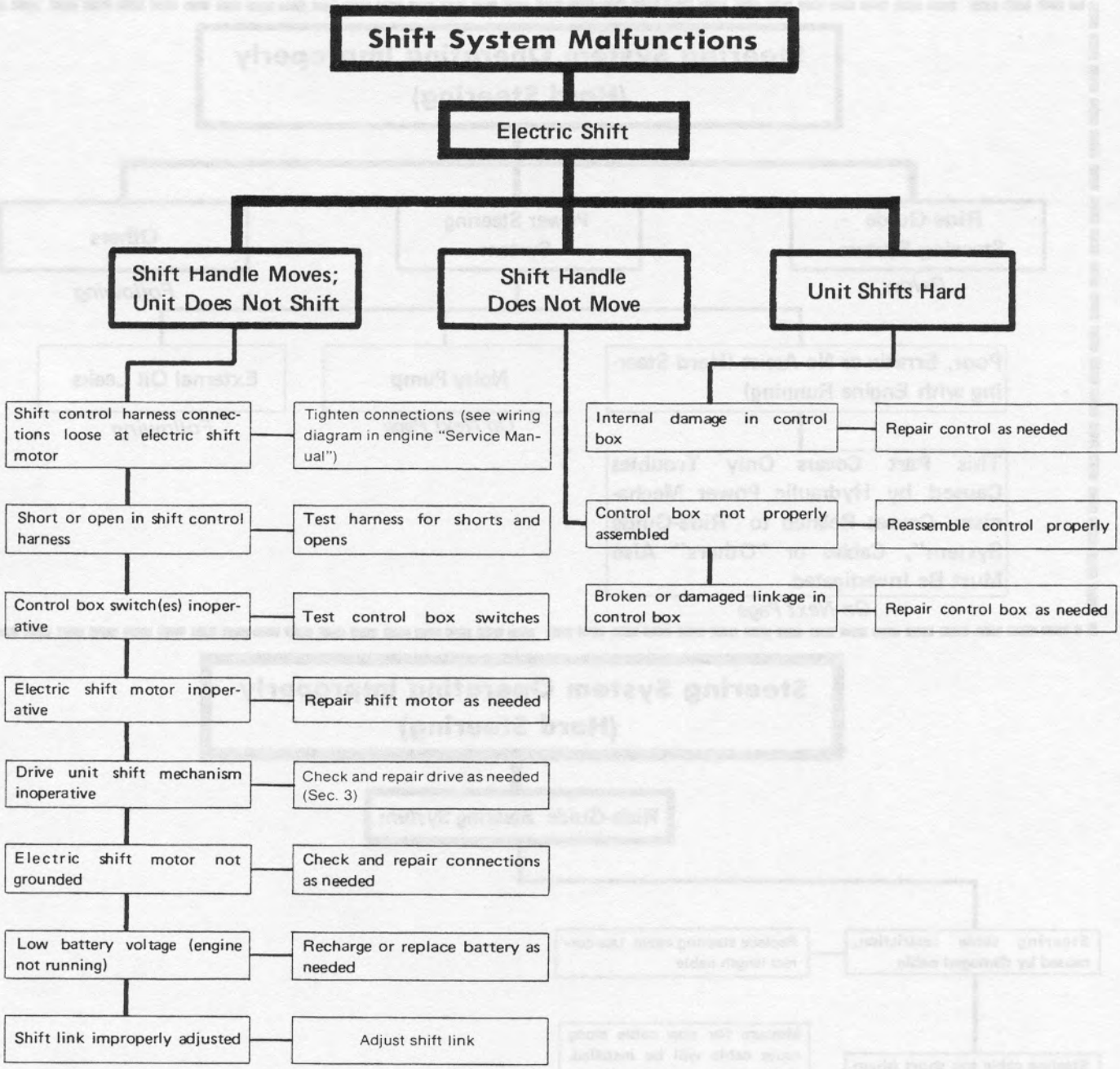
Shift System Malfunctions

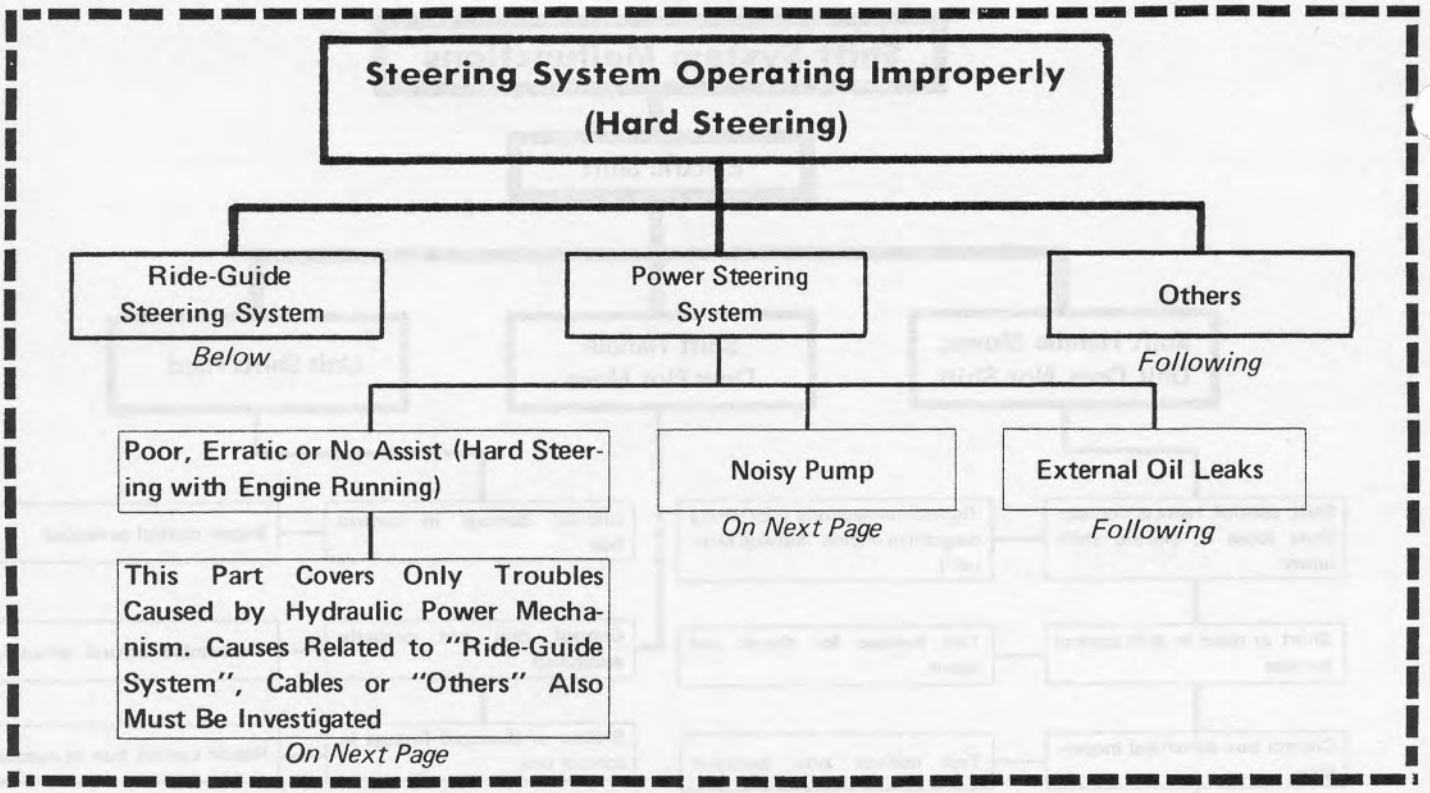
Unit Shifts Hard

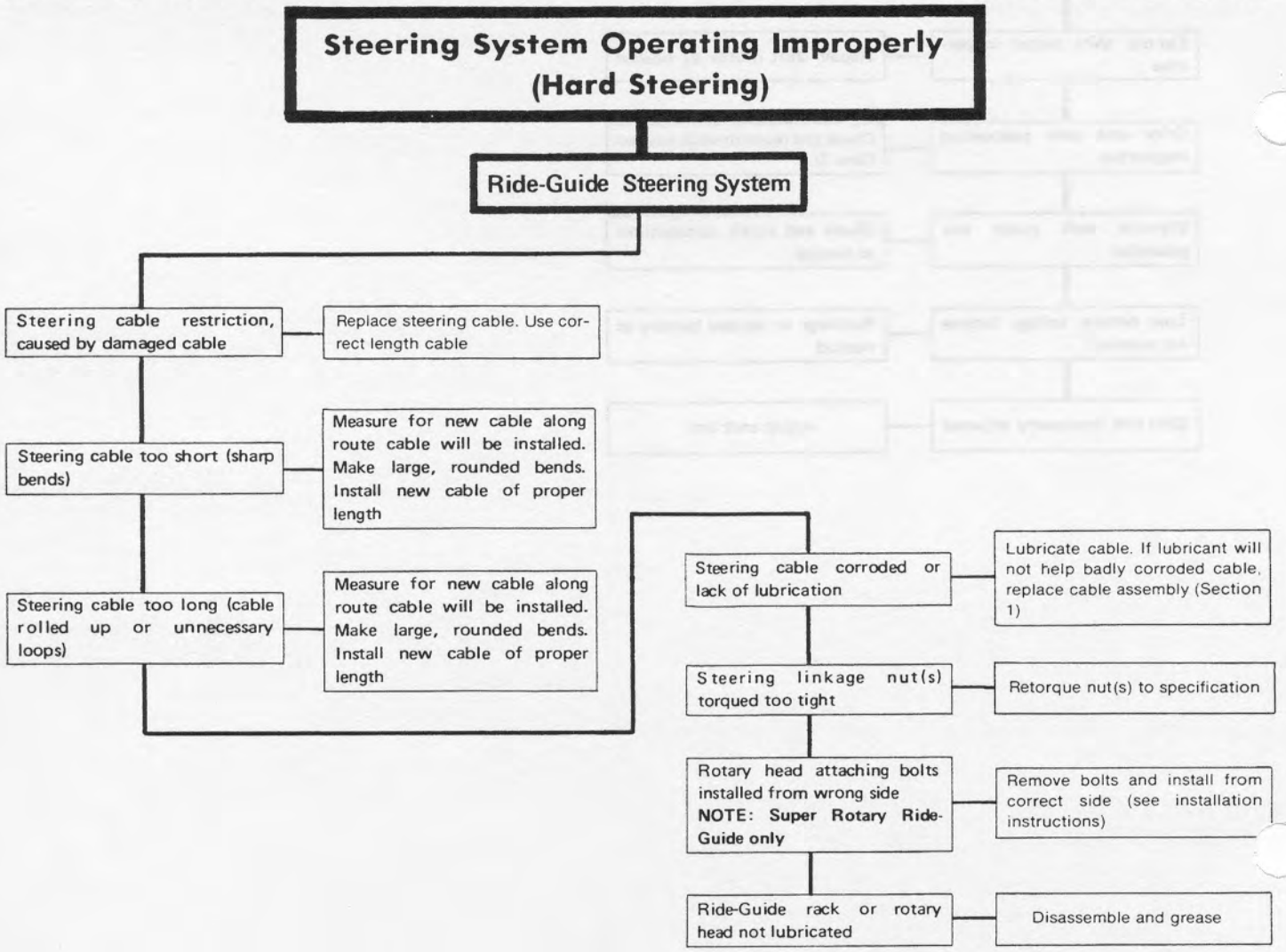
Shift cable too short (sharp bends)	Measure for new cable along route cable will be installed. Make large, rounded bends. Install and adjust new cable
Shift cable too long (cable rolled up or unnecessary loops)	Measure new cable along route that cable will be installed. Make large, rounded bends. Install and adjust new cable
Shift cutout switch inoperative	Test switch for continuity and proper adjustment. Adjust or replace as needed (Section 4)
Damaged shift cable (causing restriction). Shift control or drive unit cable	Replace shift cable and readjust
Corroded shift cables	Replace and readjust shift cable (Section 4)
Internal wear or damage in control box	Disassemble, inspect and repair as needed
Engine RPM too fast	Adjust engine RPM (see engine "Service Manual")
Shift cables improperly adjusted	Adjust shift cables (Section 4)
Corrosion buildup between shift shaft bushing (B-23-79372) and bell housing	Increase the inside diameter of bushing .007" (0.18mm), using letter drill "W" [.3860" (9.8mm)]
Shift crank and/or clutch actuating spool worn	Replace crank and spool (Section 3B)
Shift shaft metal washer missing	Replace damaged bushing assembly and install washer (Section 3B)
Bent shift shaft (3 shafts to check)	Replace bent shaft (Section 3 and/or 4)

Unit Jumps out of Gear

Shift cables improperly adjusted	Adjust shift cables (Section 4)
Worn or damaged clutch and gears	Disassemble complete drive, clean all parts in solvent and dry with compressed air. Repair gear housing as needed (Section 3B)
Shift cables transom end attaching nuts excessively torqued (end cannot pivot)	Properly install nuts (Section 4)
Shift cable pivot ends corroded or not lubricated	Clean and lubricate as needed (Section 1)
Shift cable secured too close to control box, not allowing cable housing movement	Remove clamp that secures cable closest to shift control box


Shift System Malfunctions
Electric Shift
Shift Handle Moves; Unit Does Not Shift
Shift Handle Does Not Move
Unit Shifts Hard
Shift control harness connections loose at electric shift motor
Tighten connections (see wiring diagram in engine "Service Manual")
Short or open in shift control harness
Test harness for shorts and opens
Control box switch(es) inoperative
Test control box switches
Electric shift motor inoperative
Repair shift motor as needed
Drive unit shift mechanism inoperative
Check and repair drive as needed (Sec. 3)
Electric shift motor not grounded
Check and repair connections as needed
Low battery voltage (engine not running)
Recharge or replace battery as needed
Shift link improperly adjusted
Adjust shift link
Internal damage in control box
Repair control as needed
Control box not properly assembled
Reassemble control properly
Broken or damaged linkage in control box
Repair control box as needed


Steering System Operating Improperly (Hard Steering)
Ride-Guide Steering System
Below
Power Steering System
Others
Following
Poor, Erratic or No Assist (Hard Steering with Engine Running)
Noisy Pump
On Next Page
External Oil Leaks
Following
This Part Covers Only Troubles Caused by Hydraulic Power Mechanism. Causes Related to "Ride-Guide System", Cables or "Others" Also Must Be Investigated
On Next Page


Steering System Operating Improperly (Hard Steering)
Ride-Guide Steering System
Steering cable restriction, caused by damaged cable
Replace steering cable. Use correct length cable
Steering cable too short (sharp bends)
Measure for new cable along route cable will be installed. Make large, rounded bends. Install new cable of proper length
Steering cable too long (cable rolled up or unnecessary loops)
Measure for new cable along route cable will be installed. Make large, rounded bends. Install new cable of proper length
Steering cable corroded or lack of lubrication
Lubricate cable. If lubricant will not help badly corroded cable, replace cable assembly (Section 1)
Steering linkage nut(s) torqued too tight
Retorque nut(s) to specification
Rotary head attaching bolts installed from wrong side
NOTE: Super Rotary Ride-Guide only
Remove bolts and install from correct side (see installation instructions)
Ride-Guide rack or rotary head not lubricated
Disassemble and grease

Steering System Operating Improperly (Hard Steering)

Poor, Erratic or No Assist (Hard Steering with Engine Running)

Power Steering System

This Part Covers Only Troubles Caused by Hydraulic Power Mechanism. Causes Related to "Ride-Guide Steering System", Cables or "Others" Also Must Be Investigated

Loose drive belt	Adjust belt tension (Sec. 6)
Low oil level	Fill reservoir to proper level (Section 6)
Air in system	Locate source of air in oil return lines or fittings and correct. Also could be pump internal leak (Sec. 6)
Leaking hoses	Replace hoses
Defective pump	Test pump pressure. Replace pump, if necessary (Sec. 6)
Low oil pressure in steering cylinder caused by restriction in hoses	Check for kinks and foreign object in hoses. Replace hose, if necessary (Sec. 6)
Pressure loss in cylinder, caused by worn piston ring or scored housing bore	Test Power Steering system. Replace cylinder, if necessary (Sec. 6)
Loose fit of spool in valve body or leaky valve body	Test Power Steering system. Replace valve assembly, if necessary (Sec. 6)
Control valve not positioned properly	Adjust per installation instructions (Section 6)
Improper control valve balancing	Adjust control valve (Section 6)
Power Steering mounting bracket adjusting screw loose	Turn screw in until it bottoms out on inner transom plate, then tighten locknut (Section 6)
Flow control valve in pump sticking	Remove and inspect. (Sec. 6) Replace with new valve, if necessary

Noisy Pump

Loose belt	Adjust belt tension (Sec. 6)
Low oil level	Fill reservoir (Sec. 6)
Air in oil	Locate source of air in oil return lines or fittings and correct. Also could be pump internal leak (Sec. 6)
Defective pump	Disassemble pump and check for scored parts, sticking vanes or improper installation of parts (Sec. 6)
Excessive back-pressure, caused by restriction in oil passages	Locate restriction and correct
Improper adjusted stop nuts	Check and adjust
Cables other than Ride-Guide being used that do not meet B.I.A. standards	Refer to Section 1
Power Steering mounting tube loose.	Tighten according to instructions in Section 6
Control valve mounting nut loose	Tighten (Sec. 6)