

MERCURY OUTBOARDS

SERVICE MANUAL

V-6 MODELS



V-6 OUTBOARDS

SERVICE MANUAL OUTLINE

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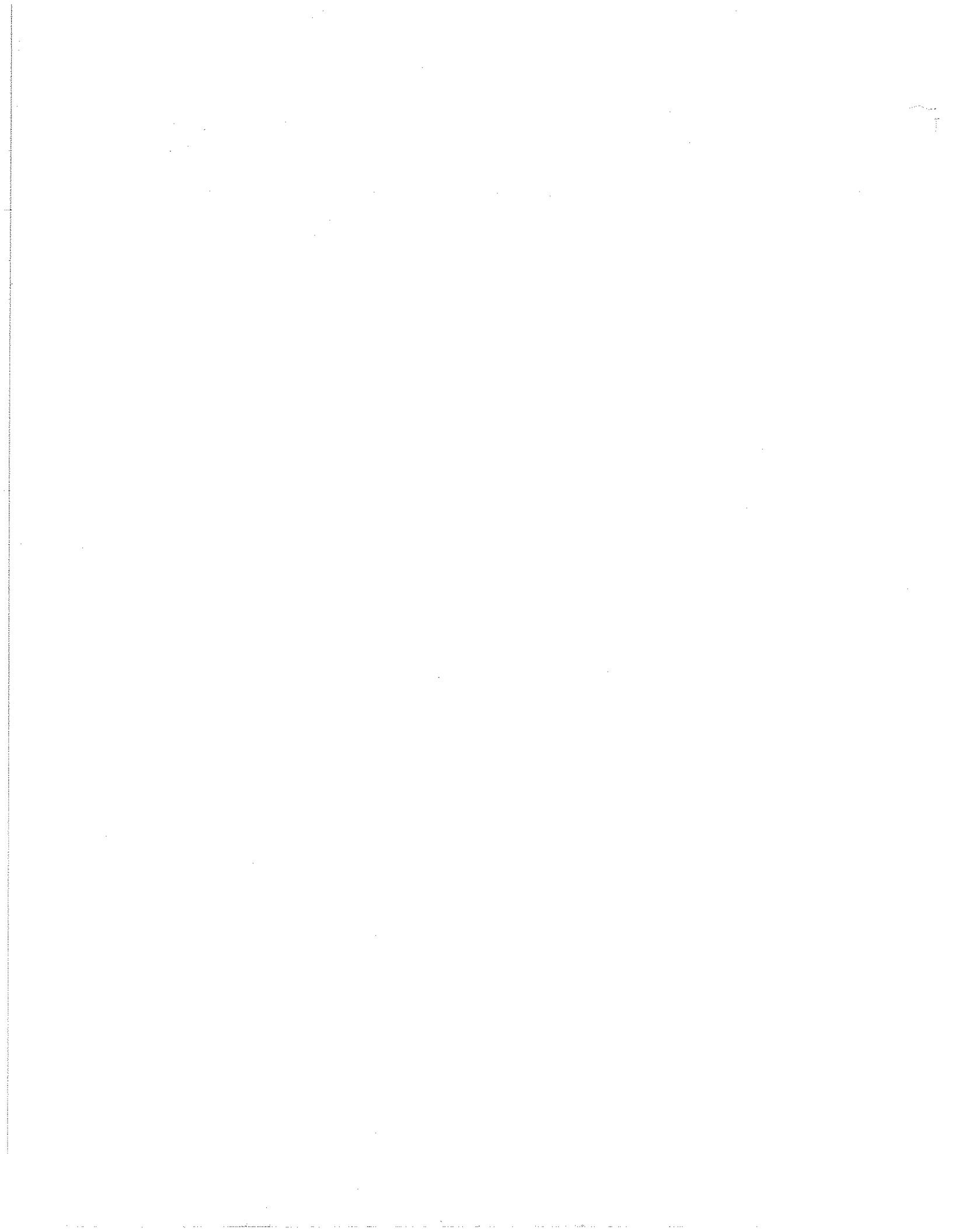
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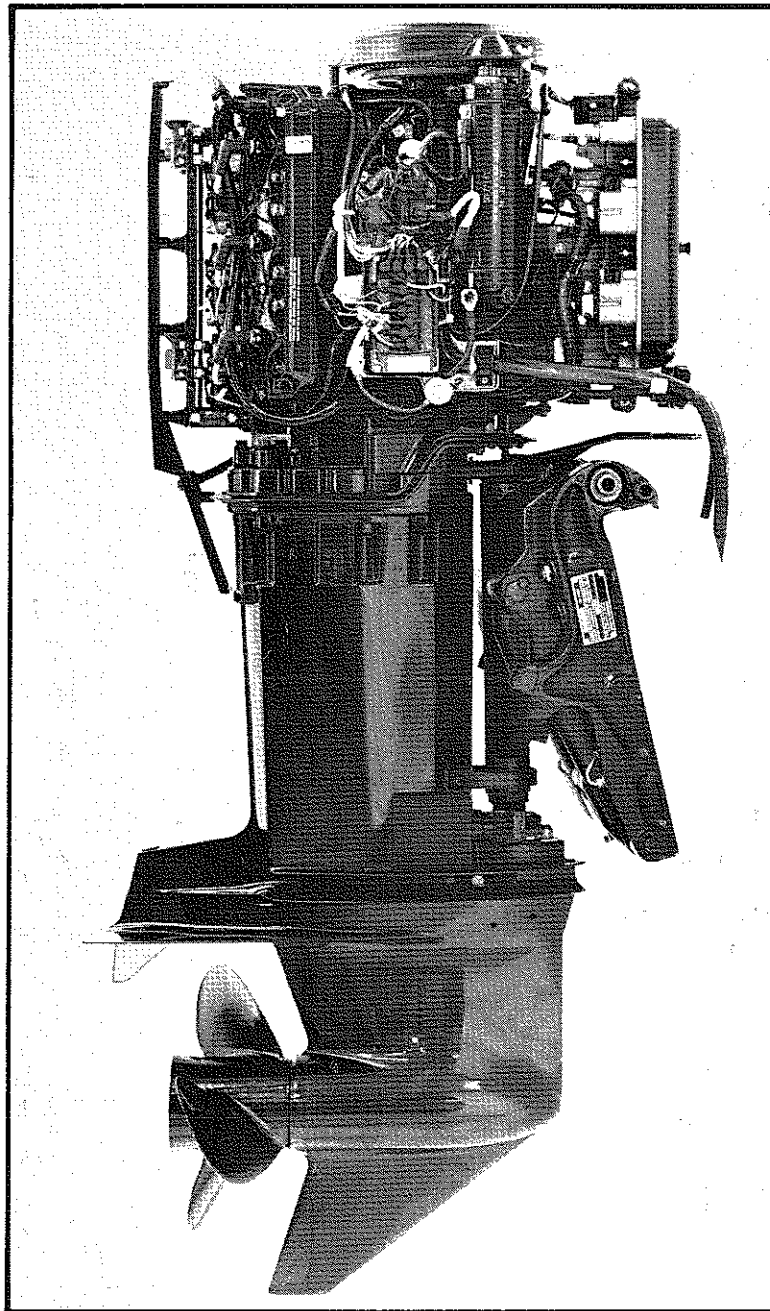
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V-6 OUTBOARDS

*General Information
and Specifications*



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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, which 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 the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

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: Indicates information or instructions that are necessary for proper operation and/or maintenance.

PROPELLER INFORMATION

For in-depth information on marine propellers and boat performance -- written by marine engineers -- see your Authorized Dealer for the illustrated "What You Should Know About Quicksilver Propellers . . . and Boat Performance Information" (Part No. C-90-86144).

HOW TO USE THIS MANUAL

The manual is divided into **SECTIONS** (shown, right) which represent major components and systems.

Some **SECTIONS** are further divided into **PARTS**. Each **PART** has a title page. An index for the particular **PART** is printed on the back of the title page.

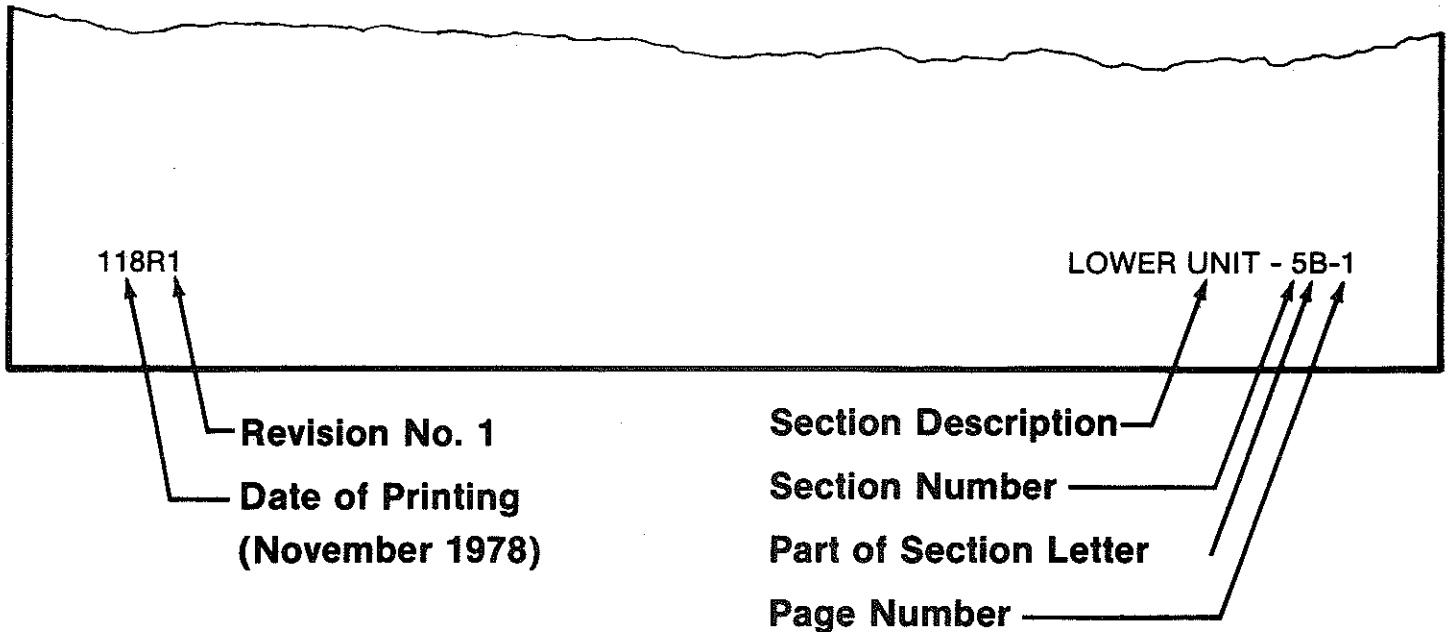
SECTIONS and **PARTS** are listed on the "Service Manual Outline" sheet which immediately follows the cover of this book.

Section	Section Heading
1	General Information
2	Electrical and Ignition
3	Fuel System and Carburetion
4	Powerhead
5	Lower Unit
6	Power Trim
7	Engine Attachments

PAGE NUMBERING

Two number groups appear at the bottom of each page. The example, below, is self-explanatory.

EXAMPLE:



SAFETY SUMMARY

SAFETY WARNING

Read and heed the "Safety Warnings," "Cautions" and "Notes" in this publication.

SAFETY WARNING

Disconnect battery cables (negative cable first) before working on the engine.

SAFETY WARNING

Wear safety glasses while cleaning with compressed air, removing the piston pin lockrings or sandblasting.

SAFETY WARNING

Hydrogen and oxygen gases are produced during normal battery operation or charging. Sparks or flame can cause this mixture to ignite and explode, if they are brought near the vent openings. Sulphuric acid in the battery can cause serious burns if spilled on skin or in eyes. Flush or wash away immediately with clear water.

SAFETY WARNING

Use cleaning solvents carefully and in open, spark or fire-free areas, with good ventilation.

SAFETY WARNING

DO NOT fill the gas tank to capacity - gasoline expands as it warms.

SAFETY WARNING

DO NOT work on the motor while it is suspended from a hoist. Use adequate lifting equipment and set the engine on a sturdy mount for servicing.

SAFETY WARNING

Keep parts and hands clear of the spinning flywheel.

SAFETY WARNING

Wear asbestos gloves when handling heated parts.

SAFETY WARNING

Keep the work area neat to avoid accidents and lost parts.

CAUTION

Keep disassembled parts clean, identified and in order.

CAUTION

DO NOT operate the motor out of water.

CAUTION

Use only recommended tools, test equipment and materials.

CAUTION

DO NOT reverse the battery leads.

CAUTION

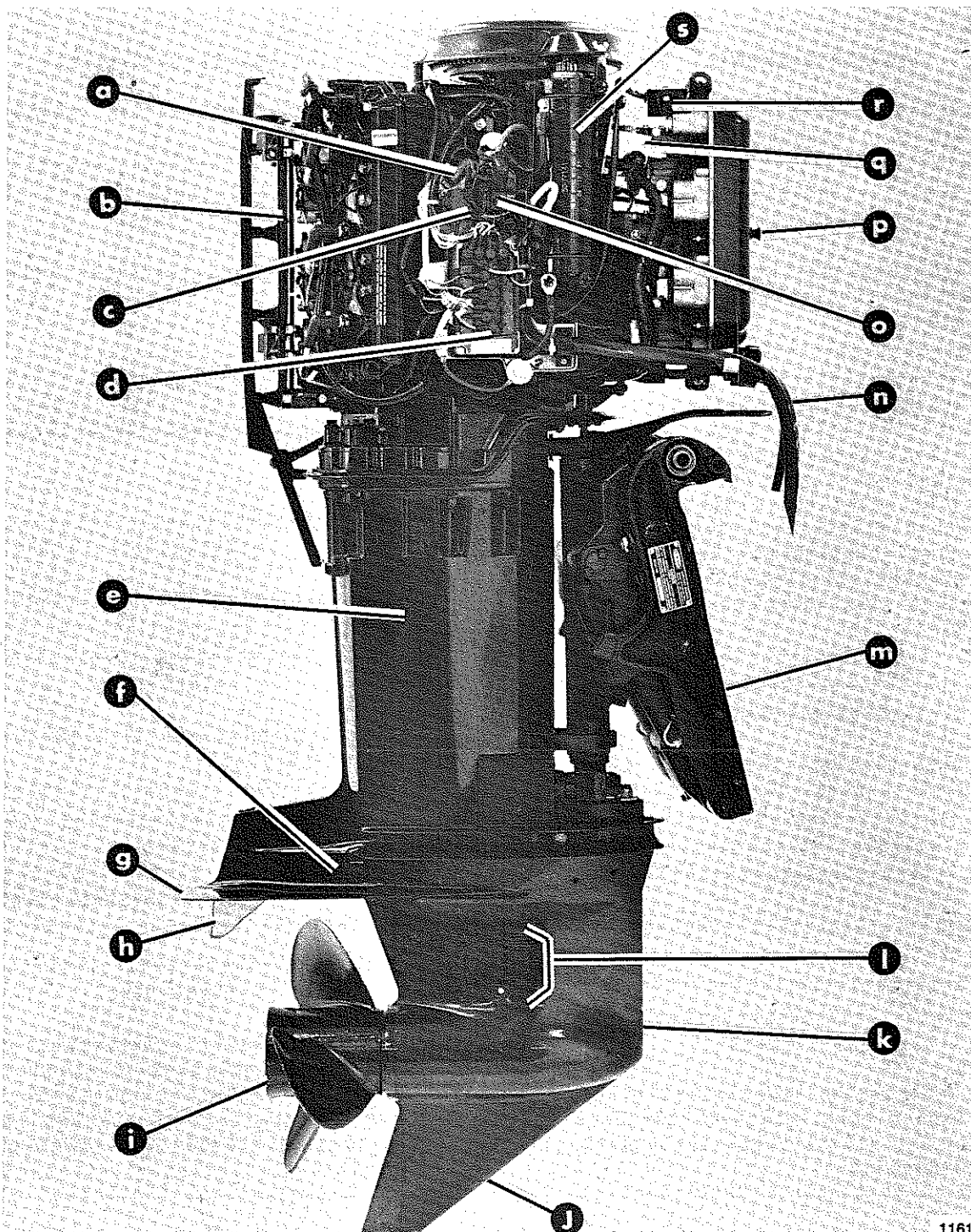
When tightening 2 or more screws on the same part, tighten each screw in increments. First tighten each screw 1/3 of the specified torque, then 2/3 and then the final torque. Follow the recommended sequence during torquing operations.

INTRODUCTION

This comprehensive overhaul and repair manual is designed as a "Service Guide" for V-6 model outboards. It provides specific information, including procedures for disassembly, assembly, inspection and adjustment, to enable dealers and service mechanics to keep the V-6 outboard in top operating

condition. The procedures are supplemented with photos and illustrations.

Before attempting particular repairs, it is suggested that the repair procedure first be read thru completely to gain a total picture of the repair method, cautions and warnings.



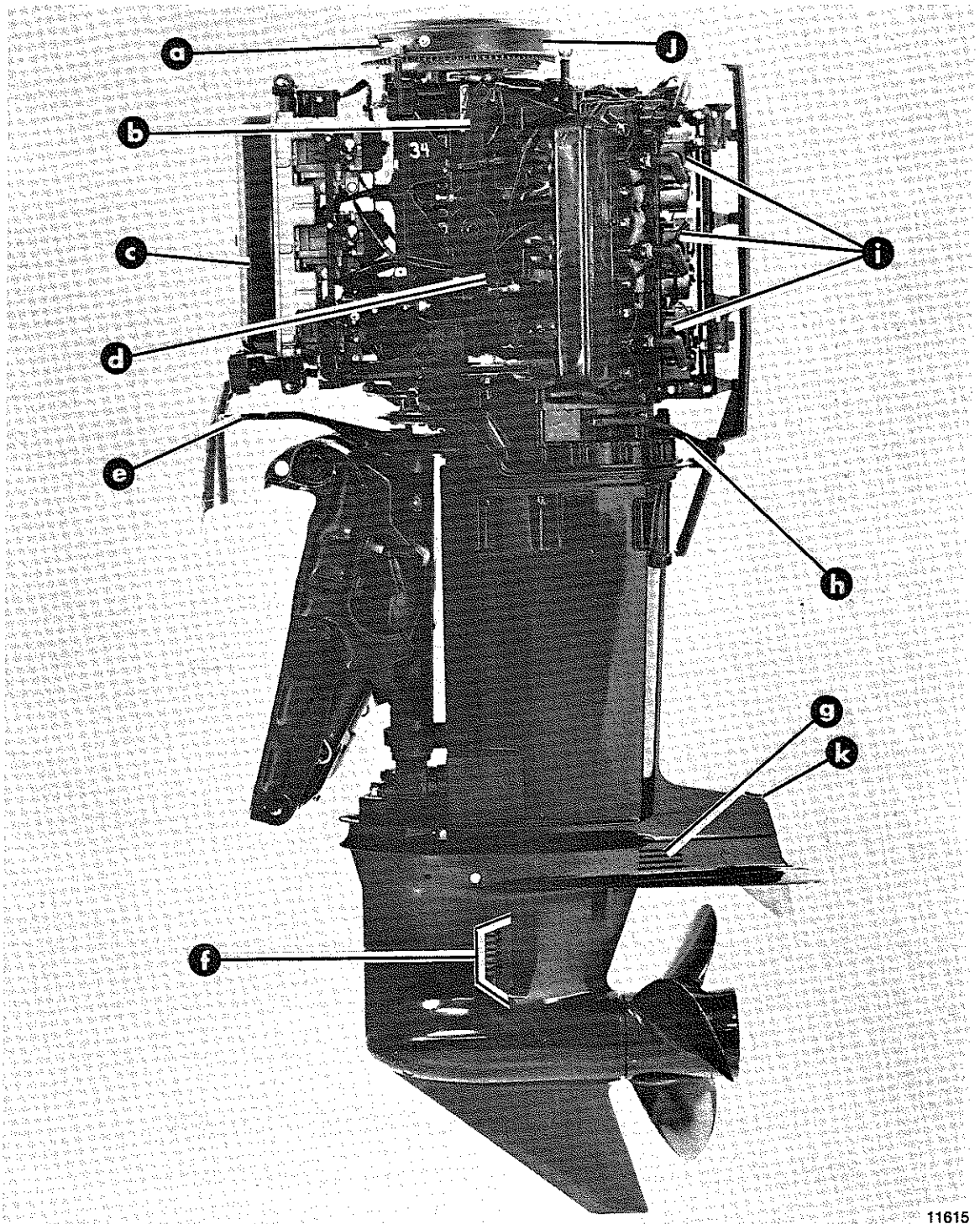
- a - Tilt Ignition Stop Switch
- b - Rear Cowl Support Bracket
- c - Rectifier
- d - Switch Boxes
- e - Drive Shaft Housing
- f - Water Discharge
- g - Anti-Cavitation Plate

- h - Trim Tab
- i - Quicksilver Propeller
- j - Skeg
- k - Gear Housing
- l - Water Intake
- m - Transom Mounting Brackets

- n - Wiring Harness and Fuel Line
- o - Starter Solenoid
- p - Manual Choke Knob
- q - Electric Choke Solenoid
- r - Idle Stabilizer
(Not Present on All Models)
- s - Starter Motor

11614

Figure 1. Starboard Side View - V-6 Outboard



11615

- | | |
|-------------------------|---------------------------------|
| a - Timing Pointer | f - Water Intake |
| b - Spark Advance Lever | g - Water Discharge |
| c - Air Silencer | h - Water Pump "Tell-Tale" Hose |
| d - Throttle Lever | i - Ignition Coils |
| e - Steering Arm | j - Flywheel Cover |
| | k - Trim Tab Adjustment Plug |

Figure 2. Port Side View - V-6 Outboard

GENERAL SPECIFICATIONS

	150 HP Model	175 HP Model	200 HP Model
Full Throttle RPM Range	5000-5500	5300-5800	
Idle RPM Range in Forward Gear	550-650		
Engine Type	60° V-Type, 6- Cylinder, 2-Cycle		
Cu. In. Displacement	122 (1999cc)		142 (2327cc)
Cylinder Bore	3.125" (79.375mm)		3.375" (85.725mm)
Stroke	2.650" (67.31mm)		
Firing Order	1-2-3-4-5-6		
Ignition Type	Thunderbolt Breakerless		
Spark Plugs	AC-V40FFM or Champion L76V*		
Engine Weight (Fuel Tank Not Included)	349 Lbs. (158kg)		331 Lbs. (150kg)
Fuel Tank (Supplied; Includes Capacity for Oil)	6 Gallons (22.7 Liters)		
Reed Stop Opening	.200" (5.08mm)	.300" (7.62mm)	
Piston Diameter (Standard) §	3.115" (79.12mm)		3.372" (85.65mm)
Piston Diameter Oversize	.015" and .030" (.38 and .76mm)		-----
Piston Ring Diameter (Standard)	3.124" (79.35mm)		3.375" (85.73mm)
Piston Ring Diameter Oversize	.015" and .030" (.38 and .76mm)		-----
Carburetion	3 Carburetors, Center Bowl, Fixed Jets		
Carburetor Jet Sizes	(See Chart, Following)		
Fuel Pump Discharge Pressure	4 to 5-1/2 PSI (.28 to .39kg/cm ²) at WOT		
Fuel Tank Weight	10 Lbs. (4.54kg) Empty; 50 Lbs. (22.78kg) Full •		
Battery	Min. 90 Amp-Hour with Min. Reserve Capacity Rating of 150 Minutes		
Starter Motor Amperes Draw-Part No. A-50-79472 Part No. A-50-77141 Part No. A-50-64975	40 Amps No Load; 175 Amps Cranking Engine 40 Amps No Load; 175 Amps Cranking Engine 55 Amps No Load; 200 Amps Cranking Engine		
Gear Housing	Forward-Neutral-Reverse		
Gear Ratio	2:1		1.86:1
Forward Gear - No. of Teeth	28		
Pinion Gear - No. of Teeth	14		15
Gear Housing Lubricant Capacity	24-1/4 Fl. Oz. (717ml)		

* Champion QL76V in Countries Other Than U.S.A.

§ Refer to Powerhead Section for Measuring

• Larger Fuel Tanks, Figure 6 1/2 Lbs. (2.9kg) per Fuel Gallon (3.79 Liters) Plus Weight of Tank

NOTE: Other Specifications (Torques, Etc) Are Listed in the Front of the Respective Sections.

Carburetor Jet Orifice Sizes

NOTE: Thread Size for All V-6 Model Carburetor Jets Is 10-32.

V-6 HP Model	Jet Type	Standard Jet Up to 2500'		2500'-5000'		5000'-7500'		7500' and Up	
		Size	Part No.	Size	Part No.	Size	Part No.	Size	Part No.
150 HP Serial No. 5203429 and Above	Main	.048	C-1395-6246	.046	C-1399-5317	.044	C-1399-5316	.042	C-1399-5315
	Vent	.098	C-1399-7335	.098	C-1399-7335	.098	C-1399-7335	.098	C-1399-7335
	Idle	.060	C-1395-6487	.062	C-1399-4217	.064	C-1399-4216	.066	C-1399-4215
150 HP Serial No. 5203428 and Below	Main	.052	C-1395-6359	.050	C-1395-6028	.048	C-1395-6246	.046	C-1399-5317
	Vent	.098	C-1399-7335	.098	C-1399-7335	.098	C-1399-7335	.098	C-1399-7335
	Idle	.064	C-1399-4216	.066	C-1399-4215	.068	C-1395-6029	.070	C-1395-6030
175 HP Below Serial No. 4838074	Main	.074	C-1399-3794	.072	C-1395-6207	.070	C-1395-6030	.068	C-1395-6029
	Vent*	.090	C-1395-6247	.088	C-1395-6202	.086	C-1395-5815	.084	C-1399-3517
	Vent+	.082	C-1399-3518	.080	C-1395-6201	.078	C-1399-3520	.076	C-1399-3796
	Idle	.048	C-1395-6246	.050	C-1395-6028	.052	C-1395-6359	.054	C-1399-5225

	Jet Type	Standard Jet Up to 2500'		2500'-5000'		5000'-7500'		7500' and Up	
		Size	Part No.	Size	Part No.	Size	Part No.	Size	Part No.
175 HP - Serial No. 4838074 and Above	Main Idle	.074 .048	C-1399-3794 C-1395-6246	.072 .050	C-1395-6207 C-1395-6028	.070 .052	C-1395-6030 C-1395-6359	.068 .054	C-1395-6029 C-1399-5225
Top Carb Port Barrel	Vent	.090	C-1395-6247	.088	C-2395-6202	.086	C-1395-5815	.084	C-1399-3517
Top Carb Starboard Barrel	Vent	.090	C-1395-6247	.088	C-1395-6202	.086	C-1395-5815	.084	C-1399-3517
Center Carb Port Barrel	Vent	.082	C-1399-3518	.080	C-1395-6201	.078	C-1399-3520	.076	C-1300-3796
Center Carb Starboard Barrel	Vent	none		none		none		none	
Bottom Carb Port Barrel	Vent	none		none		none		none	
Bottom Carb Starboard Barrel	Vent	none		none		none		none	
200 HP Below Serial No. 4839034	Main Vent Idle	.078 .084 .046	C-1399-3520 C-1399-3517 C-1399-5317	.076 .082 .048	C-1399-3796 C-1399-3518 C-1395-6246	.074 .080 .050	C-1399-3794 C-1395-6201 C-1395-6028	.072 .078 .052	C-1395-6207 C-1399-3520 C-1395-6359
200 HP - Serial No. 4839034 and Above	Main Idle	.078 .046	C-1399-3520 C-1399-5317	.076 .048	C-1399-3796 C-1395-6246	.074 .050	C-1399-3794 C-1395-6028	.072 .052	C-1395-6207 C-1395-6359
Top Carb Port Barrel	Vent	.084	C-1399-3517	.082	C-1399-3518	.080	C-1395-6201	.078	C-1399-3520
Top Carb Starboard Barrel	Vent	.084	C-1399-3517	.082	C-1399-3518	.080	C-1395-6201	.078	C-1399-3520
Center Carb Port Barrel	Vent	.084	C-1399-3517	.082	C-1399-3518	.080	C-1395-6201	.078	C-1399-3520
Center Carb Starboard Barrel	Vent	none		none		none		none	
Bottom Carb Port Barrel	Vent	.084	C-1399-3517	.082	C-1399-3518	.080	C-1395-6201	.078	C-1399-3520
Bottom Carb Starboard Barrel	Vent	none		none		none		none	

* Top Carburetor Only

+ Center and Bottom Carburetors

(Metric Conversion: 1" = 25.4mm; 1' = 0.305m)

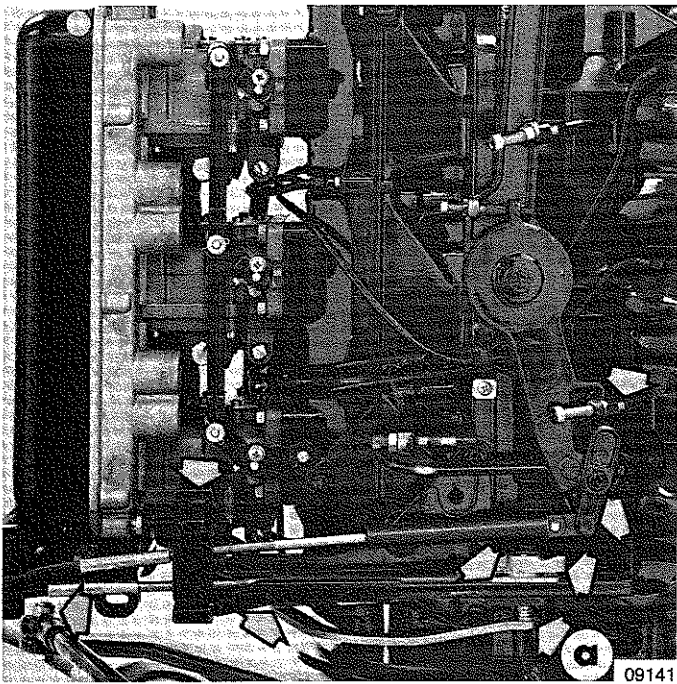
LUBRICATION

Lubrication Point Chart

Figure No	Description	Type Lubricant	Fresh Water Frequency	Salt Water Frequency
3	Throttle-Shift Linkage	Multipurpose Lubricant	Every 60 Days	Every 30 Days
4	Upper Shift Shaft			
5	Ride-Guide Steering Cable			
6-7	Tilt Tube and Swivel Pin			
9	Propeller Shaft	Perfect Seal	Once in Season	Every 60 Days
9	Gear Housing	Super-Duty Lubricant	After 1st 10 Days, Then Each 30 Days	Same as Fresh Water
5	Steering Link Rod Pivot Points	SAE 30W Engine Oil	Every 60 Days	Every 30 Days
8	Tilt Lock Lever Shaft and Locking Brace Pivot Points			
---	Engine Crankshaft Splines to Drive Shaft Splines	Multipurpose Lubricant	Once in Season Δ	Once in Season Δ
---	Gear Housing Bearing Carrier and Cover Nut	Perfect Seal		*Once in Season

Δ Refer to gear housing removal and installation (Section 5).

* Refer to lubricant instructions outlined in "Salt Water Corrosion - Gear Housing Bearing Carrier and Cover Nut" in this section (see "Index").



a - Lubrication Points (7)

Figure 3. Throttle-Shift Linkage Lubrication

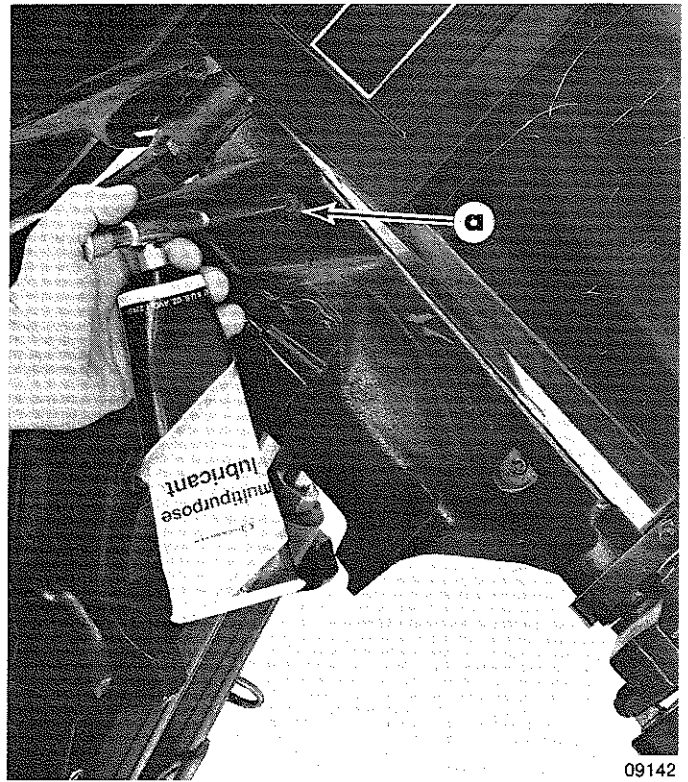
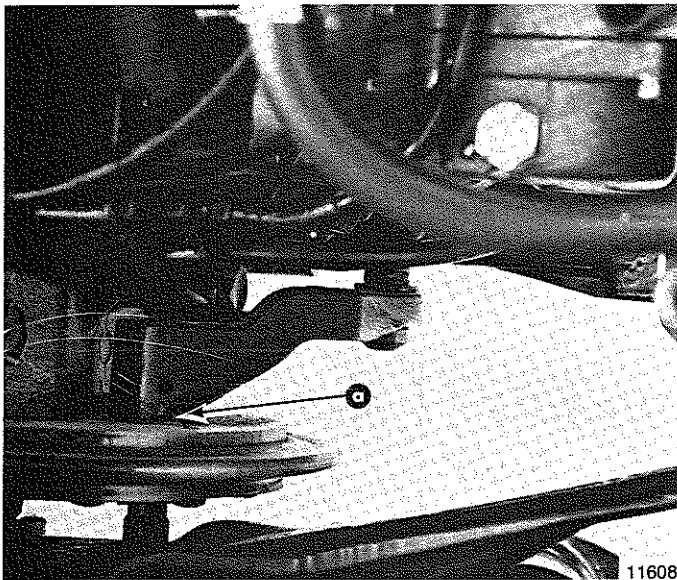
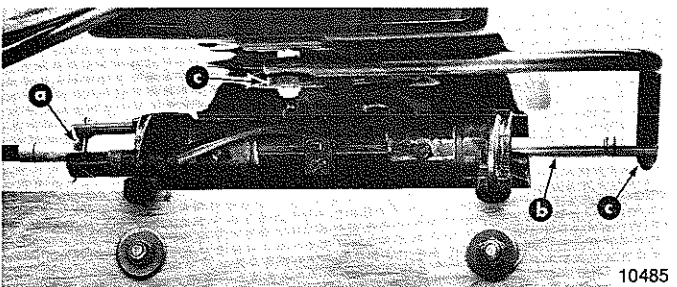


Figure 6. Swivel Pin Lubrication



a - Upper Shift Shaft

Figure 4. Lubricating Upper Shift Shaft



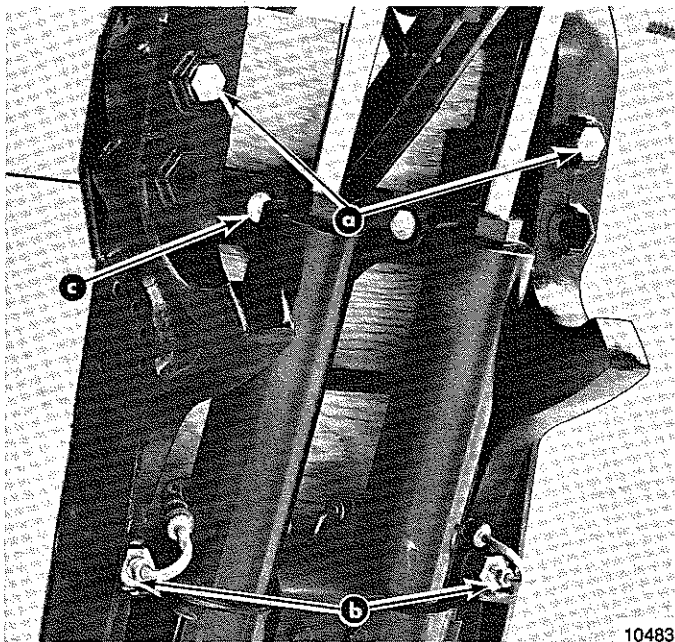
a - Grease Fitting b - Exposed Portion of Steering Cable
c - Link Rod Pivot Points

Figure 5. Lubricating Steering Cable and Pivot Points



a - Grease Fittings

Figure 7. Lubricating Tilt Tube

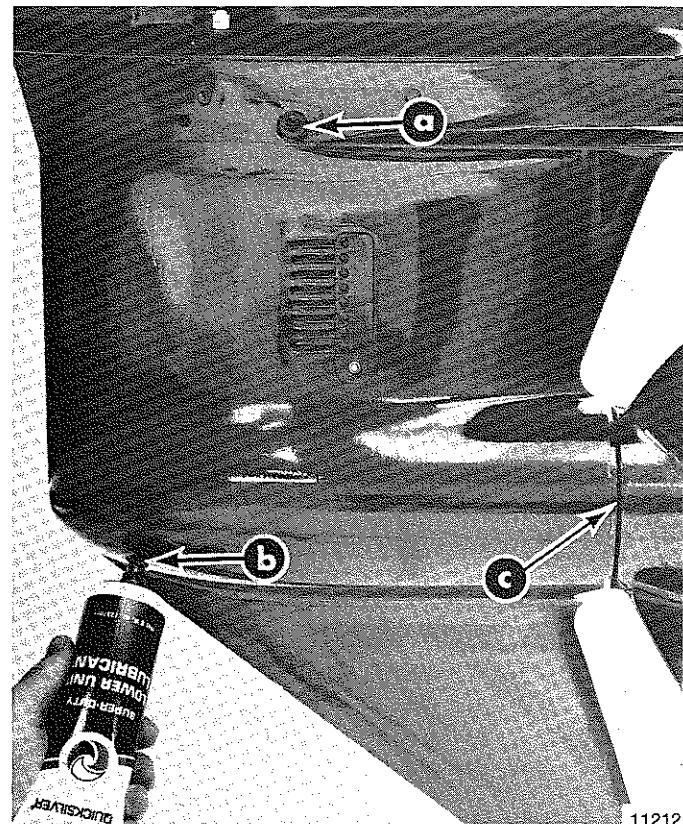


a - Tilt Lock Lever Shaft b - Locking Brace Pivot Points

Figure 8. Tilt Lock Lever and Brace Lubrication

a - Lubricant Vent Screw and Washer b - Lubricant Fill Hole
c - Propeller Shaft (Not Shown)

Figure 9. Gear Housing Lube (Filling)



Gear Housing Lubrication

SAFETY WARNING: To avoid accidental starting, disconnect spark plug ignition wires before working near the propeller.

CAUTION: DO NOT use automotive grease in the lower drive unit. Use only Quicksilver Super-Duty Gear Lubricant.

Periodically (every 25 hours) lubricate the gear housing with Quicksilver Super-Duty Outboard Gear Lubricant as follows:

1. Remove lubricant fill plug and washer from gear housing. (Figure 9)
2. Insert lubricant tube into fill hole, then remove lubricant vent screw and washer.

IMPORTANT: Never apply lubricant to gear housing without first removing lubricant vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing only when in operating position.

3. Fill gear housing with lubricant until excess starts to flow out of lubricant vent screw hole.

4. At this point, drain approximately one fluid ounce (30cc) from gear housing to permit expansion of lubricant.
5. Replace lubricant vent screw and washer.
6. Remove lubricant tube from fill hole; install fill plug and washer.

SALT WATER CORROSION - GEAR HOUSING BEARING CARRIER and COVER NUT

Salt water corrosion buildup can be sufficient to split a gear housing and destroy an entire lower unit. To protect against such damage, therefore, it is recommended that the gear housing bearing carrier and gear housing cover nut be lubricated on a regular basis, as follows:

Service first at the 20-hour inspection, then on an annual basis. Remove the cover nut and entire spool to adequately clean corrosive deposits and dried-up lubricant from both ends of the spool, as well as the gear housing internal threads and cover nut external threads. Apply a liberal amount of Perfect Seal to the 2 ends of the spool and to the gear housing and cover nut threads, then reassemble and retorque. Be cautious that Perfect Seal does not get into the bearing assemblies. Refer to gear housing disassembly and reassembly (Section 5).

Ride-Guide Steering Cable and Pivot Points Lubrication

SAFETY WARNING: Core of steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

With core of Ride-Guide Steering cable (transom end) fully retracted, lubricate transom end of steering cable thru grease fitting and exposed portion of cable end ("a" and "b" in Figure 5) with Multipurpose Lubricant. Lubricate all pivot points (Figure 5) with SAE 30W engine oil.

FUEL RECOMMENDATIONS

GASOLINE RECOMMENDATION

The only **APPROVED** gasolines for V-6 models are **REGULAR LEADED** and **PREMIUM** with minimum pump posted octane number 89 or research octane number 94. Use of any other gasoline will void outboard warranty.

In countries outside of the U.S.A. and Canada, the outboard distributor or dealer has a list of recommended gasoline in the area. The words, "Premium" and "Regular", have significant differences in different countries.

CAUTION: DO NOT USE white gasoline or fuels intended for stoves and lanterns. Use of improper gasolines and/or oils can cause serious damage to the outboard motor.

OIL RECOMMENDATION

CAUTION: The use of other than recommended gasoline and Formula 50-D or an acceptable oil may cause piston scoring, bearing failure or both. DO NOT, under any circumstances, use multigrade or other highly detergent automobile oils or oils which contain metallic additives.

Mix recommended gasoline with Quicksilver Formula 50-D 2-Cycle Outboard Motor Oil in ratio shown in the following charts. In emergency, when Quicksilver Formula 50-D Oil is not available, substitute a high quality 2-cycle oil that is intended for outboard use and meets BIA rating TC-W shown on oil container. BIA rating TC-W is the Boating Industry Association's designation for approved, 2-cycle water-cooled outboard oils. Use at oil manufacturer's recommended gasoline-oil mixture as shown on the label.

BREAK-IN PROCEDURE and FUEL MIXTURE

CAUTION: Follow break-in procedure carefully.

Mix gasoline and oil during the 10-hour break-in period at a 25:1 ratio, as shown in the following chart. Operate a new motor at 1/2-throttle (2500-3500 RPM) for two (2) hours. After 2 hours, the motor may run at any speed, although sustained operation at full throttle should be avoided for an additional eight (8) hours.

BREAK-IN FUEL MIXTURE (25:1 RATIO)

	U.S. Measure	Imperial Measure	Metric Measure
Formula 50-D	24 U.S. Oz. Oil to Each 5 Gal. of Gasoline	30 Imp. Oz. Oil to Each 5 Imp. Gal. Gasoline	800cc Oil to Each 20 Liters of Gasoline
Other Acceptable Oils	Use at 25:1 Ratio as Shown Above.		

FUEL MIXTURE after BREAK-IN

After motor break-in, use a 50:1 gasoline-oil ratio as shown in the following chart.

AFTER BREAK-IN FUEL MIXTURE (50:1 RATIO)

	U.S. Measure	Imperial Measure	Metric Measure
Formula 50-D	12 U.S. Oz. Oil to Each 5 Gal. of Gasoline	15 Imp. Oz. Oil to Each 5 Imp. Gal. Gasoline	400cc Oil to Each 20 Liters of Gasoline
Other Acceptable Oils	Use at Manufacturer's Recommended Gasoline/Oil Ratio, Not to Exceed 50:1.		

IMPORTANT: Using less than the recommended proportion of oil may result in very serious motor damage from lack of sufficient lubrication. Using more than the recommendation will cause spark plug fouling, erratic carburetion, excessive smoking and faster-than-normal carbon accumulation.

CORRECT FUEL MIXING PROCEDURE

CAUTION: Observe fire prevention rules, particularly the matter of smoking. Mix fuel outdoors or at least in a well-ventilated location.

Mix fuel directly and accurately in remote tank. Pour small, equal amounts of gasoline and oil into remote tank. Mix thoroughly, then add balance of oil and gasoline and mix again. Cleanliness, too, is important in mixing fuel. Be consistent; prepare each batch of fuel exactly the same as previous amounts.

IMPORTANT: Always use fresh gasoline. Gasoline forms gum and varnish deposits and, when kept in a tank for a length of time, may cause trouble.

ENGINE REMOVAL and INSTALLATION

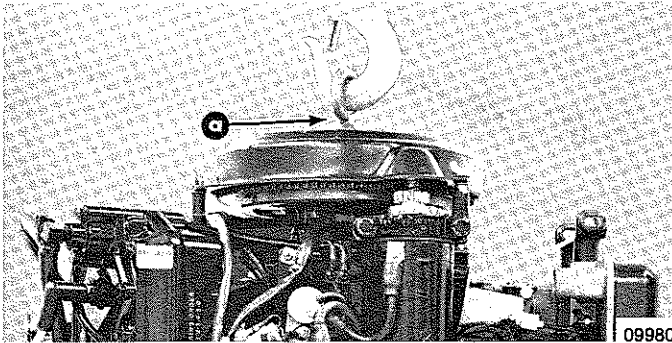
Removing Engine from Boat

NOTE: Use these instructions only for removing and replacing engine on boat transom. For complete engine installation, order instruction sheet Part No. C-90-75272.

1. Disconnect engine battery cables from battery terminals.
2. Remove front cover and lift cowling from engine.
3. Disconnect engine wiring harness and trim connector.
4. Disconnect engine fuel line from fuel tank.
5. Remove remote control cables from powerhead.
6. Install lifting eye (C-91-75132) into flywheel (Figure 1) hand-tight only.

SAFETY WARNING: Hoist must have a minimum lift capacity of 500 lbs. (227kg).

7. Connect a hoist (minimum lift capacity of 500 lbs.) to lifting eye.
8. Remove upper mounting bolts from transom bracket (it may be necessary to tilt engine up to remove bolt from transom bracket).



a - Lifting Eye (C-91-75132); Tighten Hand-Tight

Figure 1. Lifting Eye Installed into Flywheel

Installing Engine on Boat Transom

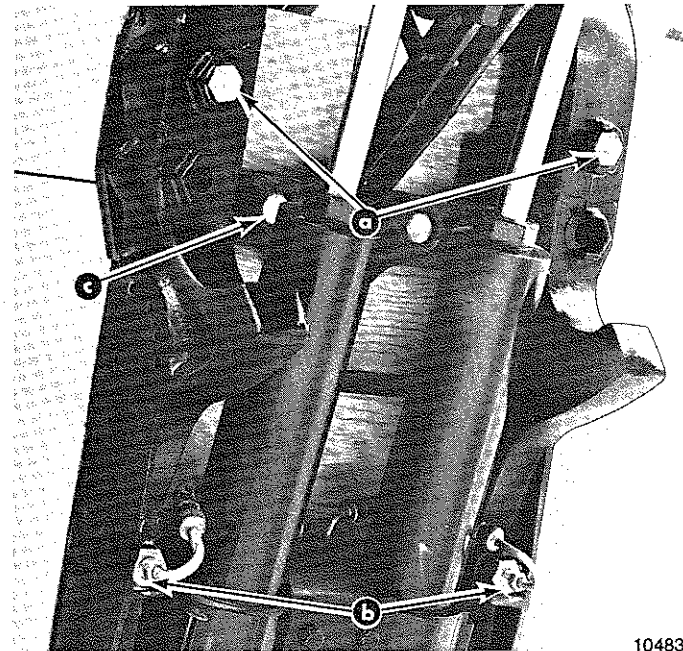
1. Install Lifting Eye (C-91-75132) into flywheel (tighten hand-tight).

SAFETY WARNING: Hoist must have a minimum lift capacity of 500 lbs. (227kg).

2. Connect a hoist (minimum lift capacity of 500 lbs.) to lifting eye.

NOTE: Before placing engine on transom, it may be necessary to install steering cable in engine tilt tube to avoid problems created by narrow engine well.

3. Lift engine and place on boat transom while guiding the tabs (located on inside of transom brackets) into pockets on both sides of engine mounting bracket. (Figure 2) It may be necessary to loosen engine mounting bracket slightly to allow engine transom brackets to seat on boat transom in order to align mounting holes.
4. Apply Marine Sealer to both hydraulic connectors within area shown in Figure 3. DO NOT apply Marine Sealer to threads of hydraulic connectors.

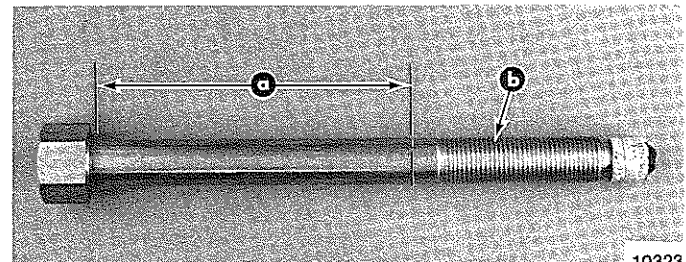


a - Upper Mounting Bolts b - Hydraulic Connectors
c - Engine Mounting Bracket

Figure 2. Engine Installed on Boat Transom

NOTE: Some hydraulic fluid will be lost when removing hydraulic hoses in Step 9.

9. With engine in vertical position, disconnect hydraulic hoses from both ends of each hydraulic connector (Figure 2) and remove connectors from transom brackets.
10. It may be necessary to loosen engine mounting bracket (Figure 2) slightly to allow engine to be removed. Lift engine from boat.



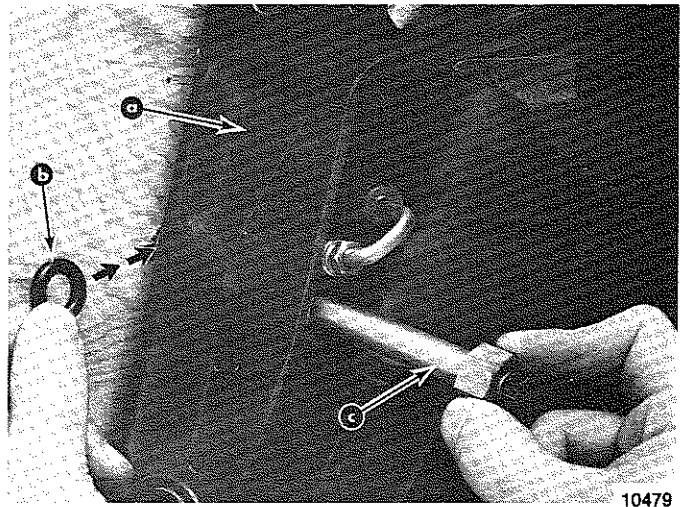
a - Apply Marine Sealer within This Area; DO NOT Apply to Threads
b - Apply Light Oil to Threads

Figure 3. Hydraulic Fitting

IMPORTANT: Hydraulic connectors (with large inside diameter) must be installed into port (left) engine transom bracket.

CAUTION: Be extremely careful, when installing hydraulic connectors, not to damage the hydraulic fittings nor to allow contaminants of any kind to enter these fittings.

5. Loosen engine mounting bracket slightly, then place hydraulic connectors into mounting holes in engine transom brackets [make sure that connector with larger inside diameter is placed into port (left) engine transom bracket]. Pull engine transom brackets away from boat transom and place an "O" ring onto end of each hydraulic connector between boat transom and transom bracket, as shown in Figure 4. Push connectors thru "O" ring and boat transom and retighten engine mounting bracket. Secure each hydraulic connector to boat transom with a flat washer and locknut. Tighten locknuts securely.
6. Reconnect hydraulic hoses to hydraulic connectors. DO NOT cross-thread or over-tighten hose fittings.
8. Disconnect hoist from lifting eye, then remove lifting eye from flywheel.
7. Install upper engine mounting bolts (Figure 2) and secure to transom with flat washers and locknuts.
9. Reconnect engine battery leads to terminals of battery, red lead to (+) positive terminal and black lead to (-) negative terminal.
10. Reconnect engine wiring harness and trim connector.
11. Fill and bleed hydraulic system as follows:
 - a. Place outboard in "full down" position.
 - b. Remove "Fill" screw and fill pump reservoir with name brand SAE 10W-30 or 10W-40 service grade "SE" automotive oil to "Full" mark on dipstick.
 - c. Bleed air from hydraulic system by operating trim system several times thru entire range while maintaining fluid level in pump reservoir. Check fluid level when engine is in "full down" position. Reinstall "Fill" screw.



10479
 a - Engine Transom Bracket b - "O" Ring
 c - Hydraulic Connector [Connector with Larger ID Is Installed in Port (Left) Engine Transom Bracket]

Figure 4. Installing Hydraulic Connectors

12. Install control cable to engine. Refer to control cable installation in Section 7 of Service Manual.
13. Reconnect fuel line to fuel tank.
14. Reinstall cowling.
15. Reinstall Ride-Guide Steering cable to engine. Refer to Ride-Guide Steering cable installation in Section 7 of Service Manual.

PROPELLER SELECTION and INSTALLATION

Select propellers from propeller charts in Quicksilver Accessories Guide.

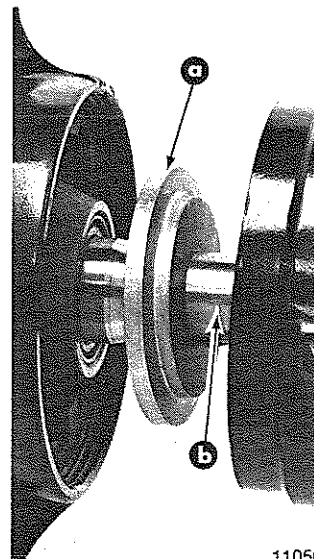
INSTALLATION

Using boat length and gross load, select 2 or more trial propellers from the propeller charts for evaluation.

SAFETY WARNING: When installing or removing propeller, because of the motor's ease in starting, be sure that the remote control is in neutral position and that the key switch is "Off". Place a block of wood between the anti-cavitation plate and propeller to prevent accidental motor starting and to protect hands from propeller blades while removing propeller nut.

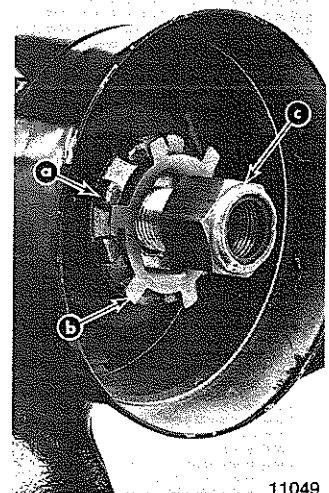
Apply a liberal coat of Perfect Seal or a waterproof-type lubricant on propeller shaft splines to aid in future removal of propeller and follow these steps:

1. Place forward thrust hub into propeller hub (shoulder into recess of propeller). (Figure 5)
2. While aligning splines, place Quicksilver Propeller (with forward thrust hub) on propeller shaft.
3. Place rear thrust hub, tab washer and propeller nut on propeller shaft. (Figure 6)



11050
 a - Forward Thrust Hub
 b - Propeller Shaft

Figure 5. Propeller Installation



11049
 a - Rear Thrust Hub
 b - Tab Washer
 c - Propeller Nut

Figure 6. Propeller Nut and Tab Washer

4. Thread propeller nut on propeller shaft and tighten, making certain that nut is recessed into tab washer.
5. Bend three of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (Figure 6)

TRIM TAB ADJUSTMENT (SINGLE ENGINE)

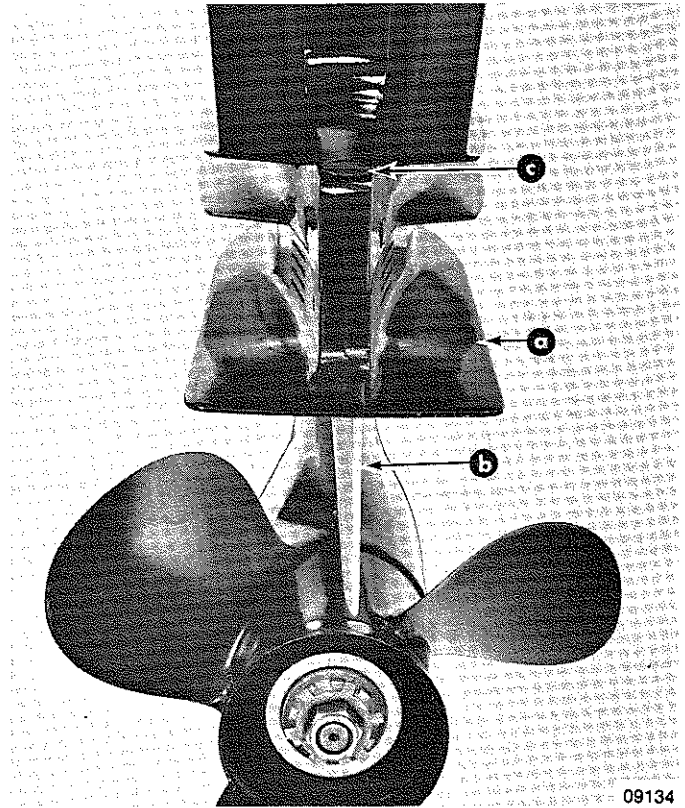
NOTE: For dual engines, refer to trim tab adjustment in Section 7 of this Service Manual.

1. Place trim tab so that trailing edge is in center of anti-cavitation plate.
2. For trim tab adjustment, remove plug at top of drive shaft extension (Figure 7), remove trim tab screw underneath and adjust trim tab. Replace screw (tighten securely) and plug.
3. Operate boat at the speed at which it would normally be operated and trim the engine in-or-out to attain the most comfortable boat attitude (with least amount of steering torque).
4. If the boat pulls to the right (starboard), the trailing edge of trim tab must be moved to the right. If the boat pulls to the left (port), the trailing edge of trim tab must be moved to the left. (Figure 7)
5. Readjust trim tab, as necessary, to balance steering.

NOTE: The effectiveness of the trim tab to balance steering will be reduced as boat transom height is increased.

a - Anti-Cavitation Plate
b - Adjustable Trim Tab
c - Plug

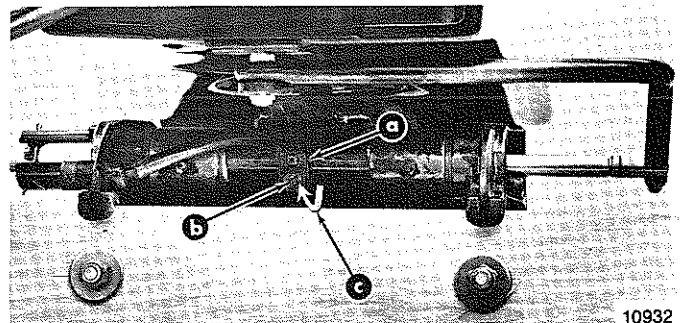
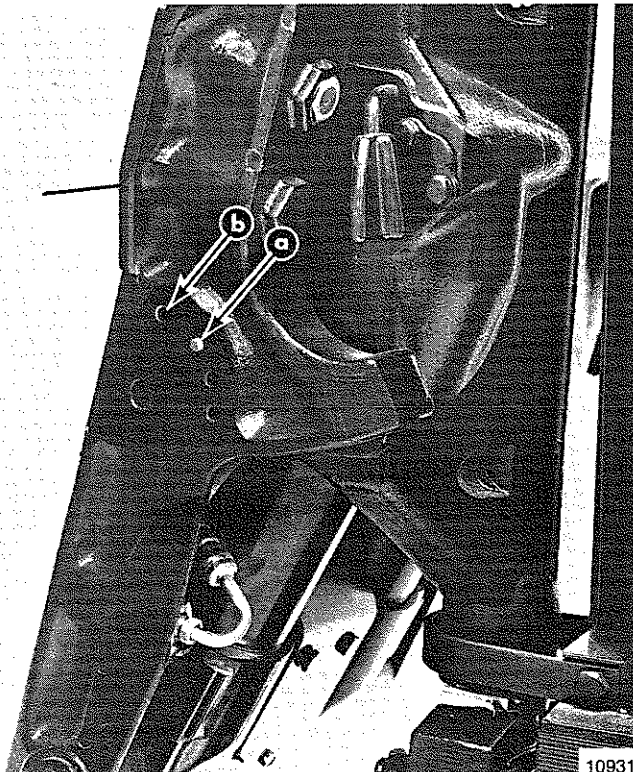
Figure 7. Adjustable Trim Tab



TILT ANGLE ADJUSTMENT

TILT ANGLE SETTING (MINIMUM)

The motor is shipped with the tilt angle cam in the second lowest position for installation convenience. Although this



a - Tilt Tube Clamp b - Clamp Screw c - Decrease Travel

Figure 9. Trim Limit Switch Adjustment

cam location may provide acceptable idle to minimum planing speed acceleration, better acceleration can be obtained by removing the roll pin ("a" in Figure 8) and reinstalling it in the lowest location (closest to the transom) ("b" in Figure 8).

SAFETY WARNING: Operating some boats at minimum trim "in" at planing speeds will cause undesirable and/or unsafe steering conditions. Each boat should be tested for handling characteristics after any adjustment is made to the tilt angle cam location.

a - Roll Pin (Installed in Second Tilt Angle Adjustment Hole)
b - Lowest Location

Figure 8. Tilt Angle Adjustment

TILT ANGLE SETTING (MAXIMUM)

The trim limit switch is pre-adjusted at the factory to maximum travel. Some boats, when trimmed to this maximum trim angle, may exhibit undesirable handling characteristics. If this condition is experienced, it will be necessary to readjust the tilt tube clamp to reduce the amount of trim travel. (Figure 9)

IMPORTANT: A nut is fastened to end of clamp screw. If clamp screw is loosened too far, nut will fall

off end of screw. Make sure that nut is on screw when retightening.

If trim limit adjustment is necessary, loosen clamp screw and rotate clamp as shown in Figure 9. Retighten screw and retest boat at maximum trim angle for handling quality.

NOTE: If trim limit switch is readjusted, the trim indicator gauge will not register full outward trim travel.

PERIODIC INSPECTION

Conduct a periodic, systematic inspection to uncover and correct a failure before it can cause inconvenience or mechanical damage. Inspection interval is based on average operating conditions in utility service. Under severe conditions, the inspection interval should be shortened. Inspection includes:

1. Clean entire unit thoroughly, including all accessible powerhead parts.
3. Check entire unit for loose, damaged or missing parts. Tighten or replace as required.
3. Lubricate gear housing as instructed previously.
4. Lubricate other points as indicated, preceding.
5. Lubricate starter motor shaft with light film of SAE No. 10 oil. **Do not over-lubricate.**
6. Service spark plugs. Inspect spark plug leads and electrical leads for damage or deterioration, as explained in "Electrical" section.

7. Inspect fuel lines for damage or deterioration and service fuel filters as indicated in Section 3.
8. Remove propeller and inspect. Trim nicks and burrs with a file, being careful not to remove more metal than absolutely necessary. Inspect for cracks, damage or bent condition. If condition is doubtful, refer to authorized Quicksilver Propeller Repair Station facilities. Before re-installing propeller, coat propeller shaft with Perfect Seal or a waterproof-type lubricant.
9. Inspect the engine surface finish for damage or corrosion. Thoroughly clean damaged or corroded areas and apply matching paint (Quicksilver Spray Paints).
10. Check trim tab and galvanic corrosion inhibitor for damage or for deterioration from salt water operation.
11. Check remote controls and steering. Be sure that all connections and fittings are in good condition, properly secured and correctly adjusted.

FLUSHING ENGINE

After operation in salt water or polluted water, install a Quicksilver Flushing Attachment (Figure 10) to flush the engine, following.

SAFETY WARNING: When flushing, be certain that area in vicinity of propeller is clear and that no person is standing nearby -- to avoid possible injury. It is recommended to remove propeller as a precautionary measure.

1. Insert rubber washer (supplied with flushing attachment) into flushing attachment hose coupling.
2. Lubricate lower unit (in area of water intake openings) and rubber cups of flushing attachment with a water/soap solution.
3. Install Quicksilver Flushing Attachment in position on drive unit, with rubber cups covering water intake openings. Attachment must be installed from front of lower unit. (Figure 10)
4. Connect garden hose between flushing attachment and a water tap.
5. Partially open water tap. **DO NOT** use full city water pressure.
6. Shift into neutral gear, then start engine. **DO NOT** operate above 1200 RPM.
7. Adjust water flow so there is a small loss of water around rubber cups.
8. Monitor engine to be sure that water is being discharged from "tell-tale" nozzle. (Figure 2) If water is not coming

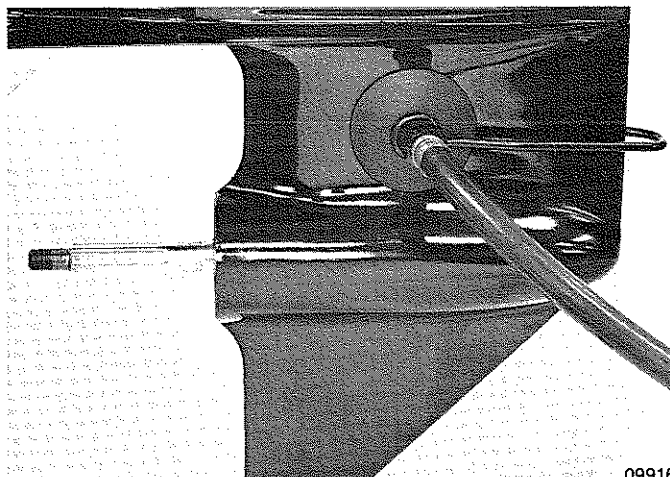


Figure 10. Quicksilver Flushing Attachment (C-73971A1) Installed

out of "tell-tale", stop engine immediately and check thoroughly before continuing to flush.

9. Flush engine until discharged water is clear, **THEN STOP ENGINE.**

NOTE: If used in salt water, operate engine for at least 5 minutes.

10. Close water tap and remove Quicksilver Flushing Attachment from lower unit.

OUT-of-SEASON ENGINE STORAGE

SAFETY WARNING: As a safety precaution, when boat is in storage, remove positive (+) battery cable. This will eliminate possibility of accidental starting of engine and resultant overheating and damage to engine from lack of water.

In preparing a motor for out-of-season storage, 2 precautions must be considered: 1) The engine must be protected from physical damage and 2) the engine must be protected from rust, corrosion and dirt.

1. Remove cowling from engine.
2. Remove sound box cover from carburetor.
3. Place engine in water or install Quicksilver Flushing Attachment over water intake by following instructions outlined in "Flushing Engine" (see "Index").
4. Start engine and allow to warm up. Disconnect fuel line and allow engine to run at low RPM while inducing approximately 2 oz. (57 g) of Quicksilver Storage Seal thru each carburetor throat. Allow engine to stall out, indicating that carburetors have run dry.
5. Remove spark plugs from engine and spray approximately one ounce (30 ml) of Quicksilver Storage Seal into each spark plug hole. Manually turn engine over several times to distribute Storage Seal throughout cylinders. Reinstall spark plugs.

6. Clean carburetor fuel filter. Refer to Section 3.
7. Drain and refill lower unit with Super-Duty Quicksilver Gear Lubricant, as explained in "Gear Housing Lubrication" (see "Index").
8. Clean motor thoroughly, including all accessible powerhead parts, and spray with Corrosion and Rust Preventive.
9. Refer to lubrication chart in this section (see "Index") and lubricate all lubrication points.
10. Remove propeller. Apply Perfect Seal or a waterproof-type lubricant to propeller shaft and reinstall propeller. Refer to "Propeller Selection and Installation" (see "Index").
11. Store battery as outlined in "Out-of-Season Battery Storage", following.

IMPORTANT: When storing outboard for the winter, be sure that all water drain holes in gear housing are open and free so that all water will drain out. Trapped water may freeze and expand, thus cracking gear housing and/or water pump housing. Check and refill gear housing with Quicksilver Super-Duty Gear Lubricant before storage to protect against possible water leakage into gear housing that is caused by loose lubricant vent plug or loose grease fill plug. Inspect gaskets under lubricant vent and fill plugs, replacing any damaged gaskets, before reinstalling plugs.

OUT-of-SEASON BATTERY STORAGE

1. Remove battery as soon as possible and remove all grease, sulfate and dirt from top surface.
2. Cover plates with distilled water, but not over 3/16" (5mm) above perforated baffles.
3. Cover terminal bolts well with grease.
4. Store battery in a COOL, DRY place in a dry carton or box.
5. Remove battery from storage every 60 days. Check water level and place on charge for 5 to 6 hours at 6 amperes. DO NOT fast charge.

CAUTION: A discharged battery can be damaged by freezing.

FOLLOWING COMPLETE SUBMERSION

Submerged engine treatment is divided into 3 distinct problem areas. The most critical is submersion in salt water; the second is submersion while running.

SALT WATER SUBMERSION (SPECIAL INSTRUCTIONS)

Due to the corrosive effect of salt water on internal engine components, complete disassembly is necessary before any attempt is made to start the engine.

SUBMERGED WHILE RUNNING (SPECIAL INSTRUCTIONS)

When an engine is submerged while running, the possibility of internal engine damage is greatly increased. If, after engine is recovered and with spark plugs removed, engine fails to turn over freely when turning flywheel, the possibility of internal damage (bent connecting rod and/or bent crankshaft) exists. If this is the case, the powerhead must be disassembled.

SUBMERGED ENGINE (FRESH WATER) (PLUS SPECIAL INSTRUCTIONS)

1. Recover engine as quickly as possible.
2. Remove cowling, then spark plugs.

3. Remove carburetor float bowl covers.
4. Flush outside of engine with fresh water to remove mud, weeds, etc. DO NOT attempt to start engine if sand has entered powerhead, as powerhead will be severely damaged. Disassemble powerhead to clean components.
5. Get as much water as possible out of powerhead. Most water can be eliminated by placing engine in a horizontal position (with spark plug holes down) and rotating flywheel.
6. Pour alcohol into carburetor throat (alcohol will absorb water). Again operate rewind starter.
7. Turn engine over and pour alcohol into spark plug opening(s) and again rotate flywheel.
8. Turn engine over (place spark plug opening down) and pour engine oil into throat of carburetors while rotating flywheel to distribute oil throughout crankcase.
9. Again turn engine over and pour approximately one teaspoon of engine oil into each spark plug opening. Again rotate flywheel to distribute oil in cylinders.
10. Reinstall spark plugs and float bowl covers.
11. Attempt to start engine, using a fresh fuel source. If engine starts, it should be run for at least one hour to eliminate any water in engine.
12. If engine fails to start, determine cause (fuel, electrical or

mechanical). DO NOT allow engine to remain idle for more than 2 hours, as serious internal damage will occur.

If unable to start engine in this period, disassemble engine and clean all parts and apply oil as soon as possible.

HOW WEATHER AFFECTS ENGINE PERFORMANCE

It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

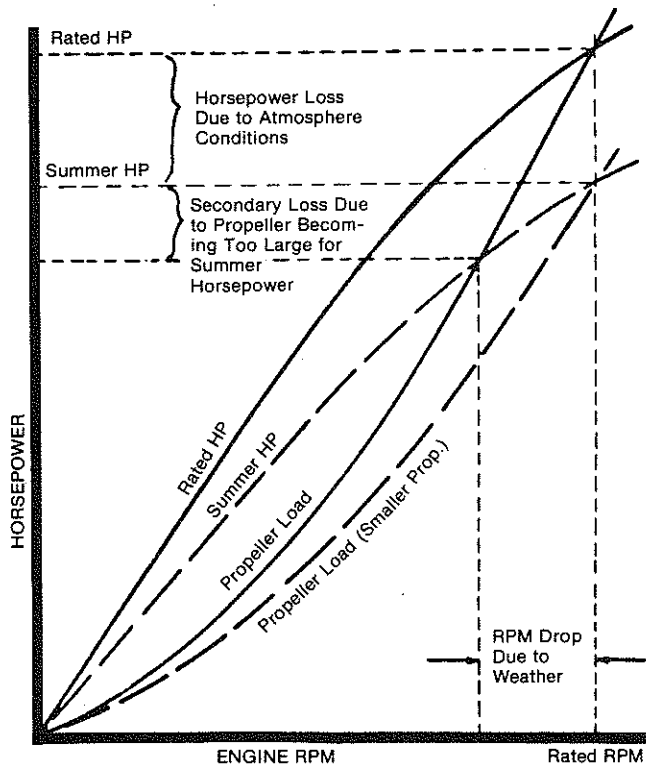
The Engine Test Code of the Society of Automotive Engineers (SAE) standardizes the computation of horsepower from data obtained on the dynamometer, correcting all values to the power that the engine will produce at sea level in dry air at 60°F (16°C) temperature and a barometric pressure of 29.92 inches of mercury.

Summer conditions of high temperature, low barometric pressure and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds -- as much as 2 or 3 miles-per-hour in some cases. (Refer to chart, right.) Nothing will regain this speed for the boater, but the coming of cool, dry weather.

In pointing out the practical consequences of weather effects, an engine--running on a hot, humid summer day--may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk spring or fall day. The horsepower, that any internal combustion engine produces, depends upon the density of the air that it consumes and, in turn, this density is dependent upon the temperature of the air, its barometric pressure and water vapor (or humidity) content.

Accompanying this weather-inspired loss of power is a second but more subtle loss. At rigging time in early spring, the engine was equipped with a propeller that allowed the engine to turn within its recommended RPM range at full throttle. With the coming of the summer weather and the consequent drop in available horsepower, this propeller will, in effect, become too large. Consequently, the engine operates at less than its recommended RPM.

Due to the horsepower/RPM characteristics of an engine, this will result in further loss of horsepower at the propeller with another decrease in boat speed. This secondary loss, however,



can be regained by switching to a smaller pitch propeller that allows the engine to again run at recommended RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine be propped to allow it to operate at or near the top end of the recommended maximum RPM range at wide-open-throttle.

Not only does this allow the engine to develop full power, but equally important is the fact that the engine also will be operating in an RPM range that discourages damaging detonation. This, of course, enhances overall reliability and durability of the engine.

DETONATION: CAUSES and PREVENTION

Detonation in a 2-cycle engine somewhat resembles the "pinging" heard in an automobile engine. It can be otherwise described as a tin-like "rattling" or "plinking" sound.

Detonation generally is thought of as spontaneous ignition, but it is best described as a noisy explosion in an unburned portion of the fuel/air charge after the spark plug has fired. Detonation creates severe, untimely shock waves in the engine, and these shock waves often find or create a weakness: The dome of a piston - the cylinder head gasket - piston rings or piston ring lands.

While there are many causes for detonation in a 2-cycle engine, emphasis is placed on those causes which are most common in marine 2-cycle application. A few, which are not commonly understood, are:

1. **Over-advanced ignition timing.**
2. **Use of low octane gasoline.**
3. **Propeller pitch too high (engine RPM below recommended maximum range).**

4. **Lean fuel mixture at or near wide-open-throttle.**
5. **Spark plugs (heat range too hot - incorrect reach - cross-firing).**
6. **Inadequate engine cooling (deteriorated cooling system).**
7. **Combustion chamber/piston deposits (result in higher compression ratio).**

If an impression exists, that 2-cycle engines are very complicated and complex, NOT SO. Two-cycle marine engines are, pound-for-pound, still one of the most dependable and easiest-to-service power packages. Generally, when they are operated on the correct diet of fuel and oil, with specified ignition timing and setup to turn at the recommended RPM at wide-open-throttle, they will provide countless hours of trouble-free operation.

Detonation usually can be prevented, provided that 1) the engine is correctly set up and 2) diligent maintenance is applied to combat the detonation causes, listed, preceding.

V-6 OUTBOARDS

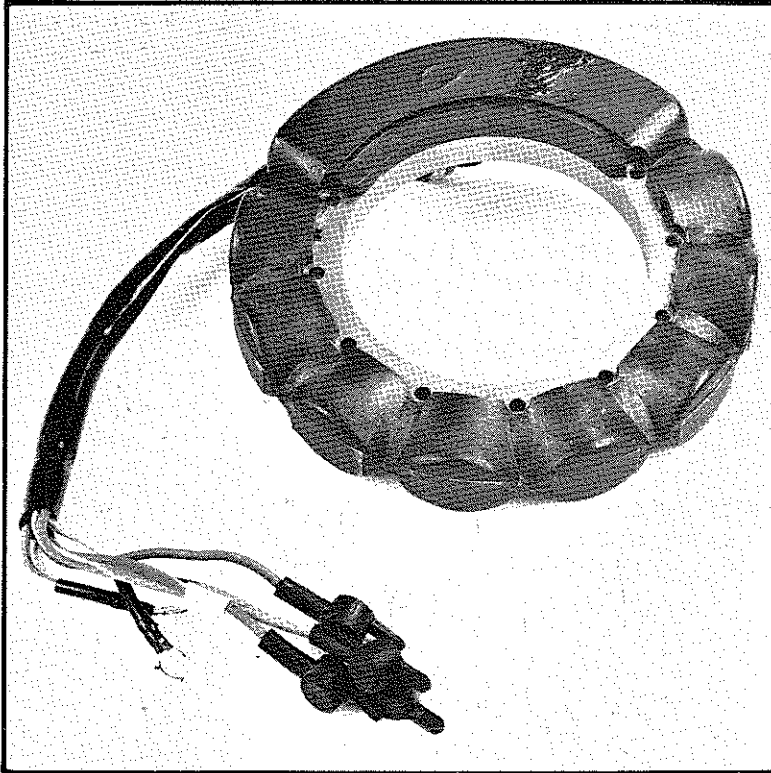
Electrical and Ignition

SECTION

2

PART

A



Ignition System

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PART A - IGNITION SYSTEM

Description

The V-6 outboard ignition system is alternator-driven with distributor-less capacitor discharge. Major components of the ignition system are the flywheel, stator assembly, trigger assembly, 2 switchboxes, 6 ignition coils and 6 spark plugs.

The stator assembly is mounted below the flywheel and has 4 ignition coils. The flywheel is fitted with permanent magnets inside the outer rim, as the flywheel rotates, and the permanent magnets pass the stationary stator ignition coils. This causes the ignition coils to produce AC voltage. The AC voltage then is conducted to the switchboxes where it is rectified and stored in a capacitor.

The trigger assembly (also mounted under the flywheel) has 3 coils. The flywheel likewise has a second set of magnets (located around the hub), as the flywheel rotates, and the second set of permanent magnets passes the trigger coils. This causes the trigger coils, in turn, to produce an AC voltage that is conducted to an electronic switch (SCR) in the switchbox.

The switch discharges the capacitor voltage into the ignition coil at the correct time and in firing order sequence.

Capacitor voltage is conducted to the ignition coil primary. The ignition coil multiplies this voltage to a value high enough to break down the gap at the spark plug.

The preceding sequence occurs once-per-engine-revolution for each cylinder.

Spark timing is changed (advanced/retarded) by rotating the trigger coil position in relation to the permanent magnets on the flywheel hub.

IMPORTANT: If the engine misfires, runs rough or does not start, the ignition system should be checked with Quicksilver Thunderbolt Ignition Analyzer (C-91-62563A1). Follow instructions in the test manual included with the analyzer.

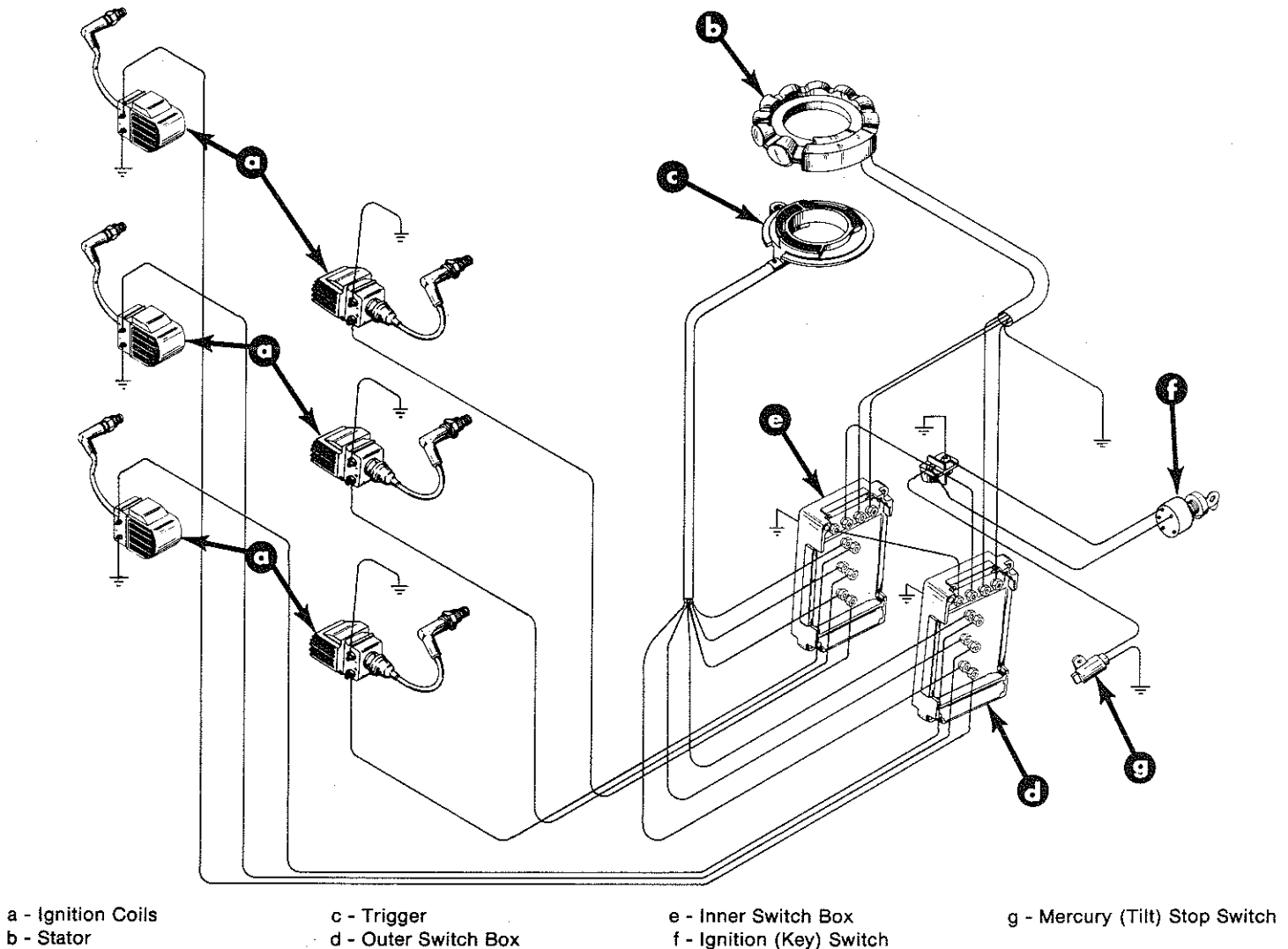


Figure 1. V-6 Engine Ignition System

Test Procedures

SAFETY WARNING: When testing or servicing the V-6 outboard ignition system, high voltage is present. Be extremely cautious. DO NOT TOUCH OR DISCONNECT any ignition parts while engine is running, while key switch is on or while battery cables are connected.

Failure to comply with the following items may result in damage to the ignition system.

1. DO NOT reverse battery cable connections. The battery negative cable is (-) ground.
2. DO NOT "spark" battery terminals with battery cable connections to check polarity.
3. DO NOT disconnect battery cables while engine is running.
4. DO NOT crank engine when switch boxes are not grounded to engine.

A process of elimination must be used when checking the ignition system without the Quicksilver Thunderbolt Ignition Analyzer (C-91-62563A1), as the switchboxes and ignition coils cannot be thoroughly checked with conventional test equipment.

All other components can be tested with a VOA meter. Before troubleshooting the ignition system, check the following:

1. Make sure that electrical harness, ignition switch, and mercury switch are not the source of the problem.
2. Check that plug-in connectors are fully engaged and terminals are free of corrosion.
3. Make sure that wires' connections are tight and free of corrosion.
4. Check all electrical components, that are grounded directly to engine, and all ground wires to see that they are grounded to engine.
5. Check for disconnected wires and short and open circuits.

STATOR TEST

Two types of stator assemblies are used on V-6 models.

TYPE I stator assembly is without a black ground wire, and the stator is grounded directly to engine thru the stator mounting plate.

TYPE II stator assembly has a black ground wire, and the stator is grounded to engine thru the black ground wire,

IMPORTANT: Stator must be grounded to engine.

1. Remove 2 screws and lift outer switch box from inner switch box. Refer to switch box(es) removal and installation, following.
2. To test, disconnect blue/white and red/white stator leads from outer switchbox and blue and red stator leads from inner switchbox.
3. Use a VOA meter and perform the following tests:

Test Leads to —	Ohm Scale	Meter Reading
Between Blue and Red Stator Leads	R x 1000	5.4-6.2
Between Blue/White and Red/White Stator Leads	R x 1000	5.4-6.2
*Between Red Stator Lead and Engine Ground	R x 1	125-175
*Between Red/White Stator Lead and Engine Ground	R x 1	125-175

* If stator assembly has a black ground wire, make sure that black wire is grounded to engine.

4. If meter readings are other than specified, replace stator assembly. Refer to stator assembly removal and installation (see "Index").

CAUTION: Switch boxes must be grounded to engine before cranking engine, or switch boxes will be damaged.

TRIGGER ASSEMBLY TEST

1. Remove 2 screws and lift outer switch box from inner switch box. Refer to switch box(es) removal and installation, following.
2. Disconnect all trigger leads from switch boxes.
3. Use a VOA meter and perform the following checks:

Test Leads to —	Ohm Scale	Meter Reading
Between Brown Trigger Lead (without Yellow Sleeve) and White Trigger Lead (with Yellow Lead)	R x 100	11-14
Between White Trigger Lead (without Yellow Sleeve) and Violet Trigger Lead (with Yellow Sleeve)	R x 100	11-14
Between Violet Trigger Lead (without Yellow Sleeve) and Brown Trigger Lead (with Yellow Sleeve)	R x 100	11-14

4. If meter readings are not as specified, replace trigger assembly. Refer to "Trigger Assembly Removal and Replacement", following.

CAUTION: Switch boxes must be grounded to engine before cranking engine, or switch boxes will be damaged.

IGNITION COIL TEST

IMPORTANT: VOA meter tests can only detect certain faults in the ignition coils. Replace ignition coil, if VOA meter readings (listed in chart, following) are not as specified. If coil tests OK, and coil is still sus-

pected of being faulty, use Quicksilver Ignition Analyzer (C-91-62563A1) to thoroughly check coil.

1. Disconnect wires from the positive (+) and negative (-) coil terminals.
2. Remove the spark plug (hi-tension) lead from coil tower.
3. Use a VOA meter and perform the following tests:

Test Leads to —	Ohm Scale	Meter Reading
Between (+) and (-) Coil Terminals	R x 1	.02-.04
Between Coil Tower and Either (+) or (-) Coil Terminal	R x 1000	No Continuity
Orange Color Coils Only - Between Coil Tower and Engine Ground (if Mounted) or To Small Pigtail Wire on Back Side (if Removed). This test Cannot Be Performed on Blue Color Coils	R x 1000	9-12

4. The primary DC resistance of these coils generally is less than one (1) OHM. If a reading (resembling a short) is obtained, this would be acceptable. Copper wire is an excellent conductor, but it will have a noticeable difference in resistance from cold to hot temperatures. Reasonable variations from these specified readings are acceptable.
5. If meter readings are not as specified, replace ignition coil. Refer to "Ignition Coil Removal and Installation", following.

MERCURY (TILT) STOP SWITCH TEST

1. Remove mounting screw that secures mercury switch and black ground wire to engine.
2. Connect a VOA meter (R x 1 scale) between black (mercury switch) lead and orange (mercury switch) lead.
3. Test mercury switch as follows:
 - a. Position mercury switch as it would be installed when engine is in "down" position. The meter should indicate no continuity.
 - b. Tilt mercury switch up, as shown in Figure 1A, and tap end of switch with finger. The meter should indicate continuity.
 - c. If these readings are not obtained, replace mercury switch.

IGNITION (KEY) SWITCH TEST

1. Disconnect remote control wiring harness and instrument panel connector.

NOTE: Refer to wiring diagram at end of this section for correct identification of connector terminals.

2. Set VOA meter on R x 1 scale for the following tests:

TEST 1: Connect VOA meter between terminals 7 and 4 of the remote control harness connector. Place key switch in "Stop" position. Meter should indicate continuity.

TEST 2: Connect VOA meter between terminal one (1) of the remote control harness connector and terminal "A" of the instrument panel connector. Place key switch in "Run" position. Meter should indicate continuity.

TEST 3: Position shift lever in neutral. Connect VOA meter between terminals one (1) and 3 of the remote control harness connector. Place key switch in "Run/Start" position. Meter should indicate continuity.
3. If meter readings are other than specified in the preceding tests, recheck at ignition switch soldered connections to verify that switch and not wiring is faulty. Remove and replace switch if meter readings are other than specified.

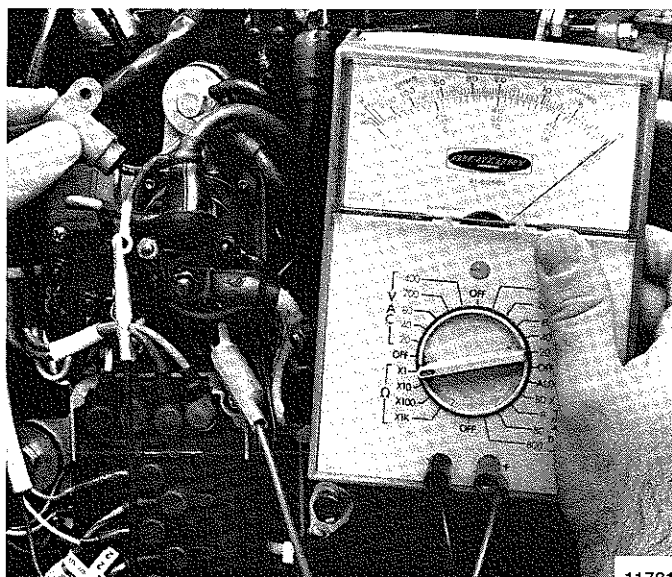


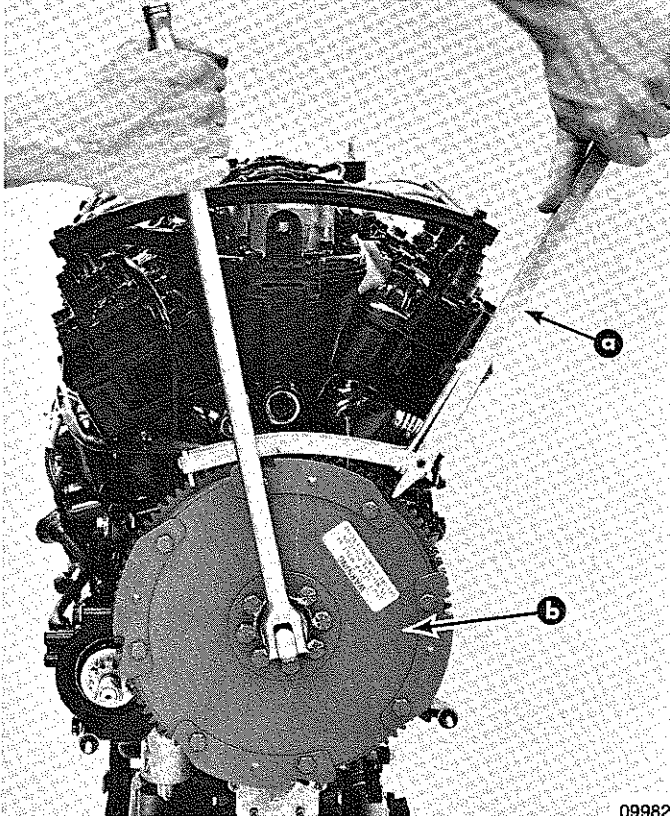
Figure 1A. Testing Mercury (Tilt) Stop Switch

Ignition Components Removal and Installation

FLYWHEEL REMOVAL and INSTALLATION

Flywheel Removal

1. Remove 3 wing nuts and lift flywheel cover off engine.
2. While holding flywheel with Flywheel Holder (C-91-52344), remove flywheel nut and washer. (Figure 2)
3. Install a crankshaft protector cap on end of crankshaft, then install Flywheel Puller (C-91-73687A1) into flywheel. (Figure 3)



a - Flywheel Holder (C-91-52344)

b - Flywheel

Figure 2. Flywheel Nut Removal

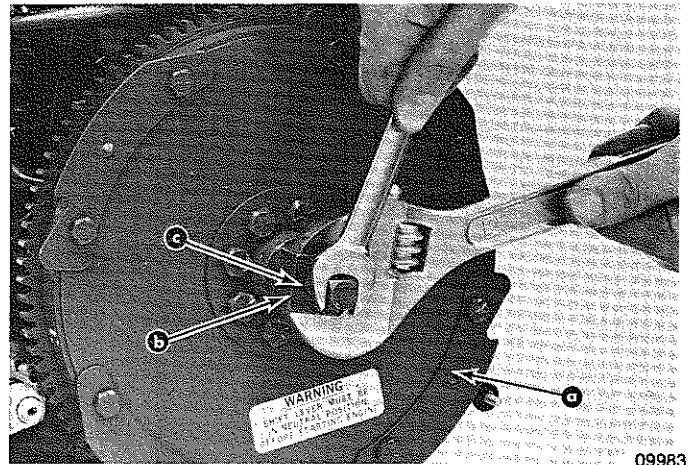
CAUTION: Crankshaft damage may result if a protector cap is not used between crankshaft and puller.

4. Remove flywheel by operating flywheel puller, as shown in Figure 3.

CAUTION: DO NOT hammer on end of puller center bolt to remove flywheel, or damage may result to crankshaft or bearings. DO NOT use heat to aid flywheel removal, as excessive heat may seize flywheel to crankshaft.

Flywheel Installation

1. Reinstall flywheel on crankshaft. Secure flywheel with flat washer and locknut. While holding flywheel with Flywheel Holder (C-91-52344), torque flywheel nut to 100 ft. lbs. (13.83mkg). (Figure 4)
2. Reinstall flywheel cover on engine.

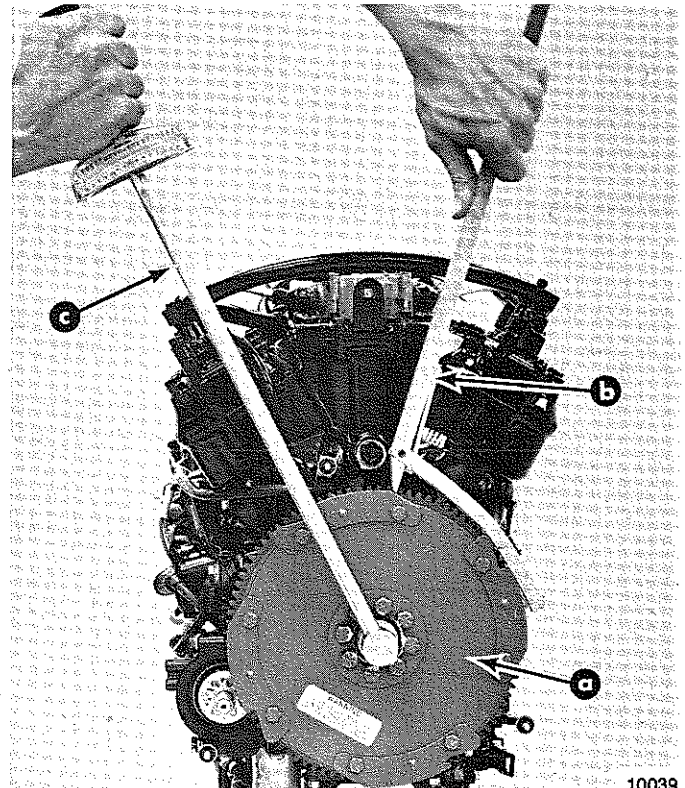


a - Flywheel

b - Flywheel Puller (C-91-73687A1)

c - Crankshaft Protector Cap (Hidden)

Figure 3. Flywheel Removal



a - Flywheel

b - Flywheel Holder (C-91-52344)

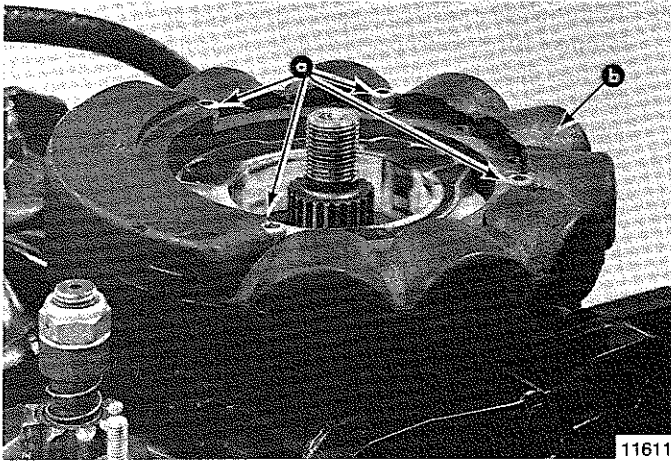
c - Torque Wrench - Torque to 100 Ft. Lbs. (13.83mkg)

Figure 4. Torquing Flywheel Locknut

STATOR ASSEMBLY REMOVAL and INSTALLATION

Stator Assembly Removal

1. Remove flywheel, as outlined in "Flywheel Removal and Installation", preceding.
2. Remove 4 screws which secure stator to the upper end cap. (Figure 5)
3. Remove 2 screws and lift outer switch box from inner switch box. (Retain round metal spacers.)



a - Stator Attaching Screws with Locknuts
b - Stator

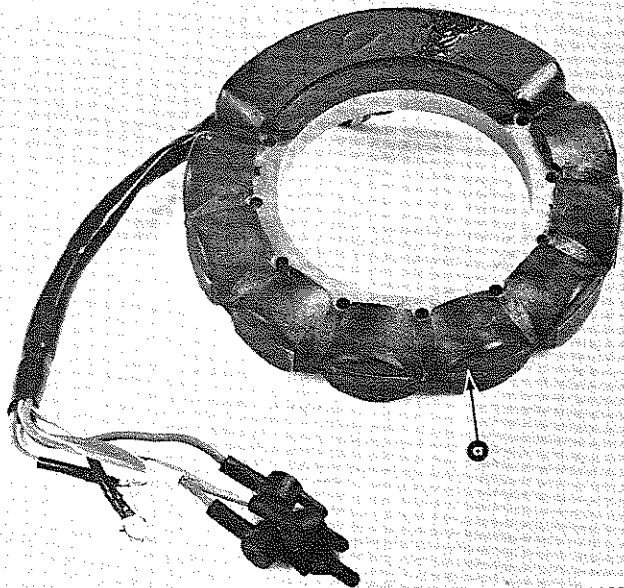
Figure 5. Stator Assembly

4. Disconnect all stator leads from their respective terminals, cut sta-strap(s) and remove stator assembly from engine. (Figure 6)

Stator Assembly Installation

1. Place a drop of Loctite Type "A" on threads of stator attaching screws (4 required). Install stator assembly in position on upper end cap (Figure 7) and secure with attaching screws. Torque screws to 30 in. lbs. (35kg-cm).
2. Reconnect wires to proper terminals of rectifier and switch boxes. Refer to wiring diagram, following in this section. Wires with yellow identification sleeve must be connected to outer switch box.
3. Install switch boxes to engine with 2 screws and 2 round metal spacers. Refer to switch box(es) removal and installation (see "Index"). Make sure that both switch boxes are grounded to engine thru mounting screws and spacers.

CAUTION: Switch boxes must be grounded to engine before cranking engine, or switch boxes will be damaged.



a - Stator Assembly

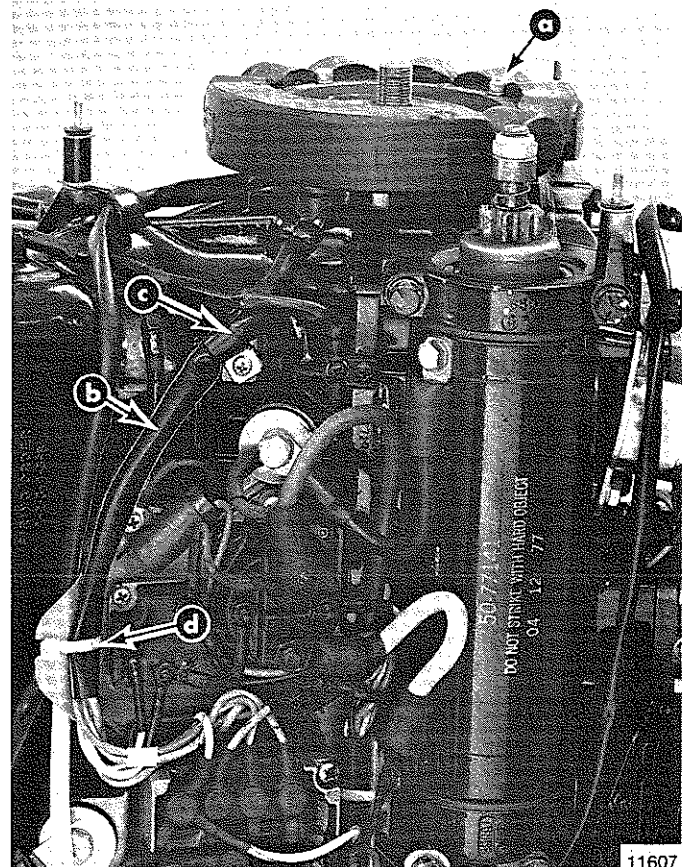
Figure 6. Removed Stator

4. Route stator wiring harness as shown in Figure 7. Secure with sta-strap and clamp.
5. Reinstall flywheel, as outlined in "Flywheel Removal and Installation", preceding.

TRIGGER PLATE ASSEMBLY REMOVAL and INSTALLATION

Trigger Plate Assembly Removal

1. Remove flywheel, as outlined in "Flywheel Removal and Installation", preceding.
2. Remove 4 screws which secure stator assembly to upper end cap. Lift stator off end cap and move to the side.
3. Remove locknut that secures link rod swivel into spark advance lever. Pull link rod out of lever.
4. Remove 2 screws and lift outer switch box from inner switch box. (Retain round metal spacers.)



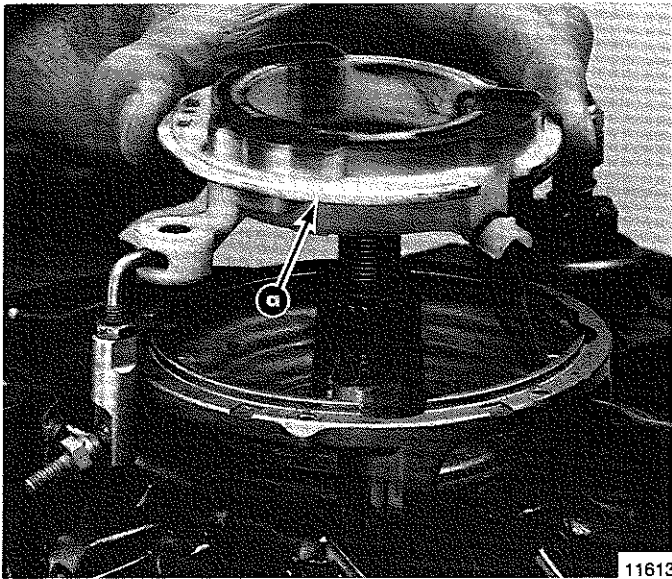
a - Stator Attaching Screws with Lockwashers (4 Req'd)
b - Stator Harness (Route as Shown; Wires with Yellow Sleeves Connected to Outer Switch Box)
c - Clamp
d - Sta-Strap

Figure 7. Stator Assembly Installed

5. Disconnect all trigger leads from their respective terminals. Cut sta-strap and remove trigger plate assembly from engine. (Figure 8)
6. If trigger assembly is faulty, remove and retain link rod swivel from trigger.

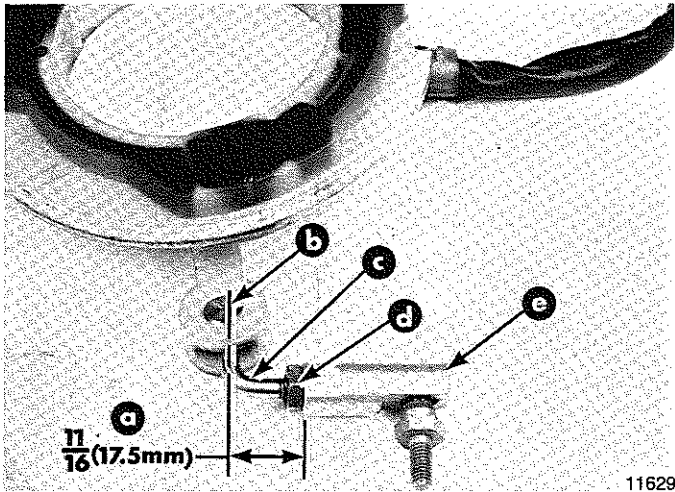
Trigger Plate Assembly Installation

1. If link rod swivel was disassembled or removed, reassemble to trigger as shown in Figure 9.
2. Place trigger plate assembly in upper end cap. (Figure 10) Fasten link rod swivel to spark advance lever with locknut. (Figure 10)



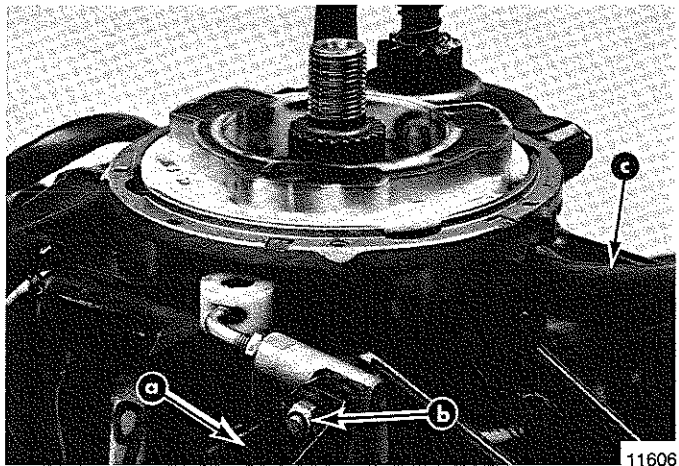
a - Trigger

Figure 8. Removing Trigger Plate Assembly



a - Retain This [11/16" (17.5mm)] Dimension
 b - Pivot
 c - Link Rod
 d - Hex Nut
 e - Ball Joint

Figure 9. Link Rod Assembled

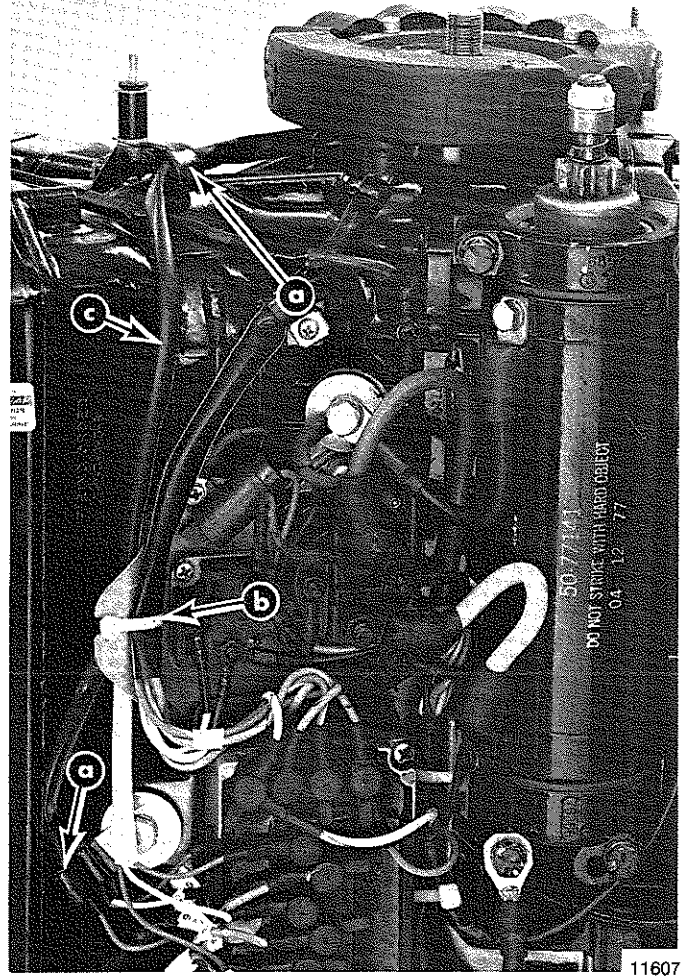


a - Spark Advance Lever b - Locknut
 c - Trigger Harness (Route as Shown in Figure 11)

Figure 10. Trigger Plate Assembly Installed

3. Route trigger wiring harness as shown in Figure 11. Reconnect wires to proper terminals of switch boxes. Refer to wiring diagram, following in this section. Wires with yellow identification sleeve must be connected to outer switch box.
4. Install switch boxes to engine with 2 screws and 2 round metal spacers. Refer to switch box(es) removal and installation (see "Index"). Make sure that both switch boxes are grounded to engine thru mounting screws and spacers.

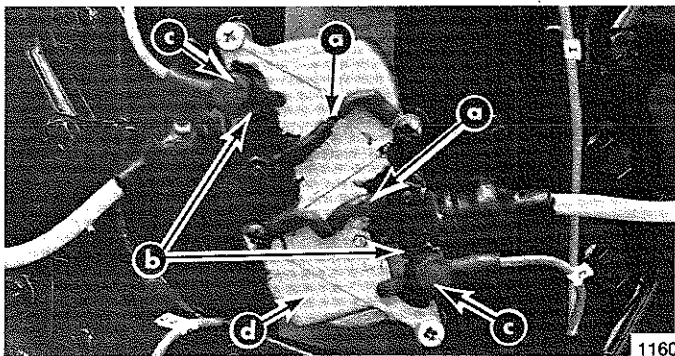
CAUTION: Switch boxes must be grounded to engine before cranking engine, or switch boxes will be damaged.



a - "J" Clamp
 b - Sta-Strap
 c - Trigger Wiring Harness (Route as Shown - Wires with Yellow Sleeve Are Connected to Outer Switch Box)

Figure 11. Trigger Harness Connected

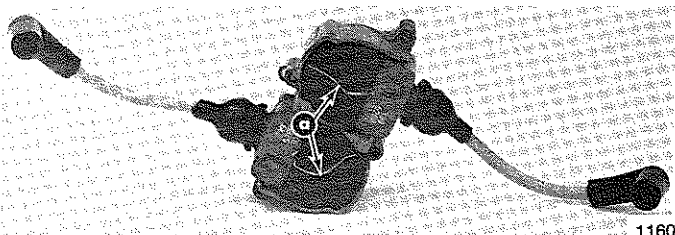
5. Place a drop of Loctite Type "A" on threads of stator attaching screws (4 required). Install stator assembly in position on upper end cap and secure with attaching screws. Torque screws to 30 in. lbs. (35kg-em).
6. Secure wires with sta-strap and "J" clamp, as shown in Figure 11.
7. Reinstall flywheel as outlined in "Flywheel Removal and Installation", preceding.



11604

a - Ground Wire [between (-) Coil Terminal and Mounting Screw]
 b - Ignition Coils c - (+) Coil Terminal d - Coil Cover

Figure 12. Ignition Coil



11605

a - Wire (Orange Colored Coils Only) - Place over Rubber Part of Coil so That Wire Will Be Grounded on Engine When Installed

Figure 13. Coil Placed in Coil Cover

IGNITION COIL REMOVAL and INSTALLATION

Ignition Coil Removal

1. Remove 3 locknuts and washers and remove rear cowl support bracket from engine.
2. Remove the spark plug (high tension) lead from the defective coil.
3. Disconnect wires from (+) and (-) terminals on defective ignition coil.
4. Remove 4 screws and lift coil cover along with coils from engine. Remove defective coil from cover.

Ignition Coil Installation

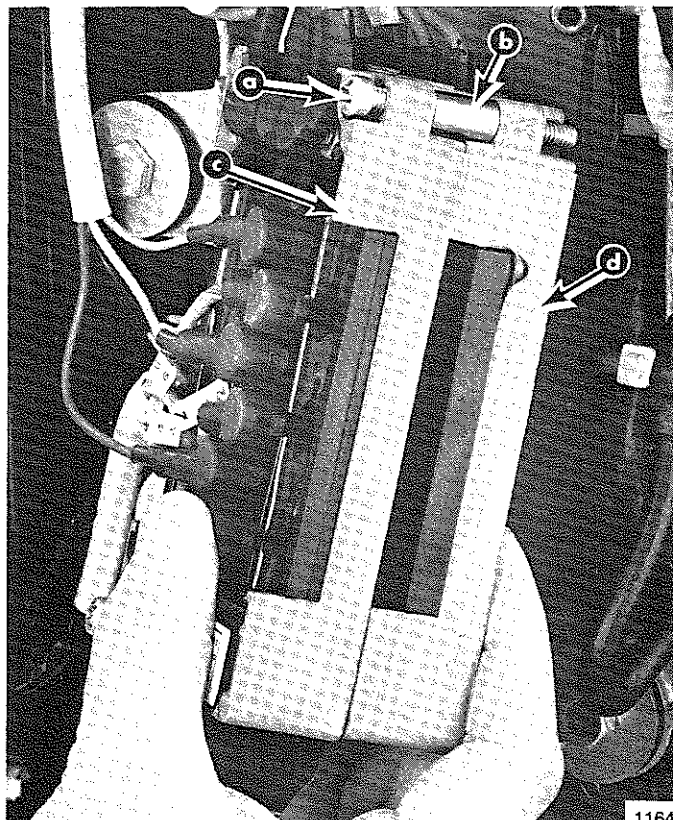
IMPORTANT: (Orange Color Coils Only) Make sure that the short wire (extending out of back side of coil) is placed across the rubber part of coil, so that coil will be grounded to engine when installed. (Figure 13)

1. Place coil in coil cover (on orange-colored coils, place the short wire that extends out of back side of coil over the rubber part of coil, as shown in Figure 13).
2. Install coil cover with coils to engine with 4 screws. Make sure that coil ground wires are fastened along with screws. (Figure 12) Tighten screws securely.
3. Reconnect switchbox wire to (+) terminal of coil and black ground wire to (-) terminal.
4. Reinstall spark plug (high tension) lead into coil.
5. Reinstall rear cowl support bracket to engine with 3 locknuts and washers. Tighten locknuts securely.

SWITCH BOX(ES) REMOVAL and INSTALLATION

Switch Box(es) Removal

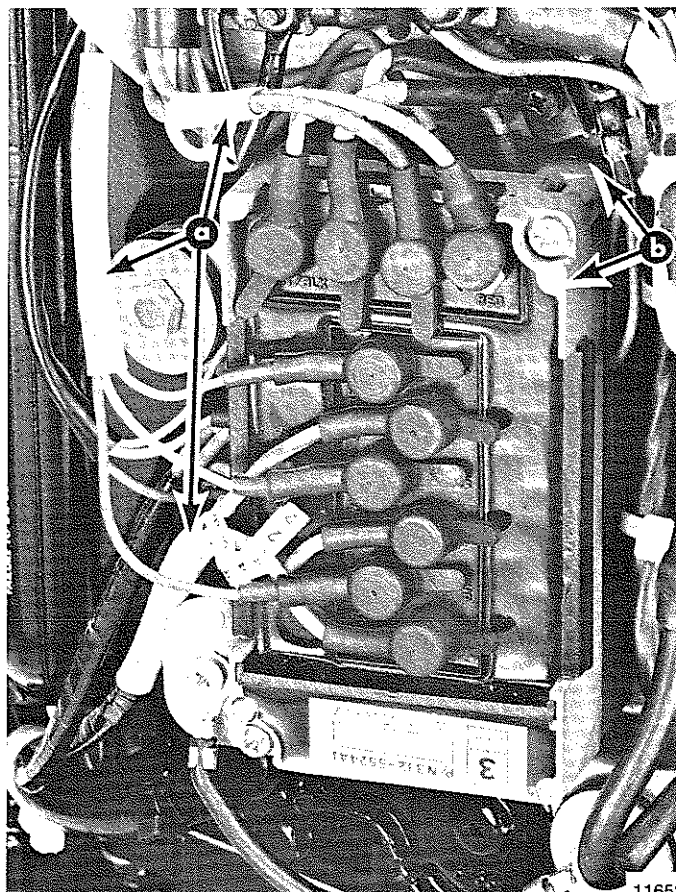
1. Remove 2 screws and lift switch boxes from engine. (Retain round metal spacers.)
2. Disconnect wires from switch boxes.



11649

a - Switch Box Mounting Screw (2 Req'd) c - Outer Switch Box
 b - Round Metal Spacer (2 Req'd) d - Inner Switch Box

Figure 14. Installing Switch Boxes



11652

a - Wires with Yellow Sleeves Are Connected to Outer Switch Box
 b - Switch Boxes MUST BE Grounded to Engine

Figure 15. Switch Boxes Installed

Switch Box(es) Installation

1. Reconnect wires to proper terminals of switch boxes. Refer to wiring diagram, following in this section. Wires with yellow identification sleeve must be connected to outer switch box. Outer switch box fires cylinders No. 2, 4 and 6.
2. Install switch boxes to engine with 2 screws and 2 round metal spacers, as shown in Figures 14 and 15. Make sure

that both switch boxes are grounded to engine thru mounting screws and spacers.

CAUTION: Switch boxes must be grounded to engine before cranking engine, or switch boxes will be damaged.

V-6 OUTBOARDS

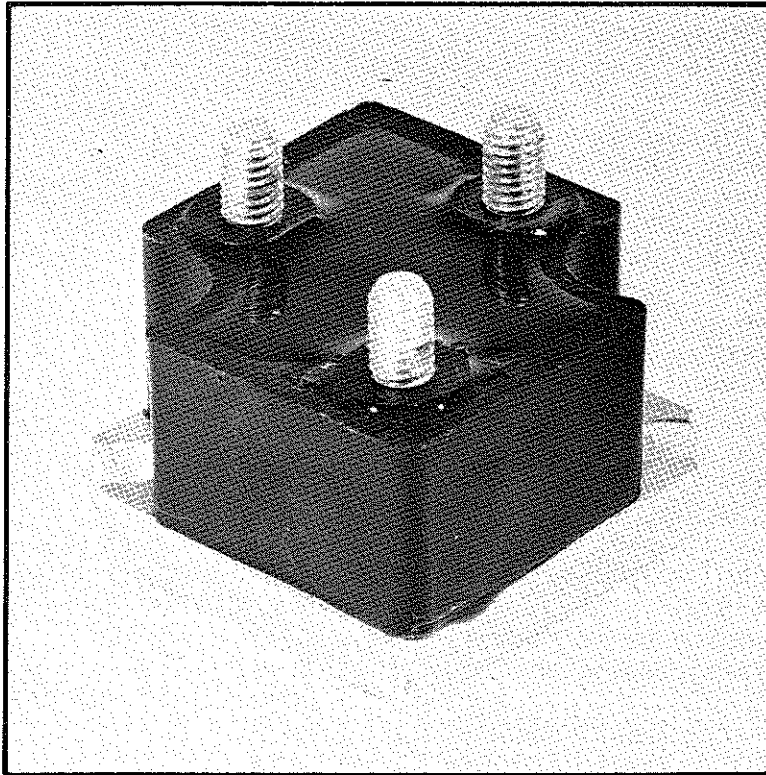
Electrical and Ignition

SECTION

2

PART

B



Battery, Charging System and Starting System

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STARTER MOTOR AMPERES DRAW

Starter Motor Part No.	No Load Amp. Draw	Normal Amp. Draw
A-50-79472	40	175
A-50-77141	40	175
A-50-64975	55	200

STATOR (ALTERNATOR COILS) AMPERES OUTPUT

Gross Amp. Output at Rectifier *	Net Amp. Output at Battery *
7 - 9	7 - 9

* Check when engine is at 3000 RPM to wide-open-throttle and battery is somewhat discharged.

BATTERY Precautions

When charging batteries, an explosive gas mixture forms in each cell. Part of this gas escapes thru holes in vent plugs and may form an explosive atmosphere around battery if ventilation is poor. This explosive gas may remain in or around battery for several hours after it has been charged. Sparks or flames can ignite this gas and cause an internal explosion which may shatter the battery.

The following precautions should be observed to prevent an explosion.

1. DO NOT smoke near batteries being charged or which have been charged very recently.
2. DO NOT break live circuits at terminals of batteries be-

cause a spark usually occurs at the point where a live circuit is broken. Always be careful when connecting or disconnecting cable clamps on chargers. Poor connections are a common cause of electrical arcs which cause explosions.

3. DO NOT reverse polarity of battery terminal to cable connections.

CAUTION: If battery acid comes into contact with skin or eyes, wash skin immediately with a mild soap. Flush eyes with water immediately and see a doctor.

CAUTION: New "sealed" type batteries, recently introduced on the market, are NOT recommended for use with unregulated charging systems, such as used on Mercury Outboards. Under continuous high speed operation conditions, the unregulated system can overcharge the battery, resulting in "boiling" or gas discharge. This results in a loss of electrolyte which cannot be added to this type of battery. The battery then is rendered useless. In addition, one manufacturer of the "sealed" battery does NOT recommend its use in "deep cycling" applications. Consequently, the "sealed" battery should not be used in applications which involve continuous discharging and recharging.

Specific Gravity Readings

Use a hydrometer to measure specific gravity of electrolyte in each cell. (Figure 1)



Figure 1. Checking Specific Gravity

Hydrometer measures percentage of sulphuric acid in battery electrolyte in terms of specific gravity. As a battery drops from a charged to a discharged condition, acid leaves the solution and enters the plates, causing a decrease in specific gravity of electrolyte. An indication of concentration of electrolyte is obtained with a hydrometer.

When using a hydrometer, observe the following points:

1. Hydrometer must be clean (inside and out) to insure an accurate reading.
2. Never take hydrometer readings immediately after water has been added. Water must be thoroughly mixed with electrolyte by charging for at least 15 minutes at a rate high enough to cause vigorous gassing.
3. If hydrometer has built-in thermometer, draw liquid in several times to ensure correct temperature before taking reading.
4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free-floating. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid. Disregard curvature where liquid rises against float stem due to capillarity.
5. Avoid dropping electrolyte on boat or clothing, as it is extremely corrosive. Wash off immediately with baking soda solution.

Specific gravity of electrolyte varies not only with percentage of acid in liquid but also with temperature. As temperature increases, electrolyte expands, so that specific gravity is reduced. As temperature drops, electrolyte contracts, so that specific gravity increases. Unless these variations in specific gravity are taken into account, specific gravity obtained by hydrometer may not give a true indication of concentration of acid in electrolyte.

A fully charged battery will have a specific gravity reading of approximately 1.270 at an electrolyte temperature of 80°F (27°C). If electrolyte temperature is above or below 80°F, additions or subtractions must be made in order to obtain a hydrometer reading corrected to 80°F standard. For every 10°F (3.3°C) above 80°F, add 4 specific gravity points (.004)

to hydrometer reading. Example: A hydrometer reading of 1.260 at 110°F (43°C) would be 1.272 corrected to 80°F, indicating a fully charged battery.

For every 10° below 80°F, subtract 4 points (.004) from the reading. Example: A hydrometer reading of 1.272 at 0°F (-18°C) would be 1.240 corrected to 80°F, indicating a partially charged battery.

SPECIFIC GRAVITY CELL COMPARISON TEST

This test may be used when an instrumental tester is not available. To perform this test, measure specific gravity of each cell, regardless of state of charge, and interpret results as follows: If specific gravity readings show a difference between highest and lowest cell of .050 (50 points) or more, battery is defective and should be replaced.

Electrolyte Level

Check electrolyte level in battery regularly. A battery in use in hot weather should be checked more frequently because of more rapid loss of water. If electrolyte level is found to be low, then colorless, odorless drinking or distilled water should be added to each cell until liquid level rises approx. 3/16" (4.8mm) over plate. **DO NOT OVERFILL**, because this will cause loss of electrolyte and result in poor performance, short life and excessive corrosion.

CAUTION: During service, only water should be added to the battery, not electrolyte.

Liquid level in cells should never be allowed to drop below top of plates, as portion of plates exposed to air may be permanently damaged with a resulting loss in performance.

Charging a Discharged Battery

The following basic rule applies to any battery charging situation:

1. Any battery may be charged at any rate (in amperes) or as long as spewing of electrolyte (from violent gassing) does not occur and for as long as electrolyte temperature does not exceed 125°F (52°C). If spewing of electrolyte occurs, or if electrolyte temperature exceeds 125°F, charging rate (in amperes) must be reduced or temporarily halted to avoid damage to the battery.
2. Battery is fully charged when, over a 2-hour period at a low charging rate (in amperes), all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. Full charge specific gravity is 1.260-1.275, corrected for electrolyte temperature with electrolyte level at

split ring, unless electrolyte loss has occurred (from age or over-filling) in which case specific gravity reading will be lower. For most satisfactory charging, lower charging rates in amperes are recommended.

3. If, after prolonged charging, specific gravity of at least 1.230 on all cells cannot be reached, battery is not in optimum condition and will not provide optimum performance; however, it may continue to provide additional service, if it has performed satisfactorily in the past.
4. To check battery voltage while cranking engine with electric starting motor, place red (+) lead of tester on positive (+) battery terminal and black (-) lead of tester on negative (-) battery terminal. If the voltage drops below 9½ volts while cranking, the battery is weak and should be recharged or replaced.

Winter Storage of Batteries

Battery companies are not responsible for battery damage either in winter storage or in dealer stock if the following instructions are not observed:

1. Remove battery from its installation as soon as possible and remove all grease, sulfate and dirt from top surface by running water over top of battery. Be sure, however, that vent caps are tight beforehand, and blow off all excess water thoroughly with compressed air. Check water level, making sure that plates are covered.
2. When adding distilled water to battery, be extremely careful not to fill more than 3/16" (4.8mm) above perforated baffles inside battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling battery will cause electrolyte to overflow (if filled beyond 3/16" above baffles).
3. Grease terminal bolts well with Multipurpose Lubricant and store battery in COOL-DRY place. Remove battery from storage every 30-45 days, check water level and put on charge for 5 or 6 hours at 6 amperes. **DO NOT FAST CHARGE.**
4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, dis-

continue charging. To check specific gravity, use a hydrometer, which can be purchased locally. (Figure 1)

5. Repeat preceding charging procedure every 30-45 days, as long as battery is in storage, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. When ready to place battery back in service, remove excess grease from terminals (a small amount is desirable on terminals at all times), recharge again as necessary and reinstall battery.

When charging 2 or more batteries, connect them in series, positive (+) terminal of one to negative (-) terminal of next.

SAFETY WARNING: Hydrogen and oxygen gases are produced during normal battery operation or charging. Sparks or flame can cause this mixture to ignite and explode, if they are brought near the vent openings. Sulphuric acid in battery can cause serious burns, if spilled on skin or in eyes. Flush or wash away immediately with clear water.

Battery Charging System

DESCRIPTION

The battery charging system components are the stator, rectifier and battery. (Figure 2) Alternating current (generated in stator alternator coils) flows to the rectifier which changes the alternating current to direct current for charging the battery.

The rectifier may be damaged by: 1) reversed battery leads, 2) running the engine with battery leads disconnected and 3) an open circuit, such as a broken wire or loose connection.

BATTERY CHARGING SYSTEM TROUBLESHOOTING

A fault in the battery charging system usually will cause the battery to become undercharged. Determine the cause of the problem as follows:

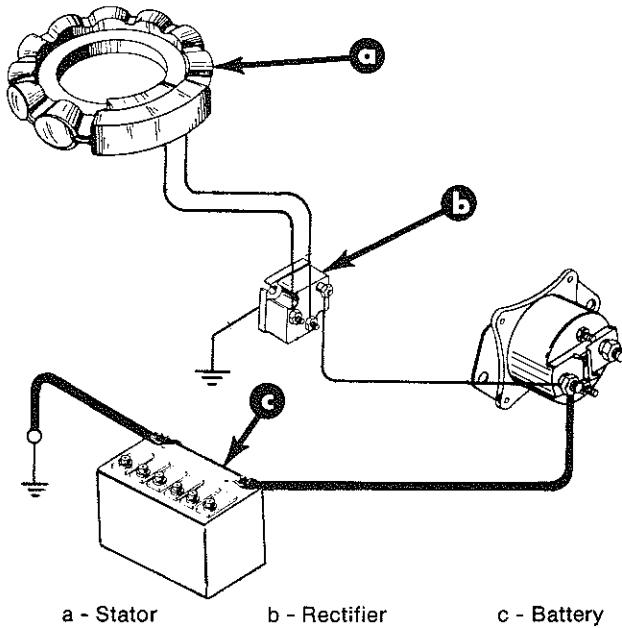
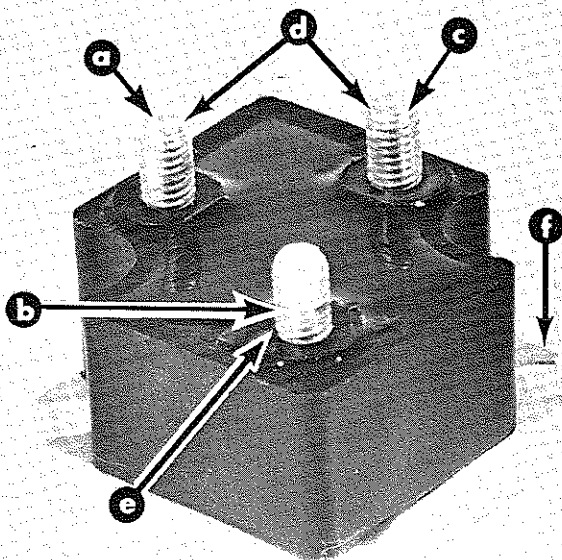


Figure 2. Battery Charging Circuit



07300
a - Terminal c - Terminal e - Positive Terminal
b - Terminal d - Alternator Terminals f - Ground

Figure 3. Rectifier Test Point

Visually check the following:

1. Check for correct battery polarity. Red cable to positive (+) battery terminal. If polarity was incorrect, check for damaged rectifier.
2. Check for loose or corroded battery terminals.
3. Check the condition of the battery.
4. Visually inspect wiring between stator and battery for cuts, chafing and disconnected, loose or corroded connections.
5. Excessive electrical load (from too many accessories) will cause battery to run down.

If visual inspection determines that battery and wiring is OK, perform the following stator and rectifier test:

Stator Test (Alternator Coils Only)

NOTE: Stator can be tested without removing from engine.

1. Disconnect both yellow/red (stator leads) from terminals on rectifier.
2. Use a VOA meter and perform the following test:

Test Leads To	Ohm Scale	Meter Reading
Connect test leads between yellow/red stator wires	R x 1	.75*
Red tester lead to either yellow/red stator wire, and black tester lead to engine ground if stator is mounted or to steel frame of stator (if off engine)	R x 1000	No continuity

* Primary DC resistance of these windings generally is less than one .75 ohm. A reading, that resembles a short, is acceptable. Copper wire is an excellent conductor but will have noticeable differences from cold to hot. Reasonable variation from specified reading is acceptable.

3. If meter readings are other than specified, replace stator assembly. Refer to stator assembly replacement in Section 2, Part A.

Rectifier Test

SAFETY WARNING: Disconnect battery leads from battery before testing rectifier.

NOTE: Rectifier can be tested without removing from engine.

1. Disconnect all wires from terminals on rectifier. (Figure 3)
2. Use a VOA meter and perform the following test. Refer to Figure 2 for rectifier terminal identification.

Check	Range	Reading
1. Red VOA lead to ground, black lead alternately to terminals "a" and "c".	R x 1000	Continuity
2. Black VOA lead to ground, red lead alternately to terminals "a" and "c".	R x 1000	No continuity
3. Black VOA lead to terminal "b", red lead alternately to terminals "a" and "c".	R x 1000	Continuity
4. Red VOA lead to terminal "b", black lead alternately to terminals "a" and "c".	R x 1000	No continuity

NOTE: If rectifier test readings are not attained, replace the rectifier. Failure to obtain stated readings in Tests 1 and 3 indicates that diodes are open-circuited. Failure to obtain

stated readings in Tests 2 and 4 indicates that diodes are short-circuited.

3. If meter readings are other than specified, replace rectifier.

STARTER SYSTEM

STARTER SYSTEM COMPONENTS

The starter system consists of the following parts:

1. Battery
2. Starter solenoid
3. Neutral start switch
4. Starter motor
5. Ignition switch

DESCRIPTION

The function of the starting system is to crank the engine. The battery supplies electrical energy to crank the starter motor. When the ignition switch is turned to "Start" position, the starter solenoid is activated and completes the starter circuit between the battery and starter.

The neutral start switch opens the starter circuit when the shift control lever is not in neutral. This prevents accidental starting when engine is in gear.

CAUTION: The starter motor may be damaged seriously if operated continuously. DO NOT operate continuously for more than 30 seconds. Allow a 2 minute cooling period between starting attempts.

TROUBLESHOOTING the STARTER CIRCUIT

Before beginning the starter circuit troubleshooting flow chart, following, check first for the following conditions:

1. Make sure that battery is fully charged.
2. Check that control level is in "neutral" position.
3. Check terminals for corrosion and loose connections.
4. Check cables and wiring for frayed and worn insulation.

The following "Starter Circuit Troubleshooting Flow Chart" is designed as an aid to troubleshooting the starter circuit. This flow chart will accurately locate any existing malfunction.

Location of "Test Points" (called out in flow chart) are numbered in Figure 4, below.

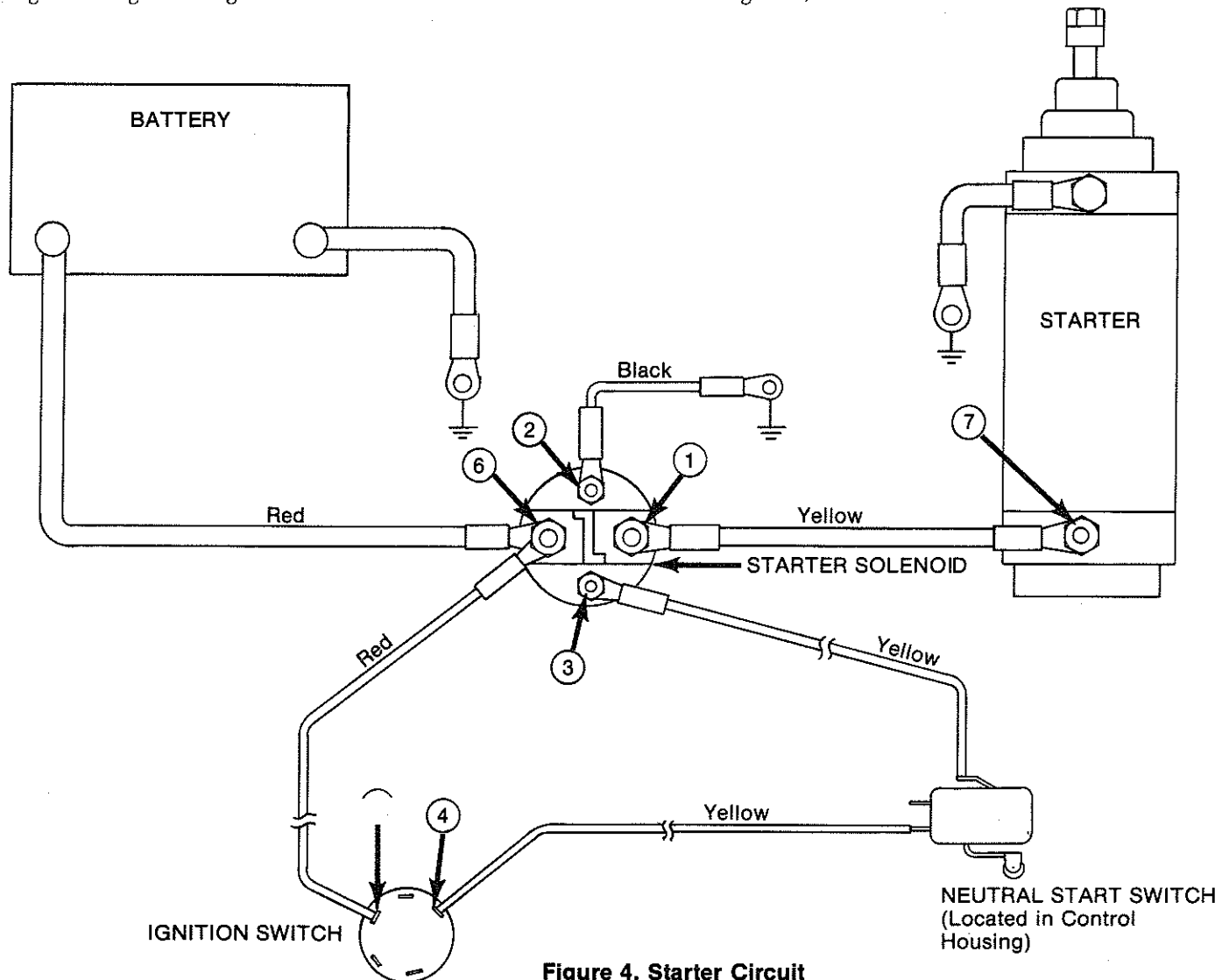


Figure 4. Starter Circuit

Starter Circuit Troubleshooting Flow Chart

Starter Motor Does Not Turn

* Battery Voltage

SAFETY WARNING: Disconnect yellow (starter motor) cable from starter solenoid test point BEFORE making tests 1-thru-6 to prevent unexpected engine cranking.

TEST 1

- a. Disconnect black ground wire(s) from Test Point 2. (Figure 1)
- b. Connect voltmeter between common engine ground and Test Point 2.
- c. Turn ignition key to "Start" position.

No voltage reading; proceed to TEST 2.

TEST 2

- a. Connect voltmeter between common engine ground and Test Point 3.
- b. Turn ignition key to "Start" position.

12 Volt Reading*

Check black ground wire for poor connection or open circuit. Reconnect ground wire to starter solenoid; proceed to TEST 6.

No voltage reading; proceed to TEST 3.

12 Volt Reading

Defective starter solenoid

TEST 3

- a. Connect voltmeter between common engine ground and Test Point 4.
- b. Turn ignition key to "Start" position.

No voltage reading; proceed to TEST 4.

12 Volt Reading*

Neutral start switch is open, or yellow wire is open between Test Points 4 and 3.

No voltage reading; proceed to TEST 5.

TEST 4

- Connect voltmeter between common engine ground and Test Point 5.

12 Volt Reading*

Defective ignition switch

TEST 5

- Connect voltage between common engine ground and Test Point 6.

No voltage reading; check red wire between battery (+) positive terminal and Test Point 6.

12 Volt Reading*

Check for open red wire between test points 5 and 6.

TEST 6

- a. Connect voltmeter between common engine ground and Test Point 1.
- b. Turn ignition key to "Start" position.

No voltage reading; Defective starter solenoid

12 Volt Reading*

Should hear solenoid click; proceed to TEST 7.

TEST 7

- a. Reconnect yellow (starter motor) cable to starter solenoid Test Point 1.
- b. Connect voltmeter between common engine ground and Test Point 7.
- c. Turn ignition key to "Start" position.

No voltage reading; check yellow cable for poor connection or open circuit.

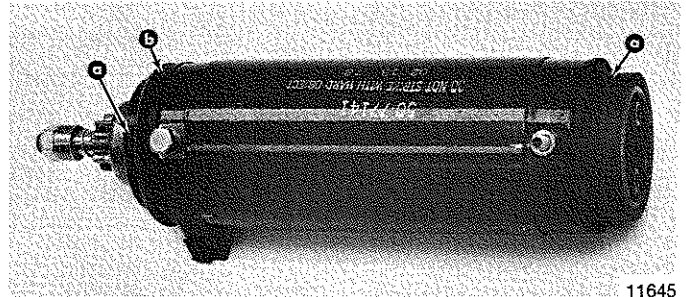
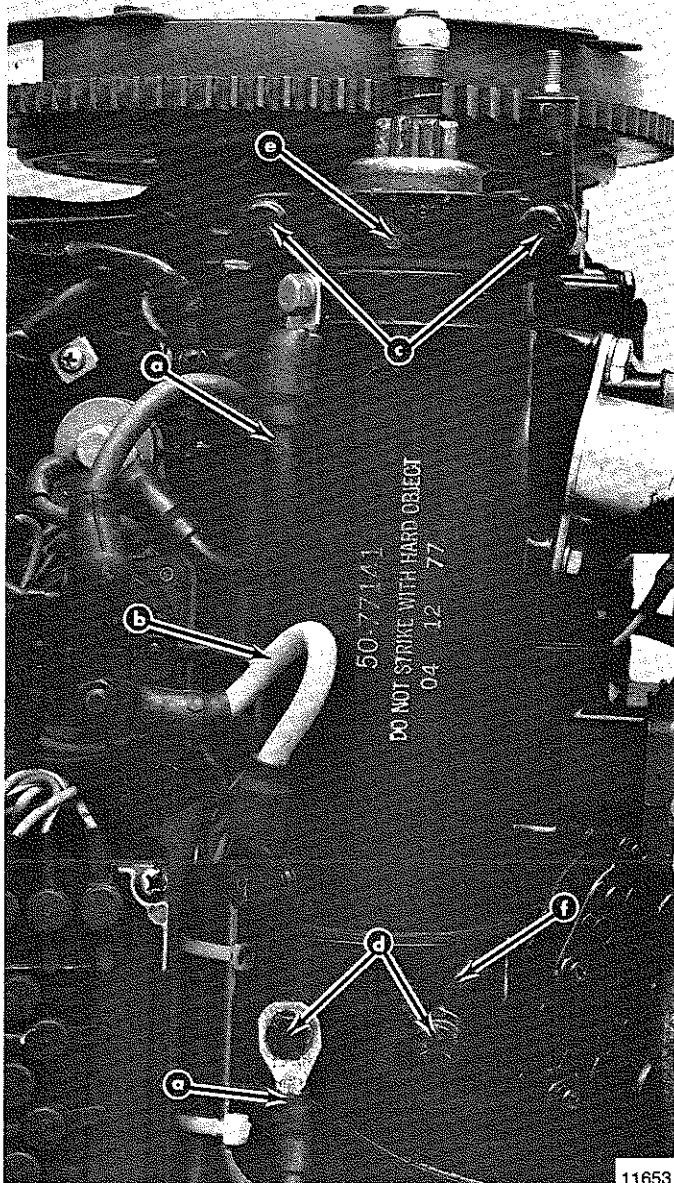
12 Volt Reading*

If starter motor does not turn, check starter motor.

Starter Removal and Installation

REMOVAL

CAUTION: Disconnect battery leads from battery before removing starter.



- a - Rubber Collar
- b - Spacer (if Equipped)

Figure 2. Rubber Collar Installed on Starter

1. Disconnect black ground cable (Figure 1) from starter.
2. Disconnect yellow cable (Figure 1) from starter.
3. Remove 4 bolts and remove upper and lower starter clamps (Figure 1) from starter. Lift starter from engine.
4. Remove rubber collars and spacer (if equipped) from starter. (Figure 2)

INSTALLATION

1. Slide rubber collars on starter, as shown in Figure 2.
2. If the removed starter was equipped with a spacer (Figure 2), replace spacer on upper collar.
3. Install starter to engine with starter clamps. (Figure 1) Make sure that black ground cable is fastened, along with lower mounting bolts.
4. Reconnect yellow cable (Figure 1) to positive (+) terminal on starter.
5. Reconnect black ground cable (Figure 1) to terminal on starter.

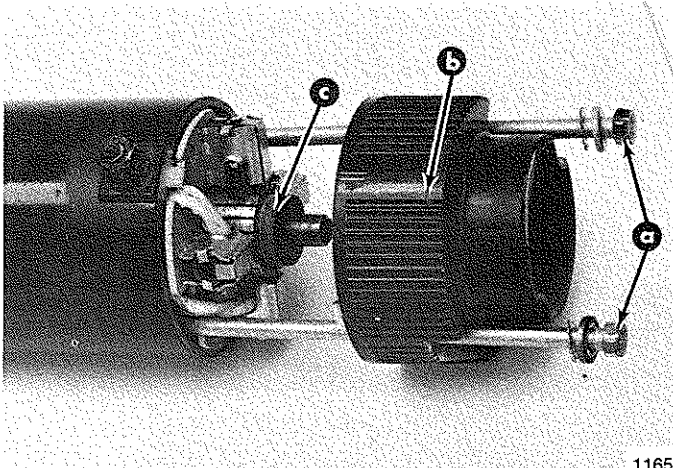
- a - Black Ground Cable
- b - Yellow Positive (+) 12-Volt Cable
- c - Upper Mounting Bolts [1-1/2" (38mm) Long]
- d - Lower Mounting Bolts [2" (51mm) Long]
- e - Upper Clamp
- f - Lower Clamp

Figure 1. Starter Installed

Prestolite Starter

DISASSEMBLY

1. Remove starter as outlined in starter "Removal" and "Installation", preceding.
2. Remove 2 thru bolts and commutator end cap from starter. (Figure 3)

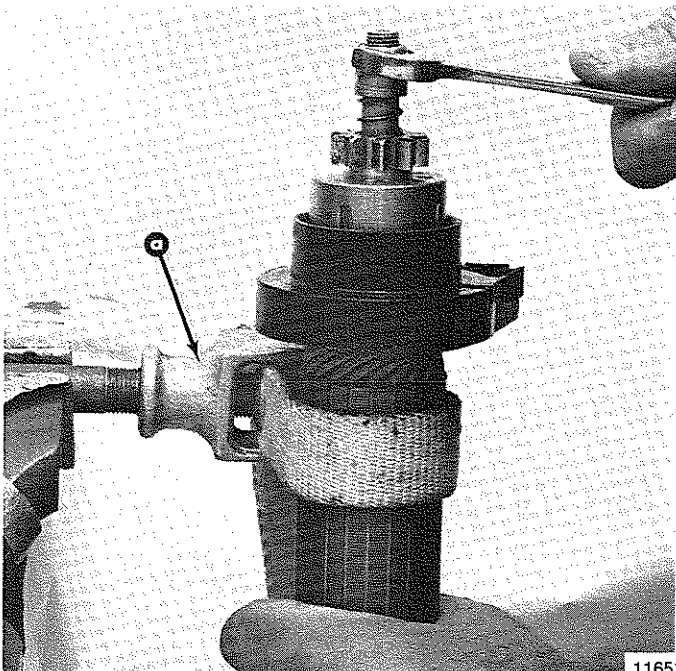


a - Thru Bolts b - Commutator End Cap c - Washers

Figure 3. Removing Commutator End Cap

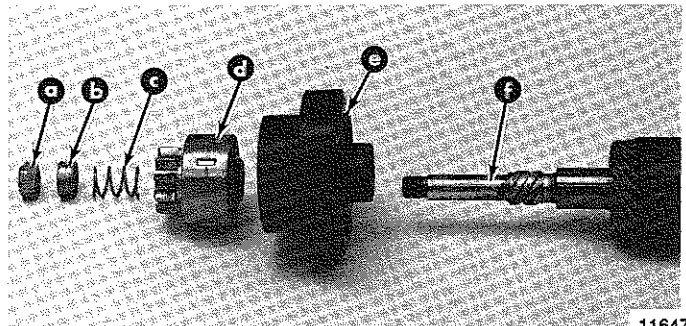
NOTE: Observe the quantity and sequence of washers (located on end of armature shaft in Figure 3) for correct reassembly, if no parts are replaced.

4. Remove washers from end of armature shaft. Reassemble in same order.
5. Pull armature out of starter frame.
6. If removal of parts (installed on armature shaft) is necessary, hold armature with a strap wrench (Figure 4) and remove locknut from end of shaft.
7. Remove parts from shaft as shown in Figure 5.



a - Strap Wrench

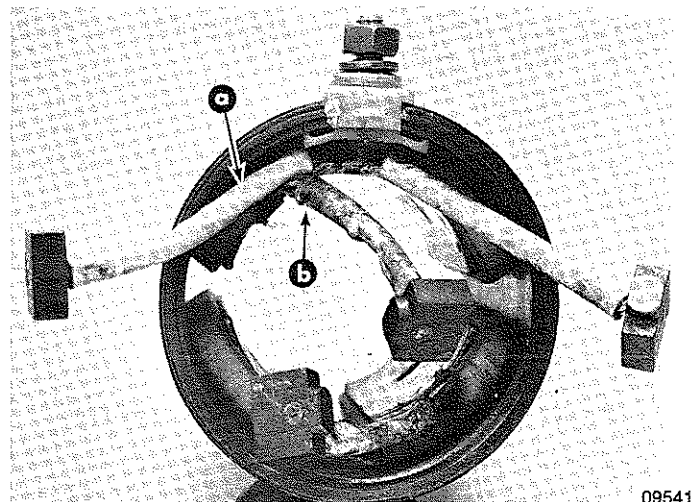
Figure 4. Removing Locknut from Armature Shaft



a - Locknut c - Spring e - Drive End Cap
b - Spacer d - Drive Assembly f - Armature Shaft

Figure 5. Parts Removed from Shaft

8. Brush replacement is recommended, if brushes are pitted, chipped or worn to less than $\frac{1}{4}$ " (6.4mm). If necessary, replace brushes as follows:
 - a. Remove positive terminal and brushes (Figure 6) as an assembly from starter frame.
 - b. Cut off negative brush leads (Figure 6) at point where they are connected to field coils.



a - Positive Brush (2) b - Negative Brush (2)

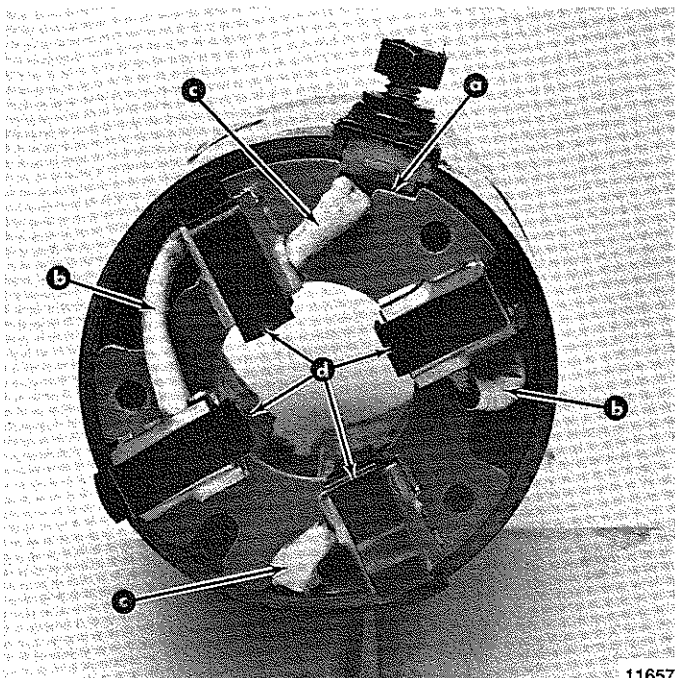
Figure 6. Starter Brushes

CLEANING, INSPECTION and TESTING

Refer to "Starter Cleaning, Inspection and Testing", following. Use "Index".

REASSEMBLY

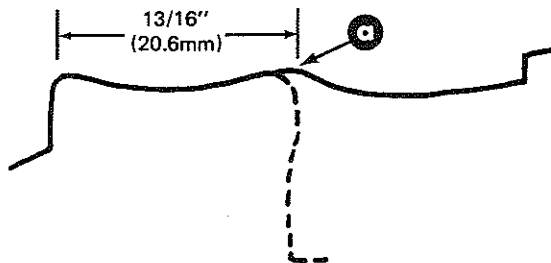
1. If removed, replace negative brushes as follows:
 - a. Clean ends of field coils by filing or grinding where old brush leads were soldered. Varnish should be removed only as far back as necessary to make solder connection.
 - b. Solder negative brush leads to field coils where old leads were soldered, using rosin core solder. Make sure that brushes will reach brush holders. **DO NOT** over-heat leads.
2. If removed, replace positive brushes and terminal, as shown in Figure 6.
3. Route brush leads and place brush plate on starter frame with notch facing positive (+) terminal, as shown in Figure 7.



11657

- a - Position Notch Facing toward Positive (+) Terminal
- b - Positive (+) Brush Leads
- c - Negative (-) Brush Leads
- d - Brush Retaining Tool

Figure 7. Brush Plate Installed and Brush Holder Tools Placed over Brushes



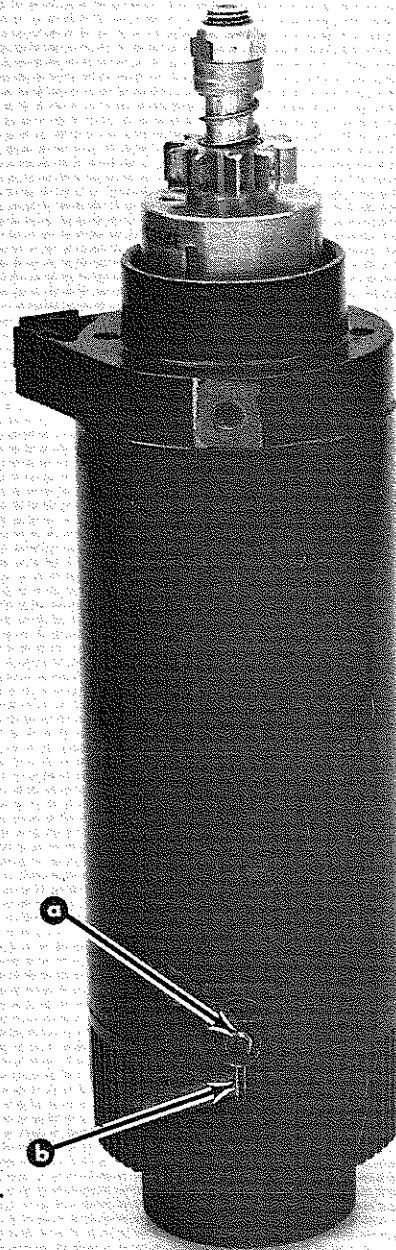
a - Bend as Shown

Figure 8. Brush Retaining Tool Dimensions

NOTE: A tool can be made to hold springs and brushes in holders, as shown in Figures 7 and 8. [Tool can be made from coil retaining clip (A-398-2321).] Bend as shown in Figure 8.

5. Place brush spring and brushes (one at-a-time) into brush holders and hold in place with tools, as shown in Figure 7, or tie in place with string or wire.
6. If removed, reinstall drive end plate, pinion gear, spring and spacer onto armature shaft. (Figure 5) Use a new lock-nut and tighten securely on end of shaft.
7. Lubricate bushing (located in drive end cap) with a drop of SAE 10W oil. DO NOT over-lubricate.
8. Lubricate helical threads on armature shaft with a drop of SAE 10W oil.
9. Install armature into starter frame. Align tab on drive end plate with slot in starter frame.
10. Remove brush retainer tool from brushes.
11. Reinstall washers (Figure 1) on armature shaft in same order as removal. Position black (hard) washers toward commutator end cap. If armature or end cap were replaced, recheck end play in Step 14, following.

12. Install commutator end cap on starter frame. Position end cap so that 2 raised lines are toward positive terminals, as shown in Figure 9.
13. Install thru bolts thru end cap, frame and into drive end plate. Torque bolts to 70 in. lbs. (81kg-cm).
14. Check armature end play. End play must be between .010 and .035 (.254mm and .889mm). If necessary, remove commutator end cap and add or remove washers (installed on armature shaft) to achieve proper end play.



- a - Positive (+) Terminal
- b - Align Raised Lines with Positive (+) Terminal

Figure 9. Starter Reassembled

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Bosch Starter

DISASSEMBLY

1. Remove starter as outlined in "Starter Removal and Installation", preceding.
2. Remove 2 thru bolts (Figure 1) from starter.

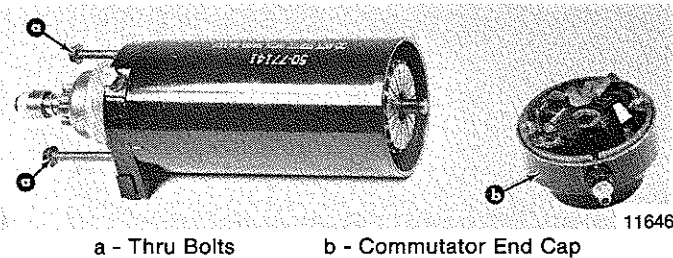


Figure 1. Commutator End Cap Removed

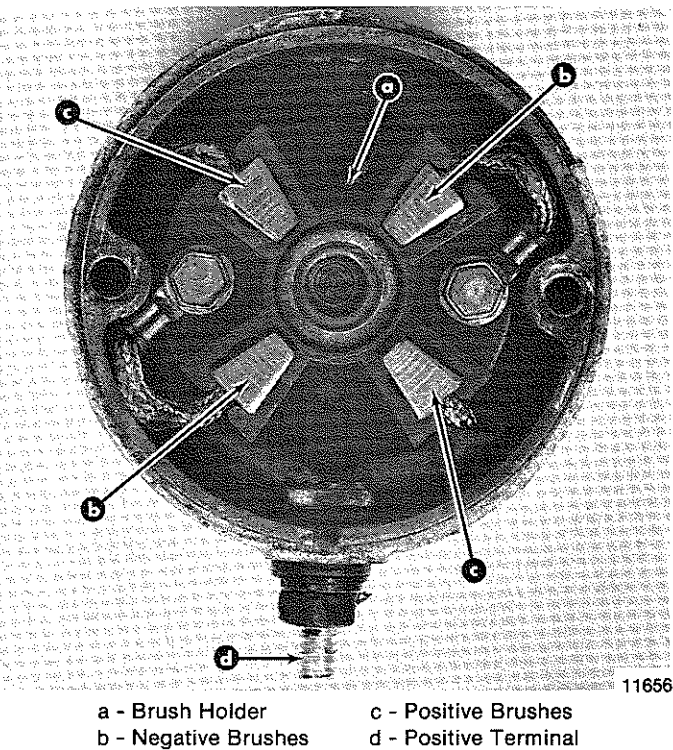
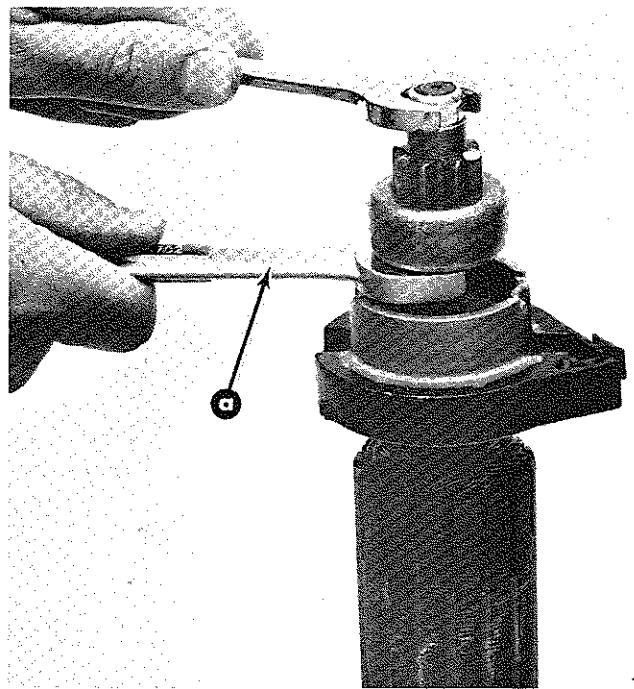


Figure 2. Brushes Installed

3. Tap commutator end cap to loosen and remove from starter frame. Be careful not to lose brush springs.
4. Brush replacement is recommended, if brushes are pitted, chipped or worn to less than 1/4" (6.4mm). If necessary, remove brushes as follows:
 - a. Lift brush holder from end cap. Remove hex nut and washers from positive terminal (Figure 2) and remove positive brushes (along with positive terminal) as an assembly.
5. Remove armature (along with drive end cap) from starter frame.
6. If necessary, remove parts from armature shaft by first removing locknut, as shown in Figure 3. Then remove parts from shaft, as shown in Figure 4.

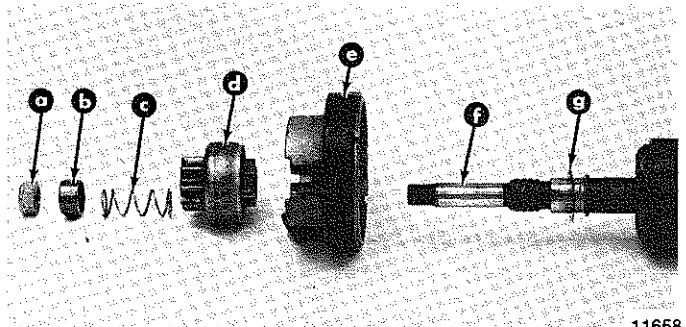
CLEANING, INSPECTION and TESTING

Refer to "Starter Cleaning, Inspection and Testing", following. Use "Index".



a - Place Wrench on Hex Portion of Drive Assembly

Figure 3. Removing Locknut



a - Locknut
b - Spacer
c - Spring
d - Drive Assembly
e - Drive End Cap
f - Armature Shaft
g - Washer

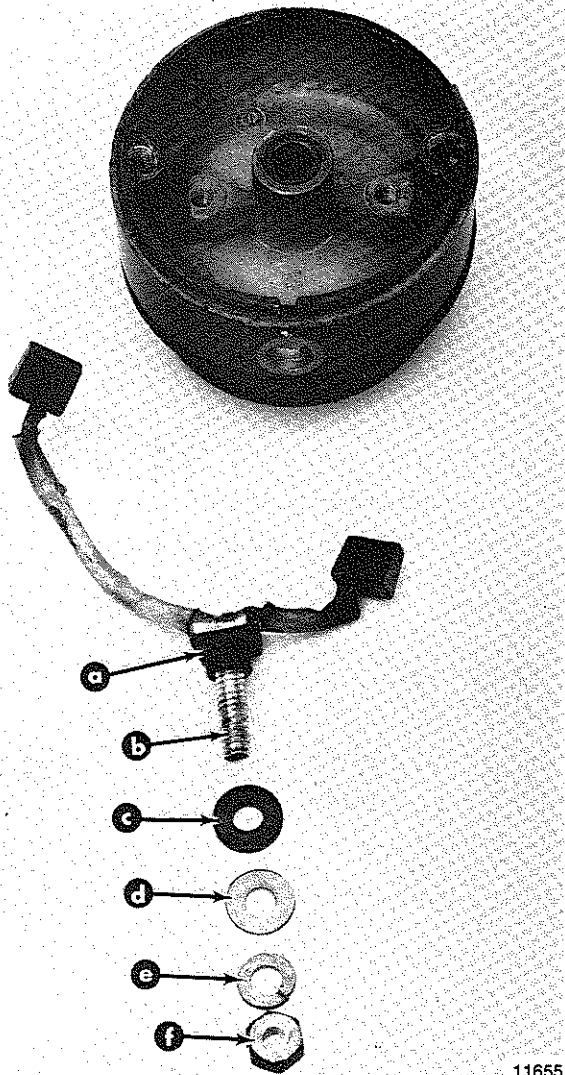
Figure 4. Parts Removed from Armature Shaft

REASSEMBLY

1. If brushes were removed, replace as follows:
 - a. Install positive brushes (along with positive terminals) into commutator end cap, as shown in Figures 5 and 6.
 - b. Install negative brushes (along with brush holder), as shown in Figure 7.
2. If removed, reinstall parts on armature shaft. (Figure 4) Use a new locknut and tighten securely on end of shaft.
3. Lubricate helix threads on armature shaft with a drop of SAE 10W oil.
4. Lubricate bushing in drive end plate with a drop of SAE 10W oil.
5. Position armature into starter frame so that commutator end of armature is at end of starter frame where permanent

magnets are recessed 1" (25.4mm). Align marks as shown in Figure 10.

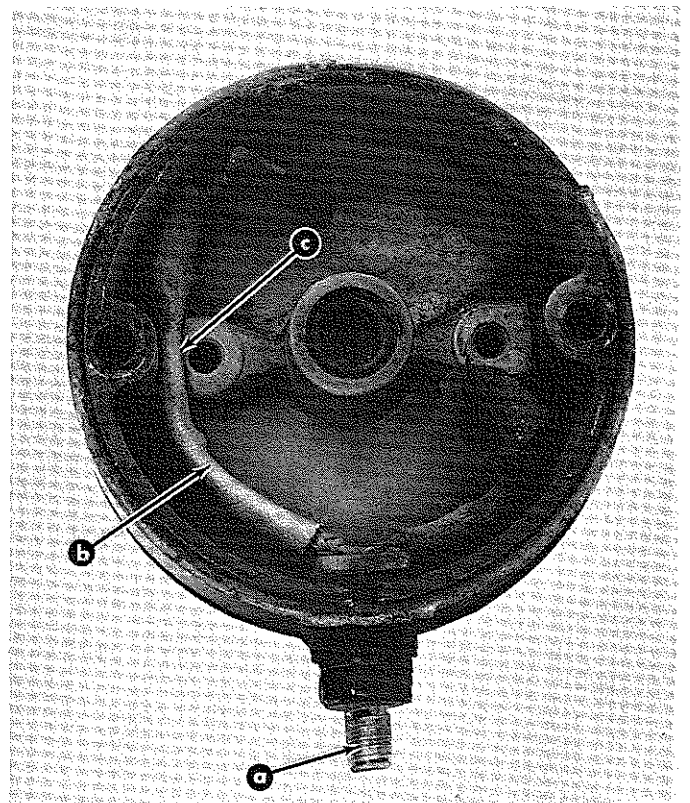
6. Lubricate bushing (located in commutator end cap) with one drop of SAE 10W oil. DO NOT over-lubricate.
7. To prevent damage to brushes and springs when installing commutator end cap, it is recommended that a brush retaining tool be made as shown in Figure 8.
8. Place springs and brushes into brush holder and hold in place with brush retainer tool. (Figure 9)



- a - Insulating Bushing
- b - Positive (+) Terminal
- c - Insulating Washer
- d - Flat Washer
- e - Lockwasher
- f - Hex Nut

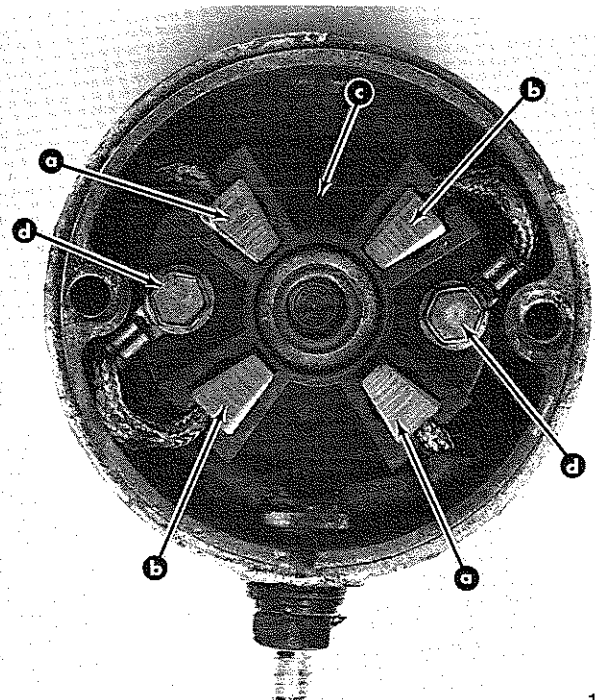
Figure 5. Positive Brushes Components

9. Install commutator end cap onto starter frame align mark on frame with positive terminal as shown in Figure 10 and remove brush retainer tool. Install thru bolts and torque to 70 in. lbs. (81kg-cm).



- a - Positive (+) Terminal
- b - Long Brush Lead
- c - Push Lead into Slot

Figure 6. Positive Brushes Installed



- a - Positive (+) Brushes
- b - Negative (-) Brushes
- c - Brush Holder
- d - Bolts (Fasten Negative Brushes and Holder)

Figure 7. Negative Brushes Installed

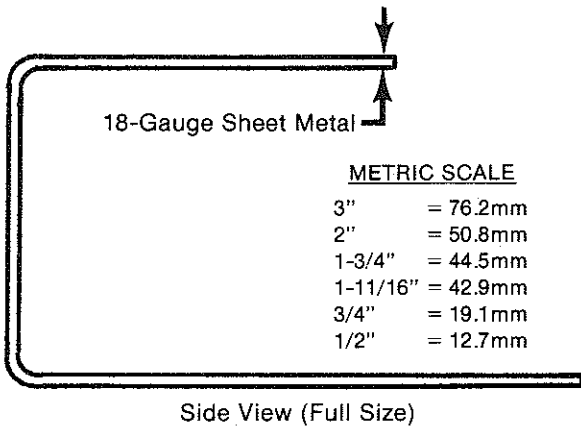
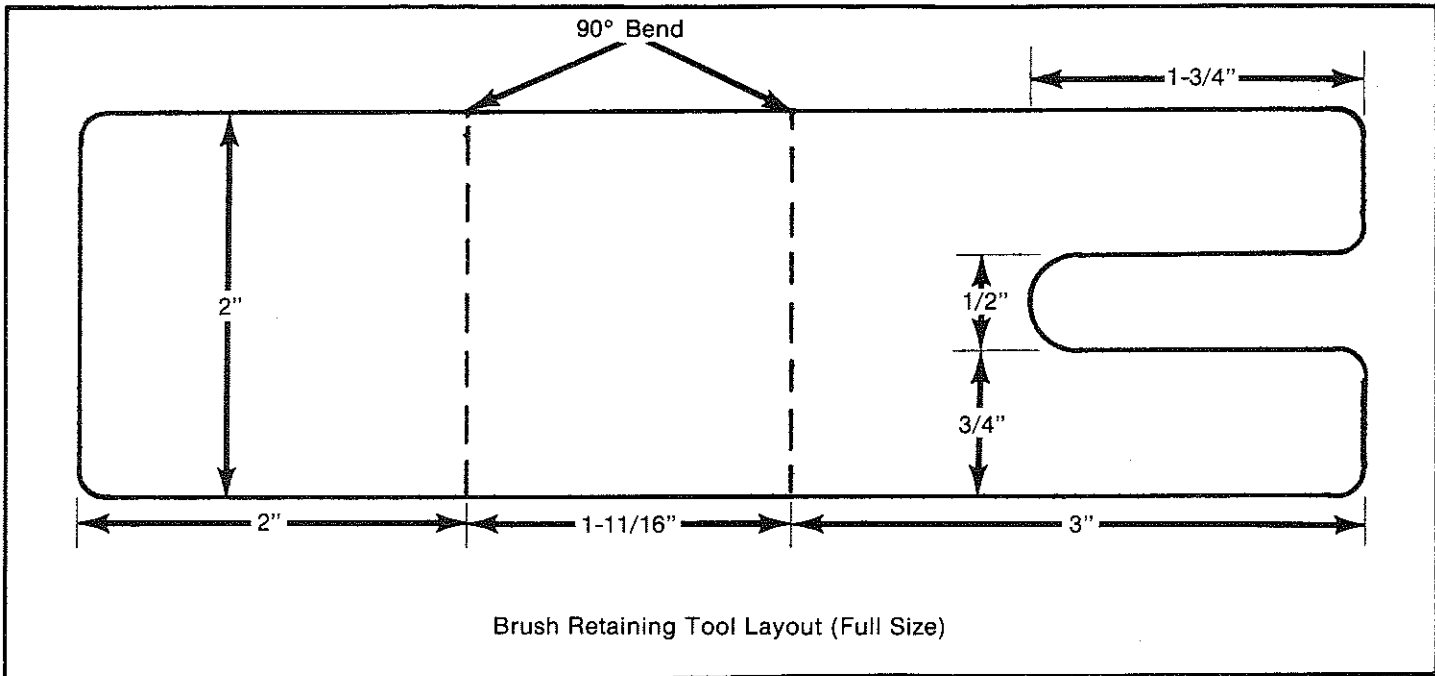
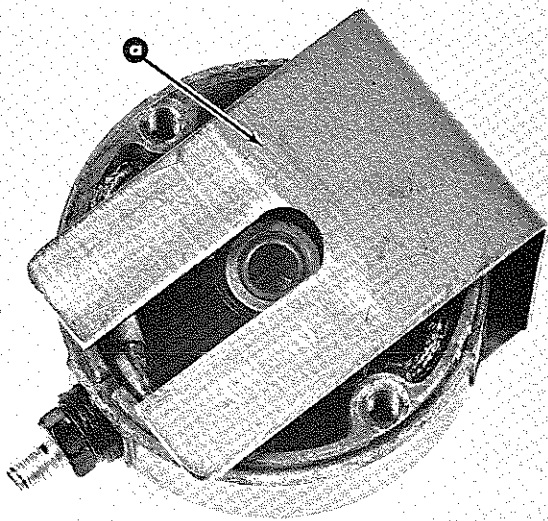
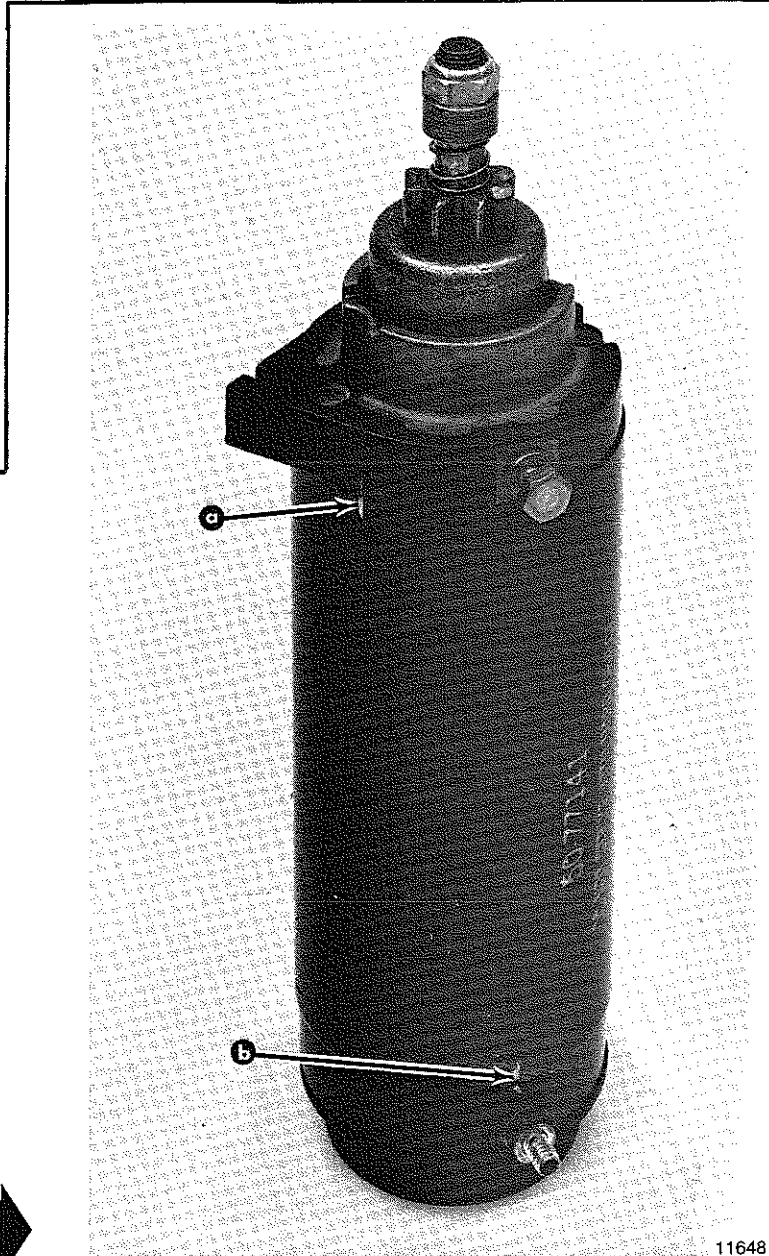


Figure 8. Brush Retainer Tool Dimensions



a - Brush Retainer Tool

Figure 9. Brush Retainer Tool Installed on Commutator End Cap

a - Alignment Marks b - Align Mark with Positive (+) Terminal

Figure 10. Alignment Marks

Starter Cleaning, Inspection and Testing

CLEANING and INSPECTION

1. Clean all starter motor parts.
2. Check pinion teeth for chips, cracks or excessive wear.
3. Replace the drive clutch spring and/or collar, if tension is not adequate, or if wear is excessive.
4. Check that the brush holder is not damaged or is not holding the brushes against the commutator.
5. Replace brushes that are pitted or worn to less than 1/4" (6.4mm) in length.
6. Replace a damaged or excessively worn bushing in the end cap.
7. Check the armature conductor (commutator bar junction) for a firm connection. A poor connection usually results in a burned commutator bar.
8. Resurface and undercut a rough commutator, as follows:

CAUTION: Do not turn down the commutator excessively.

- a. Resurface the commutator and undercut the insulation between the commutator bars 1/32" (0.8mm) to the full width of the insulation and so that the undercut is flat.
 - b. Clean the commutator slots after undercutting.
 - c. Sand the commutator lightly with No. 00 sandpaper to remove burrs, then clean the commutator.
 - d. Recheck the armature on a growler for shorts, as specified in the following procedure ("Testing").
9. Open-circuited armatures often can be saved where an open circuit is obvious and repairable. The most likely place for an open circuit is at the commutator bars, as a result of excessively long cranking periods. Long cranking periods overheat the starter motor so that solder in the



Figure 1. Armature Tests for Shorts (Bosch)

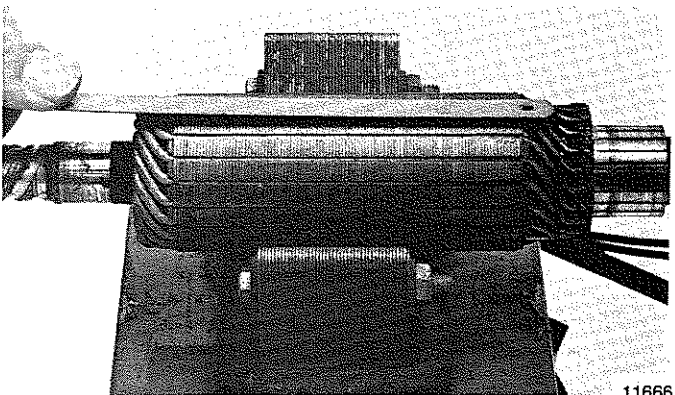


Figure 2. Armature Tests for Shorts (Prestolite)

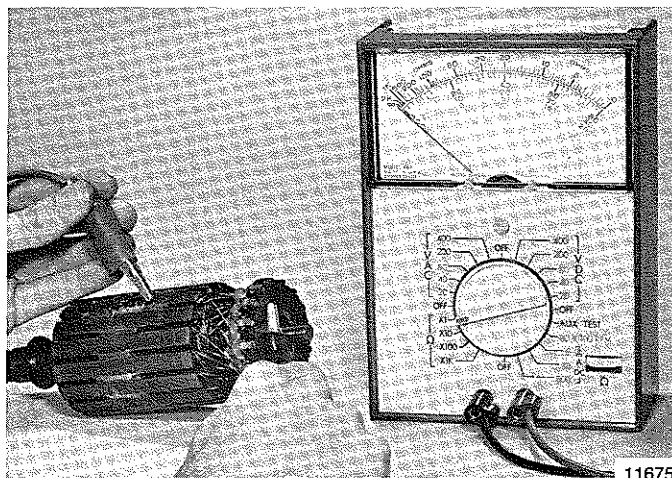


Figure 3. Armature Test for Ground (Bosch)

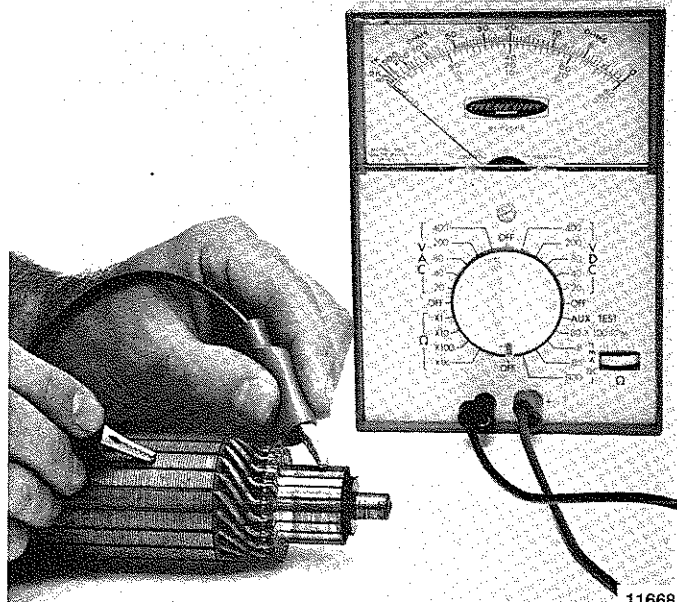


Figure 4. Armature Test for Ground (Prestolite)

connections melts and is thrown out. The resulting poor connections then cause arcing and burning of the commutator bars.

10. Repair bars, that are not too badly burned, by resoldering the leads in bars (using rosin flux solder) and turning down the commutator in a lathe to remove burned material, then undercut the mica.
11. Clean out the copper or brush dust from slots between the commutator bars.
12. Check the armature for ground. See the following procedure ("Testing").

TESTING

Armature Test for Shorts

Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. (Figure 1 or 2) If saw blade vibrates, armature is shorted. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.

Armature Test for Ground

1. Set VOA meter to (R x 1 scale). Place one lead of VOA meter on armature core or shaft and other lead on commutator, as shown in Figure 3 or 4.
2. If meter indicates continuity, armature is grounded and must be replaced.

Checking Positive Brushes and Terminal

Set VOA meter to (R x 1 scale). Connect meter leads between positive brushes. (Figure 5 or 6) Meter must indicate full continuity or zero resistance. If resistance is indicated, check lead to brush and lead to positive terminal solder connection. If connection cannot be repaired, brushes must be replaced.

Testing Field Coil for Ground (Prestolite)

1. Set VOA meter to (R x 1 scale). Place one lead of VOA meter on negative brush and other lead on starter frame (bare metal).

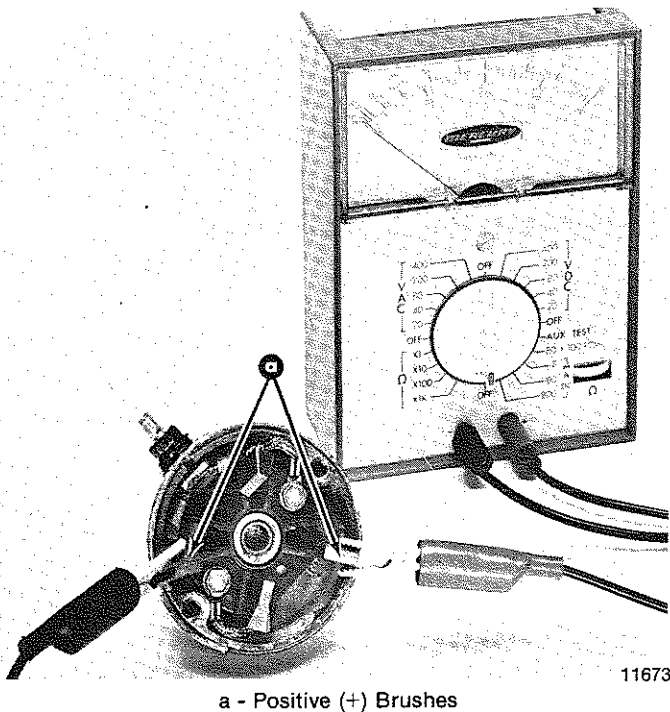


Figure 5. Checking Positive Brushes (Bosch)

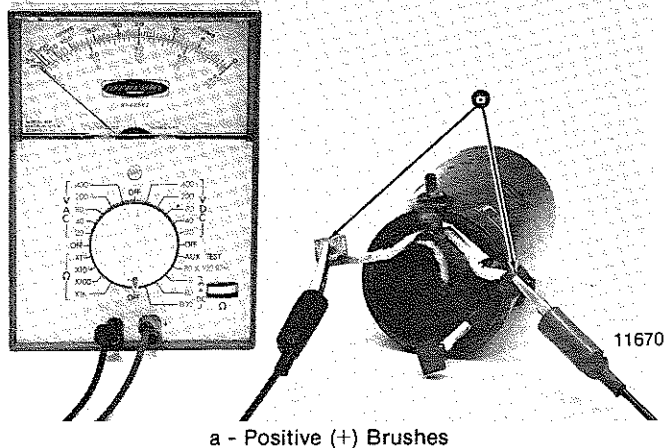


Figure 6. Checking Positive Brushes (Prestolite)

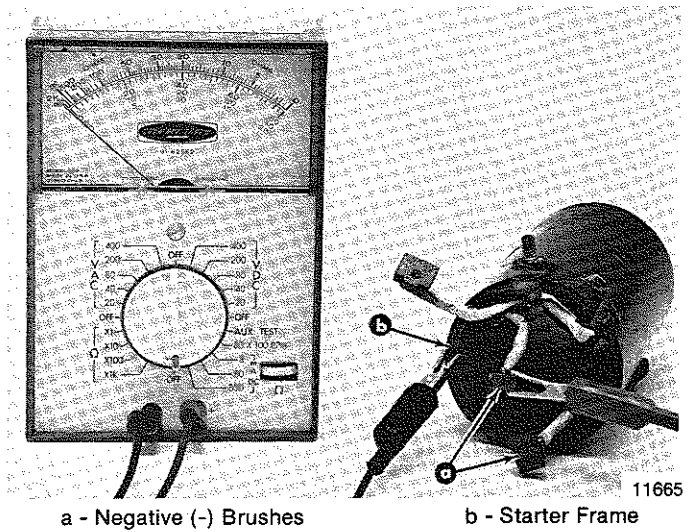


Figure 7. Testing Field Coil for Ground

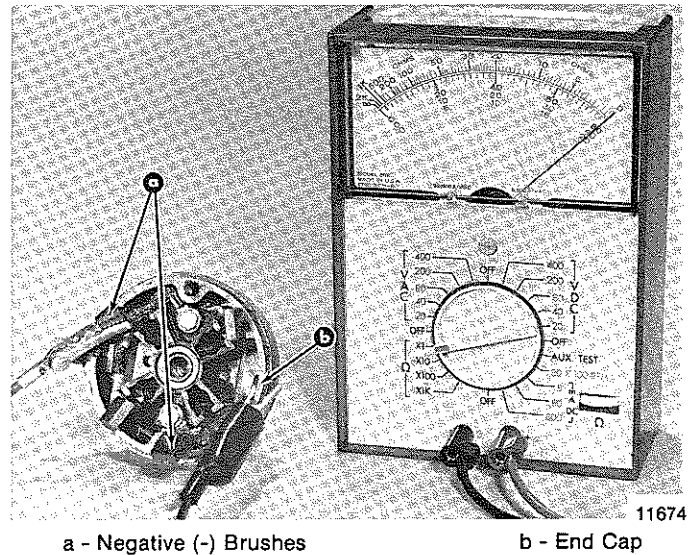


Figure 8. Testing Negative Brushes for Ground (Bosch)

2. If meter indicates NO continuity, field coils are open and must be replaced. (Figure 5)
3. Check other negative brush to starter frame by repeating Steps 1 and 2, preceding.

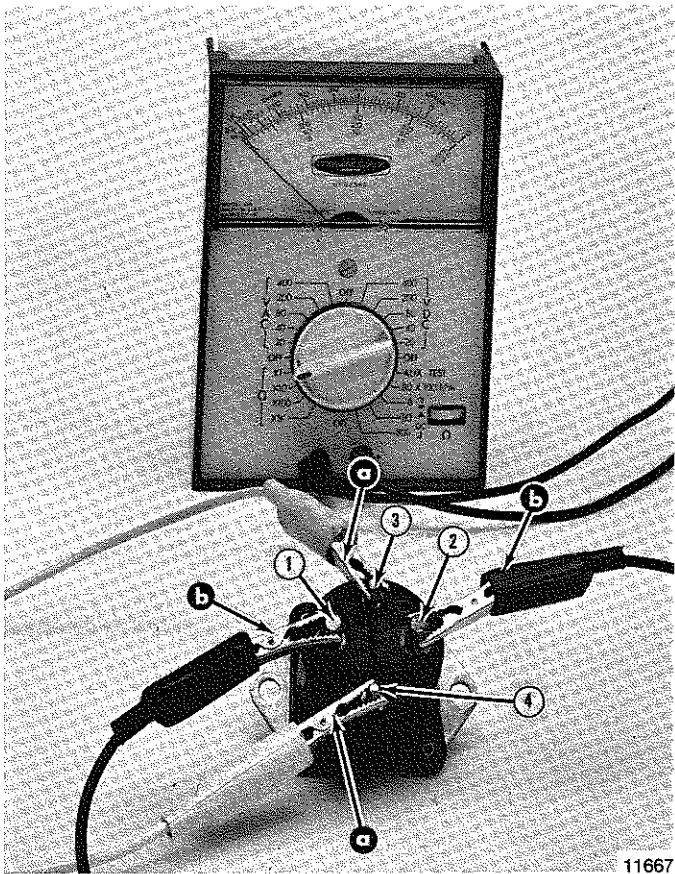
Testing Negative Brushes for Ground (Bosch)

Set VOA meter to (R x 1 scale). Place one lead of the VOA on the negative brush and the other lead on the end cap (bare metal). (Figure 8) If the meter indicates NO continuity, replace the negative brush. Repeat this procedure on the other negative brush.

STARTER SOLENOID TEST

Test starter solenoid as follows:

1. Disconnect all leads from solenoid terminals.
2. Use a VOA meter, set to (R x 1 scale) and connect between solenoid terminals 1 and 2, as shown in Figure 9.
3. Connect a 12-volt supply between solenoid terminals 3 and 4, as shown in Figure 9. Solenoid should click and meter should read zero ohms.



a - 12-Volt Supply
b - VOA Leads

Figure 9. Testing Starter Solenoid

V-6 OUTBOARDS

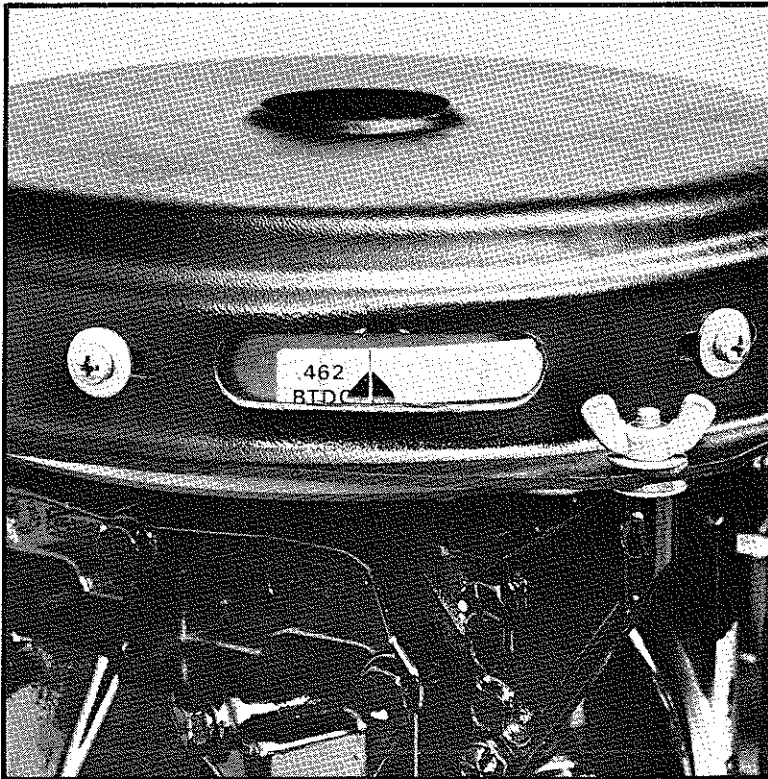
Electrical and Ignition

SECTION

2

PART

C



Timing, Synchronizing and Adjusting

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TIMING/SYNCHRONIZING/ADJUSTING

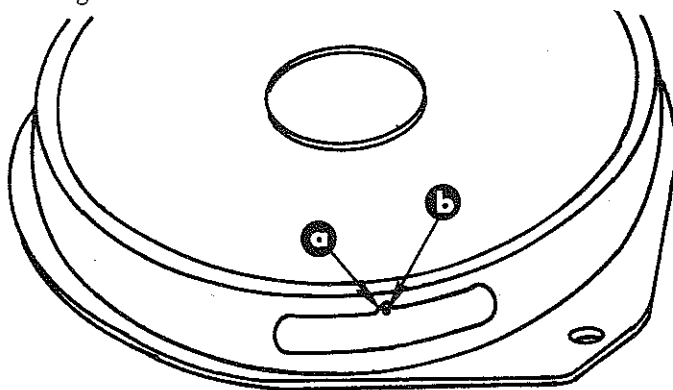
175 HP Models (1976-77)

Firing Order	1-2-3-4-5-6
Firing Sequence	60° Consecutive
Spark Plug	AC-V40FFM or Champion L76V
Spark Plug Gap	Not Adjustable
Timing Maximum	15° (One Punch Mark) BTDC
Throttle Primary Pickup	8-10° (3 Punch Marks) ATDC
Throttle Secondary Pickup	Not Adjustable
Full Throttle RPM	4800-5800 RPM
Idle RPM	550-650 RPM in Gear
Water Pressure	8 to 11 psi (.56 to .77kg/cm ²) @ 3000 RPM

IMPORTANT: Timing procedure has been changed for all Merc 1750 (1976-77) models, as shown in Figure 1 (one punch mark replaces 2 punch marks on flywheel). If timing change has not been made to engine being timed, complete Step 1, following, before timing engine.

NEW TIMING CHANGE (Figure 1)

1. Remove ALL spark plugs. Install a dial indicator (C-91-58222A1 or equivalent) in No. 1 spark plug hole.
2. Rotate flywheel until top dead center (TDC) is found and set the dial indicator to zero.
3. Rotate the flywheel counterclockwise to approximately .100" before top dead center (BTDC), then rotate the flywheel clockwise until .069" BTDC is located. (DO NOT locate .069" BTDC by rotating flywheel counterclockwise.)
4. With a center punch, and using the existing timing reference mark on flywheel cover as a guide, make a new punch mark on flywheel in center of timing mark as shown in Figure 1.



a - Reference Point b - Punch Mark on Flywheel

Figure 1. New Punch Mark on Flywheel

5. Remove dial indicator and install spark plug in No. 1 cylinder only.
6. Remove (or paint over with black paint) the .119" (22°) BTDC timing decal on the front air box cover.

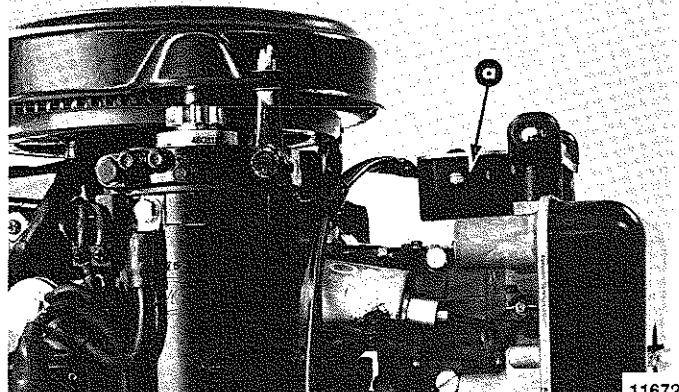
TIMING ADJUSTMENTS

IMPORTANT: If link rod was disassembled, make sure that 11/16" (17.5mm) dimension is retained, as shown in Figure 5.

1. Place engine in test tank or, if engine is mounted on boat, place boat and engine in water.

CAUTION: Engine is timed while cranking engine over with starter motor. To prevent engine from starting when being cranked, all spark plugs must be removed, except No. 1 plug.

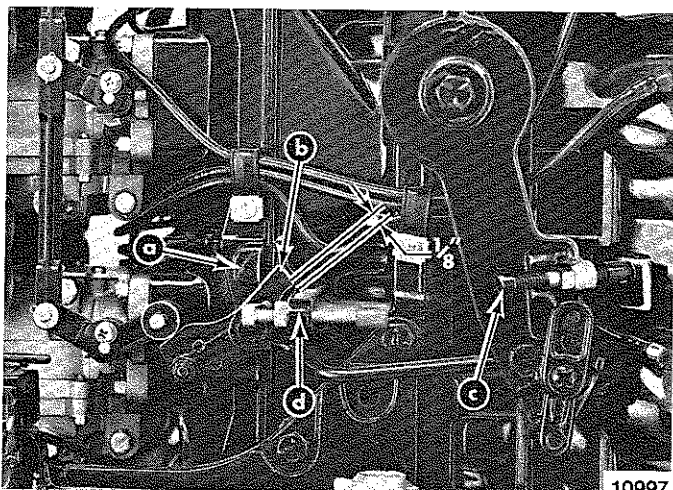
2. Remove all spark plugs, except No. 1 plug (top cylinder, starboard bank), from engine.
3. If engine is equipped with an idle stabilizer (Figure 2), temporarily disconnect the white/black (idle stabilizer) wire from terminal on outer switchbox and electrically isolate (tape) the terminal end of wire. Replace the other white/black wire back on terminal and properly secure with hex nut.
4. Disconnect remote fuel line from engine.
5. Connect electrical harness to engine.
6. If boss on reed block housing is as shown in Figure 3 (no edge), proceed with Step "a", immediately following. Or, if boss on reed block housing is as shown in Figure 4 (with edge), proceed with Step "b".
 - a. Remove throttle cable barrel from barrel retainer on cable anchor bracket. Adjust idle RPM stop screw to align bottom edge of throttle cam to obtain 1/8" (3.2mm) clearance between top front corner of throttle stop screw boss, as shown in Figure 3. Do not reinstall throttle cable at this time.
 - b. Remove throttle cable barrel from barrel retainer on cable anchor bracket and adjust idle stop screw so that top surface of throttle cam is aligned with edge on reed



a - Idle Stabilizer (if Equipped)

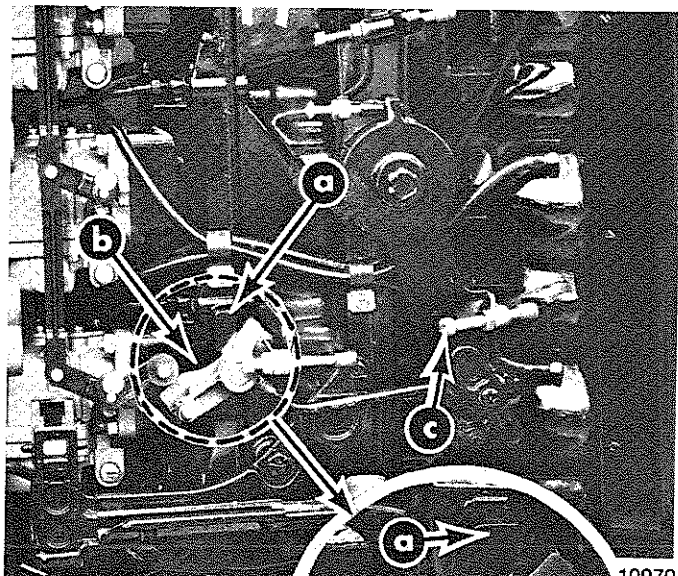
Figure 2. Idle Stabilizer (if Equipped)

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a - Reed Block Housing Boss c - Idle Stop Screw
b - Throttle Cam d - Throttle Stop Screw Boss

Figure 3. Idle Stop Screw Adjustment



a - Reed Block Housing Boss
b - Throttle Cam (Top Surface)
c - Idle Stop Screw
d - Edge (Align with Top Surface of Throttle Cam)

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Figure 4. Idle Stop Screw Adjustment

block housing boss, as shown in Figure 4. Do not re-install throttle cable at this time.

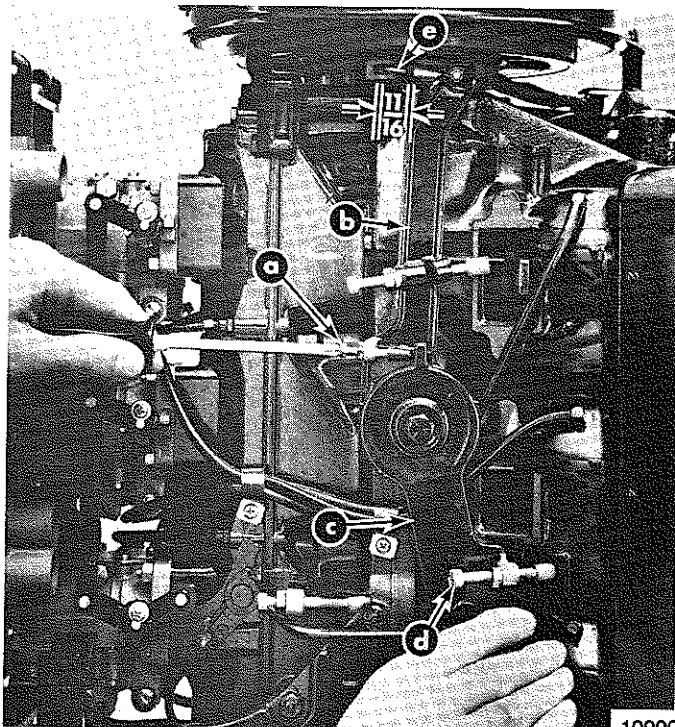
7. Connect Timing Light to No. 1 spark plug (top, starboard bank).

SAFETY WARNING: Before cranking engine, keep clear of propeller, as it may rotate.

8. With engine in neutral, hold throttle so that idle stop screw (Figure 5) is against idle stop. Crank engine with starter motor and adjust throttle primary pickup screw (Figure 5) to align 3 punch marks on flywheel with notch

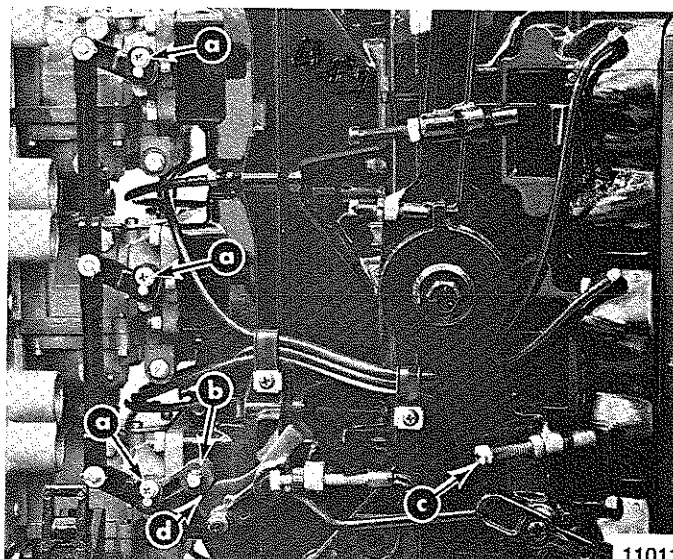
in window of flywheel cover. Retighten nut on adjustment screw.

9. Synchronize carburetors as follows:
 - a. Loosen 3 carburetor synchronizing screws (Figure 6) to allow throttle shutter plates to close completely.
 - b. Position throttle lever so that idle stop screw is against stop and move roller arm until roller just touches throttle cam, as shown in Figure 6, without moving roller from this position. Retighten carburetor synchronizing screws.
 - c. Remove sound box cover and check that all carburetor shutter plates close completely and open exactly at the same time.



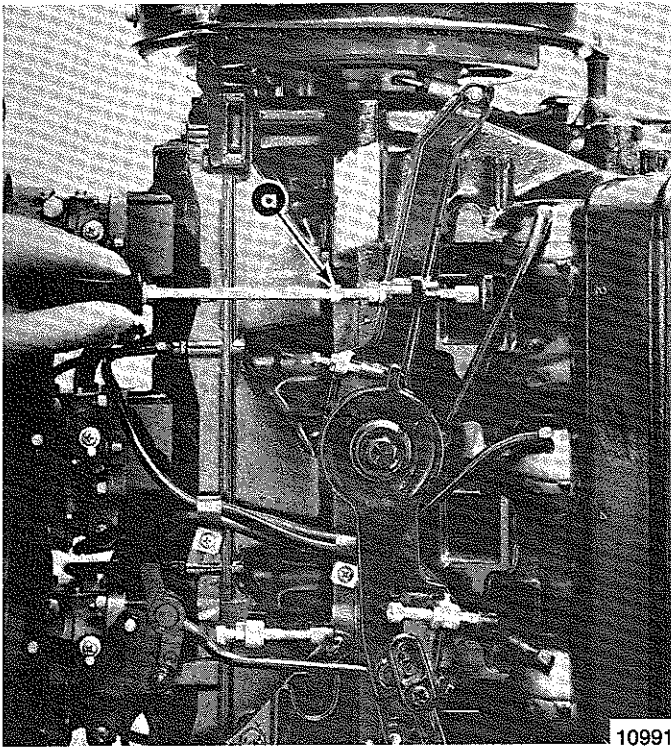
a - Primary Pickup Screw d - Idle Stop Screw (Position against Stop When Adjusting Primary Pickup)
b - Maximum Spark Advance Lever
c - Throttle Lever
e - Link Rod

Figure 5. Throttle Primary Pickup Adjustment



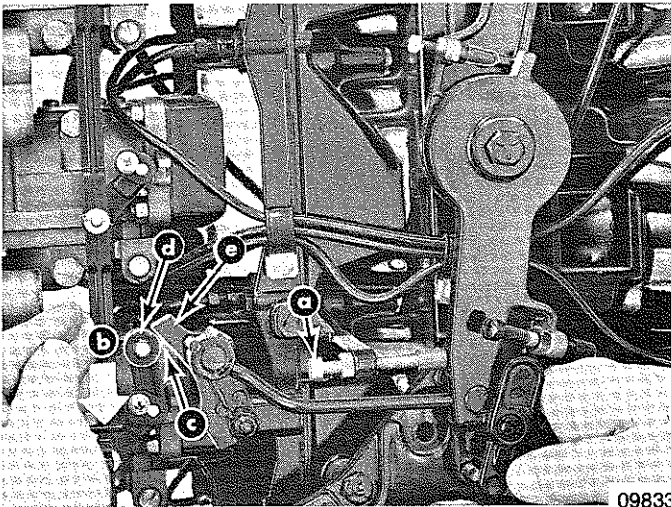
a - Synchronizing Screw c - Idle Stop Screw (Against Stop)
b - Roller d - Just Touching

Figure 6. Carburetor Synchronizing



a - Maximum Spark Advance Screw

Figure 7. Maximum Spark Advance Adjustment



a - Full Throttle Stop Screw b - Push Downward d - Roller
c - .010" to .015" Clearance e - Throttle Cam

Figure 8. Full Throttle Stop Adjustment

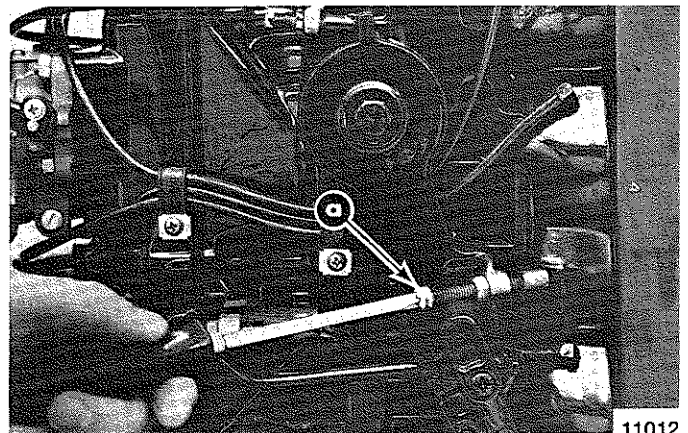
NOTE: Timing mark (2 punch marks) on flywheel is no longer used.

10. With engine in neutral, move throttle lever to place maximum spark screw against stop. Crank engine with starter motor and adjust maximum spark screw (Figure 7) to align

- one punch mark on flywheel with notch in window of flywheel cover. (Figure 1) Because of spark advance characteristics of this ignition system, this adjustment will result in a spark advance of 15° at maximum RPM. Retighten nut on adjustment screw. Remove timing light from engine.
11. With engine not running, move throttle lever to wide-open-throttle (WOT) and adjust full throttle shutter opening at (Figure 8) to allow full throttle shutter opening at WOT. Make sure that throttle shutters do not act as a throttle stop. Allow .010"-.015" (.25mm to .38mm) clearance between roller and throttle cam at WOT, as shown in Figure 8. Retighten nut on adjustment screw.
12. If engine is equipped with idle stabilizer (Figure 2), reconnect white/black (idle stabilizer) wire to switch box.
13. Adjust engine idle RPM as follows:
 - a. With engine in water, connect electrical harness and fuel line to engine. Start engine and allow to warm up.
 - b. With throttle cable barrel removed from barrel retainer, adjust idle RPM to 550-650 RPM with engine running in forward gear. (Figure 9) Retighten nut on adjustment screw.
 - c. With end of throttle cable connected to throttle lever, hold throttle lever against idle stop. Adjust throttle cable barrel to slip into barrel retainer on cable anchor bracket with a very light preload of throttle lever against idle stop. Lock barrel in place.
 - d. Check preload on throttle cable by placing a thin piece of paper between idle stop screw and idle stop. Preload is correct when paper can be removed without tearing but has some drag on it. Readjust cable barrel, if necessary.

IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from forward to neutral. (Readjust throttle cable barrel, if necessary.)

NOTE: Carburetor idle mixture is not equipped with adjustment screw. See "Fuel Section" for jet change.



a - Idle Stop Screw

Figure 9. Idle RPM Adjustment

TIMING/SYNCHRONIZING/ADJUSTING

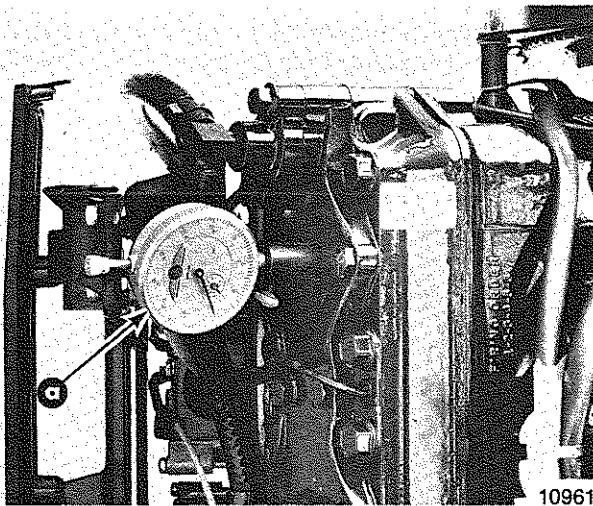
175 HP (1978 and Newer)

Firing Order	1-2-3-4-5-6
Firing Sequence	60° Consecutive
Spark Plug	AC-V40FFM or Champion L76V
Spark Plug Gap	Not Adjustable
Timing Maximum	18° BTDC (20° at Cranking Speed)
Throttle Primary Pickup	14° ATDC
Full Throttle RPM	5300-5800 RPM
Idle RPM	600-700 RPM in Forward Gear
Water Pressure	18 to 25 psi (1.27 to 1.76kg/cm ²) @ 5000 RPM

TIMING POINTER ADJUSTMENT

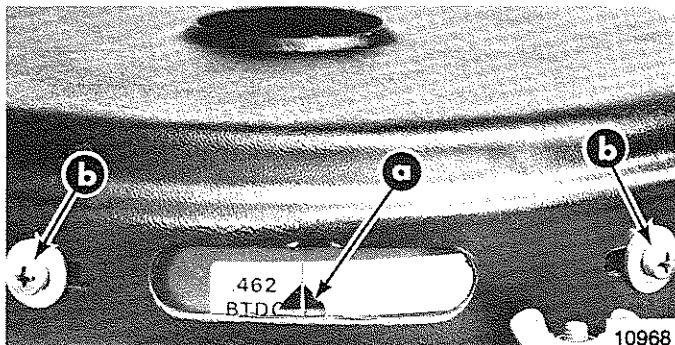
SAFETY WARNING: Engine could possibly start when turning flywheel to check timing pointer adjustment, therefore, remove all spark plugs to prevent engine from starting.

1. Remove all spark plugs and install Dial Indicator (C-91-58222A1) (Figure 1) into No. 1 cylinder (top cylinder, starboard bank).
2. Turn flywheel in a clockwise direction until No. 1 piston is at top dead center (TDC). Set dial indicator at "0" (zero) and tighten indicator set screw.



a - Dial Indicator Installed in No. 1 Cylinder

Figure 1. Dial Indicator Installed in Cylinder



a - Timing Pointer

b - Timing Pointer Attaching Screw

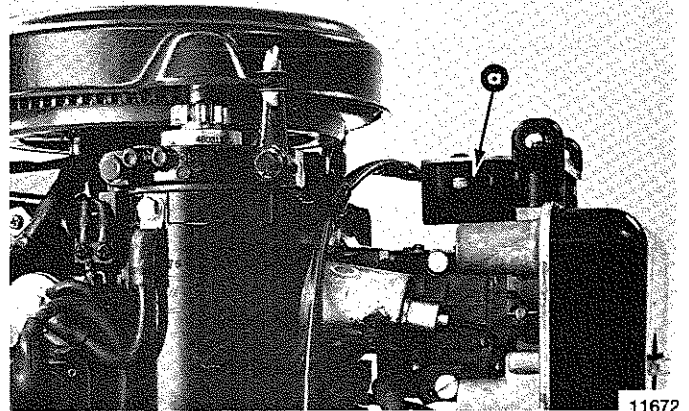
Figure 2. Timing Pointer Alignment

3. Turn flywheel counterclockwise until dial indicator needle is approx. ¼-turn beyond .462" (12mm), then turn flywheel clockwise so that dial indicator reads .462" exactly.
4. Reposition timing pointer, if necessary, so that timing pointer is aligned with .462" mark on timing decal, as shown in Figure 2. Retighten pointer attaching screws.
5. Remove dial indicator from cylinder and reinstall No. 1 spark plug and spark plug lead.

TIMING ADJUSTMENTS

IMPORTANT: If link rod was disassembled, make sure that 11/16" (17.5mm) dimension is retained, as shown in Figure 5.

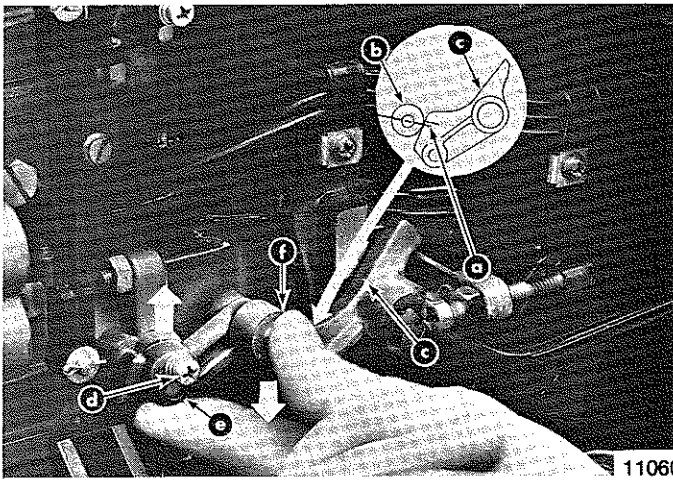
CAUTION: Engine is timed while cranking engine over with starter motor. To prevent engine from starting when being cranked, all spark plugs must be removed, except No. 1 plug.



a - Idle Stabilizer (if Equipped)

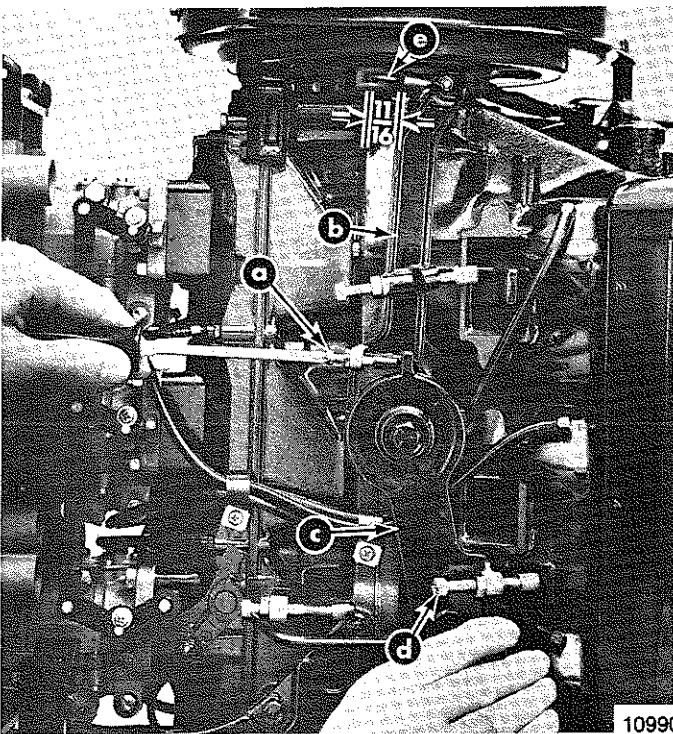
Figure 3. Idle Stabilizer (if Equipped)

1. Remove all spark plugs, except No. 1 spark plug (top cylinder, starboard bank), from engine.
2. If engine is equipped with an idle stabilizer (Figure 3), temporarily disconnect the white/black (idle stabilizer) wire from terminal on outer switchbox and electrically isolate (tape) the terminal end of wire. Replace the other white/black wire back on terminal and properly secure with hex nut.
3. Disconnect remote fuel line from engine.
4. Connect electrical harness to engine.
5. Remove throttle cable barrel from barrel retainer on cable anchor bracket.



- 11060
- a - First Slash Mark (Align with Point of Contact with Roller)
 - b - Roller
 - c - Cam Follower
 - d - Carburetor Synchronizing Screw (One Each Carburetor)
 - e - Push Up on Throttle Shaft (Removes Looseness)
 - f - Push Down on Roller (Removes Looseness)

Figure 4. Adjusting Throttle Cam



- 10990
- a - Primary Pickup Screw
 - b - Maximum Spark Advance Lever
 - c - Throttle Lever
 - d - Idle Stop Screw (Position against Stop When Adjusting Primary Pickup)
 - e - Link Rod

Figure 5. Throttle Primary Pickup Adjustment

6. Adjust throttle cam and carburetor synchronizing, as follows:
 - a. Remove choke knob and wing nuts and remove sound box cover from engine. This is necessary to be sure that all carburetor throttle shutters are closed and that they will open together.
 - b. Loosen carburetor synchronizing screws (Figure 4) and allow all throttle shutters to close freely.
 - c. Lightly press cam follower roller against throttle cam and, at the same time, lift up on bottom carburetor throttle shaft, as shown in Figure 4. This must be done to remove looseness in the linkage components.

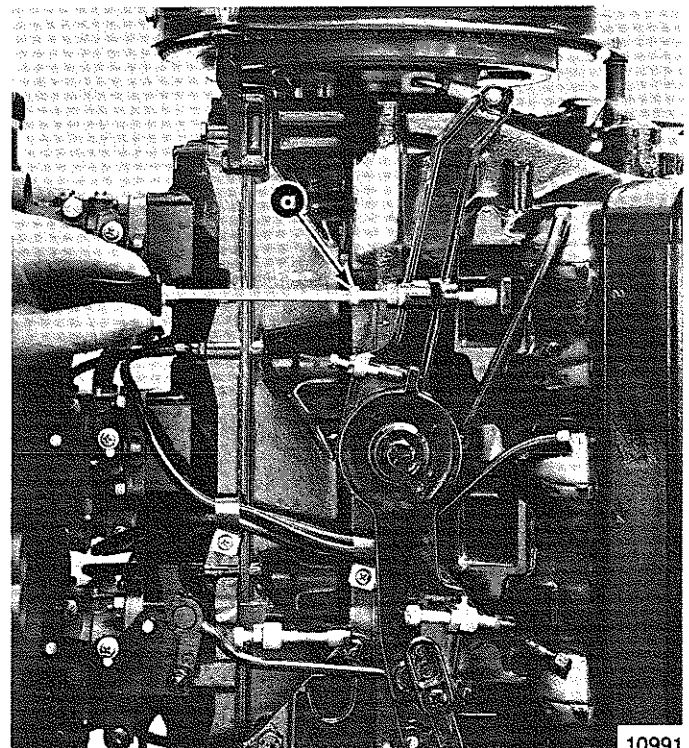
- d. Adjust idle stop screw (Figure 5) so that the first (short) slash mark on throttle cam is at the point of contact with roller, as shown in Figure 4. Retighten nut on idle adjustment screw.
- e. While continuing to maintain slight pressure against roller and lifting up the bottom throttle shaft, retighten all carburetor synchronizing screws. CHECK that carburetor throttle shutters are completely closed when roller is at point of contact with first (short) slash mark on throttle cam and that all looseness is removed from linkage so that carburetor shutter plates will start to open exactly at the same time that throttle lever is actuated.

IMPORTANT: Actuate throttle and spark levers a few times, then return throttle lever to idle stop. Check that roller is at point of contact with first (short) slash mark on throttle cam, that all carburetor throttle shutters are completely closed and that all looseness is removed so that carburetor throttle shutters will start to open exactly at the same time that throttle lever is actuated (readjust if necessary).

- f. Reinstall sound box cover to engine.
7. Connect Timing Light to No. 1 spark plug (top starboard bank).

SAFETY WARNING: Before cranking engine, keep clear of propeller, as it may rotate.

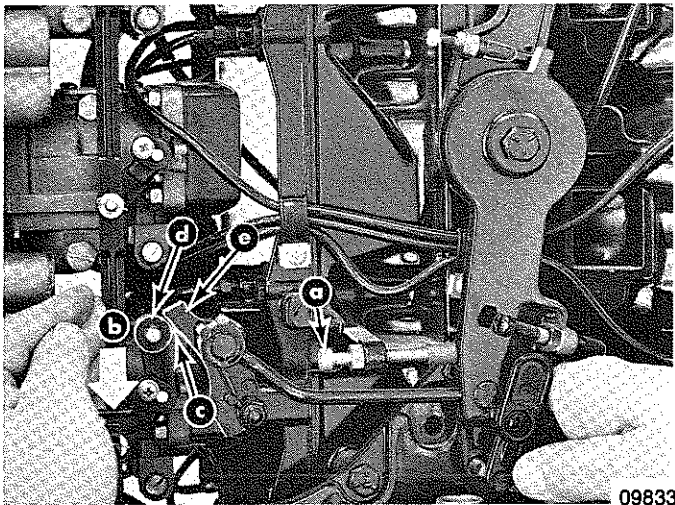
8. With engine in neutral, hold throttle so that idle stop screw (Figure 5) is against idle stop. Crank engine with starter motor and adjust throttle primary pickup screw (Figure 5) to align 14° ATDC mark on timing decal with timing pointer. Retighten nut on adjustment screw.



- 10991
- a - Maximum Spark Advance Screw

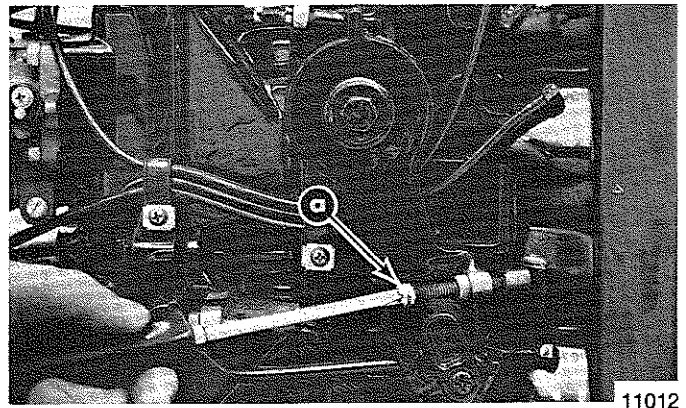
Figure 6. Maximum Spark Advance Adjustment

9. With engine in neutral, move throttle lever to place maximum spark screw against stop. Crank engine with starter motor and adjust maximum spark screw (Figure 6) to align 20° BTDC mark on timing decal with the pointer. Due to the advance characteristics of this ignition system, this adjustment will result in a spark advance of 18° at maximum RPM. Retighten nut on adjustment screw. Remove timing light from engine.
10. With engine not running, move throttle lever to wide-open-throttle (WOT) and adjust full throttle stop screw (Figure 7) to allow full throttle shutter opening at WOT. Make sure that throttle shutters do not act as a throttle stop. Allow .010"-.015" (.25mm to .38mm) clearance between roller and throttle cam at WOT, as shown in Figure 7. Retighten nut on adjustment screw.
11. If engine is equipped with an idle stabilizer (Figure 3), reconnect white/black (idle stabilizer) wire to switch box.
12. Adjust engine idle RPM as follows:
 - a. With engine in water, connect electrical harness and fuel line to engine. Start engine and allow to warm up.
 - b. With throttle cable barrel removed from barrel retainer, adjust idle RPM to 600-700 RPM with engine



a - Full Throttle Stop Screw b - Push Downward d - Roller
 c - .010" to .015" Clearance e - Throttle Cam

Figure 7. Full Throttle Stop Adjustment



a - Idle Stop Screw

Figure 8. Idle RPM Adjustment

- running in forward gear. (Figure 8) Retighten nut on adjustment screw.
- c. With end of throttle cable connected to throttle lever, hold throttle lever against idle stop. Adjust throttle cable barrel to slip into barrel retainer on cable anchor bracket with a very light preload of throttle lever against idle stop. Lock barrel in place.
- d. Check preload on throttle cable by placing a thin piece of paper between idle stop screw and idle stop. Preload is correct when paper can be removed without tearing but has some drag on it. Readjust cable barrel, if necessary.

IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from forward to neutral. (Readjust throttle cable barrel, if necessary.)

NOTE: Carburetor idle mixture is not equipped with adjustment screw. See "Fuel Section" for jet change.

NOTE: If sufficient throttle cable barrel adjustment is not available, a check must be made for correct installation of link rod (located between throttle lever and throttle cam). Each end of this link rod must be threaded into its plastic barrel until it bottoms against throttle lever or throttle cam casting, then turned out only far enough to obtain correct orientation of link rod (less than one turn). All timing adjustments must be reset after this procedure.

TIMING/SYNCHRONIZING/ADJUSTING 150 HP Models (Serial No. 5203428 and Below §) and 200 HP (thru Serial No. 5363917)

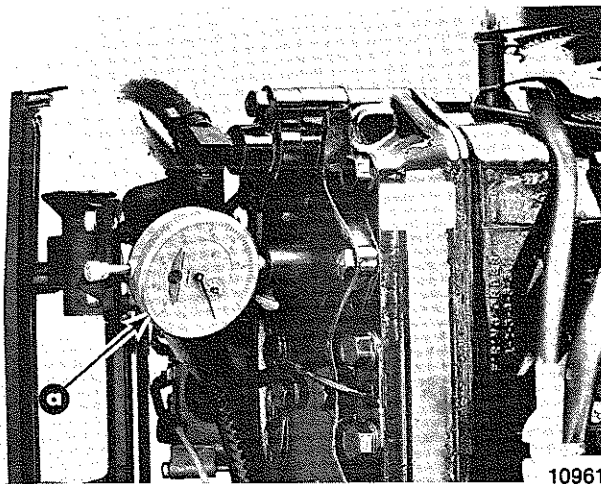
§ If 150 HP Engine (Being Timed) Is Modified with New Carburetors Part No. 1382-7563A__ (WH9- Will Be Stamped on Top of Carburetor Mounting Flange), Then Use Timing Procedure for 150 HP Models, Serial No. 5203429 and Above, following.

	150 HP Model	200 HP Model
Firing Order	1-2-3-4-5-6	1-2-3-4-5-6
Firing Sequence	60° Consecutive	60° Consecutive
Spark Plug	AC-V40FFM or Champion L76V	AC-V40FFM or Champion L76V
Spark Plug Gap	Not Adjustable	Not Adjustable
Timing Maximum	16° BTDC (18° at Cranking)	18° BTDC (20° at Cranking)
Throttle Primary Pickup	7.5° to 8.5° ATDC	8° to 10° ATDC
Throttle Secondary Pickup	Not Adjustable	Not Adjustable
Full Throttle RPM	5000 to 5500 RPM	5300 to 5800 RPM
Idle RPM (in Forward Gear)	600-700 RPM @ 7.5° to 8.5° ATDC	550-650 RPM @ 12° to 15° ATDC*
Water Pressure	18 to 25 psi @ 5000 RPM	18 to 25 psi @ 5000 RPM

* See "Caution" on Page 2C-9.

TIMING POINTER ADJUSTMENT

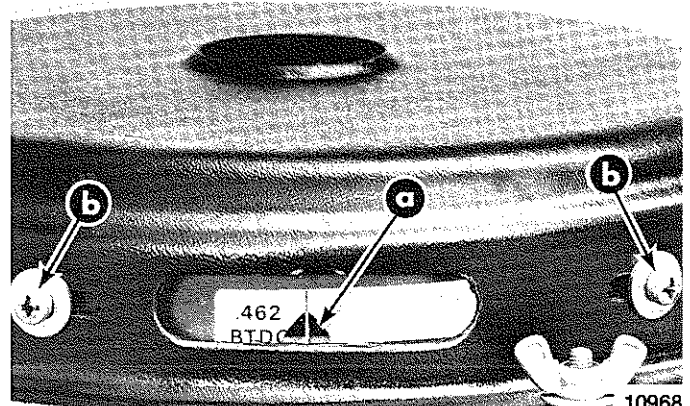
SAFETY WARNING; Engine could start when turning flywheel to check timing pointer adjustment. Remove all spark plugs from engine to prevent engine from starting.



a - Dial Indicator Installed in No. 1 Cylinder

Figure 1. Dial Indicator Installed into Cylinder

1. Remove all spark plugs and install Dial Indicator (C-91-58222A1) (Figure 1) into No. 1 cylinder (top cylinder, starboard bank).
2. Turn flywheel in a clockwise direction until No. 1 piston is at top dead center (TDC). Set dial indicator at "0" (zero) and tighten indicator set screw.
3. Turn flywheel counterclockwise until dial indicator needle is approximately ¼-turn beyond .462", then turn flywheel clockwise so that dial indicator reads .462" exactly.
4. Reposition timing pointer (if necessary) so that timing pointer is aligned with .462" mark on timing decal, as shown in Figure 2. Retighten pointer attaching screws.
5. Remove dial indicator from cylinder and reinstall No. 1 spark plug and spark plug lead.

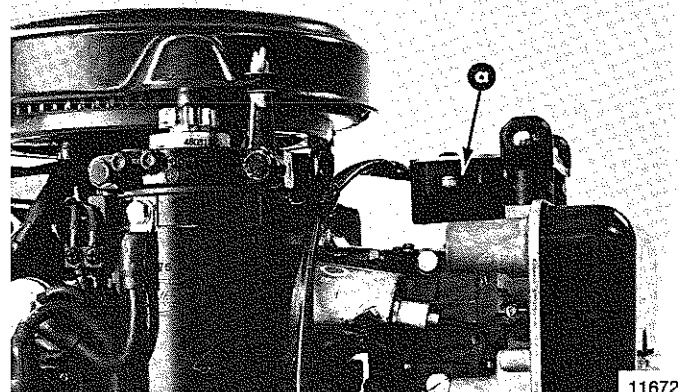


a - Timing Pointer b - Timing Pointer Attaching Screw

Figure 2. Timing Pointer Alignment

TIMING ADJUSTMENTS

IMPORTANT: If link rod was disassembled, make sure that 11/16" (17.5mm) dimension is retained, as shown in Figure 5.



a - Idle Stabilizer (if Equipped)

Figure 3. Idle Stabilizer (if Equipped)

CAUTION: Engine is timed while cranking engine with starter motor. To prevent engine from starting when being cranked, all spark plugs must be removed, except No. 1 plug.

1. Remove all spark plugs except No. 1 plug (top cylinder, starboard bank) from engine.
2. If engine is equipped with an idle stabilizer (Figure 3), temporarily disconnect the white/black (idle stabilizer) wire from terminal on outer switchbox and electrically isolate (tape) the terminal end of wire. Replace the other white/black wire back on terminal and properly secure with hex nut.
3. Disconnect remote fuel line from engine.
4. Connect electrical harness to engine.
5. Remove throttle cable barrel from barrel retainer on cable anchor bracket and adjust idle stop screw (Figure 4) so that top surface of throttle cam is aligned with edge on reed block housing boss, as shown in Figure 4. **DO NOT** re-install throttle cable at this time.

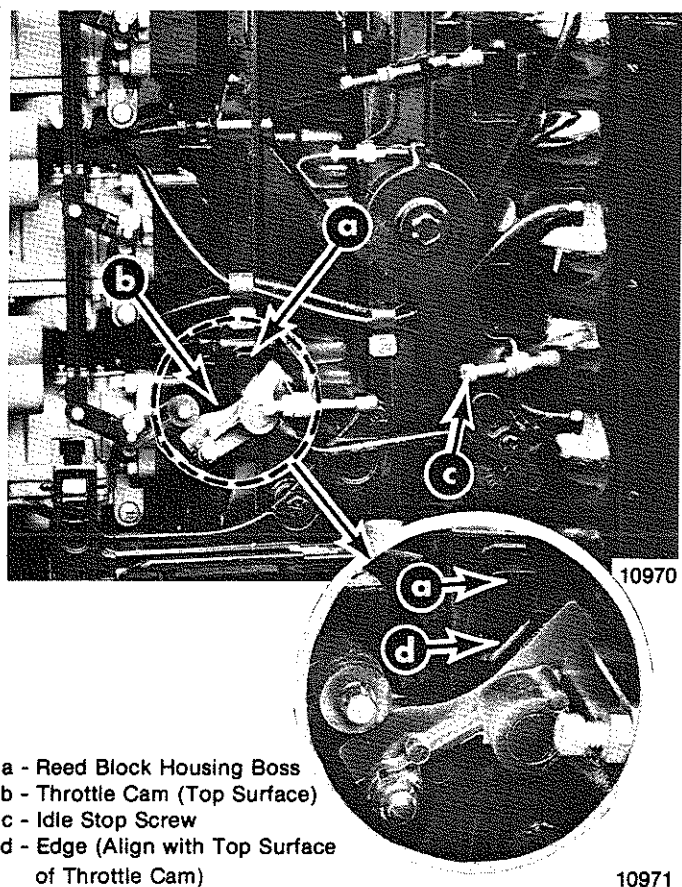
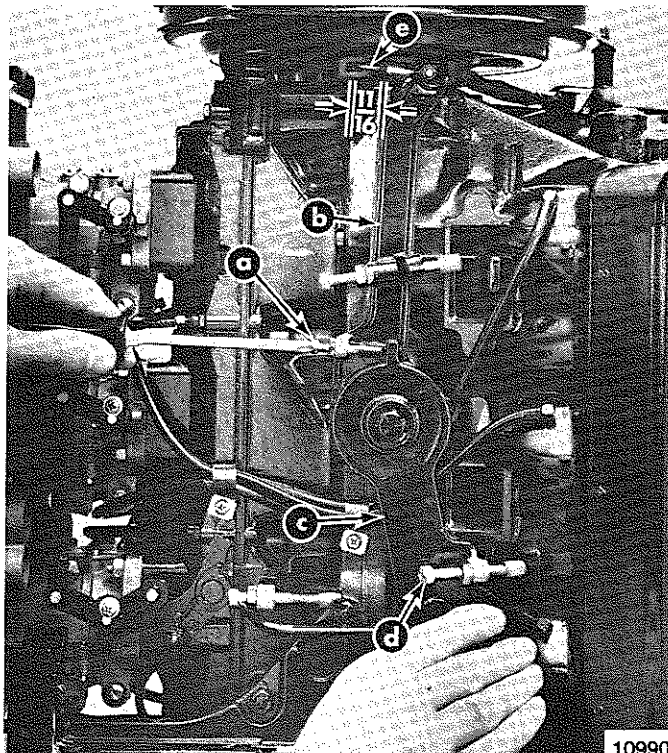


Figure 4. Idle Stop Screw Adjustment

6. Connect Timing Light to No. 1 spark plug (top starboard bank).

SAFETY WARNING: Before cranking engine, keep clear of propeller, as it may rotate.

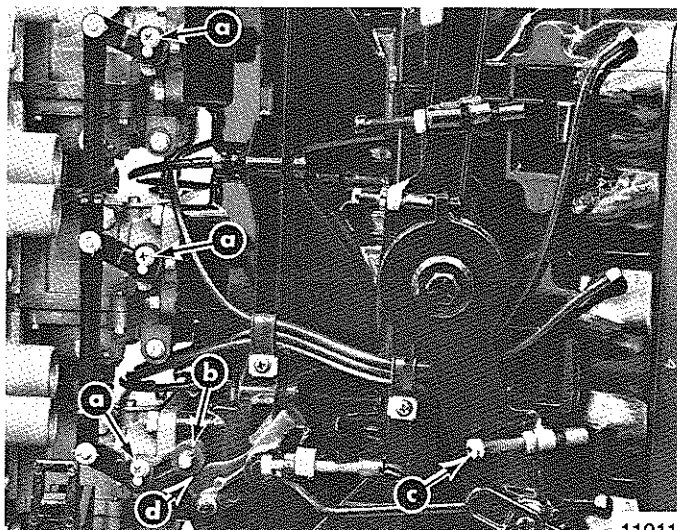
7. With engine in neutral, hold throttle arm so that idle stop screw (Figure 5) is against idle stop, then crank engine with starter motor and adjust throttle primary pickup screw (Figure 5) to align specified throttle primary pickup mark on timing decal with timing pointer. Retighten nut on adjustment screw.
8. Synchronize carburetors as follows:



- a - Primary Pickup Screw d - Idle Stop Screw (Position against Stop When Adjusting Primary Pickup)
 b - Maximum Spark Advance Lever
 c - Throttle Lever
 e - Link Rod

Figure 5. Throttle Primary Pickup Adjustment

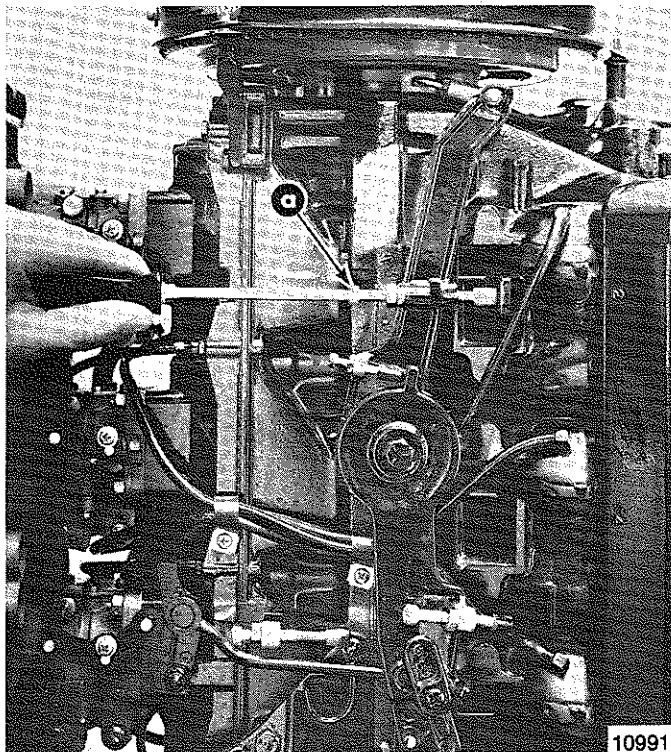
- a. Loosen 3 carburetor synchronizing screws (Figure 6) to allow throttle shutter plates to close completely.
- b. Position throttle lever so that idle stop screw is against stop and move roller arm until roller just touches throttle cam, as shown in Figure 6, without moving roller from this position. Retighten carburetor synchronizing screws.
- c. Remove sound box cover and check that all carburetor shutter plates close completely and open exactly at the same time.
9. With engine in neutral, move throttle lever to place maximum spark screw against stop. Crank engine with starter



- a - Synchronizing Screw c - Idle Stop Screw (Against Stop)
 b - Roller d - Just Touching

Figure 6. Carburetor Synchronizing

motor and adjust maximum spark screw (Figure 7) to align 20° (200 HP) or 18° (150 HP) BTDC mark on timing decal with timing pointer. Due to the spark advance characteristics of this ignition system, this adjustment will result in a spark advance of 18° (200 HP) or 16° (150 HP) at maximum RPM. Retighten nut on adjustment screw. Remove timing light from engine.



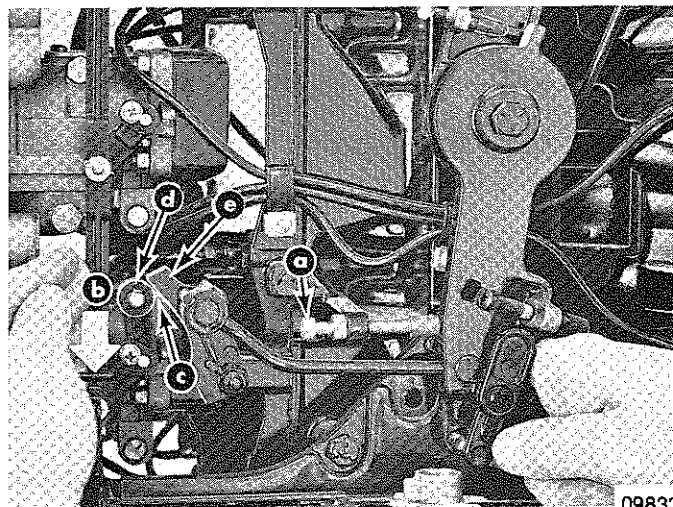
a - Maximum Spark Advance Screw

Figure 7. Maximum Spark Advance Adjustment

10. With engine not running, move throttle lever to wide-open-throttle (WOT) and adjust full throttle stop screw (Figure 8) to allow full throttle shutter opening at WOT. Make sure that throttle shutters do not act as a throttle stop. Allow .010"-.015" (.25mm to .38mm) clearance between roller and throttle cam at WOT, as shown in Figure 8. Retighten nut on adjustment screw.
11. If engine is equipped with an idle stabilizer (Figure 3), reconnect white/black (idle stabilizer) wire to switch box.
12. Adjust engine idle RPM as follows:

CAUTION: Engine idle RPM must NEVER exceed 800 RPM in gear.

- a. With engine in water, connect electrical harness and fuel line to engine. Start engine and allow to warm up.
- b. With throttle cable barrel removed from barrel retainer, adjust idle RPM to specified idle RPM with engine running in forward gear. (Figure 9) Retighten nut on adjustment screw.
- c. With end of throttle cable connected to throttle lever, hold throttle lever against idle stop. Adjust throttle cable barrel to slip into barrel retainer on cable anchor



a - Full Throttle Stop Screw b - Push Downward d - Roller
c - .010" to .015" Clearance e - Throttle Cam

Figure 8. Full Throttle Stop Adjustment

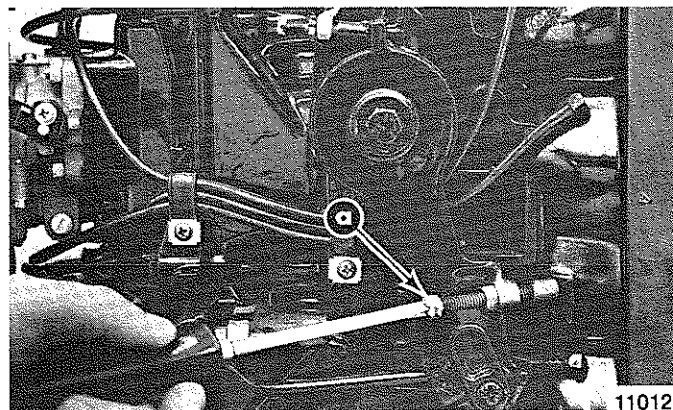
bracket with a very light preload of throttle lever against idle stop. Lock barrel in place.

- d. Check preload on throttle cable by placing a thin piece of paper between idle stop screw and idle stop. Preload is correct when paper can be removed without tearing but has some drag on it. Readjust cable barrel, if necessary.

IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from forward to neutral. (Readjust throttle cable barrel, if necessary.)

NOTE: Carburetor idle mixture is not equipped with adjustment screw. See "Fuel Section" for jet change.

NOTE: If sufficient throttle cable barrel adjustment is not available, a check must be made for correct installation of link rod (located between the throttle lever and throttle cam). Each end of this link rod must be threaded into its plastic barrel until it bottoms against the throttle lever or throttle cam casting, then turned out only far enough to obtain correct orientation of link rod (less than one turn). All timing adjustments must be reset after this procedure.



a - Idle Stop Screw

Figure 9. Idle RPM Adjustment

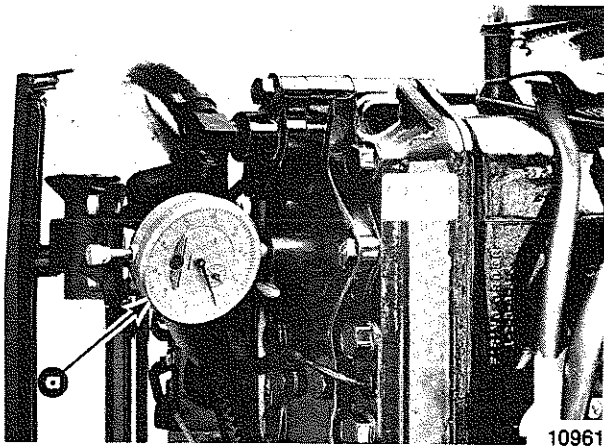
TIMING/SYNCHRONIZING/ADJUSTING 150 HP Models (Serial No. 5203429 and Above) and 200 HP Models (Serial No. 5363918 and Above)

	150 HP Model	200 HP Model
Firing Order	1-2-3-4-5-6	1-2-3-4-5-6
Firing Sequence	60° Consecutive	60° Consecutive
Spark Plug	AC-V40FFM or Champion L76V	AC-V40FFM or Champion L76V
Spark Plug Gap	Not Adjustable	Not Adjustable
Timing Maximum	16° BTDC (18° at Cranking)	18° BTDC (20° at Cranking)
Throttle Primary Pickup	11° ATDC	10° ATDC
Throttle Secondary Pickup	Not Adjustable	Not Adjustable
Full Throttle RPM	5000 to 5500 RPM	5300 to 5800 RPM
Idle RPM (in Forward Gear)	600-700 RPM	600-700 RPM
Water Pressure @ 5000 RPM	18 to 25 psi (1.3 to 1.8kg/cm ²)	18 to 25 psi (1.3 to 1.8kg/cm ²)

TIMING POINTER ADJUSTMENT

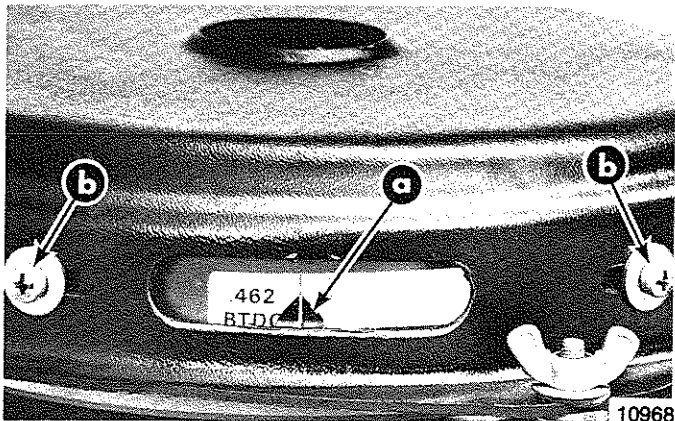
SAFETY WARNING; Engine could start when turning flywheel to check timing pointer adjustment. Remove all spark plugs from engine to prevent engine from starting.

1. Remove all spark plugs and install Dial Indicator (C-91-5822A1) (Figure 1) into No. 1 cylinder (top cylinder, starboard bank).



a - Dial Indicator Installed in No. 1 Cylinder

Figure 1. Dial Indicator Installed into Cylinder



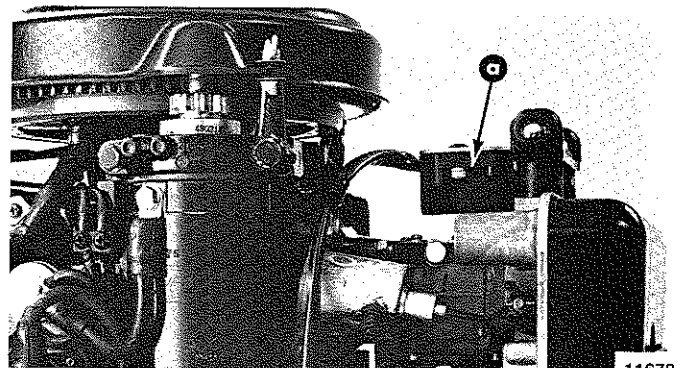
a - Timing Pointer b - Timing Pointer Attaching Screw

Figure 2. Timing Pointer Alignment

2. Turn flywheel in a clockwise direction until No. 1 piston is at top dead center (TDC). Set dial indicator at "0" (zero) and tighten indicator set screw.
3. Turn flywheel counterclockwise until dial indicator needle is approximately ¼-turn beyond .462", then turn flywheel clockwise so that dial indicator reads .462" exactly.
4. Reposition timing pointer (if necessary) so that timing pointer is aligned with .462" mark on timing decal, as shown in Figure 2. Retighten pointer attaching screws.
5. Remove dial indicator from cylinder and reinstall No. 1 spark plug and spark plug lead.

TIMING ADJUSTMENTS

IMPORTANT: If link rod was disassembled, make sure that 11/16" (17.5mm) dimension is retained, as shown in Figure 5.



a - Idle Stabilizer (if Equipped)

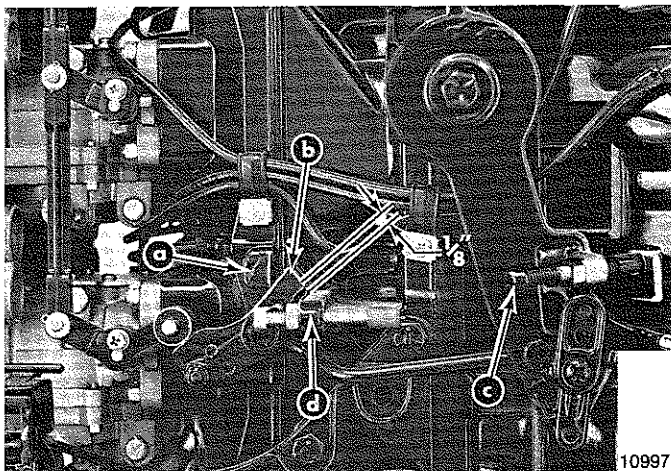
Figure 3. Idle Stabilizer (if Equipped)

CAUTION: Engine is timed while cranking engine with starter motor. To prevent engine from starting when being cranked, all spark plugs must be removed, except No. 1 plug.

1. Remove all spark plugs except No. 1 plug (top cylinder, starboard bank) from engine.
2. If engine is equipped with an idle stabilizer (Figure 3), temporarily disconnect the white/black (idle stabilizer) wire from terminal on outer switchbox and electrically isolate (tape) the terminal end of wire. Replace the other

white/black wire back on terminal and properly secure with hex nut.

3. Disconnect remote fuel line from engine.
4. Connect electrical harness to engine.
5. Remove throttle cable barrel from barrel retainer on cable mounting bracket and adjust idle stop screw (Figure 4) so that bottom edge of throttle cam is $\frac{1}{8}$ " (3.2mm) from front corner of throttle stop screw boss, as shown in Figure 4. DO NOT reinstall throttle cable at this time.



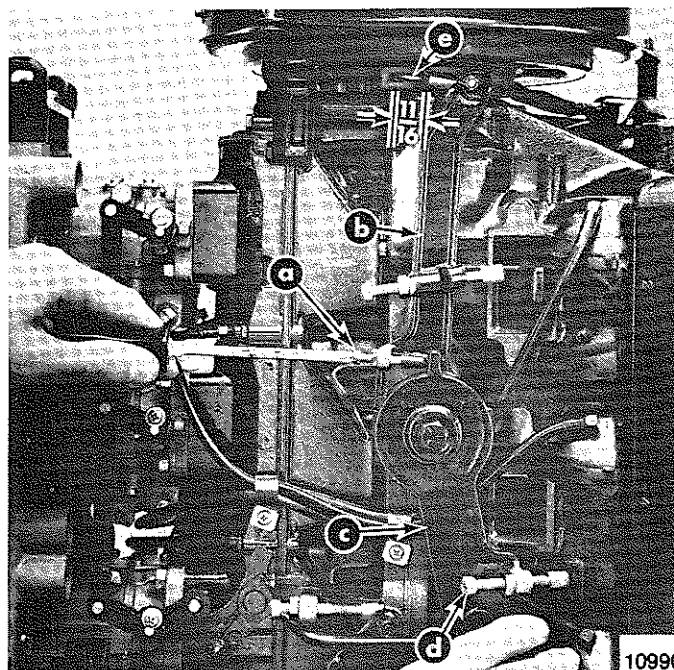
a - Reed Block Housing Boss c - Idle Stop Screw
b - Throttle Cam d - Throttle Stop Screw Boss

Figure 4. Idle Stop Screw Adjustment

6. Connect Timing Light to No. 1 spark plug (top starboard bank).

SAFETY WARNING: Before cranking engine, keep clear of propeller, as it may rotate.

7. With engine in neutral, hold throttle arm so that idle stop screw (Figure 5) is against idle stop, then crank engine with starter motor and adjust throttle primary pickup screw (Figure 5) to align specified throttle primary pickup mark on timing decal with timing pointer. Retighten nut on adjustment screw.
8. Synchronize carburetors as follows:
 - a. Loosen 3 carburetor synchronizing screws (Figure 6) to allow throttle shutter plates to close completely.
 - b. Position throttle lever so that idle stop screw is against stop and move roller arm until roller just touches throttle cam, as shown in Figure 6, without moving roller from this position. Retighten carburetor synchronizing screws.
 - c. Remove sound box cover and check that all carburetor shutter plates close completely and open exactly at the same time.
9. With engine in neutral, move throttle lever to place maximum spark screw against stop. Crank engine with starter motor and adjust maximum spark screw (Figure 7) to align 20° (200 HP) or 18° (150 HP) BTDC mark on timing decal with timing pointer. Due to the spark advance characteristics of this ignition system, this adjustment will result in a spark advance of 18° (200 HP) or 16° (150 HP) at maximum RPM. Retighten nut on adjustment screw. Remove timing light from engine.
10. With engine not running, move throttle lever to wide-open-throttle (WOT) and adjust full throttle stop screw (Figure 8) to allow full throttle shutter opening at WOT. Make sure that throttle shutters do not act as a throttle stop. Allow .010"-.015" (.25mm to .38mm) clearance



a - Primary Pickup Screw d - Idle Stop Screw (Position against Stop When Adjusting Primary Pickup)
b - Maximum Spark Advance Lever
c - Throttle Lever e - Link Rod

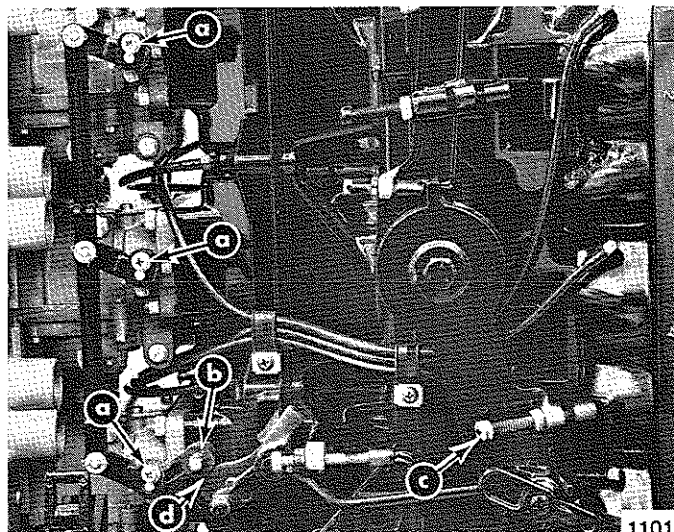
Figure 5. Throttle Primary Pickup Adjustment

between roller and throttle cam at WOT, as shown in Figure 8. Retighten nut on adjustment screw.

11. If engine is equipped with an idle stabilizer (Figure 3), re-connect white/black (idle stabilizer) wire to switch box.
12. Adjust engine idle RPM as follows:

CAUTION: Engine idle RPM must NEVER exceed 800 RPM in gear.

- a. With engine in water, connect electrical harness and fuel line to engine. Start engine and allow to warm up.
- b. With throttle cable barrel removed from barrel retainer, adjust idle RPM to specified idle RPM with engine running in forward gear. (Figure 9) Retighten nut on adjustment screw.



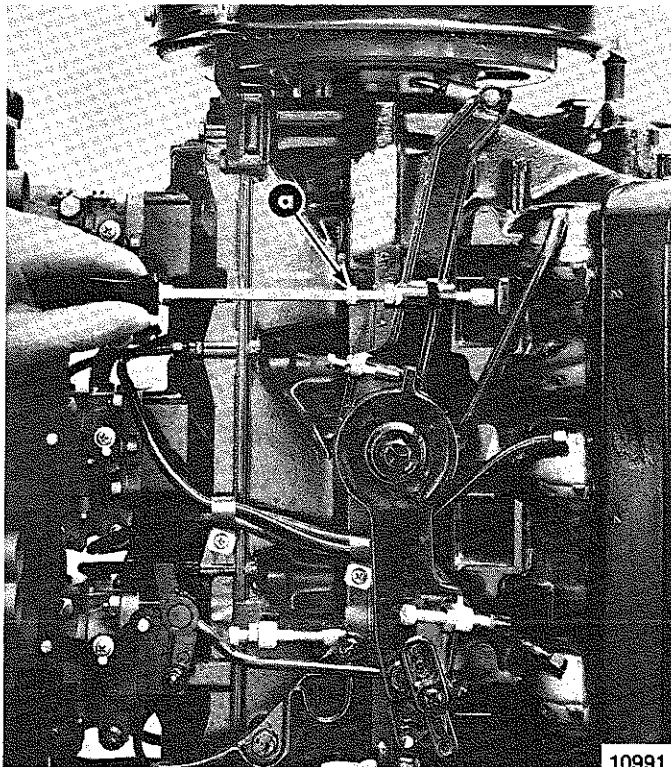
a - Synchronizing Screw c - Idle Stop Screw (Against Stop)
b - Roller d - Just Touching

Figure 6. Carburetor Synchronizing

- c. With end of throttle cable connected to throttle lever, hold throttle lever against idle stop. Adjust throttle cable barrel to slip into barrel retainer on cable anchor bracket with a very light preload of throttle lever against idle stop. Lock barrel in place.
- d. Check preload on throttle cable by placing a thin piece of paper between idle stop screw and idle stop. Preload is correct when paper can be removed without tearing but has some drag on it. Readjust cable barrel, if necessary.

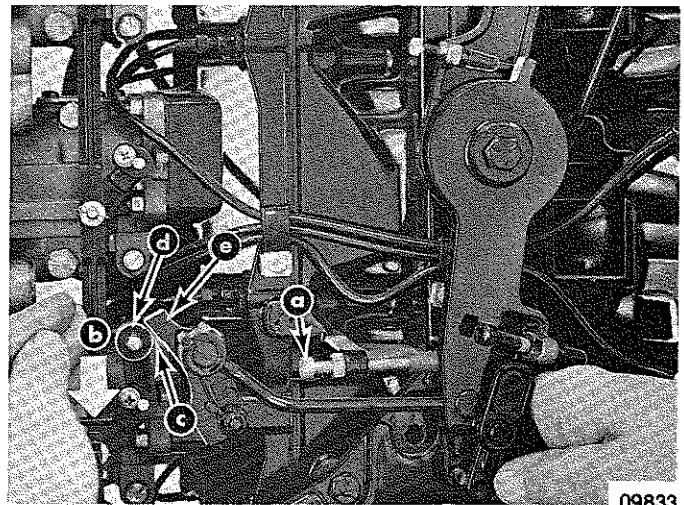
IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from forward to neutral. (Readjust throttle cable barrel, if necessary.)

NOTE: Carburetor idle mixture is not equipped with adjustment screw. See "Fuel Section" for jet change.



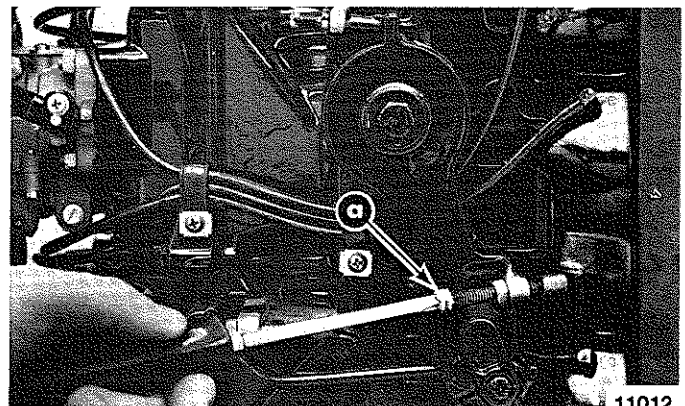
a - Maximum Spark Advance Screw

Figure 7. Maximum Spark Advance Adjustment



a - Full Throttle Stop Screw b - Push Downward d - Roller
c - .010" to .015" Clearance e - Throttle Cam

Figure 8. Full Throttle Stop Adjustment



a - Idle Stop Screw

Figure 9. Idle RPM Adjustment

NOTE: If sufficient throttle cable barrel adjustment is not available, a check must be made for correct installation of link rod (located between the throttle lever and throttle cam). Each end of this link rod must be threaded into its plastic barrel until it bottoms against the throttle lever or throttle cam casting, then turned out only far enough to obtain correct orientation of link rod (less than one turn). All timing adjustments must be reset after this procedure.

TIMING/SYNCHRONIZING/ADJUSTING

225 HP Model

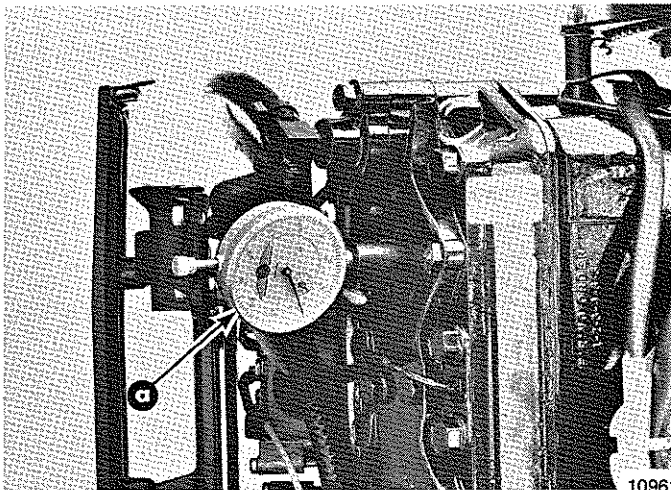
Firing Order	1-2-3-4-5-6
Firing Sequence	60° Consecutive
Spark Plug	AC-V40FFM or Champion L76V
Spark Plug Gap	Not Adjustable
Timing Maximum	22° at Cranking Speed 20° at 5400 RPM 26° over 5600 RPM *
Throttle Primary Pickup	12° ATDC
Throttle Secondary Pickup	Not Adjustable
Full Throttle RPM	5300 to 5800 RPM
Idle RPM (in Forward Gear)	600-700 RPM
Water Pressure	18 to 25 psi (1.27 to 1.76kg/cm ²) @ 5000 RPM

* Engine is equipped with a High Speed Spark Advance Module (Figure 3) which automatically increases maximum timing to 26° when engine is above 5500 ± 100 RPM. Need not be disconnected to time engine.

TIMING POINTER ADJUSTMENT

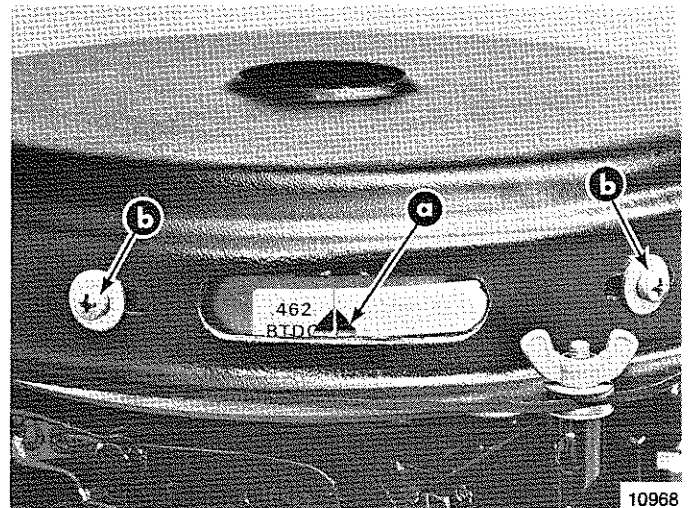
SAFETY WARNING: Engine could start when turning flywheel to check timing pointer adjustment. To prevent engine from starting, remove all spark plugs.

1. Remove all spark plugs and install Dial Indicator (C-91-58222A1) (Figure 1) into No. 1 cylinder (top cylinder, starboard bank).



a - Dial Indicator Installed in No. 1 Cylinder

Figure 1. Dial Indicator Installed into Cylinder



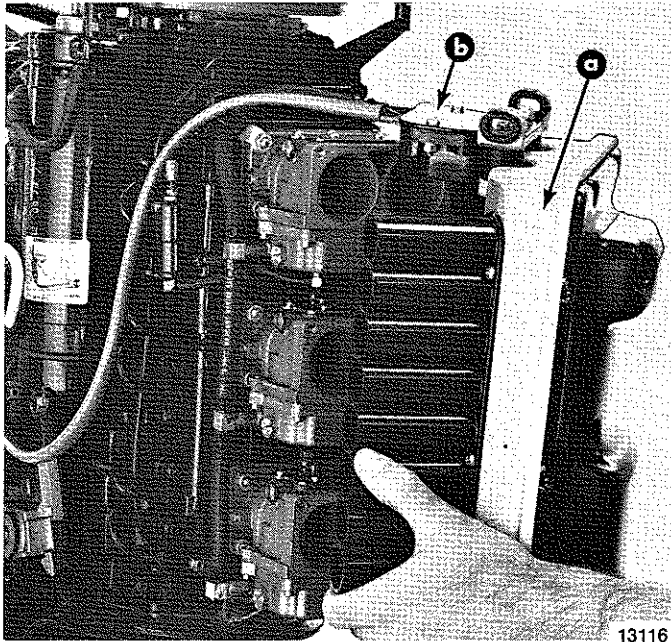
a - Timing Pointer b - Timing Pointer Attaching Screw

Figure 2. Timing Pointer Adjustment

2. Turn flywheel in a clockwise direction until No. 1 piston is at top dead center (TDC). Set dial indicator at "0" (zero) and tighten indicator set screw.
3. Turn flywheel counterclockwise until dial indicator needle is approximately ¼-turn beyond .462", then turn flywheel clockwise so that dial indicator reads .462" exactly.
4. Reposition timing pointer (if necessary) so that timing pointer is aligned with .462" mark on timing decal, as shown in Figure 2. Retighten pointer attaching screws.
5. Remove dial indicator from cylinder and reinstall No. 1 spark plug and spark plug lead.

TIMING ADJUSTMENTS

IMPORTANT: If link rod was disassembled, make sure that 11/16" (17.5mm) dimension is retained, as shown in Figure 7.



- a - Sound Attenuator
- b - High Speed Spark Advance Module -
DO NOT Disconnect to Time Engine

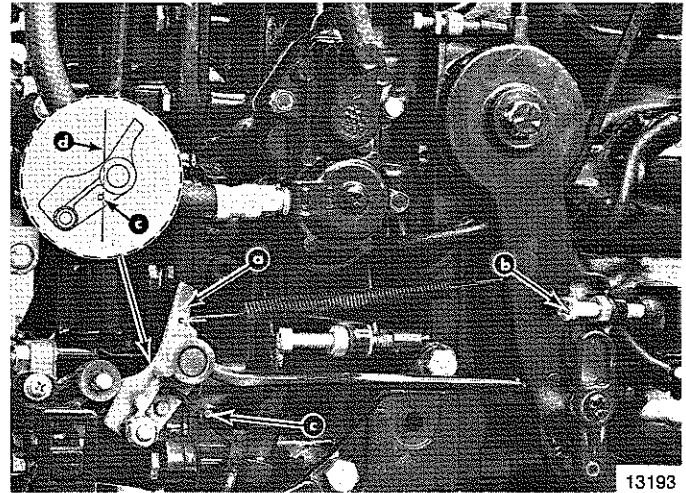
Figure 3. Removing Sound Attenuator

CAUTION: Engine is timed while cranking engine with starter motor. To prevent engine from starting when being cranked, all spark plugs, except No. 1, must be removed.

1. Remove all spark plugs, except No. 1 plug (top cylinder starboard bank), from engine.

IMPORTANT: An idle stabilizer is not a standard feature on the 1980 model 225 HP. If, however, an idle stabilizer is installed as an option, the idle stabilizer **MUST BE disconnected** (as outlined in Step 2) **BEFORE** timing engine.

2. If engine is equipped with an idle stabilizer, temporarily disconnect the white/black (idle stabilizer) wire from terminal on switchbox and electrically isolate (tape) the terminal end of wire. Replace the other white/black wire back on terminal and properly secure with hex nut.
3. Disconnect remote fuel line from engine.
4. Connect electrical harness to engine.
5. Remove throttle cable barrel from barrel retainer on engine.
6. Remove 6 bolts which secure sound attenuator (Figure 3) to carburetors. Lift attenuator from carburetors and move aside.

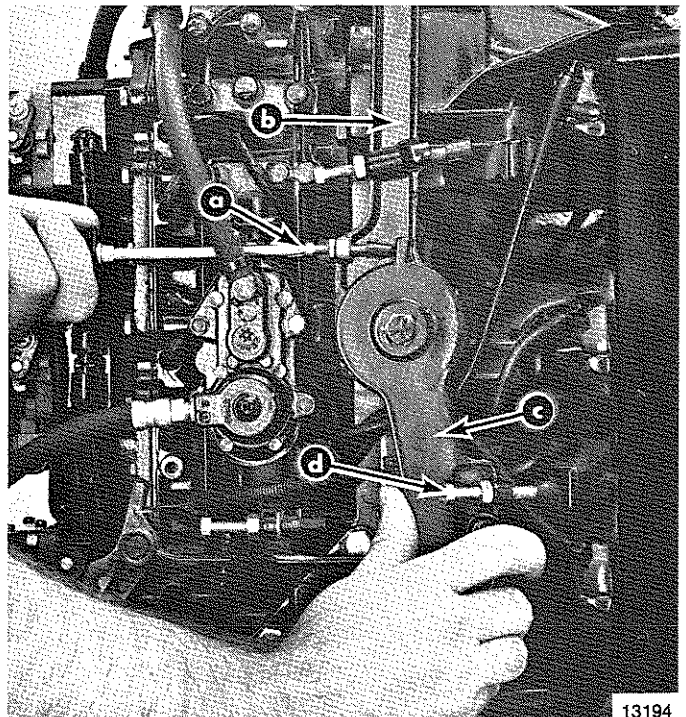


- a - Throttle Cam
- b - Idle Stop Screw
- c - 1/8" (3.2mm) Dia. Rod or Drill (Adjust Idle Stop Screw to Position Rod or Drill against Carburetor Adaptor Flange)
- d - Carburetor Adaptor Flange

Figure 4. Idle Stop Screw Adjustment

IMPORTANT: When adjusting idle stop screw in Step 7, the rod or drill, that is inserted in throttle cam, must be held perpendicular to cam.

7. Place 1/8" (3.2mm) diameter rod or drill into hole in throttle cam. Hold rod or drill perpendicular to throttle cam and adjust idle stop screw to position rod or drill against edge of



- a - Primary Pickup Screw
- b - Maximum Spark Advance Lever
- c - Throttle Lever
- d - Idle Stop Screw (Position against Stop When Adjusting Primary Pickup)

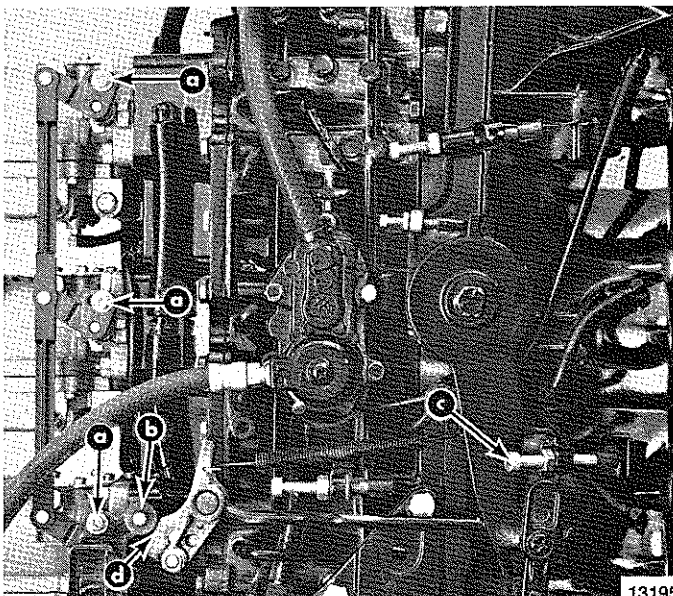
Figure 5. Throttle Primary Pickup Adjustment

carburetor adaptor flange, as shown in Figure 4. Retighten nut on adjustment screw.

8. Connect timing light to No. 1 spark plug (top starboard bank).

SAFETY WARNING: Before cranking engine, keep clear of propeller, as it may rotate.

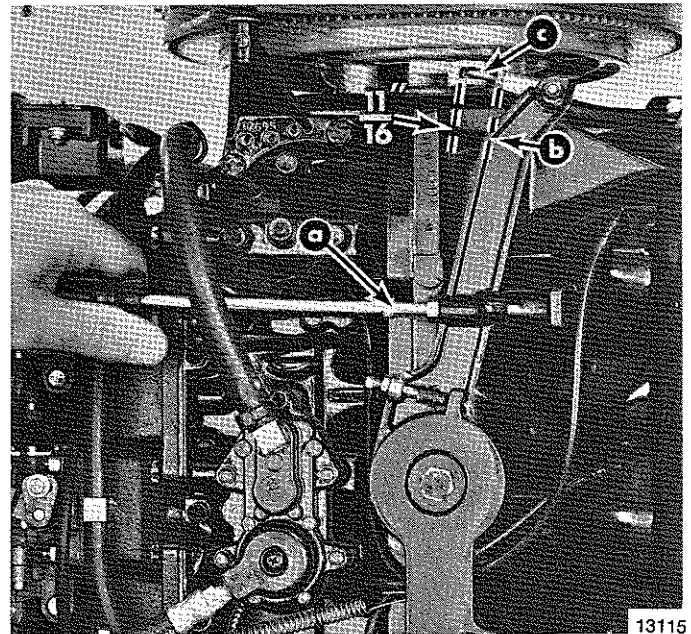
9. With engine in neutral, hold throttle arm so that idle stop screw (Figure 5) is against idle stop, then crank engine with starter motor and adjust throttle primary pickup screw (Figure 5) to align specified throttle primary pickup mark on timing decal with timing pointer. Retighten nut on adjustment screw.
10. Synchronize carburetors, as follows:
 - a. Loosen 3 carburetor synchronizing screws (Figure 6) to allow throttle shutter plates to close completely.
 - b. Position throttle lever so that idle stop screw is against stop and move roller arm until roller just touches throttle cam, as shown in Figure 6, without moving roller from this position. Retighten carburetor synchronizing screws.
 - c. Look into carburetors and check that all carburetor shutter plates close completely and open exactly at the same time.



a - Synchronizing Screw c - Idle Stop Screw (against Stop)
b - Roller d - Just Touching

Figure 6. Carburetor Synchronizing

11. With engine in neutral, move throttle lever to place maximum spark screw against stop. Crank engine with starter motor and adjust maximum spark screw (Figure 7) to align 22° BTDC mark on timing decal with timing pointer. Due to the spark advance characteristics of this ignition system, this adjustment will result in a spark advance of 20° at 5400 RPM and 26° above 5600 RPM. Retighten nut on adjustment screw. Remove timing light from engine.
12. With engine not running, move throttle lever to wide-open-throttle (WOT) and adjust full throttle stop screw (Figure 8) to allow full throttle shutter opening at WOT.

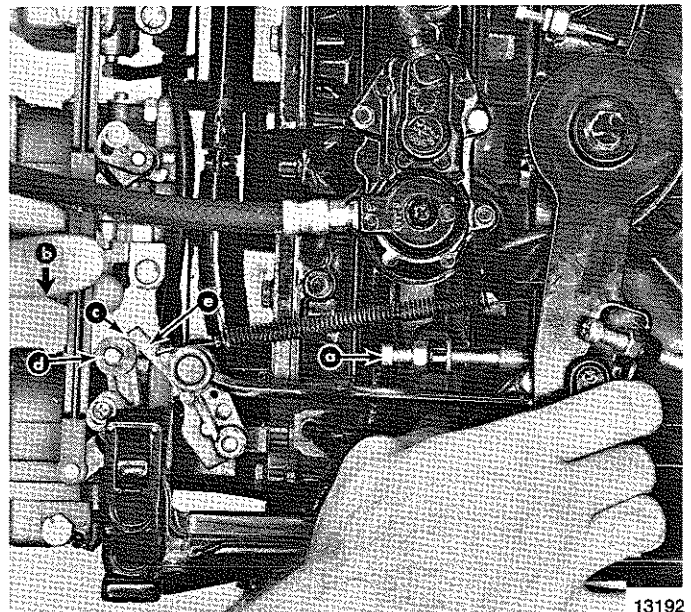


a - Maximum Spark Advance Screw
b - 11/16" (17.5mm)
c - Link Rod

Figure 7. Maximum Spark Advance Adjustment

Make sure that throttle shutters do not act as a throttle stop. Allow .010"-.015" (0.25mm to 0.38mm) clearance between roller and throttle cam at WOT, as shown in Figure 8. Retighten nut on adjustment screw.

13. If engine is equipped with an idle stabilizer (Figure 3), reconnect white/black (idle stabilizer) wire to switch box.
14. Adjust engine idle RPM, as follows:



a - Full Throttle Stop Screw
b - Push Downward
c - .010" to .015" (0.25mm to 0.38mm) Clearance
d - Roller
e - Throttle Cam

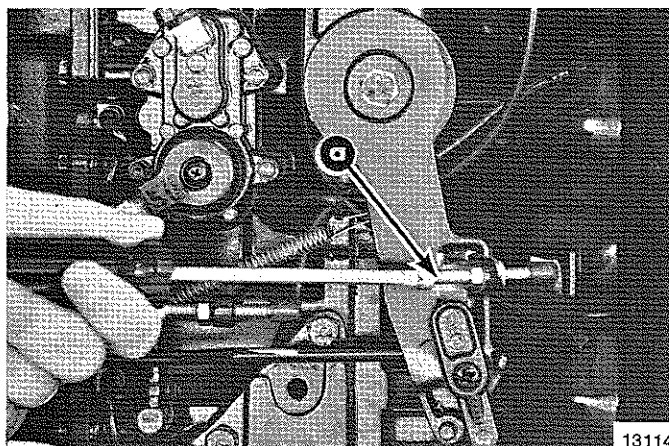
Figure 8. Full Throttle Stop Adjustment

CAUTION: Engine idle RPM must NEVER exceed 750 RPM in gear.

- a. With engine in water, connect electrical harness and fuel line to engine. Start engine and allow to warm up.
- b. With throttle cable barrel removed from barrel retainer, adjust idle RPM to specified idle RPM with engine running in forward gear. (Figure 9) Retighten nut on adjustment screw.
- c. With end of throttle cable connected to throttle lever, hold throttle lever against idle stop. Adjust throttle cable barrel to slip into barrel retainer on cable anchor bracket with a very light preload of throttle lever against idle stop. Lock barrel in place.
- d. Check preload on throttle cable by placing a thin piece of paper between idle stop screw and idle stop. Preload is correct when paper can be removed without tearing but has some drag on it. Readjust cable barrel, if necessary.

IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from forward to neutral. If necessary, readjust throttle cable barrel.

NOTE: Carburetor idle mixture is not equipped with adjustment screw. See "Fuel System and Carburetion" Section 3 for jet change.



a - Idle Stop Screw

Figure 9. Idle RPM Adjustment

NOTE: If sufficient throttle cable barrel adjustment is not available, a check must be made for correct installation of link rod (located between the throttle lever and throttle cam). Each end of this link rod must be threaded into its plastic barrel until it bottoms against the throttle lever or throttle cam casting, then turned out only far enough to obtain correct orientation of link rod (less than one turn). All timing adjustments must be reset after this procedure.

V-6 OUTBOARDS

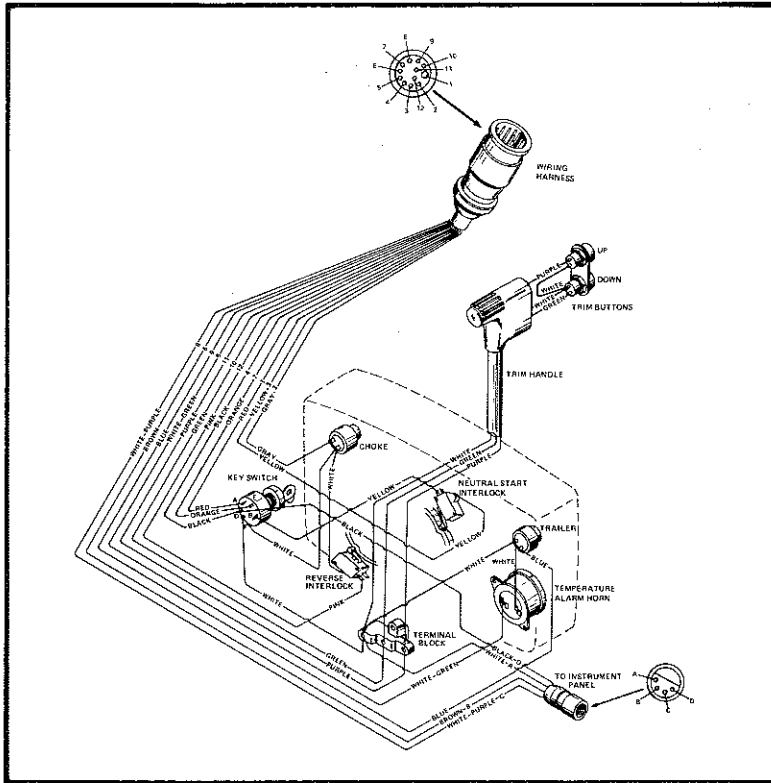
Electrical and Ignition

SECTION

2

PART

D



Wiring

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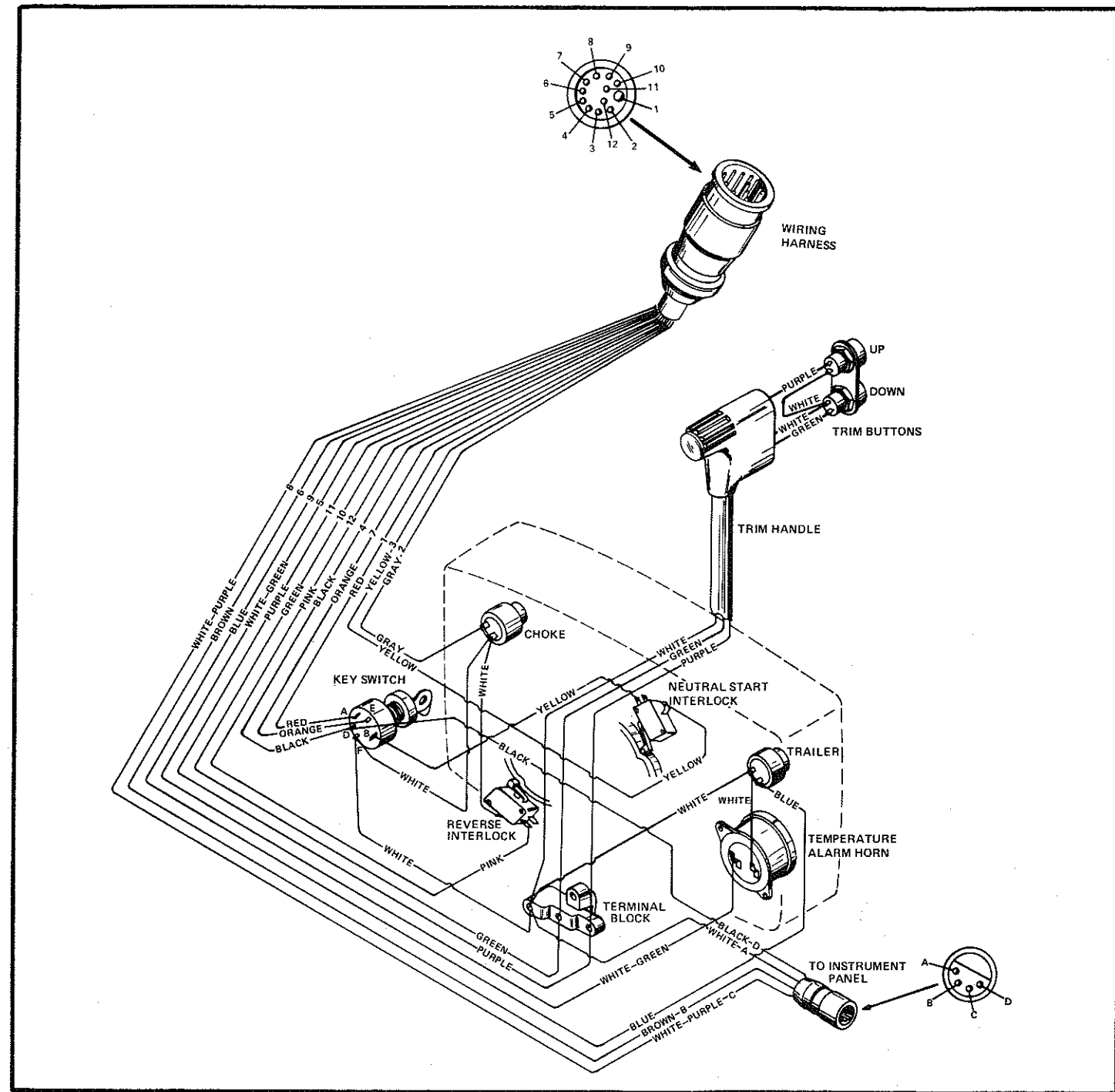
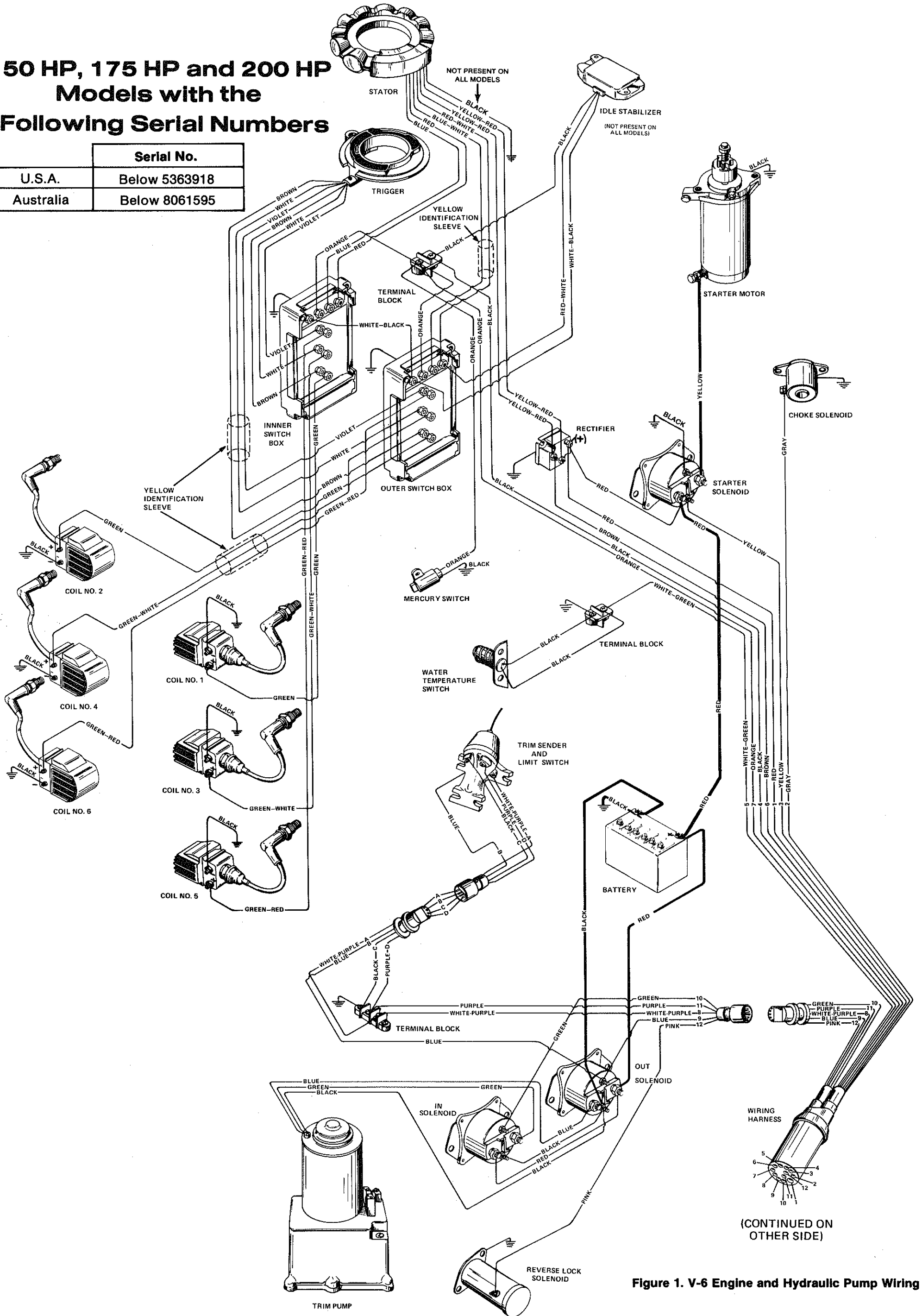


Figure 2. V-6 Remote Control Wiring

V-6 WIRING DIAGRAMS

150 HP, 175 HP and 200 HP Models with the Following Serial Numbers

	Serial No.
U.S.A.	Below 5363918
Australia	Below 8061595



(CONTINUED ON OTHER SIDE)

Figure 1. V-6 Engine and Hydraulic Pump Wiring

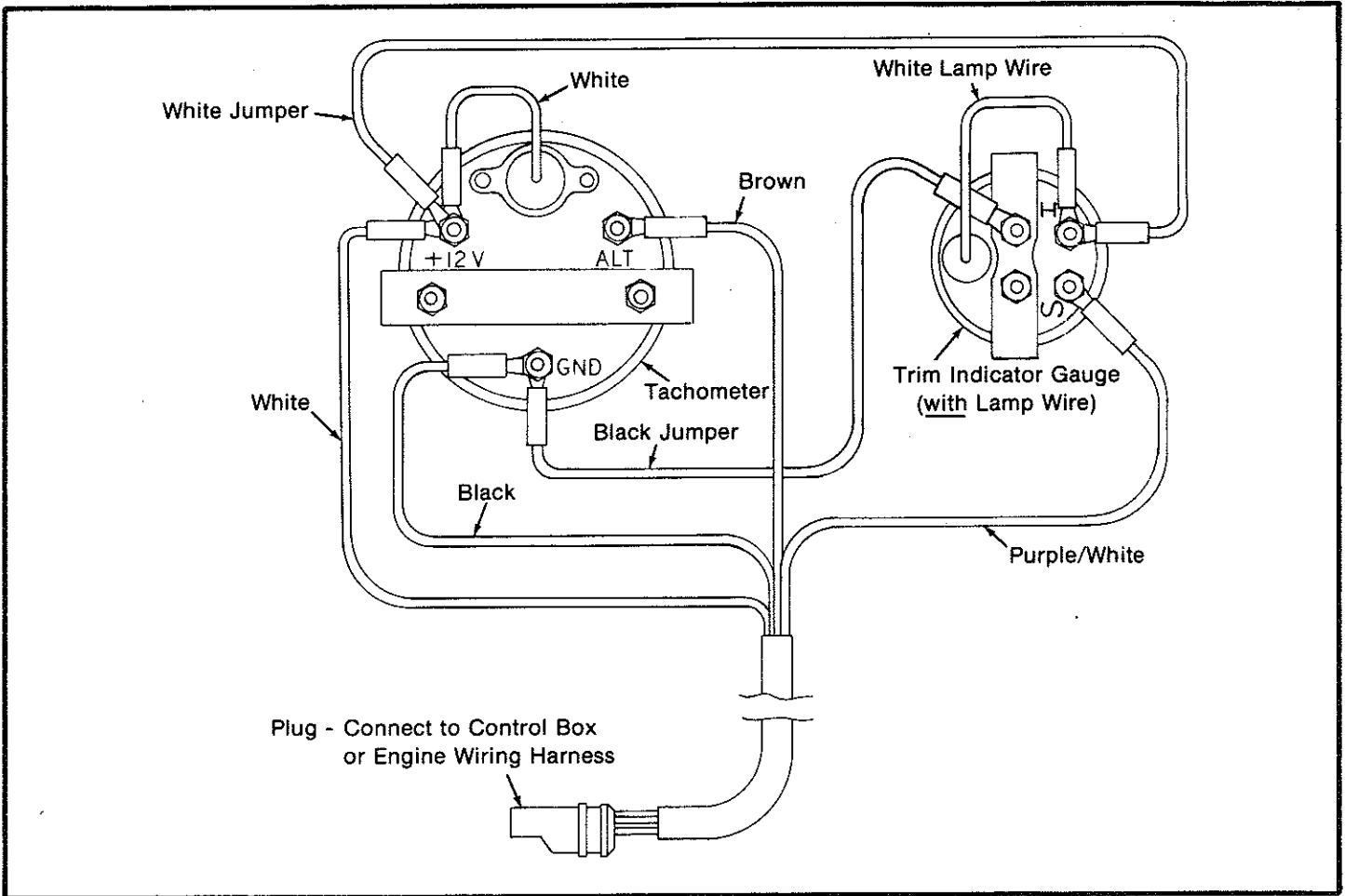


Figure 3. Tachometer with Trim Indicator Gauge (with Lamp Wire)

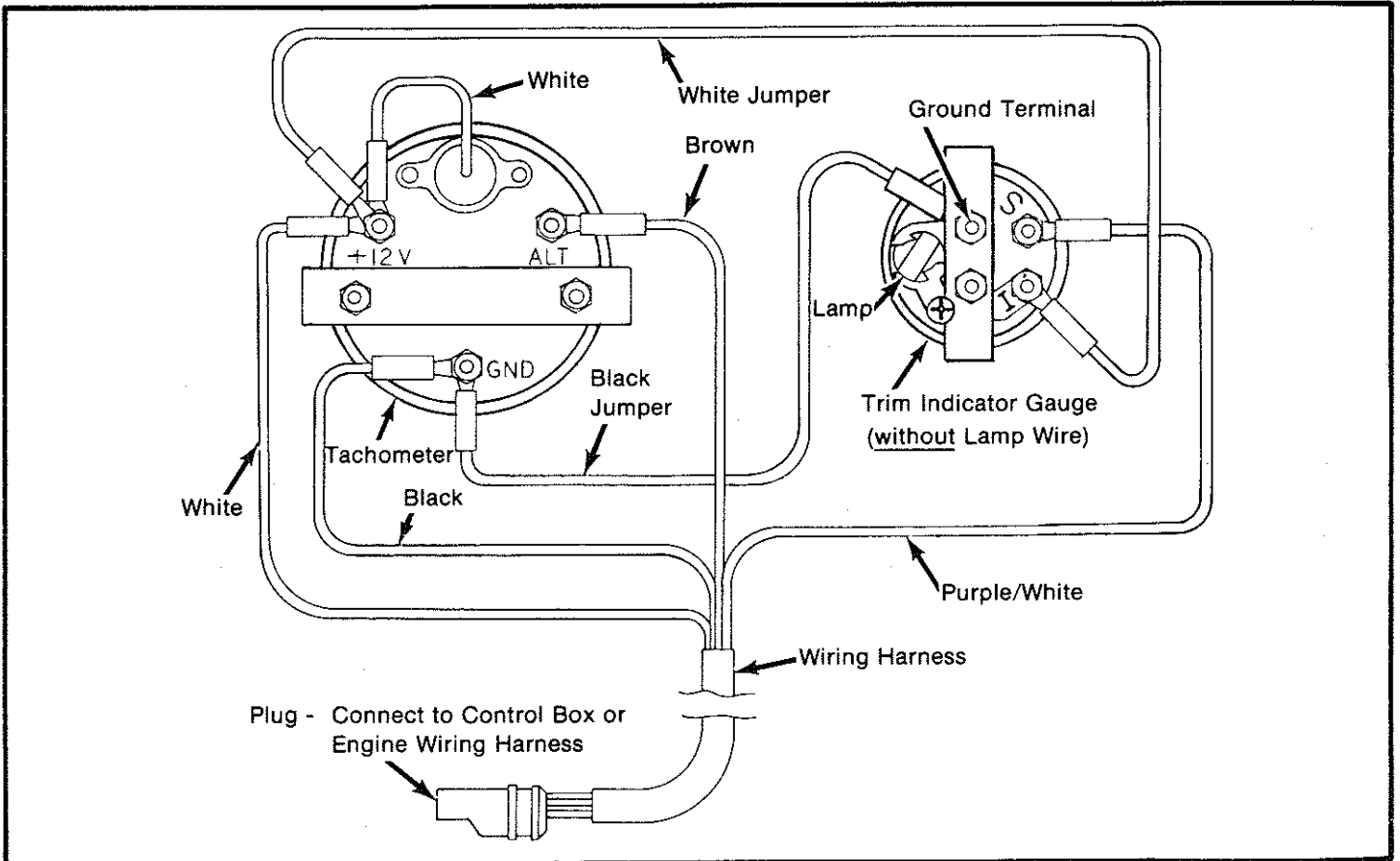


Figure 4. Tachometer with Trim Indicator Gauge (without Lamp Wire)

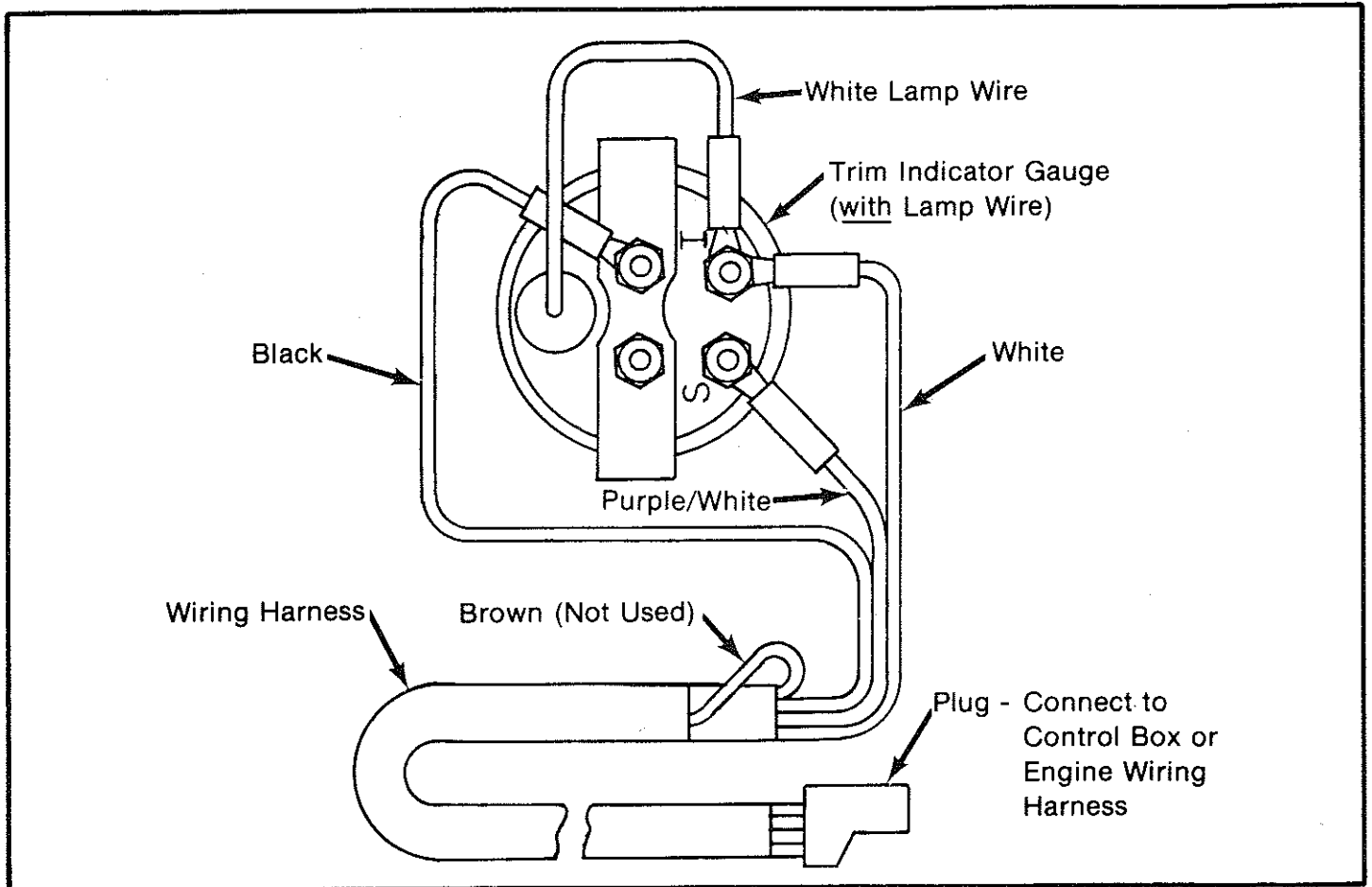


Figure 5. Trim Indicator Gauge (with Lamp Wire)

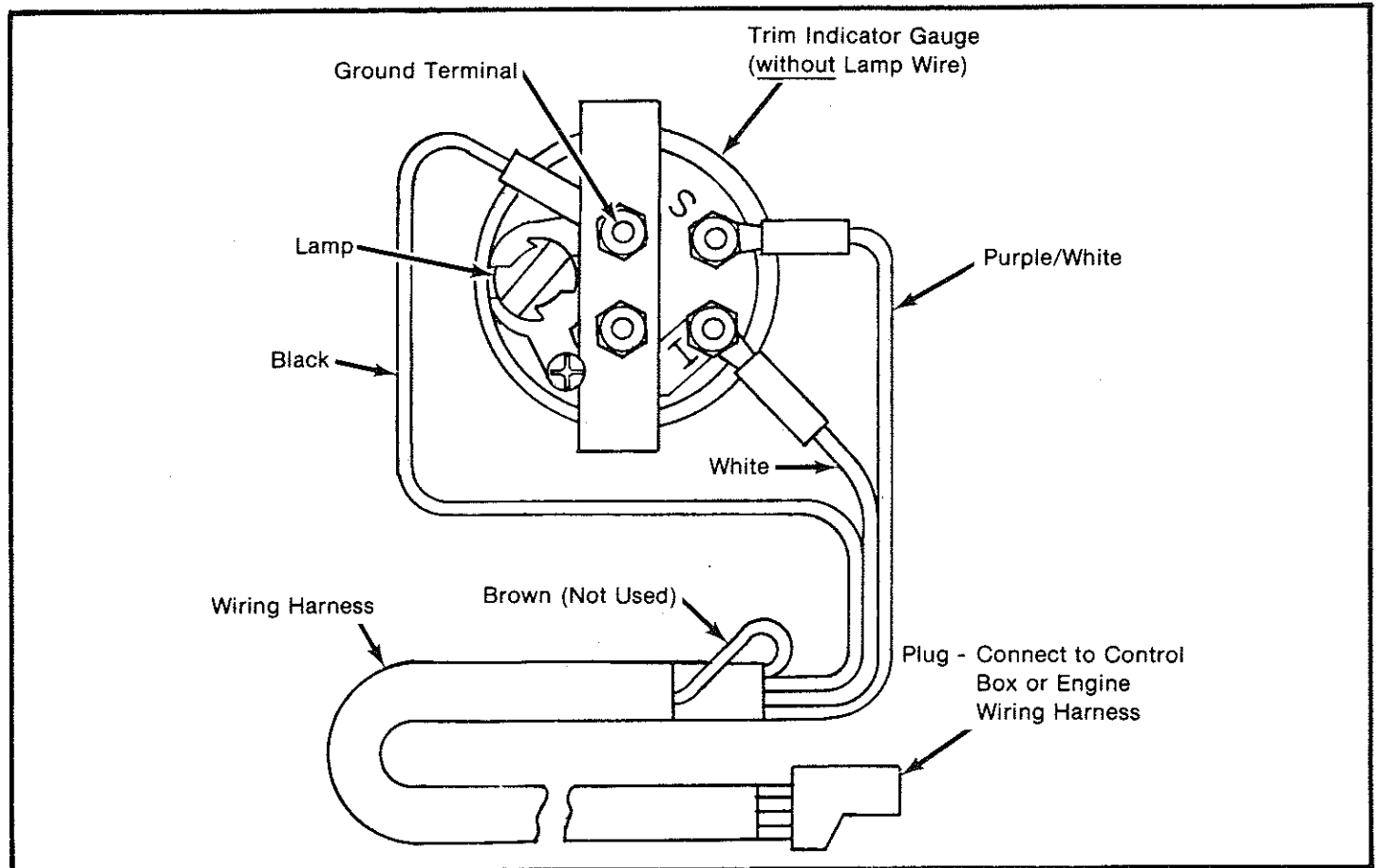


Figure 6. Trim Indicator Gauge (without Lamp Wire)

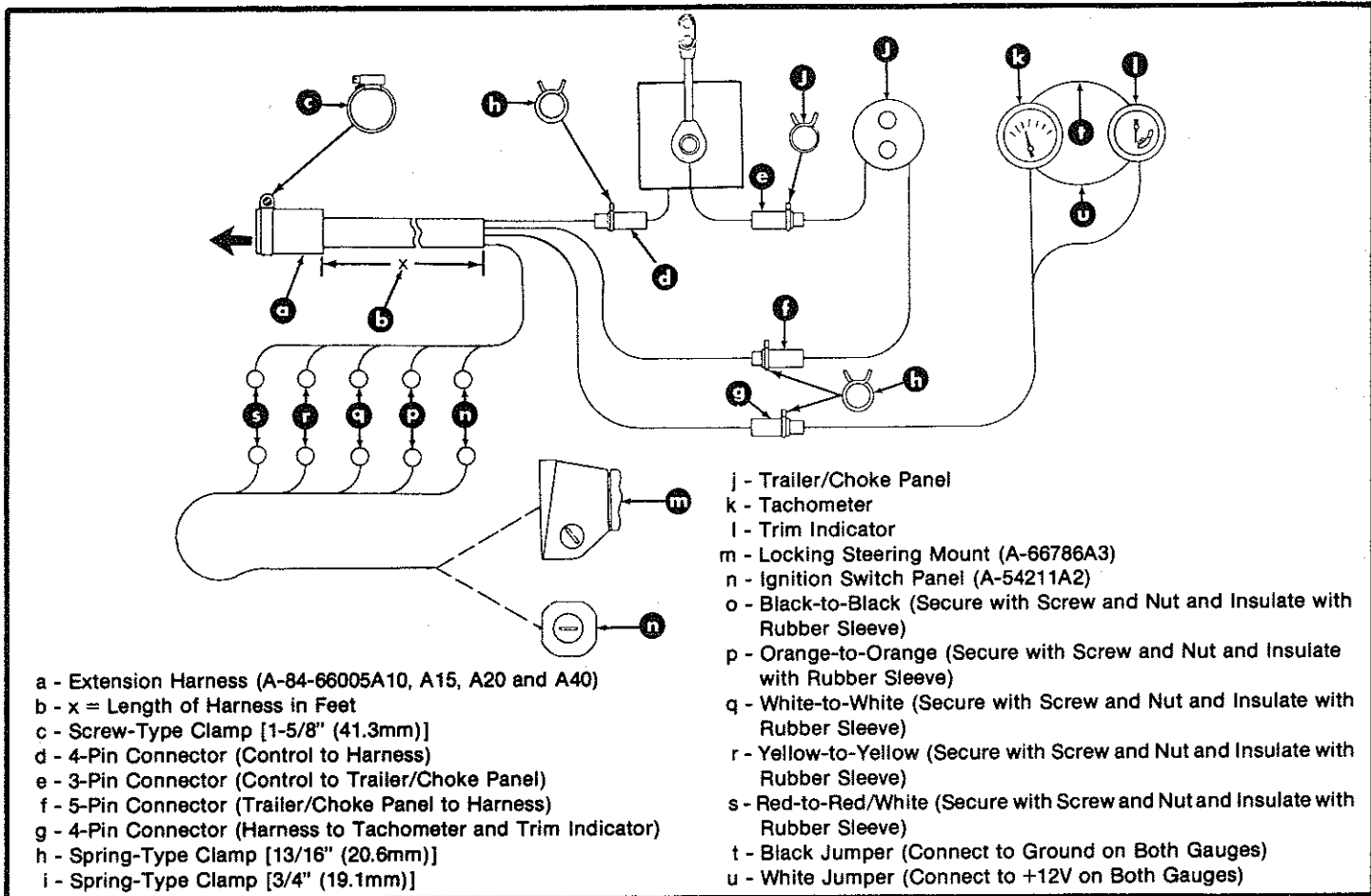


Figure 7. Harness Wiring - V-6 Models with Panel Control

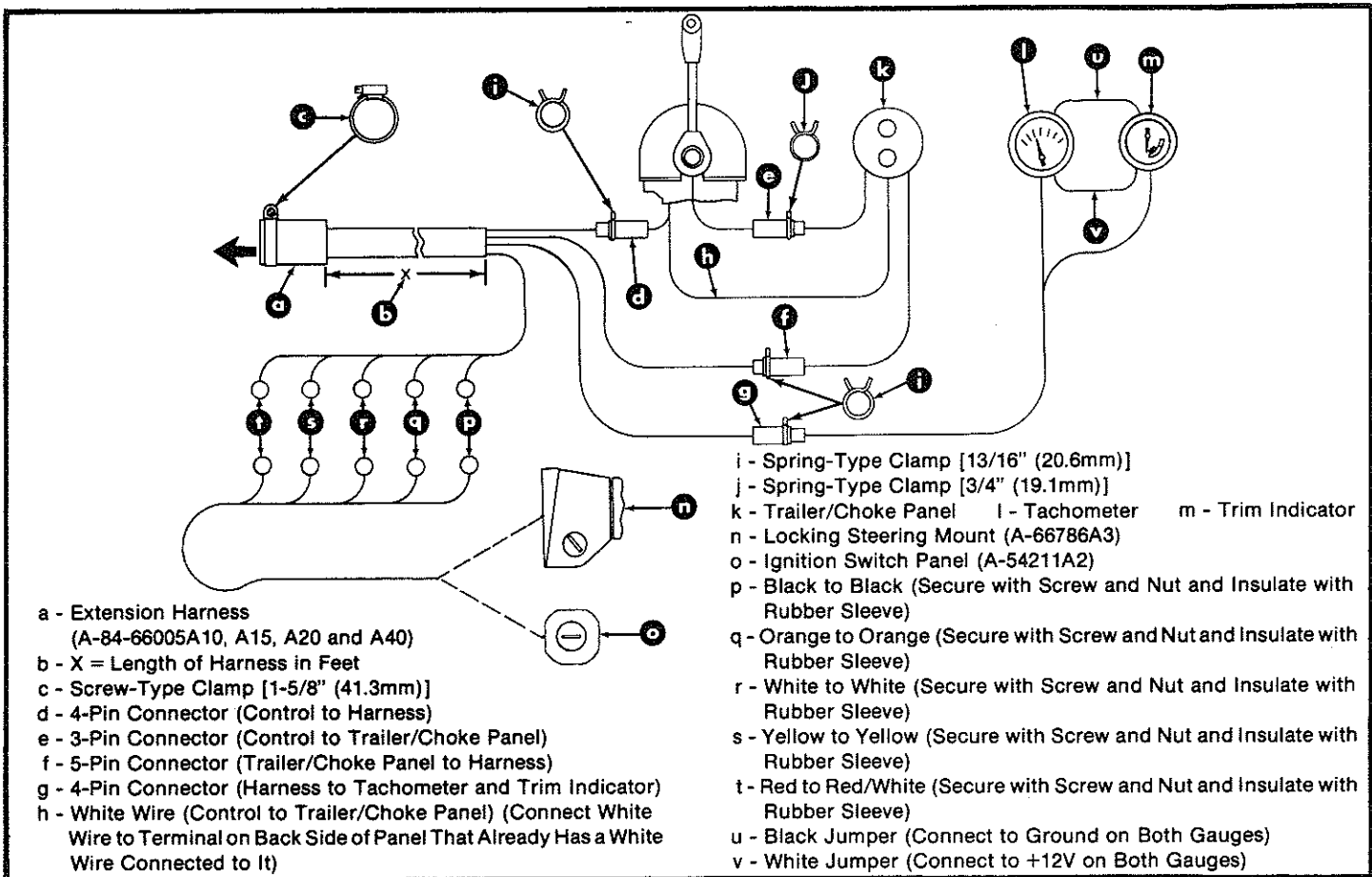
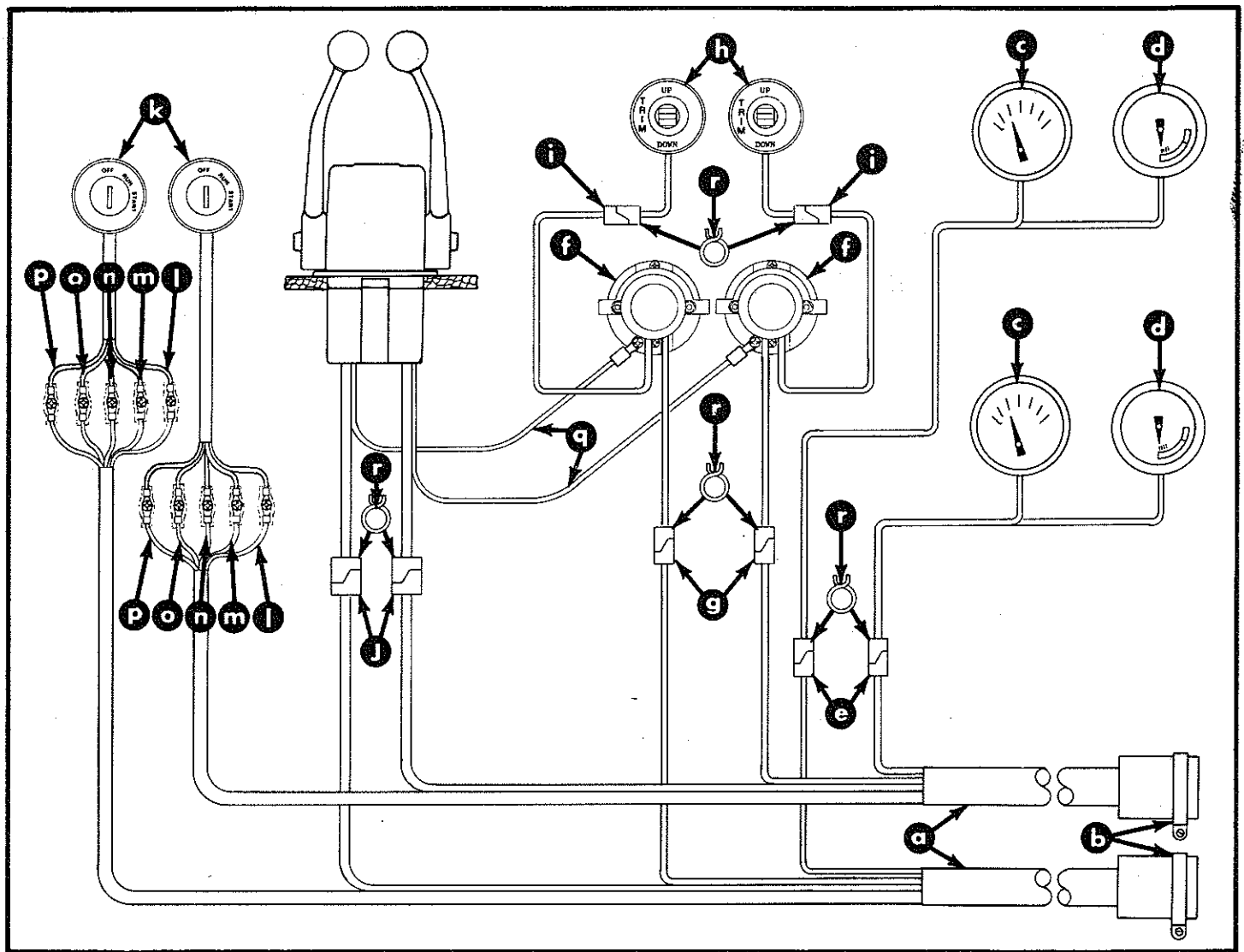


Figure 8. Harness Wiring - V-6 Models with Single Engine Console Control



- a - Wiring Harnesses (Starboard and Port)
- b - Screw-Type Clamps [1-5/8" (41.3mm)]
- c - Tachometer
- d - Trim Indicator
- e - 4-Pin Connector (Tachometer/Trim Indicator to Harness)
- f - Choke/Trailer Panel (Rear View of Panels)
- g - 5-Pin Connector (Choke/Trailer Panel to Harness)
- h - Trim Switch
- i - 3-Pin Connector (Trim Switch to Choke/Trailer Panel)
- j - 4-Pin Connector (Control to Harness)
- k - Ignition Switch Panel
- l - Black to Black (Secure with Screw and Nut and Insulate with Rubber Sleeve)
- m - Orange to Orange (Secure with Screw and Nut and Insulate with Rubber Sleeve)
- n - White to White (Secure with Screw and Nut and Insulate with Rubber Sleeve)
- o - Yellow to Yellow (Secure with Screw and Nut and Insulate with Rubber Sleeve)
- p - Red to Red/White (Secure with Screw and Nut and Insulate with Rubber Sleeve)
- q - White Wire (Control to Choke/Trailer Panel) (Connect White Wire to Terminal on Back Side of Panel That Already Has a White Wire Connected to It)
- r - Spring-Type Clamp (Secure Wiring Connections with Clamp)

Figure 9. Harness Wiring - V-6 Models with Dual Engine Console Control

150 HP, 175 HP and 200 HP Models with the Following Serial Numbers

Serial No.	
U.S.A.	5363918 thru 5464484
Australia	8061595 thru 8063934

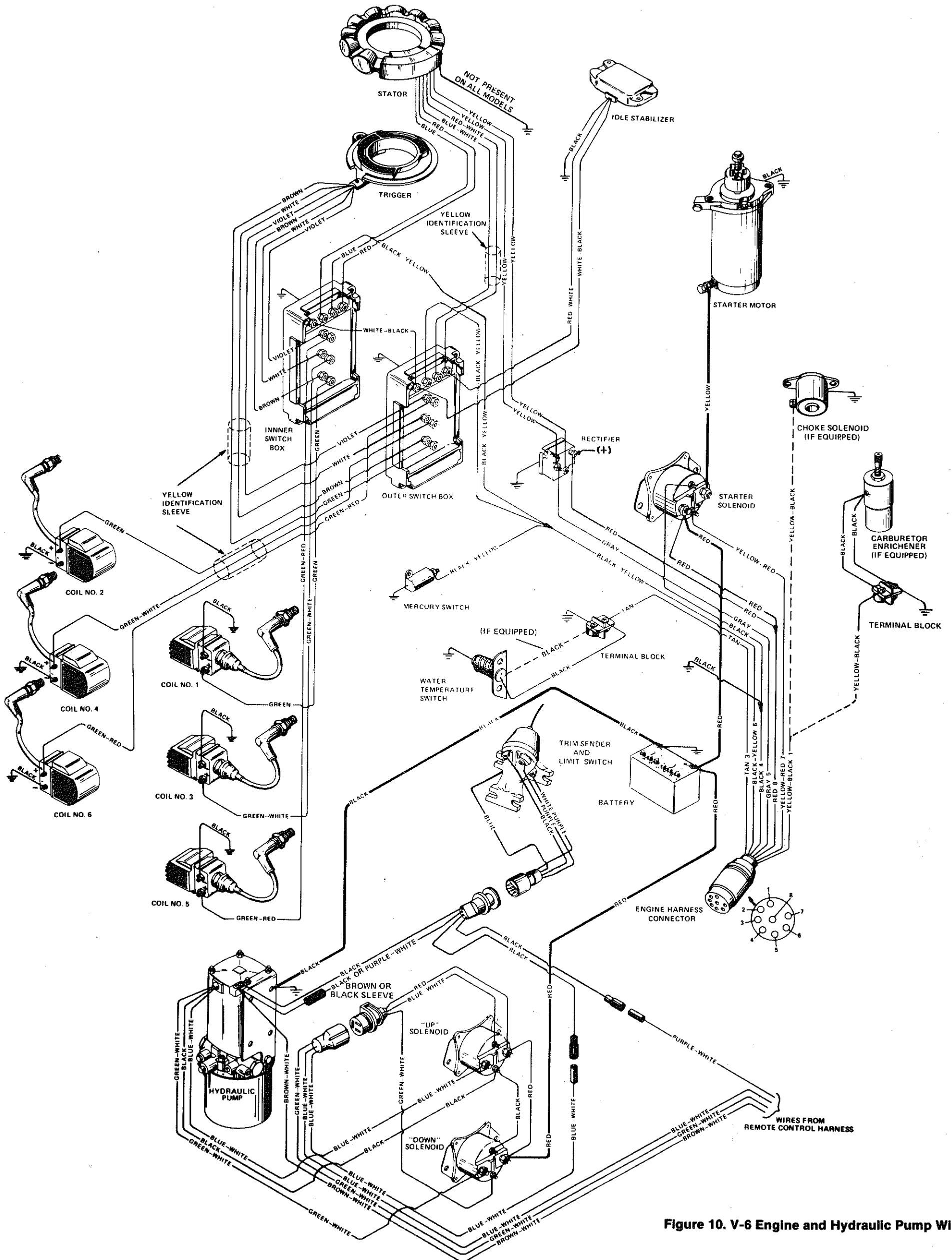


Figure 10. V-6 Engine and Hydraulic Pump Wiring

"Commander" Deluxe Side Mount Trim Control

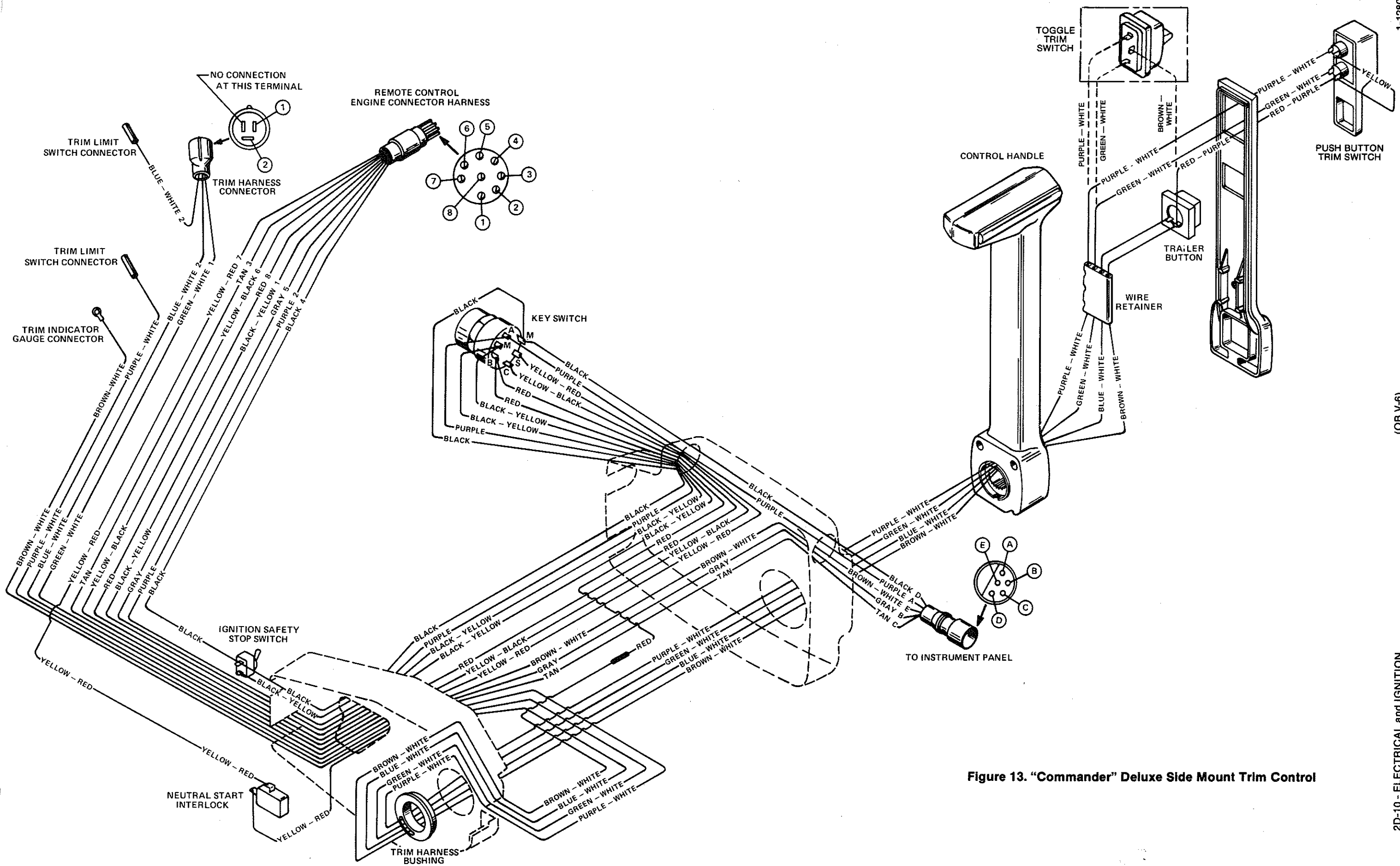


Figure 13. "Commander" Deluxe Side Mount Trim Control

225 HP Model

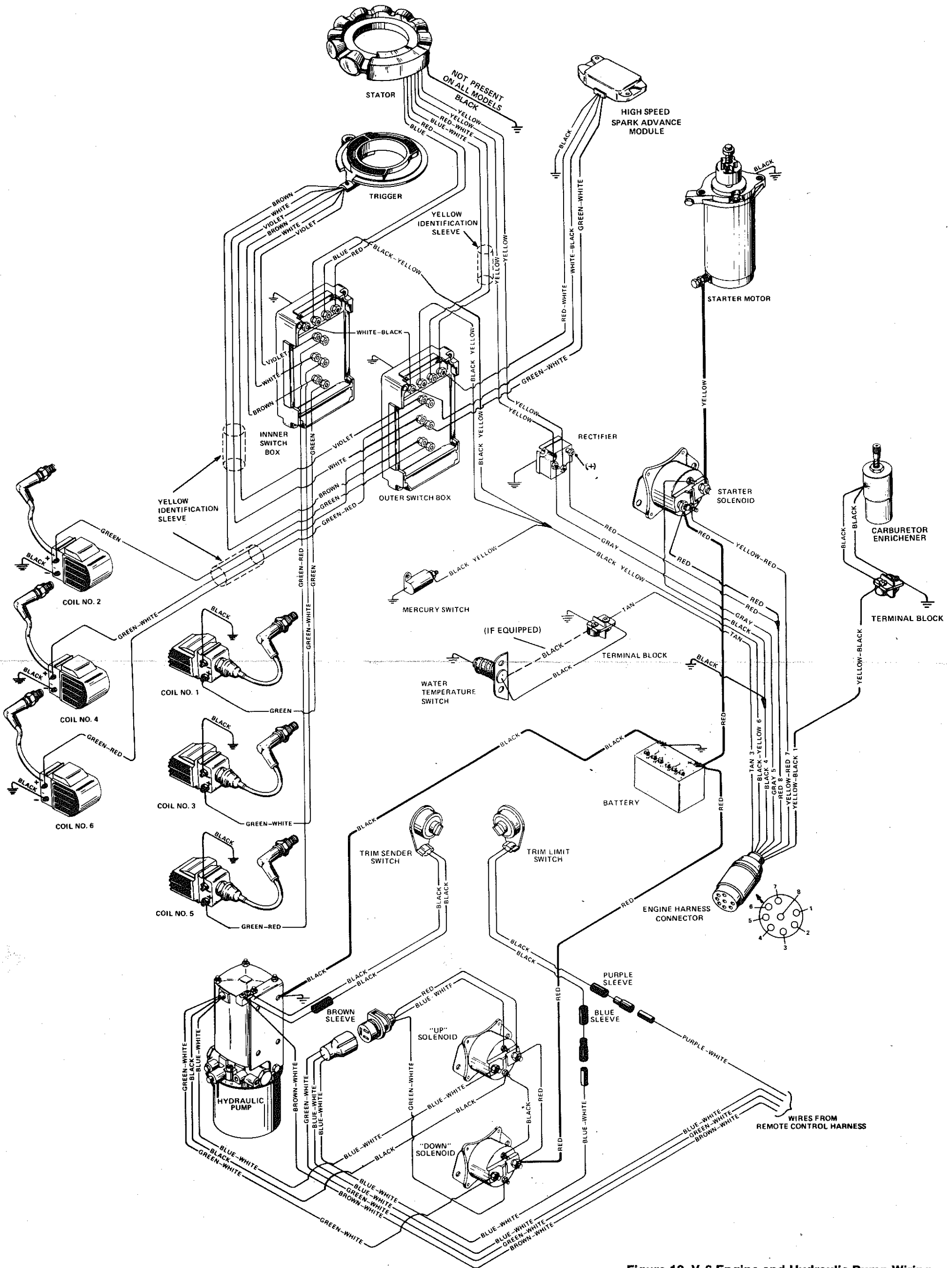
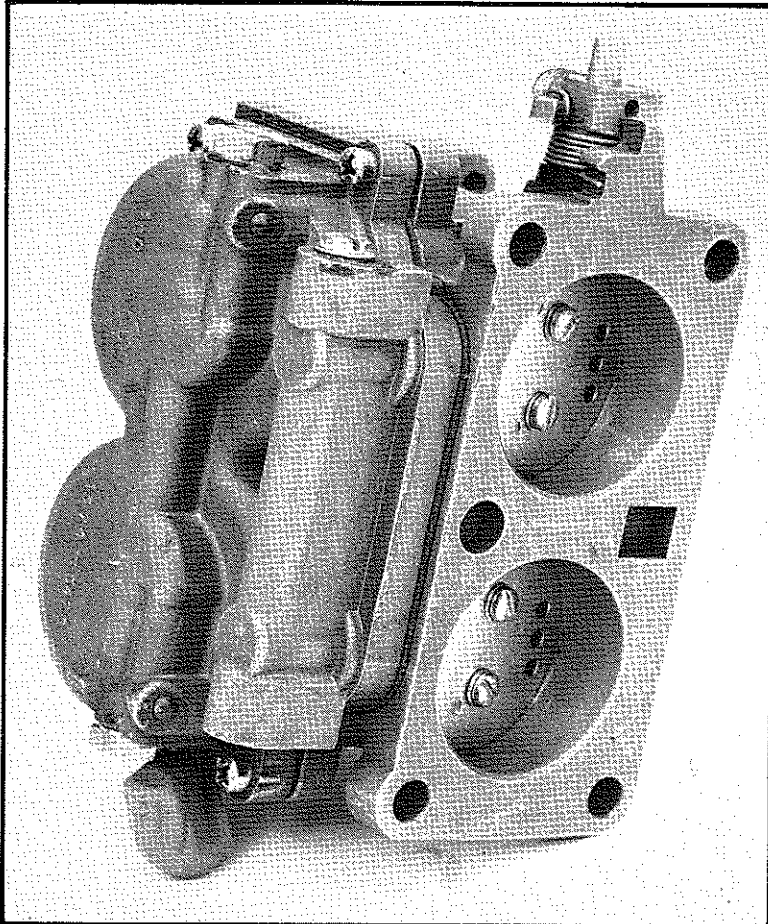


Figure 12. V-6 Engine and Hydraulic Pump Wiring

V-6 OUTBOARDS

Fuel System and Carburetion



SECTION

3

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FUEL SYSTEM - TROUBLESHOOTING

General Information

Problems, that are thought to be caused by the fuel system, may be, in reality, something completely different. Items, that are shown in the list on the right, could give the impression that there is a problem in the fuel system.

1. Propeller
2. Spark plugs
3. Ignition timing
4. Ignition spark voltage
5. Cylinder compression
6. Reed valves

To diagnose the fuel system, see the "Trouble Chart", below.

Trouble Chart

PROBLEM: Engine Turns Over but Will Not Start or Starts Hard When Cold

Possible Cause	Corrective Action
Improper starting procedure used.	Check proper starting procedure, as outlined in "Operation and Maintenance Manual".
Fuel tank empty or too low. Improperly mixed fuel. Contaminants (water, dirt, etc) in fuel.	Check fuel in fuel tank and replace or add whichever is necessary.
Fuel tank air vent closed or restricted.	Check air vent on fuel tank. Air vent must be open all-the-way and free from any contaminants.
A pinched, cut or restricted fuel line. Also loose fuel line connection.	Check all fuel lines and replace as needed. Check and tighten all fuel line connections.
Dirty or restricted fuel filter.	Check and replace or clean all fuel filters.
Low fuel pump pressure.	Refer to "Testing" in this section.
An anti-siphon valve.	Refer to "Checking for Restricted Fuel Flow" in this section.
Choke solenoid not operating.	Check choke solenoid and electrical wiring to solenoid. Replace solenoid, if necessary.
A needle and seat (in carburetor) that is either stuck open or closed. (A needle and seat, that is stuck open, will cause a flooding condition. A needle and seat, that is stuck closed, will prevent fuel from entering carburetor.)	Refer to "Carburetor Disassembly" in this section.
Improper carburetor jets or a restricted jet.	Refer to "Carburetor Adjustments" in this section.
Improper carburetor float level.	Refer to "Carburetor Adjustments" in this section.

PROBLEM 1: Engine Idles Rough and Stalls.

PROBLEM 2: Engine Hesitates upon Acceleration.

PROBLEM 3: Engine Runs Uneven or Surges.

Improperly mixed fuel. Contaminants (water, dirt, etc) in fuel.	Check fuel in fuel tank and replace if necessary.
Fuel tank air vent closed or restricted.	Check air vent on fuel tank. Air vent must be open all-the-way and free from restrictions.
A pinched, cut or restricted fuel line. Also loose fuel line connection.	Check all fuel lines and replace as needed. Check and tighten all fuel line connections.
A dirty or restricted fuel filter.	Check and replace or clean all fuel filters.
Low fuel pump pressure.	Refer to "Testing" in this section.
An anti-siphon valve.	Refer to "Checking for Restricted Fuel Flow" in this section.
A needle and seat (in carburetor) that is either stuck open or closed. (A needle and seat, that is stuck open, will cause a flooding condition. A needle and seat, that is stuck closed, will prevent fuel from entering carburetor.)	Refer to "Carburetor Adjustments" in this section.
Improper carburetor jets or a restricted jet.	Refer to "Carburetor Adjustments" in this section.
Improper carburetor float level.	Refer to "Carburetor Adjustments" in this section.
Carburetor loose on reed block housing.	Tighten carburetor(s) nuts securely.

Possible Cause	Corrective Action
Reed block housing loose, or gaskets are defective.	Using a pressure oil can, spray 2-cycle oil around reed block housing/crankcase housing matching surfaces and carburetor base. If engine RPM changes, tighten or replace reed block housing gaskets or carburetor base gaskets, as needed.
Improperly routed or restricted bleed hose(s).	Refer to "Reed Blocks - Reassembly and Installation" in "Powerhead" section.

FUEL PUMP

Description/Operation

The fuel pump is a crankcase-pressure-operated, diaphragm-type pump. Crankcase pulsating pressure (created by the up-and-down movement of cylinder piston) is transferred to fuel pump by way of a passage (hole) between crankcase and fuel pump.

When cylinder piston is in an upward motion, a vacuum is created in the crankcase, thus pulling in a fuel/air mixture (from carburetor) into crankcase. This vacuum also pulls in

on the fuel pump diaphragm, thus the inlet check valve (in fuel pump) is opened and fuel (from fuel tank) is drawn into fuel pump.

Downward motion of the cylinder's piston forces the fuel/air mixture out of the crankcase into the cylinder. This motion also forces out on the fuel pump diaphragm, which, in turn, closes the inlet check valve (to keep fuel from returning to fuel tank) and opens the outlet check valve, thus forcing fuel to the carburetor.

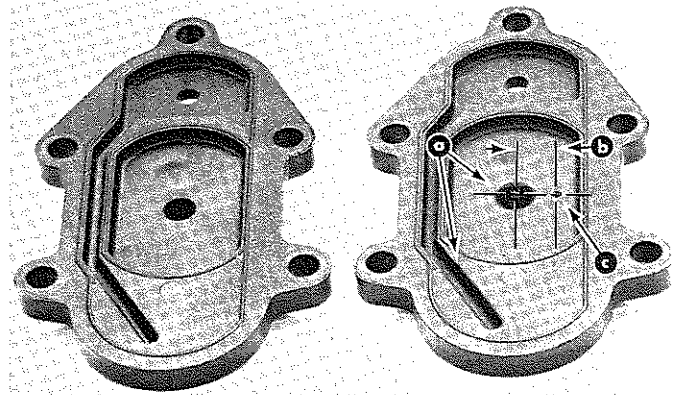
Checking for Restricted Fuel Flow

While anti-siphon valves may be helpful from a safety standpoint, they clog with debris, they may be too small, or they may have too heavy a spring. Summarizing, the pressure drop across these valves can, and often does, create operational problems and/or powerhead damage by restricting fuel to the fuel pump and carburetor(s). Some symptoms of restricted (lean) fuel flow, which could be caused by use of an anti-siphon valve, are:

- 1 - Loss of fuel pump pressure
- 2 - Loss of power
- 3 - High speed surging
- 4 - Preignition/detonation (piston dome erosion)
- 5 - Outboard cuts out or hesitates upon acceleration
- 6 - Outboard runs rough
- 7 - Outboard quits and cannot be restarted
- 8 - Outboard will not start
- 9 - Vapor lock

Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking [if such a device (or bad fuel) is a problem source] is to operate the outboard with a separate fuel supply which is known to be good, such as a 6-gallon (22½ liter) fuel tank.

If, after using a separate fuel supply, it is found that the anti-siphon valve is the cause of the problem, there are 2 solutions



11534
a - Bevel Edges b - 3/8" (9.5mm) c - .078" Dia. Drill Thru

Figure 1. Fuel Pump Pulse Chamber (Left) and Revised Fuel Pump Pulse Chamber (Right)

to the problem; either 1) remove the anti-siphon valve or 2) replace it with a solenoid-operated fuel shutoff valve.

If the fuel pump diaphragm is split on a 175 HP model, the cause of the split may be the fuel pump pulse chamber. Compare pulse chamber (removed from fuel pump) with Figure 1 (left). If pulse chamber (removed from fuel pump) is identical to Figure 1 (left), revise as shown in Figure 1 (right).

Testing

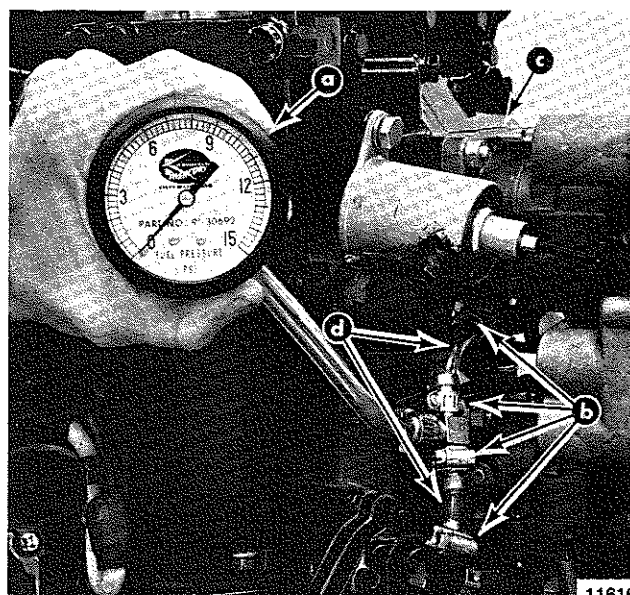
1. Install Fuel Pressure Gauge (C-91-30692) between fuel pump and top carburetor (Figure 2), as follows:

NOTE: Always use a clear gas line in conjunction with Fuel Pressure Gauge.

- a. Remove clamps (2), which secure gas line to fuel pump and top carburetor, then remove (and retain) gas line.

IMPORTANT: In order to achieve a correct fuel pump pressure reading, fuel line between fuel pump and top carburetor must be the same length as original fuel line.

- b. Using hose clamps, secure one end of clear gas line (used with Fuel Pressure Gauge) to top carburetor and the other end to fuel pump.
 - c. Hold Fuel Pressure Gauge level with top carburetor when performing Steps 2, 3 and 4.
2. Start engine and allow it to idle.
 3. Inspect fuel passing thru clear gas line for air bubbles. (See "Air Bubbles in Gas Line" in Troubleshooting Chart, following, if air bubbles are found.)
 4. Check fuel pressure reading (on gauge) while engine is idling. Pressure should not be below 3 psi (0.21kg/cm²). Run engine at wide-open-throttle (WOT) and check fuel pressure reading (on gauge). Pressure should be 4 to 5½ psi (0.3 to 0.4kg/cm²). (See "Lack of Fuel Pump Pressure"



a - Fuel Pressure Gauge c - Top Carburetor
b - Clamps d - Clear Gas Line

Figure 2. Fuel Pressure Gauge Installation
in Troubleshooting Chart, following, if pressure is not as described.)

Troubleshooting Fuel Pump

PROBLEM: Air Bubbles in Gas Line

Possible Cause	Corrective Action
Low fuel in fuel tank	Fill tank with fuel.
Loose gas line connection	Check and tighten all connections.
Fuel pump fitting loose.	Tighten fitting.
A hole or cut in fuel line.	Check condition of all fuel lines and replace any found to be bad.
Fuel pump anchor screw(s) loose.	Tighten all screws evenly and securely.
Fuel pump filter cover anchor screw loose.	Tighten screw securely.
Fuel pump filter "O" ring worn out.	Replace "O" ring.
Fuel pump gasket(s) worn out.	Rebuild fuel pump.

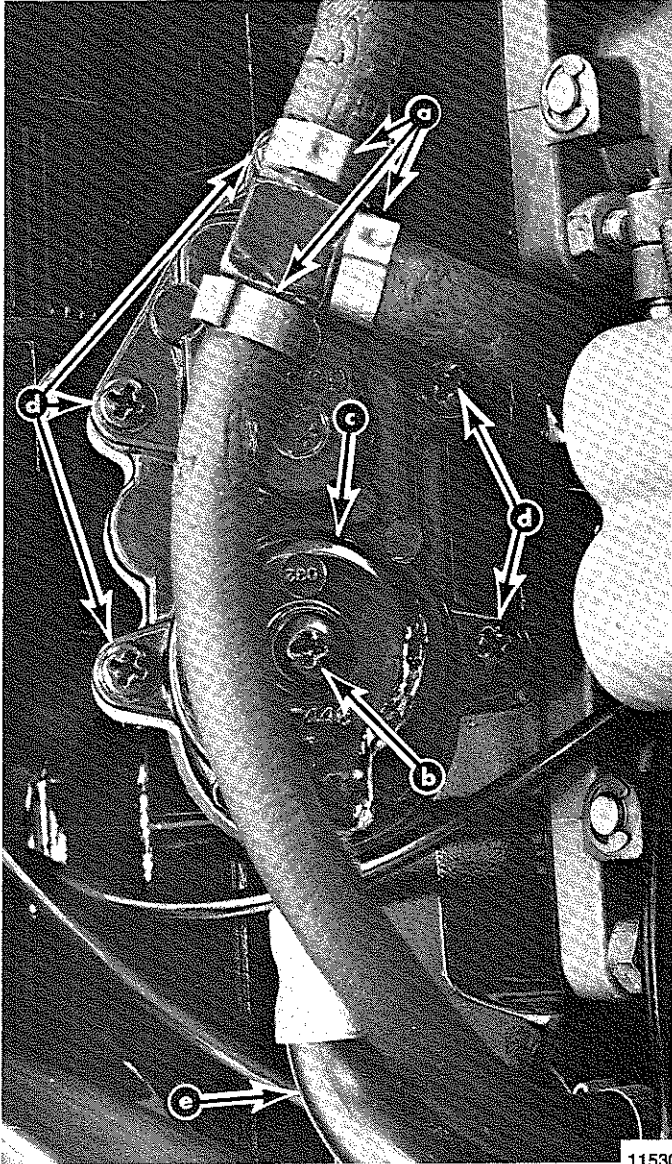
PROBLEM: Lack of Fuel Pump Pressure

An anti-siphon valve	Read "Checking for Restricted Fuel Flow", preceding.
Air in fuel line	"Air Bubbles in Gas Line", above.
A dirty or clogged fuel filter	Clean or replace fuel filter.
The fuel pickup in gas tank clogged or dirty	Clean or replace pickup.
Worn out fuel pump diaphragm	Rebuild fuel pump.
Worn out check valve	Rebuild fuel pump.
A leaky check valve gasket	Rebuild fuel pump.
Pulse hole(s) plugged	Remove fuel pump and clean out holes.

Removal/Disassembly

NOTE: These instructions are written as a complete removal/disassembly. If the fuel pump filter only is to be replaced or cleaned, follow Steps 2 and 3.

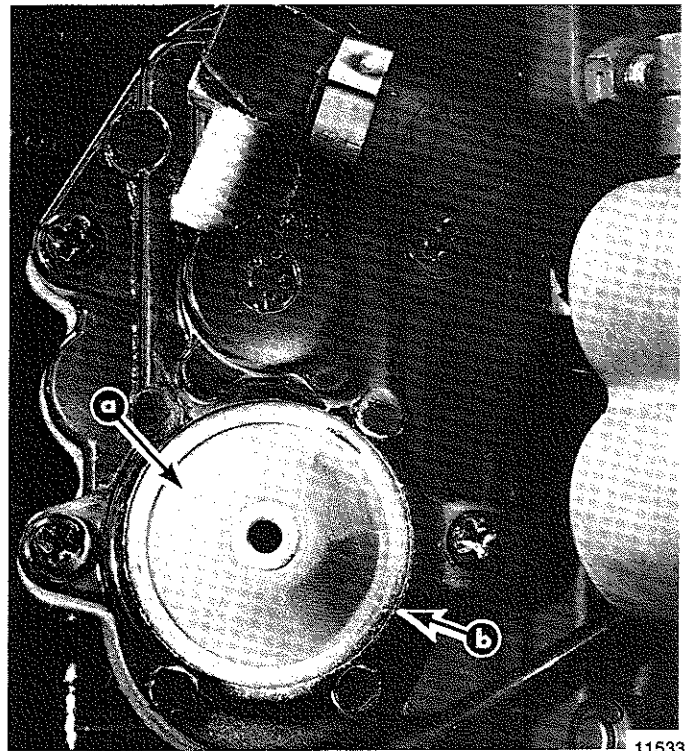
IMPORTANT: Fuel pump diaphragm and gaskets should not be re-used once fuel pump is disassembled.



a - Clamps
b - Screw (Fuel Filter Cover)
c - Fuel Filter Cover
d - Screws (Fuel Pump to Engine)
e - Fuel Line (Fuel Tank to Fuel Pump)

Figure 4. Fuel Pump

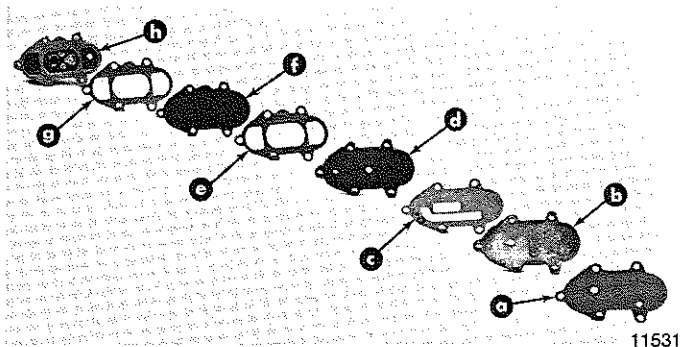
1. Remove (and discard) clamps (Figure 4), which secure carburetor gas lines to fuel pump, and disconnect lines from fuel pump.
2. Remove screw and plastic flat washer, which secure fuel filter cover to pump (Figure 4), and remove cover from pump.
3. Remove (and discard) fuel filter "O" ring and discard or clean fuel filter. (Figure 5)



a - Fuel Filter
b - "O" Ring

Figure 5. Fuel Pump Filter

4. Remove (and retain) screws, which secure fuel pump to engine (Figure 4), and lift pump from engine.
5. Separate fuel pump as shown in Figure 6.
6. Remove (and discard) all gasket material and diaphragm from engine, fuel pump base, pulse chamber and fuel pump housing.
7. Remove (and retain) screws, which secure check valve retainer to fuel pump housing (Figure 7), then remove retainer, inlet and outlet check valves and gaskets from under check valves.

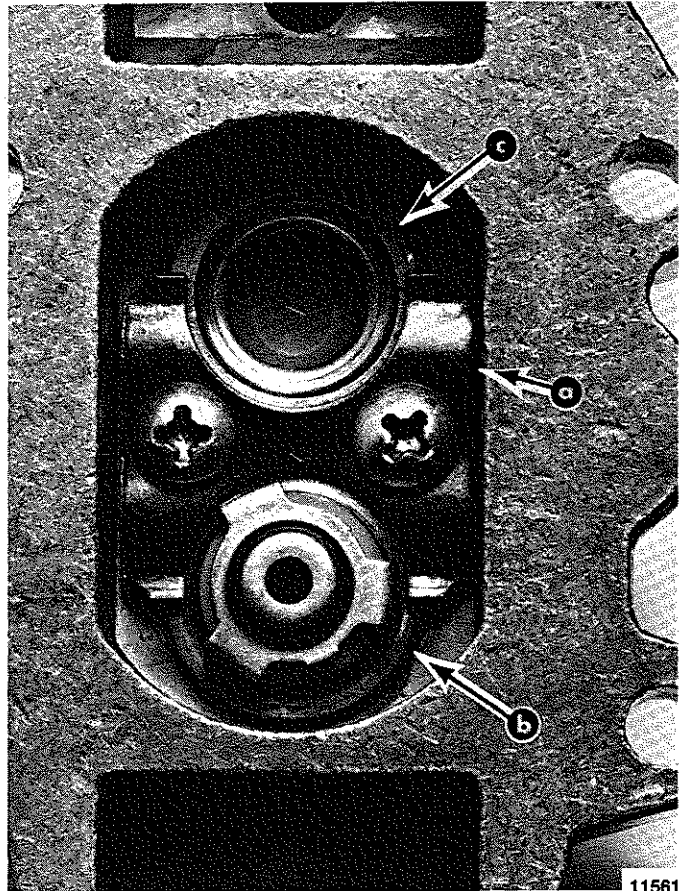


a - Gasket (Fuel Pump Base to Engine)
b - Fuel Pump Base
c - Gasket (Fuel Pump Base to Pulse Chamber)
d - Pulse Chamber
e - Gasket (Pulse Chamber to Diaphragm)
f - Diaphragm
g - Gasket (Diaphragm to Fuel Pump Housing)
h - Fuel Pump Housing

Figure 6. Fuel Pump Disassembly/Reassembly Sequence

- a - Retainer (Check Valves)
- b - Inlet Check Valve
- c - Outlet Check Valve

Figure 7. Inlet and Outlet Check Valves

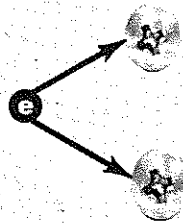
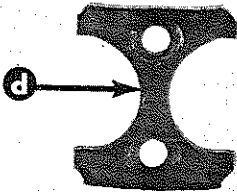
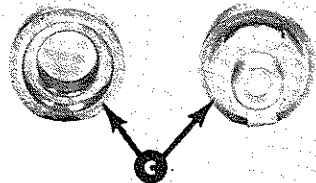
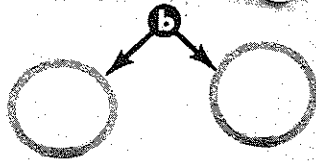
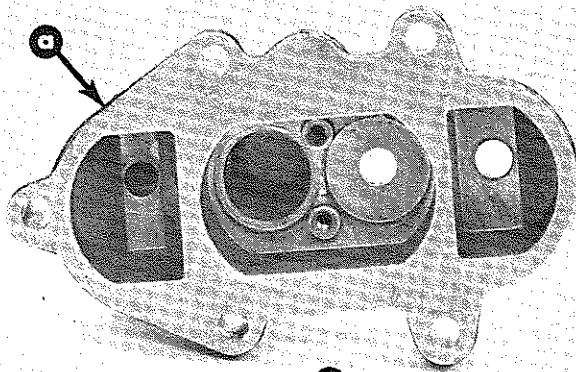


Cleaning/Inspection

1. Clean fuel pump housing, check valves, pulse chamber and pump base in solvent and dry all but check valves with compressed air.
2. Inspect spring tension in each check valve and replace valve or valves if spring tension is weak or springs are broken.
3. Inspect fuel pump housing, pulse chamber and base for cracks or rough gasket surface and replace if any are found.
4. Inspect fitting on fuel pump housing for looseness or any signs of fuel or air leaks. Replace or tighten fitting if a leak is found.

Reassembly/Installation

CAUTION: DO NOT use gasket sealer on any fuel pump gaskets.

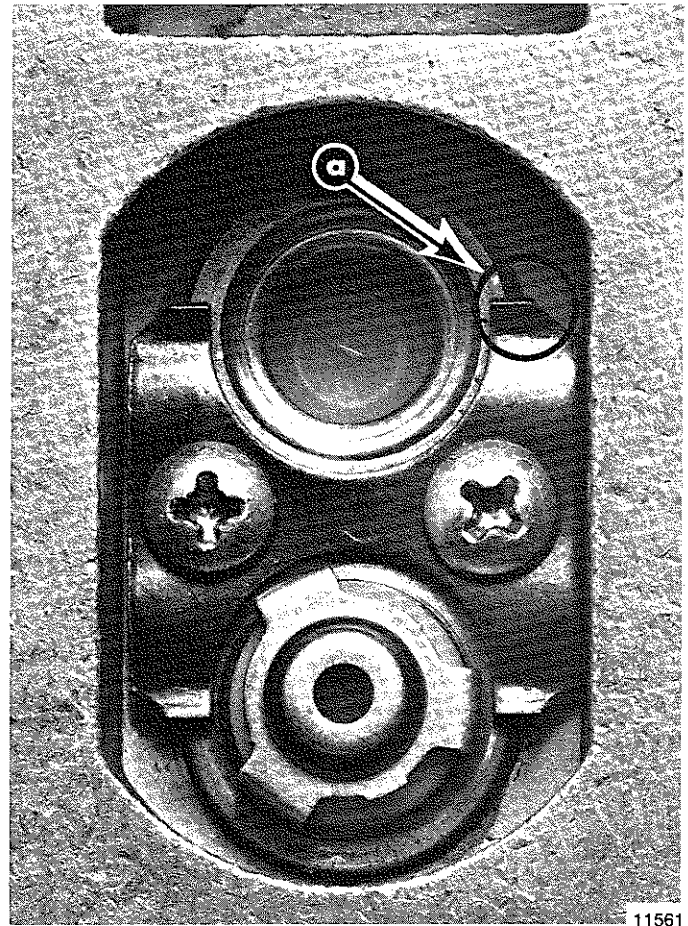


a - Fuel Pump Housing
b - Gasket (Inlet and Outlet Check Valves)

c - Inlet and Outlet Check Valves
d - Retainer (Check Valves)
e - Screws

11532

Figure 8. Fuel Pump Housing Assembly Sequence



11561

a - Must Be Turned Up

Figure 9. Fuel Pump Housing Assembly

1. Place check valve gaskets into position in fuel pump housing. (Figure 8)
2. Install check valves into fuel pump housing. (Figure 8)

IMPORTANT: When check valve retainer is installed in fuel pump housing, ends of retainer, which are over check valves, MUST BE turned up. (Figure 9)

3. Secure check valves to fuel pump housing with retainer and 2 screws. (Figure 9) Tighten screws securely.
4. Assemble fuel pump as shown in Figure 6.
5. Secure fuel pump assembly to engine with 5 screws. (Figure 4) Tighten screws evenly and securely.
6. Install fuel pump filter and "O" ring. (Figure 5)
7. Position fuel filter cover over filter and secure to pump with screw and plastic flat washer. (Figure 4)
8. Install gas lines (from carburetors) onto fuel pump fitting and secure with clamps. (Figure 4)

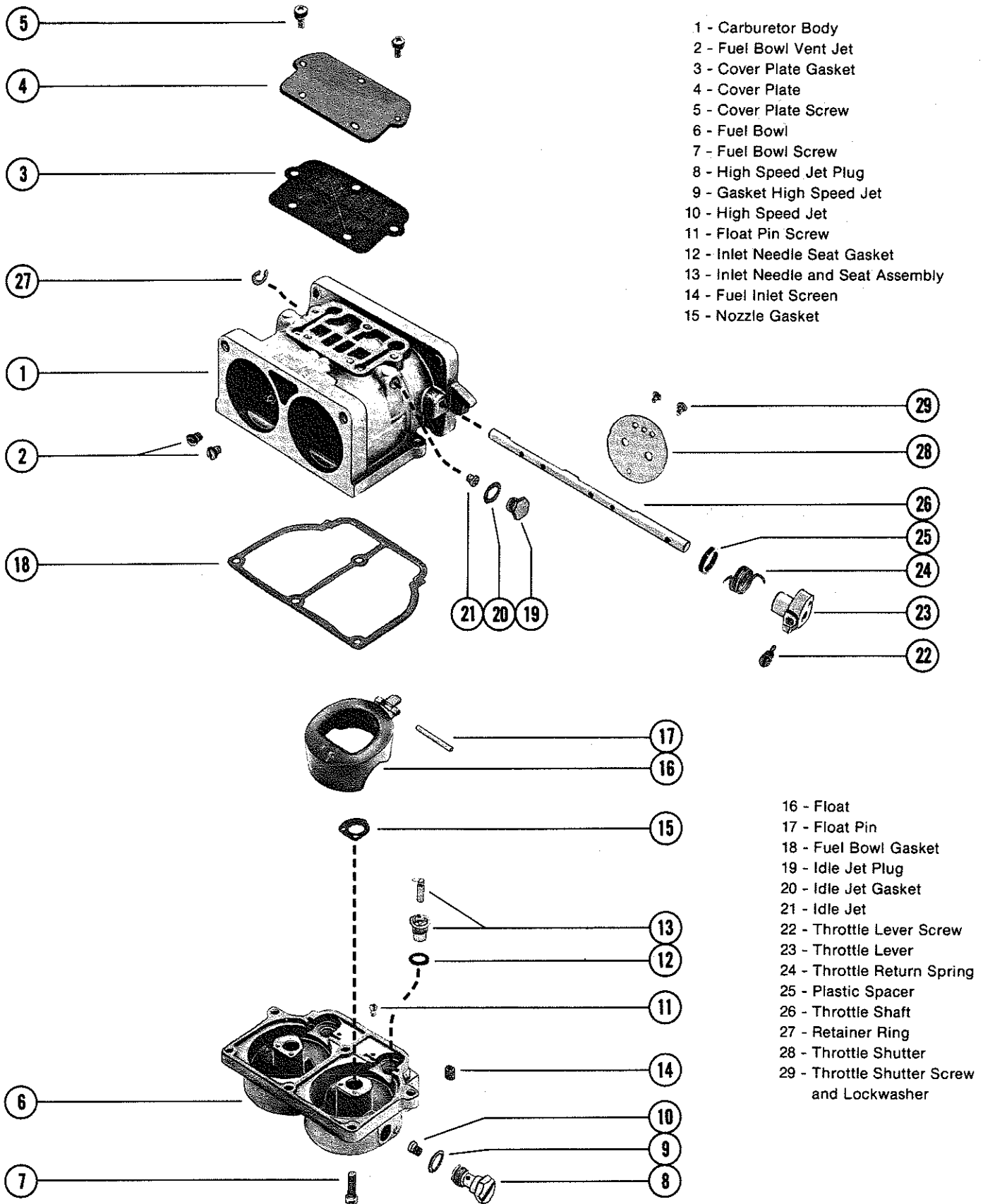


Figure 1. Dual Float Center Bowl Type Carburetor

DUAL FLOAT CENTER BOWL TYPE CARBURETOR (V-6 MODEL)

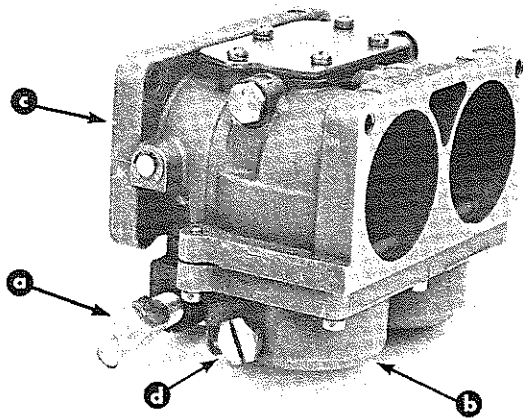
Removing Carburetor from Engine

1. Remove choke knob and wing nuts with washers from sound box cover and remove sound box cover from choke plate.
2. Remove electrical cable and fuel line from bracket on bottom of choke plate, then remove 6 bolts which secure choke plate to carburetors. Disconnect rubber drain hose from bottom of choke plate and remove choke plate from carburetors. Note that choke solenoid plunger will pull out of choke solenoid.
3. Disconnect throttle linkage from carburetor(s).
4. Remove fuel hose clamp(s), then fuel hose from carburetor(s).
5. Remove 4 nuts which secure carburetor to engine. Lift carburetor(s) from engine.
6. Clean all old gasket material from engine carburetor flanges. Be careful not to damage gasket surface.

Carburetor Disassembly

FLOAT BOWL DISASSEMBLY

1. Remove 2 main jet plugs (Figure 2) and gaskets from fuel bowl.
2. Remove fuel hose fitting (Figure 2) from fuel bowl.
3. Remove 6 screws which attach fuel bowl (Figure 2) to carburetor body. Lift fuel bowl from carburetor body.
4. Remove fuel bowl gasket and 2 nozzle gaskets (Figure 1) from carburetor.
5. Remove 2 screws which hold both float pins to fuel bowl. (Figure 3) Remove both floats, float pins, inlet needles and inlet needle seats with gaskets from fuel bowl.
6. Check to see if filter screen (Figure 3) needs replacement (loose torn, etc). If replacement is necessary, remove filter screen from fuel bowl.

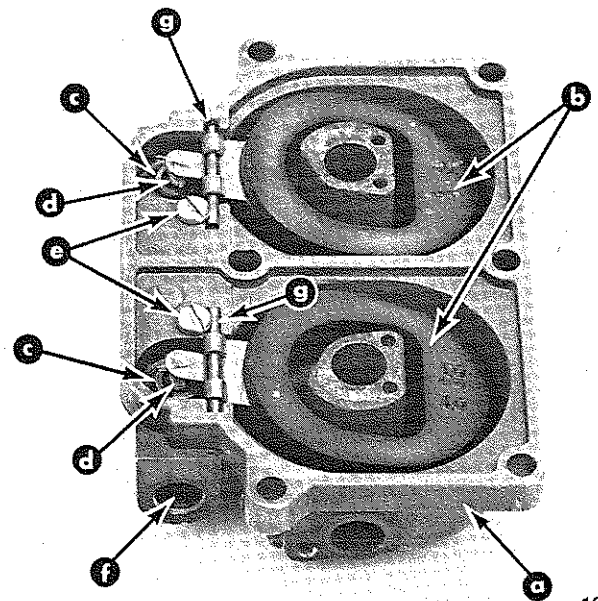


10291
a - Fuel Hose Fitting b - Fuel Bowl c - Carburetor Body
d - Main Jet Plug

Figure 2. Typical Carburetor

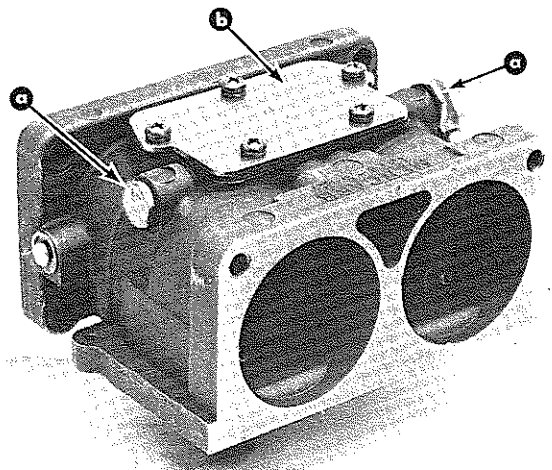
CARBURETOR BODY DISASSEMBLY

1. Remove 2 idle jet plugs (Figure 4) and gaskets from carburetor body.
2. Remove 2 idle jets (Figure 5) from carburetor body.
3. Remove 5 screws which attach cover plate (Figure 4) to carburetor body. Remove cover plate and gasket from carburetor.
4. Remove screw that secures throttle lever to throttle shaft (Figure 6) Remove throttle lever, throttle return spring and plastic spacer from throttle shaft.



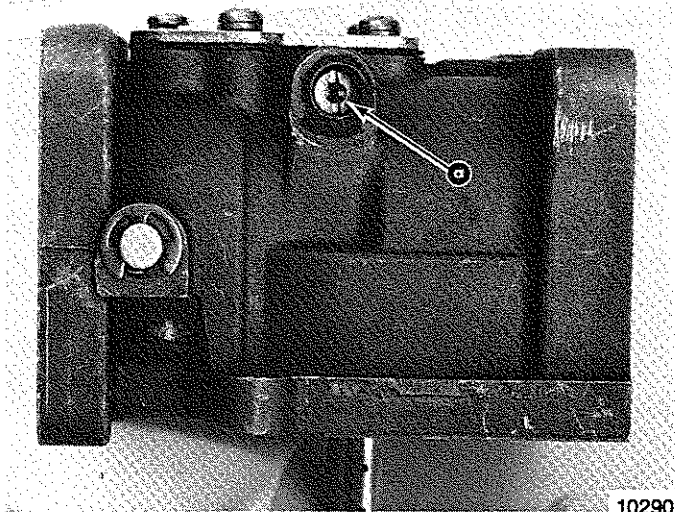
10281
a - Fuel Bowl b - Float c - Inlet Needle Seat with Gasket
d - Inlet Needle with Spring e - Screw f - Filter Screen
g - Float Pin

Figure 3. Float Removal



10292
a - Idle Jet Plugs b - Cover Plate

Figure 4. Carburetor Body



a - Idle Jet (One Each Side)

Figure 5. Idle Jet Removal

NOTE: It is NOT necessary to disassemble carburetor beyond this point for cleaning. Examine throttle shaft for wear and inspect for damaged throttle shutter plates. If removal of throttle shaft and/or throttle shutter plates is necessary, follow Step 5.

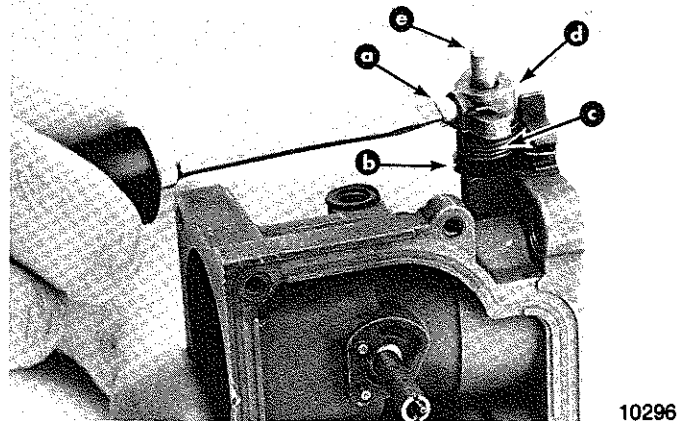
5. If necessary, remove 4 screws which secure 2 throttle shutter plates to throttle shaft. Remove throttle shutter plates from throttle shaft, then pull throttle shaft out of carburetor.

CARBURETOR CLEANING and INSPECTION

1. Place carburetor body, fuel bowl and metal parts in carburetor cleaning solution for a short period of time to remove all dirt, gum and varnish which may have accumulated.

CAUTION: Do not place floats, inlet needles or any rubber or plastic parts into carburetor cleaner.

2. After soaking carburetor parts, rinse thoroughly with water, then solvent. Blow parts dry with compressed air. Be sure to blow thru all passages, orifices and nozzles.
3. Check for float deterioration (saturation).
4. Examine inlet needle and seat for wear. If worn, replace with new inlet needle and seat assembly.



a - Screw (Secures Throttle Lever to Throttle Shaft)

b - Plastic Spacer

c - Throttle Return Spring

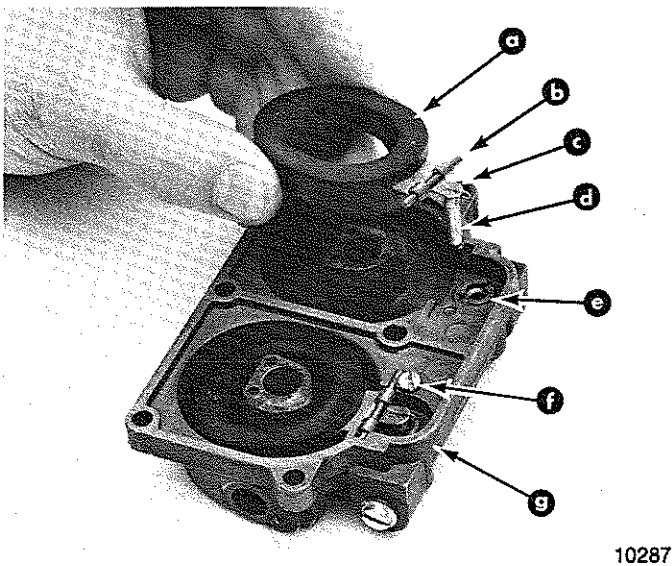
d - Throttle Lever

e - Throttle Shaft

Figure 6. Throttle Lever Removal

Carburetor Reassembly

IMPORTANT: Make certain that all parts are kept clean during reassembly of carburetor.



a - Float

b - Float Pin

c - Float Tab

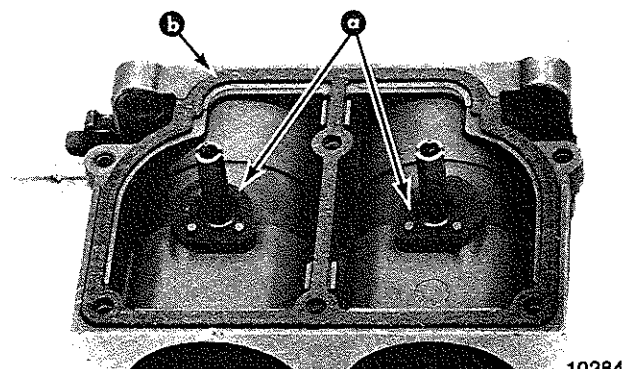
d - Inlet Needle with Spring

e - Inlet Needle Seat with Gasket

f - Screw

g - Fuel Bowl

Figure 7. Installing Floats



a - Nozzle Gasket

b - Fuel Bowl Gasket

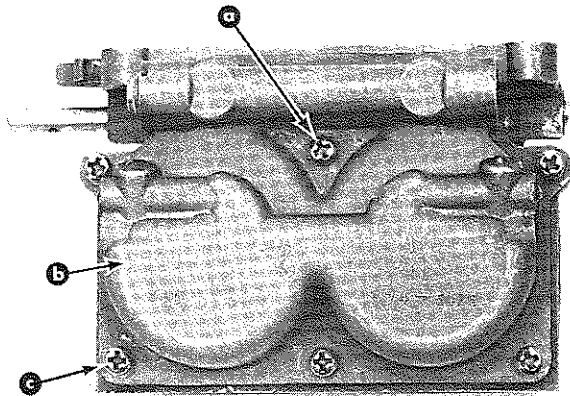
Figure 8. Installing New Gaskets

FUEL BOWL REASSEMBLY

1. If removed, install new filter screen into fuel inlet, as shown in Figure 3.
2. Install both inlet needle seats with gaskets (Figure 7) into fuel bowl.
3. Place each float with float pin and inlet needle with spring (hooked on end of tab) into fuel bowl, as shown in Figure 7. Insert needle into seat and secure float pin to fuel bowl with screw. Tighten screw securely.
4. Adjust each float as outlined in "Carburetor Adjustments", following.

IMPORTANT: When installing fuel bowl to carburetor body, tighten screws in sequence as shown in Figure 9.

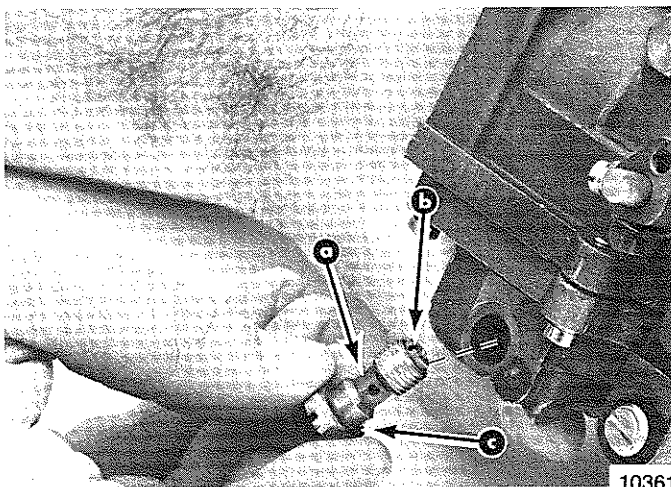
- Place new fuel bowl gasket and 2 nozzle gaskets on carburetor body, as shown in Figure 8, then install fuel bowl to carburetor body with 6 screws and lockwashers. Tighten screws in sequence shown in Figure 9. Tighten screws securely.



10293

- a - Tighten This Screw First, Then Tighten Other Screws in a Circular Pattern in Either Direction and Retighten This Screw Last
- b - Fuel Bowl
- c - Fuel Bowl Screw with Lockwasher (6 Required)

Figure 9. Installing Fuel Bowl to Carburetor Body



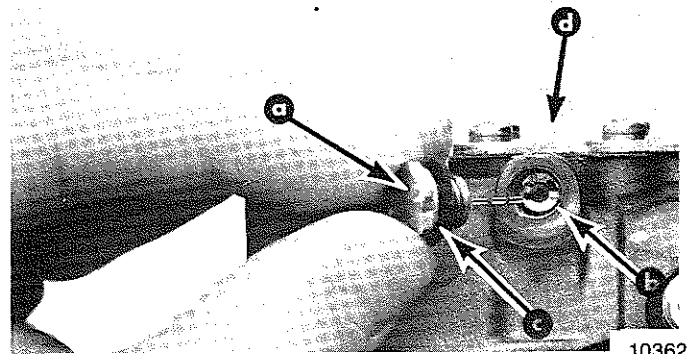
10361

- a - Main Jet Plug b - Main Jet c - Gasket

Figure 10. Installing Main Jet Plugs

CARBURETOR BODY REASSEMBLY

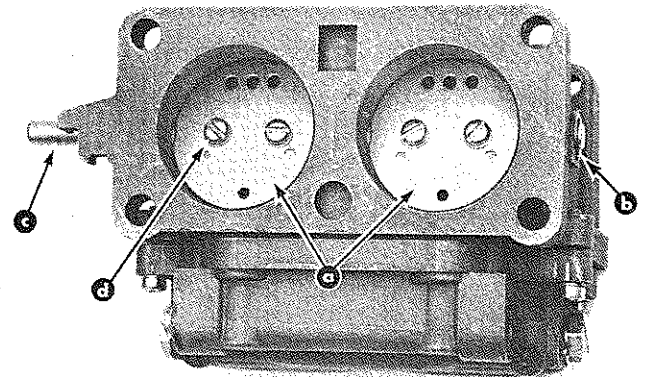
- Install 2 main jet plugs (Figure 10) (with main jets and gaskets) into fuel bowl. Tighten main jet plugs securely.
- Install 2 idle jets (Figure 11) into carburetor body. Tighten jets securely.
- Install 2 idle jet plugs with gaskets (Figure 11) into carburetor body. Tighten jet plugs securely.
- Install cover plate (Figure 11) with new gasket to top of carburetor with 5 screws and lockwashers. Tighten screws securely.
- If removed, install throttle shaft (with retainer ring attached to end) into carburetor body, as shown in Figure 12.



10362

- a - Idle Jet Plug b - Idle Jet c - Gasket
- d - Cover Plate with Gasket

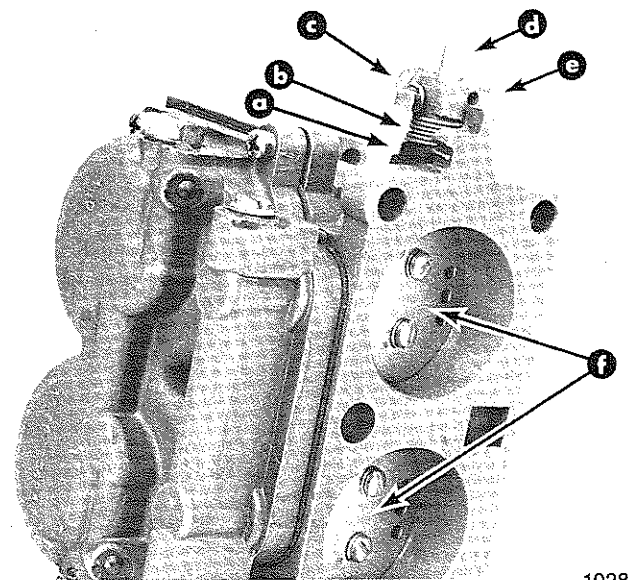
Figure 11. Installing Idle Jet Plugs



10295

- a - Throttle Shutter (Install as Shown)
- b - Retainer Ring c - Throttle Shaft
- d - Throttle Shutter Screw with Lockwasher (4 Required)

Figure 12. Installing Throttle Shaft and Throttle Shutters



10286

- a - Plastic Spacer
- b - Throttle Return Spring (Install as Shown)
- c - Screw (Secures Throttle Lever to Throttle Shaft)
- d - Throttle Shaft e - Throttle Lever
- f - Throttle Shutters (Position as Shown When Installing Throttle Return Spring and Lever)

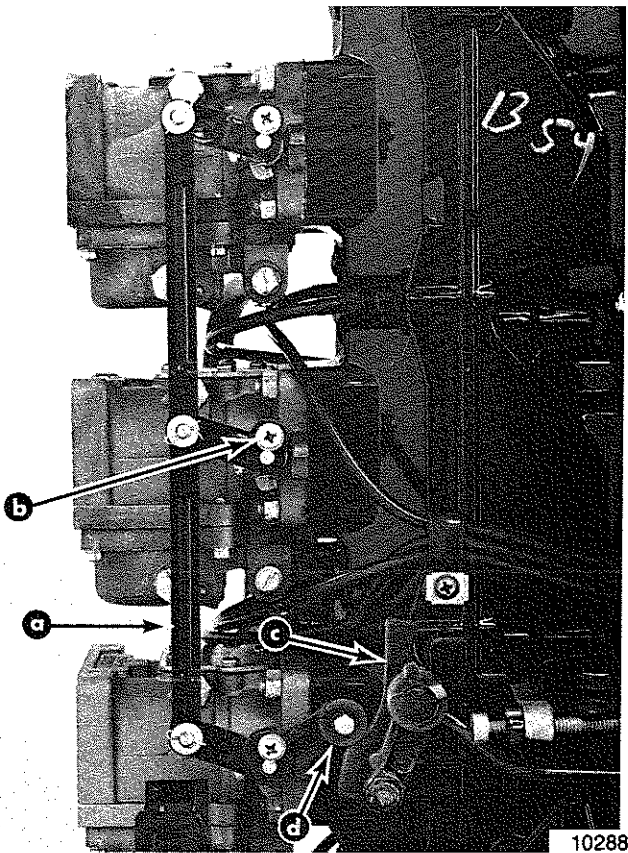
Figure 13. Installing Throttle Lever

Install both throttle shutter plates onto flat of throttle shaft and position with 3 holes toward top of carburetor and numbers facing outwards toward back of carburetor, as shown in Figure 12. Secure throttle shutter plates to throttle shaft with 4 new screws and lockwashers. Tighten screws securely.

- Position throttle shutters as shown in Figure 13, then install plastic spacer, throttle return spring and throttle lever onto end of throttle shaft, as shown in Figure 13. Secure throttle lever to throttle shaft with screw. (Figure 13) Tighten screw securely.

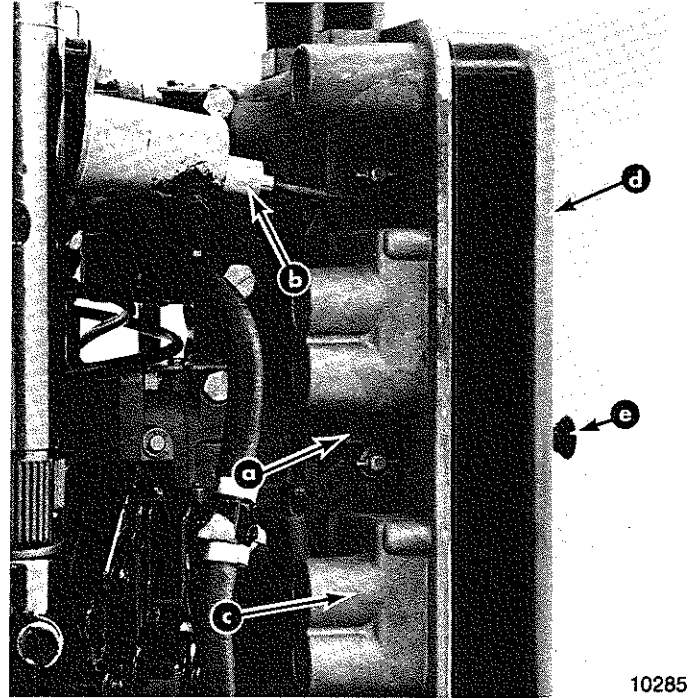
Installing Carburetor to Engine

- Place new flange gasket onto carburetor mounting studs on engine. Install carburetor onto studs and secure with 4 nuts. Tighten nuts securely.
- Connect fuel hose(s) to carburetor fuel fitting(s). Secure fuel hose to fitting with clamp(s).
- Reinstall throttle linkage to carburetor as shown in Figure 13. To synchronize carburetors, refer to "Timing/Synchronizing/Adjusting" in Section 2.



a - Throttle Linkage c - Roller Arm
b - Synchronization Screws d - Throttle Cam

Figure 14. Installing Throttle Linkage



a - Choke Rod (Positioned Correctly)
b - Solenoid Plunger Inserted into Solenoid
c - Choke Plate d - Sound Box Cover e - Choke Knob

Figure 15. Choke Rod

- Connect drain hose to bottom of choke plate, insert choke solenoid plunger into choke solenoid and secure choke plate onto carburetors with 6 bolts. Tighten bolts securely.
- Reinstall fuel line and electrical cable into bracket on bottom of choke plate.
- Reinstall sound box cover to choke plate with 2 flat washers, 2 locknuts and 2 wing nuts.
- Install choke knob to choke rod with screw.

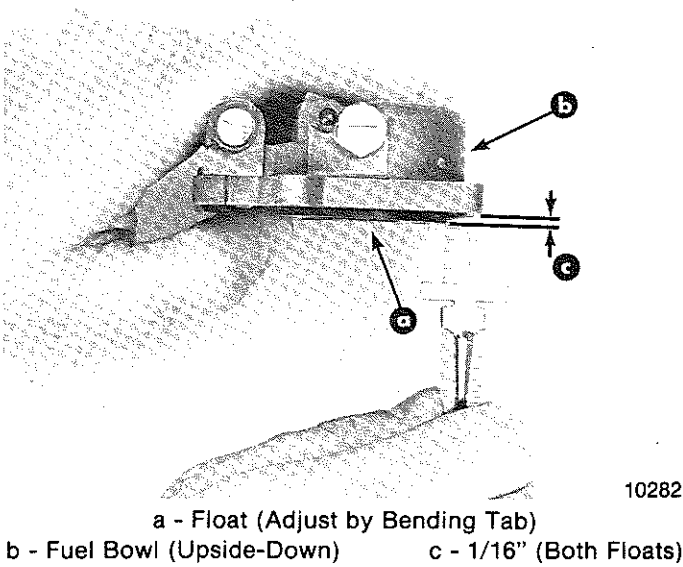
IMPORTANT: Check to see if choke rod has turned during disassembly. Make sure that choke rod is positioned as shown in Figure 15.

Carburetor Adjustments

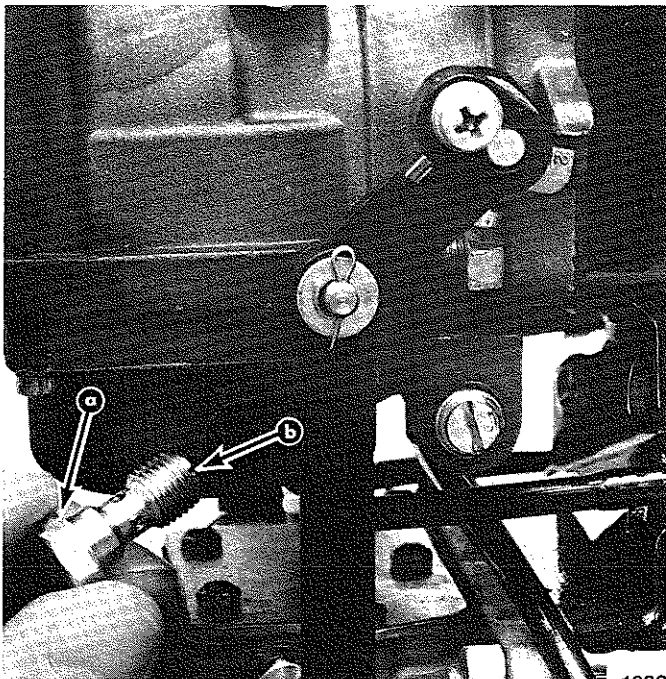
FLOAT ADJUSTMENT

NOTE: Float drop adjustment is the only adjustment made to adjust float setting.

Adjust float drop by turning fuel bowl upside-down, then adjust both floats to 1/16" (1.6mm) from carburetor body to top of float, as shown in Figure 16. Adjust float by bending float tab. (Figure 16)

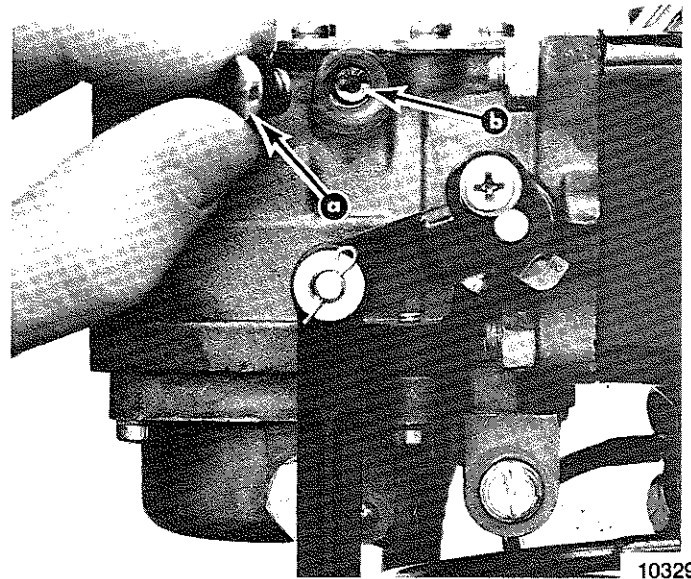


10282
 a - Float (Adjust by Bending Tab)
 b - Fuel Bowl (Upside-Down) c - 1/16" (Both Floats)
Figure 16. Float Adjustment



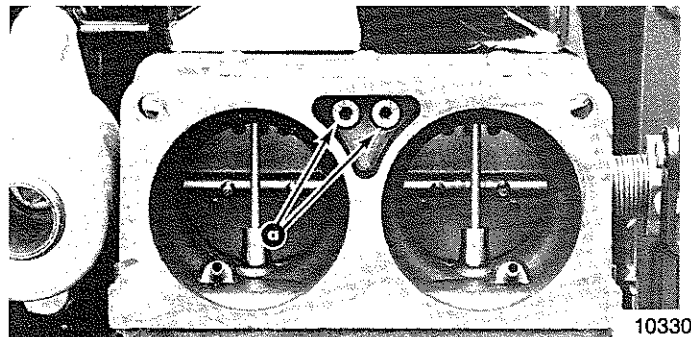
10328
 a - High Speed Jet Plug
 b - High Speed Jet (2 Required)

Figure 17. High Speed Jet Adjustment



10329
 a - Idle Jet Plug b - Idle Jet (2 Required)

Figure 18. Jet Adjustment



10330
 a - Fuel Bowl Vent Jet

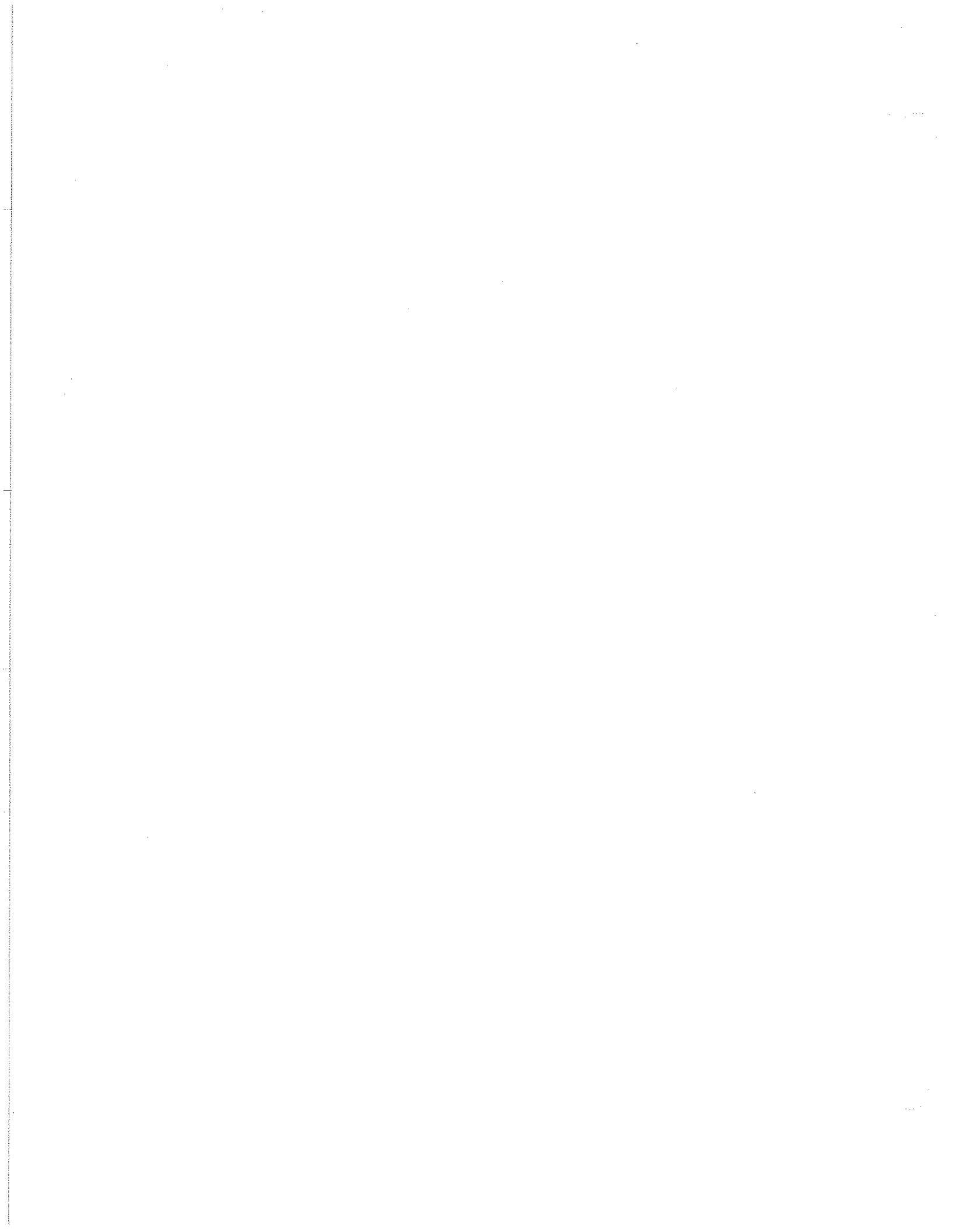
Figure 19. Fuel Bowl Vent Adjustment

CARBURETOR JET SIZES

NOTE: Thread Size for the following Jets Is 10-32.

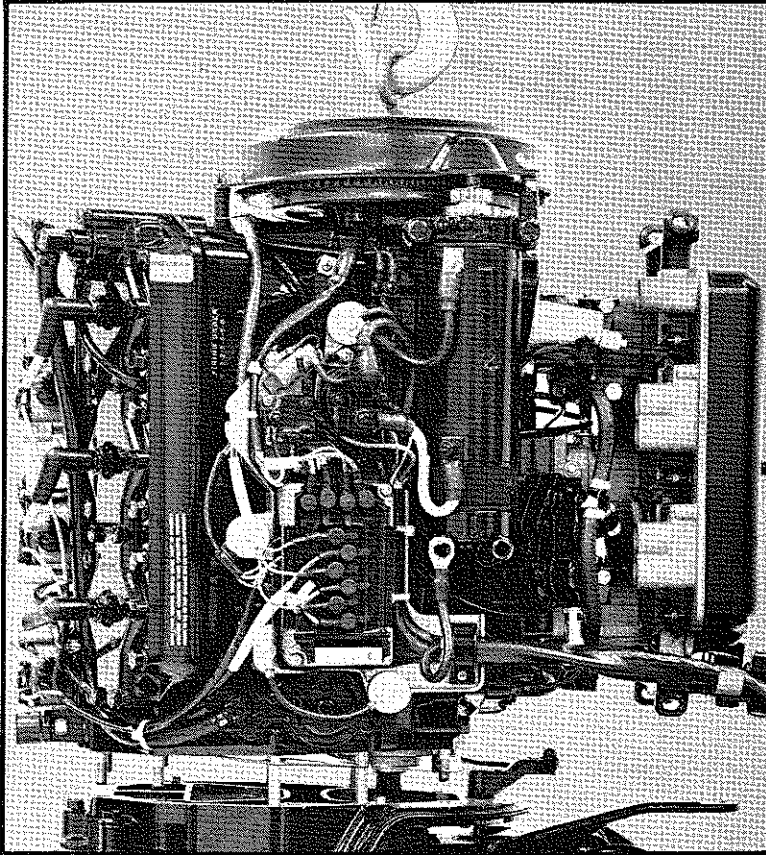
V-6 Model	Jet Type	Std. Up to 2500' Size	2500'-5000' Size	5000'-7500' Size	7500' and Up Size
150 HP Serial No. 5203429 and Above	Main	.048	.046	.044	.042
	Vent	.098	.098	.098	.098
	Idle	.060	.062	.064	.066
150 HP Serial No. 5203428 and Below	Main	.052	.050	.048	.046
	Vent	.098	.098	.098	.098
	Idle	.064	.066	.068	.070
175 HP	Main	.074	.072	.070	.068
	Vent*	.090	.088	.086	.084
	Vent• Idle	.082 .048	.080 .050	.0785 .052	.076 .054
200 HP	Main	.0785	.076	.074	.072
	Vent	.084	.082	.080	.0785
	Idle	.046	.048	.050	.052

* Top Carburetor Only • Center and Bottom Carburetors
 (Metric Conversion: 1" = 25.4mm)



V-6 OUTBOARDS

Powerhead



SECTION

4

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GENERAL INFORMATION

Powerhead "Disassembly" and "Reassembly" instructions are printed in a sequence that should be followed to assure best results when removing or replacing powerhead components. If complete disassembly is not necessary, start reassembly at point disassembly was stopped. (Refer to "Index", preceding.) Usually, complete disassembly of powerhead will be required.

If major powerhead repairs are to be performed, remove powerhead from drive shaft housing. Removal of powerhead is not required for 1) inspection of cylinder walls and pistons (refer to "Powerhead Removal and Disassembly", following,

and remove cylinder heads and exhaust covers), 2) minor repairs on components, such as ignition system, carburetors, reed blocks and cylinder heads, and 3) checking operation of thermostats and temperature sender (remove thermostats and temperature sender, then refer to "Cleaning and Inspection", following).

A powerhead repair stand may be purchased from:

Bob Kerr's Marine Tool Co.
P.O. Box 1135
Winter Garden, FL 32787
Telephone: (305) 656-2089

Tools for Powerhead Repair

Tool Description	Part No.
Lifting Eye	C-91-75132
Flywheel Holder	C-91-52344
Protector Cap	C-91-24161
Flywheel Puller	C-91-73687A1
Powerhead Stand	C-91-30591A1
Piston Ring Expander	C-91-24697
Lockring Removal Tool	C-91-52952A1
Piston Support Block	C-91-77005
Piston Pin Tool	C-91-74607A1

Tool Description	Part No.
Torch Lamp	C-91-63209
Driver Head	C-91-55919
Driver Rod	C-91-37323
Universal Puller Plate	C-91-37241
VOA Meter	C-91-62562
Snap Ring Pliers	C-91-24283
Lockring Installation Tool	C-91-77109A1
Piston Ring Compressor*	C-91-65494
	C-91-85534

* C-91-65494 for 150 and 175 HP models; C-91-85534 for 200 HP model

V-6 Powerhead Torques

Fastener Location	Size	Torque
Flywheel Nut	5/8-18	100 Ft. Lbs.
Crankcase to Cylinder Block Screws	3/8-18	34 Ft. Lbs.
Crankcase to Cylinder Block Screws	5/16-18	210 In. Lbs.
Cylinder Block Cover	5/16-18	210 In. Lbs.
Cylinder Head Cover Mounting Screws	5/16-18	150 In. Lbs.
Cylinder Head Mounting Screws	3/8-16	30 Ft. Lbs.
Exhaust Manifold Cover Screws	5/16-18	180 In. Lbs.
End Cap Screws (Lower)	1/4-20	60 In. Lbs.
End Cap Screws (Upper)	5/16-18	150 In. Lbs.
Thermostat Cover Screws	5/16-18	150 In. Lbs.
Connecting Rod Nuts*	5/16-24	30 Ft. Lbs.

Fastener Location	Size	Torque
Reed Stop Retaining Screws	8-32	25 In. Lbs.
Reed Block Housing Mounting Screws	1/4-20	60 In. Lbs.
Reed Block Mounting Screws	1/4-20	60 In. Lbs.
Poppet Valve Cover Screws	5/16-18	150 In. Lbs.
Coil Terminal Nuts	10-32	20 In. Lbs.
Stator Mounting Screws	10-24	30 In. Lbs.
Spark Plug	14mm	20 Ft. Lbs.
Starter Motor to Crankcase	5/16-18	180 In. Lbs.
Carburetor Mounting Nuts	1/4-28	180 In. Lbs.
Fuel Pump Attaching Screws	10-32	25 In. Lbs.
Powerhead to Exhaust Extension Plate	3/8-24	45 Ft. Lbs.

* Clean nut and bolt in solvent, dry with compressed air and torque, using Loctite.

Metric Conversion: One (1) in. lb. = 1.1521kg-cm; one (1) ft. lb. = .1383mkg.

Miscellaneous Powerhead Specs

Tapered Piston Diameters		
Models	(a) Skirt	(b) Above Rings
150 HP and 175 HP	3.120" (79.248mm)	3.108" (78.943mm)

Models	Barrel Profile Piston Diameters
150 HP (V-6) 175 HP (V-6)	(c) 3.115" (79.121mm)
200 HP (V-6)	(d) 3.372" (85.649mm)

Models	Barrel Profile Piston Diameters for .015" and .030" Oversize Pistons
150 HP and 175 HP	(c) 3.130" (79.502mm) (.015" oversize) 3.145" (79.883mm) (.030" oversize)

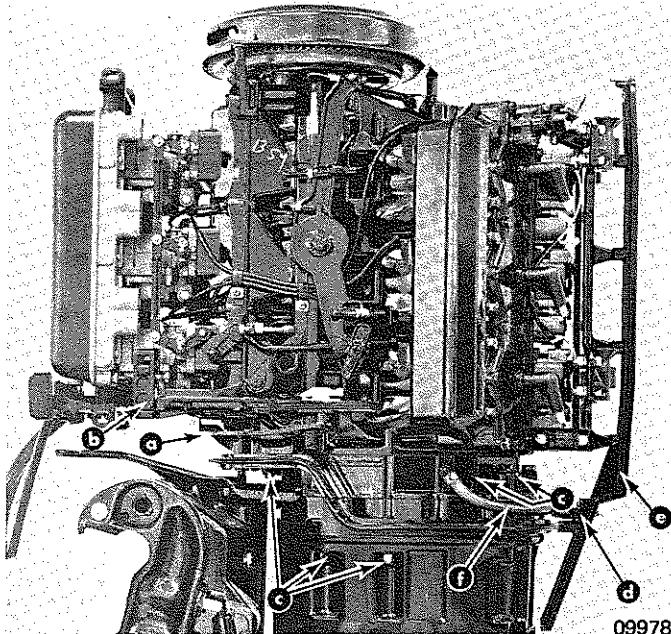
- (a) Measure outside of piston skirt at bottom of skirt, in line with piston pin and at a right angle (90°) to piston pin.
- (b) Measure outside of piston above top piston ring, in line with piston pin and at a right angle (90°) to piston pin.
- (c) Measure outside of piston 29/32" (23mm) up from bottom of piston, in line with piston pin and at right angle (90°) to piston pin.
- (d) Measure outside of piston 1/2" (12.7mm) up from bottom of piston, in line with piston pin and at right angle (90°) to piston pin.

Models	Cylinder Block Finish Hone
150 HP V-6 and 175 HP V-6 with a Standard Piston	3.125" (79.375mm)
150 HP V-6 and 175 HP V-6 with a .015" Oversize Piston	3.140" (79.756mm)
150 HP V-6 and 175 HP V-6 with a .030" Oversize Piston	3.150" (80.010mm)

POWERHEAD REMOVAL and DISASSEMBLY

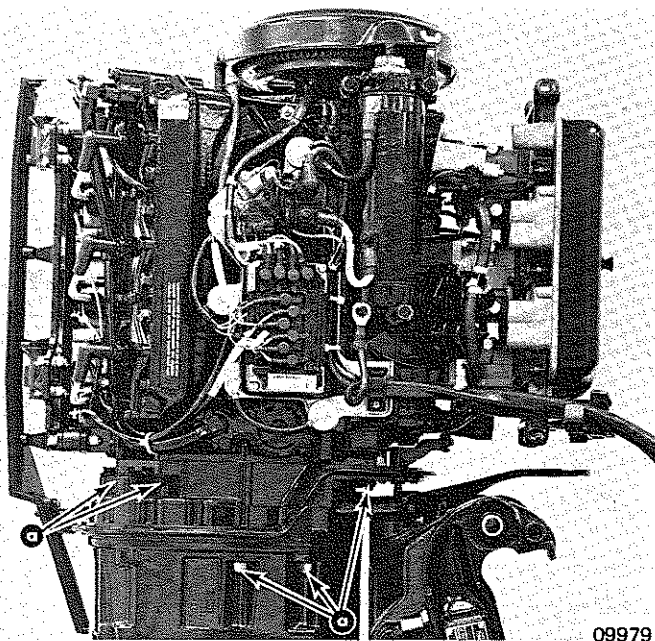
Powerhead Removal

1. Disconnect engine battery cables from terminals of battery.
2. Disconnect engine harness from "Extension Harness" by separating connectors.
3. Disconnect engine fuel hose from fuel tank.
4. Remove front cowl cover and each half (port and starboard) of engine "clam-shell" cowl.
5. Disconnect remote control cables from powerhead.



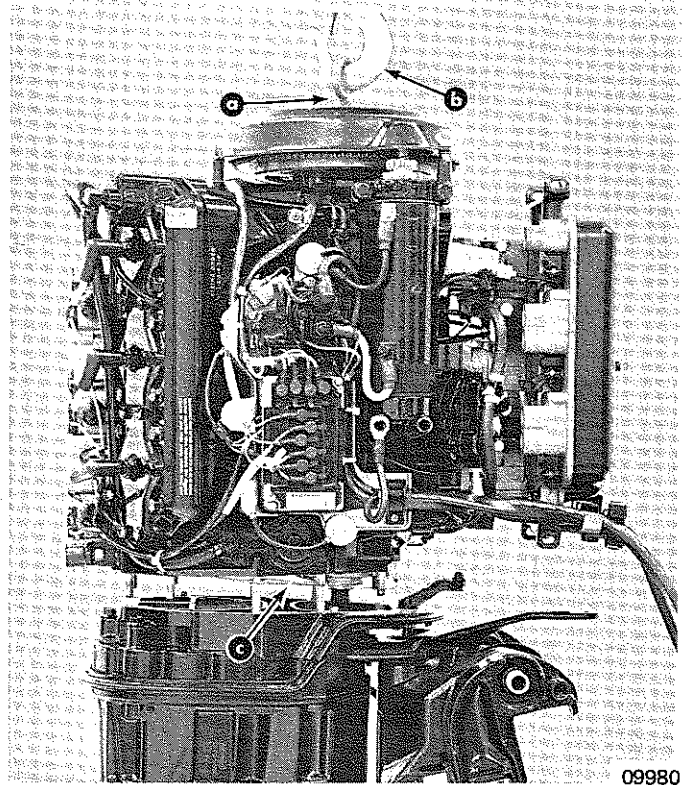
- | | |
|----------------------------------|--------------------------------|
| a - Shift Link Rod | d - "Tell-Tale" Nozzle |
| b - Control Cable Anchor Bracket | e - Rear Cowl Bracket Assembly |
| c - Powerhead Attaching Locknuts | f - Water Hose |

Figure 1. Powerhead (Port Side Shown)



- a - Powerhead Attaching Locknuts

Figure 2. Powerhead (Starboard Side)



- | | |
|------------------------------|-----------|
| a - Lifting Eye (C-91-75132) | b - Hoist |
| c - Powerhead Base Gasket | |

Figure 3. Lifting Powerhead from Drive Shaft Housing

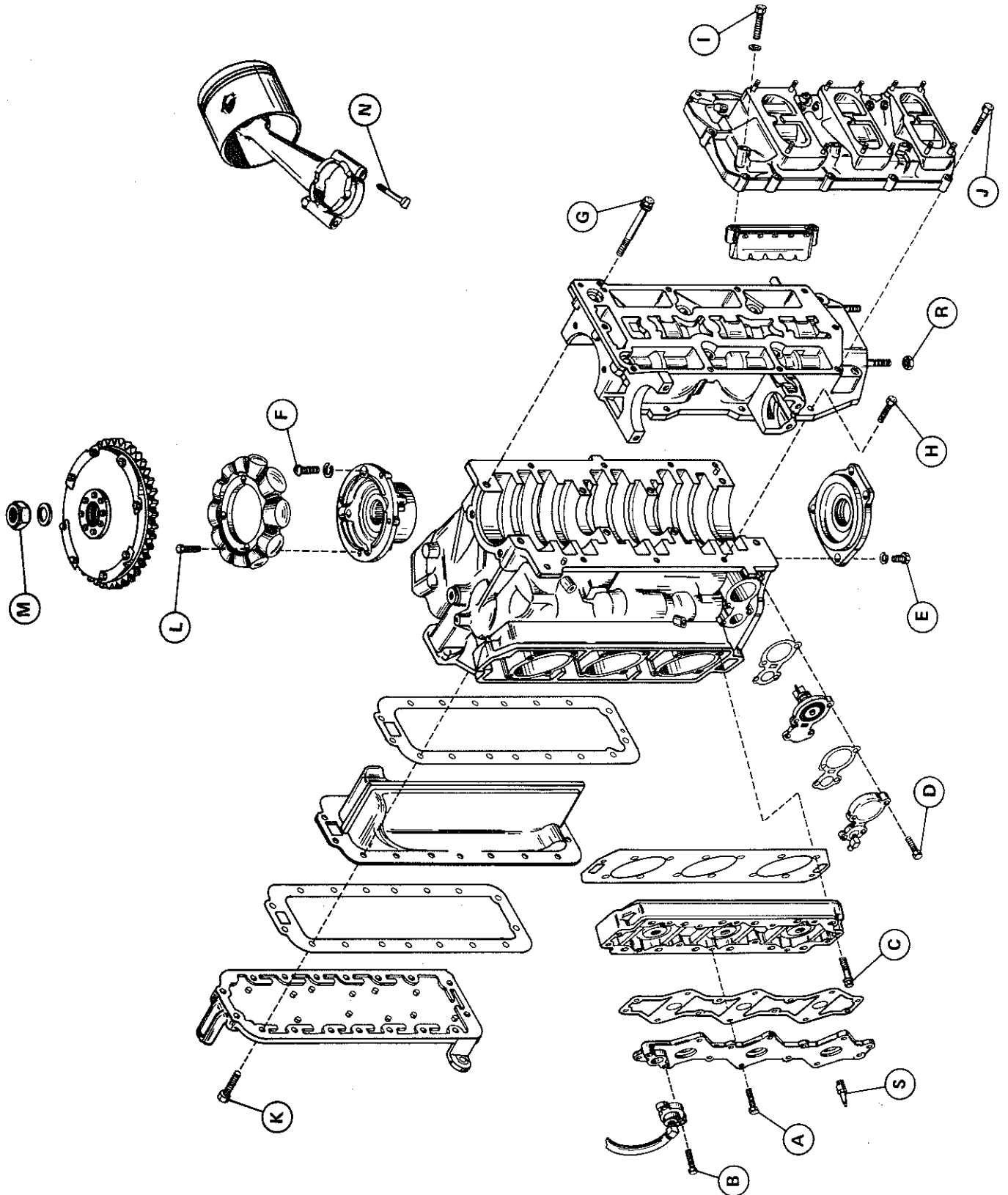
6. Disconnect high tension leads from spark plugs, then remove spark plugs from cylinder heads.
7. Remove locknut, washer, latch and wear plate which secure shift link rod assembly to control cable anchor bracket. (Figure 1)
8. Remove water hose from "tell-tale" nozzle. (Figure 1)
9. Remove 3 locknuts and 3 flat washers which secure rear cowl bracket assembly (Figure 1) to exhaust manifold cover. Lift rear cowl bracket assembly from engine.
10. Remove 10 locknuts and 10 flat washers (5 each side) which secure powerhead to drive shaft housing. (Figures 1 and 2)
11. Remove plastic cap from center of flywheel and install Lifting Eye (C-91-75132) into flywheel. (Figure 3)

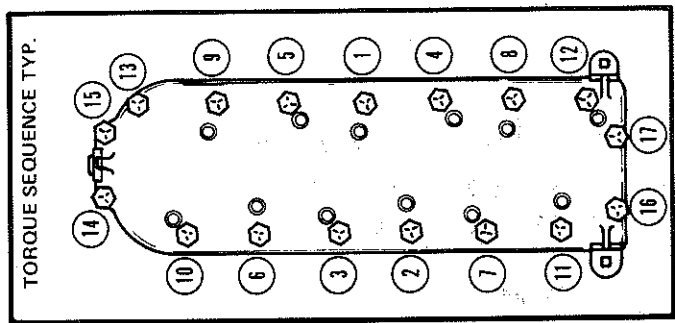
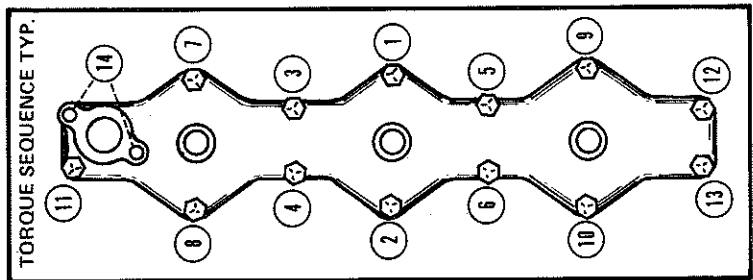
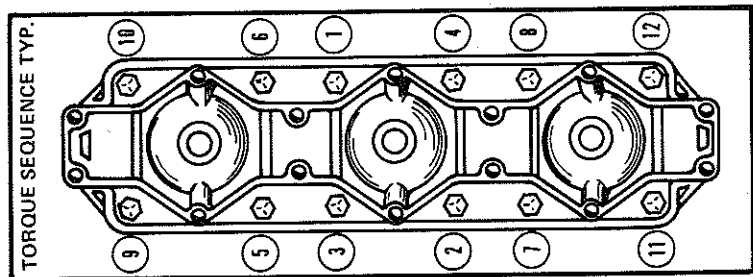
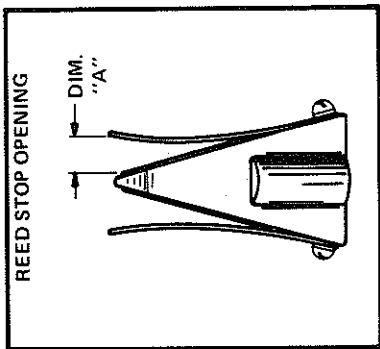
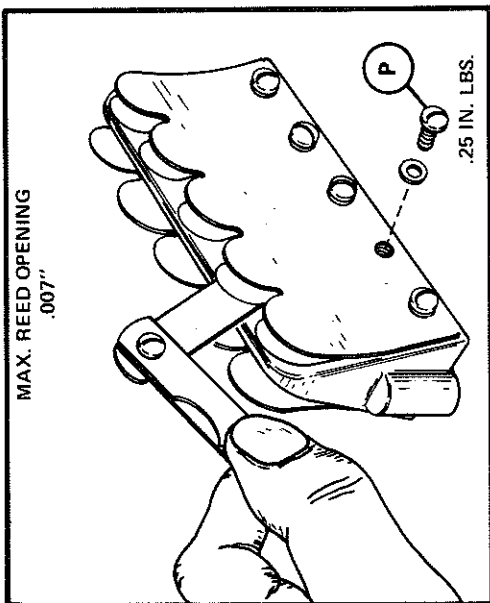
SAFETY WARNING: BE SURE that Lifting Eye is threaded into flywheel as far as possible BEFORE removing powerhead.

12. Using a hoist, lift powerhead assembly from drive shaft housing. (Figure 3)
13. Install powerhead in a suitable, floor-mounted repair stand (refer to "General" information, preceding). (Figure 4) Be sure that repair stand used can adequately support powerhead without damaging gasket surface of cylinder block.

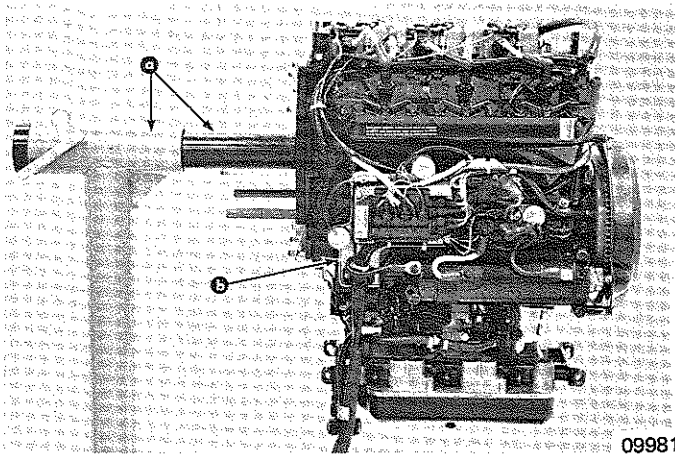
Torque Specifications V-6 Powerhead

(See Torque Chart on Next Page)





Fastener Location	V-6 Powerhead Torque		Loctite and Sealants
	Size	Torque	
A	$\frac{5}{16}$ - 18	150 IN. LBS. 173 KG-CM	
B	$\frac{5}{16}$ - 18	150 IN. LBS. 173 KG-CM	
C	$\frac{3}{8}$ - 16	30 FT. LBS. 4.15 MKG.	
D	$\frac{5}{16}$ - 18	150 IN. LBS. 173 KG-CM	
E	$\frac{1}{4}$ - 20	60 IN. LBS. 69 KG-CM	
F	$\frac{5}{16}$ - 18	150 IN. LBS. 173 KG-CM	
G	$\frac{3}{8}$ - 16	34 FT. LBS. 4.84 MKG.	LIGHT OIL
H	$\frac{5}{16}$ - 18	200 IN. LBS. 230 KG-CM	
I	$\frac{1}{4}$ - 20	60 IN. LBS. 69 KG-CM	
J	$\frac{1}{4}$ - 20	60 IN. LBS. 69 KG-CM	
K	$\frac{3}{8}$ - 16	30 FT. LBS. 35 KG-CM	LOCTITE 271
L	10 - 24	30 IN. LBS. 35 KG-CM	LOCTITE TYPE A
M	$\frac{5}{16}$ - 18	100 FT. LBS. 13.83 MKG.	
N	$\frac{5}{16}$ - 24	27 FT. LBS. 3.73 MKG.	LOCTITE 271
P	8 - 32	25 IN. LBS. 29 KG-CM	
R	$\frac{3}{8}$ - 24	45 FT. LBS. 6.22 MKG.	
S	14 MM	17 FT. LBS. 2.35 MKG.	



SAFETY WARNING: DO NOT attempt to place powerhead on a powerhead stand that is mounted in a vise.

14. Remove Lifting Eye from flywheel.

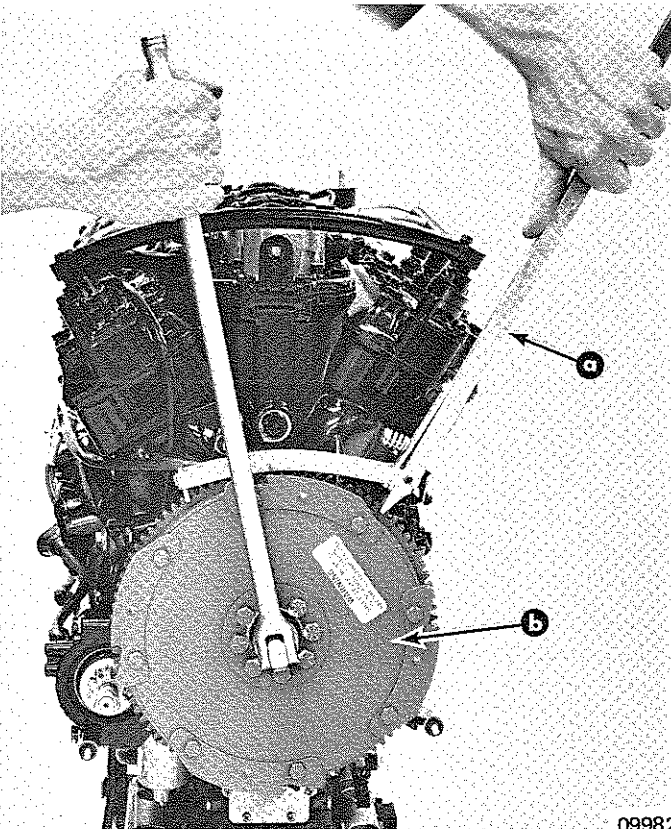
a - Powerhead Repair Stand
b - Ignition Plate



Figure 4. Powerhead Installed in Repair Stand

Flywheel and Accessories - Removal

1. Remove flywheel cover from engine.
2. While holding flywheel with Flywheel Holder (C-91-52344), remove flywheel nut and washer. (Figure 1)



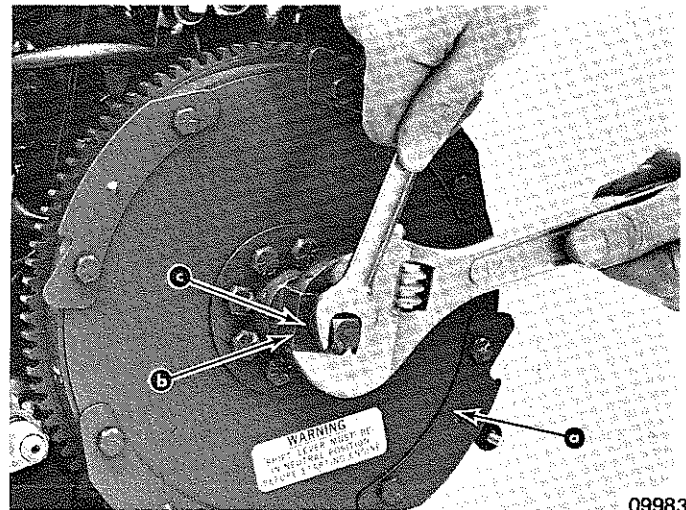
a - Flywheel Holder (C-91-52344) b - Flywheel

Figure 1. Flywheel Removal

3. Install a crankshaft Protector Cap (C-91-24161) on end of crankshaft, then install Flywheel Puller (C-91-73687A1) into flywheel. (Figure 2)

CAUTION: Crankshaft damage may result if a protector cap is not used between crankshaft and puller.

4. Remove flywheel by operating Flywheel Puller as shown in Figure 2.



a - Flywheel c - Crankshaft Protector Cap (Hidden)
b - Flywheel Puller (C-91-73687A1)

Figure 2. Flywheel Removal

CAUTION: DO NOT hammer on end of puller center bolt to remove flywheel, or damage may result to crankshaft or bearings. DO NOT use heat to aid flywheel removal, as excessive heat may seize flywheel to crankshaft.

5. Disconnect stator wires and trigger wires from terminals of switch boxes.
6. Remove stator assembly from engine.

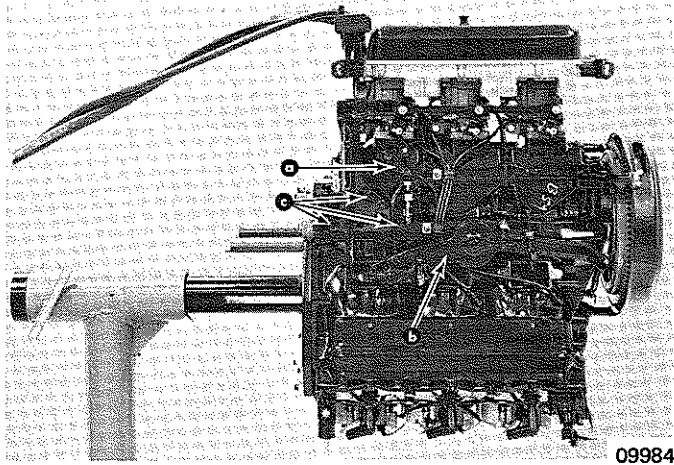
NOTE: Loctite has been applied to threads of stator attaching screws.

7. Remove locknut which secures trigger plate link rod to upper end of vertical throttle lever. Pull link rod swivel from throttle lever.
8. Remove trigger plate assembly from upper end cap.
9. Remove electrical cables from starter motor.
10. Remove 2 covers (upper and lower), which secure starter motor to crankcase cover, then remove starter motor.
11. Disconnect gray engine harness wire from terminal of choke solenoid. Remove choke solenoid from reed block housing.

12. Disconnect white/green engine harness wire from terminal block with cylinder head temperature sender wires attached.
13. Disconnect green, green/white and green/red switch box wires from positive (+) terminals of secondary ignition coils.
14. Remove screws, which secure secondary ignition coil covers and ignition coils to exhaust manifold cover, then lift coil assemblies from engine.

NOTE: Loctite has been applied to threads of ignition coil attaching screws.

15. Remove 3 bolts, which secure ignition plate to cylinder block, then lift ignition plate (with electrical components) from cylinder block.



a - Throttle Cam c - Control Cable Anchor
b - Vertical Throttle Lever Bracket Bolts

Figure 3. Powerhead (Port Side)

16. Remove throttle cam and bushings from reed block housing stud by removing attaching locknut. (Figure 3)
17. Lift vertical throttle lever (Figure 3) from cylinder block after removing pivot bolt.

NOTE: A flat washer is located between vertical throttle lever and cylinder block.

18. Remove 3 bolts, which secure control cable anchor bracket (Figure 3) to crankcase cover, then remove anchor bracket.
19. Remove 5 attaching screws which secure fuel pump assembly to reed block housing. Being careful not to separate fuel pump components, lift fuel pump assembly from reed block housing. Insert 2 of the attaching screws back thru fuel pump assembly and thread a 10-32 nut onto screws. This will prevent fuel pump components from separating during remainder of powerhead disassembly.

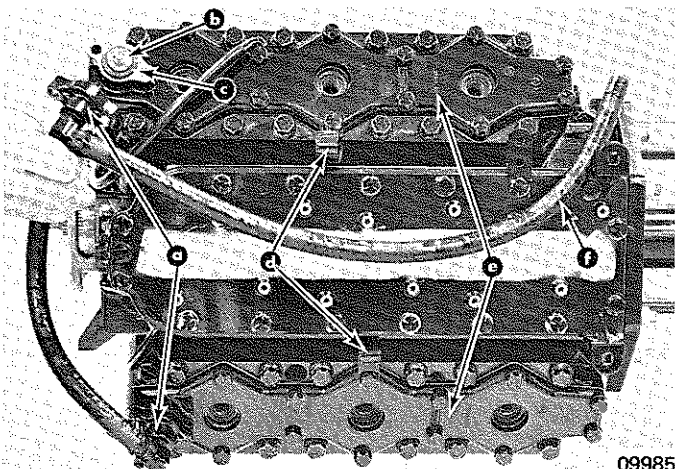
NOTE: It is not necessary to disconnect fuel hoses from fuel pump, as fuel pump will be removed with carburetors.

20. Disconnect bleed hose from check valve located at lower (port side) corner of air intake box.
21. Remove 12 locknuts which secure carburetors (4 on each carburetor) to reed block housing.
22. Pull carburetors, choke plate/air box, fuel pump and cowl brackets from powerhead as an assembly.

NOTE: Depending upon the particular routing of powerhead bleed hoses, it may be necessary to disconnect one or 2 bleed hoses to allow removal of carburetor assembly. If a bleed hose must be disconnected, it is preferable to disconnect from cylinder block elbow instead of from a reed block housing check valve.

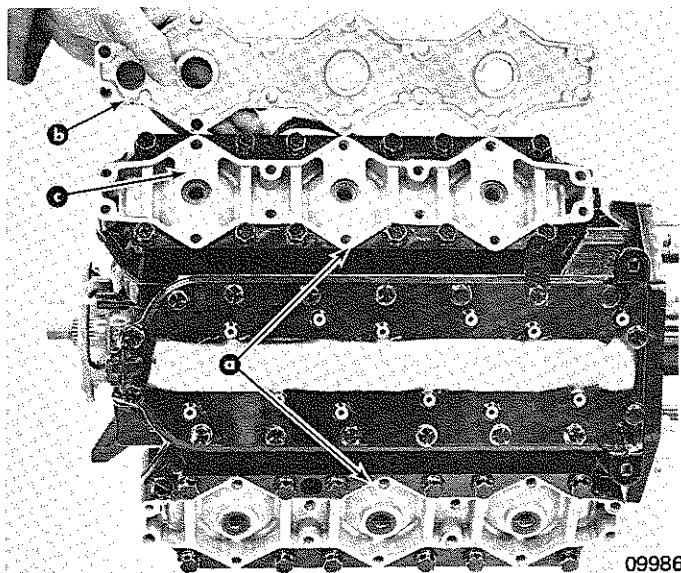
Cylinder Heads and Exhaust Covers - Removal

1. Disconnect water distribution hose from fitting on pressure relief valve cover.
2. Remove bolts which secure thermostat covers to cylinder head covers.
3. Remove thermostat cover and thermostat from each cylinder head cover. (Figure 4)
4. Note location of "J" clips on cylinder head cover bolts (to aid in reassembly), then remove bolts and cover from each cylinder head. (Figure 5)
5. Disconnect temperature sender wires from terminals of terminal block on starboard side of powerhead.



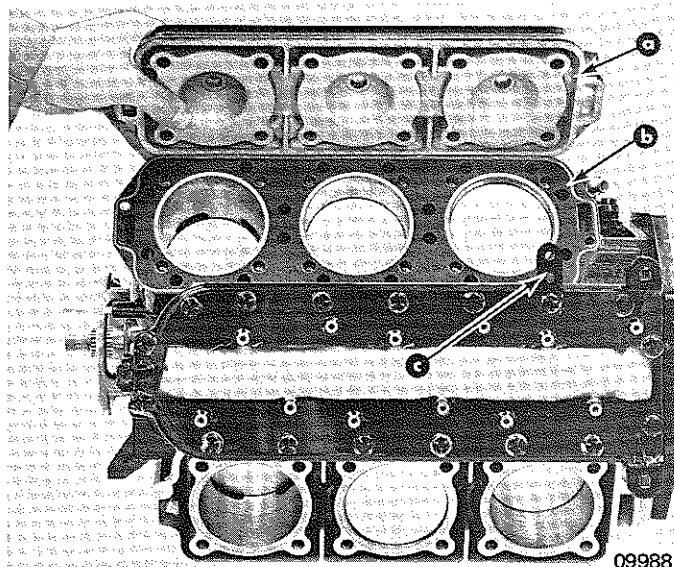
- 09985
- a - Thermostat Covers
 - b - Thermostat
 - c - Thermostat Gasket
 - d - "J" Clips
 - e - Cylinder Head Covers
 - f - Water Distribution Hose

Figure 4. Thermostat Removal



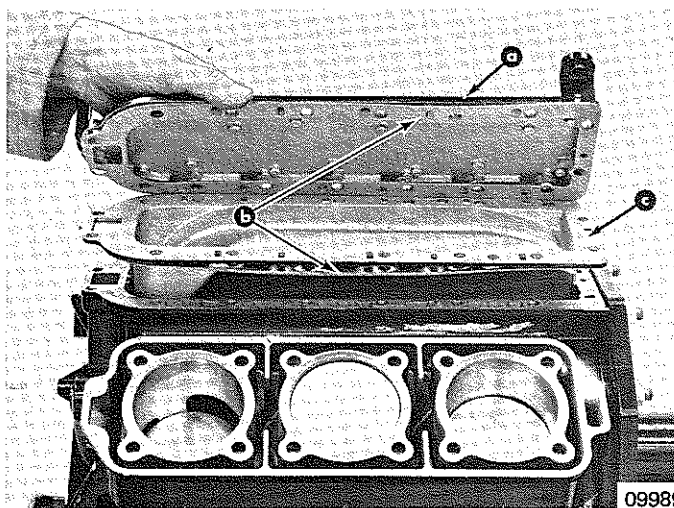
- 09986
- a - Cylinder Heads
 - b - Cylinder Head Cover
 - c - Cylinder Head Cover Gasket

Figure 5. Cylinder Head Covers



- 09988
- a - Cylinder Head
 - b - Cylinder Head Gasket
 - c - Wiring Harness Support Plate

Figure 6. Cylinder Head



- 09989
- a - Exhaust Manifold Cover
 - b - Gaskets
 - c - Exhaust Divider Plate

Figure 7. Exhaust Manifold Cover and Divider Plate

6. Remove cylinder head attaching bolts, then remove cylinder heads and cylinder head gaskets from cylinder block. (Figure 6) Remove temperature sender from starboard side cylinder head.

NOTE: Mark location of wiring harness support plate (Figure 6) on exhaust manifold cover bolt (to aid in reassembly).

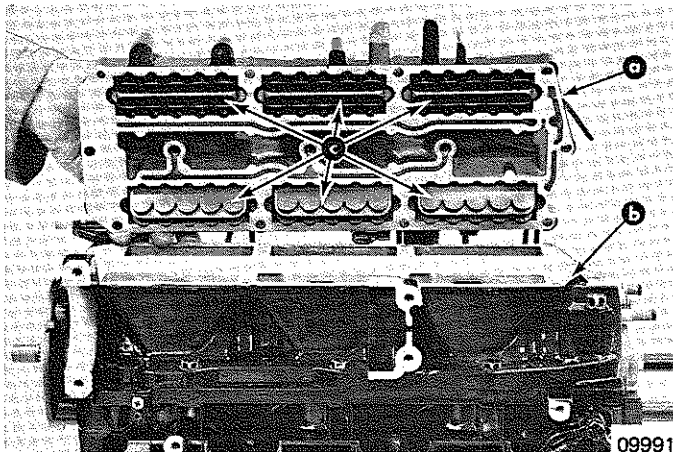
7. Remove bolts from exhaust manifold cover, then remove exhaust manifold cover, exhaust divider plate and divider plate seal from cylinder block. (Figure 7)

Reed Blocks - Removal and Disassembly

1. Disconnect bleed hoses from fittings on side of cylinders (one bleed hose is connected from reed block housing to each cylinder).

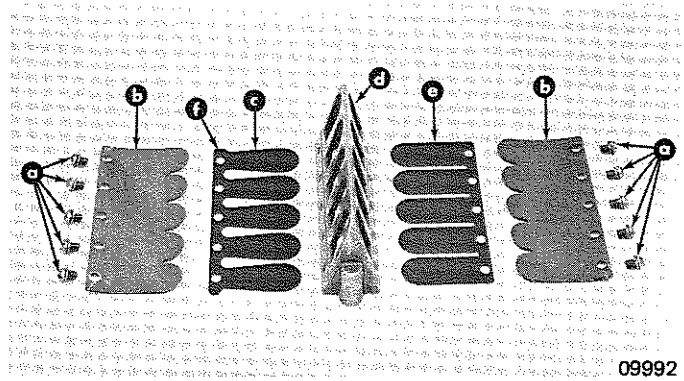
NOTE: It is not necessary to remove bleed hoses from fittings on reed block housing.

2. **Loosen** (but do not remove) bolts in reed block housing which are used to attach reed blocks to housing. These are the bolts directly above and below carburetor mounting flanges.
3. Remove bolts, which secure reed block housing to crankcase cover, then remove housing and reed blocks as an assembly. (Figure 8)



a - Reed Block Housing b - Crankcase Cover
c - Reed Block Assemblies

Figure 8. Reed Block Housing



a - Screws and Lockwashers b - Reed Stop
c - "Teardrop"-Shaped Reed (This Reed Is Used on Both Sides in Some Models, Only One Side in Others and Not at All in Some Models)
d - Reed Block
e - "Straight-Cut" Reed (This Reed Is Used on Both Sides in Some Models, Only One Side in Others and Not at All in Some Models)
f - Identification "Tang"

Figure 9. Reed Block Components

4. Remove bolts, which secure reed blocks to housing, and remove reed blocks.

IMPORTANT: Reed blocks can be inspected without disassembling. If inspection of reed blocks indicates that replacement of a part is necessary (refer to "Cleaning and Inspection", following), disassemble reed block(s) as outlined, following.

5. To disassemble reed blocks, remove screws and lockwashers which secure reed stops and reeds to reed blocks. Lift reed stops and reeds from reed blocks. (Figure 9)

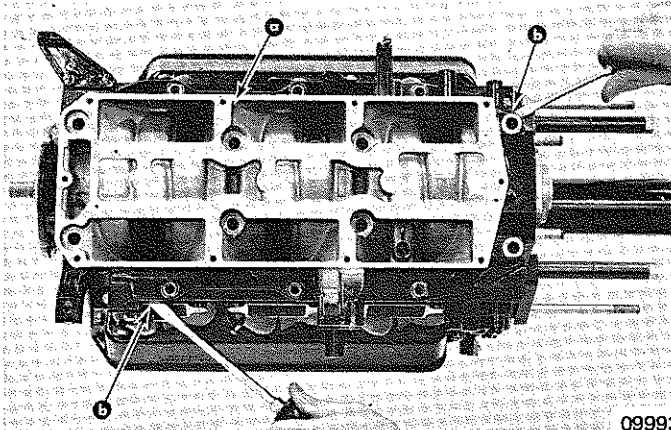
Pistons and Connecting Rods

REMOVAL

1. Remove bolts, which are used to attach upper and lower end caps to crankcase cover, then loosen (but do not remove) bolts which attach end caps to cylinder block.

NOTE: End cap bolts, which are threaded into cylinder block, should be loosened, but remain installed, to hold crankshaft in position until connecting rods are removed from crankshaft.

2. Remove bolts, which attach crankcase cover to cylinder block, and remove crankcase cover. Be careful not to damage sealing surfaces or crankshaft.



a - Crankcase Cover b - Recess

Figure 10. Removing Crankcase Cover

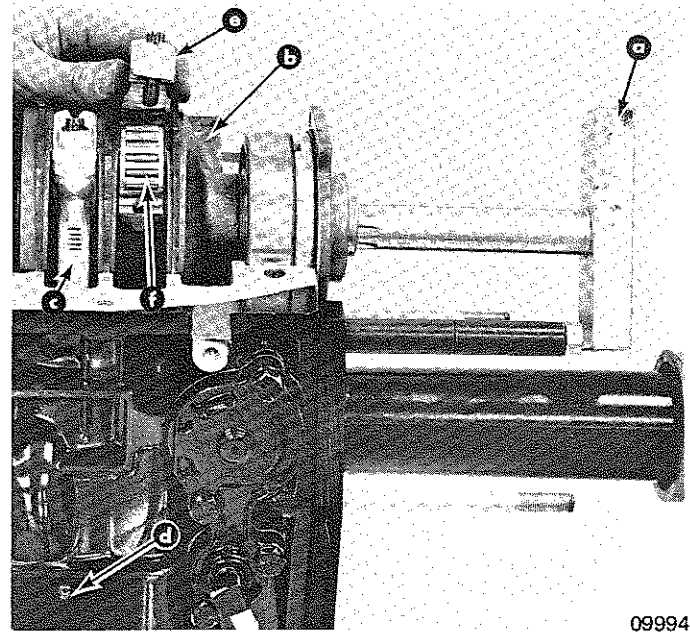
NOTE: A sealant is used between cylinder block and crankcase cover. It may be necessary to pry crankcase cover off cylinder block, using special recesses provided. (Figure 10)

IMPORTANT: The crankcase cover and cylinder block are a matched, line-bored assembly and never should be mismatched by using a different crankcase cover or cylinder block.

3. Install Powerhead Stand (C-91-30591A1) into drive shaft end of crankshaft. Use Powerhead Stand to turn crankshaft to desired positions when removing connecting rods from crankshaft. (Figure 11)
4. Use an awl (or felt tip marker) to scribe an identification number on outside edge of each connecting rod "I" beam. (Figure 11) Number each connecting rod with the same number as the cylinder to which it is installed; i.e., mark a one ["1"] on connecting rod which is installed in No. 1 cylinder, "2" on rod which is in No. 2 cylinder, etc.

CAUTION: As connecting rod cap is removed from each connecting rod, be careful that piston and connecting rod do not slip out of cylinder block and sustain damage by striking floor.

5. Remove connecting rod bolts with a 5/16"-12 point socket, then lift rod cap, connecting rod bearings and cages from connecting rod and crankshaft. (Figure 11) After each connecting rod cap is removed, remove its respective piston assembly from cylinder block before proceeding to



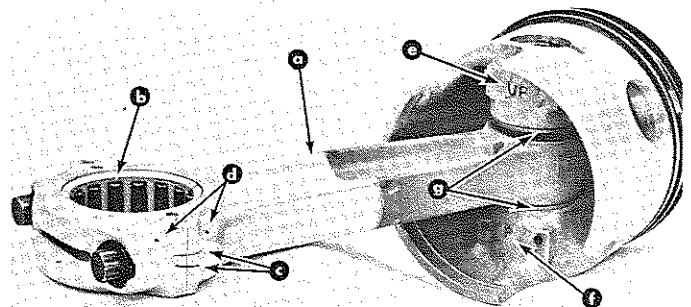
a - Powerhead Stand (C-91-30591A1) e - Connecting Rod Cap
b - Crankshaft f - Connecting Rod Bearings and Cages
c - Numbered Connecting Rod
d - Number Marked on Cylinder Block

Figure 11. Crankshaft and Connecting Rods

another connecting rod. Keep rod caps, connecting rods and bearings together, if they are to be re-used. Re-assemble rod cap to its respective connecting rod after removing piston assembly from cylinder block.

CAUTION: Immediately after disassembling rod cap from connecting rod and crankshaft, reassemble cap to its respective rod, being certain that "etched" alignment marks (Figure 12) are properly aligned.

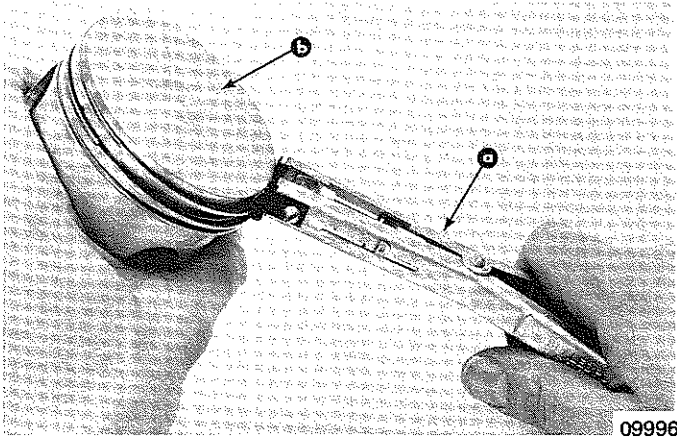
NOTE: Cleanliness is essential when handling roller bearings. Use care not to get dirt or lint on bearings. If bearings are to be re-used, store them in a numbered container. DO NOT intermix roller bearings from one connecting rod with those from another.



a - Connecting Rod e - Piston Pin Boss Marked "UP"
b - Roller Bearings and Cages f - Piston Pin Boss Marked "S" (Starboard) or "P" (Port)
c - "Etched" Alignment Marks g - Locating Washers
d - Alignment Bumps

Figure 12. Connecting Rod with Piston

SAFETY WARNING: Eye protection MUST BE WORN while removing piston pin lockrings. (Figure 14)



a - Piston Ring Expander (C-91-24697) b - Piston

Figure 13. Piston Ring Removal

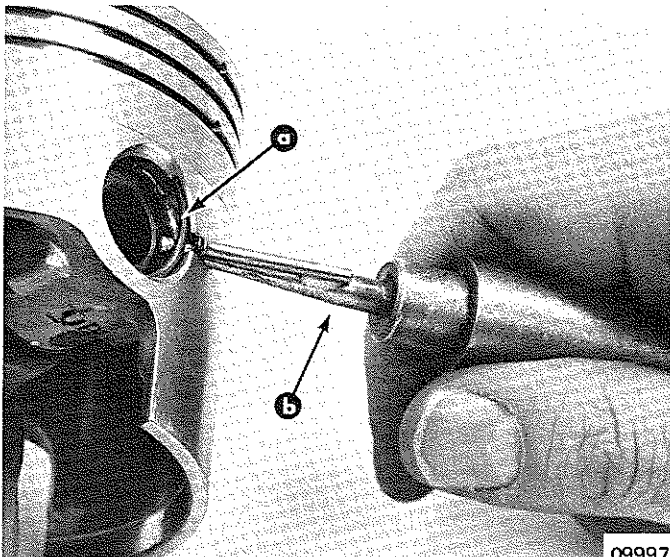
6. As each piston and connecting rod assembly is removed, remove piston rings from piston with Piston Ring Expander (C-91-24697). (Figure 13) Discard piston rings.
7. After removing all pistons and connecting rods from cylinder block, inspect each piston and connecting rod assembly as outlined in "Cleaning and Inspection", following.

DISASSEMBLY

3-Ring Pistons

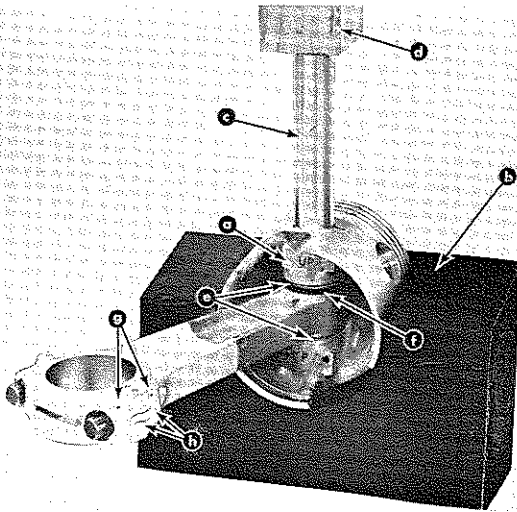
CAUTION: Figure 13 shows a 3-ring piston that was used in early model V-6 engines. Unless this piston is going to be replaced. **DO NOT** remove it from connecting rod. A 3-ring piston cannot be re-used once it has been removed from connecting rod.

1. If inspection determines that replacement of a 3-ring piston is necessary, or if condition of wrist pin end of connecting rod is questionable, or if connecting rod is suspected of being bent, remove piston from connecting rod as outlined, following:



a - Piston Pin Lockring
b - Lockring Removal Tool (C-91-52952A1)

Figure 14. Removing Piston Pin Lockring



a - Piston Pin Boss Marked "UP" f - Needle Bearings (Hidden)
b - Piston Support Block (C-91-77005)
c - Piston Pin Tool (C-91-74607A1) g - Alignment Bumps
d - Arbor Press h - "Etched" Alignment Marks
e - Locating Washers

Figure 15. Removing Piston from Connecting Rod

- c. Place piston and connecting rod in position on Piston Support Block (C-91-77005) with "UP" side of piston positioned up (away from piston support block). (Figure 15)
- d. Remove piston pin from piston with Piston Pin Tool (C-91-74607A1) and an arbor press. (Figure 15)
- e. If connecting rod will be re-used, retain piston pin needle bearings (29 needle bearings on each piston end of rod) and 2 locating washers.

NOTE: Cleanliness is essential when handling needle bearings. Use care not to get dirt or lint on needle bearings. If bearings are to be re-used, store them in a numbered container. **DO NOT** intermix needle bearings from one connecting rod with those from another.

- f. Discard piston and piston pin which were removed from connecting rod.

2-Ring Pistons

NOTE: Unlike 3-ring pistons, 2-ring pistons can be removed from connecting rod and then reinstalled.

1. Use an awl (or felt tip marker) to scribe a number on inside of piston skirt to match number (on connecting rod) that was scribed on rod when rod was removed from cylinder block.

SAFETY WARNING: Eye protection MUST BE WORN while removing piston pin lockrings.

2. Remove (and discard) piston pin lockrings from both ends of piston pin. (Figure 14) NEVER re-use piston pin lockrings.
3. Heat dome of piston to approximately 190°F (88°C) with Torch Lamp (C-91-63209).

4. Place piston and connecting rod in position on Piston Support Block (C-91-77005).
5. Remove piston pin from piston with Piston Pin Tool (C-91-74607A1) and an arbor press. (Figure 15)
6. Remove piston pin needle bearings (29 per piston) and locating washers (2 per piston) from connecting rod.

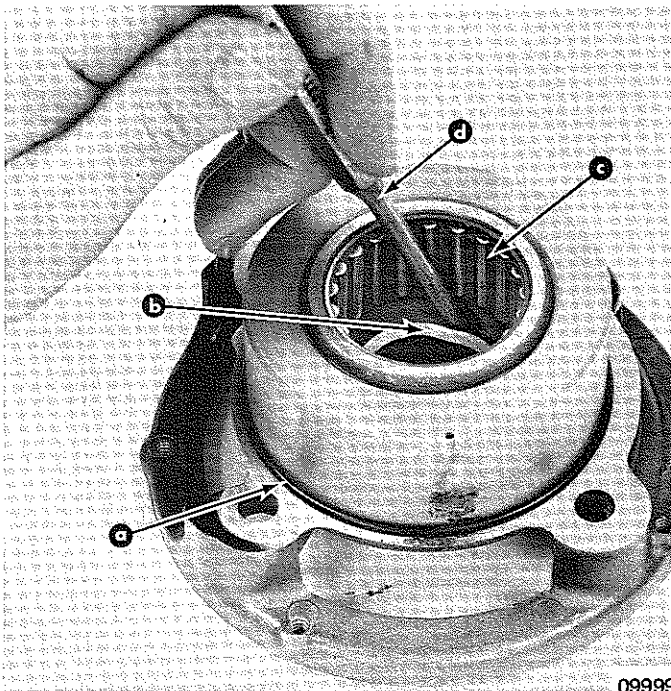
NOTE: Cleanliness is essential when handling needle bearings. Use care not to get dirt or lint on needle bearings. If bearings are to be re-used, store them in a numbered container. DO NOT intermix needle bearings from one connecting rod with those from another.

End Caps - Removal and Disassembly

1. Remove bolts which secure upper and lower end caps to cylinder block.

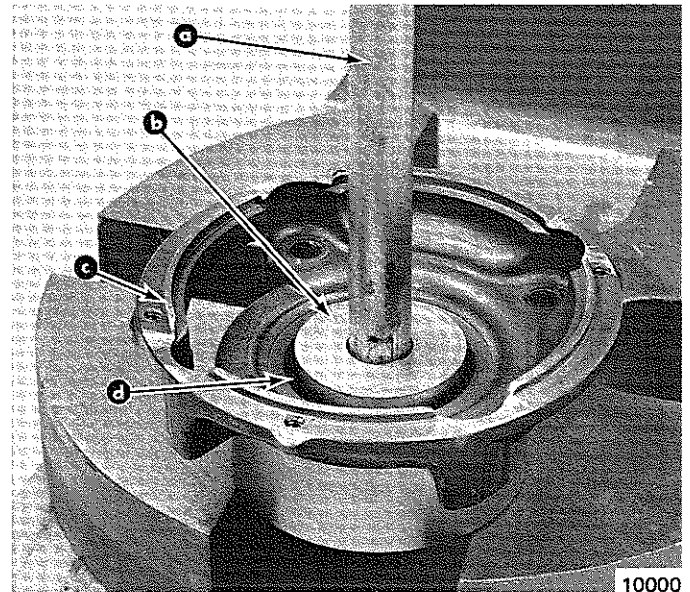
NOTE: These bolts were previously loosened to allow removal of crankcase cover.

2. Remove upper and lower end caps from around crankshaft.
3. Remove "O" ring from around each end cap (Figure 16) and discard.
4. Drive oil seal(s) from each end cap with a suitable punch, as shown in Figure 16. Discard oil seals.



- | | |
|--------------|-------------------------------|
| a - "O" Ring | c - Crankshaft Roller Bearing |
| b - Oil Seal | d - Punch |

Figure 16. Removing End Cap Oil Seal (Upper End Cap Shown)



- | | |
|------------------------------|--|
| a - Driver Rod (C-91-37323) | c - Upper End Cap |
| b - Driver Head (C-91-55919) | d - Crankshaft Roller Bearing (Hidden) |

Figure 17. Removing Crankshaft Roller Bearing from Upper End Cap

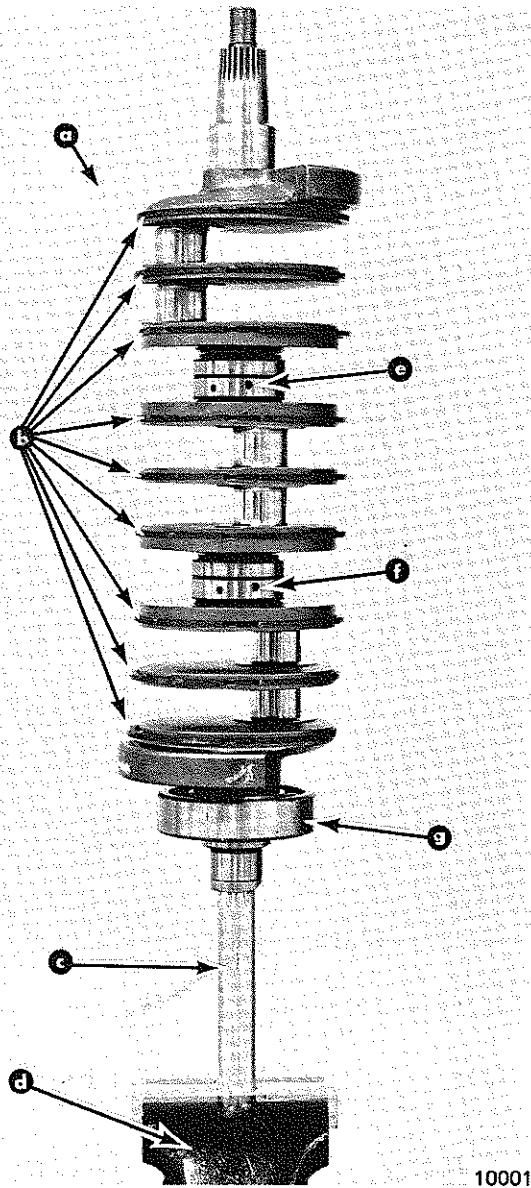
5. Inspect crankshaft roller bearing, which is installed in upper end cap, as outlined in "Cleaning and Inspection", following.

IMPORTANT: DO NOT remove crankshaft roller bearing from upper end cap, unless replacement of bearing is required.

6. If inspection determines that replacement of crankshaft roller bearing in upper end cap is required, press bearing from end cap with Driver Head (C-91-55919) and Driver Rod (C-91-37323), as shown in Figure 17.

Crankshaft - Removal and Disassembly

1. Lift crankshaft assembly from cylinder and place assembly on Powerhead Stand (C-91-30591A1) mounted in a vise. (Figure 18)

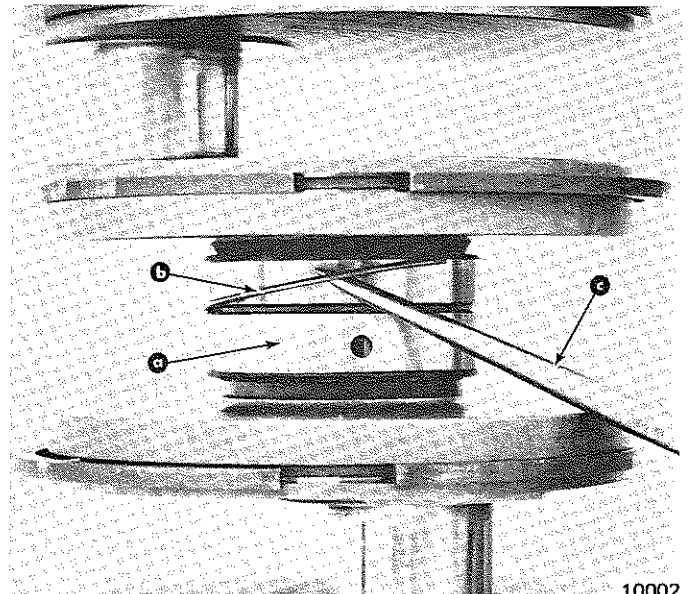


- | | |
|--|--|
| a - Crankshaft Assembly | f - Lower Crankshaft Main Bearing (Arrow Pointing to Dowel Pin Hole) |
| b - Crankshaft Sealing Rings | g - Crankshaft Ball Bearing |
| c - Powerhead Stand (C-91-30591A1) | |
| d - Vise | |
| e - Upper Crankshaft Main Bearing (Arrow Pointing to Dowel Pin Hole) | |

Figure 18. Crankshaft Assembly

IMPORTANT: DO NOT remove crankshaft sealing rings (Figure 18) from crankshaft, unless replacement of a sealing ring(s) is necessary. Usually, crankshaft sealing rings do not require replacement, unless broken.

2. Remove retaining ring from upper crankshaft main bearing race (Figure 19), then remove bearing race halves and roller bearings from crankshaft. (Figure 20)
3. Reassemble crankshaft bearing race halves with retaining



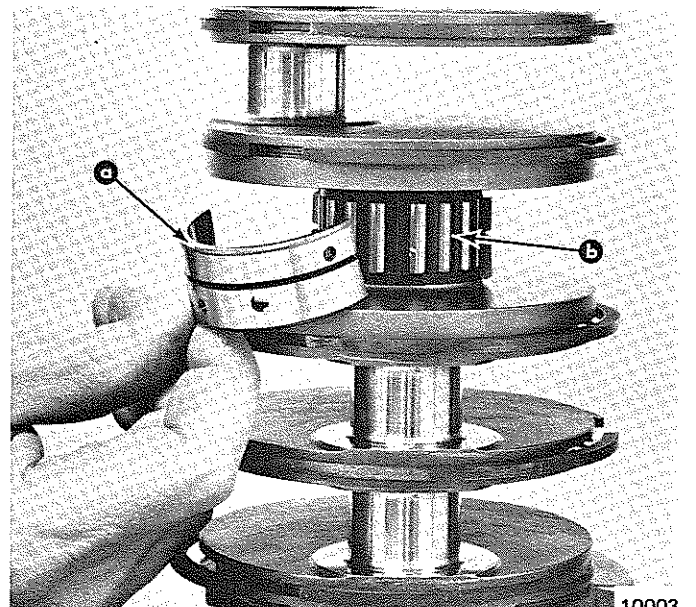
- | | |
|-----------------------------------|--------------------|
| a - Upper Crankshaft Main Bearing | b - Retaining Ring |
| | c - Awl |

Figure 19. Crankshaft Main Bearing Retaining Ring Removal

ring (bearing race halves are a matched assembly). Keep main bearing roller bearings with corresponding bearing race.

NOTE: Cleanliness is essential when handling roller bearings. Use care not to get dirt or lint on bearings. If bearings are to be re-used, store them in a marked container. DO NOT intermix roller bearings from upper crankshaft main bearing with those from lower main bearing.

4. Remove lower crankshaft main bearing assembly (Figure 18) in same manner as outlined in Steps 2 and 3, preceding.
5. Inspect crankshaft ball bearing, which is installed on lower

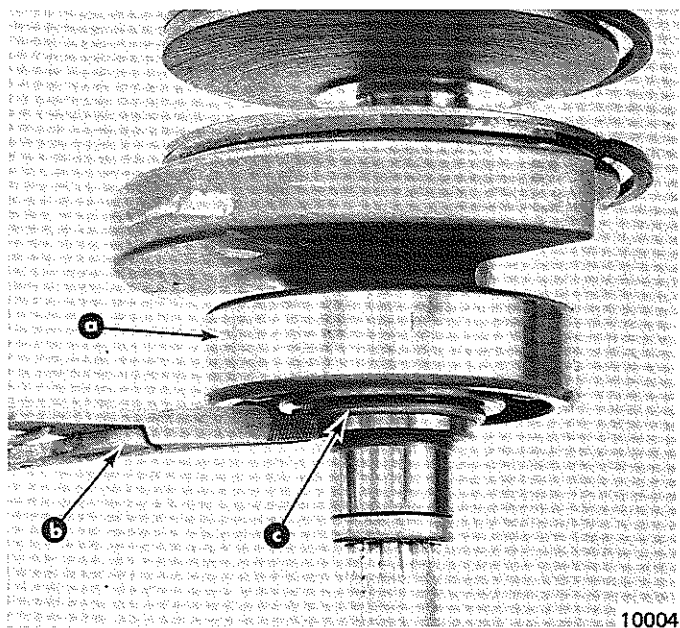


- | | |
|-----------------------|---------------------|
| a - Bearing Race Half | b - Roller Bearings |
|-----------------------|---------------------|

Figure 20. Crankshaft Main Bearing Removal

end of crankshaft (Figure 18), as outlined in "Cleaning and Inspection", following.

IMPORTANT: DO NOT remove lower crankshaft ball bearing, unless replacement of bearing is required.

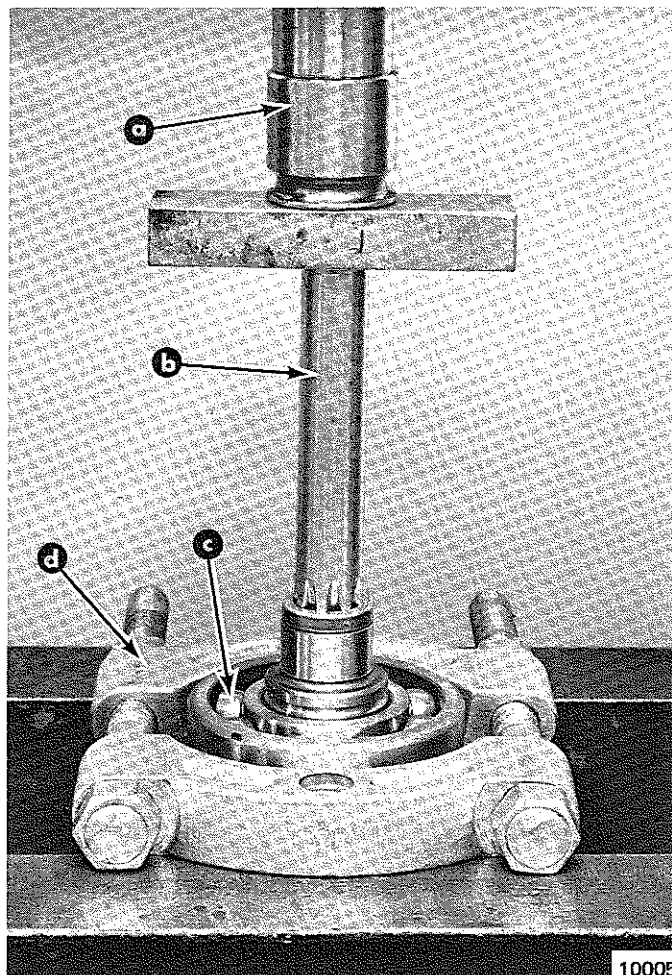


- a - Crankshaft Ball Bearing
- b - Snap Ring Pliers
- c - Retaining Ring

Figure 21. Removing Crankshaft Ball Bearing Retaining Ring

6. If inspection determines that replacement of lower crankshaft ball bearing is required, remove bearing as outlined, following:

- a. Remove retaining ring, which secures lower crankshaft ball bearing, using a suitable pair of snap ring pliers (expanding type). (Figure 21)
- b. Install Universal Puller Plate (C-91-37241) between crankshaft ball bearing and crankshaft counterweight. (Figure 22)
- c. Place crankshaft assembly in press and support under Universal Puller Plate.
- d. Install Powerhead Stand (C-91-30591A1) into end of crankshaft.



- a - Press
- b - Powerhead Stand (C-91-30591A1)
- c - Crankshaft Ball Bearing
- d - Universal Puller Plate (C-91-37241)

Figure 22. Removing Crankshaft Ball Bearing

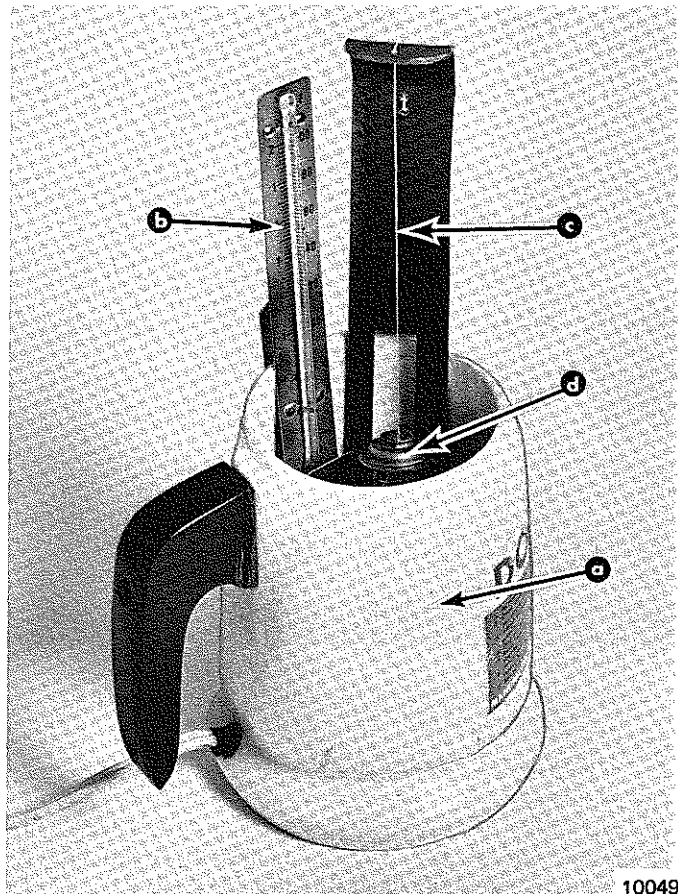
CAUTION: BE CAREFUL that, when crankshaft is pressed out of ball bearing, crankshaft is properly supported and is not allowed to drop on floor.

- e. Press crankshaft out of bearing as shown in Figure 22.

CLEANING and INSPECTION

Thermostats and Temperature Sender

1. Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
2. Remove and discard gasket from each thermostat.
3. Wash thermostats with clean water.



10049

- a - Thermostat Tester c - Thread
b - Thermometer d - Thermostat

Figure 1. Testing Thermostat

4. Using a thermostat tester, similar to the one shown in Figure 1, test each thermostat as follows:
 - a. Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.
 - b. Suspend thermostat (from thread) and thermometer inside tester (Figure 1) so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.
 - c. Fill thermostat tester with water to cover thermostat.
 - d. Plug tester into electrical outlet.
 - e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step "a", when it starts to open.) Thermostat must begin to open when temperature reaches 140°-145°F (60°-63°C).
 - f. Continue to heat water until thermostat is completely open.
 - g. Unplug thermostat tester.

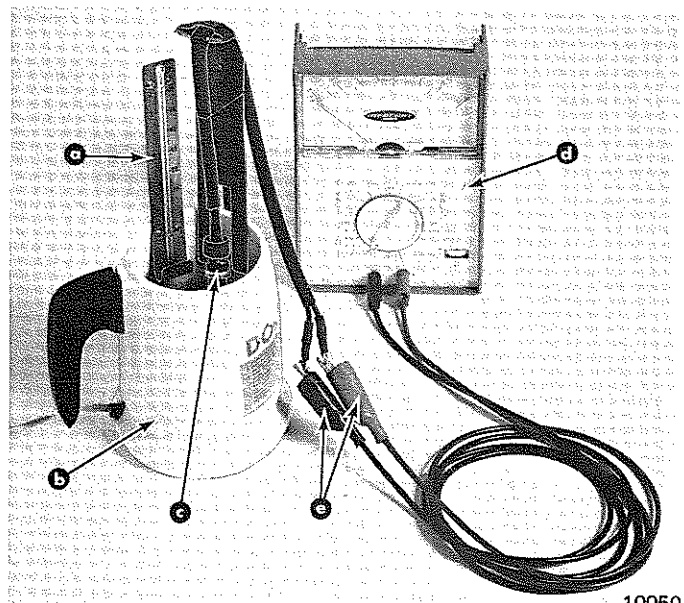
- h. Replace thermostat, if it fails to open at the specified temperature, or if it does not fully open.

NOTE: BE SURE that water in thermostat tester is allowed to cool sufficiently [below 130°F (56°C)] before testing the other thermostat.

5. Clean metal surface of temperature sender (area which contacts cylinder head).
6. Clean terminal rings at ends of temperature sender wires to assure good electrical contacts.

NOTE: Electrical switch in temperature sender is designed to "close" if temperature of powerhead reaches a predetermined point. If switch in temperature sender closes, a circuit, that activates an alarm horn, then is completed.

7. Using a thermostat tester similar to the one shown in Figure 2, test temperature sender as follows:
 - a. Turn VOA Meter (C-91-62562) to Rx1K range (same as Rx1000). Short the meter leads together and adjust pointer to 0 (zero) ohms position by adjusting the meter "zeroing" (Ω) thumb wheel. Separate the test leads.
 - b. Connect a test lead to each temperature sender wire. VOA meter must have a scale reading of " ∞ " (no continuity) that would indicate electrical switch in sender is "open". If meter has a scale reading other than " ∞ ", sender should be replaced.
 - c. With meter still connected to temperature sender, suspend sender and a thermometer inside thermostat tester (Figure 2) so that neither touches the container. Bottom of thermometer must be even with bottom of temperature sender to obtain correct temperature of sender operation.



10050

- a - Thermometer d - VOA Meter
b - Thermostat Tester (C-91-62562)
c - Temperature Sender e - VOA Meter Leads

Figure 2. Testing Temperature Sender

- d. Fill thermostat tester with water to cover temperature sender.
- e. Plug thermostat tester into electrical outlet.
- f. Observe temperature at which switch in temperature sender "closes". [VOA Meter must have a scale reading of 0 (zero) ohms.] Switch must "close" when temperature reaches 180°-200°F (82°-93°C).

- g. Unplug thermostat tester.
- h. As water in thermostat tester cools, observe temperature at which switch in temperature sender "opens". [VOA Meter must have a scale reading of "∞" (no continuity).] Switch must "open" when temperature drops to 160°-180°F (77°-82°C).
- i. Replace temperature sender if switch fails to "open" or "close" at the specified temperatures.

Cylinder Heads and Exhaust Covers

1. Thoroughly clean cylinder heads and gasket surfaces. Remove carbon deposits and "varnish" from cylinder heads (with a fine wire brush on a shaft attached to an electric drill or use carbon remover solution).
2. Inspect cylinder heads. Check for deep grooves, cracks and distortion which could cause compression leakage.
3. Check spark plug holes for stripped or damaged threads.
4. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

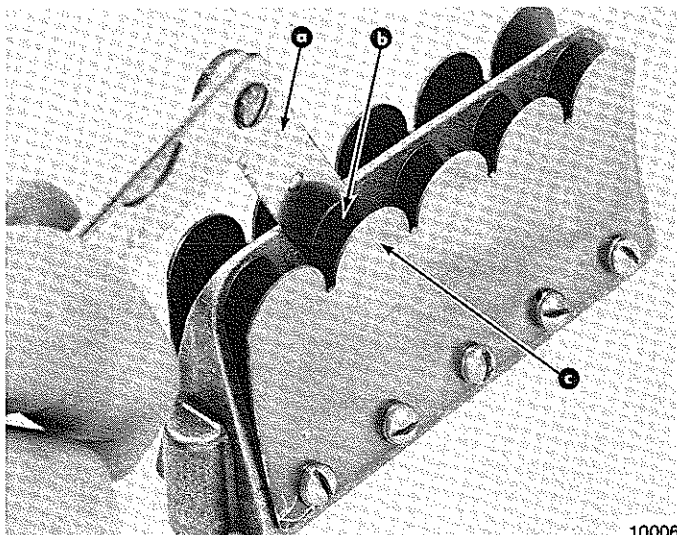
NOTE: Piston striking cylinder head could be an indication that connecting rod bearings (either end) are failing.

5. Replace cylinder head(s) as necessary.
6. Thoroughly clean gasket surfaces of cylinder head covers. Check covers for deep grooves, cracks and distortion that could cause water leakage. Replace cover(s) as necessary.
7. Thoroughly clean gasket surfaces of exhaust divider plate and exhaust manifold cover.
8. Inspect exhaust divider plate and exhaust manifold cover for deep grooves, cracks or distortion that could cause leakage. Replace parts as necessary.

Reed Blocks and Reed Block Housing

IMPORTANT: DO NOT remove reeds from reed blocks, unless replacement is necessary. DO NOT turn used reeds over for re-use. Replace reeds in sets only.

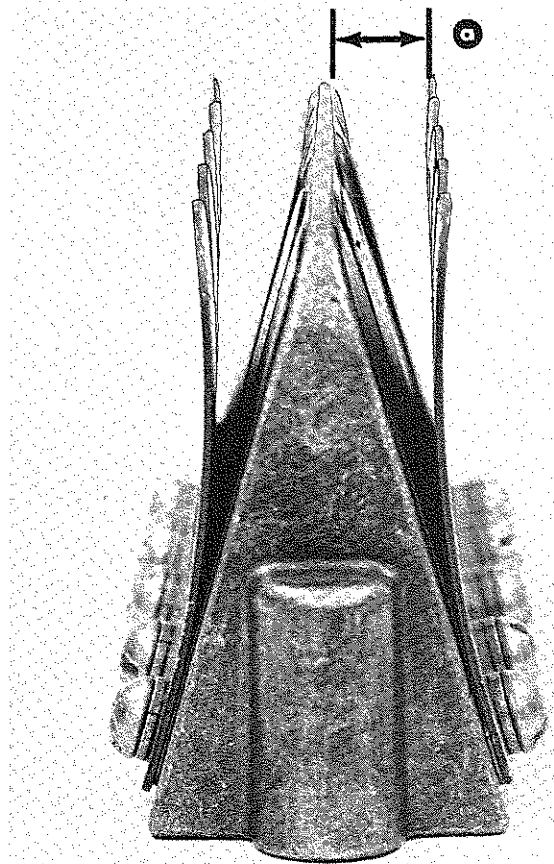
1. Thoroughly clean gasket surfaces of reed blocks and reed block housing. Check for deep grooves, cracks and distortion that could cause leakage. Replace parts as necessary.
2. Check for wear (indentations) on face of each reed block. Replace block(s), if reeds have made indentations.
3. Check for chipped and broken reeds.
4. Check reeds to be sure that they are not preloaded (adhere tightly to reed block) and that they are not standing open an excessive amount [greater than .020" (0.51mm)]. (Figure 3)



a - Feeler Gauge b - Reed c - Reed Stop

Figure 3. Checking Reed Opening

5. Replace reeds as necessary. Install new reeds as outlined in "Powerhead Reassembly", following.



a - Reed Stop Opening [.300" (7.62mm) for 175 HP and 200 HP; .200" (5.08mm) for 150 HP Models]

Figure 4. Checking Reed Stop Opening

6. If installing new reeds [and having torqued reed stop retaining screws to 25 in. lbs. (29kg-cm)], check new reeds as outlined in Step 4, preceding.
7. Measuring from top of closed reed to bottom of reed stop (Figure 4), check reed stop opening of each reed stop. (Dimension of reed stop opening should be .200" on 150 HP engines and .300" on 175 HP and 200 HP engines.) If reed stop opening is not correct, carefully bend reed stop to achieve specified opening.

CAUTION: If an adjustment of reed stop is required, be careful that reed is not damaged.

8. Check rubber bleed hoses (still connected to check valves) on reed block housing. Replace any hose that is cracked, cut or deteriorating.
9. Check operation of bleed system check valves in reed block housing. If valves are working properly, air can be drawn thru check valves "one way" only. If air can pass thru a check valve both ways, valve is not working properly and must be replaced.
10. Check that bleed system check valves are threaded tight into reed housing. Tighten check valves as necessary.
11. Inspect passages in reed block housing to be sure that they are not obstructed.

Pistons and Piston Rings

CAUTION: DO NOT attempt to re-use a 3-ring piston that has been removed from its connecting rod. Removal of a 3-ring piston from its connecting rod will damage that piston.

IMPORTANT: If engine was submerged while engine was running, piston pin and/or connecting rod may be bent. If piston pin is bent, piston must be replaced. (Piston pins are not sold separately because of matched fit into piston.) If piston pin is bent, connecting rod must be checked for straightness (refer to "Connecting Rods", following, for checking straightness).

1. Check pistons for scoring, cracks, metal damage and cracked or worn piston pin bosses. Replace piston(s), if any of these conditions is found.
2. Thoroughly clean pistons. Remove carbon deposits and "varnish" from pistons with a soft wire brush or carbon remover solution. **DO NOT** burr or round machined edges. Clean (polish) piston skirt with crocus cloth.
3. After thoroughly cleaning pistons, use a micrometer to check each piston for size and round. Pistons must be measured as described, following:

NOTE: Two different shaped pistons (tapered and barrel profile) are used in V-6 engines. They can be identified only by measuring.

Tapered Piston Diameters		
Models	(a) Skirt	(b) Above Rings
150 HP and 175 HP (V-6)	3.120" (79.248mm)	3.108" (78.943mm)

Models	Barrel Profile Piston Diameters
150 HP and 175 HP (V-6)	(c) 3.115" (79.121mm)
200 HP (V-6)	(d) 3.372" (85.649mm)

Models	Barrel Profile Piston Diameters for .015" (0.381mm) and .030" (0.762mm) Oversize Pistons
150 HP and 175 HP (V-6)	(c) 3.130" (79.502mm) (.015" oversize) 3.145" (79.883mm) (.030" oversize)

- (a) Measure outside of piston skirt at bottom of skirt in line with piston pin and at right angle (90°) to piston pin.
- (b) Measure outside of piston above top piston ring in line with piston pin and at right angle (90°) to piston pin.

- (c) Measure outside of piston 29/32" (23mm) up from bottom of piston in line with piston pin and at right angle (90°) to piston pin.
- (d) Measure outside of piston 1/2" (12.7mm) up from bottom of piston in line with piston pin and at right angle (90°) to piston pin.

SPECIAL INFORMATION PISTON RING IDENTIFICATION

CAUTION: This information must be read before cleaning piston ring grooves.

Model 150 HP and 175 HP V-6 engines contain 2 different types of 2-ring pistons. Some pistons contain one keystone (tapered) ring, that is always used in the top ring groove, and one rectangular ring which is used in the bottom ring groove. Other 2-ring pistons contain 2 keystone rings. It will be necessary to measure ring thickness in order to identify each ring. (Figure a) This information must be kept in mind when using a broken ring to clean ring grooves. Never use a rectangular ring to clean a ring groove, that is made to accommodate a keystone ring, or vice versa.

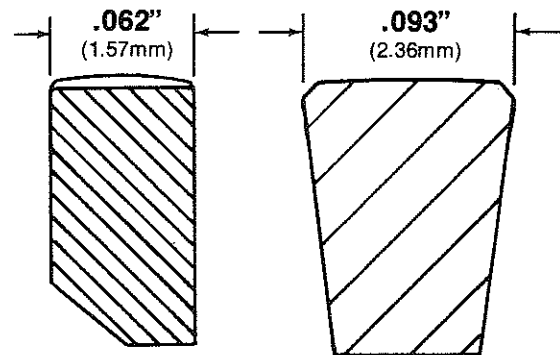


Figure a. Rectangular Ring (Left) and Keystone (Tapered) Ring (Right)

CAUTION: DO NOT use an automotive-type ring groove cleaner to clean piston ring grooves. This type tool could loosen piston ring locating pins.

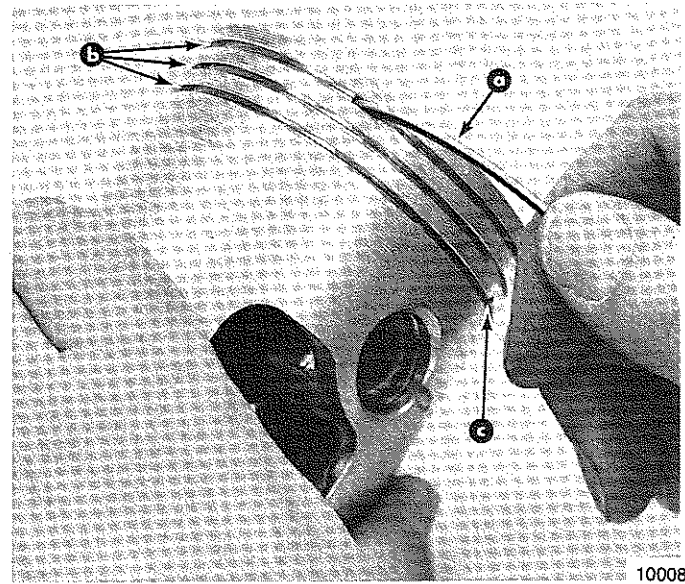
4. Clean ring grooves with recessed end of a broken ring (see

“Piston Ring Identification”, preceding). (Figure 5) DO NOT burr or round machined edges.

5. Inspect piston ring grooves for wear, burn and distortion. Inspect piston ring locating pins (one located in each piston ring groove) for tightness. (Figure 5) Replace pistons as necessary.

- a - Broken Piston Ring
- b - Piston Ring Groove
- c - Piston Ring Locating Pin

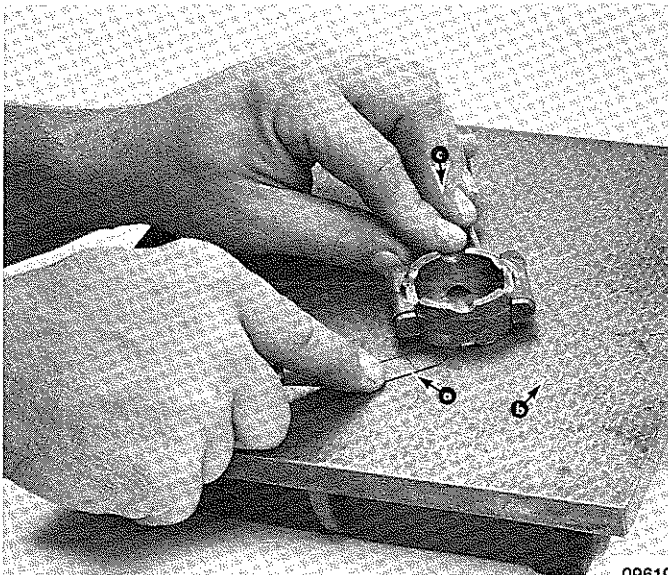
Figure 5. Cleaning Piston Ring Grooves



10008

Connecting Rods

1. If a connecting rod is equipped with a 3-ring piston, and condition of connecting rod is questionable, remove piston from rod (refer to “Powerhead Disassembly - Pistons and Connecting Rods”, preceding) and thoroughly inspect rod.



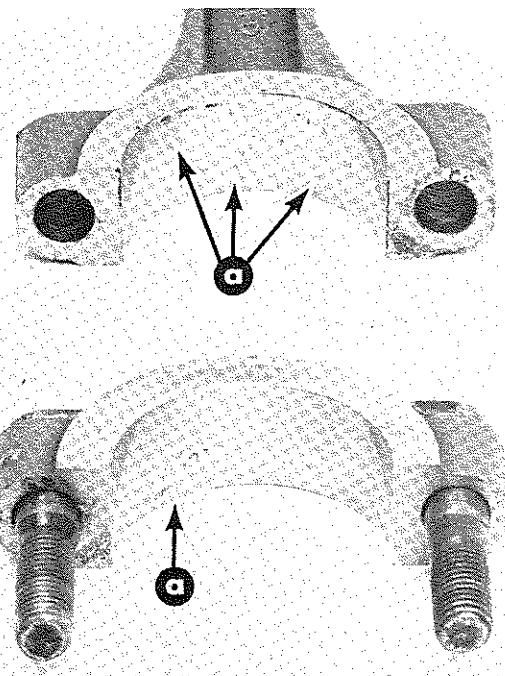
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- a - Feeler Gauge b - Surface Plate c - Even Downward Pressure

Figure 6. Checking Connecting Rod Alignment

2. Check connecting rods for alignment by placing rods on a surface plate. (Figure 6) If light can be seen under any portion of machined surfaces, if rod has a slight wobble on plate or if a .002” (0.051mm) feeler gauge can be inserted between any machined surface and surface plate, rod is bent and must be discarded.
3. Carefully inspect connecting rod bearings for rust or signs of bearing failure. Replace bearings as necessary.

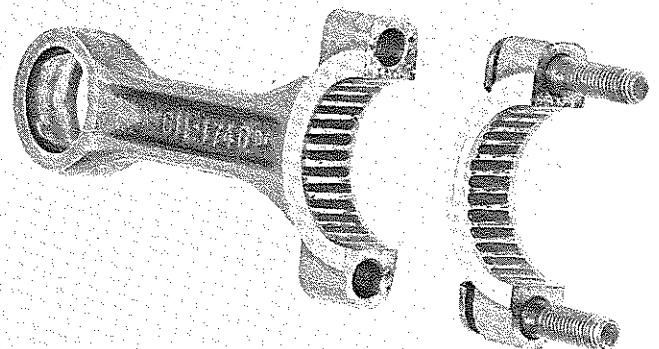
CAUTION: DO NOT intermix new and used bearings. If replacement of some bearings is required, replace all bearings at that location.



09627

- a - Pitting

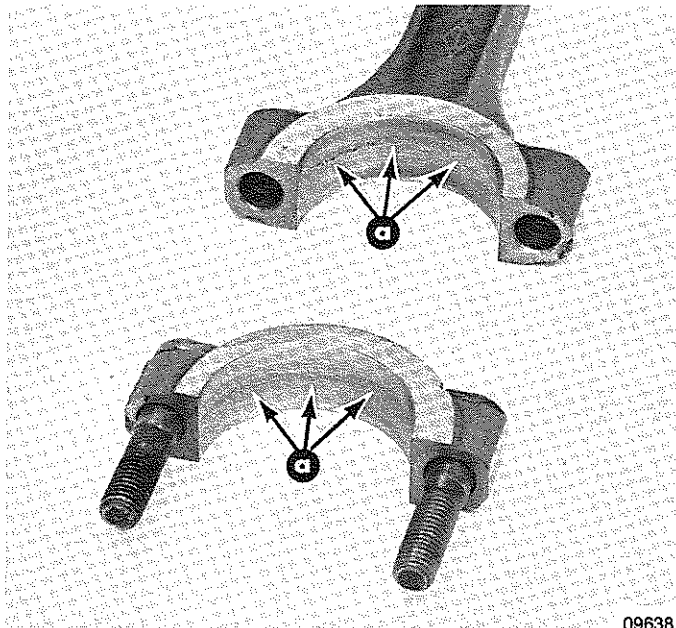
Figure 7. Connecting Rod with Rust Pitting



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Figure 8. Connecting Rod with Water Marks

4. Inspect crankshaft end and piston pin end bearing surfaces of connecting rod for the following:
 - a. Rust: Rust formation on bearing surfaces causes uneven pitting of surface(s). (Figure 7)
 - b. Water marks: When bearing surfaces are subjected to water contamination, a bearing surface "etching" occurs. This etching resembles the size of the bearing. (Figure 8)

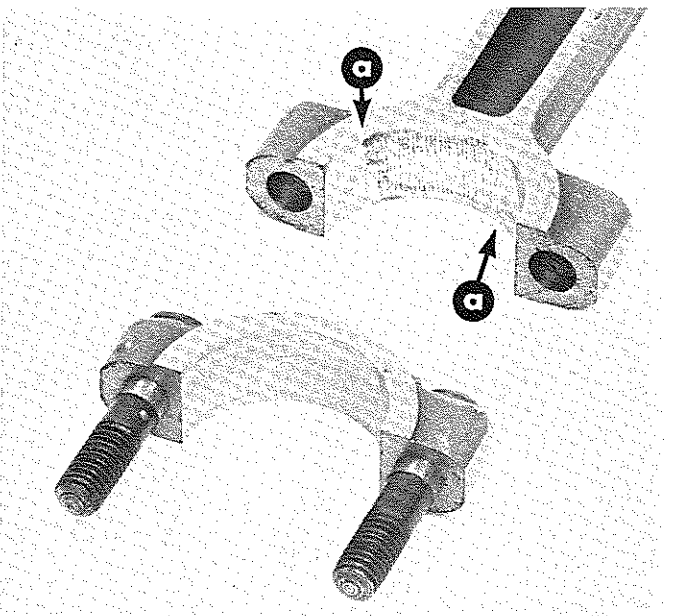


a - Spalling

09638

Figure 9. Connecting Rod with Spalling

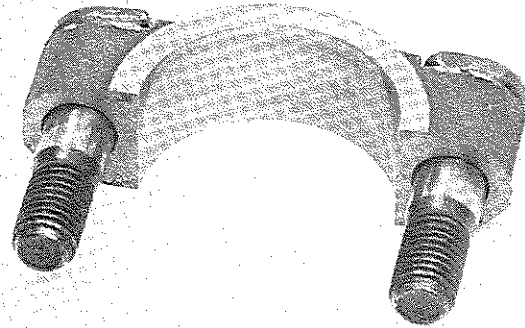
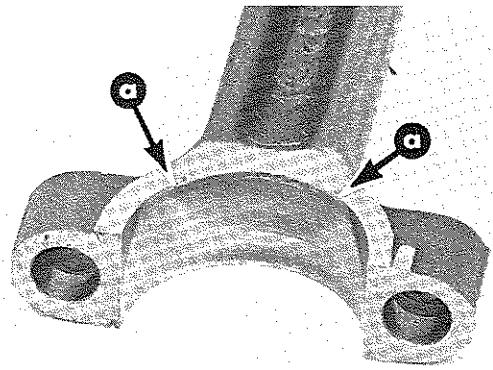
- c. Spalling: Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the "I" beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication. (Figure 9)
- d. Chatter marks: Chatter marks are the result of a combination of low speed-low load-cold water temperature



a - Chatter Marks between Arrows

09625

Figure 10. Connecting Rod with Chatter Marks



a - Uneven Wear between Arrows

09637

Figure 11. Connecting Rod with Uneven Wear

operation, aggravated by inadequate lubrication and/or improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting rod with tremendous force, and this force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a split second, until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. The repetition of this action causes a rough bearing surface(s) which resembles a tiny washboard. (Figure 10) In some instances, the connecting rod crankpin bore becomes highly polished. During operation, the engine will emit a "whirr" and/or "chirp" sound when it is accelerated rapidly from idle speed to approximately 1500 RPM, then quickly returned to idle. If the preceding conditions are found, replace both the crankshaft and connecting rod(s).

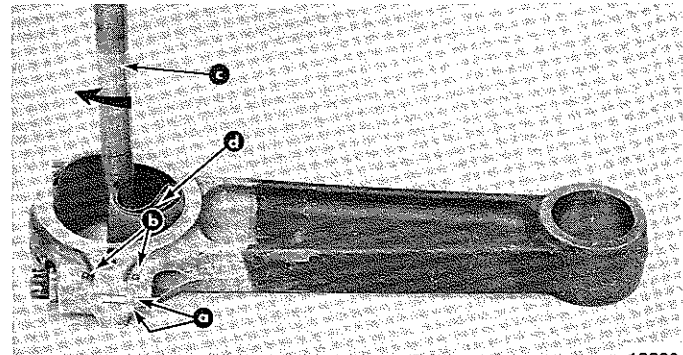
- e. Uneven wear: Uneven wear could be caused by a bent connecting rod or improper shimming of crankshaft end play [failure to maintain approximately the same amount of shim(s) under each end cap, thereby causing the crankshaft journal not to be centered over the cylinder bore]. (Figure 11)
 - f. Overheating: Overheating is visible as a bluish bearing surface color that is caused by inadequate lubrication or excessive RPM.
5. If necessary, clean connecting rod bearing surfaces as follows:
 - a. Be sure that "etched" marks on knob side of connecting rod (crankshaft end) are perfectly aligned with "etched" marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely. (Figure 12)

CAUTION: Crocus cloth MUST BE USED to clean bearing surface at crankshaft end of connecting rod. DO NOT use any other type of abrasive cloth.

- b. Clean **CRANKSHAFT END** of connecting rod by using **CROCUS CLOTH** placed in a slotted $\frac{3}{8}$ " (9.5mm) diameter shaft, as shown in Figure 12. Chuck shaft in a drill press and operate press at high speed while keeping connecting rod at a 90° angle to slotted shaft.

IMPORTANT: Clean connecting rod just enough to clean up bearing surfaces. DO NOT continue to clean after marks are removed from bearing surfaces.

- c. Clean **PISTON PIN END** of connecting rod, using same method as in Step "b", preceding, but using 320 grit carborundum cloth instead of crocus cloth.
 d. Thoroughly wash connecting rods to remove abrasive grit. Recheck bearing surfaces of connecting rods.



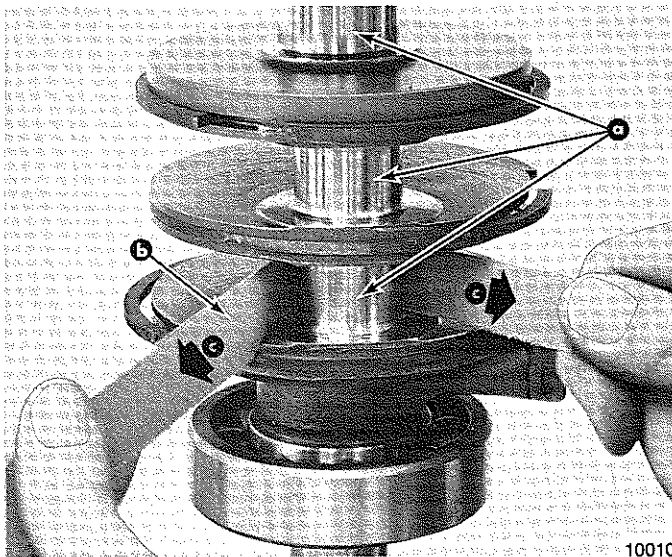
10009
 a - "Etched" Alignment Marks b - Alignment Bumps (Knobs)
 c - Slotted $\frac{3}{8}$ " (9.5mm) Diameter Shaft d - Crocus Cloth

Figure 12. Cleaning Connecting Rod Bearing Surface (Crankshaft End Shown)

Replace any connecting rods that cannot be properly "cleaned up". Lubricate bearing surfaces of connecting rods (which will be re-used) with light oil to prevent rust.

Crankshaft

1. Inspect crankshaft to drive shaft splines for wear. (Replace crankshaft, if necessary.)
2. Check crankshaft for straightness. (Replace as necessary.)
3. Inspect crankshaft oil seal surfaces. Sealing surfaces must not be grooved, pitted or scratched. (Replace as necessary.)
4. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear and/or overheating. (Refer to "Connecting Rods", Step 4, preceding.)



10010
 a - Crankshaft Journals
 b - Crocus Cloth
 c - Work Cloth "Back-and-Forth"

Figure 13. Cleaning Crankshaft Surfaces

5. If necessary, clean crankshaft surfaces with crocus cloth, as shown in Figure 13.

SAFETY WARNING: DO NOT spin-dry crankshaft ball bearing with compressed air.

6. Thoroughly clean (with solvent) and dry crankshaft and crankshaft ball bearing. Recheck surfaces of crankshaft. Replace crankshaft, if surfaces cannot be properly "cleaned up". If crankshaft will be re-used, lubricate surfaces of crankshaft with light oil to prevent rust. **DO NOT** lubricate crankshaft ball bearing at this time.

CRANKSHAFT (and END CAP) BEARINGS

1. After cleaning crankshaft, grasp outer race of crankshaft ball bearing (installed on lower end of crankshaft) and attempt to work race back-and-forth. There should not be excessive play.
2. Lubricate ball bearing with light oil. Rotate outer bearing race. Bearing should have smooth action and no rust stains. If ball bearing sounds or feels "rough" or has "catches", remove and discard bearing. (Refer to "Powerhead Removal and Disassembly - Crankshaft Removal and Disassembly", preceding.)
3. Thoroughly clean (with solvent) and dry crankshaft centermain roller bearings. Lubricate bearings with light oil.

CAUTION: DO NOT intermix halves of upper and lower crankshaft centermain roller bearings. Replace bearings in pairs only.

4. Thoroughly inspect centermain roller bearings. Replace bearings if they are rusted, fractured, worn, galled or badly discolored.
5. Clean (with solvent) and dry crankshaft roller bearings which is installed in upper end cap. Lubricate bearing with light oil.
6. Thoroughly inspect upper end cap roller bearing. If roller bearing is rusted, fractured, worn, galled or badly discolored, remove bearing from upper end cap and discard. (Refer to "Powerhead Removal and Disassembly - End Caps Removal and Disassembly", preceding.)

Cylinder Block and Crankcase Cover

IMPORTANT: Crankcase cover and cylinder block are a matched, line-bored assembly and never should be mismatched by using a different crankcase cover or cylinder block.

CAUTION: If crankcase cover or cylinder block is to be submerged in a very strong cleaning solution, it will be necessary to remove the crankcase cover/cylinder block bleed system from crankcase cover/cylinder block to prevent damage to hoses and check valves.

1. Thoroughly clean cylinder block and crankcase cover. Be sure that all sealant and old gaskets are removed from matching surfaces. Be sure that carbon deposits are removed from exhaust ports.
2. Inspect cylinder block and crankcase cover for cracks or fractures.
3. Check gasket surfaces for nicks, deep grooves, cracks and distortion that could cause compression leakages.
4. Check all water and oil passages in cylinder block and crankcase cover to be sure that they are not obstructed and that plugs are in place and tight.

CYLINDER BORES (Cleaning and Inspection)

NOTE: The cylinder bores of a 200 HP V-6 engine are chrome, thus inspection and cleaning of these bores MUST BE treated differently than 175 HP and 150 HP V-6 engines.

150 HP and 175 HP V-6 Engines

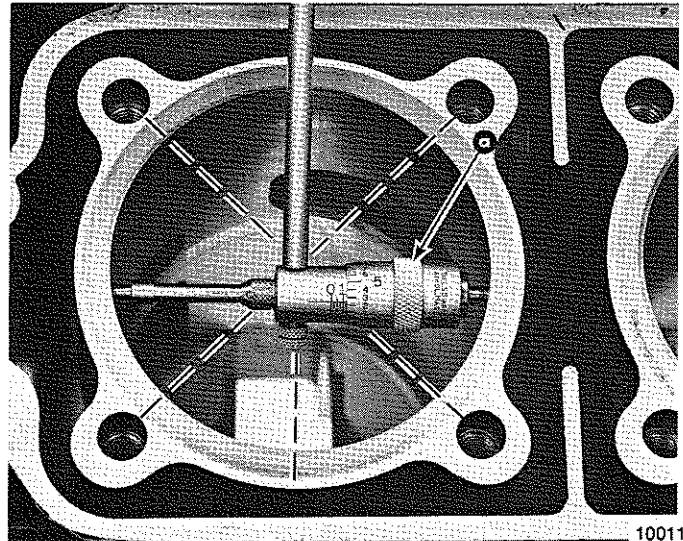
1. Inspect cylinder bores for scoring (a transfer of aluminum from piston to cylinder wall). Cylinder wall scoring usually can be "cleaned up" by honing or reboring.

Honing Procedure

- a. When cylinders are to be honed, follow the hone manufacturer's recommendations for use of the hone and cleaning and lubrication during honing.
- b. For best results, a continuous flow of honing oil should be pumped into the work area. If pumping oil is not practical, use an oil can. Apply oil generously and frequently on both stones and work.

CAUTION: When honing cylinder block, remove hone frequently and check condition of cylinder walls. DO NOT hone any more than absolutely necessary, as hone can remove cylinder wall material rapidly.

- c. Start stroking at smallest diameter. Maintain firm stone pressure against cylinder wall to assure fast stock removal and accurate results.
- d. Localize stroking in the smallest diameter until drill speed is constant throughout length of bore. Expand stones, as necessary, to compensate for stock removal and stone wear. Stroke at a rate of 30 complete cycles per minute to produce best cross-hatch pattern. Use honing oil generously.
- e. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. A good cleaning is essential. If any of the abrasive material is allowed to



a - Inside Micrometer

Figure 14. Measuring Cylinder Bores

remain in the cylinder bore, it will cause rapid wear of new piston rings and cylinder bore in addition to bearings. After cleaning, bores should be swabbed several times with engine oil and a clean cloth, then wiped with a clean, dry cloth. Cylinders should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

2. Hone all cylinder walls just enough to de-glaze walls.
3. Measure cylinder bore diameter (with an inside micrometer) of each cylinder, as shown in Figure 14. Check for tapered, out-of-round ("egg-shaped") and oversize bore.

Models	Cylinder Block Finish Hone
150 HP V-6 and 175 HP V-6 with a Standard Piston	3.125" (79.375mm)
150 HP V-6 and 175 HP V-6 with a .015" (0.381mm) Oversize Piston	3.140" (79.756mm)
150 HP V-6 and 175 HP V-6 with a .030" (0.762mm) Oversize Piston	3.155" (80.137mm)

4. If a cylinder bore is tapered, out-of-round or worn more than .006" (0.152mm) from standard "Cylinder Block Finish Hone" diameter (refer to chart, preceding), it will be necessary to re bore that cylinder(s) to .015" (0.381mm) or .030" (0.762mm) oversize and install oversize piston(s) and piston rings during reassembly.

NOTE: The weight of an oversize piston is approximately the same as a standard size piston; therefore, it is not necessary to re bore all cylinders in a block just because one cylinder requires reboring.

5. After honing and thoroughly cleaning cylinder bores, apply light oil to cylinder walls to prevent rusting.

200 HP V-6 Engines

IMPORTANT: The cylinders of a 200 HP V-6 engine are chrome and cannot be rebored or efficiently

honed. (Honing of a chrome cylinder is not necessary or recommended.)

1. Carefully inspect chrome surfaced cylinder bores for signs of flaking, grooving, scoring or other damage.

IMPORTANT: DO NOT mistake porosity for a damaged cylinder.

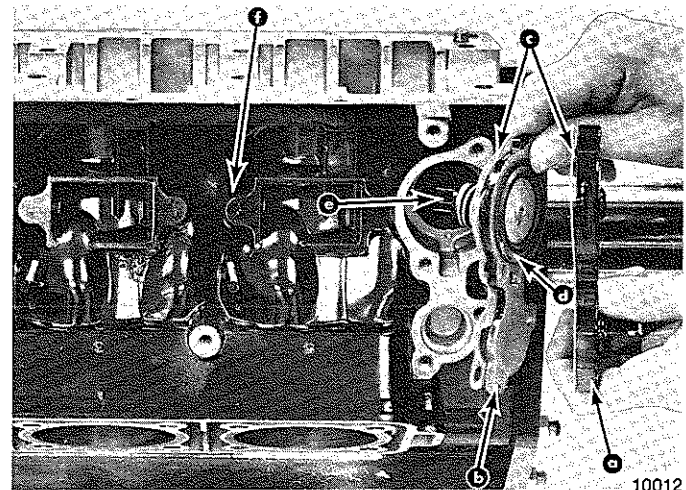
2. If chrome surfacing is flaking, or if a groove or any other mark penetrates the chrome surfacing to the aluminum portion of cylinder block, cylinder block and crankcase cover must be replaced.
3. To determine if a groove or any other mark in cylinder wall penetrates chrome surfacing to the aluminum portion of cylinder block, apply a small amount of muratic acid (or toilet bowl cleaner) over the groove or mark. [DO NOT allow the muratic acid (or toilet bowl cleaner) to contact the aluminum portion of cylinder block.] If a groove or mark penetrates the chrome surfacing, a "fizzing" action (or "bubbling" action) will appear, thus indicating aluminum is being dissolved.
4. If a piston(s) is scored and has transferred aluminum to cylinder walls, remove the aluminum, clean cylinder walls and inspect cylinders for further damage, as follows:

- a. Remove all loose aluminum deposits from cylinder walls with a stiff bristle brush.
- b. Apply a small amount of muratic acid (or toilet bowl cleaner) onto the aluminum deposits. [DO NOT allow muratic acid (or toilet bowl cleaner) to contact the aluminum portion of cylinder block.] A "fizzing" action will appear, thus indicating that aluminum is being dissolved.
- c. Leave the acid on the aluminum deposit for one to 2 minutes, then wash cylinder thoroughly with hot water and detergent.
- d. Steps "b" and "c" may require repeating several times before all the aluminum deposits are gone.
- e. Check each cylinder for an out-of-round ("egg-shaped") condition. Using an inside micrometer or telescopic gauge, as shown in Figure 14, take measurements $\frac{1}{4}$ " (6.35mm) from top of each cylinder bore and at right angles (90°) to each other. A .006" (0.152mm) or less out-of-round is acceptable. If out-of-round is more than .006", cylinder block and crankcase cover must be replaced.
- f. After cleaning and inspection, cylinder bores should be swabbed several times with light engine oil and a clean cloth.

Water Pressure Relief Valve

1. If not yet removed, remove relief valve cover, relief valve plate and poppet valve from side of cylinder block. (Figure 15)
2. Discard gaskets and clean all gasket surfaces.
3. Inspect all gasket surfaces for nicks, deep grooves, cracks and distortion that could cause leakage.
4. Replace diaphragm by removing screw and washer that secure diaphragm to poppet valve. Discard old diaphragm and install new diaphragm. Secure new diaphragm to poppet valve with washer and screw. Be sure that poppet valve compression spring and diaphragm are properly installed.
5. Using new gaskets, reinstall relief valve plate assembly and relief valve cover on cylinder block. (Figure 15) Secure with bolts. Tighten bolts evenly until torqued to 150 in. lbs. (173kg-cm).

Figure 15. Removing Water Pressure Relief Valve 



a - Relief Valve Cover
b - Relief Valve Plate
c - Gaskets

d - Diaphragm
e - Poppet Valve
f - Starboard Side of Cylinder Block

POWERHEAD REASSEMBLY and INSTALLATION

General

Before proceeding with powerhead reassembly, be sure that all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in "Cleaning and Inspection", preceding. Parts, which have not been properly cleaned (or which are questionable), can severely damage an otherwise perfectly good powerhead within the first few minutes of operation. All new powerhead gaskets **MUST BE** installed during reassembly.

During reassembly, lubricate parts with Quicksilver Formula 50 Outboard Oil whenever "light oil" is specified or Quicksilver Multipurpose Lubricant whenever "grease" is specified. Quicksilver part numbers of lubricants, sealers and locking compounds and tools are listed in "Powerhead General Information", preceding.

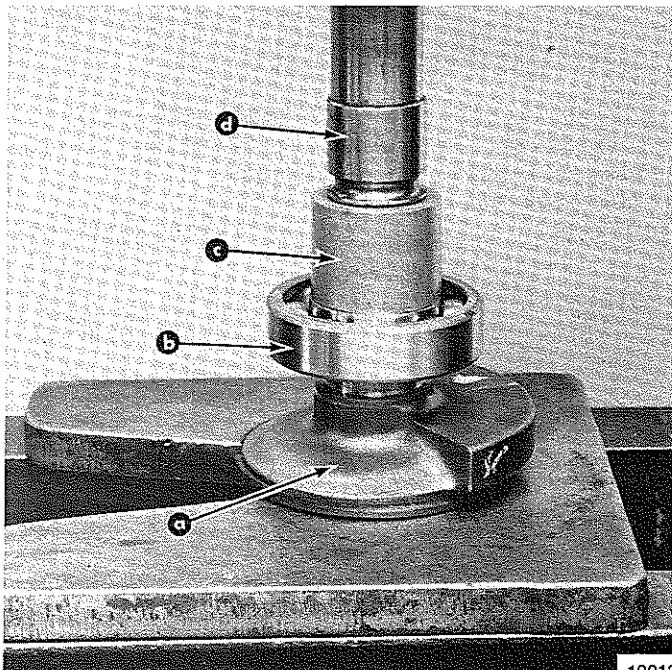
A torque wrench is essential for correct reassembly of powerhead. **DO NOT** attempt to reassemble powerhead without using a torque wrench. Attaching bolts for covers, housings and cylinder heads **MUST BE** torqued by tightening bolts in 3 progressive steps (following specified torque sequence) until specified torque is reached (see "Example", following).

EXAMPLE: If cylinder head attaching bolts require a torque of 30 ft. lbs. (4.15mkg), a) tighten all bolts to 10 ft. lbs. (1.38mkg), following specified torque sequence, b) tighten all bolts to 20 ft. lbs. (2.77mkg), following torque sequence, then finally c) tighten all bolts to 30 ft. lbs., following torque sequence.

Powerhead torques are listed in "Powerhead General Information", Page 4-1.

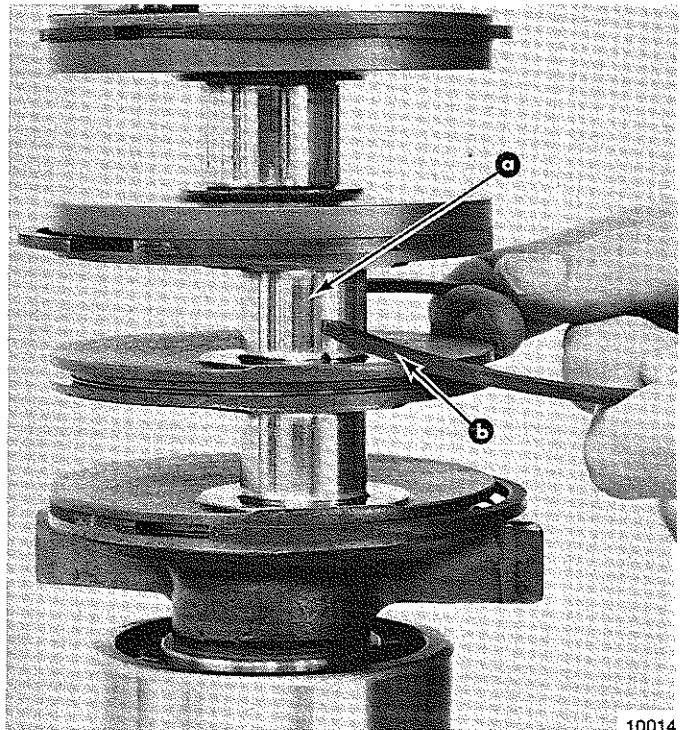
Crankshaft - Reassembly and Installation

1. If removed, reinstall new crankshaft ball bearing (on drive shaft end of crankshaft), as follows:
 - a. Support crankshaft assembly in press between counterweights and directly under lower crankshaft end. (Figure 1)
 - b. Press lower ball bearing on crankshaft, using tubing as a mandrel. (Figure 1) Press only on inner race of bearing. Be sure that bearing is seated firmly against counterweight.
 - c. Remove crankshaft assembly from press.
 - d. Reinstall retaining ring, which secures lower crankshaft ball bearing, using a suitable pair of Snap Ring Pliers (C-91-24283, expanding type). (Figure 21 in "Crankshaft - Removal and Disassembly", preceding)
2. Place crankshaft assembly on Powerhead Stand (C-91-



10013
a - Crankshaft Assembly (Lower End) c - Suitable Mandrel
b - Crankshaft Ball Bearing d - Press

Figure 1. Installing Lower Crankshaft Ball Bearing

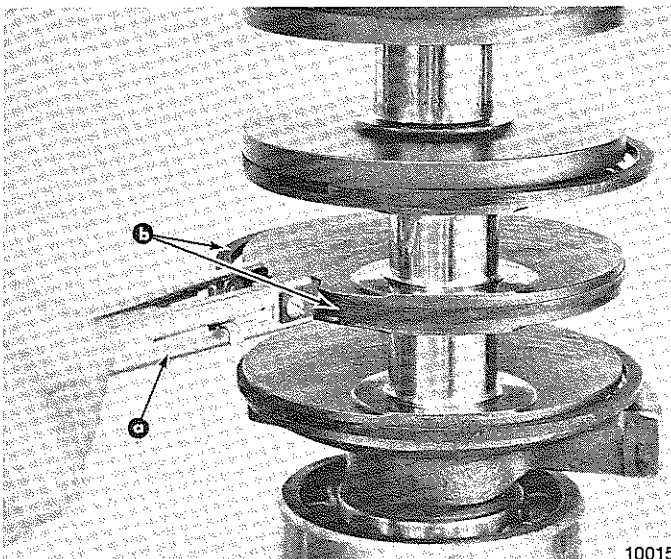


10014
a - Crankshaft Journal b - Crankshaft Sealing Ring

Figure 2. Installing Crankshaft Sealing Ring

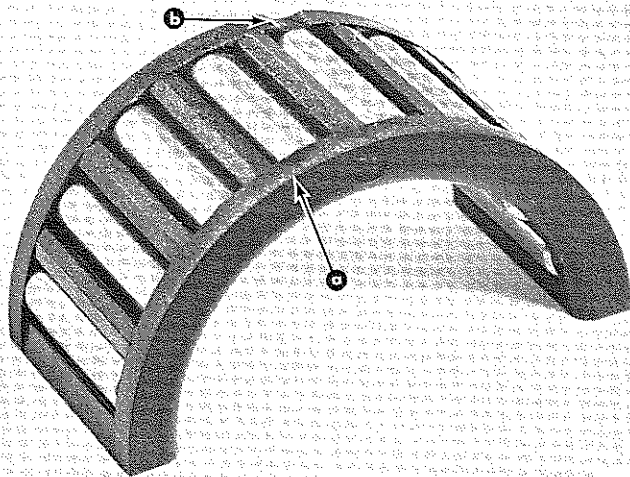
30591A1) mounted in a vise. (Figure 18 in "Crankshaft - Removal and Disassembly")

3. If removed, reinstall new crankshaft sealing ring(s), following:
 - a. Spread sealing ring enough to allow installation around the nearest crankshaft journal, then install around journal. (Figure 2)
 - b. Using Piston Ring Expander (C-91-24697), install crankshaft sealing ring into crankshaft groove. (Figure 3)
4. Place crankshaft roller bearings around upper and lower main bearing journals with notch in bearing cages (Figure 4) positioned UP. (Figure 20 in "Crankshaft - Removal and Disassembly")



10015
 a - Piston Ring Expander (C-91-24697)
 b - Crankshaft Sealing Ring Installed in Crankshaft Groove

Figure 3. Installing Crankshaft Sealing Ring into Groove



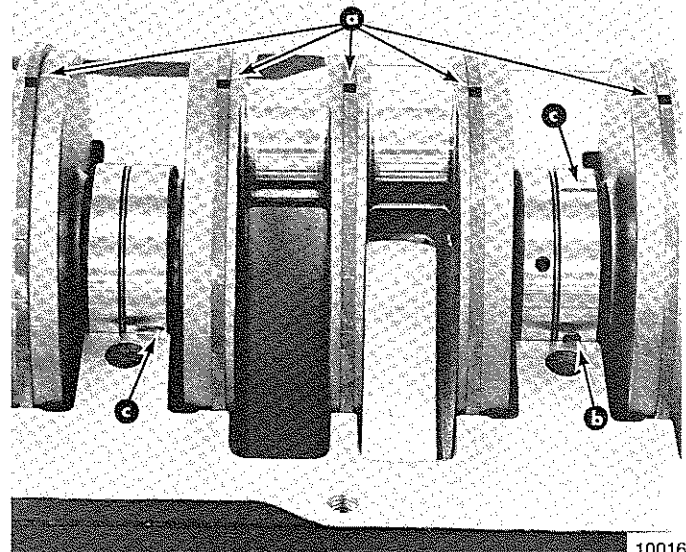
10048
 a - Crankshaft Roller Bearing Half
 b - Install Roller Bearing with Notch in Bearing Cage toward Flywheel End of Crankshaft

Figure 4. Main Crankshaft Roller Bearing

5. Reinstall bearing race halves around main crankshaft roller bearings with dowel pin hole (larger of the 3 holes in bearing race) toward drive shaft end of crankshaft. (Figure 18 in "Crankshaft - Removal and Disassembly") Secure bearing race halves with retaining ring. (Figure 19 in "Crankshaft - Removal and Disassembly")
6. Lubricate crankshaft sealing rings, crankshaft ball bearing and crankshaft main roller bearings with light oil: (Figure 18 in "Crankshaft - Removal and Disassembly") Lubricate crankshaft main roller bearings by squirting oil thru one of the holes in bearing race.
7. Check cylinder block to be sure that crankshaft main bearing dowel pins are in place. If not in place, install new pins in cylinder block.
8. With all crankshaft seal ring gaps positioned straight UP, place crankshaft assembly into cylinder block. Be sure that drive shaft end of crankshaft is toward drive shaft end of cylinder block. Gently push crankshaft down into position and rotate main bearing races until dowel pin hole in races

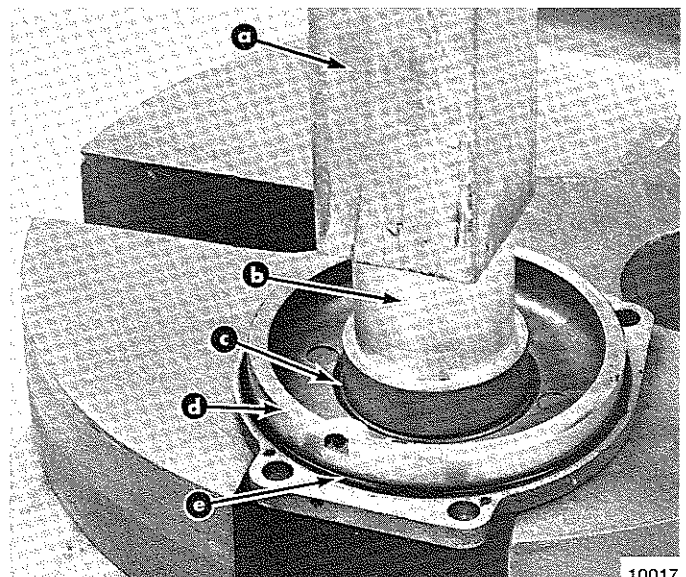
is aligned with dowel pins, then compress crankshaft sealing rings with fingers and push crankshaft the rest of the way down until properly seated in cylinder block. (Figure 5)

NOTE: To facilitate installation of cylinder block dowel pins in dowel pin holes of bearing races, 1) position bearing races with center of dowel pin holes aligned with edge of cylinder block (see bearing race on right side of Figure 5), 2) place a mark exactly at top of bearing races with a grease pencil, then 3) rotate each race until grease pencil mark is aligned with edge of cylinder block (see bearing race on left side of Figure 5). This will position dowel pin hole in bearing races very close to cylinder block dowel pins.



10016
 a - Crankshaft Seal Ring Gaps Must Be Positioned Straight Up
 b - Dowel Pin Hole
 c - Grease Pencil Mark

Figure 5. Installing Crankshaft



10017
 a - Press
 b - Driver Head (C-91-55919)
 c - Oil Seal (Hidden)
 d - Lower End Cap
 e - "O" Ring

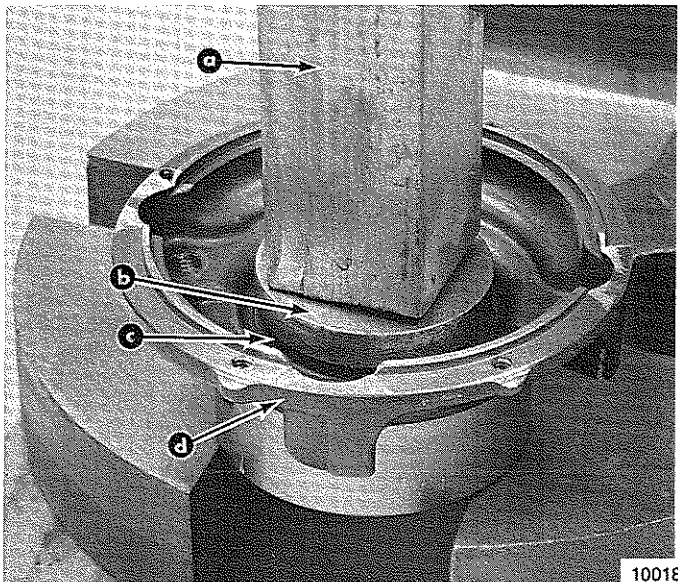
Figure 6. Installing Oil Seals in Lower End Cap

End Caps - Reassembly and Installation

1. Apply a thin bead of Loctite Type "A" to outer diameter (area which contacts end cap) on 2 lower end cap oil seals.
2. Using Driver Head (C-91-55919), press one oil seal into lower end cap [with lip of seal DOWN (away from cylinder block when installed)] until firmly seated on end cap shoulder. (Figure 6) Remove any excess Loctite.
3. Press second oil seal into lower end cap (with lip of seal DOWN) until firmly seated on first oil seal. (Figure 6) Remove any excess Loctite.
4. Using light oil, lubricate lips of lower end cap oil seals, surface of end cap, which contacts cylinder block, and lower end cap "O" ring.

NOTE: The larger "O" ring is used with the lower end cap.

5. Install "O" ring (which was just lubricated) around lower end cap. (Figure 6)
6. Apply a thin bead of Loctite Type "A" to outer diameter (area which contacts end cap) of upper end cap oil seal.



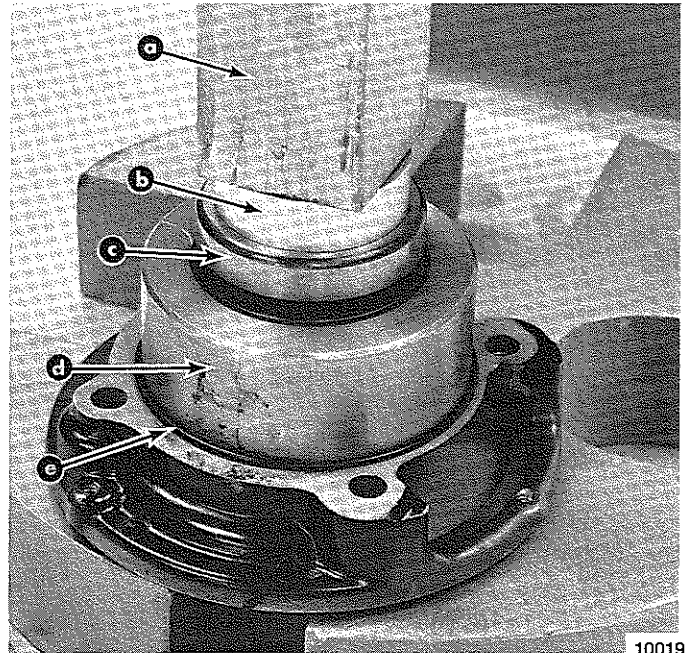
a - Press
b - Suitable Mandrel
c - Oil Seal (Hidden)
d - Upper End Cap

Figure 7. Installing Oil Seal in Upper End Cap

7. Using a suitable mandrel, press oil seal into upper end cap [with lip of seal DOWN (toward cylinder block when installed)] until seal surface is flush with surface of end cap. (Figure 7) Remove any excess Loctite.

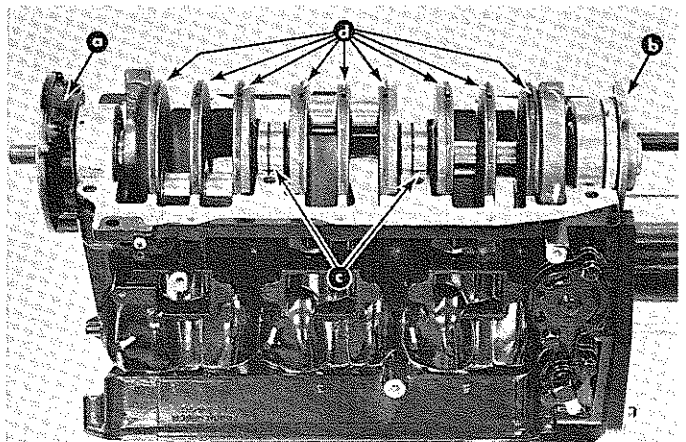
CAUTION: If end cap oil seal is pressed too far into upper end cap, end cap bleed passage could be restricted. Be sure that oil seal is properly installed.

8. If removed, reinstall crankshaft roller bearing into upper end cap as shown in Figure 8. Press roller bearing into end cap until firmly seated against end cap shoulder.
9. Lubricate lip of upper end cap oil seal, end cap roller bear-



a - Press
b - Driver Head (C-91-55919)
c - Crankshaft Roller Bearing
d - Upper End Cap
e - "O" Ring

Figure 8. Installing Crankshaft Roller Bearing into Upper End Cap



a - Upper End Cap
b - Lower End Cap
c - Centermain Crankshaft Bearings
d - Crankshaft Sealing Rings

Figure 9. Crankshaft and End Caps Installed

ing, surface of end cap (that contacts cylinder block) and upper end cap "O" ring with light oil.

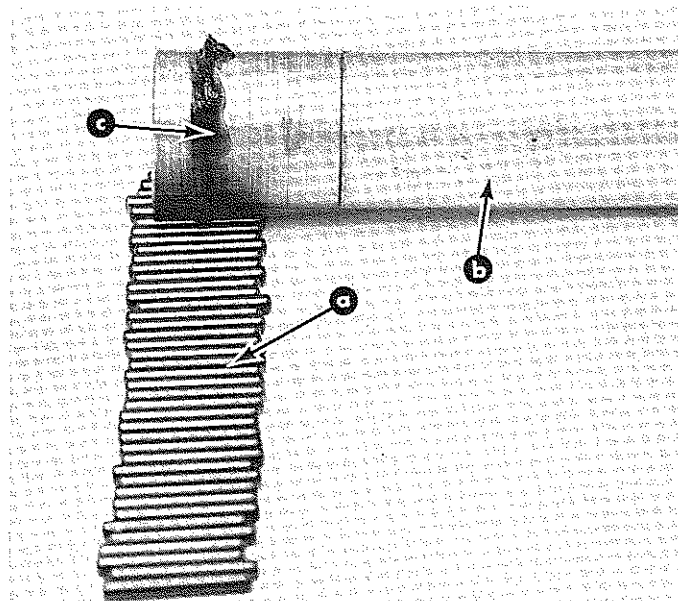
NOTE: The smaller "O" ring is used with the upper end cap.

10. Install "O" ring (that was just lubricated) around upper end cap. (Figure 8)
11. Lubricate crankshaft ends (oil seal areas) with light oil, then install upper and lower end caps. (Figure 9) Secure end caps to cylinder block with attaching bolts. **DO NOT** tighten end cap bolts at this time.

CONNECTING RODS and PISTONS

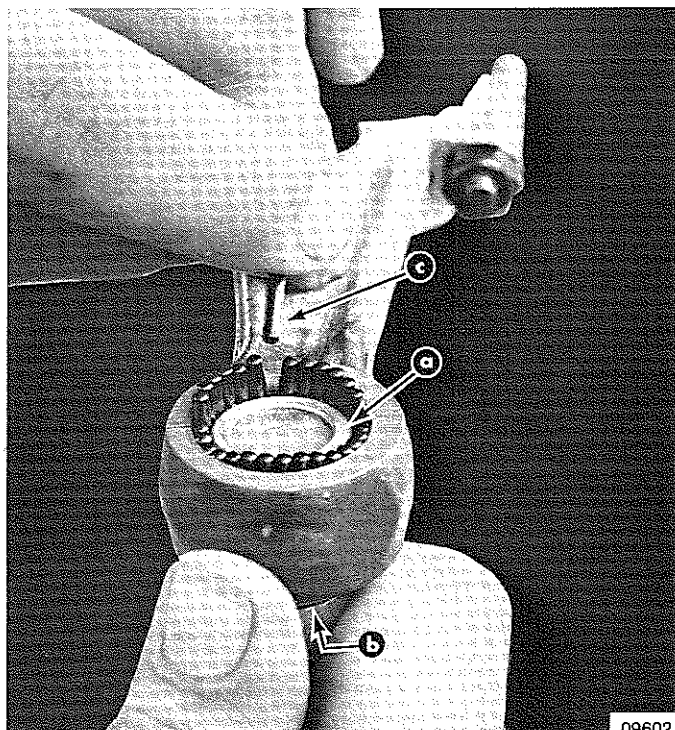
REASSEMBLY

CAUTION: DO NOT attempt to re-use any 3-ring piston that has been removed from a connecting rod. Removal of a 3-ring piston (from connecting rod) will damage that piston and necessitate installation of a new piston.



09600
a - Piston Pin Needle Bearings b - Piston Pin Tool c - Grease

Figure 10. Installing Piston Pin Needle Bearings



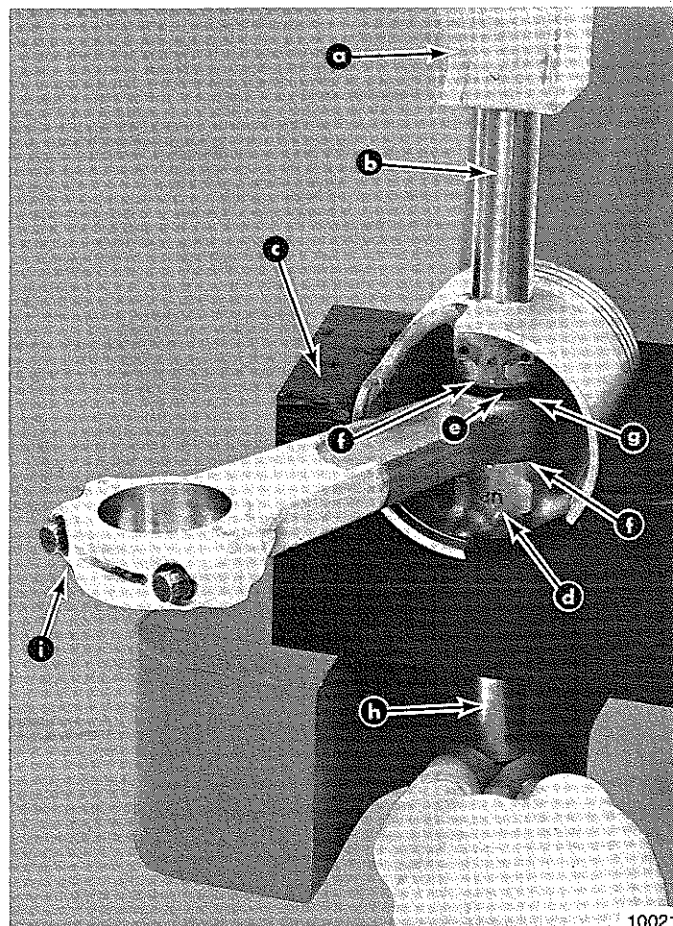
09602
a - Sleeve of Piston Pin Tool
b - Locating Washer (Hidden)
c - Needle Bearing Being Installed

Figure 11. Installing Piston Pin Needle Bearings

1. Place a clean piece of paper on bench and line up piston pin needle bearings (those retained from disassembly or new ones), as shown in Figure 10.

NOTE: There are 29 piston pin needle bearings per piston.

CAUTION: Never intermix new needle bearings with used needle bearings at the same connecting rod end. Never intermix needle bearings of one connecting rod with those of another connecting rod. Should one (or more) piston pin needle bearing of a connecting rod require replacement (or should one or more be lost), replace all of that connecting rod's piston pin needle bearings.



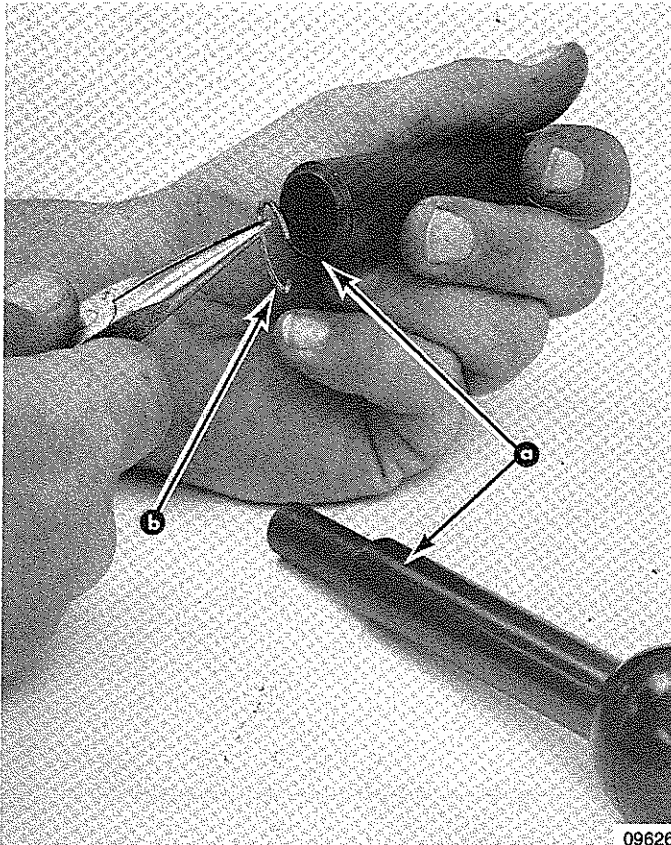
10021
a - Press
b - Piston Pin
c - Piston Support Block (C-91-77005)
d - Piston Pin Boss Marked "UP"
e - Piston Pin Needle Bearings
f - Locating Washers
g - Sleeve Portion of Piston Pin Tool (Hidden)
h - Piston Pin Tool
i - 2 Alignment Bumps (Hidden) Must Be Toward "UP" Marked Side of Piston

Figure 12. Installing Piston

2. Place a small amount of grease (Multipurpose Lubricant) on sleeve portion of Piston Pin Tool (C-91-74607A1) and roll tool over lined-up bearings, as shown in Figure 10.
3. Place lower locating washer on Piston Pin Tool (shoulder

on washer toward bearings) and, leaving one or 2 bearings off sleeve, place sleeve portion of tool thru connecting rod. Add needle bearings, as necessary, until no more can be installed (29 needle bearings per connecting rod). (Figure 11)

4. Place upper locating washer over sleeve portion of Piston Pin Tool (shoulder of washer toward bearings), then slide tool handle out of sleeve. (Sleeve and locating washers will maintain needle bearings in position in connecting rod.)
5. Apply a light coat of oil onto each piston pin before installing into piston.

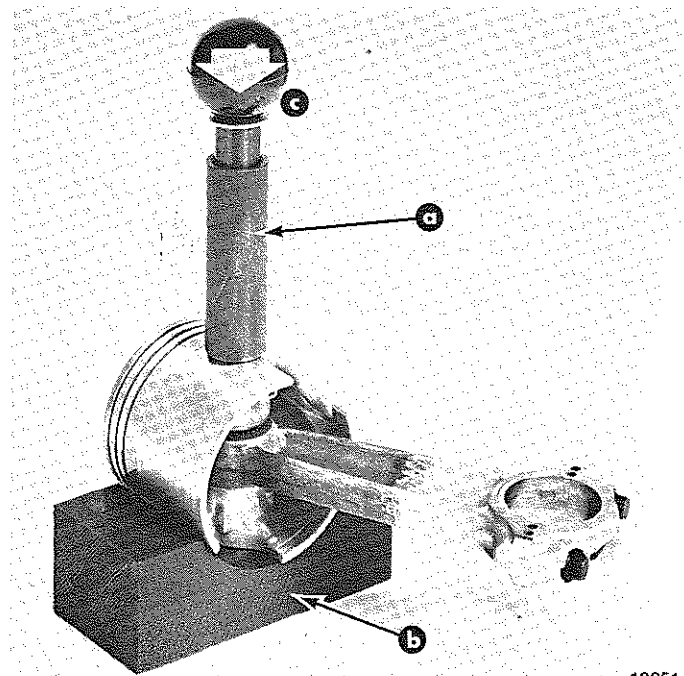


a - Lockring Installation Tool (C-91-77109A1)
b - Lockring

Figure 13. Placing "C" Type Lockring into Lockring Installation Tool

6. Place piston in position on Piston Support Block (C-91-77005) with "UP" marked side of piston positioned down (toward piston support block). (Figure 12)

IMPORTANT: Different pistons are used for port and starboard cylinders. Pistons are marked "P" (port side) or "S" (starboard side) on piston pin boss and on piston crown. (Figure 17) Pistons marked "P" must be installed in cylinders Nos. 2, 4 and 6, and pistons marked "S" must be installed in cylinder Nos. 1, 3 and 5.



a - Lockring Installation Tool
b - Piston Support Block
c - Push Down

Figure 14. Installing Lockring into Piston

7. Use Torch Lamp (C-91-63209) to heat piston dome to approximately 190°F (88°C). This will make piston pin installation easier.
8. While using one hand to hold sleeve, bearings and locating washers in place, insert connecting rod into position between piston pin bosses [2 bumps on crankshaft end of rod (Figure 12 in "Pistons and Connecting Rods - Removal", preceding) must be toward "UP" marked side of piston], then install handle portion of Piston Pin Tool thru lower piston pin boss and into sleeve. (Figure 12)
9. While holding piston pin needle bearings in place with Piston Pin Tool, press piston pin into position (as far as possible) with an arbor press. (Figure 12) Use Piston Pin Tool (between arbor press and piston pin) to position piston pin the rest of the way into piston.

SAFETY WARNING: Eye protection MUST BE WORN while installing piston pin lockrings.

CAUTION: DO NOT re-use piston pin lockrings. Use only new lockrings and make sure that they are properly seated in piston grooves.

10. Install new piston pin lockrings (one at each end of piston pin) with Lockring Installation Tool (C-91-77109A1), as shown in Figures 13 and 14. Double check that lockrings are properly seated in piston grooves.

Checking Piston Ring End Gap and Installing Rings onto Pistons

SPECIAL INFORMATION

Because of continuous improvements being made in V-6 engines, there are several piston/ring combinations. The following **MUST BE** read and understood completely before trying to determine ring end gap or trying to install rings on pistons.

3-Ring Pistons

Three-ring pistons can be found only in early model 175 HP V-6 engines. Once a 3-ring piston has been removed from its connecting rod, it **MUST BE** replaced. All 3 rings of a 3-ring piston are identical and the only stipulation for installation on a piston is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

2-Ring Pistons

All 200 HP V-6 engines are equipped with 2-ring pistons. Both rings of a 200 HP V-6 are a keystone (tapered) type ring. The only stipulation for installation on a piston is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

There are 2 different types of 2-ring pistons for 175 HP and 150 HP V-6 engines. One is designed for one keystone (tapered) ring (Figure "b") and one rectangular ring (Figure "a"). It will be necessary to measure each ring in order to identify. (Figure "a" or "b") When one keystone ring and one rectangular ring are used, the keystone ring always is used as the top ring.

The other 2-ring piston is designed for 2 keystone rings, and the only stipulation (which also applies when one keystone and one rectangular ring are used) is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

.015" (0.381mm) and .030" (0.762mm) Oversize Pistons and Rings

All oversize pistons for 175 HP and 150 HP V-6 engines are equipped with 2 keystone (tapered) rings. The only stipulation for installation of rings on a piston is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

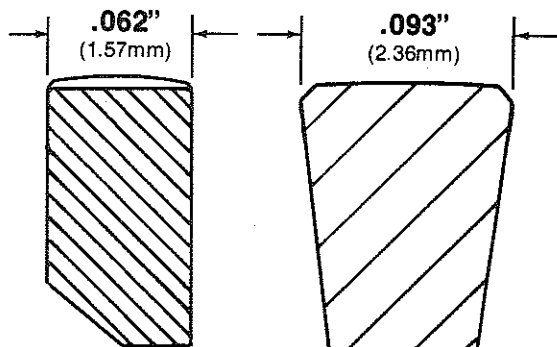
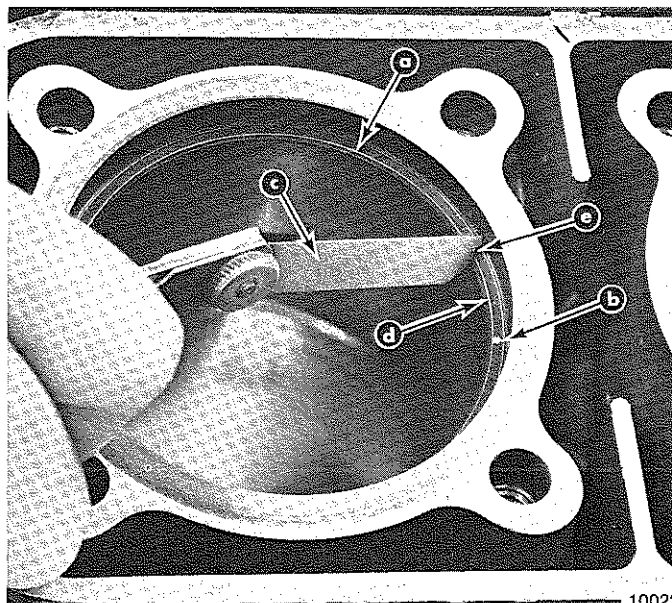


Figure a. Rectangular Ring

Figure b. Keystone (Tapered) Ring

1. Insert each new piston ring (one at a time) into the bore of its respective cylinder. Position piston ring about $\frac{1}{2}$ " (12.7mm) into cylinder, using a piston to assure proper positioning of ring.
2. Check end gap of each piston ring with a feeler gauge. (Figure 15) End gap must be within .018" to .025" (0.45mm to 0.64mm). If end gap is greater, check other new piston rings in cylinder bore until rings (within tolerance) are found. If end gap is less than tolerance, and another ring within tolerance cannot be found, it may be necessary to file some material from piston ring end (at gap). If it is necessary to file a piston ring, be sure that all rough edges are removed after filing.
3. Continue to check piston ring gaps (as outlined, preceding) until new piston rings (within tolerance) have been found for each cylinder.
4. Remove piston rings from cylinder bores.



10022
a - Piston Rings b - Dot ("Pip" Mark) on Side of Piston Ring
c - Feeler Gauge d - Piston Ring End Gap
e - Piston Ring End Gap

Figure 15. Checking Piston Ring End Gap

IMPORTANT: Piston rings, that are checked in No. 1 cylinder, MUST BE installed on No. 1 piston; rings, which are checked in No. 2 cylinder, MUST BE installed on No. 2 piston, etc.

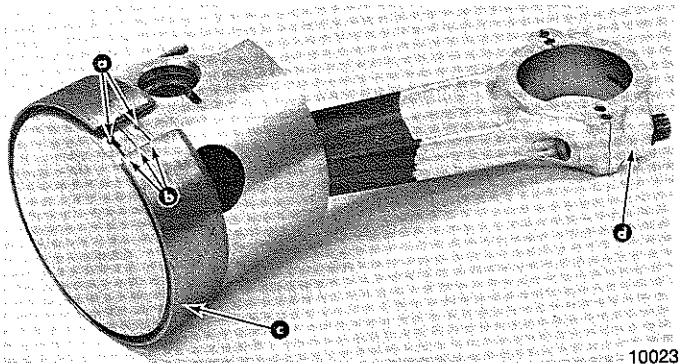
5. Using Piston Ring Expander (C-91-24697), install No. 1 piston rings on No. 1 piston, No. 2 piston rings on No. 2 piston, etc. (Figure 13 in "Pistons and Connecting Rods - Removal", preceding). Piston rings **MUST BE** installed on piston with DOT on SIDE of PISTON RING toward piston dome (crown). (Figure 15)

IMPORTANT: Piston rings MUST BE properly installed on pistons (refer to "Special Information, preceding).

6. Check piston rings to be sure that they rotate freely in ring grooves. If a ring does not rotate freely, condition must be corrected before installing piston assembly into cylinder block.

Piston Installation

1. Install Powerhead Stand (C-91-30591A1) into drive shaft end of crankshaft. Use Powerhead Stand to turn crankshaft to desired positions when attaching connecting rods to crankshaft.
2. Install each piston as follows:
 - a. Lubricate piston rings, piston skirt, piston pin needle bearings and respective cylinder wall with light oil.



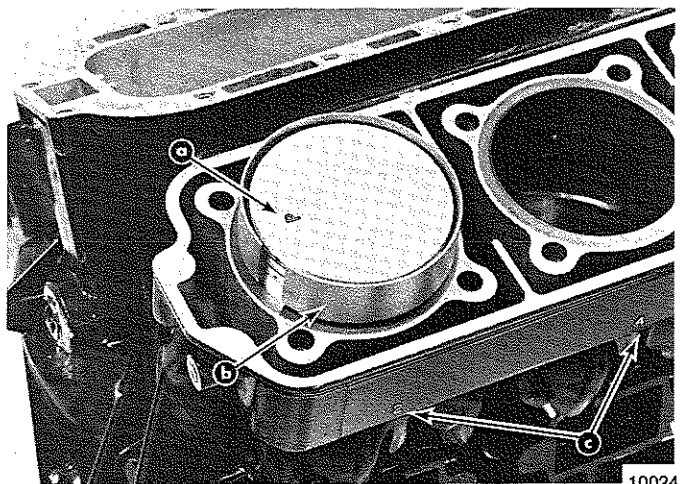
- a - Piston Ring Locating Pins (One in Each Ring Groove)
- b - Piston Rings
- c - Piston Ring Compressor (C-91-65494 for 150 HP and 175 HP V-6 Pistons, C-91-85534 for 200 HP V-6 Pistons)
- d - Connecting Rod Cap

Figure 16. Piston Ring Compressor Installed

- b. Rotate each piston ring so that locating pin in ring groove is positioned at piston ring end gap. (Figure 16)
- c. Install Piston Ring Compressor (C-91-65494 for 150 HP and 175 HP V-6 pistons, C-91-85534 for 200 HP V-6 pistons) around connecting rod and into position over piston rings, as shown in Figure 16.

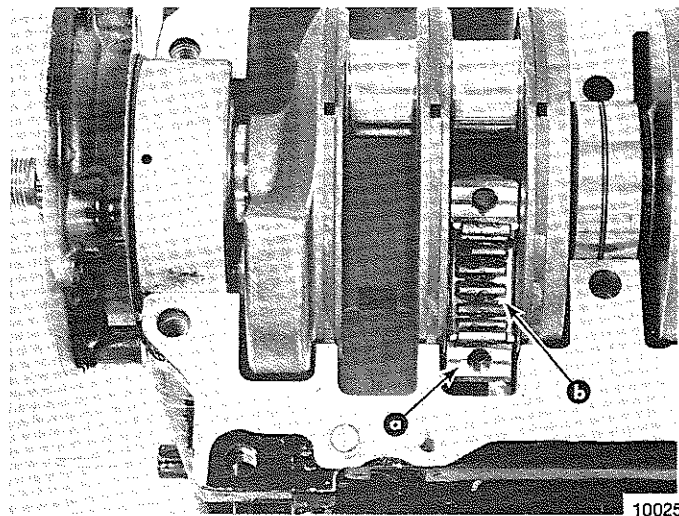
CAUTION: Piston rings must be properly positioned with locating pins between piston ring end gaps.

- d. Check that number, scribed on connecting rod during disassembly (Figure 11 in "Pistons and Connecting Rods - Removal", preceding), matches cylinder num-



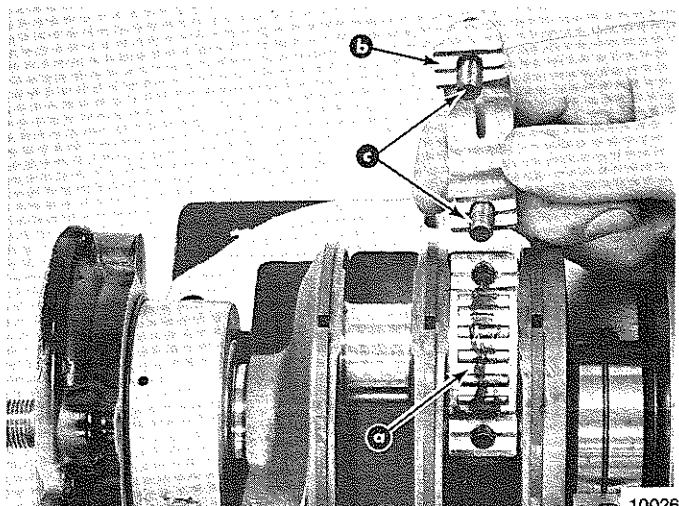
- a - Stamped Letter ("P" or "S") on Piston Crown (Dome)
- b - Piston Ring Compressor
- c - Stamped Numbers on Side of Cylinder Block

Figure 17. Installing Piston into Cylinder



- a - Connecting Rod
- b - Bearing Cage and Roller Bearings

Figure 18. Installing Connecting Rod Bearings



- a - Bearing Cage and Roller Bearings
- b - Connecting Rod Cap
- c - Connecting Rod Bolts

Figure 19. Installing Connecting Rod Bearings

ber in which piston is to be installed [i.e., connecting rod, that is marked one (1), must be installed in No. 1 cylinder, etc].

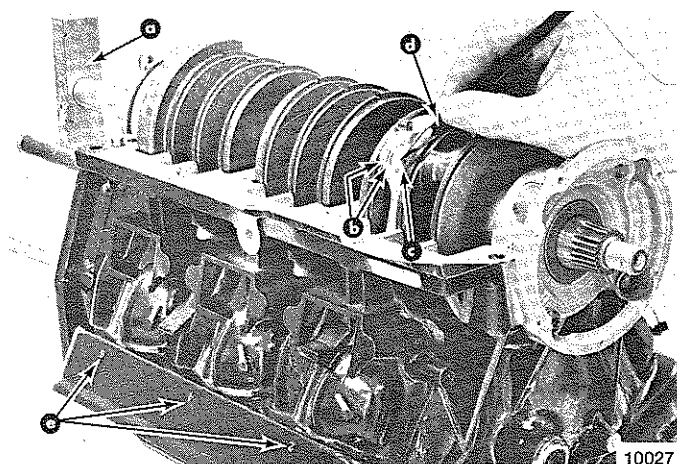
- e. Remove 2 bolts and connecting rod cap from piston/rod assembly to be installed. (Figure 16)
- f. Install piston assembly into its respective cylinder so that side of piston with "UP" (marked on piston pin boss, Figure 3) is toward flywheel end of powerhead. (Figure 17) After aligning connecting rod with cylinder block opening, push on crown of piston until piston is installed into bore of cylinder, and piston ring compressor falls off.

IMPORTANT: Pistons must be installed in correct cylinder with "UP" side of pistons toward flywheel end of powerhead. (This will position large hole in piston skirt directly opposite exhaust port.) Pistons are marked "P" (port side) or "S" (starboard side) on piston pin boss and on piston crown. (Figure 17) Pistons marked "P" must be installed in cylinder

Nos. 2, 4 and 6, and pistons marked "S" must be installed in cylinder Nos. 1, 3 and 5.

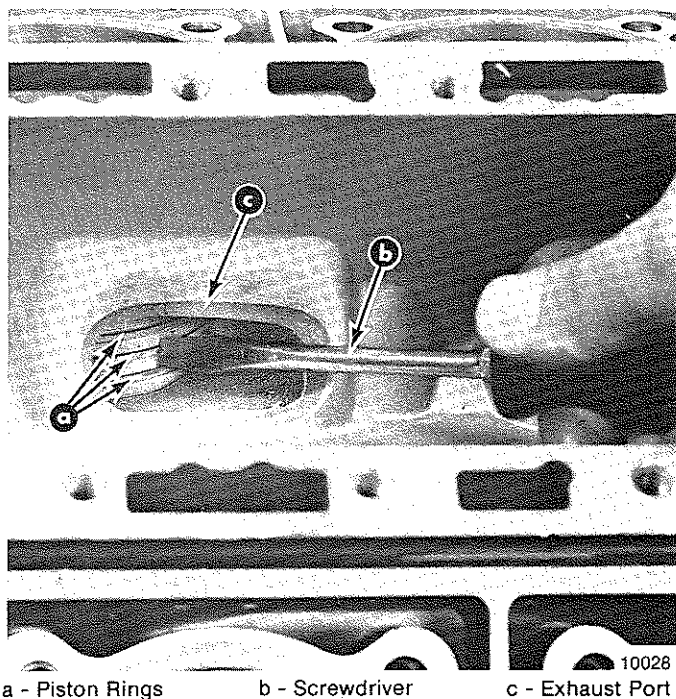
CAUTION: Never intermix new roller bearings with used roller bearings in the same connecting rod end. If a quantity of bearings requires replacement, replace all bearings at that rod end.

- g. Apply a coating of grease (Multipurpose Lubricant) to bearing surface of connecting rod, then install bearing cage and roller bearings into grease. (Figure 18)
- h. Bring connecting rod up to crankshaft journal.
- i. Apply a coating of grease to crankshaft journal, then install other bearing cage and remaining roller bearings into grease. (Figure 19)
- j. Clean connecting rod bolts with solvent and dry with compressed air.



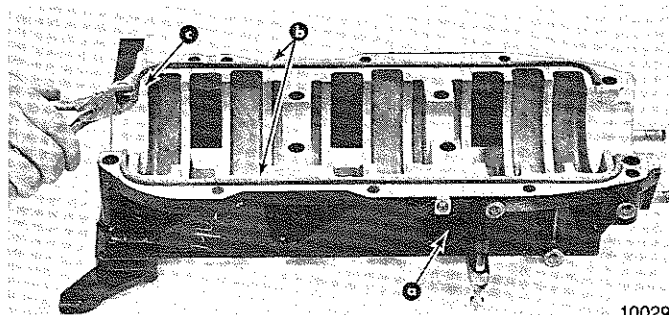
- a - Powerhead Stand (C-91-30591A1)
- b - "Etched" Alignment Marks
- c - Chamfered Corner
- d - Pencil
- e - Stamped Numbers on Side of Cylinder Block

Figure 20. Installing Connecting Rod Cap



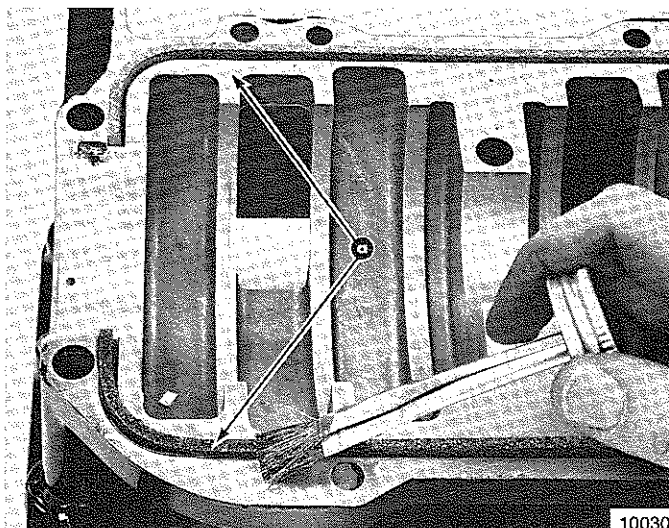
- a - Piston Rings
- b - Screwdriver
- c - Exhaust Port

Figure 21. Checking Piston Rings



- a - Crankcase Cover
- b - Gasket Strips
- c - Trim End of Each Gasket Strip as Necessary

Figure 22. Trimming Crankcase Cover Gaskets



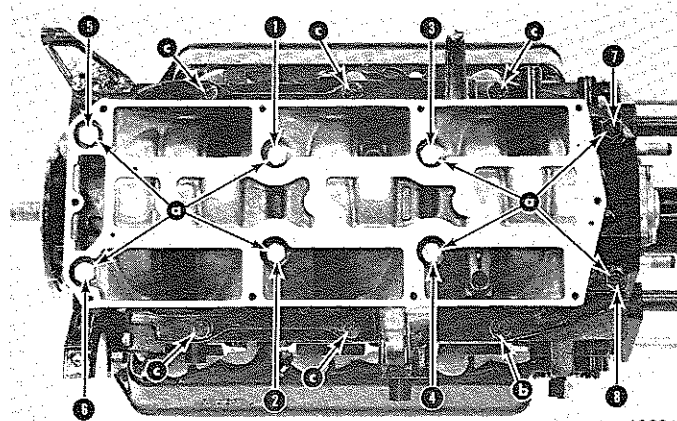
- a - Apply Permatex 2C-12 to These Surfaces

Figure 23. Applying Sealer to Crankcase Cover

- k. Apply a drop of Loctite Type "A" to threads of each connecting rod bolt.
 - l. Install connecting rod cap, being sure that alignment marks (bumps and etched marks - Figure 20) on connecting rod and cap are properly aligned. Install connecting rod bolts as far as possible by hand, then check alignment between rod cap and rod, as shown in Figure 20.
- NOTE: Alignment of connecting rod cap to connecting rod can be checked by moving pencil point back-and-forth on chamfered corners between rod cap and rod. (Figure 20) If a ridge is felt, rod cap is misaligned. Misalignment must be corrected before proceeding.*
- m. Tighten connecting rod bolts (using a 5/16"-12 point socket) evenly in 3 progressive steps until torqued to 30 ft. lbs. (4.15mkg). Recheck alignment between rod cap and rod, as shown in Figure 20.
 - n. Check that all roller bearings have been installed by inserting a small tool thru slot in connecting rod cap and rotating cage. Be careful not to scratch bearings.
 - o. Repeat procedures in Steps "a" thru "n", preceding, for remaining cylinders.
5. Check piston rings for spring tension by inserting a screwdriver thru exhaust port and pressing on each piston ring. (Figure 21) If no spring tension exists (ring fails to return to position), it is likely that the ring was broken during installation. Use caution not to burr piston rings during

inspection. Replace only piston rings that may have been broken.

6. Using Powerhead Stand (C-91-30591A1), rotate crankshaft several times to assure free operation (no binds and/or catches).
7. Thoroughly clean machined, mating surfaces of crankcase cover and cylinder block with solvent to remove all oil.
8. Install gasket strips into grooves in crankcase cover, then trim end of each gasket strip flush with edge of cover, as shown in Figure 22.
9. Apply a THIN, even coat of Permatex 2C-12 on crankcase cover and cylinder block. (Figure 23)
10. Place crankcase cover in position on cylinder block. Secure crankcase cover with 8 large bolts. Turn bolts in (following torque sequence in Figure 24) a LITTLE at-a-time, compressing crankshaft seal rings until crankcase cover has been drawn down to cylinder block. Tighten 8 large crankcase cover bolts evenly in 3 progressive steps (following torque sequence in Figure 24) until each bolt is torqued to specification listed on Page 4-1.
11. Install 6 smaller crankcase cover bolts (the longer seal bolt should be installed at location shown in Figure 24) and tighten evenly in 3 progressive steps until each bolt is torqued to specification.
12. Install bolts which secure upper and lower end caps to crankcase cover. Tighten end cap attaching bolts evenly until lower end cap bolts and upper end cap bolts are



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- a - Large Crankcase Cover Attaching Bolts
(Torque Following Sequence)
- b - Smaller Crankcase Cover Bolt (Seal Bolt)
- c - Smaller Crankcase Cover Bolts

Figure 24. Installing Crankcase Cover

torqued to specifications.

13. Wipe off any excess sealer that may have come out between crankcase cover and cylinder block.
14. Using Powerhead Stand, rotate crankshaft several times to assure free operation (no binds and/or catches).

Reed Blocks - Reassembly and Installation

SPECIAL INFORMATION

IMPORTANT: Always replace reeds in sets. DO NOT turn used reeds over for re-use.

There are 2 different shaped reeds at 2 different thicknesses in V-6 engines. Read the following carefully before installing reeds onto reed blocks or reed blocks into reed block housing.

150 HP V-6 Engines

Reeds in 150 HP V-6 engines are "straight-cut" shaped reeds. (Figure "a") Both reeds are .010" (.254mm) thick.

175 HP V-6 Engines

Earlier model 175 HP V-6 engines are equipped with one "teardrop" shaped reed (Figure "b") and one "straight-cut" shaped reed (Figure "a"). The "teardrop" shaped reed is .010" (0.254mm) thick; the "straight-cut" shaped reed is .008" (0.203mm) thick. When one "teardrop" shaped reed and one "straight-cut" shaped reed are used, the reed block **MUST BE** installed in reed block housing so that the "teardrop" shaped reed is toward center (inside) of reed block housing. [For identification purposes, "teardrop" shaped reeds have a tang that extends beyond edge of reed stop. (Figure 25)] Later model 175 HP V-6 engines are equipped with 2 "teardrop" shaped reeds that are .010" thick. If one or both reeds (of a reed block) need to be replaced, always replace both reeds with 2 "teardrop" shaped reeds that are .010" thick, even though one of the reeds may be a "straight-cut" shaped reed.

200 HP V-6 Engines

Reeds in 200 HP V-6 engines are "teardrop" shaped reeds. (Figure "b") Both reeds are .010" (.254mm) thick.

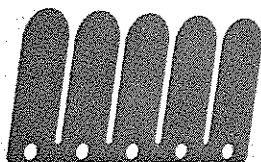


Figure a. "Straight-Cut" Shaped Reed

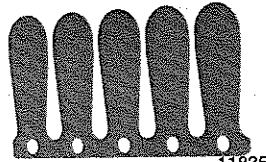
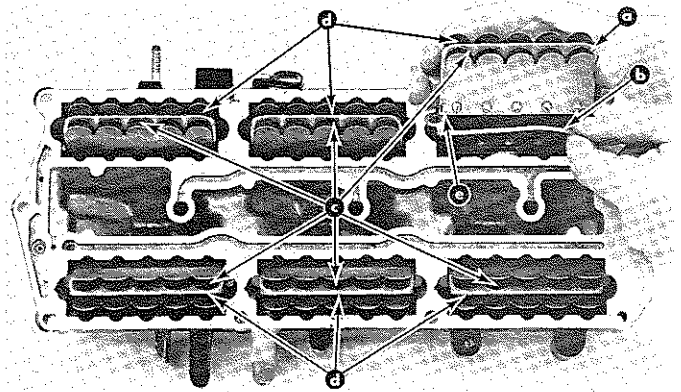


Figure b. "Teardrop" Shaped Reed

1. If disassembled, reassemble each reed block, following:
 - a. Coat reeds with light oil.

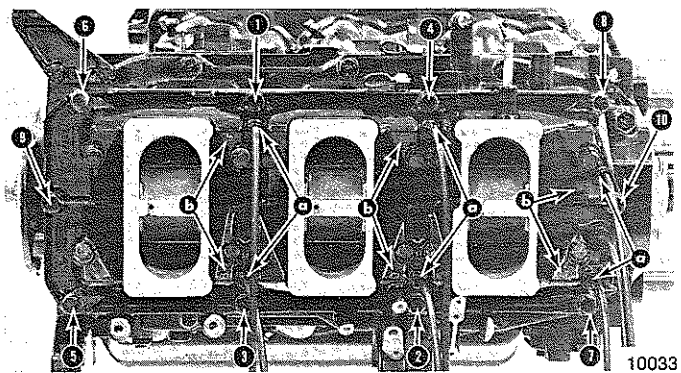
IMPORTANT: Replace reeds in sets only. DO NOT turn used reed over for re-use.
 - b. Place reeds and reed stops in position on reed block. (See "Special Information", above.)
 - c. Secure reeds and reed stops with screws and lockwashers. (Figure 9 in "Reed Blocks - Removal and Disassembly", preceding.) Torque screws to specifications on Page 4-1.
 - d. Refer to "Cleaning and Inspection", preceding, and check reed opening, then reed stop setting.
2. Place reed block gaskets, then reed blocks (Figure 25) into position in reed block housing. (See "Special Information", above.)



a - Reed Block
b - Reed Block Gasket
c - Identification Tang for "Teardrop" Shaped Reed

10032

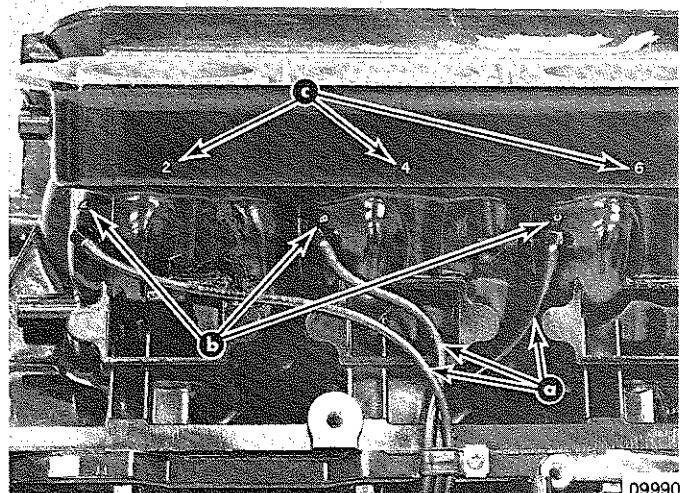
Figure 25. Installing Reed Blocks



a - Bleed System Bleed Valve
b - Letters Stamped on Reed Block Housing

10033

Figure 26. Installing Reed Block Housing

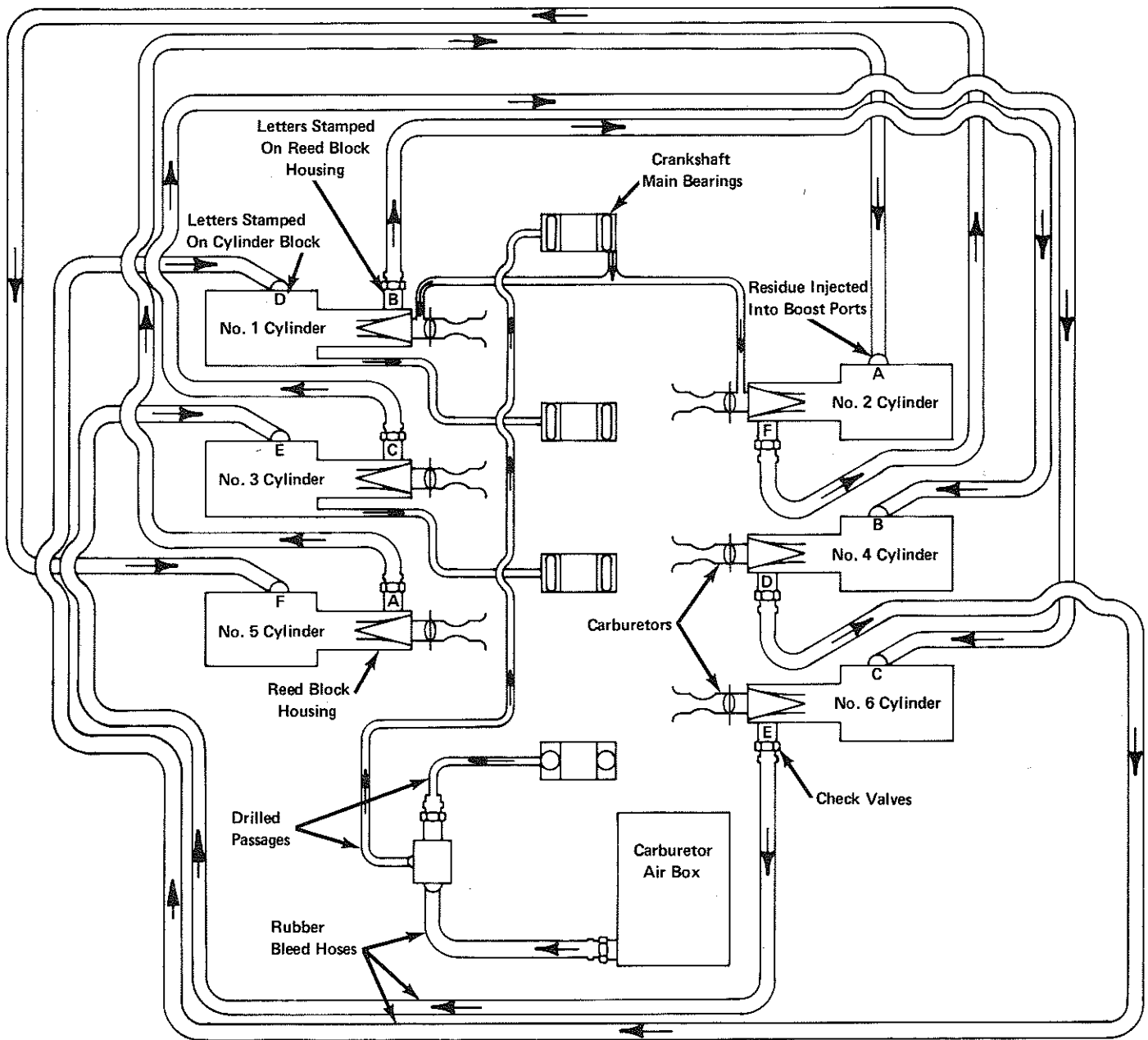


a - Bleed Hoses
b - Letters Stamped on Cylinder Block
c - Cylinder Numbers Stamped on Cylinder Block

09990

Figure 27. Bleed Hoses Installed

3. Secure reed blocks to reed block housing with attaching bolts. Tighten bolts evenly until torqued to specification.
4. Place reed block housing gasket in position on crankcase cover. Be sure that gasket is properly installed with bleed system holes in gasket aligned with holes in crankcase cover.





 RUBBER BLEED HOSES
 DRILLED PASSAGES

Figure 28. Bleed System

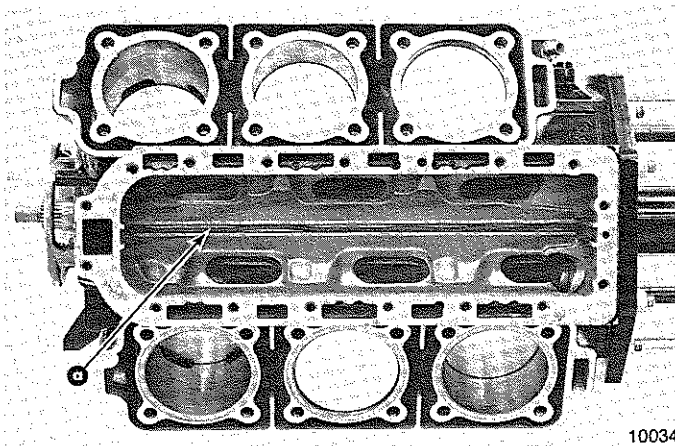
5. Place reed block housing in position on powerhead and secure with attaching bolts. (Figure 8 in "Reed Blocks - Removal and Disassembly", preceding) Following torque sequence in Figure 26, tighten reed block housing attaching bolts in 3 progressive steps until torqued to specification.
6. Install bleed hoses thru respective bleed hose clamps and connect bleed hoses from reed block housing to fittings on side of cylinders (one bleed hose extends from reed block housing to each cylinder). Bleed system check valves on reed block housing (Figure 26) and fittings on side of cylinders

(Figure 27) are marked with a stamped letter. Bleed hoses are properly installed when hose from check valve marked "A" links with cylinder fitting marked "A", "B" to "B", etc. (Figure 28)

IMPORTANT: Bleed hoses MUST BE correctly routed as shown in Figure 28. If bleed hoses are connected to wrong cylinders, engine will not operate properly. Install bleed hoses all-the-way onto fittings.

Exhaust Covers and Cylinder Heads - Installation

CAUTION: New gaskets **MUST BE** properly installed to allow correct water flow thru powerhead.



a - Divider Plate Seal

Figure 29. Divider Plate Seal Installed

1. Place exhaust divider plate seal into cylinder block slot (between exhaust ports). (Figure 29)
2. Place a divider plate gasket on each side of exhaust divider plate. Be sure that gaskets are properly installed so that holes in gaskets are aligned with holes in divider plate. Install exhaust divider plate (with gaskets) into place on cylinder block. (Figure 7 in "Cylinder Heads and Exhaust Covers - Removal", preceding.)

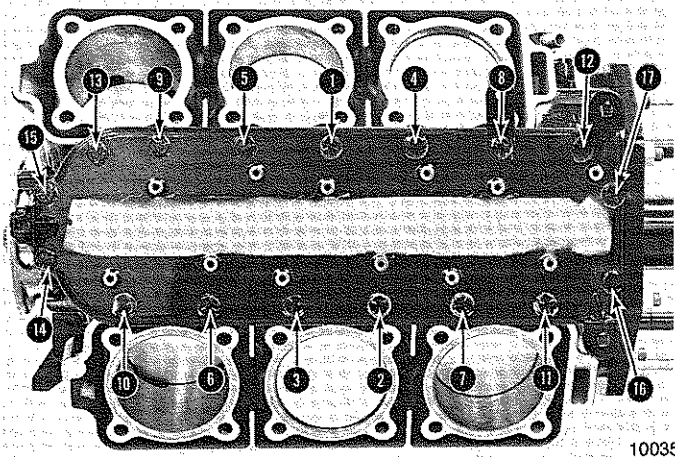
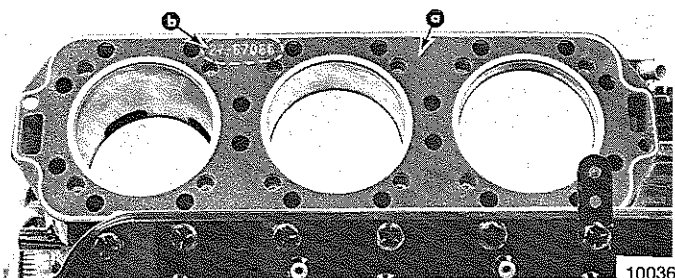
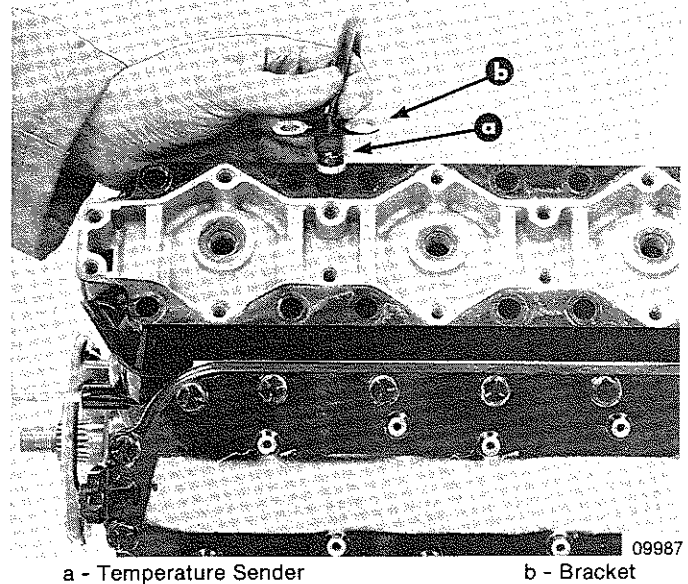


Figure 30. Exhaust Manifold Cover



a - Cylinder Head Gasket
b - Numbered Side of Cylinder Head Gasket

Figure 31. Cylinder Head Gasket



a - Temperature Sender

b - Bracket

Figure 32. Installing Cylinder Head and Temperature Sender

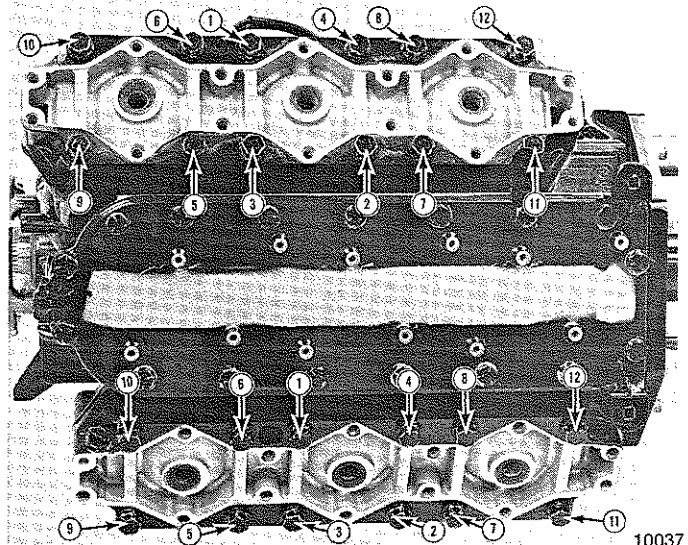


Figure 33. Cylinder Head Torque Sequence

3. Position exhaust manifold cover over divider plate gasket and secure with attaching bolts. Torque exhaust manifold cover bolts in 3 progressive steps (following torque sequence in Figure 30) until bolts are torqued to specification on Page 4-1.

NOTE: One of the exhaust manifold cover bolts has a wiring harness support plate assembly on it. Location of this plate was marked during disassembly. Reinstall support plate on correct bolt.

4. Place cylinder head gasket over starboard side of cylinders with numbered side of gasket up (away from cylinder block). (Figure 31)

IMPORTANT: Cylinder head gasket **MUST BE** installed correctly.

5. Place cylinder head over starboard side cylinders so that hole for temperature sender is toward flywheel end of cylinder block. (Figure 32)

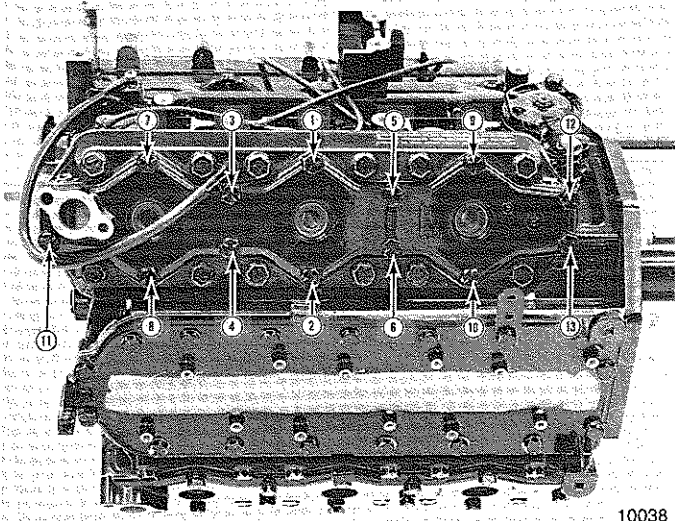


Figure 34. Cylinder Head Covers

6. Install temperature sender (with bracket) into starboard side cylinder head, as shown in Figure 32.
7. Install bolts which secure starboard cylinder head to cylinder block. Torque cylinder head bolts in 3 progressive steps (following torque sequence in Figure 33) until bolts are torqued to specification.
8. Install cylinder head gasket and cylinder head over port side cylinders. Secure with bolts and use torque procedure

9. Reconnect temperature sender wires to terminals of terminal block on starboard side of powerhead.
10. Install cylinder head cover gasket and cylinder head cover on each cylinder head. Install covers with thermostat openings toward flywheel end of powerhead. (Figure 5 in "Cylinder Heads and Exhaust Covers - Removal")
11. Install cylinder head cover bolts with "J" clips placed at proper locations. Torque cylinder head cover bolts in 3 progressive steps (following torque sequence in Figure 34) until bolts are torqued to specification.

NOTE: Location of cylinder head cover "J" clips was noted during disassembly.

12. Install a new thermostat gasket around each thermostat so that shoulder on gasket will be toward cylinder head cover when installed.
13. Install thermostat, then thermostat covers (with water distribution hoses) onto cylinder head covers. (Figure 4 in "Cylinder Heads and Exhaust Covers - Removal") Secure thermostat covers with attaching bolts and torque bolts to specification.
14. Connect water distribution hoses (from starboard side thermostat cover) to discharge fitting on pressure relief valve cover. Clamp hose securely at fitting. (Refer to Figure 35 for water flow schematic.)

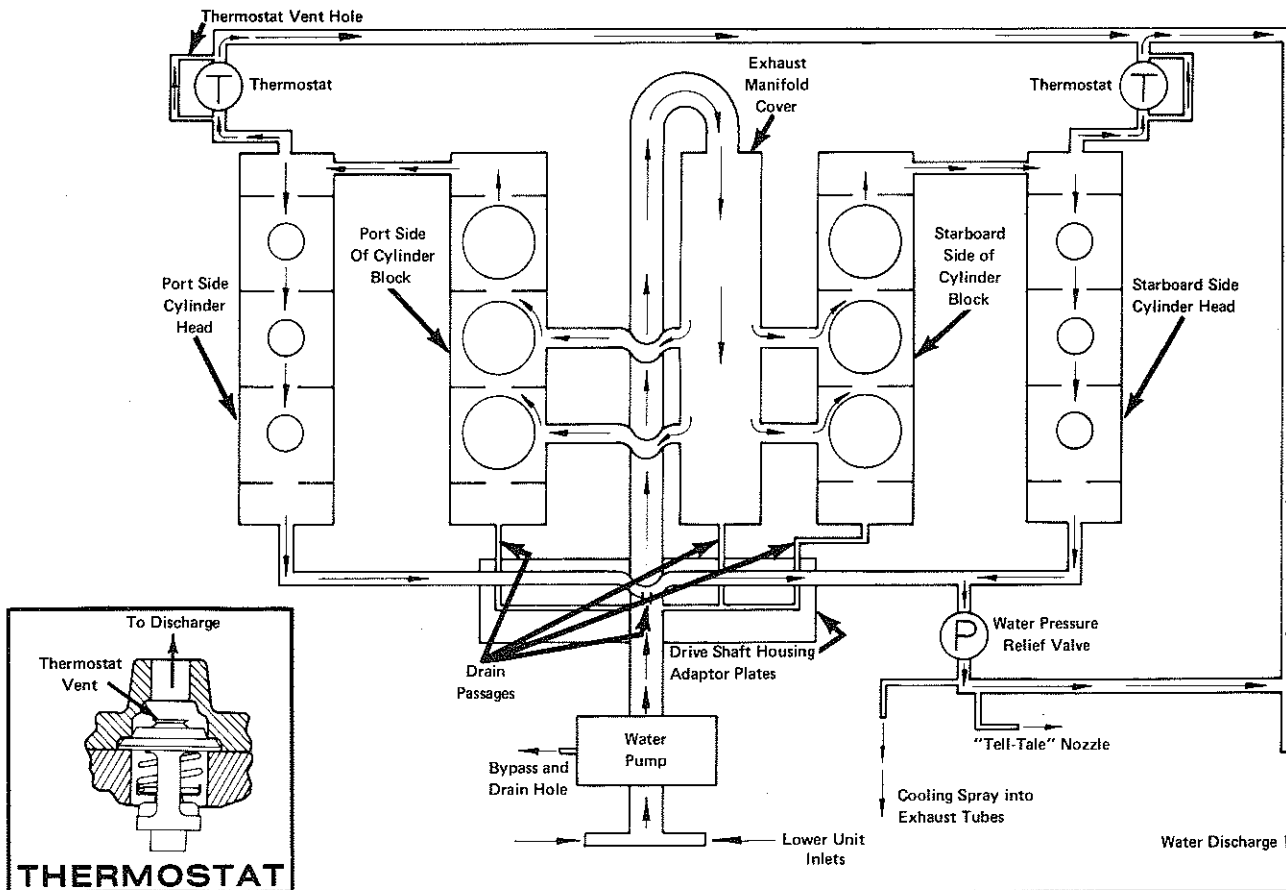
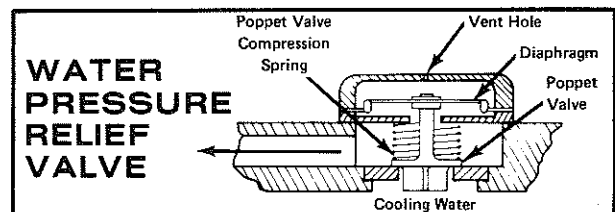


Figure 35. Cooling System (Water Flow)



Accessories and Flywheel - Installation

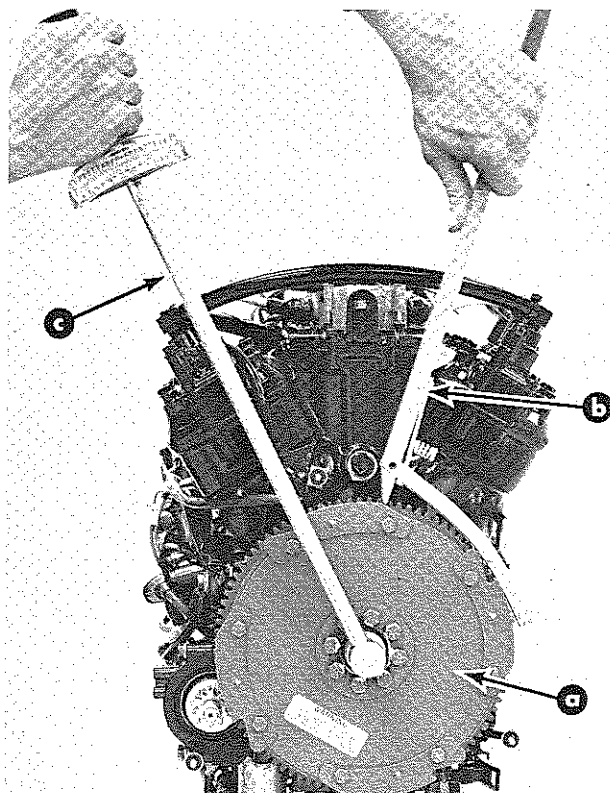
1. Place carburetor gaskets on 3 carburetor mounting flanges of reed block housing.
2. Reinstall carburetors, choke plate/air box, fuel pump and cowl brackets onto powerhead as an assembly. Secure carburetors with 12 locknuts (4 on each carburetor), torqued to specification listed on Page 4-1.
3. Reconnect bleed hose from fitting on reed block housing to check valve [located at lower (port side) corner of air intake box]. (Figure 8 in "Reed Blocks - Removal and Disassembly", preceding)
4. Replace fuel pump gaskets and diaphragm, then reassemble fuel pump to reed block housing. Secure fuel pump assembly with 5 screws and torque to specification.
5. Reinstall control cable anchor bracket to crankcase cover with 3 bolts. (Figure 3 in "Flywheel and Accessories - Removal") Tighten bolts securely.
6. Lubricate bushing in vertical throttle lever with grease, then re-attach vertical throttle lever assembly to cylinder block with pivot bolt. A flat washer must be reinstalled around pivot bolt and positioned between throttle lever and cylinder block. Tighten pivot bolt securely. (Figure 3 in "Flywheel and Accessories - Removal")
7. Lubricate 2 throttle cam bushings with grease, then re-install throttle cam (with one bushing each side of cam) onto reed block housing stud. Secure throttle cam with locknut. (Figure 3 in "Flywheel and Accessories - Removal") Thread locknut onto stud until 2 or 3 stud threads can be seen on outside of locknut. **DO NOT** tighten locknut. Throttle cam must be free to swivel.

SAFETY WARNING: DO NOT tighten throttle cam attaching locknut. Throttle cam must be free to swivel on stud.

8. Reattach ignition plate (with electrical components) to starboard side of powerhead with 3 bolts and flat washers. Be sure that ground wires and "J" clips are properly installed, then tighten bolts securely.
9. Place a drop of Loctite Type "A" on threads of secondary ignition coil attaching screws. Reinstall 6 secondary ignition coils and coil covers on exhaust manifold cover. Install ground wires from negative (-) ignition coils' terminals around appropriate screws, then secure coils and coil covers with screws. Tighten screws securely.
10. Reconnect green, green/white and green/red switch box wires to positive (+) terminals of respective secondary ignition coils. Secure with lockwasher and nut. Torque terminal nuts to specification. Reinstall rubber boots over coil terminals.

NOTE: Green, green/white and green/red switch box wires have numbered tape flags on them. Switch box wire (identified with "1" on it) must be attached to ignition coil that will fire No. 1 cylinder, etc.

11. Reconnect white/green engine harness wire to terminal block with temperature sender wires attached. Connect wire to terminal, that is not grounded, then insulate terminals with Liquid Neoprene.
12. Insert choke plunger inside choke solenoid and attach solenoid to reed block housing with lockwashers and bolts. Tighten bolts securely.



a - Flywheel
b - Flywheel Holder (C-91-52344)
c - Torque Wrench

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Figure 37. Torquing Flywheel Locknut

13. Reconnect gray engine harness wire to terminal of choke solenoid with lockwasher and nut. Insulate terminal with Liquid Neoprene.
14. Place starter motor (with rubber collars) in position on crankcase cover and secure with 2 covers (upper and lower). Be sure that ground wire is installed on lower mounting bolt, then torque bolts to specification.
15. Reconnect electrical cables to starter motor. Insulate cable ends with Liquid Neoprene.
16. Reinstall trigger plate assembly in upper end cap and insert link rod swivel into vertical throttle lever. Secure link rod to throttle lever with locknut. Tighten locknut securely.
17. Place a drop of Loctite Type "A" on threads of stator attaching screws. Install stator assembly in position in upper end cap and secure with attaching screws. Torque screws to specification.
18. Reconnect stator wires and trigger wires to proper terminals of switch boxes. Reinstall rubber boots over terminals.

NOTE: Wires, with a yellow identification sleeve around them, must be connected to outer switch box. Outer switch box fires cylinders No. 2, 4 and 6.

19. Reinstall sta-straps, as necessary, to secure wiring. Reinstall wiring in proper "J" clips and close clips.
20. Reinstall flywheel on crankshaft. Secure flywheel with flat washer and locknut. While holding flywheel with Flywheel Holder (C-91-52344), torque flywheel locknut to specification. (Figure 27)
21. Reinstall flywheel cover. Secure with flat washers and wing nuts.

Powerhead Installation

1. Install Lifting Eye (C-91-75132) into flywheel.

SAFETY WARNING: BE SURE that Lifting Eye is threaded into flywheel as far as possible BEFORE lifting powerhead.

2. Using a hoist, lift powerhead high enough to allow removal of powerhead from repair stand. Remove powerhead from repair stand, being careful not to damage drive shaft housing gasket surface of powerhead.
3. Place a new gasket around powerhead studs and into position on base of powerhead.
4. Lubricate drive shaft splines with grease and install powerhead on drive shaft housing, using hoist. (Figure 3 in "Powerhead Removal", preceding) It may be necessary to turn flywheel (aligning crankshaft splines with drive shaft splines) so that powerhead will be fully installed.
5. Install 10 flat washers and 10 locknuts which secure powerhead to exhaust extension plate/drive shaft housing. (Figures 1 and 2 in "Powerhead Removal") Torque locknuts in 3 progressive steps until torqued to specification listed on Page 4-1.
6. Disconnect hoist from Lifting Eye, then remove Lifting Eye from flywheel.
7. Reinstall plastic cap in center of flywheel.
8. Reinstall rear cowl bracket assembly (Figure 1 in "Powerhead Removal") to exhaust manifold cover with 3 flat washers and 3 locknuts. Tighten locknuts securely.
9. Reconnect water hose from port side of exhaust adaptor plate to "tell-tale" nozzle. (Figure 1 in "Powerhead Removal") Securely clamp water hose at nozzle.

10. With spring and guide block installed on shift link rod, insert shift link rod into control cable anchor bracket. Guide block must be installed with anchor pin forward.
11. Secure shift link rod assembly with wear plate, latch, washer and locknut. Thread locknut onto shift link rod until 2 or 3 threads are exposed beyond top of nut. DO NOT tighten locknut.
12. Install spark plugs into cylinder heads, torquing to specification.
13. Reconnect ignition coil high tension leads to their respective spark plugs.
14. Connect remote control cables to engine.
15. Connect engine battery cables to terminals of battery.

CAUTION: Be sure that battery cables are connected to battery terminals of same polarity.

16. Connect engine harness to "Extension Harness" by plugging together connectors and securing with clamps.
17. Connect engine fuel hose to fuel tank hose.
18. Refer to Section 2 and complete "Timing/Synchronizing/Adjusting" of this engine.
19. While operating engine, check powerhead for water leaks (check cylinder block, cylinder heads, cylinder head covers, exhaust manifold cover and thermostat covers for water leaks), fuel leaks and exhaust leaks. If a powerhead leak(s) is detected, repair powerhead before placing engine in service.
20. Reinstall port and starboard halves of "clam-shell" cowl, then install front cowl cover.

Powerhead Break-In

CAUTION: To avoid possible engine damage, "Break-In Procedure", following, MUST BE completed BEFORE operating engine at full throttle continuously.

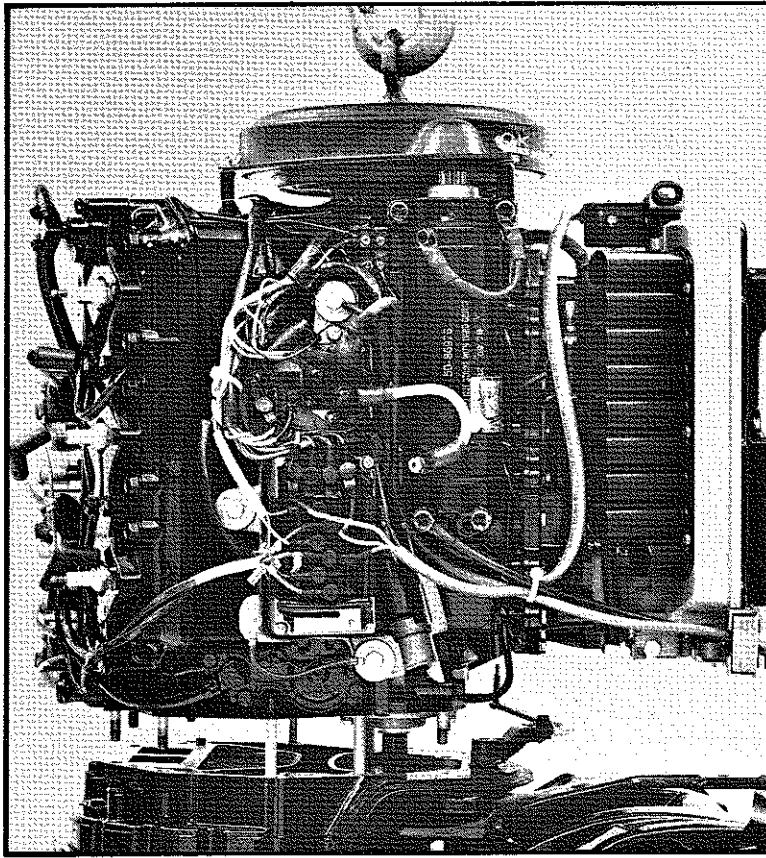
The owner must be advised that break-in procedures must be followed exactly when an overhauled engine is returned to service. (Refer to "Break-In Procedure", following).

BREAK-IN PROCEDURE

Operate overhauled engine at ½ throttle (2500-3500 RPM) for two (2) hours. After 2 hours, the engine may run at any speed, although sustained operation at full throttle should be avoided for an additional eight (8) hours. Mix gasoline and oil during the break-in period (first 10 hours of operation) at a 25:1 ratio.

V-6 OUTBOARDS

Powerhead



225 HP MODEL

SECTION

4

PART

A

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Thermostats and Temperature Sender	4A-14	Reassembly and Installation	4A-33
Cylinder Heads and Exhaust Covers	4A-15	Exhaust Covers and Cylinder Heads -	
Cylinder Block and Crankcase Cover	4A-15	Installation	4A-34
Idle Shutoff Valve	4A-16	Accessories, Flywheel and Powerhead -	
Pistons	4A-17	Installation	4A-37
Connecting Rods	4A-17		

GENERAL INFORMATION

Powerhead "Disassembly" and "Reassembly" instructions are printed in a sequence that should be followed to assure best results when removing or replacing powerhead components. If complete disassembly is not necessary, start reassembly at point disassembly was stopped. (Refer to "Index", preceding.) Usually, complete disassembly of powerhead will be required.

If major powerhead repairs are to be performed, remove powerhead from drive shaft housing. Removal of powerhead is not required for 1) inspection of cylinder walls and pistons (refer to "Powerhead Removal and Disassembly", following,

and remove cylinder heads and exhaust covers), 2) minor repairs on components, such as ignition system, carburetors, reed blocks and cylinder heads, and 3) checking operation of thermostats and temperature sender (remove thermostats and temperature sender, then refer to "Cleaning and Inspection", following).

A powerhead repair stand may be purchased from:

Bob Kerr's Marine Tool Co.
P.O. Box 1135
Winter Garden, FL 32787
Telephone: (305) 656-2089

Tools for Powerhead Repair

Tool Description	Part No.
Lifting Eye	C-91-75132
Flywheel Holder	C-91-52344
Protector Cap	C-91-24161
Flywheel Puller	C-91-73687A1
Powerhead Stand	C-91-30591A1
Piston Ring Expander	C-91-24697
Lockring Removal Tool	C-91-52952A1
Piston Support Block	C-91-77005
Piston Pin Tool	C-91-74607A1

Tool Description	Part No.
Torch Lamp	C-91-63209
Driver Head	C-91-55919
Driver Rod	C-91-37323
Universal Puller Plate	C-91-37241
VOA Meter	C-91-62562
Snap Ring Pliers	C-91-24283
Lockring Installation Tool	C-91-77109A1
Piston Ring Compressor*	C-91-85534

225 HP V-6 Model Powerhead Torques

	Fastener Shown in Figure A on Next Page	Size	Torque	Loctite and Sealants
—	Coil Terminal Nuts	10-32	20 In. Lbs. (23kg-cm)	
—	Fuel Pump Attaching Screws	10-32	25 In. Lbs. (29kg-cm)	
A	Reed Attaching Screws	8-32	25 In. Lbs. (29kg-cm)	
B	Stator Attaching Screws	10-24	30 In. Lbs. (35kg-cm)	Loctite Type "A"
—	Coil Attaching Screws	10-32	35 In. Lbs. (40kg-cm)	Loctite Type "A"
C	Reed Block Attaching Screws	1/4-20	60 In. Lbs. (69kg-cm)	
D	Intake Manifold Attaching Screws	1/4-20	60 In. Lbs. (69kg-cm)	
E	End Cap Screws (Lower)	1/4-20	60 In. Lbs. (69kg-cm)	
—	Carburetor Nuts	1/4-28	80 In. Lbs. (92kg-cm)	
F	End Cap Screws (Upper)	5/16-18	150 In. Lbs. (173kg-cm)	
G	Idle Shut Off Valve Cover Screws	5/16-18	150 In. Lbs. (173kg-cm)	
H	Thermostat Cover Screws	5/16-18	150 In. Lbs. (173kg-cm)	
I	Cylinder Head Cover Screws	.312-18	150 In. Lbs. (173kg-cm)	
J	Exhaust Manifold Cover Screws	.312-18	180 In. Lbs. (207kg-cm)	Loctite 271
—	Starter Motor Attaching Screws	5/16-18	180 In. Lbs. (207kg-cm)	
K	Crankcase Cover Screws	5/16-18	200 In. Lbs. (230kg-cm)	
L	Spark Plug	14 MM	17 Ft. Lbs. (2.35mkg)	
M	Cylinder Head Attaching Screws	3/8-16	30 Ft. Lbs. (4.15mkg)	
N	Connecting Rod Screws	.3125-24	30 Ft. Lbs. (4.15mkg)	Loctite 271
O	Crankcase Cover Screws	3/8-16	35 Ft. Lbs. (4.84mkg)	Light Oil
P	Powerhead to Exhaust Extension Plate	3/8-24	45 Ft. Lbs. (6.22mkg)	
Q	Flywheel Nut	5/8-18	100 Ft. Lbs. (13.83mkg)	

Barrel Profile Piston Diameter		
R	225 HP (V-6)	(a) 3.372" (85.649mm)

(a) Measure outside of piston 1/2" (12.7mm) up from bottom of piston, in line with piston pin and at right angle (90°) to piston pin.

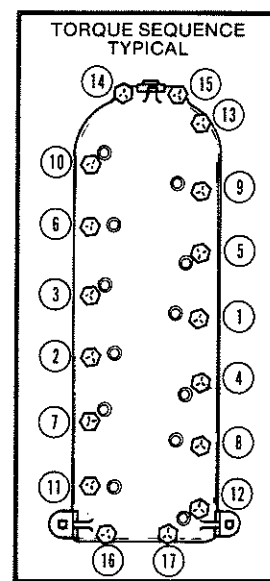
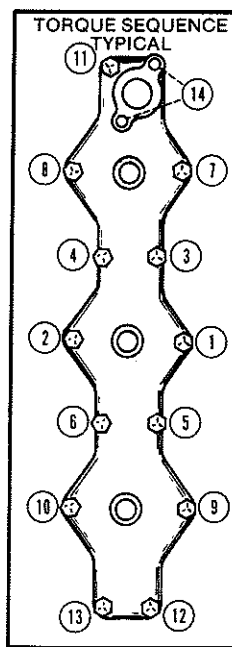
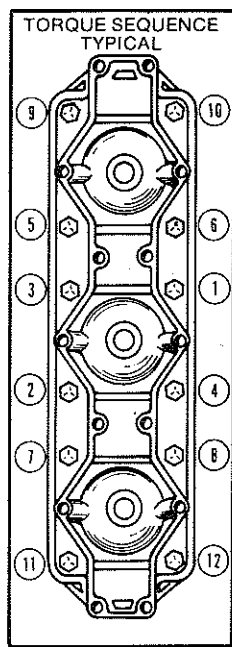
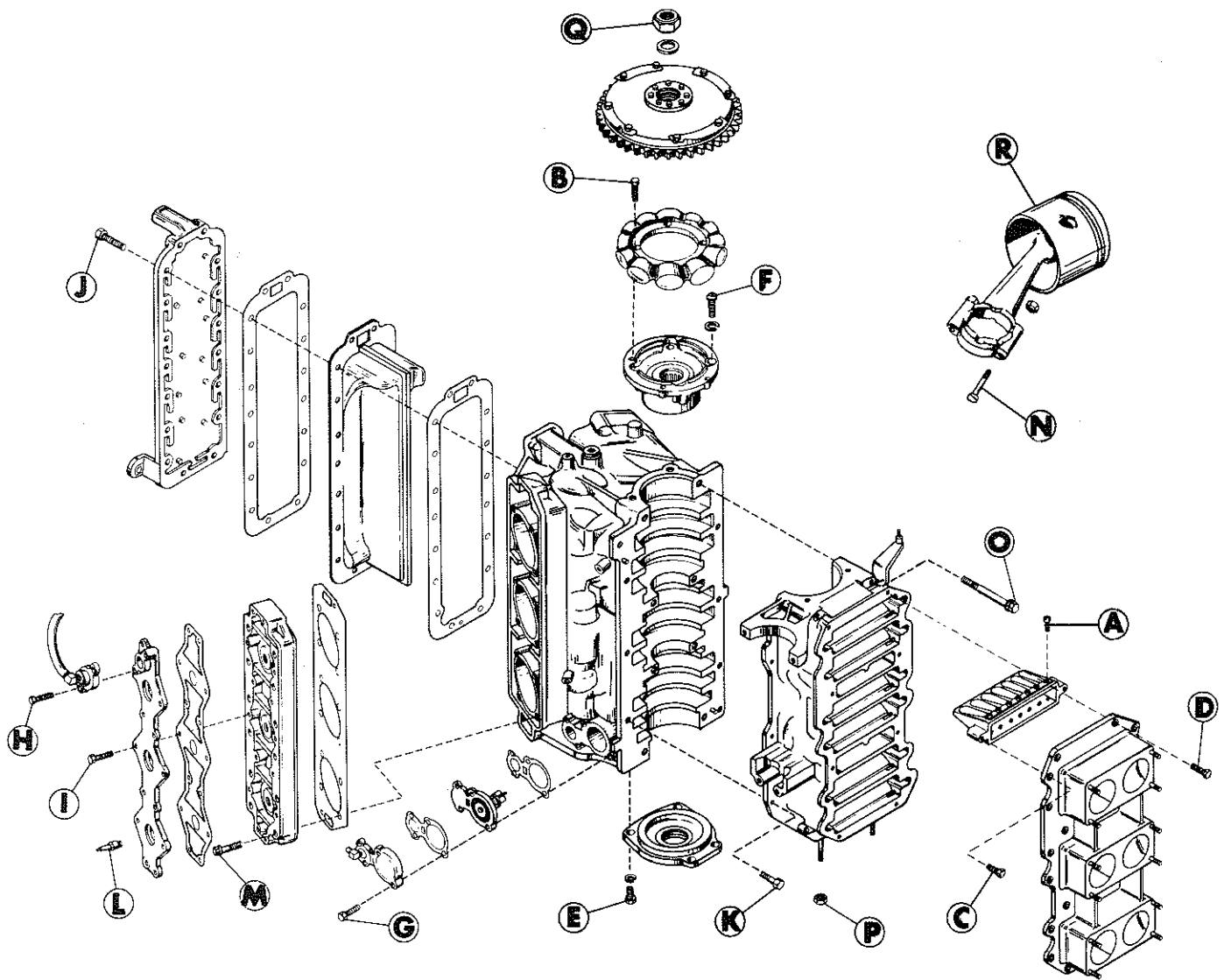


Figure A. Model 225 HP Fastener Locations and Torque Sequence (Torque Chart on Page 4A-1)

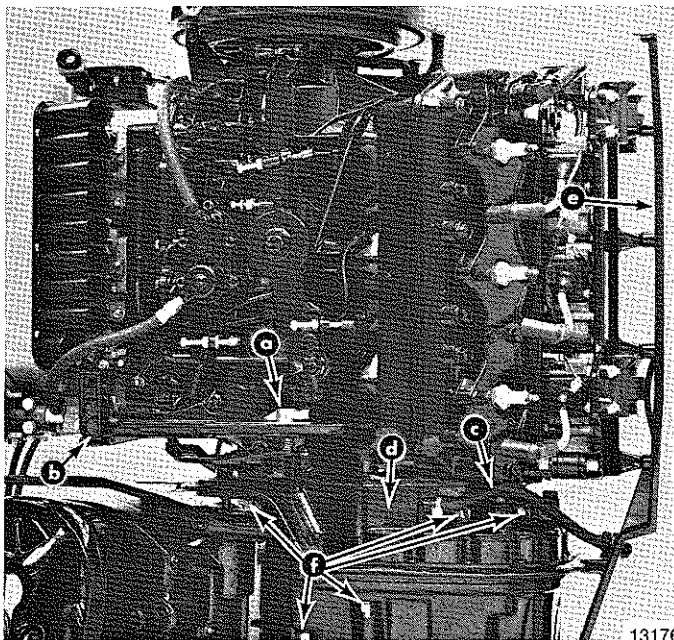
POWERHEAD REMOVAL and DISASSEMBLY

Powerhead Removal

1. Disconnect battery cables from battery terminals.
2. Disconnect fuel tank hose from outboard.
3. Remove front cover and clam-shell cowling from outboard.
4. Remove 2 screws, which secure remote control harness retainer, and remove retainer.
5. Disconnect remote control harness connector from engine harness connector and pull battery cables from remote control harness sleeve.

SAFETY WARNING: Remove high tension leads from spark plugs BEFORE working on powerhead.

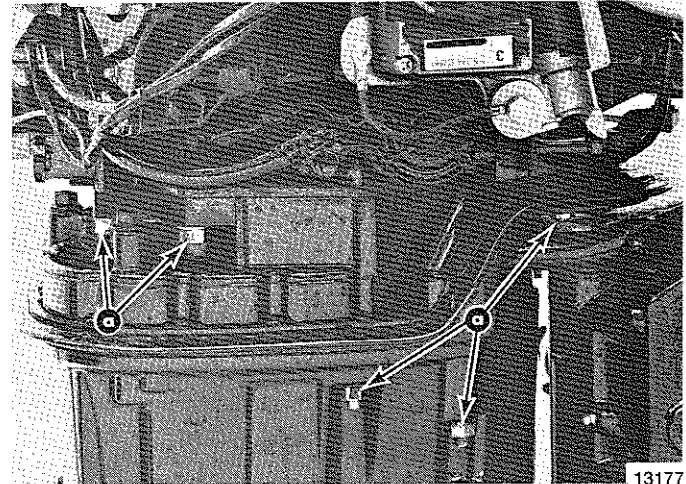
6. Disconnect high tension leads from spark plugs.
7. Shift outboard into neutral position.



- a - Shift Cable Latch Assembly e - Rear Cowl Support Bracket
 b - Control Cable Anchor Bracket f - Powerhead Attaching
 c - "Tell-Tale" Hose Locknuts and Flat Washers
 d - Exhaust Plate Assembly

Figure 1. Powerhead (Port Side)

8. Remove locknut, that secures shift cable latch assembly (Figure 1), then remove shift cable latch, flat washer, nylon wear plate and spring from control cable anchor bracket.
9. Remove sta-strap [secures "tell-tale" hose to elbow fitting on exhaust plate assembly (Figure 1)] and remove hose from fitting.
10. Remove 3 locknuts and flat washers, which secure the rear cowl support bracket and bracket bumpers to powerhead (Figure 1), and remove bracket (with attached bumpers) from powerhead.
11. Remove 10 locknuts and flat washers (5 each side; secure powerhead to drive shaft housing). (Figures 1 and 2)



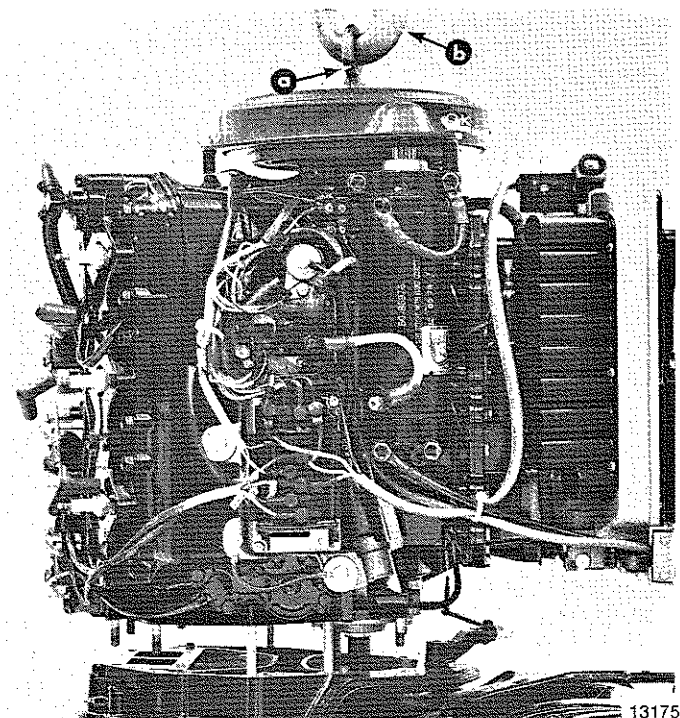
- a - Powerhead Attaching Locknuts

Figure 2. Powerhead (Starboard Side)

12. Remove plastic cap from center of flywheel cover and install Lifting Eye (C-91-75132) into flywheel. (Figure 3)

SAFETY WARNING: BE SURE that Lifting Eye is threaded into flywheel as-far-as possible BEFORE removing powerhead.

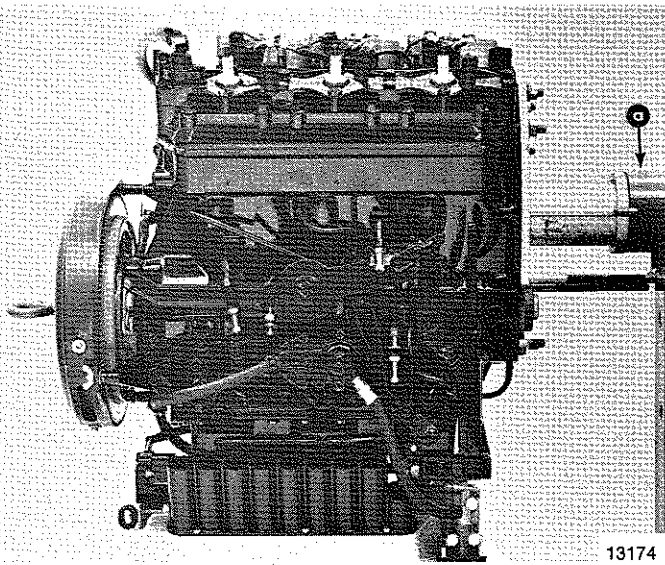
13. Using a hoist, lift powerhead assembly from drive shaft housing. (Figure 3)



- a - Lifting Eye (C-91-75132)

- b - Hoist

Figure 3. Lifting Powerhead from Drive Shaft Housing



14. Install powerhead into a suitable, floor-mounted repair stand (refer to "General Information", preceding). (Figure 4) Be sure that repair stand can adequately support powerhead without damaging gasket surface of cylinder block.

SAFETY WARNING: DO NOT attempt to place powerhead on a powerhead stand that is mounted in a vise.

15. Remove Lifting Eye from flywheel.

a - Powerhead Repair Stand

Figure 4. Powerhead Installed in Repair Stand

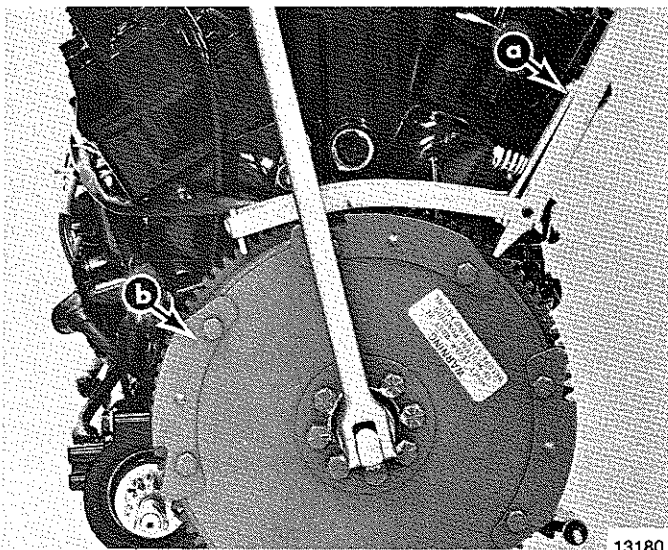
Flywheel and Accessories - Removal

1. Remove flywheel cover from powerhead.
2. While holding flywheel with Flywheel Holder (C-91-52344), remove flywheel nut and washer. (Figure 5)
3. Install a crankshaft Protector Cap (C-91-24161) on end of crankshaft, then install Flywheel Puller (C-91-73687A1) into flywheel. (Figure 6)

CAUTION: Crankshaft damage may result if a protector cap is not used between crankshaft and puller.

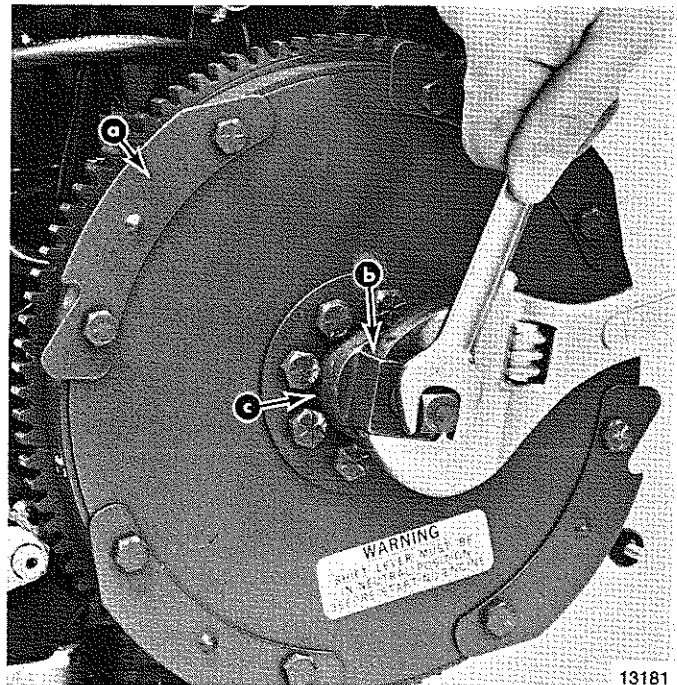
4. Remove flywheel by operating Flywheel Puller as shown in Figure 6.

CAUTION: DO NOT strike end of puller center bolt to remove flywheel, or damage may result to crankshaft or bearings. DO NOT use heat to aid flywheel removal, as excessive heat may seize flywheel to crankshaft.



a - Flywheel Holder (C-91-52344) b - Flywheel

Figure 5. Flywheel Nut Removal



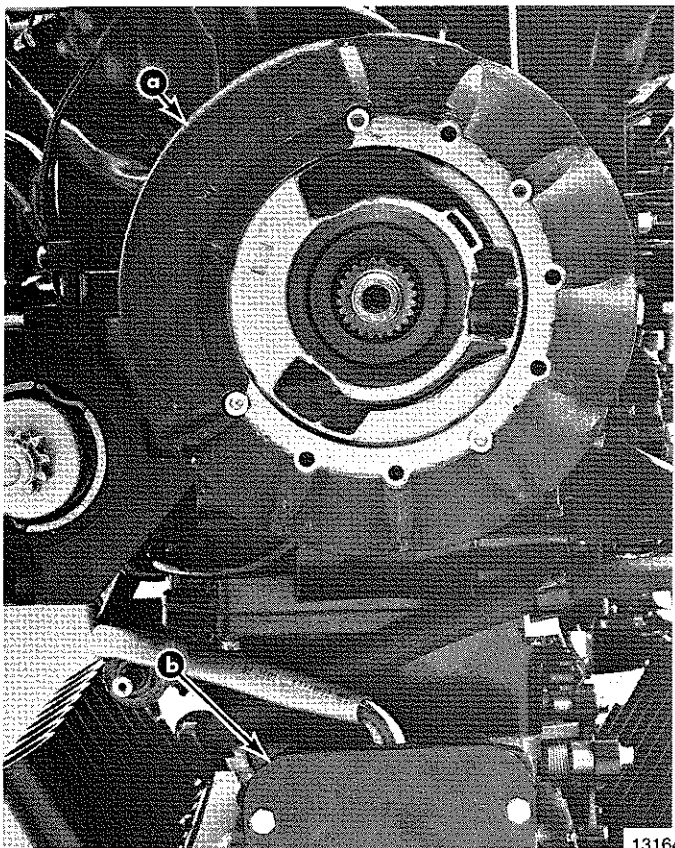
a - Flywheel c - Crankshaft Protector Cap (Hidden)
b - Flywheel Puller (C-91-73687A1)

Figure 6. Flywheel Removal

5. Remove 4 allen screws and lockwashers which secure stator to end cap. (Figure 7)

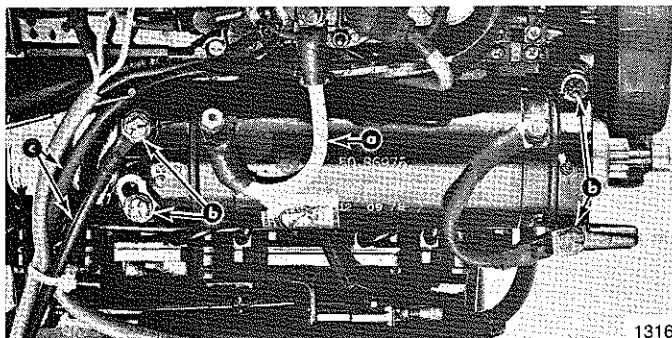
NOTE: Loctite has been applied to threads of stator attaching screws.

6. Remove 2 locknuts which secure the high speed spark advance module to air box. (Figure 7) Lift module from studs and reinstall locknuts.
7. Remove nut and lockwasher [secure the yellow wire (Figure 8) to starter motor], then remove wire from starter and reinstall lockwasher and nut.
8. Remove 4 bolts (Figure 8) which secure the upper and lower starter motor anchor caps. Remove upper and lower caps and starter motor from powerhead.



a - Stator b - High Speed Spark Advance Module

Figure 7. Top View of Powerhead with Flywheel Removed

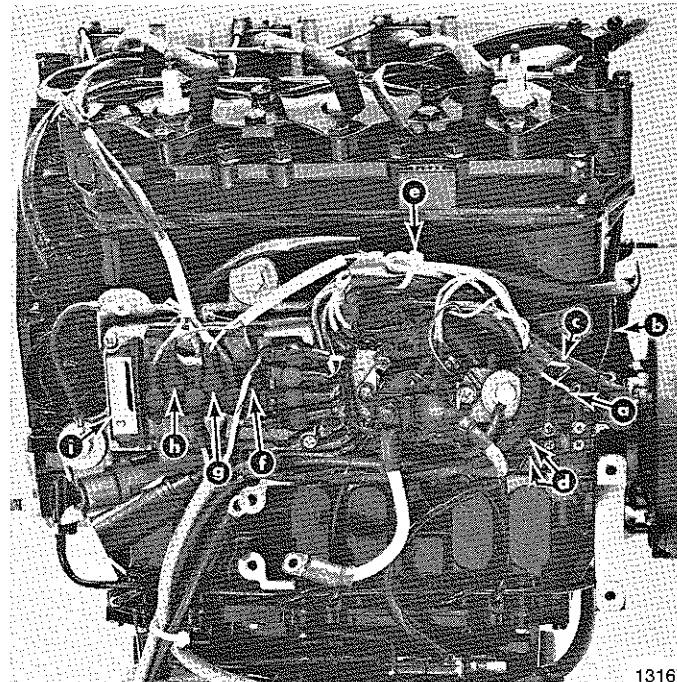


a - Yellow Wire b - Starter Motor Bolts c - Battery Cables

Figure 8. Starter Motor Removal

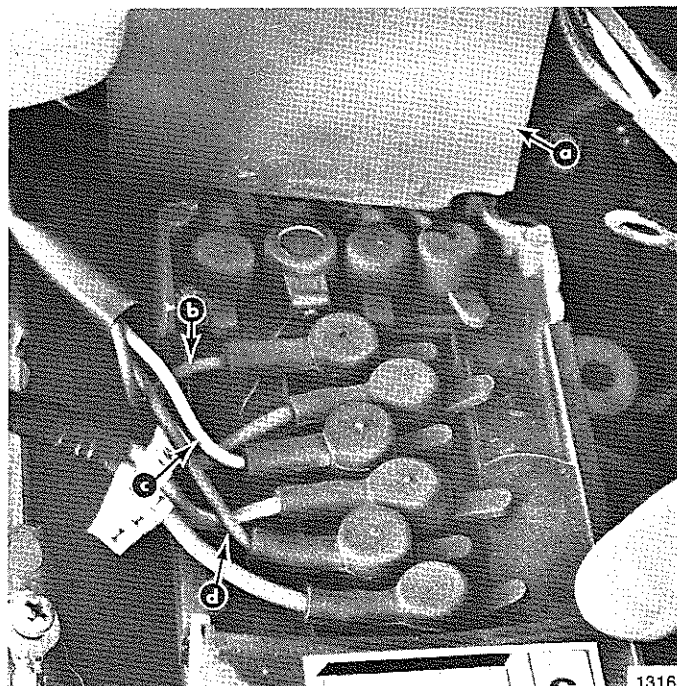
9. Remove tan wire (from ignition plate harness) and black wire (from temperature sender) from terminal block on the starboard side of powerhead. (Figure 9)
10. Remove yellow/black wire (from ignition plate harness) and 2 black wires (from carburetor enrichener) from terminal block on the starboard side of powerhead. (Figure 9)
11. Cut (and remove) sta-strap that secures trigger harness to ignition plate. (Figure 9)
12. Remove nuts, which secure the violet, white and brown trigger wires to the outer switch box (Figure 9), then remove wires from switch box and thread nuts back onto switch box.
13. Remove 2 phillips head screws and spacers, which secure the outer and inner switch boxes to ignition plate, and lift outer switch box away from inner switch box. (Figure 10)

14. Remove nuts, which secure the violet, white and brown trigger wires to the inner switch box (Figure 10), then remove wires from switch box and thread nuts back onto switch box.



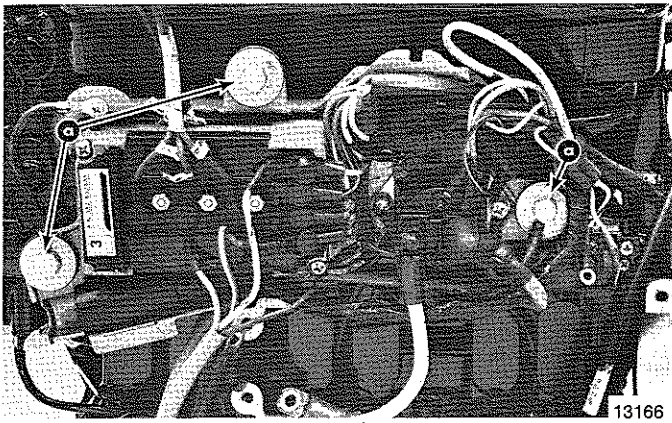
a - Tan Wire f - Violet Trigger Wire
 b - Temperature Sender Black Wire g - White Trigger Wire
 c - Yellow/Black Wire h - Brown Trigger Wire
 d - Carburetor Enrichener Black Wires i - Outer Switch Box
 e - Sta-Strap

Figure 9. Starboard Side of Powerhead with Starter Motor Removed



a - Outer Switch Box c - White Trigger Wire
 b - Violet Trigger Wire d - Brown Trigger Wire

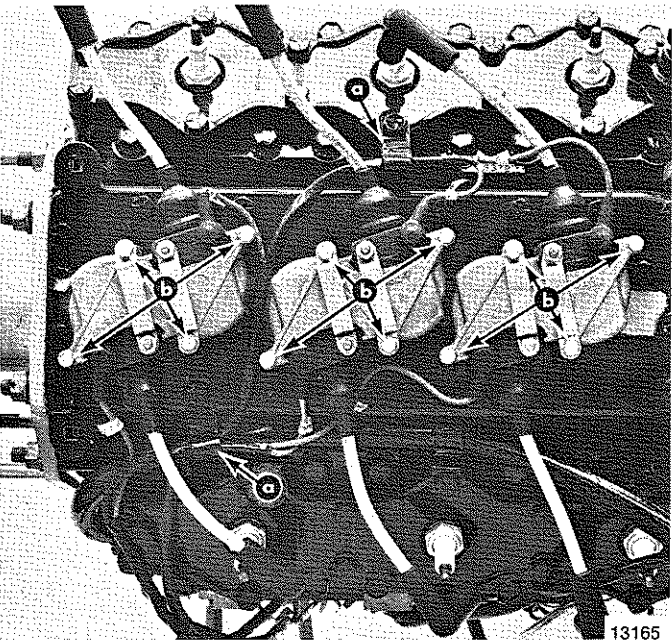
Figure 10. Removing Trigger Wires from Inner Switch Box



a - Ignition Plate Bolts

Figure 11. Ignition Plate with Trigger Wires Removed from Switch Boxes

15. Secure inner and outer switch boxes back onto ignition plate with 2 phillips head screws and spacers. (Figure 11)
16. Remove coil wires from "J" clamps. (Figure 12)
17. Remove 12 screws which secure coils to exhaust manifold cover. (Figure 12)
18. Remove 3 bolts, flat washers and rubber mounts [secure ignition plate to powerhead (Figure 11)] and remove ignition plate (with attached stator and coils) from powerhead.



a - "J" Clamps b - Coil Attaching Screws

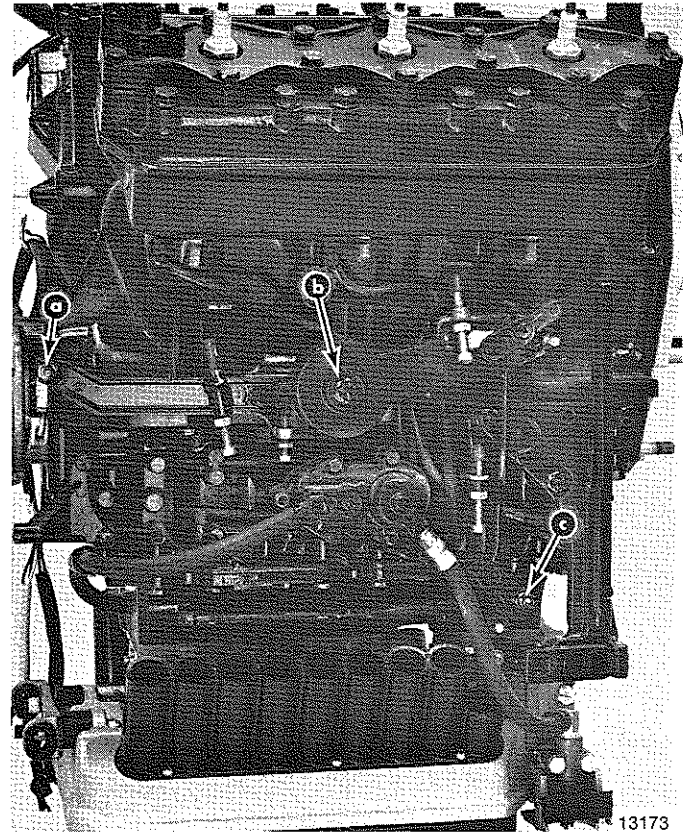
Figure 12. Ignition Coils

19. Remove locknut, that secures trigger linkage to spark/throttle lever. (Figure 13) Remove linkage from lever and reinstall locknut onto linkage.
20. Remove trigger from powerhead.
21. Remove locknut that secures throttle cam (Figure 13) to stud on intake manifold. (DO NOT try to remove throttle cam from stud at this time.)
22. Remove bolt that secures spark/throttle lever to powerhead. (Figure 13)

NOTE: A flat washer is positioned between spark/throttle lever and powerhead.

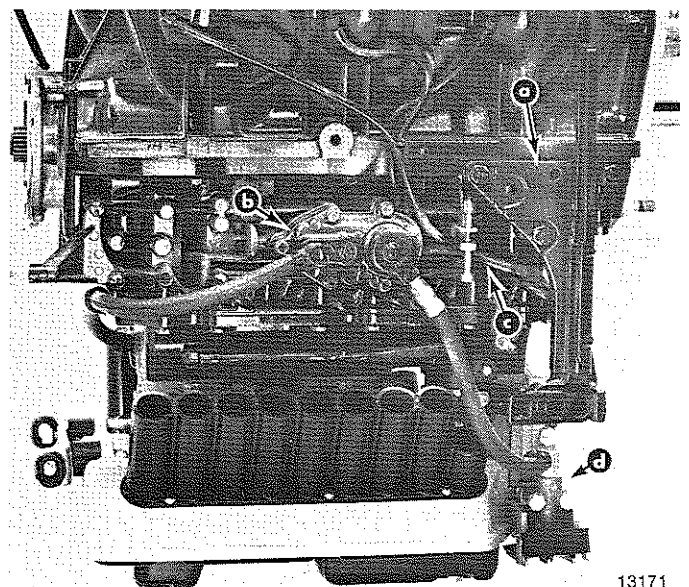
23. Remove spark/throttle lever and throttle cam from powerhead as an assembly. Insert bolt, that secured spark/throttle lever to powerhead, back thru lever and install a nut onto bolt to help hold spark/throttle lever assembly together.

NOTE: Two nylon bushings (one on the inside and one on the outside) are installed on throttle cam mounting stud.



a - Trigger Linkage Nut c - Throttle Cam Locknut
b - Spark/Throttle Lever Bolt

Figure 13. Spark/Throttle Lever Removal



a - Control Cable Anchor Bracket c - Pulse Hose
b - Fuel Pump Assembly d - Check Unit Adaptor

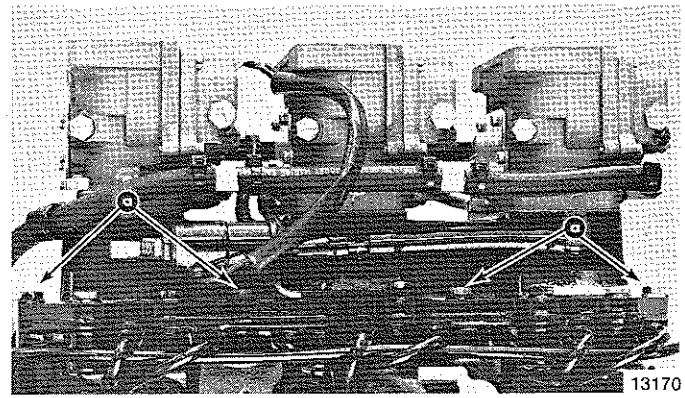
Figure 14. Powerhead with Spark/Throttle Lever Removed

24. Remove 3 bolts [secure control cable anchor bracket to powerhead (Figure 14)] and remove bracket from powerhead.
25. Remove 2 bolts which secure check unit adaptor to air box. (Figure 14)
26. Remove 5 attaching screws which secure fuel pump assembly to powerhead. (Figure 14) Being careful not to separate fuel pump components, lift fuel pump assembly away from powerhead and disconnect pulse hose from fitting on powerhead. Insert 2 of the attaching screws back thru fuel pump assembly and thread a 10-32 nut onto screws. This will prevent fuel pump components from separating during the remainder of powerhead disassembly.

NOTE: It is not necessary to disconnect fuel hoses from fuel pump, as fuel pump will be removed with carburetors.

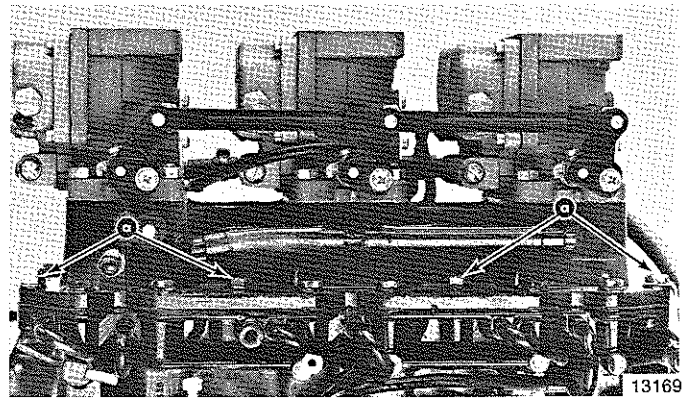
27. Remove 6 bolts, which secure the air box to carburetors, then remove air box.
28. Remove 8 bolts [attach the intake manifold to crankshaft cover (Figures 15 and 16)] and remove manifold from powerhead.

NOTE: Inspect and disassemble the intake manifold as instructed in "Cleaning and Inspection", following.




a - Intake Manifold Attaching Bolts

Figure 15. Intake Manifold Attaching Bolts (Starboard Side)

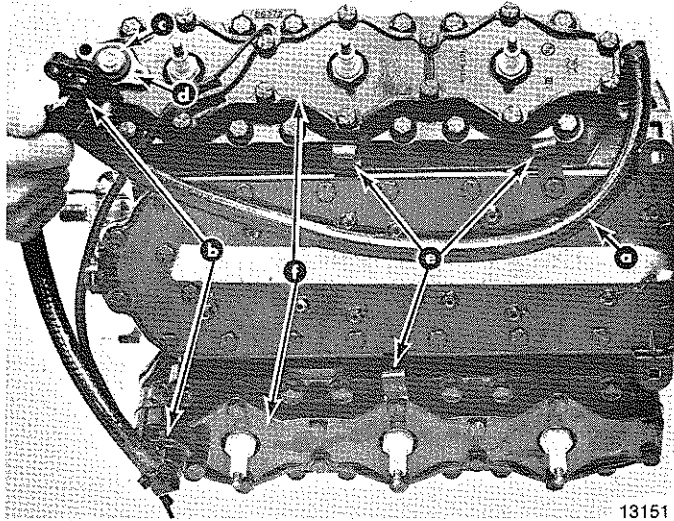


a - Intake Manifold Attaching Bolts

Figure 16. Intake Manifold Attaching Bolts (Port Side) 

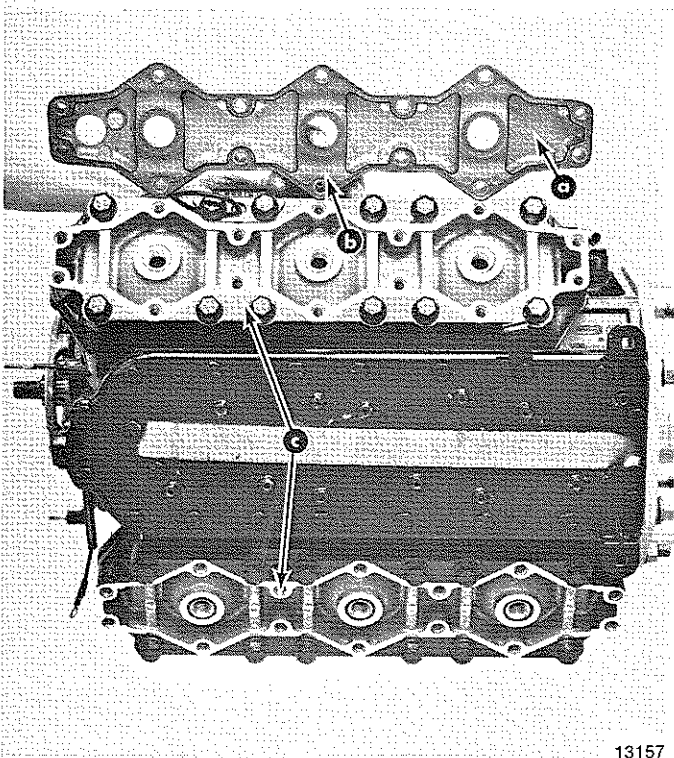
Cylinder Heads and Exhaust Covers - Removal

1. Disconnect water distribution hose from fitting on idle shutoff valve. (Figure 1)
2. Remove bolts which secure thermostat covers to cylinder head covers. (Figure 1)
3. Remove thermostat covers, thermostats and gaskets from each cylinder head cover. (Figure 1)



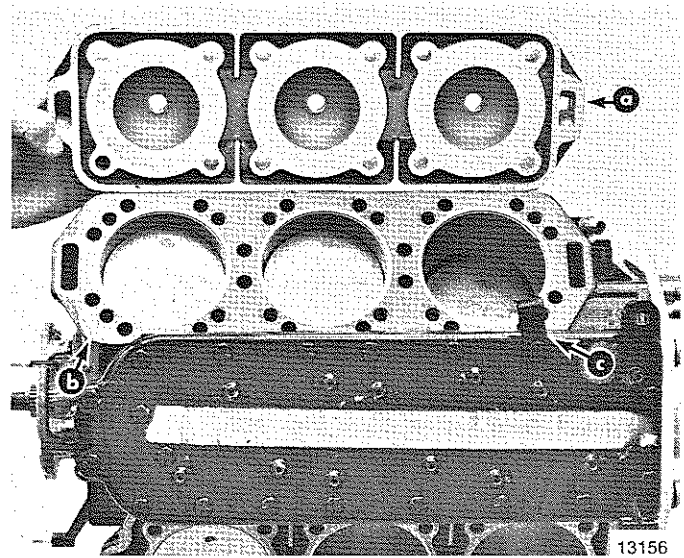
- | | |
|-----------------------------|--------------------------|
| a - Water Distribution Hose | d - Thermostat Gasket |
| b - Thermostat Covers | e - "J" Clips |
| c - Thermostat | f - Cylinder Head Covers |

Figure 1. Thermostat Removal



- | | |
|--------------------------------|-------------------|
| a - Cylinder Head Cover | c - Cylinder Head |
| b - Cylinder Head Cover Gasket | |

Figure 2. Cylinder Head Cover Removal



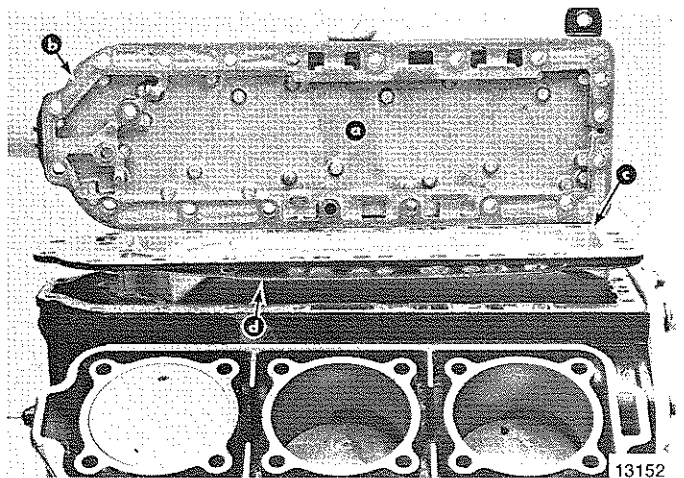
- | | | |
|-------------------|--------------------------|--------------|
| a - Cylinder Head | b - Cylinder Head Gasket | c - "J" Clip |
|-------------------|--------------------------|--------------|

Figure 3. Cylinder Head Removal

4. Mark location of "J" clips (Figure 1) on cylinder head covers (to aid in reassembly), then remove bolts, covers and gaskets from each cylinder head. (Figure 2)
5. Remove cylinder head attaching bolts. Remove cylinder heads and cylinder head gaskets from cylinder block. (Figure 3)
6. Remove temperature sender from starboard side cylinder head.

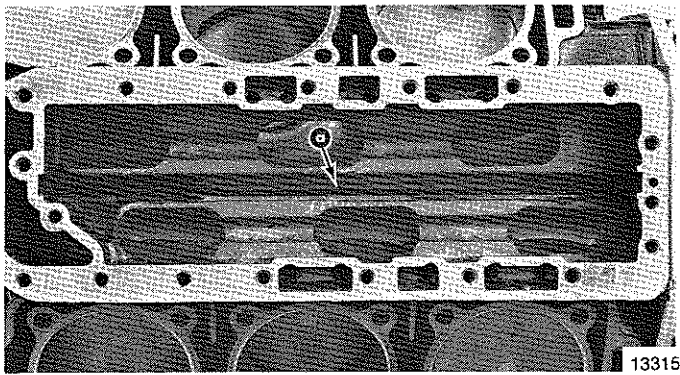
NOTE: Mark location of "J" clip (Figure 3) on exhaust manifold cover (to aid in reassembly).

7. Remove bolts from exhaust manifold cover, then remove exhaust manifold cover, gasket, exhaust divider plate and divider plate gasket from cylinder block. (Figure 4)
8. Remove exhaust divider plate seal from cylinder block. (Figure 5)



- | | |
|--|--|
| a - Exhaust Manifold Cover | c - Exhaust Divider Plate |
| b - Gasket (Exhaust Manifold Cover to Exhaust Divider Plate) | d - Gasket (Exhaust Divider Plate to Cylinder Block) |

Figure 4. Exhaust Manifold Cover and Divider Plate



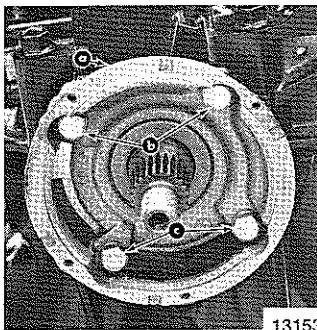
a - Exhaust Divider Plate Seal
Figure 5. Exhaust Divider Plate Seal

Pistons and Connecting Rods - Removal

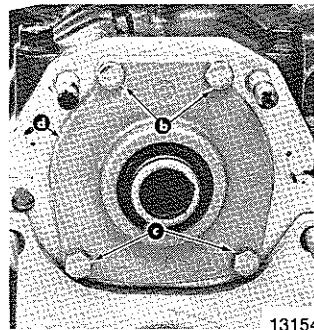
1. Remove bolts (Figure 6) which are used to attach the upper and lower end caps to crankcase cover. Loosen (DO NOT REMOVE) bolts (Figure 6) which are used to attach the upper and lower end caps to cylinder block.

NOTE: End cap bolts (threaded into cylinder block) should be loosened, but remain installed, to hold crankshaft in position until connecting rods are removed from crankshaft.

2. Disconnect bleed hoses (3 on the starboard side and 3 on the port side) from fittings on cylinder block.

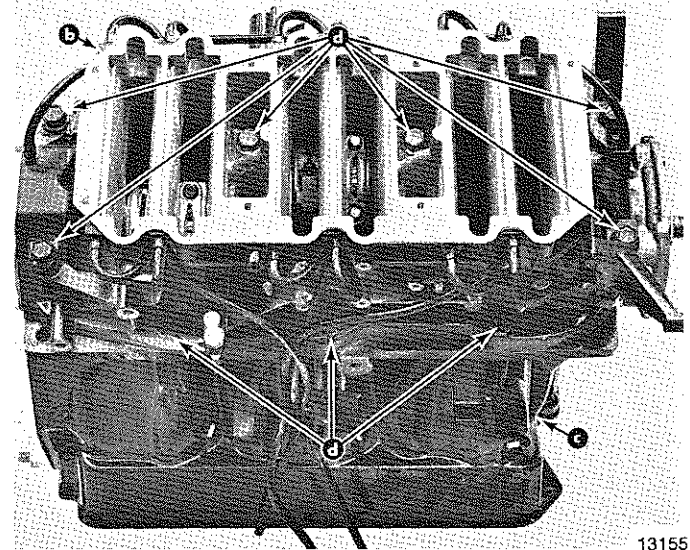


a - Upper End Cap
 b - Remove These Bolts



c - Loosen (DO NOT Remove) These Bolts
 d - Lower End Cap

Figure 6. Upper and Lower End Caps

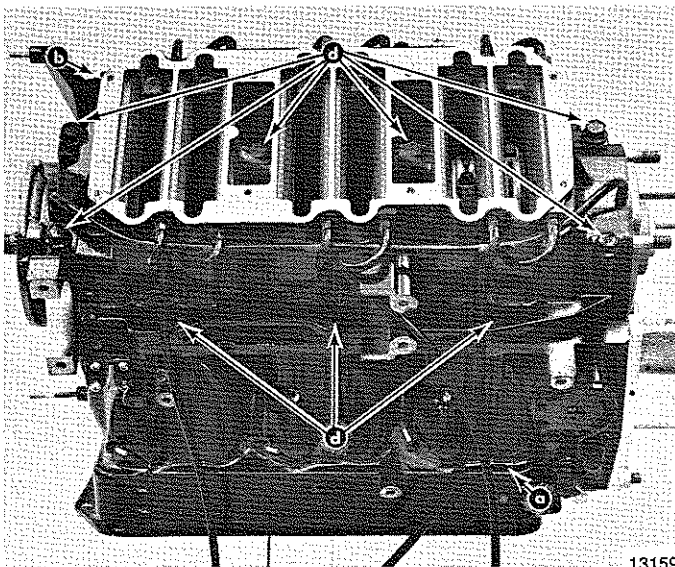


c - Port Side of Cylinder Block
 d - Crankcase Cover Bolts

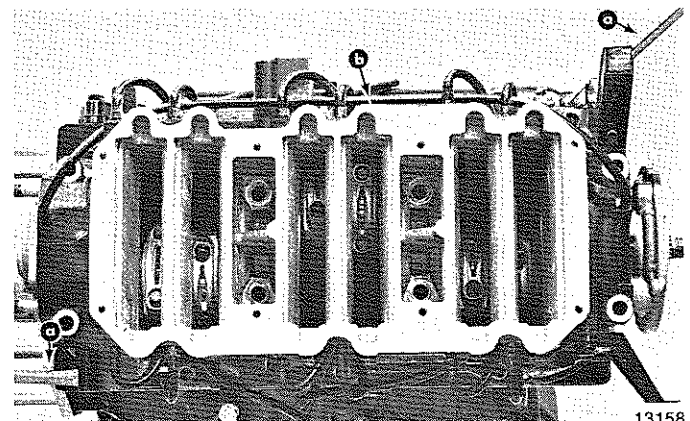
Figure 7. Crankcase Cover

3. Remove bolts, which attach crankcase cover to cylinder block (Figure 7), and remove crankcase cover. Be careful not to damage sealing surfaces or crankshaft.

NOTE: A sealant is used between cylinder block and crankcase cover. It may be necessary to pry crankcase cover off cylinder block, using special recesses provided, as shown in Figure 8.



a - Starboard Side of Cylinder Block
 b - Crankcase Cover



a - Pry Bar
 b - Crankcase Cover

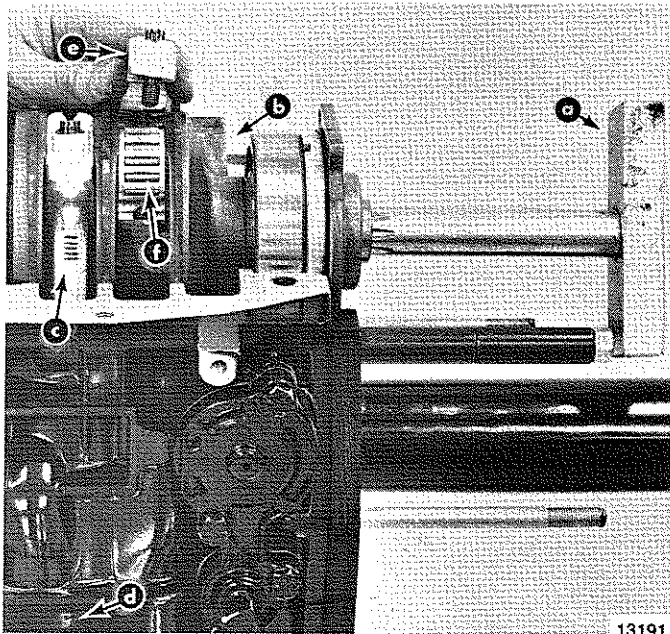
Figure 8. Prying Crankcase Cover Off Cylinder Block (if Necessary)

IMPORTANT: The crankcase cover and cylinder block are a matched, line-bored assembly and never should be mismatched by using a different crankcase cover or cylinder block.

4. Install Powerhead Stand (C-91-30591A1) into drive shaft end of crankshaft. Use Powerhead Stand to turn crankshaft to desired positions when removing connecting rods from crankshaft. (Figure 9)
5. Use an awl (or a felt tip marker) to scribe an identification number on the outside edge of each connecting rod "I" beam. (Figure 9) Number each connecting rod with the same number as the cylinder to which it is installed; i.e., mark a "1" on connecting rod that is installed in No. 1 cylinder, "2" on rod that is in No. 2 cylinder, etc.

CAUTION: As connecting rod cap is removed, be aware of these 2 cautions: 1) that bearings will be free and can be lost as they fall inside of cylinder block, and 2) that piston assembly will be free and may slip out of cylinder block and sustain damage by striking floor.

6. Remove connecting rod bolts with a 5/16"-12 point socket, then lift rod cap, connecting rod bearings (16) and cages from connecting rod and crankshaft. (Figure 9) After each connecting rod cap is removed, lift its respective piston assembly from cylinder block before proceeding to another connecting rod. Reassemble rod cap to its respective connecting rod (Figure 10) after removing piston assembly from cylinder block.

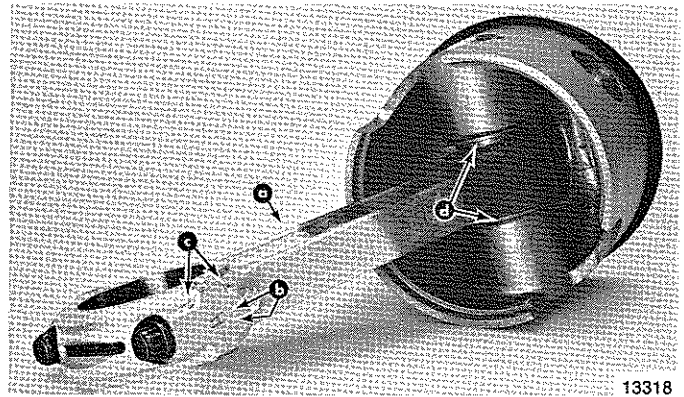


- a - Powerhead Stand (C-91-30591A1)
- b - Crankshaft
- c - Numbered Connecting Rod
- d - Number Marked on Cylinder Block
- e - Connecting Rod Cap
- f - Connecting Rod Bearings and Cages

Figure 9. Crankshaft and Connecting Rods

- a - Piston Ring Expander (C-91-24697)
- b - Piston

Figure 11. Piston Ring Removal



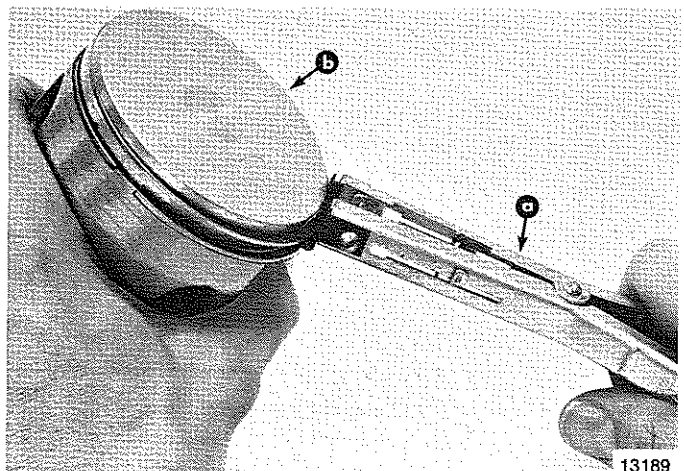
- a - Connecting Rod
- b - "Etched" Alignment Marks
- c - Alignment Bumps
- d - Locating Washers

Figure 10. Connecting Rod and Piston

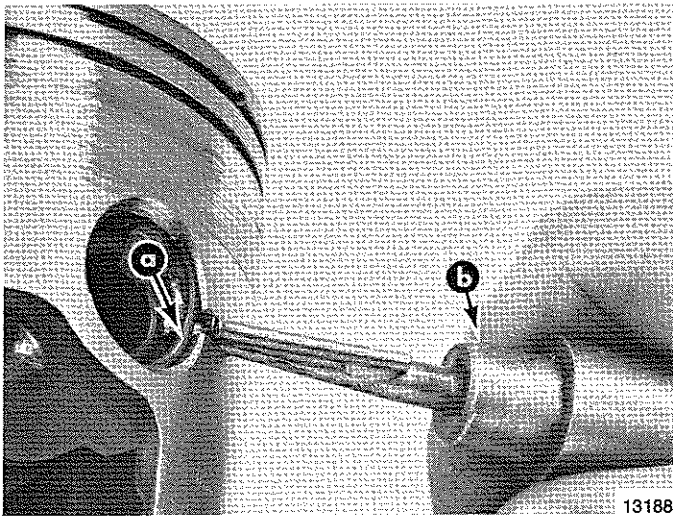
CAUTION: Immediately after removing piston assembly from cylinder block, reassemble its respective rod cap, being certain that "etched" alignment marks (Figure 10) are properly aligned.

CAUTION: It is recommended that NEW connecting rod bearings be installed during re-assembly, regardless of appearance, to assure lasting repair. If, for some reason, bearings must be re-used, keep them separate and identified so that they can be reassembled on the same crankpin throw and with the same connecting rod.

7. As each piston and connecting rod assembly is removed, remove piston rings from pistons with Piston Ring Expander (C-91-24697). (Figure 11) Discard piston rings.
8. After removing all pistons and connecting rods from cylinder block, inspect each piston, its respective connecting rod and piston pin bearings, as outlined in "Cleaning and Inspection", following.
9. If inspection shows that replacement of a piston is necessary, or if condition of wrist pin end of connecting rod is suspected of being bent, or that connecting rod is suspected of being bent, remove piston from connecting rod as outlined, following.



13189



a - Piston Pin Lockring b - Lockring Removal Tool (C-91-52952A1)

Figure 12. Removing Piston Pin Lockring

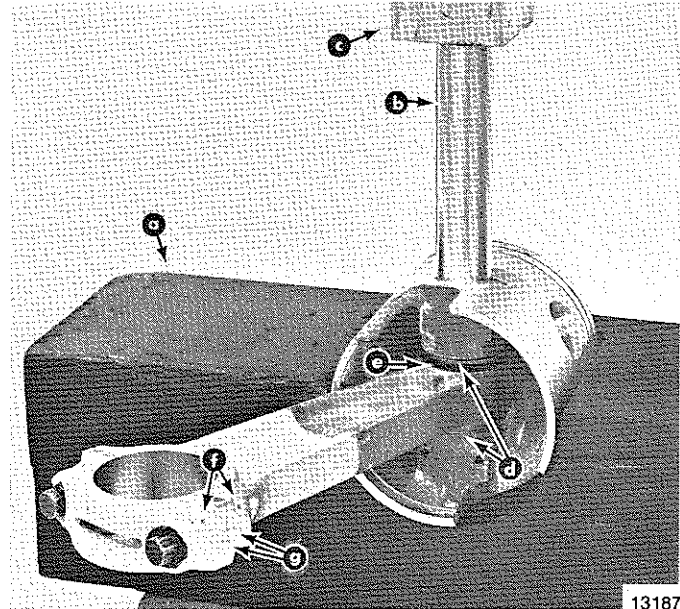
- a. Use an awl (or felt tip marker) to scribe a number on inside of piston skirt to match number (on connecting rod) that was scribed on rod when rod was removed from crankshaft.

SAFETY WARNING: Eye protection MUST BE WORN while removing piston pin lockring.

- b. Remove (and discard) piston pin lockrings from both ends of piston pin. (Figure 12) NEVER re-use piston pin lockrings.
- c. Heat dome of piston to approximately 190°F (88°C) with Torch Lamp (C-91-63209).
- d. Place piston and connecting rod in position on Piston Support Block (C-91-77005). (Figure 13)
- e. Remove piston pin from piston with Piston Pin Tool (C-91-74607A1) and an arbor press. (Figure 13)

- f. Remove piston pin needle bearings (29 per piston) and locating washers (2 per piston) from connecting rod.

CAUTION: If piston is removed from connecting rod, it is recommended that NEW piston pin needle bearings be installed during reassembly, regardless of appearance, to assure lasting repair. If, for some reason, bearings must be re-used, keep them separate and identified so that they can be reassembled on the same connecting rod and the same piston.



a - Piston Support Block (C-91-77005) d - Locating Washers
 b - Piston Pin tool (C-91-74607A1) e - Needle Bearings (Hidden)
 c - Arbor Press f - Alignment Bumps
 g - "Etched" Alignment Marks

Figure 13. Removing Piston from Connecting Rod

End Caps - Removal and Disassembly

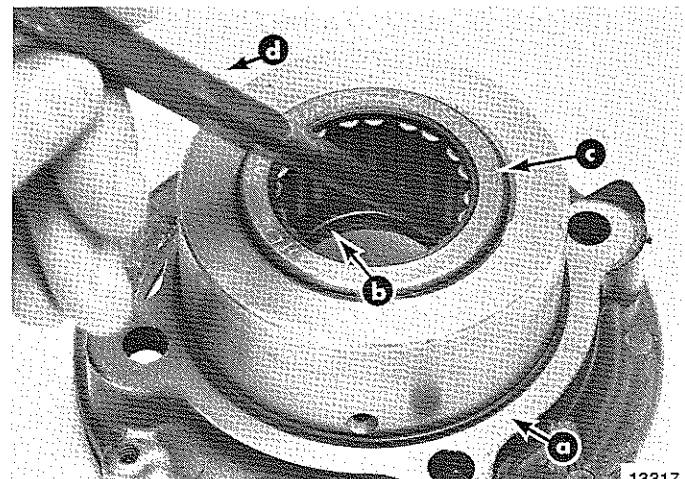
1. Remove bolts which secure upper and lower end caps to cylinder block. (Figure 6)

NOTE: These bolts were previously loosened to allow removal of crankshaft cover.

2. Remove upper and lower end caps from around crankshaft.
3. Remove (and discard) "O" ring from around each end cap. (Figure 14)
4. Drive oil seal(s) from each end cap with a suitable punch, as shown in Figure 14. Discard oil seals.
5. Inspect crankshaft roller bearing, which is installed in upper end cap, as outlined in "Cleaning and Inspection", following.

IMPORTANT: DO NOT remove crankshaft roller bearing from upper end cap, unless replacement of bearing is required.

6. If inspection determines that replacement of crankshaft roller bearing in upper end cap is required, press bearing from end cap with Drive Head (C-91-55919) and Driver Rod (C-91-37323), as shown in Figure 15.

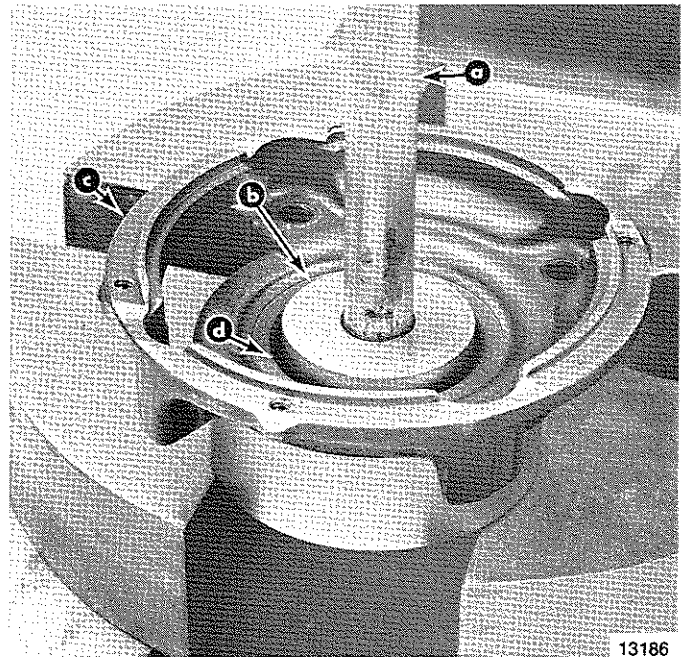


a - "O" Ring c - Crankshaft Roller Bearing
 b - Oil Seal d - Punch

Figure 14. Removing End Cap Oil Seal (Upper End Cap Shown)

- a - Driver Rod (C-91-37323)
- b - Driver Head (C-91-55919)
- c - Upper End Cap
- d - Crankshaft Roller Bearing (Hidden)

Figure 15. Removing Crankshaft Roller Bearing from Upper End Cap



13186

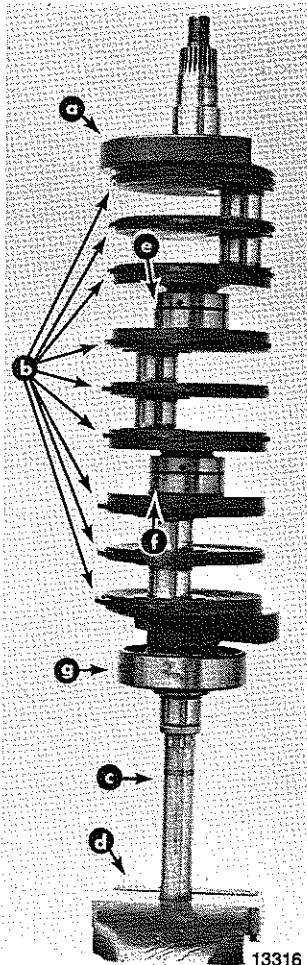
Crankshaft - Removal and Disassembly

1. Lift crankshaft assembly from cylinder block and place assembly on Powerhead Stand (C-91-30591A1) mounted in a vise. (Figure 16)

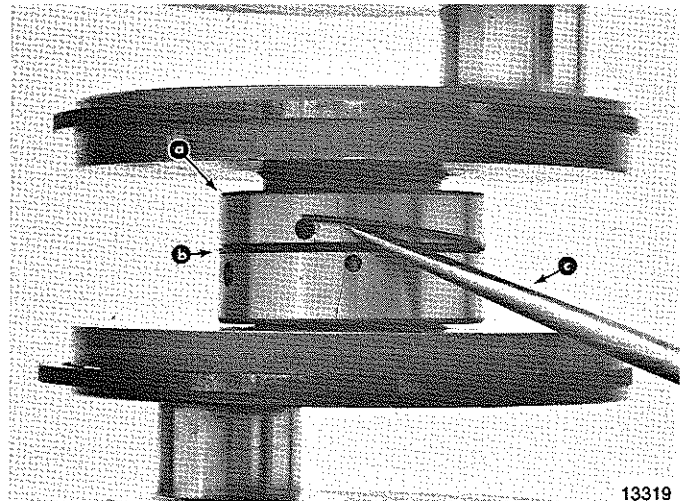
IMPORTANT: DO NOT remove crankshaft sealing rings (Figure 16) from crankshaft, unless replacement of a sealing ring(s) is necessary. Usually, crankshaft sealing rings do not require replacement, unless broken.

- a - Crankshaft Assembly
- b - Crankshaft Sealing Rings
- c - Powerhead Stand (C-91-30591A1)
- d - Vise
- e - Upper Crankshaft Main Bearing (Arrow Pointing to Dowel Pin Hole)
- f - Lower Crankshaft Main Bearing (Arrow Pointing to Dowel Pin Hole)
- g - Crankshaft Ball Bearing

Figure 16. Crankshaft Assembly



13316



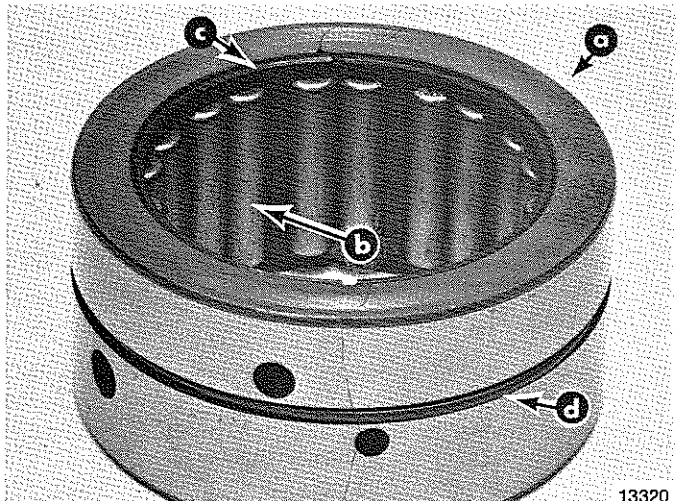
13319

- a - Upper Crankshaft Main Bearing
- b - Retaining Ring
- c - Awl

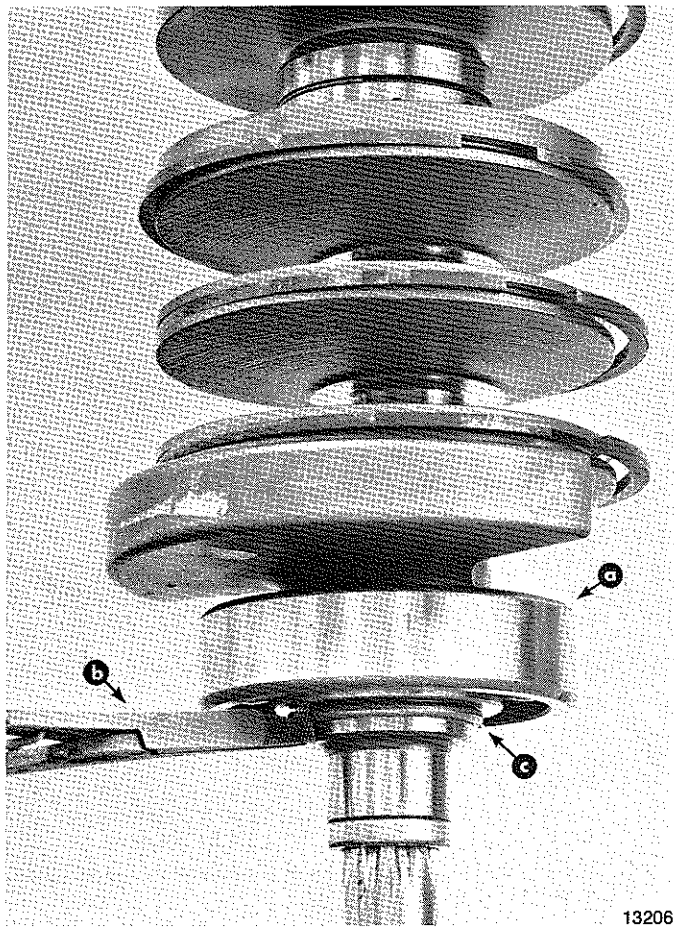
Figure 17. Crankshaft Main Bearing Retaining Ring Removal

- a - Bearing Race
- b - Roller Bearings
- c - Bearing Cage
- d - Retaining Ring

Figure 18. Crankshaft Main Bearing



13320



a - Crankshaft Ball Bearing
b - Snap Ring Pliers
c - Retaining Ring

Figure 19. Removing Crankshaft Ball Bearing Retaining Ring

IMPORTANT: When upper and lower main bearing races are separated, the rollers will be free. Care **MUST BE** taken not to allow rollers to fall from crankshaft and become lost.

2. Remove retaining ring from upper crankshaft main bearing race (Figure 17), then remove bearing race halves and roller bearings from crankshaft. (Figure 18)
3. Reassemble crankshaft bearing race halves with retaining ring (bearing race halves are a matched assembly). Keep main bearing roller bearings with corresponding bearing race. (Figure 18)

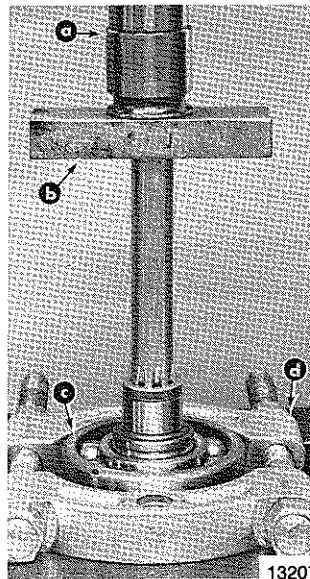
NOTE: Cleanliness is essential when handling roller bearings. Use care not to get dirt or lint on bearings. If bearings are to be re-used, store them in a marked container. DO NOT intermix

roller bearings from upper crankshaft main bearing with those from lower main bearing.

4. Remove lower crankshaft main bearing assembly (Figure 16) in the same manner as outlined in Steps 2 and 3, preceding.
5. Inspect crankshaft ball bearing, that is installed on lower end of crankshaft (Figure 16), as outlined in "Cleaning and Inspection", following.

IMPORTANT: DO NOT remove lower crankshaft ball bearing, unless replacement of bearing is required.

6. If inspection determines that replacement of lower crankshaft ball bearing is required, remove bearing as outlined, following.



a - Press
b - Powerhead Stand (C-91-30591A1)
c - Crankshaft Ball Bearing
d - Universal Puller Plate (C-91-37241)

Figure 20. Removing Crankshaft Ball Bearing

- a. Remove retaining ring (secures lower crankshaft ball bearing), using a suitable pair of snap ring pliers (expanding type). (Figure 19)

- b. Install Universal Puller Plate (C-91-37241) between crankshaft ball bearing and crankshaft counterweight. (Figure 20)

- c. Place crankshaft assembly in press and support under Universal Puller Plate.

- d. Install Powerhead Stand (C-91-30591A1) into end of crankshaft.

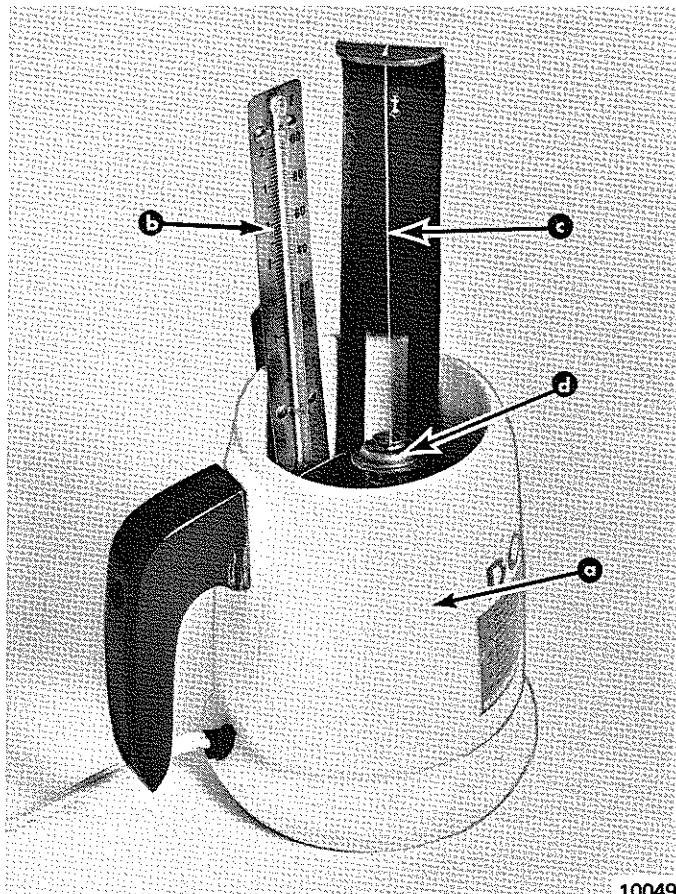
CAUTION: BE CAREFUL that, when crankshaft is pressed out of ball bearing, crankshaft is properly supported and is not allowed to drop on floor.

- e. Press crankshaft out of bearing as shown in Figure 20.

CLEANING and INSPECTION

Thermostats and Temperature Sender

1. Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
2. Remove and discard gasket from each thermostat.
3. Wash thermostats with clean water.



10049

- | | |
|-----------------------|----------------|
| a - Thermostat Tester | c - Thread |
| b - Thermometer | d - Thermostat |

Figure 1. Testing Thermostat

4. Using a thermostat tester, similar to the one shown in Figure 1, test each thermostat as follows:
 - a. Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.
 - b. Suspend thermostat (from thread) and thermometer inside tester (Figure 1) so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.
 - c. Fill thermostat tester with water to cover thermostat.
 - d. Plug tester into electrical outlet.
 - e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step "a", when it starts to open.) Thermostat must begin to open when temperature reaches 140°-145°F (60°-63°C).
 - f. Continue to heat water until thermostat is completely open.
 - g. Unplug thermostat tester.

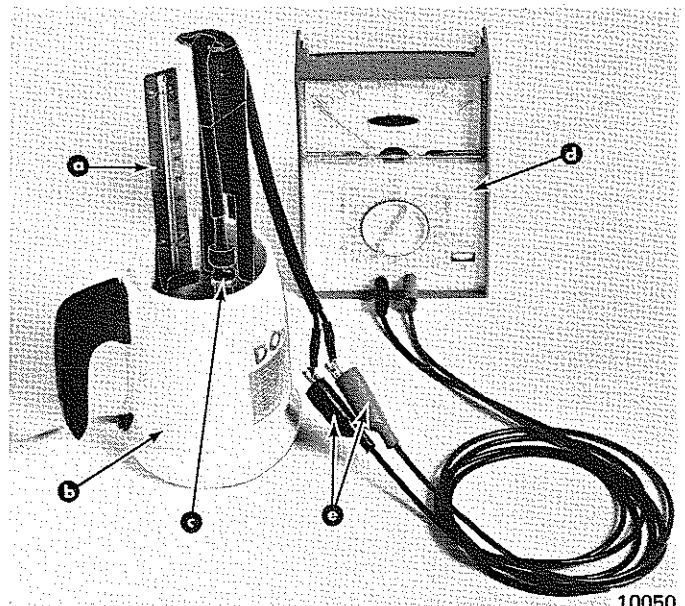
5. Replace thermostat, if it fails to open at the specified temperature, or if it does not fully open.

NOTE: BE SURE that water in thermostat tester is allowed to cool sufficiently [below 130°F (56°C)] before testing the other thermostat.

6. Clean metal surface of temperature sender (area which contacts cylinder head).
7. Clean terminal rings at ends of temperature sender wires to assure good electrical contacts.

NOTE: Electrical switch in temperature sender is designed to "close" if temperature of powerhead reaches a predetermined point. If switch in temperature sender closes, a circuit, that activates an alarm horn, then is completed.

7. Using a thermostat tester similar to the one shown in Figure 2, test temperature sender as follows:
 - a. Turn VOA Meter (C-91-62562) to Rx1K range (same as Rx1000). Short the meter leads together and adjust pointer to 0 (zero) ohms position by adjusting the meter "zeroing" (Ω) thumb wheel. Separate the test leads.
 - b. Connect a test lead to each temperature sender wire. VOA meter must have a scale reading of " ∞ " (no continuity) that would indicate electrical switch in sender is "open". If meter has a scale reading other than " ∞ ", sender should be replaced.
 - c. With meter still connected to temperature sender, suspend sender and a thermometer inside thermostat tester (Figure 2) so that neither touches the container. Bottom of thermometer must be even with bottom of temperature sender to obtain correct temperature of sender operation.



10050

- | | |
|------------------------|----------------------------|
| a - Thermometer | d - VOA Meter (C-91-62562) |
| b - Thermostat Tester | e - VOA Meter Leads |
| c - Temperature Sender | |

Figure 2. Testing Temperature Sender

- d. Fill thermostat tester with water to cover temperature sender.
- e. Plug thermostat tester into electrical outlet.
- f. Observe temperature at which switch in temperature sender "closes". [VOA Meter must have a scale reading of 0 (zero) ohms.] Switch must "close" when temperature reaches 180°-200°F (82°-93°C).
- g. Unplug thermostat tester.
- h. As water in thermostat tester cools, observe temperature at which switch in temperature sender "opens". [VOA Meter must have a scale reading of "∞" (no continuity).] Switch must "open" when temperature drops to 160°-180°F (77°-82°C).
- i. Replace temperature sender if switch fails to "open" or "close" at the specified temperatures.

Cylinder Heads and Exhaust Covers

1. Thoroughly clean cylinder heads and gasket surfaces. Remove carbon deposits and "varnish" from cylinder heads (with a fine wire brush on a shaft attached to an electric drill or use carbon remover solution).
2. Inspect cylinder heads. Check for deep grooves, cracks and distortion which could cause compression leakage.
3. Check spark plug holes for stripped or damaged threads.
4. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

NOTE: Piston striking cylinder head could be an indication that connecting rod bearings (either end) are failing.

5. Replace cylinder head(s) as necessary.
6. Thoroughly clean gasket surfaces of cylinder head covers. Check covers for deep grooves, cracks and distortion that could cause water leakage. Replace cover(s) as necessary.
7. Thoroughly clean gasket surfaces of exhaust divider plate and exhaust manifold cover.
8. Inspect exhaust divider plate and exhaust manifold cover for deep grooves, cracks or distortion that could cause leakage. Replace parts as necessary.

Cylinder Block and Crankcase Cover

IMPORTANT: Crankcase cover and cylinder block are a matched, line-bored assembly and never should be mismatched by using a different crankcase cover or cylinder block.

CAUTION: If crankcase cover or cylinder block is to be submerged in a very strong cleaning solution, it will be necessary to remove the crankcase cover/cylinder block bleed system from crankcase cover/cylinder block to prevent damage to hoses and check valves.

1. Thoroughly clean cylinder block and crankcase cover. Be sure that all sealant and old gaskets are removed from matching surfaces. Be certain that carbon deposits are removed from exhaust ports.
2. Inspect cylinder block and crankcase cover for cracks or fractures.
3. Check gasket surfaces for nicks, deep grooves, cracks and distortion that could cause compression leakages.
4. Check all water and oil passages in cylinder block and crankcase cover to be sure that they are not obstructed and that plugs are in place and tight.

IMPORTANT: The cylinders of a 225 HP engine are chrome and cannot be rebored or efficiently honed. (Honing of a chrome cylinder is not necessary or recommended.)

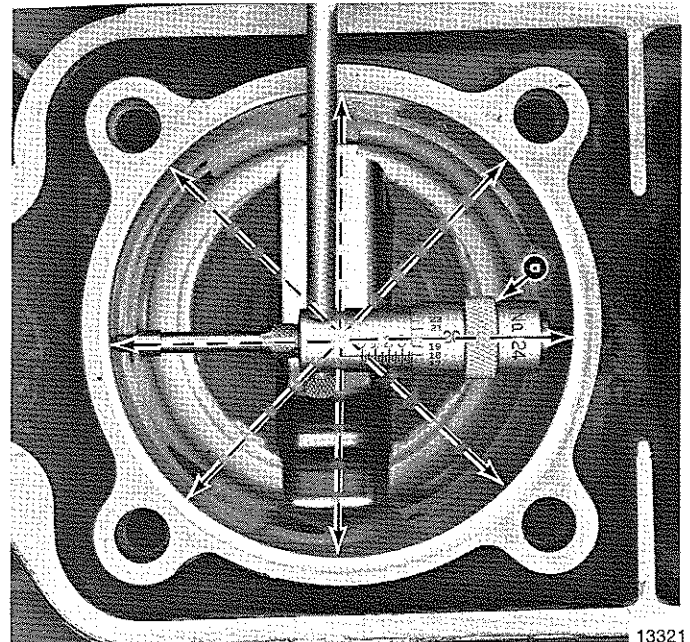
5. Carefully inspect chrome surfaced cylinder bores for signs of flaking, grooving, scoring or other damage.

IMPORTANT: DO NOT mistake porosity for a damaged cylinder.

6. If chrome surface is flaking, or if a groove or any other mark penetrates the chrome surface down to the aluminum

portion of cylinder block, cylinder block and crankcase cover must be replaced.

7. To determine if a groove or any other mark in cylinder wall penetrates chrome surface down to the aluminum portion of cylinder block, apply a small amount of muratic acid (or toilet bowl cleaner) over the groove or mark. DO NOT allow the muratic acid (or toilet bowl cleaner) to contact the aluminum portion of cylinder block. If a groove or mark penetrates the chrome surface, a "fizzing" action (or "bubbling" action) will appear, thus indicating that aluminum is being dissolved.



a - Inside Micrometer

Figure 3. Measuring Cylinder Bores

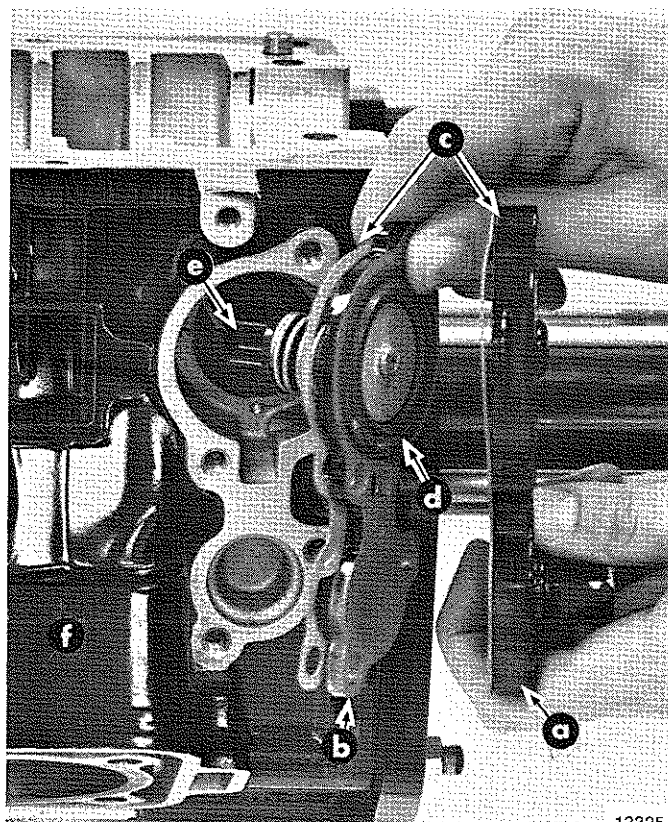
8. If a piston(s) is scored and has transferred aluminum to cylinder walls, remove the aluminum, clean the cylinder walls and inspect cylinders for further damage, as follows:
 - a. Remove all loose aluminum deposits from cylinder wall with a stiff bristle brush.
 - b. Apply a small amount of muratic acid (or toilet bowl cleaner) onto the aluminum deposits. [DO NOT allow muratic acid (or toilet bowl cleaner) to contact the aluminum portion of cylinder block.] A "fizzing" action will appear, thus indicating that aluminum is being dissolved.
 - c. Leave the acid on the aluminum deposit for one to 2 minutes, then wash cylinder thoroughly with hot water and detergent.
 - d. Steps "b" and "c" may require repeating several times before all the aluminum deposits are gone.
 - e. Check each cylinder for an out-of-round ("egg-shaped") condition. Using an inside micrometer or telescopic gauge, as shown in Figure 3, take 4 measurements ¼" (6.35mm) from top of each cylinder bore 45° from each other. A .006" (0.152mm) or less out-of-round is acceptable. If out-of-round is more than .006", cylinder block and crankcase cover MUST BE replaced.
 - f. After cleaning and inspection, cylinder bores should be swabbed several times with light engine oil and a clean cloth.

Idle Shutoff Valve

1. If not yet removed, remove idle shutoff valve cover, valve plate and poppet valve from the starboard side of cylinder block. (Figure 4)
2. Discard gaskets and clean all gasket surfaces.
3. Inspect all gasket surfaces for nicks, deep grooves, cracks and distortion that could cause leakage.
4. Replace diaphragm by removing screw and washer which secure diaphragm to poppet valve. Discard old diaphragm and install new diaphragm. Secure new diaphragm to poppet valve with washer and screw. Be sure that poppet valve compression spring and diaphragm are properly installed.
5. Using new gaskets, reinstall idle shutoff valve plate assembly and valve cover on cylinder block. (Figure 4) Secure with bolts tightened evenly and torqued to specification shown on Page 4A-1.

- | | |
|------------------------------|--------------------------------------|
| a - Idle Shutoff Valve Cover | e - Poppet Valve |
| b - Idle Shutoff Valve Plate | f - Starboard Side of Cylinder Block |
| c - Gaskets | |
| d - Diaphragm | |

Figure 4. Idle Shutoff Valve



13325

Pistons

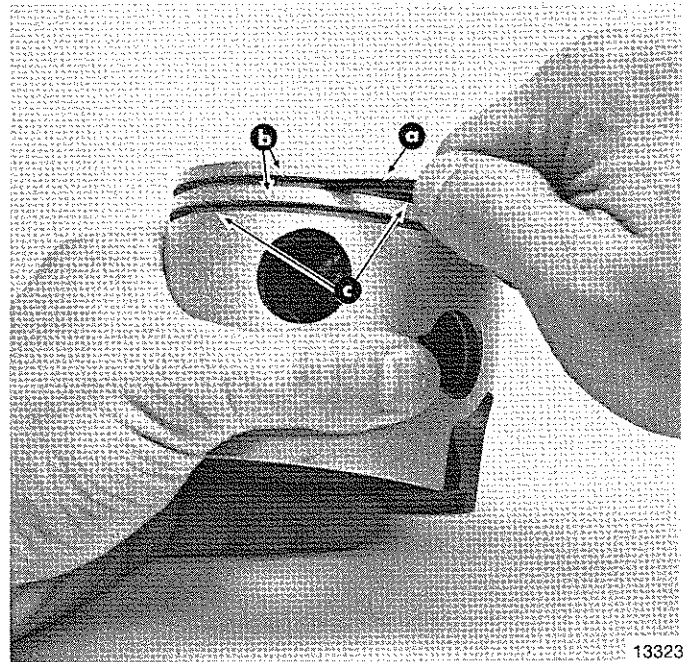
IMPORTANT: If engine was submerged while engine was running, piston pin and/or connecting rod may be bent. If piston pin is bent, piston must be replaced. (Piston pins are not sold separately because of matched fit into piston.) If piston pin is bent, connecting rod must be checked for straightness (refer to "Connecting Rods", following, for checking straightness).

1. Check pistons for scoring, cracks, metal damage and cracked or worn piston pin bosses. Replace piston(s), if any of these conditions is found.
2. Thoroughly clean pistons. Remove carbon deposits and "varnish" from pistons with a soft wire brush or carbon remover solution. DO NOT burr or round machined edges. Clean (polish) piston skirt with crocus cloth.
3. After thoroughly cleaning pistons, use a micrometer to check each piston for size and round. Pistons must be measured as described, following:
 - a. Measure outside of piston $\frac{1}{2}$ " (12.7mm) up from bottom of piston in line with piston pin and at right angle (90°) to piston pin. Measurement taken must be 3.372" (85.649mm).

CAUTION: DO NOT use an automotive-type ring groove cleaner to clean piston ring grooves. This type tool could loosen piston ring locating pins.

4. Clean ring grooves with recessed end of a broken ring. (Figure 5) DO NOT burr or round machined edges.

5. Inspect piston ring grooves for wear, burn and distortion. Inspect piston ring locating pins (one located in each piston ring groove) for tightness. (Figure 5) Replace pistons as necessary.



a - Broken Piston Ring c - Piston Ring Locating Pins
b - Piston Ring Grooves

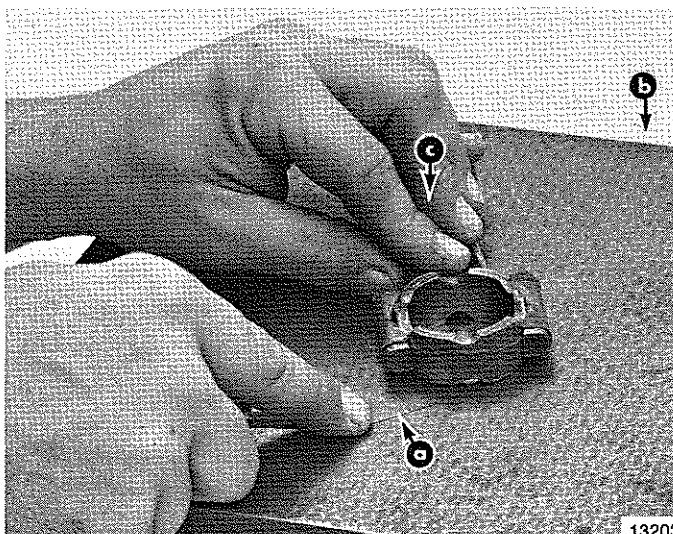
Figure 5. Cleaning Piston Ring Grooves

Connecting Rods

1. Check connecting rods for alignment by placing rods on a surface plate. (Figure 6) If light can be seen under any portion of machined surfaces, if rod has a slight wobble on plate, or if a .002" (0.051mm) feeler gauge can be inserted between any machined surface and surface plate, rod is bent and must be discarded.

2. Carefully inspect connecting rod bearings for rust or signs of bearing failure. Replace bearings as necessary.

CAUTION: DO NOT intermix new and used bearings. If replacement of some bearings is required, replace all bearings at that location.

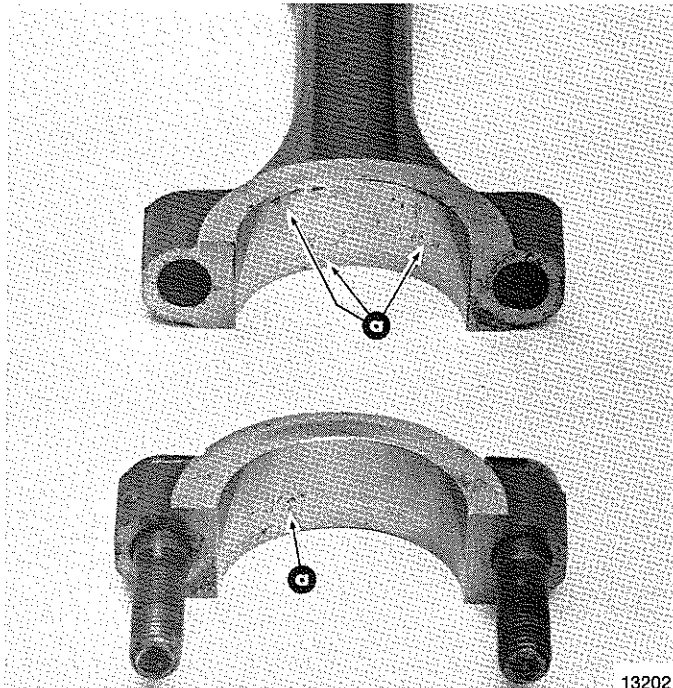


a - Feeler Gauge c - Even Downward Pressure
b - Surface Plate

Figure 6. Checking Connecting Rod Alignment

3. Inspect crankshaft end and piston pin end bearing surfaces of connecting rod for the following:
 - a. Rust: Rust formation on bearing surfaces causes uneven pitting of surface(s). (Figure 7)
 - b. Water Marks: When bearing surfaces are subjected to water contamination, a bearing surface "etching" occurs. This etching resembles the size of the bearing. (Figure 8)
 - c. Spalling: Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the "T" beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication. (Figure 9)
 - d. Chatter Marks: Chatter marks are the result of a combination of low speed-low load-cold water temperature operation, aggravated by inadequate lubrication and/or improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting

rod with tremendous force, and this force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a split second until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. The repetition of this action causes a rough bearing surface(s) which resembles a tiny washboard. (Figure 10) In some instances, the connecting rod crankpin bore becomes highly polished. During operation, the engine will emit a "whirr" and/or "chirp" sound when it is accelerated rapidly from idle speed to approximately 1500 RPM, then quickly returned to idle. If the preceding conditions are found, replace both the crankshaft and connecting rod(s).



a - Pitting

Figure 7. Connecting Rod with Rust Pitting

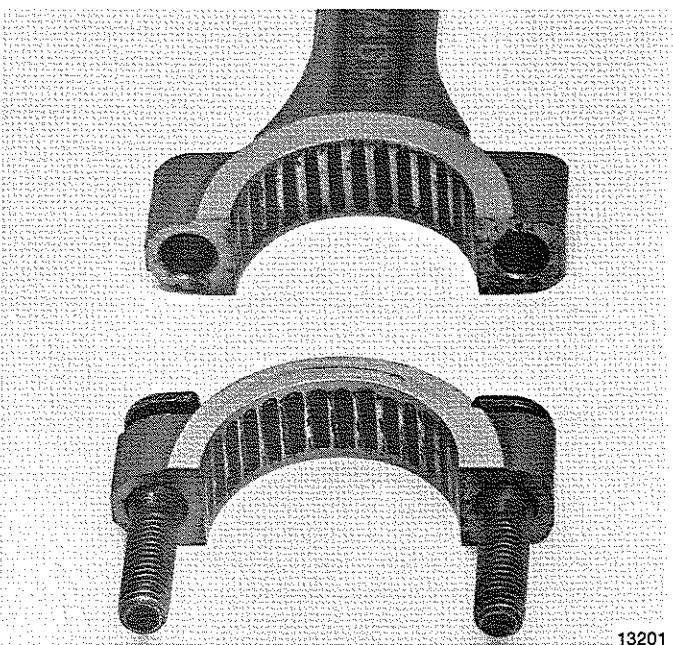
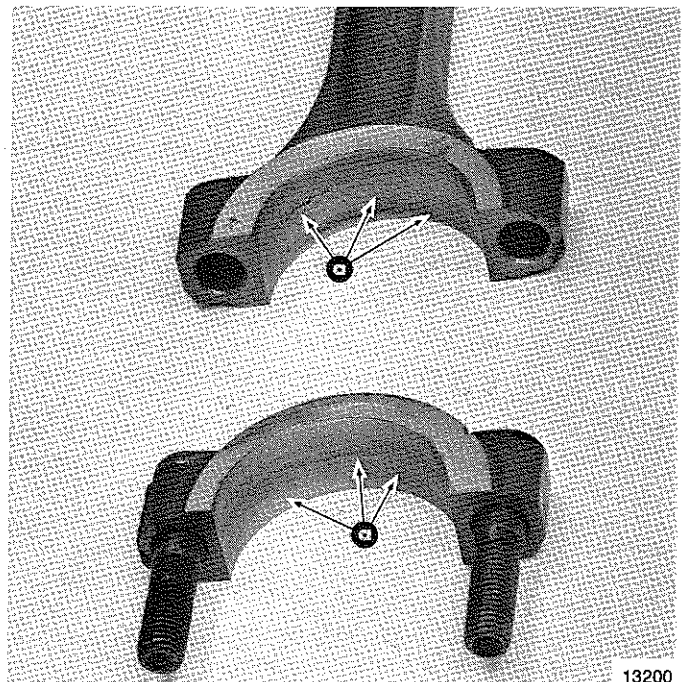
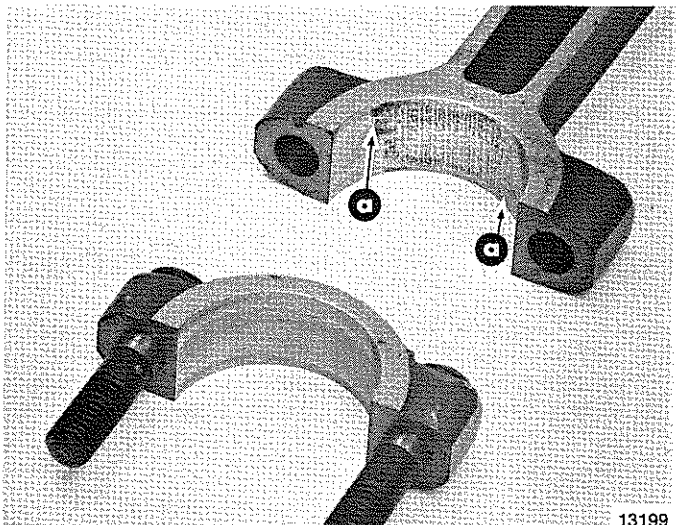


Figure 8. Connecting Rod with Water Marks



a - Spalling

Figure 9. Connecting Rod with Spalling



a - Chatter Marks between Arrows

Figure 10. Connecting Rod with Chatter Marks

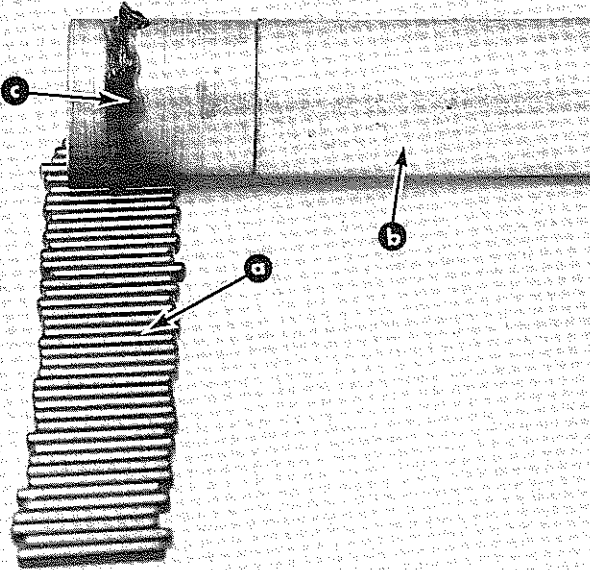
- e. Uneven Wear: Uneven wear could be caused by a bent connecting rod. (Figure 11)
 - f. Overheating: Overheating is visible as a bluish bearing surface color that is caused by inadequate lubrication or excessive RPM.
4. If necessary, clean connecting rod bearing surfaces, as follows:
- a. Be sure that "etched" marks on knob side of connecting rod (crankshaft end) are perfectly aligned with "etched" marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely. (Figure 12)

CAUTION: Crocus cloth MUST BE USED to clean bearing surface at crankshaft end of connecting rod. DO NOT use any other type of abrasive cloth.

CONNECTING RODS and PISTONS

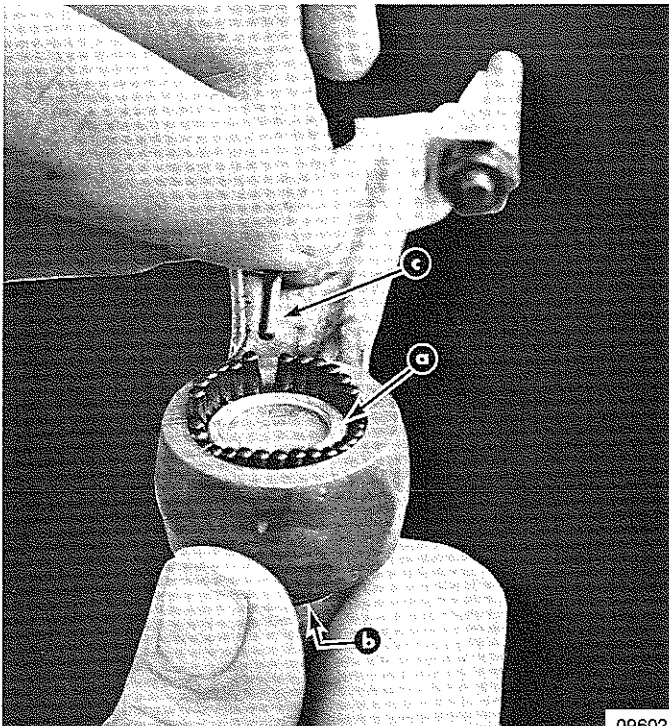
REASSEMBLY

CAUTION: DO NOT attempt to re-use any 3-ring piston that has been removed from a connecting rod. Removal of a 3-ring piston (from connecting rod) will damage that piston and necessitate installation of a new piston.



09600
a - Piston Pin Needle Bearings b - Piston Pin Tool c - Grease

Figure 10. Installing Piston Pin Needle Bearings



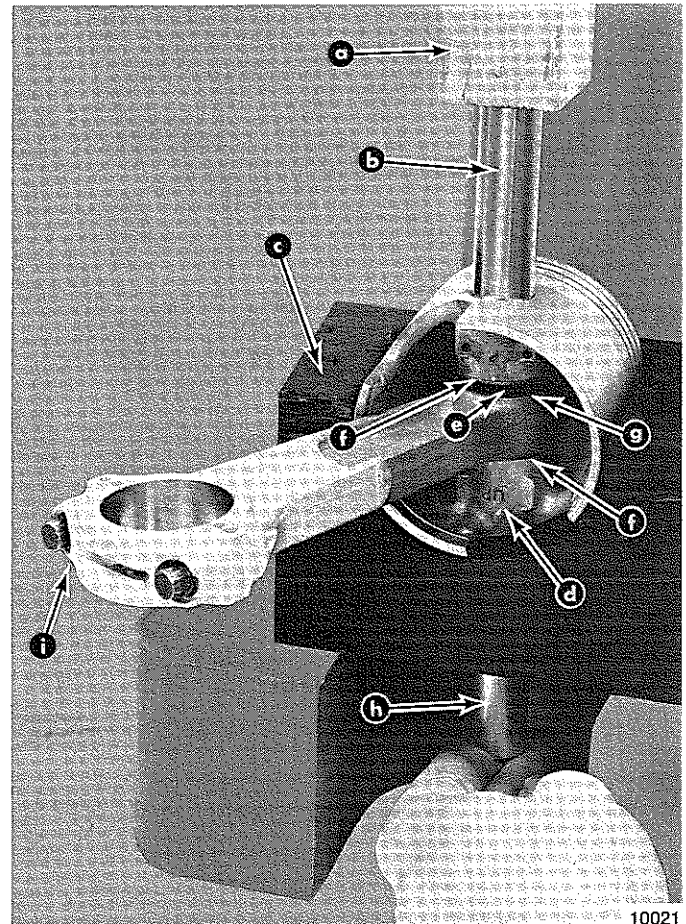
09602
a - Sleeve of Piston Pin Tool
b - Locating Washer (Hidden)
c - Needle Bearing Being Installed

Figure 11. Installing Piston Pin Needle Bearings

1. Place a clean piece of paper on bench and line up piston pin needle bearings (those retained from disassembly or new ones), as shown in Figure 10.

NOTE: There are 29 piston pin needle bearings per piston.

CAUTION: Never intermix new needle bearings with used needle bearings at the same connecting rod end. Never intermix needle bearings of one connecting rod with those of another connecting rod. Should one (or more) piston pin needle bearing of a connecting rod require replacement (or should one or more be lost), replace all of that connecting rod's piston pin needle bearings.



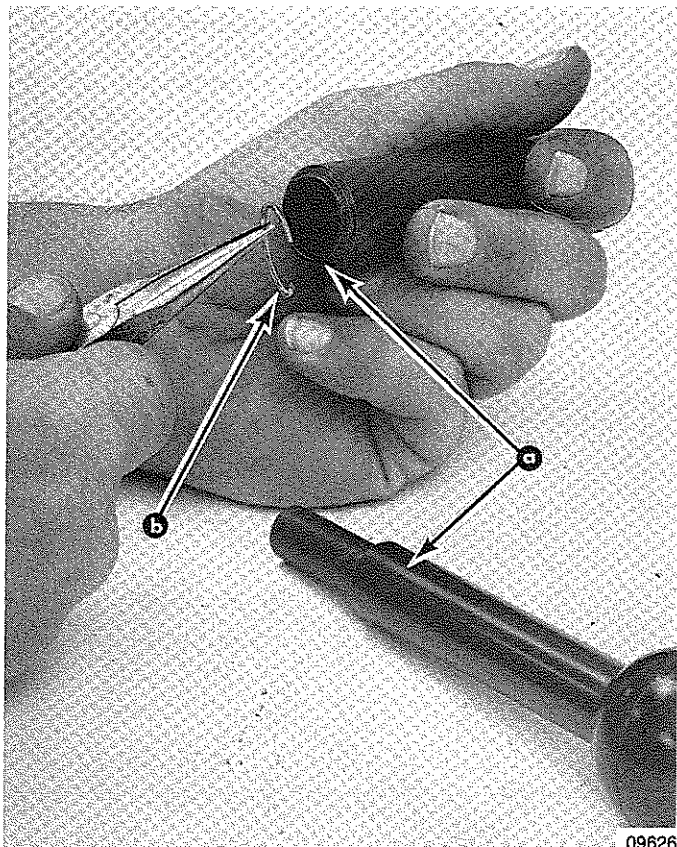
10021
a - Press
b - Piston Pin
c - Piston Support Block (C-91-77005)
d - Piston Pin Boss Marked "UP"
e - Piston Pin Needle Bearings
f - Locating Washers
g - Sleeve Portion of Piston Pin Tool (Hidden)
h - Piston Pin Tool
i - 2 Alignment Bumps (Hidden) Must Be Toward "UP" Marked Side of Piston

Figure 12. Installing Piston

2. Place a small amount of grease (Multipurpose Lubricant) on sleeve portion of Piston Pin Tool (C-91-74607A1) and roll tool over lined-up bearings, as shown in Figure 10.
3. Place lower locating washer on Piston Pin Tool (shoulder

on washer toward bearings) and, leaving one or 2 bearings off sleeve, place sleeve portion of tool thru connecting rod. Add needle bearings, as necessary, until no more can be installed (29 needle bearings per connecting rod). (Figure 11)

4. Place upper locating washer over sleeve portion of Piston Pin Tool (shoulder of washer toward bearings), then slide tool handle out of sleeve. (Sleeve and locating washers will maintain needle bearings in position in connecting rod.)
5. Apply a light coat of oil onto each piston pin before installing into piston.

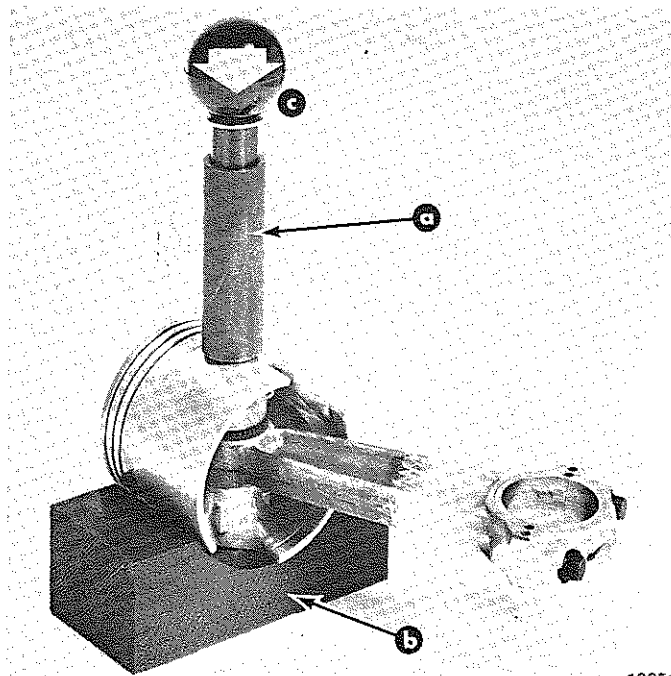


a - Lockring Installation Tool (C-91-77109A1)
b - Lockring

Figure 13. Placing "C" Type Lockring into Lockring Installation Tool

6. Place piston in position on Piston Support Block (C-91-77005) with "UP" marked side of piston positioned down (toward piston support block). (Figure 12)

IMPORTANT: Different pistons are used for port and starboard cylinders. Pistons are marked "P" (port side) or "S" (starboard side) on piston pin boss and on piston crown. (Figure 17) Pistons marked "P" must be installed in cylinders Nos. 2, 4 and 6, and pistons marked "S" must be installed in cylinder Nos. 1, 3 and 5.



a - Lockring Installation Tool
b - Piston Support Block
c - Push Down

Figure 14. Installing Lockring into Piston

7. Use Torch Lamp (C-91-63209) to heat piston dome to approximately 190°F (88°C). This will make piston pin installation easier.
8. While using one hand to hold sleeve, bearings and locating washers in place, insert connecting rod into position between piston pin bosses [2 bumps on crankshaft end of rod (Figure 12 in "Pistons and Connecting Rods - Removal", preceding) must be toward "UP" marked side of piston], then install handle portion of Piston Pin Tool thru hole in Piston Support Block thru lower piston pin boss and into sleeve. (Figure 12)
9. While holding piston pin needle bearings in place with Piston Pin Tool, press piston pin into position (as far as possible) with an arbor press. (Figure 12) Use Piston Pin Tool (between arbor press and piston pin) to position piston pin the rest of the way into piston.

SAFETY WARNING: Eye protection MUST BE WORN while installing piston pin lockrings.

CAUTION: DO NOT re-use piston pin lockrings. Use only new lockrings and make sure that they are properly seated in piston grooves.

10. Install new piston pin lockrings (one at each end of piston pin) with Lockring Installation Tool (C-91-77109A1), as shown in Figures 13 and 14. Double check that lockrings are properly seated in piston grooves.

Checking Piston Ring End Gap and Installing Rings onto Pistons

SPECIAL INFORMATION

Because of continuous improvements being made in V-6 engines, there are several piston/ring combinations. The following **MUST BE** read and understood completely before trying to determine ring end gap or trying to install rings on pistons.

3-Ring Pistons

Three-ring pistons can be found only in early model 175 HP V-6 engines. Once a 3-ring piston has been removed from its connecting rod, it **MUST BE** replaced. All 3 rings of a 3-ring piston are identical and the only stipulation for installation on a piston is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

2-Ring Pistons

All 200 HP V-6 engines are equipped with 2-ring pistons. Both rings of a 200 HP V-6 are a keystone (tapered) type ring. The only stipulation for installation on a piston is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

There are 2 different types of 2-ring pistons for 175 HP and 150 HP V-6 engines. One is designed for one keystone (tapered) ring (Figure "b") and one rectangular ring (Figure "a"). It will be necessary to measure each ring in order to identify. (Figure "a" or "b") When one keystone ring and one rectangular ring are used, the keystone ring always is used as the top ring.

The other 2-ring piston is designed for 2 keystone rings, and the only stipulation (which also applies when one keystone and one rectangular ring are used) is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

.015" (0.381mm) and .030" (0.762mm) Oversize Pistons and Rings

All oversize pistons for 175 HP and 150 HP V-6 engines are equipped with 2 keystone (tapered) rings. The only stipulation for installation of rings on a piston is that the dot (Figure 15) on side of each ring **MUST BE** toward piston dome (crown).

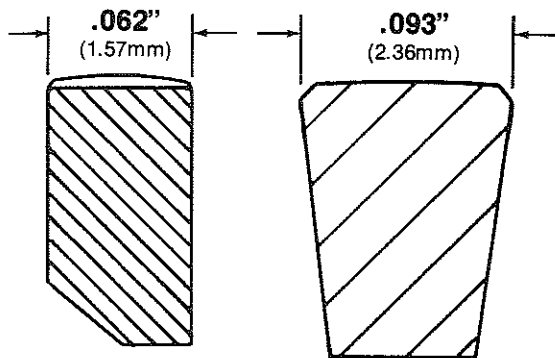
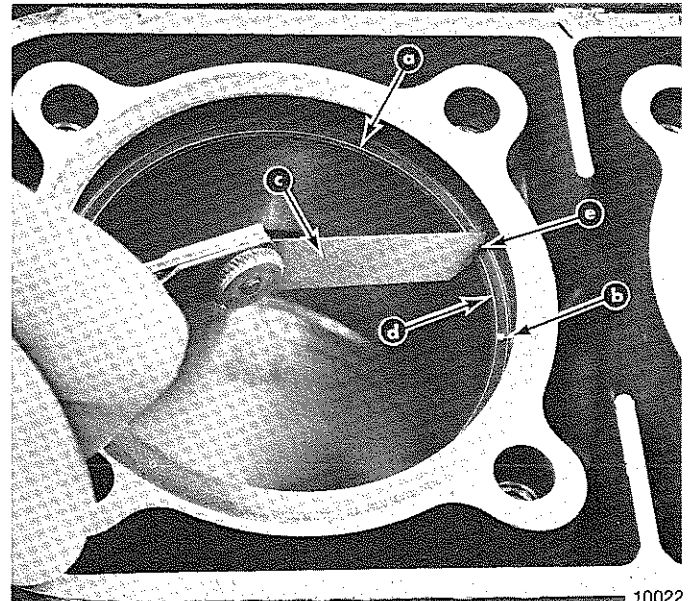


Figure a. Rectangular Ring

Figure b. Keystone (Tapered) Ring

1. Insert each new piston ring (one at a time) into the bore of its respective cylinder. Position piston ring about ½" (12.7mm) into cylinder, using a piston to assure proper positioning of ring.
2. Check end gap of each piston ring with a feeler gauge. (Figure 15) End gap must be within .018" to .025" (0.45mm to 0.64mm). If end gap is greater, check other new piston rings in cylinder bore until rings (within tolerance) are found. If end gap is less than tolerance, and another ring within tolerance cannot be found, it may be necessary to file some material from piston ring end (at gap). If it is necessary to file a piston ring, be sure that all rough edges are removed after filing.
3. Continue to check piston ring gaps (as outlined, preceding) until new piston rings (within tolerance) have been found for each cylinder.
4. Remove piston rings from cylinder bores.



10022
a - Piston Rings b - Dot ("Pip" Mark) on Side of Piston Ring
c - Feeler Gauge d - Piston Ring End Gap
e - Piston Ring End Gap

Figure 15. Checking Piston Ring End Gap

IMPORTANT: Piston rings, that are checked in No. 1 cylinder, MUST BE installed on No. 1 piston; rings, which are checked in No. 2 cylinder, MUST BE installed on No. 2 piston, etc.

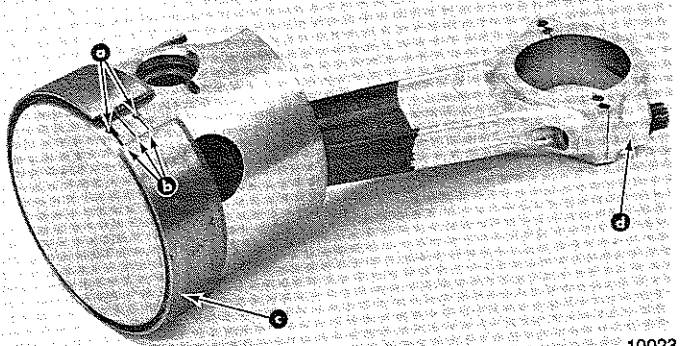
5. Using Piston Ring Expander (C-91-24697), install No. 1 piston rings on No. 1 piston, No. 2 piston rings on No. 2 piston, etc. (Figure 13 in "Pistons and Connecting Rods - Removal", preceding). Piston rings **MUST BE** installed on piston with DOT on SIDE of PISTON RING toward piston dome (crown). (Figure 15)

IMPORTANT: Piston rings MUST BE properly installed on pistons (refer to "Special Information, preceding).

6. Check piston rings to be sure that they rotate freely in ring grooves. If a ring does not rotate freely, condition must be corrected before installing piston assembly into cylinder block.

Piston Installation

1. Install Powerhead Stand (C-91-30591A1) into drive shaft end of crankshaft. Use Powerhead Stand to turn crankshaft to desired positions when attaching connecting rods to crankshaft.
2. Install each piston as follows:
 - a. Lubricate piston rings, piston skirt, piston pin needle bearings and respective cylinder wall with light oil.



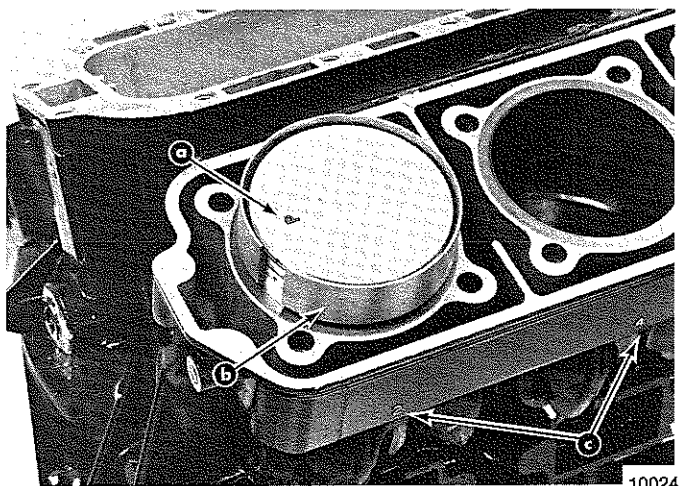
- a - Piston Ring Locating Pins (One in Each Ring Groove)
- b - Piston Rings
- c - Piston Ring Compressor (C-91-65494 for 150 HP and 175 HP V-6 Pistons, C-91-85534 for 200 HP V-6 Pistons)
- d - Connecting Rod Cap

Figure 16. Piston Ring Compressor Installed

- b. Rotate each piston ring so that locating pin in ring groove is positioned at piston ring end gap. (Figure 16)
- c. Install Piston Ring Compressor (C-91-65494 for 150 HP and 175 HP V-6 pistons, C-91-85534 for 200 HP V-6 pistons) around connecting rod and into position over piston rings, as shown in Figure 16.

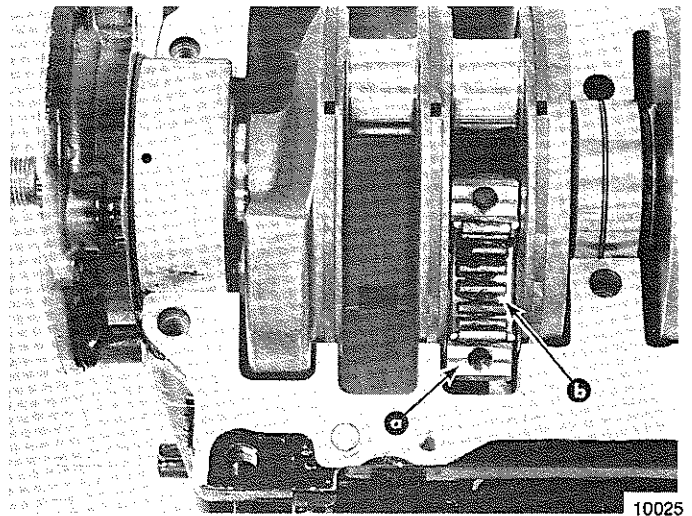
CAUTION: Piston rings must be properly positioned with locating pins between piston ring end gaps.

- d. Check that number, scribed on connecting rod during disassembly (Figure 11 in "Pistons and Connecting Rods - Removal", preceding), matches cylinder num-



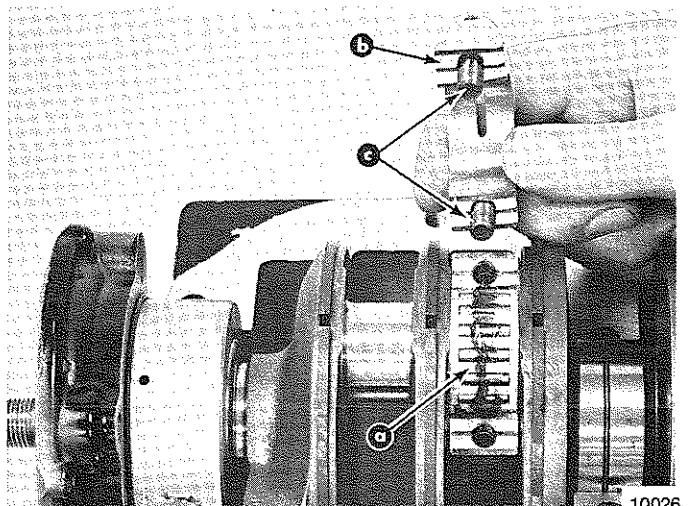
- a - Stamped Letter ("P" or "S") on Piston Crown (Dome)
- b - Piston Ring Compressor
- c - Stamped Numbers on Side of Cylinder Block

Figure 17. Installing Piston into Cylinder



- a - Connecting Rod
- b - Bearing Cage and Roller Bearings

Figure 18. Installing Connecting Rod Bearings



- a - Bearing Cage and Roller Bearings
- b - Connecting Rod Cap
- c - Connecting Rod Bolts

Figure 19. Installing Connecting Rod Bearings

ber in which piston is to be installed [i.e., connecting rod, that is marked one (1), must be installed in No. 1 cylinder, etc].

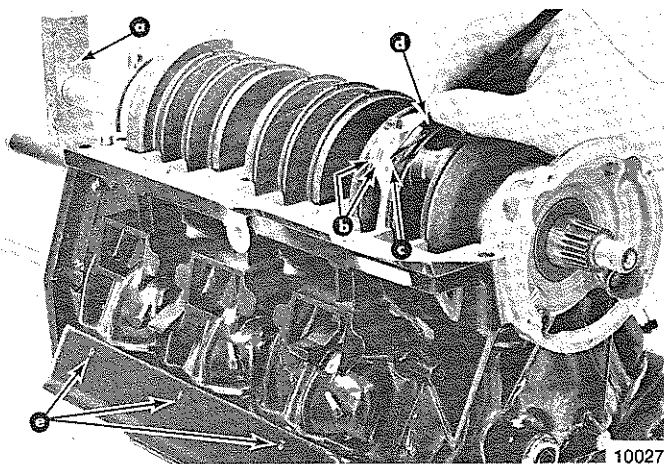
- e. Remove 2 bolts and connecting rod cap from piston/rod assembly to be installed. (Figure 16)
- f. Install piston assembly into its respective cylinder so that side of piston with "UP" (marked on piston pin boss, Figure 3) is toward flywheel end of powerhead. (Figure 17) After aligning connecting rod with cylinder block opening, push on crown of piston until piston is installed into bore of cylinder, and piston ring compressor falls off.

IMPORTANT: Pistons must be installed in correct cylinder with "UP" side of pistons toward flywheel end of powerhead. (This will position large hole in piston skirt directly opposite exhaust port.) Pistons are marked "P" (port side) or "S" (starboard side) on piston pin boss and on piston crown. (Figure 17) Pistons marked "P" must be installed in cylinder

Nos. 2, 4 and 6, and pistons marked "S" must be installed in cylinder Nos. 1, 3 and 5.

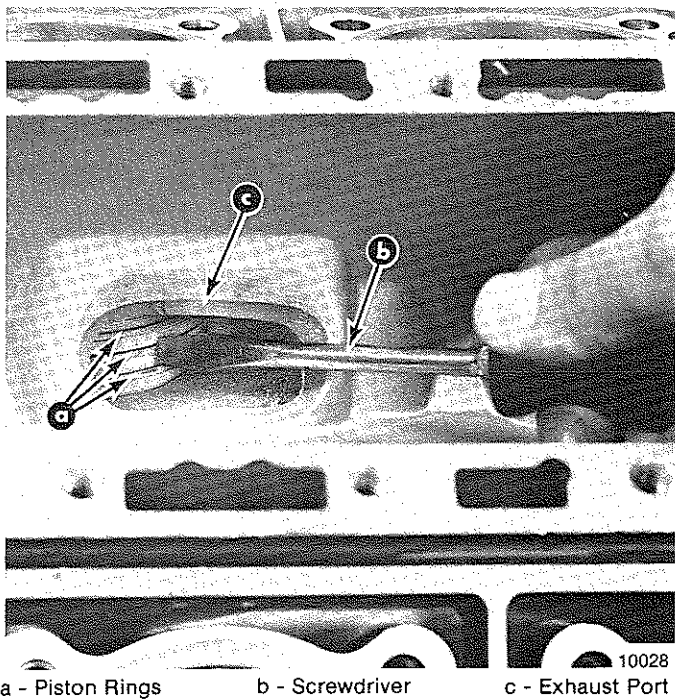
CAUTION: Never intermix new roller bearings with used roller bearings in the same connecting rod end. If a quantity of bearings requires replacement, replace all bearings at that rod end.

- g. Apply a coating of grease (Multipurpose Lubricant) to bearing surface of connecting rod, then install bearing cage and roller bearings into grease. (Figure 18)
- h. Bring connecting rod up to crankshaft journal.
- i. Apply a coating of grease to crankshaft journal, then install other bearing cage and remaining roller bearings into grease. (Figure 19)
- j. Clean connecting rod bolts with solvent and dry with compressed air.



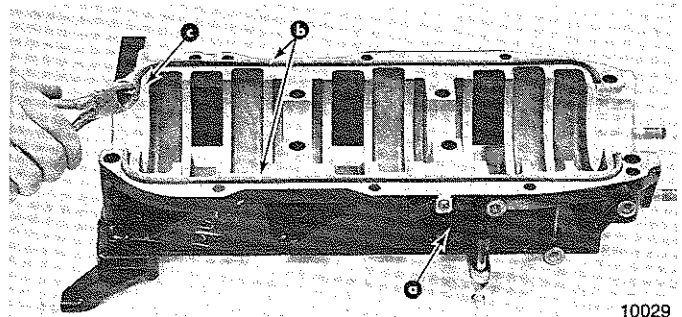
a - Powerhead Stand (C-91-30591A1) d - Pencil
b - "Etched" Alignment Marks e - Stamped Numbers on Side of Cylinder Block
c - Chamfered Corner

Figure 20. Installing Connecting Rod Cap



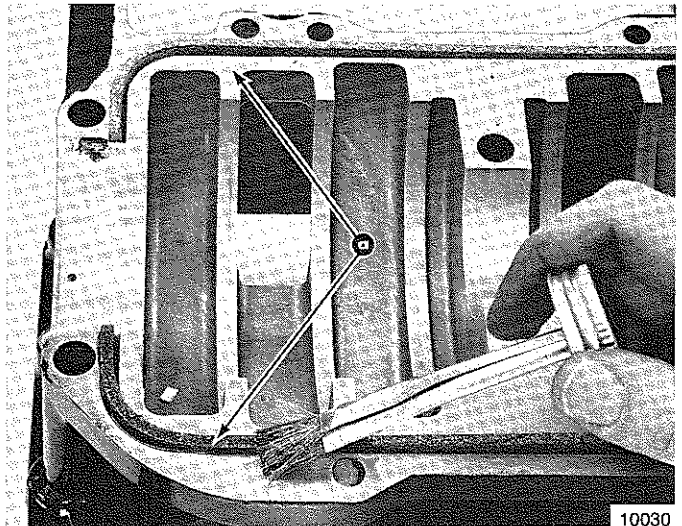
a - Piston Rings b - Screwdriver c - Exhaust Port

Figure 21. Checking Piston Rings



a - Crankcase Cover b - Gasket Strips c - Trim End of Each Gasket Strip as Necessary

Figure 22. Trimming Crankcase Cover Gaskets



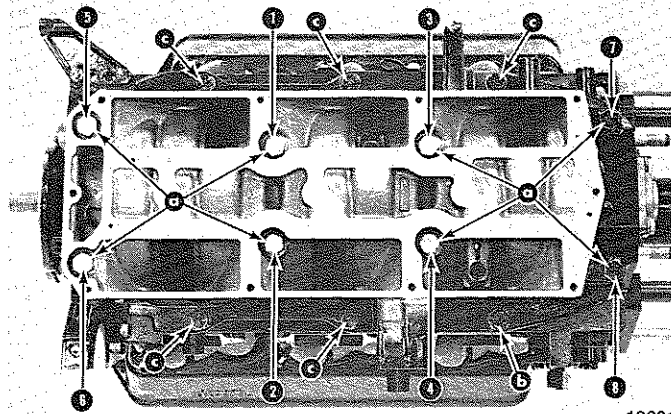
a - Apply Permatex 2C-12 to These Surfaces

Figure 23. Applying Sealer to Crankcase Cover

- k. Apply a drop of Loctite Type "A" to threads of each connecting rod bolt.
 - l. Install connecting rod cap, being sure that alignment marks (bumps and etched marks - Figure 20) on connecting rod and cap are properly aligned. Install connecting rod bolts as far as possible by hand, then check alignment between rod cap and rod, as shown in Figure 20.
- NOTE: Alignment of connecting rod cap to connecting rod can be checked by moving pencil point back-and-forth on chamfered corners between rod cap and rod. (Figure 20) If a ridge is felt, rod cap is misaligned. Misalignment must be corrected before proceeding.*
- m. Tighten connecting rod bolts (using a 5/16"-12 point socket) evenly in 3 progressive steps until torqued to 30 ft. lbs. (4.15mkg). Recheck alignment between rod cap and rod, as shown in Figure 20.
 - n. Check that all roller bearings have been installed by inserting a small tool thru slot in connecting rod cap and rotating cage. Be careful not to scratch bearings.
 - o. Repeat procedures in Steps "a" thru "n", preceding, for remaining cylinders.
5. Check piston rings for spring tension by inserting a screwdriver thru exhaust port and pressing on each piston ring. (Figure 21) If no spring tension exists (ring fails to return to position), it is likely that the ring was broken during installation. Use caution not to burr piston rings during

inspection. Replace only piston rings that may have been broken.

6. Using Powerhead Stand (C-91-30591A1), rotate crankshaft several times to assure free operation (no binds and/or catches).
7. Thoroughly clean machined, mating surfaces of crankcase cover and cylinder block with solvent to remove all oil.
8. Install gasket strips into grooves in crankcase cover, then trim end of each gasket strip flush with edge of cover, as shown in Figure 22.
9. Apply a THIN, even coat of Permatex 2C-12 on crankcase cover and cylinder block. (Figure 23)
10. Place crankcase cover in position on cylinder block. Secure crankcase cover with 8 large bolts. Turn bolts in (following torque sequence in Figure 24) a LITTLE at-a-time, compressing crankshaft seal rings until crankcase cover has been drawn down to cylinder block. Tighten 8 large crankcase cover bolts evenly in 3 progressive steps (following torque sequence in Figure 24) until each bolt is torqued to specification listed on Page 4-1.
11. Install 6 smaller crankcase cover bolts (the longer seal bolt should be installed at location shown in Figure 24) and tighten evenly in 3 progressive steps until each bolt is torqued to specification.
12. Install bolts which secure upper and lower end caps to crankcase cover. Tighten end cap attaching bolts evenly until lower end cap bolts and upper end cap bolts are



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- a - Large Crankcase Cover Attaching Bolts
(Torque Following Sequence)
- b - Smaller Crankcase Cover Bolt (Seal Bolt)
- c - Smaller Crankcase Cover Bolts

Figure 24. Installing Crankcase Cover

torqued to specifications.

13. Wipe off any excess sealer that may have come out between crankcase cover and cylinder block.
14. Using Powerhead Stand, rotate crankshaft several times to assure free operation (no binds and/or catches).

Reed Blocks - Reassembly and Installation

SPECIAL INFORMATION

IMPORTANT: Always replace reeds in sets. DO NOT turn used reeds over for re-use.

There are 2 different shaped reeds at 2 different thicknesses in V-6 engines. Read the following carefully before installing reeds onto reed blocks or reed blocks into reed block housing.

150 HP V-6 Engines

Reeds in 150 HP V-6 engines are "straight-cut" shaped reeds. (Figure "a") Both reeds are .010" (.254mm) thick.

175 HP V-6 Engines

Earlier model 175 HP V-6 engines are equipped with one "teardrop" shaped reed (Figure "b") and one "straight-cut" shaped reed (Figure "a"). The "teardrop" shaped reed is .010" (0.254mm) thick; the "straight-cut" shaped reed is .008" (0.203mm) thick. When one "teardrop" shaped reed and one "straight-cut" shaped reed are used, the reed block **MUST BE** installed in reed block housing so that the "teardrop" shaped reed is toward center (inside) of reed block housing. [For identification purposes, "teardrop" shaped reeds have a tang that extends beyond edge of reed stop. (Figure 25)] Later model 175 HP V-6 engines are equipped with 2 "teardrop" shaped reeds that are .010" thick. If one or both reeds (of a reed block) need to be replaced, always replace both reeds with 2 "teardrop" shaped reeds that are .010" thick, even though one of the reeds may be a "straight-cut" shaped reed.

200 HP V-6 Engines

Reeds in 200 HP V-6 engines are "teardrop" shaped reeds. (Figure "b") Both reeds are .010" (.254mm) thick.

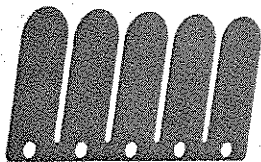


Figure a. "Straight-Cut" Shaped Reed

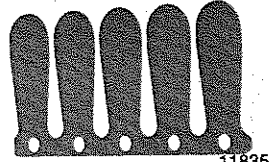
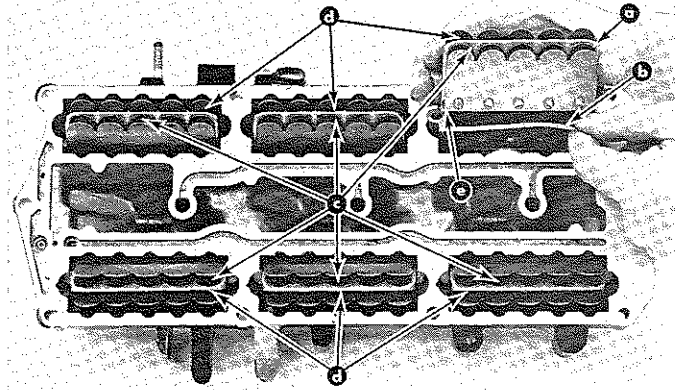


Figure b. "Teardrop" Shaped Reed

1. If disassembled, reassemble each reed block, following:
 - a. Coat reeds with light oil.

IMPORTANT: Replace reeds in sets only. DO NOT turn used reed over for re-use.

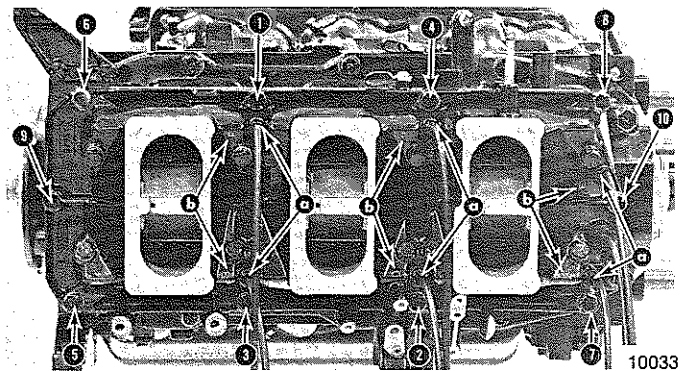
- b. Place reeds and reed stops in position on reed block. (See "Special Information", above.)
 - c. Secure reeds and reed stops with screws and lockwashers. (Figure 9 in "Reed Blocks - Removal and Disassembly", preceding.) Torque screws to specifications on Page 4-1.
 - d. Refer to "Cleaning and Inspection", preceding, and check reed opening, then reed stop setting.
2. Place reed block gaskets, then reed blocks (Figure 25) into position in reed block housing. (See "Special Information", above.)



a - Reed Block
b - Reed Block Gasket
c - Identification Tang for "Teardrop" Shaped Reed

10032

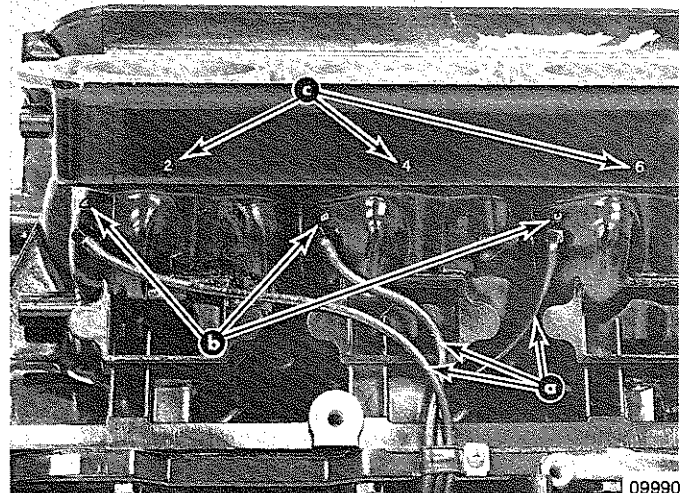
Figure 25. Installing Reed Blocks



a - Bleed System Bleed Valve
b - Letters Stamped on Reed Block Housing

10033

Figure 26. Installing Reed Block Housing

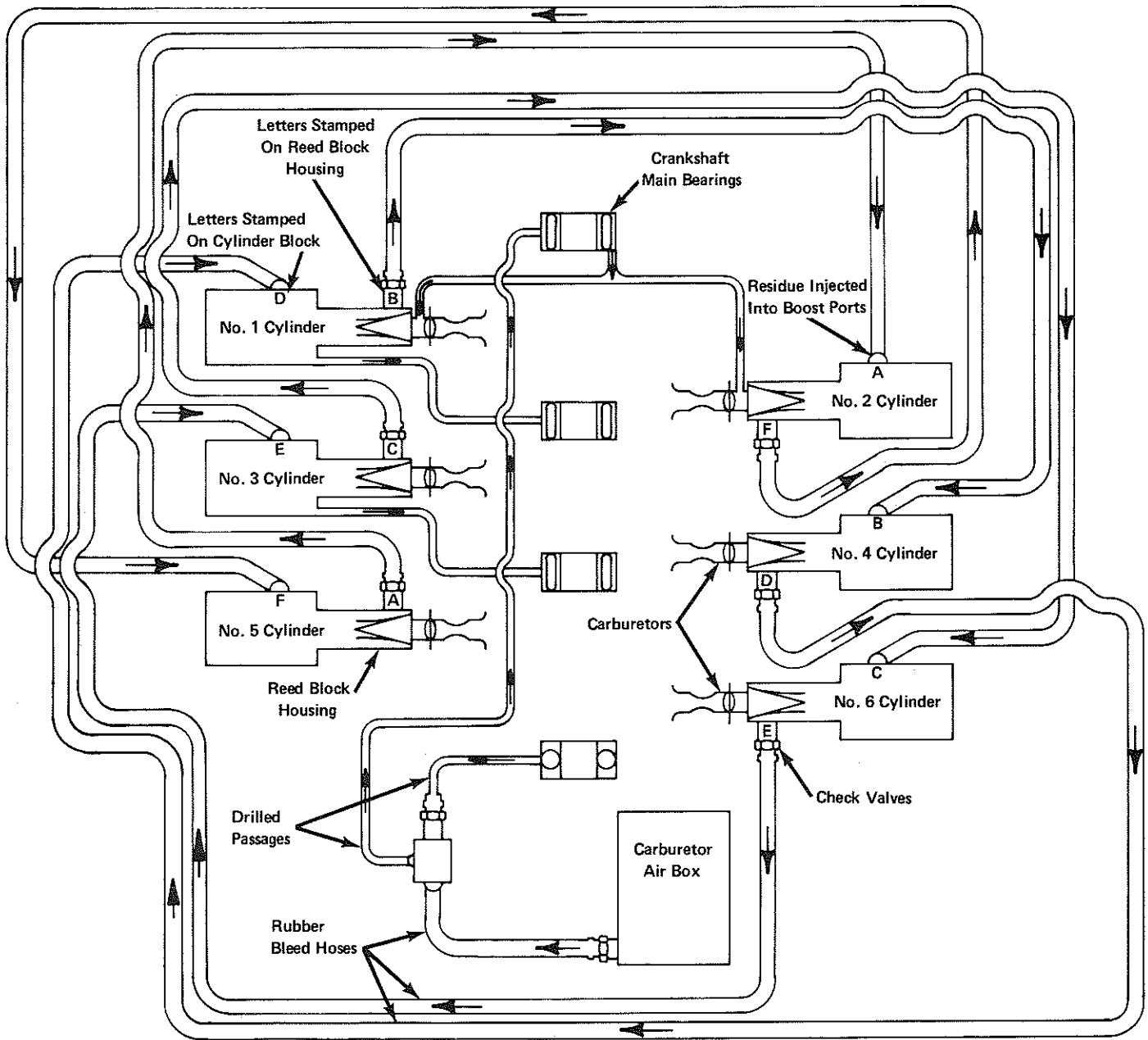


a - Bleed Hoses
b - Letters Stamped on Cylinder Block
c - Cylinder Numbers Stamped on Cylinder Block

09990

Figure 27. Bleed Hoses Installed

3. Secure reed blocks to reed block housing with attaching bolts. Tighten bolts evenly until torqued to specification.
4. Place reed block housing gasket in position on crankcase cover. Be sure that gasket is properly installed with bleed system holes in gasket aligned with holes in crankcase cover.



RUBBER BLEED HOSES
 DRILLED PASSAGES

Figure 28. Bleed System

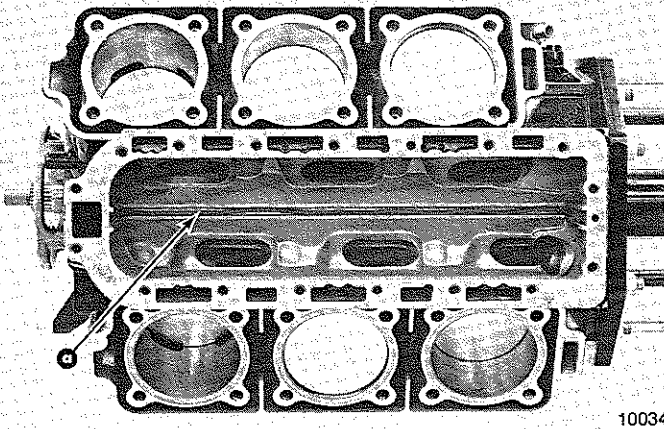
5. Place reed block housing in position on powerhead and secure with attaching bolts. (Figure 8 in "Reed Blocks - Removal and Disassembly", preceding) Following torque sequence in Figure 26, tighten reed block housing attaching bolts in 3 progressive steps until torqued to specification.
6. Install bleed hoses thru respective bleed hose clamps and connect bleed hoses from reed block housing to fittings on side of cylinders (one bleed hose extends from reed block housing to each cylinder). Bleed system check valves on reed block housing (Figure 26) and fittings on side of cylinders

(Figure 27) are marked with a stamped letter. Bleed hoses are properly installed when hose from check valve marked "A" links with cylinder fitting marked "A", "B" to "B", etc. (Figure 28)

IMPORTANT: Bleed hoses MUST BE correctly routed as shown in Figure 28. If bleed hoses are connected to wrong cylinders, engine will not operate properly. Install bleed hoses all-the-way onto fittings.

Exhaust Covers and Cylinder Heads - Installation

CAUTION: New gaskets **MUST BE** properly installed to allow correct water flow thru powerhead.



a - Divider Plate Seal

Figure 29. Divider Plate Seal Installed

1. Place exhaust divider plate seal into cylinder block slot (between exhaust ports). (Figure 29)
2. Place a divider plate gasket on each side of exhaust divider plate. Be sure that gaskets are properly installed so that holes in gaskets are aligned with holes in divider plate. Install exhaust divider plate (with gaskets) into place on cylinder block. (Figure 7 in "Cylinder Heads and Exhaust Covers - Removal", preceding.)

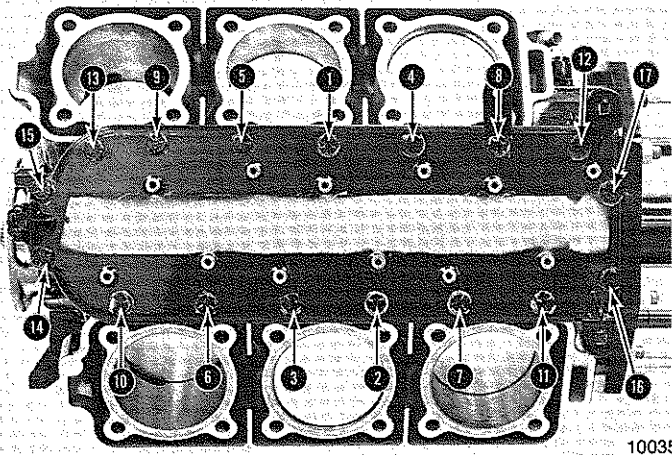
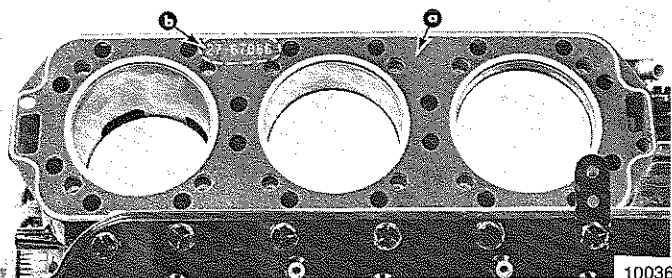
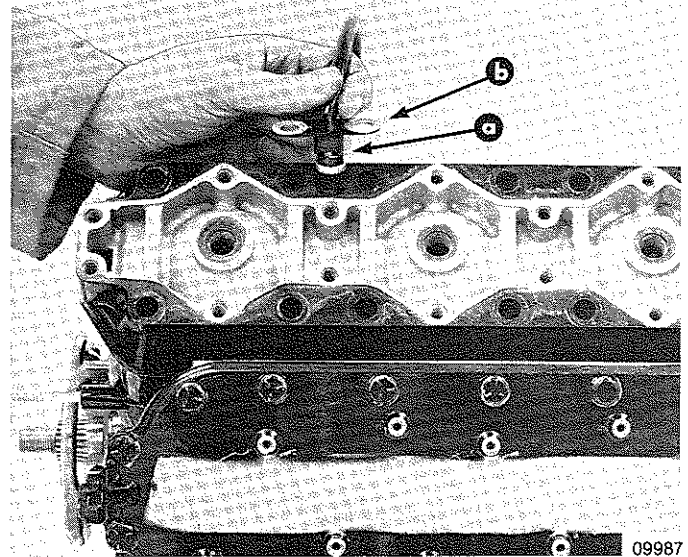


Figure 30. Exhaust Manifold Cover



a - Cylinder Head Gasket
b - Numbered Side of Cylinder Head Gasket

Figure 31. Cylinder Head Gasket



a - Temperature Sender

b - Bracket

Figure 32. Installing Cylinder Head and Temperature Sender

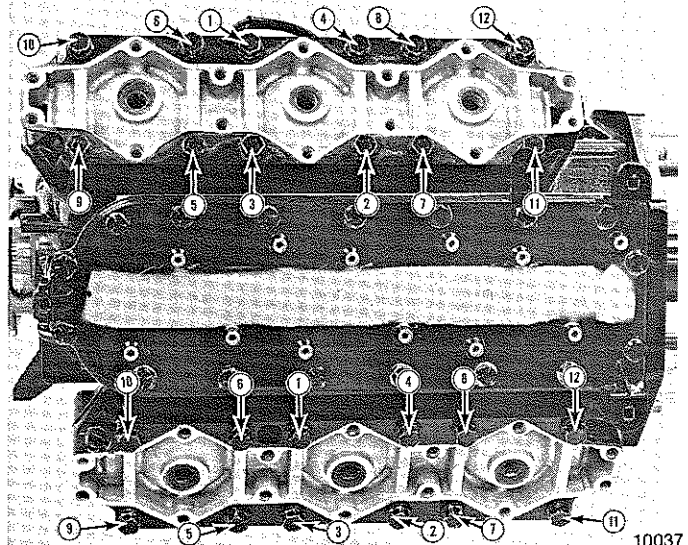


Figure 33. Cylinder Head Torque Sequence

3. Position exhaust manifold cover over divider plate gasket and secure with attaching bolts. Torque exhaust manifold cover bolts in 3 progressive steps (following torque sequence in Figure 30) until bolts are torqued to specification on Page 4-1.

NOTE: One of the exhaust manifold cover bolts has a wiring harness support plate assembly on it. Location of this plate was marked during disassembly. Reinstall support plate on correct bolt.

4. Place cylinder head gasket over starboard side of cylinders with numbered side of gasket up (away from cylinder block). (Figure 31)

IMPORTANT: Cylinder head gasket MUST BE installed correctly.

5. Place cylinder head over starboard side cylinders so that hole for temperature sender is toward flywheel end of cylinder block. (Figure 32)

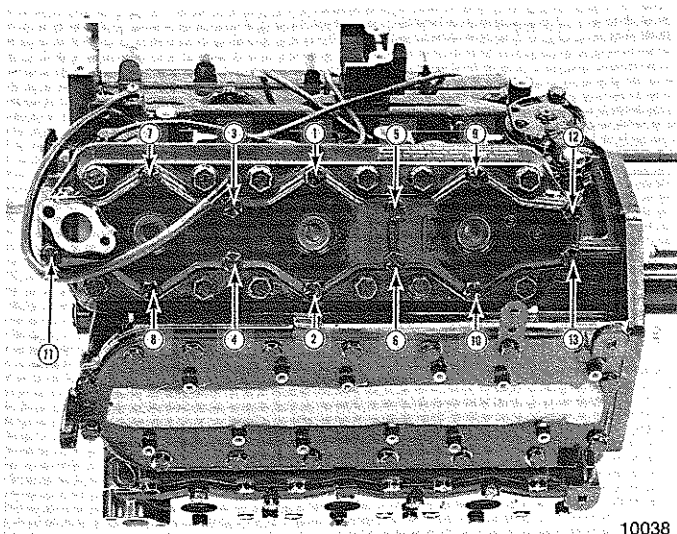


Figure 34. Cylinder Head Covers

6. Install temperature sender (with bracket) into starboard side cylinder head, as shown in Figure 32.
7. Install bolts which secure starboard cylinder head to cylinder block. Torque cylinder head bolts in 3 progressive steps (following torque sequence in Figure 33) until bolts are torqued to specification.
8. Install cylinder head gasket and cylinder head over port side cylinders. Secure with bolts and use torque procedure

9. Reconnect temperature sender wires to terminals of terminal block on starboard side of powerhead.
10. Install cylinder head cover gasket and cylinder head cover on each cylinder head. Install covers with thermostat openings toward flywheel end of powerhead. (Figure 5 in "Cylinder Heads and Exhaust Covers - Removal")
11. Install cylinder head cover bolts with "J" clips placed at proper locations. Torque cylinder head cover bolts in 3 progressive steps (following torque sequence in Figure 34) until bolts are torqued to specification.

NOTE: Location of cylinder head cover "J" clips was noted during disassembly.

12. Install a new thermostat gasket around each thermostat so that shoulder on gasket will be toward cylinder head cover when installed.
13. Install thermostat, then thermostat covers (with water distribution hoses) onto cylinder head covers. (Figure 4 in "Cylinder Heads and Exhaust Covers - Removal") Secure thermostat covers with attaching bolts and torque bolts to specification.
14. Connect water distribution hoses (from starboard side thermostat cover) to discharge fitting on pressure relief valve cover. Clamp hose securely at fitting. (Refer to Figure 35 for water flow schematic.)

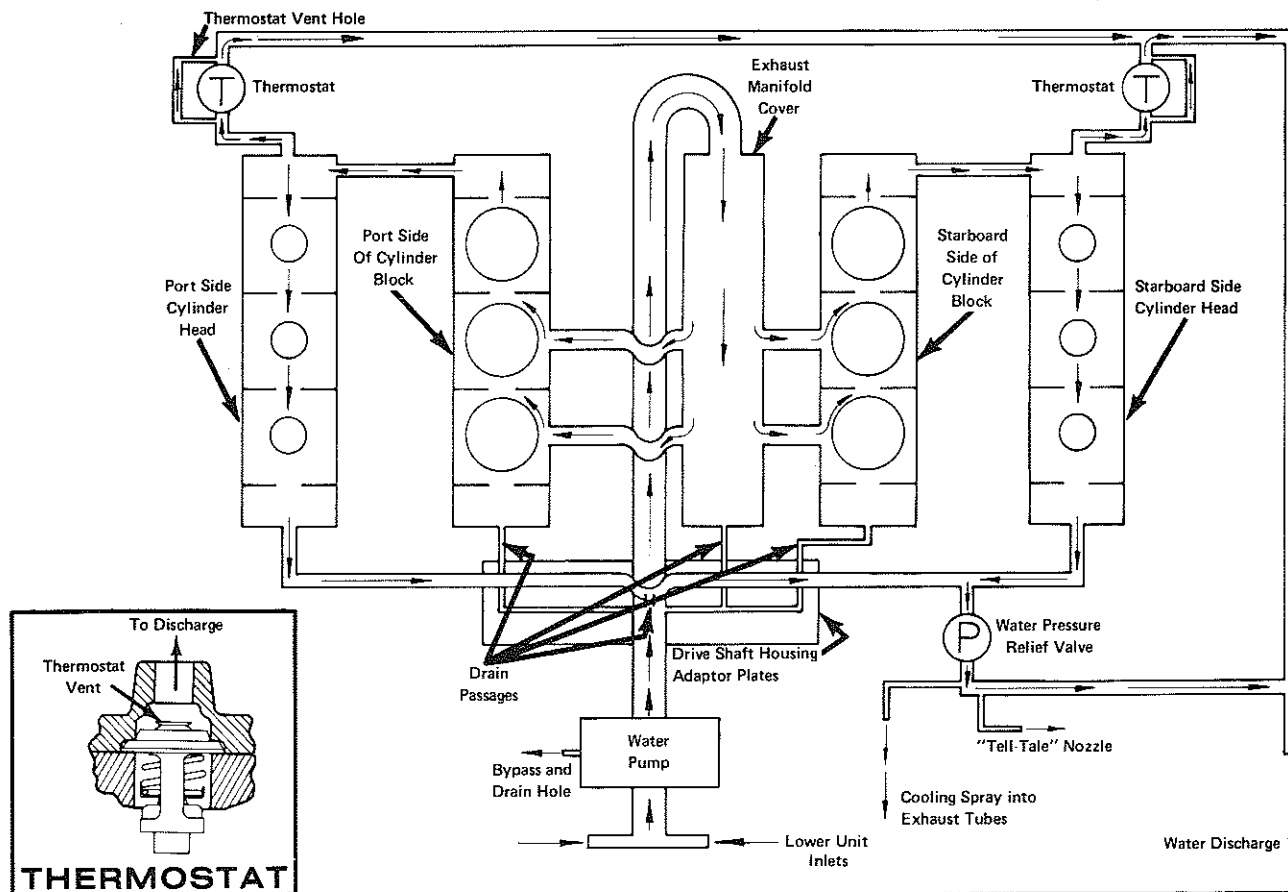


Figure 35. Cooling System (Water Flow)

Accessories and Flywheel - Installation

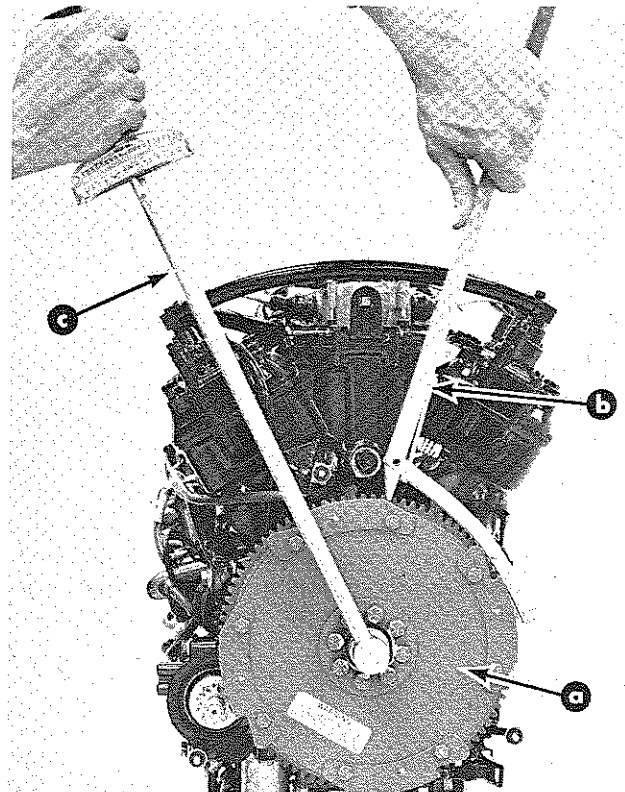
1. Place carburetor gaskets on 3 carburetor mounting flanges of reed block housing.
2. Reinstall carburetors, choke plate/air box, fuel pump and cowl brackets onto powerhead as an assembly. Secure carburetors with 12 locknuts (4 on each carburetor), torqued to specification listed on Page 4-1.
3. Reconnect bleed hose from fitting on reed block housing to check valve [located at lower (port side) corner of air intake box]. (Figure 8 in "Reed Blocks - Removal and Disassembly", preceding)
4. Replace fuel pump gaskets and diaphragm, then reassemble fuel pump to reed block housing. Secure fuel pump assembly with 5 screws and torque to specification.
5. Reinstall control cable anchor bracket to crankcase cover with 3 bolts. (Figure 3 in "Flywheel and Accessories - Removal") Tighten bolts securely.
6. Lubricate bushing in vertical throttle lever with grease, then re-attach vertical throttle lever assembly to cylinder block with pivot bolt. A flat washer must be reinstalled around pivot bolt and positioned between throttle lever and cylinder block. Tighten pivot bolt securely. (Figure 3 in "Flywheel and Accessories - Removal")
7. Lubricate 2 throttle cam bushings with grease, then re-install throttle cam (with one bushing each side of cam) onto reed block housing stud. Secure throttle cam with locknut. (Figure 3 in "Flywheel and Accessories - Removal") Thread locknut onto stud until 2 or 3 stud threads can be seen on outside of locknut. **DO NOT** tighten locknut. Throttle cam must be free to swivel.

SAFETY WARNING: DO NOT tighten throttle cam attaching locknut. Throttle cam must be free to swivel on stud.

8. Reattach ignition plate (with electrical components) to starboard side of powerhead with 3 bolts and flat washers. Be sure that ground wires and "J" clips are properly installed, then tighten bolts securely.
9. Place a drop of Loctite Type "A" on threads of secondary ignition coil attaching screws. Reinstall 6 secondary ignition coils and coil covers on exhaust manifold cover. Install ground wires from negative (-) ignition coils' terminals around appropriate screws, then secure coils and coil covers with screws. Tighten screws securely.
10. Reconnect green, green/white and green/red switch box wires to positive (+) terminals of respective secondary ignition coils. Secure with lockwasher and nut. Torque terminal nuts to specification. Reinstall rubber boots over coil terminals.

NOTE: Green, green/white and green/red switch box wires have numbered tape flags on them. Switch box wire (identified with "1" on it) must be attached to ignition coil that will fire No. 1 cylinder, etc.

11. Reconnect white/green engine harness wire to terminal block with temperature sender wires attached. Connect wire to terminal, that is not grounded, then insulate terminals with Liquid Neoprene.
12. Insert choke plunger inside choke solenoid and attach solenoid to reed block housing with lockwashers and bolts. Tighten bolts securely.



a - Flywheel
b - Flywheel Holder (C-91-52344)
c - Torque Wrench

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Figure 37. Torquing Flywheel Locknut

13. Reconnect gray engine harness wire to terminal of choke solenoid with lockwasher and nut. Insulate terminal with Liquid Neoprene.
14. Place starter motor (with rubber collars) in position on crankcase cover and secure with 2 covers (upper and lower). Be sure that ground wire is installed on lower mounting bolt, then torque bolts to specification.
15. Reconnect electrical cables to starter motor. Insulate cable ends with Liquid Neoprene.
16. Reinstall trigger plate assembly in upper end cap and insert link rod swivel into vertical throttle lever. Secure link rod to throttle lever with locknut. Tighten locknut securely.
17. Place a drop of Loctite Type "A" on threads of stator attaching screws. Install stator assembly in position in upper end cap and secure with attaching screws. Torque screws to specification.
18. Reconnect stator wires and trigger wires to proper terminals of switch boxes. Reinstall rubber boots over terminals.

NOTE: Wires, with a yellow identification sleeve around them, must be connected to outer switch box. Outer switch box fires cylinders No. 2, 4 and 6.

19. Reinstall sta-straps, as necessary, to secure wiring. Reinstall wiring in proper "J" clips and close clips.
20. Reinstall flywheel on crankshaft. Secure flywheel with flat washer and locknut. While holding flywheel with Flywheel Holder (C-91-52344), torque flywheel locknut to specification. (Figure 27)
21. Reinstall flywheel cover. Secure with flat washers and wing nuts.

Powerhead Installation

1. Install Lifting Eye (C-91-75132) into flywheel.

SAFETY WARNING: BE SURE that Lifting Eye is threaded into flywheel as far as possible BEFORE lifting powerhead.

2. Using a hoist, lift powerhead high enough to allow removal of powerhead from repair stand. Remove powerhead from repair stand, being careful not to damage drive shaft housing gasket surface of powerhead.
3. Place a new gasket around powerhead studs and into position on base of powerhead.
4. Lubricate drive shaft splines with grease and install powerhead on drive shaft housing, using hoist. (Figure 3 in "Powerhead Removal", preceding) It may be necessary to turn flywheel (aligning crankshaft splines with drive shaft splines) so that powerhead will be fully installed.
5. Install 10 flat washers and 10 locknuts which secure powerhead to exhaust extension plate/drive shaft housing. (Figures 1 and 2 in "Powerhead Removal") Torque locknuts in 3 progressive steps until torqued to specification listed on Page 4-1.
6. Disconnect hoist from Lifting Eye, then remove Lifting Eye from flywheel.
7. Reinstall plastic cap in center of flywheel.
8. Reinstall rear cowl bracket assembly (Figure 1 in "Powerhead Removal") to exhaust manifold cover with 3 flat washers and 3 locknuts. Tighten locknuts securely.
9. Reconnect water hose from port side of exhaust adaptor plate to "tell-tale" nozzle. (Figure 1 in "Powerhead Removal") Securely clamp water hose at nozzle.

10. With spring and guide block installed on shift link rod, insert shift link rod into control cable anchor bracket. Guide block must be installed with anchor pin forward.
11. Secure shift link rod assembly with wear plate, latch, washer and locknut. Thread locknut onto shift link rod until 2 or 3 threads are exposed beyond top of nut. DO NOT tighten locknut.
12. Install spark plugs into cylinder heads, torquing to specification.
13. Reconnect ignition coil high tension leads to their respective spark plugs.
14. Connect remote control cables to engine.
15. Connect engine battery cables to terminals of battery.

CAUTION: Be sure that battery cables are connected to battery terminals of same polarity.

16. Connect engine harness to "Extension Harness" by plugging together connectors and securing with clamps.
17. Connect engine fuel hose to fuel tank hose.
18. Refer to Section 2 and complete "Timing/Synchronizing/Adjusting" of this engine.
19. While operating engine, check powerhead for water leaks (check cylinder block, cylinder heads, cylinder head covers, exhaust manifold cover and thermostat covers for water leaks), fuel leaks and exhaust leaks. If a powerhead leak(s) is detected, repair powerhead before placing engine in service.
20. Reinstall port and starboard halves of "clam-shell" cowl, then install front cowl cover.

Powerhead Break-In

CAUTION: To avoid possible engine damage, "Break-In Procedure", following, MUST BE completed BEFORE operating engine at full throttle continuously.

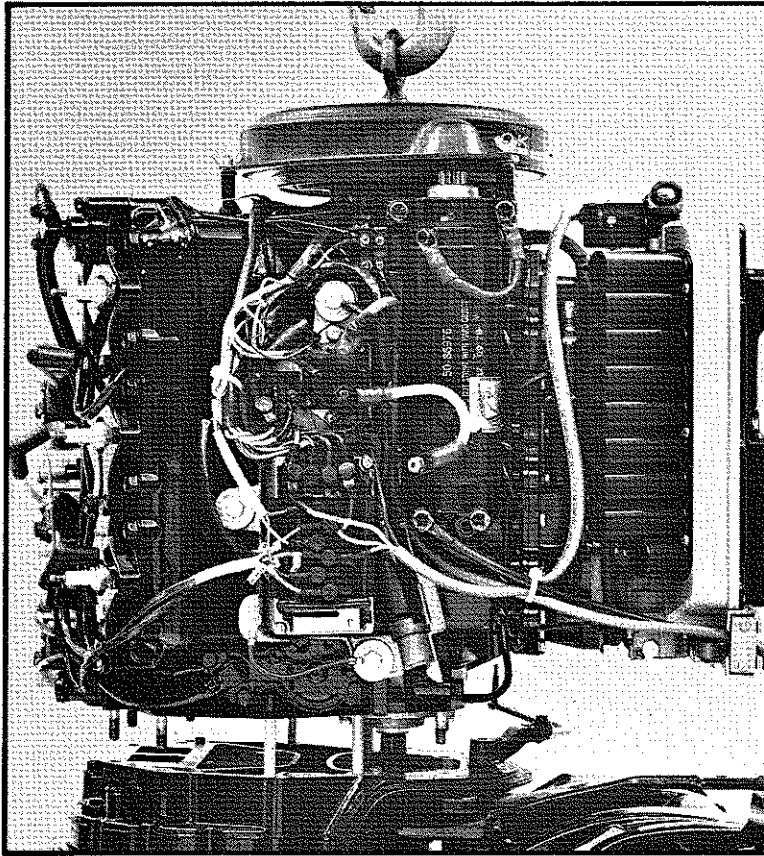
The owner must be advised that break-in procedures must be followed exactly when an overhauled engine is returned to service. (Refer to "Break-In Procedure", following).

BREAK-IN PROCEDURE

Operate overhauled engine at ½ throttle (2500-3500 RPM) for two (2) hours. After 2 hours, the engine may run at any speed, although sustained operation at full throttle should be avoided for an additional eight (8) hours. Mix gasoline and oil during the break-in period (first 10 hours of operation) at a 25:1 ratio.

V-6 OUTBOARDS

Powerhead



225 HP MODEL

SECTION

4

PART

A

INDEX

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GENERAL INFORMATION

Powerhead "Disassembly" and "Reassembly" instructions are printed in a sequence that should be followed to assure best results when removing or replacing powerhead components. If complete disassembly is not necessary, start reassembly at point disassembly was stopped. (Refer to "Index", preceding.) Usually, complete disassembly of powerhead will be required.

If major powerhead repairs are to be performed, remove powerhead from drive shaft housing. Removal of powerhead is not required for 1) inspection of cylinder walls and pistons (refer to "Powerhead Removal and Disassembly", following,

and remove cylinder heads and exhaust covers), 2) minor repairs on components, such as ignition system, carburetors, reed blocks and cylinder heads, and 3) checking operation of thermostats and temperature sender (remove thermostats and temperature sender, then refer to "Cleaning and Inspection", following).

A powerhead repair stand may be purchased from:

Bob Kerr's Marine Tool Co.
P.O. Box 1135
Winter Garden, FL 32787
Telephone: (305) 656-2089

Tools for Powerhead Repair

Tool Description	Part No.
Lifting Eye	C-91-75132
Flywheel Holder	C-91-52344
Protector Cap	C-91-24161
Flywheel Puller	C-91-73687A1
Powerhead Stand	C-91-30591A1
Piston Ring Expander	C-91-24697
Lockring Removal Tool	C-91-52952A1
Piston Support Block	C-91-77005
Piston Pin Tool	C-91-74607A1

Tool Description	Part No.
Torch Lamp	C-91-63209
Driver Head	C-91-55919
Driver Rod	C-91-37323
Universal Puller Plate	C-91-37241
VOA Meter	C-91-62562
Snap Ring Pliers	C-91-24283
Lockring Installation Tool	C-91-77109A1
Piston Ring Compressor*	C-91-85534

225 HP V-6 Model Powerhead Torques

	Fastener Shown in Figure A on Next Page	Size	Torque	Loctite and Sealants
—	Coil Terminal Nuts	10-32	20 In. Lbs. (23kg-cm)	
—	Fuel Pump Attaching Screws	10-32	25 In. Lbs. (29kg-cm)	
A	Reed Attaching Screws	8-32	25 In. Lbs. (29kg-cm)	
B	Stator Attaching Screws	10-24	30 In. Lbs. (35kg-cm)	Loctite Type "A"
—	Coil Attaching Screws	10-32	35 In. Lbs. (40kg-cm)	Loctite Type "A"
C	Reed Block Attaching Screws	1/4-20	60 In. Lbs. (69kg-cm)	
D	Intake Manifold Attaching Screws	1/4-20	60 In. Lbs. (69kg-cm)	
E	End Cap Screws (Lower)	1/4-20	60 In. Lbs. (69kg-cm)	
—	Carburetor Nuts	1/4-28	80 In. Lbs. (92kg-cm)	
F	End Cap Screws (Upper)	5/16-18	150 In. Lbs. (173kg-cm)	
G	Idle Shut Off Valve Cover Screws	5/16-18	150 In. Lbs. (173kg-cm)	
H	Thermostat Cover Screws	5/16-18	150 In. Lbs. (173kg-cm)	
I	Cylinder Head Cover Screws	.312-18	150 In. Lbs. (173kg-cm)	
J	Exhaust Manifold Cover Screws	.312-18	180 In. Lbs. (207kg-cm)	Loctite 271
—	Starter Motor Attaching Screws	5/16-18	180 In. Lbs. (207kg-cm)	
K	Crankcase Cover Screws	5/16-18	200 In. Lbs. (230kg-cm)	
L	Spark Plug	14 MM	17 Ft. Lbs. (2.35mkg)	
M	Cylinder Head Attaching Screws	3/8-16	30 Ft. Lbs. (4.15mkg)	
N	Connecting Rod Screws	.3125-24	30 Ft. Lbs. (4.15mkg)	Loctite 271
O	Crankcase Cover Screws	3/8-16	35 Ft. Lbs. (4.84mkg)	Light Oil
P	Powerhead to Exhaust Extension Plate	3/8-24	45 Ft. Lbs. (6.22mkg)	
Q	Flywheel Nut	5/8-18	100 Ft. Lbs. (13.83mkg)	

Barrel Profile Piston Diameter		
R	225 HP (V-6)	(a) 3.372" (85.649mm)

(a) Measure outside of piston 1/2" (12.7mm) up from bottom of piston, in line with piston pin and at right angle (90°) to piston pin.

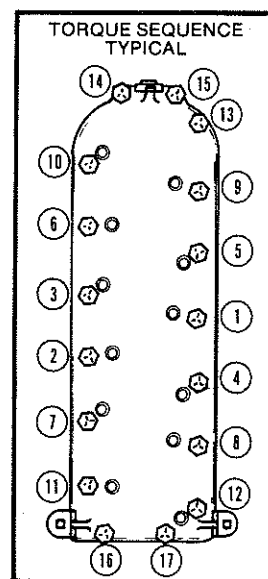
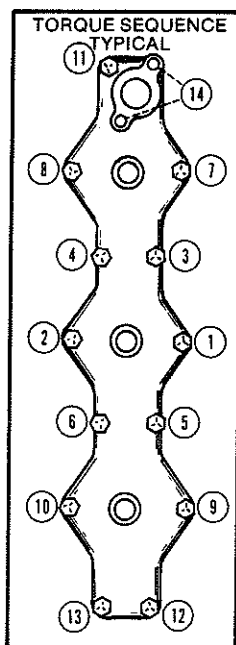
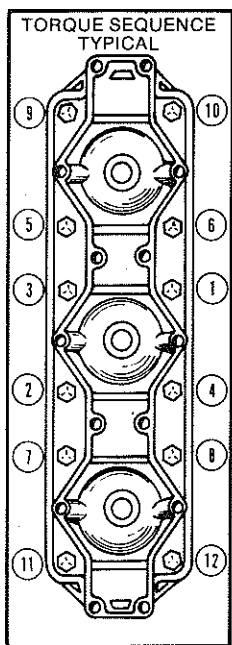
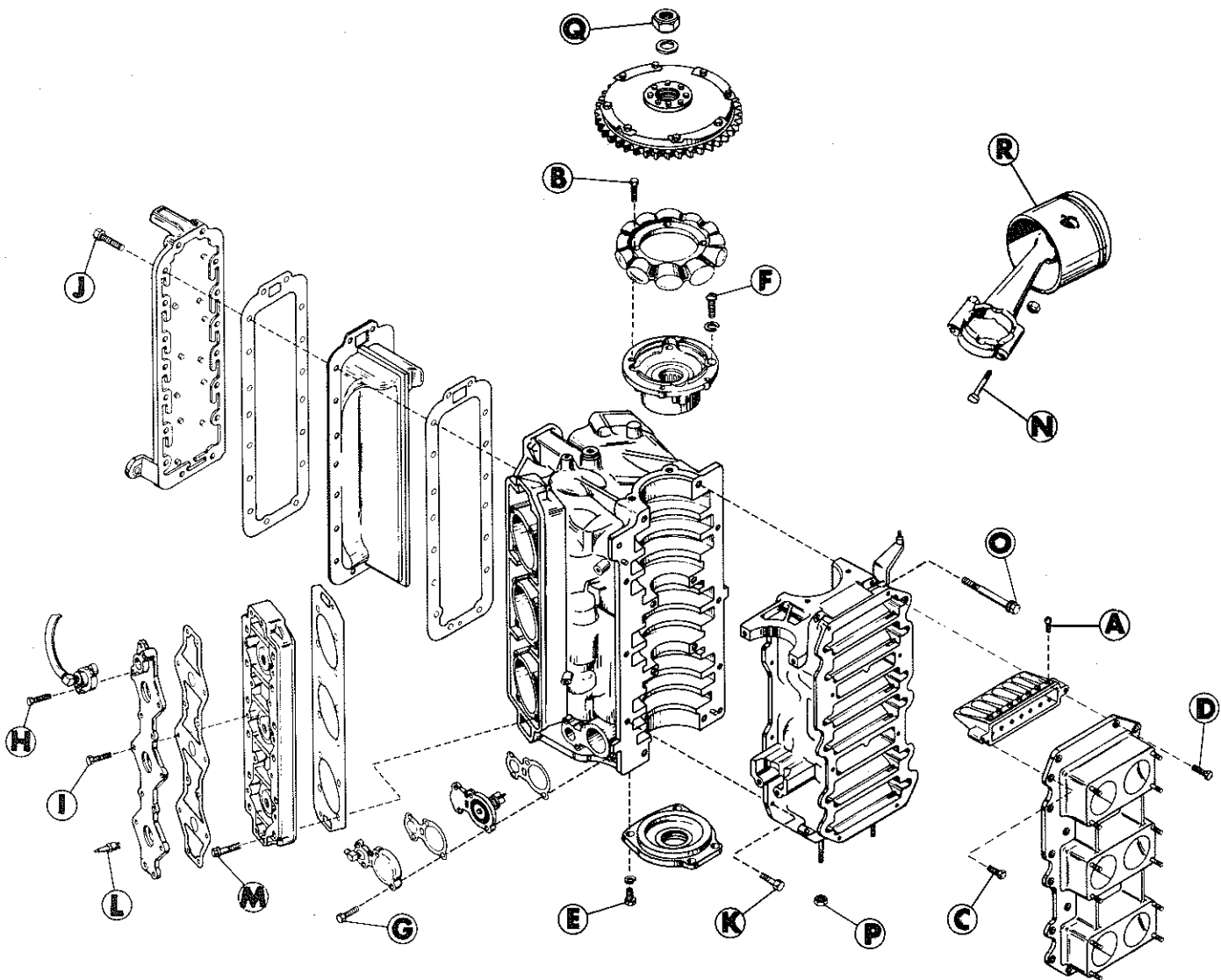


Figure A. Model 225 HP Fastener Locations and Torque Sequence (Torque Chart on Page 4A-1)

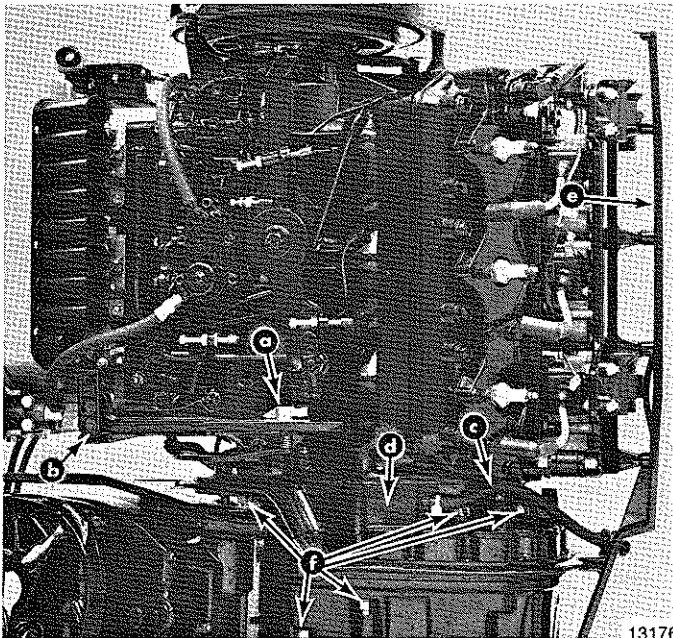
POWERHEAD REMOVAL and DISASSEMBLY

Powerhead Removal

1. Disconnect battery cables from battery terminals.
2. Disconnect fuel tank hose from outboard.
3. Remove front cover and clam-shell cowling from outboard.
4. Remove 2 screws, which secure remote control harness retainer, and remove retainer.
5. Disconnect remote control harness connector from engine harness connector and pull battery cables from remote control harness sleeve.

SAFETY WARNING: Remove high tension leads from spark plugs BEFORE working on powerhead.

6. Disconnect high tension leads from spark plugs.
7. Shift outboard into neutral position.

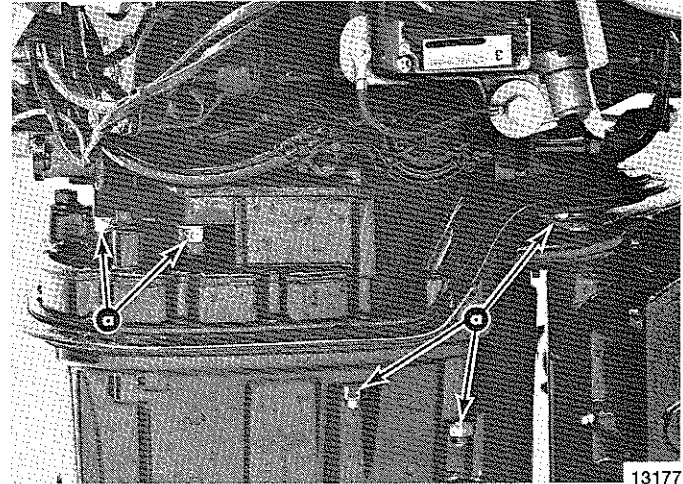


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- | | |
|----------------------------------|---|
| a - Shift Cable Latch Assembly | e - Rear Cowl Support Bracket |
| b - Control Cable Anchor Bracket | f - Powerhead Attaching Locknuts and Flat Washers |
| c - "Tell-Tale" Hose | |
| d - Exhaust Plate Assembly | |

Figure 1. Powerhead (Port Side)

8. Remove locknut, that secures shift cable latch assembly (Figure 1), then remove shift cable latch, flat washer, nylon wear plate and spring from control cable anchor bracket.
9. Remove sta-strap [secures "tell-tale" hose to elbow fitting on exhaust plate assembly (Figure 1)] and remove hose from fitting.
10. Remove 3 locknuts and flat washers, which secure the rear cowl support bracket and bracket bumpers to powerhead (Figure 1), and remove bracket (with attached bumpers) from powerhead.
11. Remove 10 locknuts and flat washers (5 each side; secure powerhead to drive shaft housing). (Figures 1 and 2)



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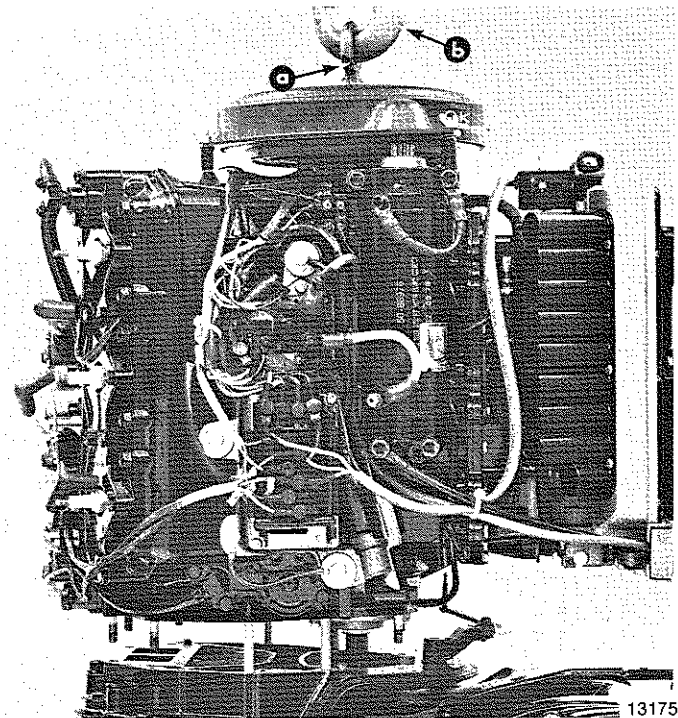
a - Powerhead Attaching Locknuts

Figure 2. Powerhead (Starboard Side)

12. Remove plastic cap from center of flywheel cover and install Lifting Eye (C-91-75132) into flywheel. (Figure 3)

SAFETY WARNING: BE SURE that Lifting Eye is threaded into flywheel as-far-as possible BEFORE removing powerhead.

13. Using a hoist, lift powerhead assembly from drive shaft housing. (Figure 3)

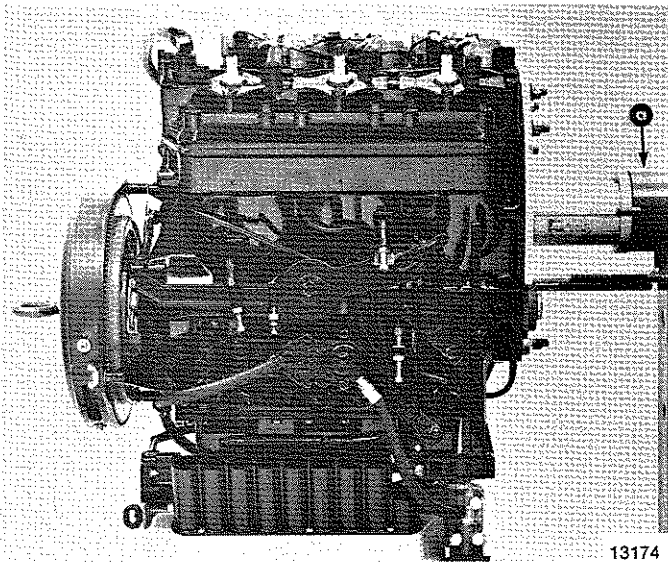


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a - Lifting Eye (C-91-75132)

b - Hoist

Figure 3. Lifting Powerhead from Drive Shaft Housing



14. Install powerhead into a suitable, floor-mounted repair stand (refer to "General Information", preceding). (Figure 4) Be sure that repair stand can adequately support powerhead without damaging gasket surface of cylinder block.

SAFETY WARNING: DO NOT attempt to place powerhead on a powerhead stand that is mounted in a vise.

15. Remove Lifting Eye from flywheel.



a - Powerhead Repair Stand

Figure 4. Powerhead Installed in Repair Stand

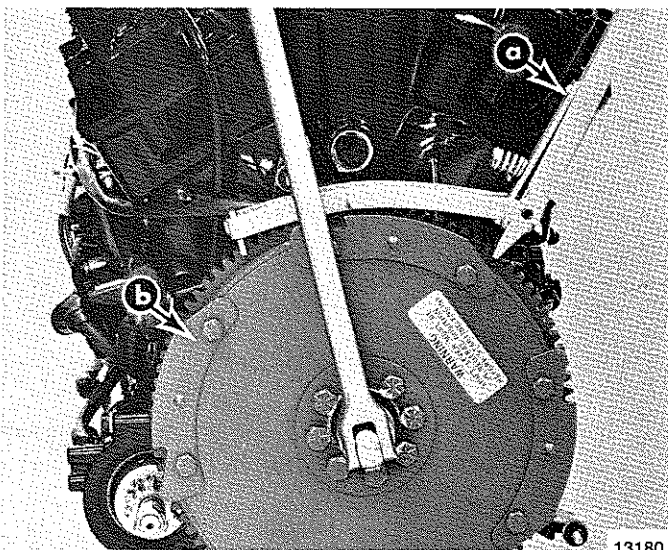
Flywheel and Accessories - Removal

1. Remove flywheel cover from powerhead.
2. While holding flywheel with Flywheel Holder (C-91-52344), remove flywheel nut and washer. (Figure 5)
3. Install a crankshaft Protector Cap (C-91-24161) on end of crankshaft, then install Flywheel Puller (C-91-73687A1) into flywheel. (Figure 6)

CAUTION: Crankshaft damage may result if a protector cap is not used between crankshaft and puller.

4. Remove flywheel by operating Flywheel Puller as shown in Figure 6.

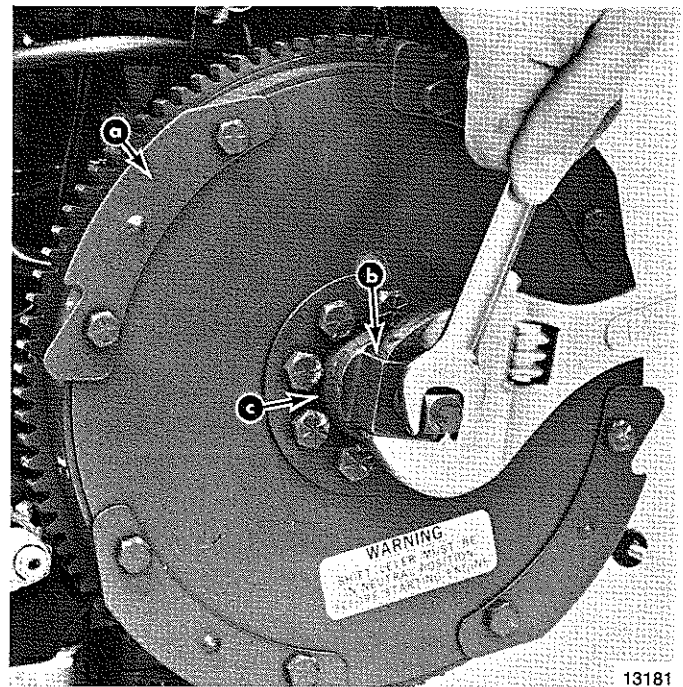
CAUTION: DO NOT strike end of puller center bolt to remove flywheel, or damage may result to crankshaft or bearings. DO NOT use heat to aid flywheel removal, as excessive heat may seize flywheel to crankshaft.



a - Flywheel Holder (C-91-52344)

b - Flywheel

Figure 5. Flywheel Nut Removal



a - Flywheel

b - Flywheel Puller (C-91-73687A1)

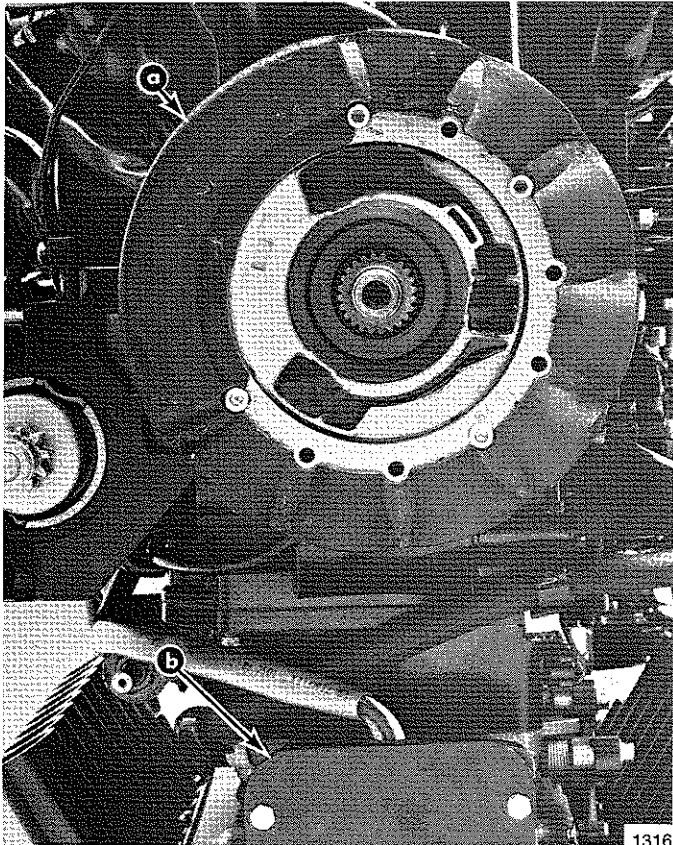
c - Crankshaft Protector Cap (Hidden)

Figure 6. Flywheel Removal

5. Remove 4 allen screws and lockwashers which secure stator to end cap. (Figure 7)

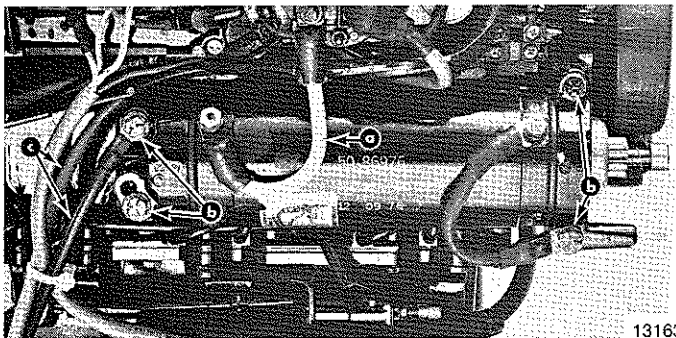
NOTE: Loctite has been applied to threads of stator attaching screws.

6. Remove 2 locknuts which secure the high speed spark advance module to air box. (Figure 7) Lift module from studs and reinstall locknuts.
7. Remove nut and lockwasher [secure the yellow wire (Figure 8) to starter motor], then remove wire from starter and reinstall lockwasher and nut.
8. Remove 4 bolts (Figure 8) which secure the upper and lower starter motor anchor caps. Remove upper and lower caps and starter motor from powerhead.



a - Stator b - High Speed Spark Advance Module

Figure 7. Top View of Powerhead with Flywheel Removed

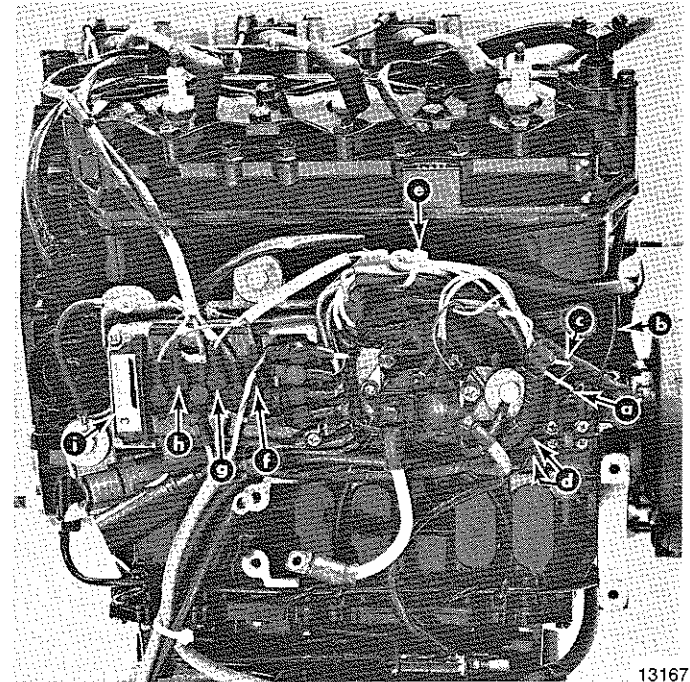


a - Yellow Wire b - Starter Motor Bolts c - Battery Cables

Figure 8. Starter Motor Removal

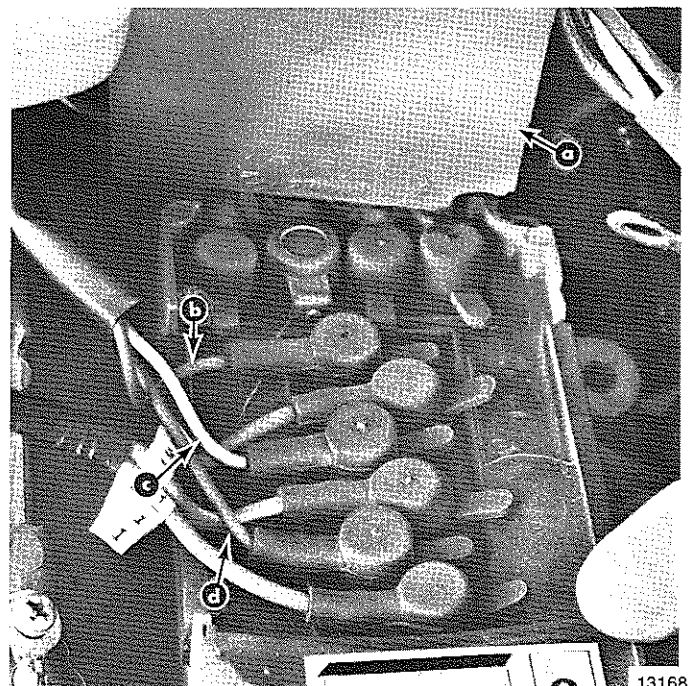
9. Remove tan wire (from ignition plate harness) and black wire (from temperature sender) from terminal block on the starboard side of powerhead. (Figure 9)
10. Remove yellow/black wire (from ignition plate harness) and 2 black wires (from carburetor enrichener) from terminal block on the starboard side of powerhead. (Figure 9)
11. Cut (and remove) sta-strap that secures trigger harness to ignition plate. (Figure 9)
12. Remove nuts, which secure the violet, white and brown trigger wires to the outer switch box (Figure 9), then remove wires from switch box and thread nuts back onto switch box.
13. Remove 2 phillips head screws and spacers, which secure the outer and inner switch boxes to ignition plate, and lift outer switch box away from inner switch box. (Figure 10)

14. Remove nuts, which secure the violet, white and brown trigger wires to the inner switch box (Figure 10), then remove wires from switch box and thread nuts back onto switch box.



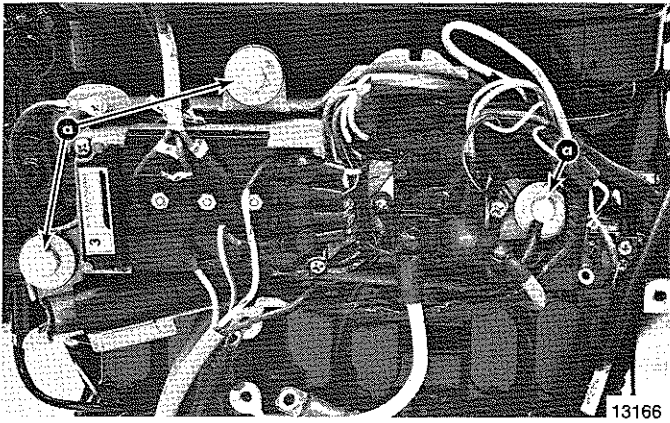
a - Tan Wire f - Violet Trigger Wire
 b - Temperature Sender Black Wire g - White Trigger Wire
 c - Yellow/Black Wire h - Brown Trigger Wire
 d - Carburetor Enrichener Black Wires i - Outer Switch Box
 e - Sta-Strap

Figure 9. Starboard Side of Powerhead with Starter Motor Removed



a - Outer Switch Box c - White Trigger Wire
 b - Violet Trigger Wire d - Brown Trigger Wire

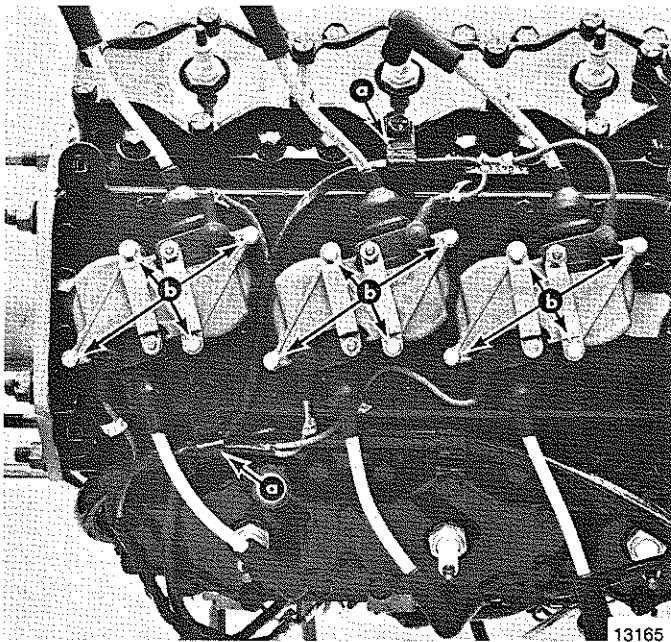
Figure 10. Removing Trigger Wires from Inner Switch Box



a - Ignition Plate Bolts

Figure 11. Ignition Plate with Trigger Wires Removed from Switch Boxes

15. Secure inner and outer switch boxes back onto ignition plate with 2 phillips head screws and spacers. (Figure 11)
16. Remove coil wires from "J" clamps. (Figure 12)
17. Remove 12 screws which secure coils to exhaust manifold cover. (Figure 12)
18. Remove 3 bolts, flat washers and rubber mounts [secure ignition plate to powerhead (Figure 11)] and remove ignition plate (with attached stator and coils) from powerhead.



a - "J" Clamps b - Coil Attaching Screws

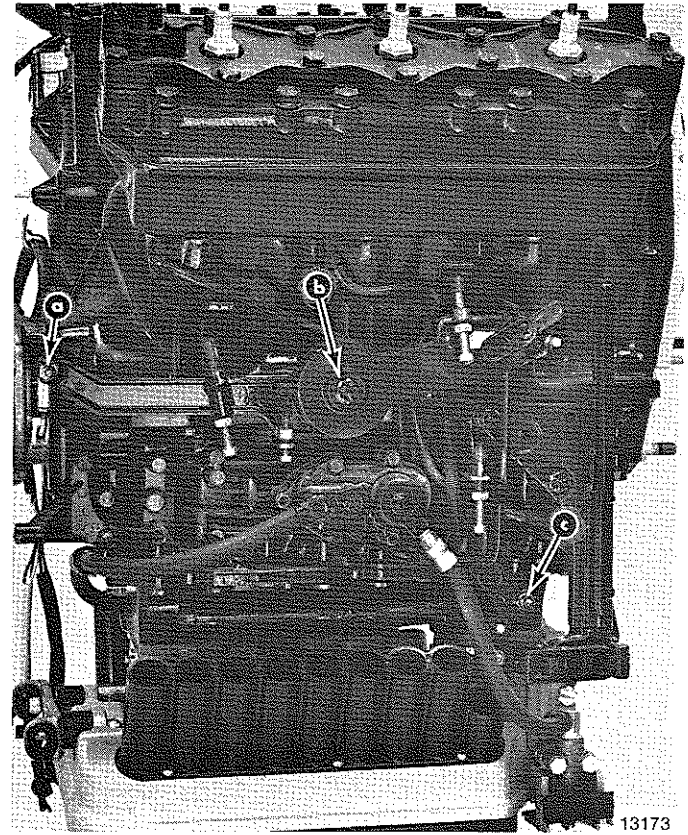
Figure 12. Ignition Coils

19. Remove locknut, that secures trigger linkage to spark/throttle lever. (Figure 13) Remove linkage from lever and reinstall locknut onto linkage.
20. Remove trigger from powerhead.
21. Remove locknut that secures throttle cam (Figure 13) to stud on intake manifold. (DO NOT try to remove throttle cam from stud at this time.)
22. Remove bolt that secures spark/throttle lever to powerhead. (Figure 13)

NOTE: A flat washer is positioned between spark/throttle lever and powerhead.

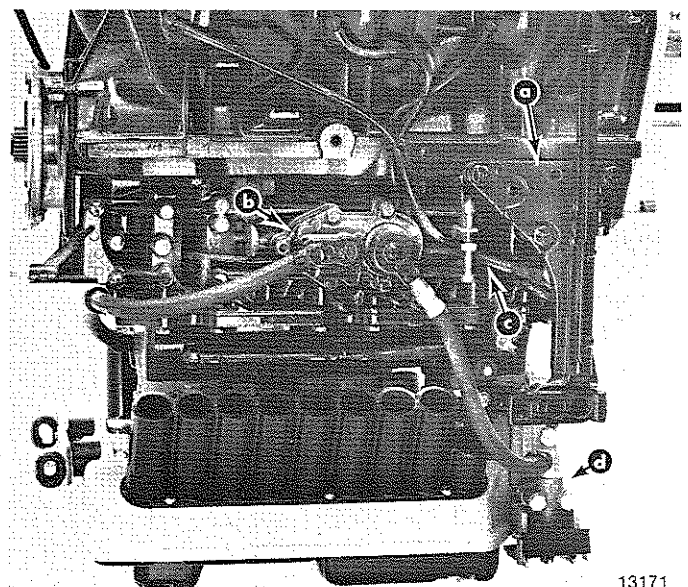
23. Remove spark/throttle lever and throttle cam from powerhead as an assembly. Insert bolt, that secured spark/throttle lever to powerhead, back thru lever and install a nut onto bolt to help hold spark/throttle lever assembly together.

NOTE: Two nylon bushings (one on the inside and one on the outside) are installed on throttle cam mounting stud.



a - Trigger Linkage Nut c - Throttle Cam Locknut
b - Spark/Throttle Lever Bolt

Figure 13. Spark/Throttle Lever Removal



a - Control Cable Anchor Bracket c - Pulse Hose
b - Fuel Pump Assembly d - Check Unit Adaptor

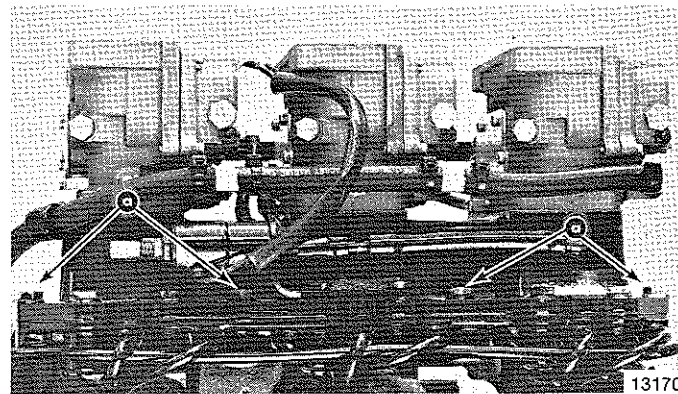
Figure 14. Powerhead with Spark/Throttle Lever Removed

24. Remove 3 bolts [secure control cable anchor bracket to powerhead (Figure 14)] and remove bracket from powerhead.
25. Remove 2 bolts which secure check unit adaptor to air box. (Figure 14)
26. Remove 5 attaching screws which secure fuel pump assembly to powerhead. (Figure 14) Being careful not to separate fuel pump components, lift fuel pump assembly away from powerhead and disconnect pulse hose from fitting on powerhead. Insert 2 of the attaching screws back thru fuel pump assembly and thread a 10-32 nut onto screws. This will prevent fuel pump components from separating during the remainder of powerhead disassembly.

NOTE: It is not necessary to disconnect fuel hoses from fuel pump, as fuel pump will be removed with carburetors.

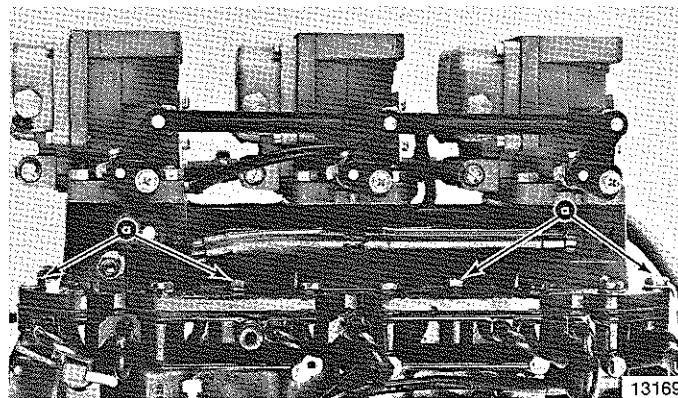
27. Remove 6 bolts, which secure the air box to carburetors, then remove air box.
28. Remove 8 bolts [attach the intake manifold to crankshaft cover (Figures 15 and 16)] and remove manifold from powerhead.

NOTE: Inspect and disassemble the intake manifold as instructed in "Cleaning and Inspection", following.



a - Intake Manifold Attaching Bolts

Figure 15. Intake Manifold Attaching Bolts (Starboard Side)

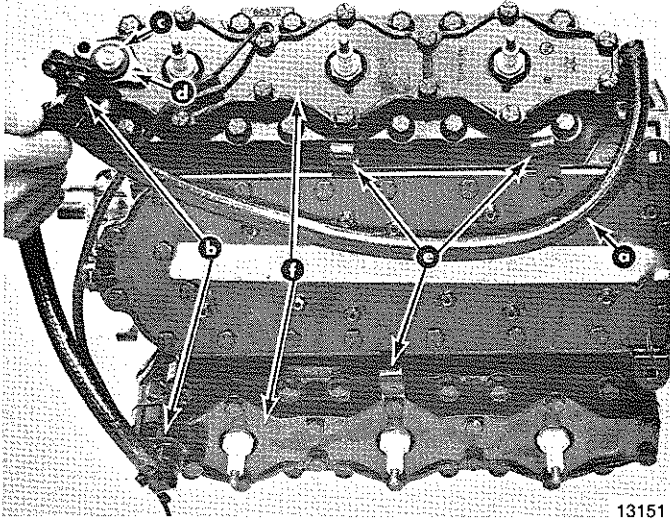


a - Intake Manifold Attaching Bolts

Figure 16. Intake Manifold Attaching Bolts (Port Side)

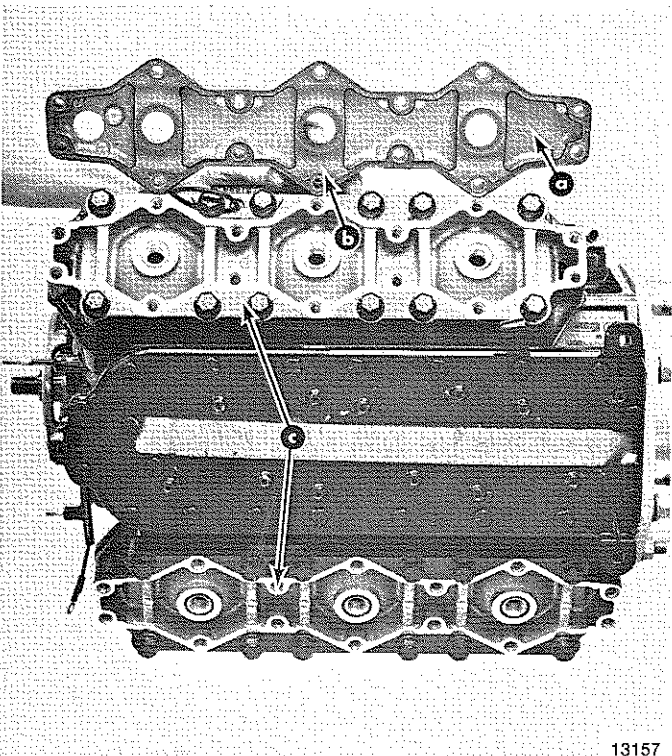
Cylinder Heads and Exhaust Covers - Removal

1. Disconnect water distribution hose from fitting on idle shutoff valve. (Figure 1)
2. Remove bolts which secure thermostat covers to cylinder head covers. (Figure 1)
3. Remove thermostat covers, thermostats and gaskets from each cylinder head cover. (Figure 1)



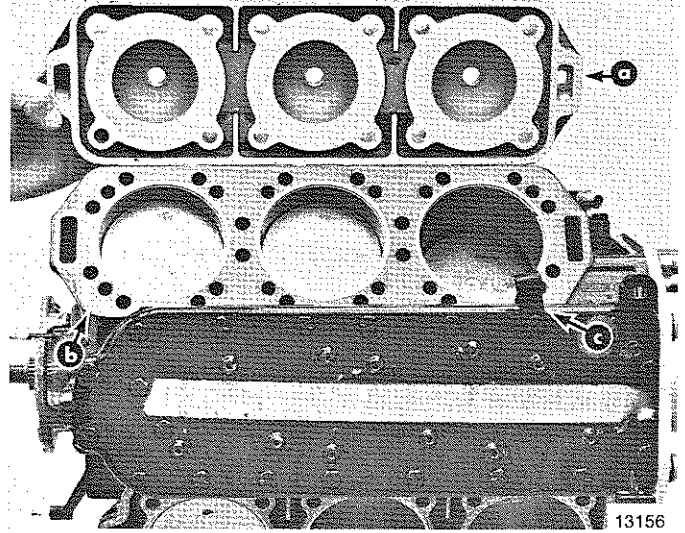
- | | |
|-----------------------------|--------------------------|
| a - Water Distribution Hose | d - Thermostat Gasket |
| b - Thermostat Covers | e - "J" Clips |
| c - Thermostat | f - Cylinder Head Covers |

Figure 1. Thermostat Removal



- | | |
|--------------------------------|-------------------|
| a - Cylinder Head Cover | c - Cylinder Head |
| b - Cylinder Head Cover Gasket | |

Figure 2. Cylinder Head Cover Removal



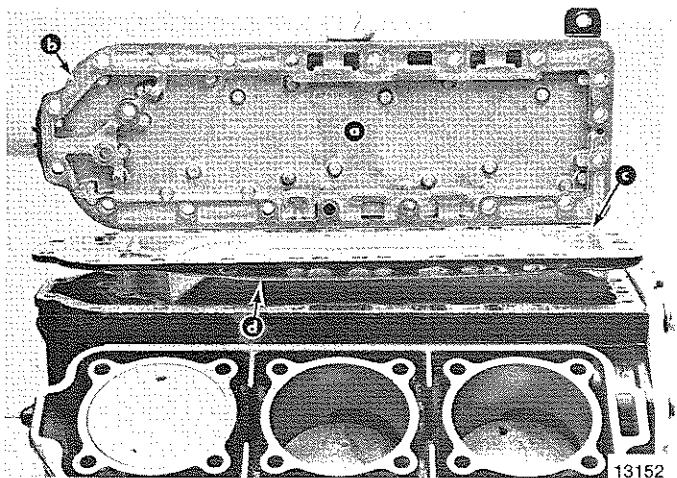
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|-------------------|--------------------------|--------------|
| a - Cylinder Head | b - Cylinder Head Gasket | c - "J" Clip |
|-------------------|--------------------------|--------------|

Figure 3. Cylinder Head Removal

4. Mark location of "J" clips (Figure 1) on cylinder head covers (to aid in reassembly), then remove bolts, covers and gaskets from each cylinder head. (Figure 2)
5. Remove cylinder head attaching bolts. Remove cylinder heads and cylinder head gaskets from cylinder block. (Figure 3)
6. Remove temperature sender from starboard side cylinder head.

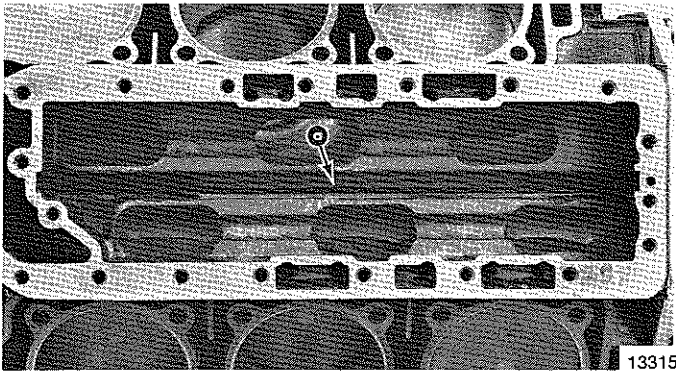
NOTE: Mark location of "J" clip (Figure 3) on exhaust manifold cover (to aid in reassembly).

7. Remove bolts from exhaust manifold cover, then remove exhaust manifold cover, gasket, exhaust divider plate and divider plate gasket from cylinder block. (Figure 4)
8. Remove exhaust divider plate seal from cylinder block. (Figure 5)



- | | |
|--|--|
| a - Exhaust Manifold Cover | c - Exhaust Divider Plate |
| b - Gasket (Exhaust Manifold Cover to Exhaust Divider Plate) | d - Gasket (Exhaust Divider Plate to Cylinder Block) |

Figure 4. Exhaust Manifold Cover and Divider Plate



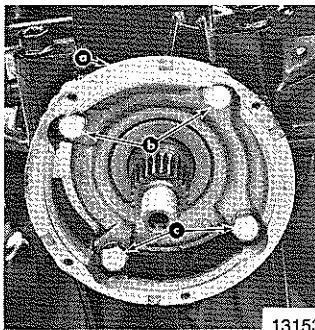
a - Exhaust Divider Plate Seal
Figure 5. Exhaust Divider Plate Seal

Pistons and Connecting Rods - Removal

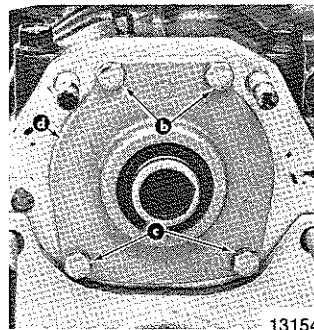
1. Remove bolts (Figure 6) which are used to attach the upper and lower end caps to crankcase cover. Loosen (DO NOT REMOVE) bolts (Figure 6) which are used to attach the upper and lower end caps to cylinder block.

NOTE: End cap bolts (threaded into cylinder block) should be loosened, but remain installed, to hold crankshaft in position until connecting rods are removed from crankshaft.

2. Disconnect bleed hoses (3 on the starboard side and 3 on the port side) from fittings on cylinder block.

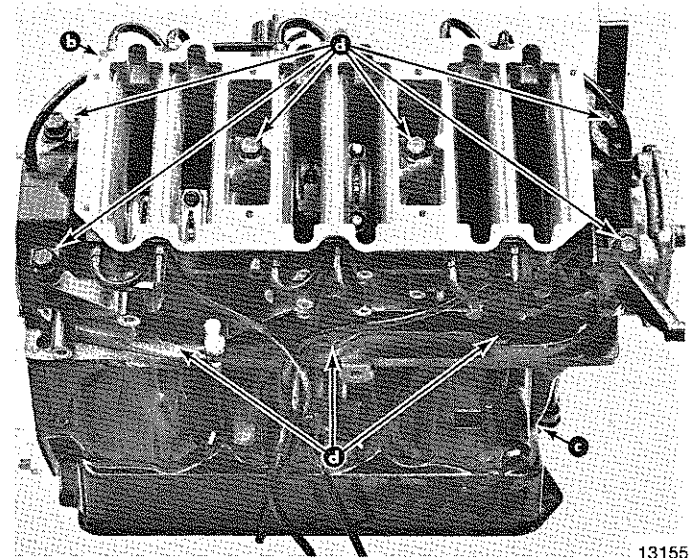


a - Upper End Cap
 b - Remove These Bolts



c - Loosen (DO NOT Remove) These Bolts
 d - Lower End Cap

Figure 6. Upper and Lower End Caps

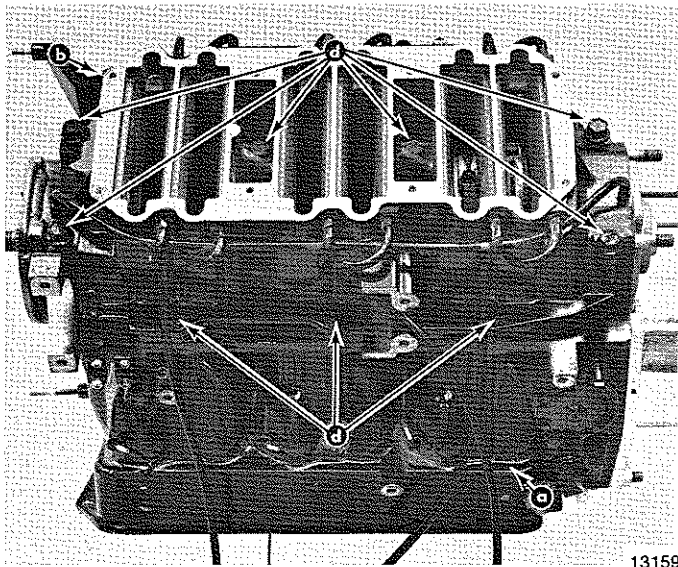


c - Port Side of Cylinder Block
 d - Crankcase Cover Bolts

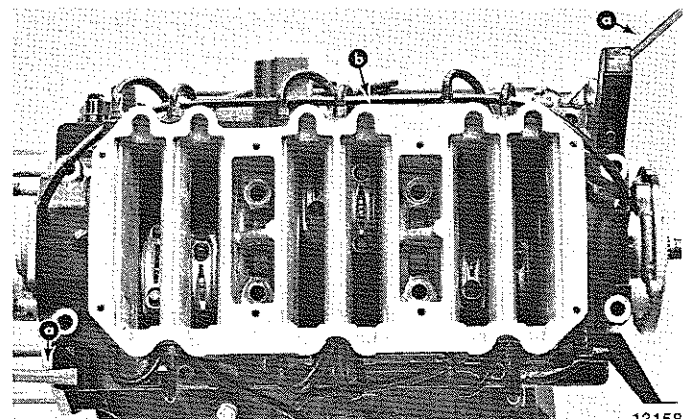
Figure 7. Crankcase Cover

3. Remove bolts, which attach crankcase cover to cylinder block (Figure 7), and remove crankcase cover. Be careful not to damage sealing surfaces or crankshaft.

NOTE: A sealant is used between cylinder block and crankcase cover. It may be necessary to pry crankcase cover off cylinder block, using special recesses provided, as shown in Figure 8.



a - Starboard Side of Cylinder Block
 b - Crankcase Cover



a - Pry Bar
 b - Crankcase Cover

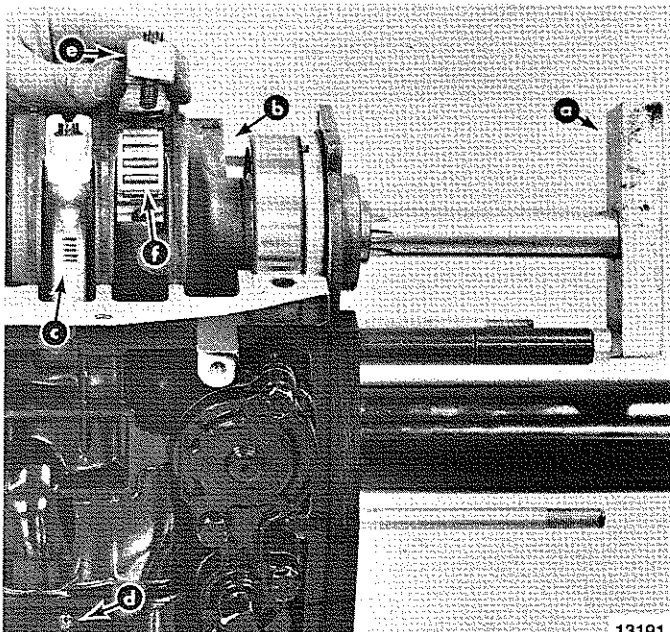
Figure 8. Prying Crankcase Cover Off Cylinder Block (if Necessary)

IMPORTANT: The crankcase cover and cylinder block are a matched, line-bored assembly and never should be mismatched by using a different crankcase cover or cylinder block.

4. Install Powerhead Stand (C-91-30591A1) into drive shaft end of crankshaft. Use Powerhead Stand to turn crankshaft to desired positions when removing connecting rods from crankshaft. (Figure 9)
5. Use an awl (or a felt tip marker) to scribe an identification number on the outside edge of each connecting rod "I" beam. (Figure 9) Number each connecting rod with the same number as the cylinder to which it is installed; i.e., mark a "1" on connecting rod that is installed in No. 1 cylinder, "2" on rod that is in No. 2 cylinder, etc.

CAUTION: As connecting rod cap is removed, be aware of these 2 cautions: 1) that bearings will be free and can be lost as they fall inside of cylinder block, and 2) that piston assembly will be free and may slip out of cylinder block and sustain damage by striking floor.

6. Remove connecting rod bolts with a 5/16"-12 point socket, then lift rod cap, connecting rod bearings (16) and cages from connecting rod and crankshaft. (Figure 9) After each connecting rod cap is removed, lift its respective piston assembly from cylinder block before proceeding to another connecting rod. Reassemble rod cap to its respective connecting rod (Figure 10) after removing piston assembly from cylinder block.

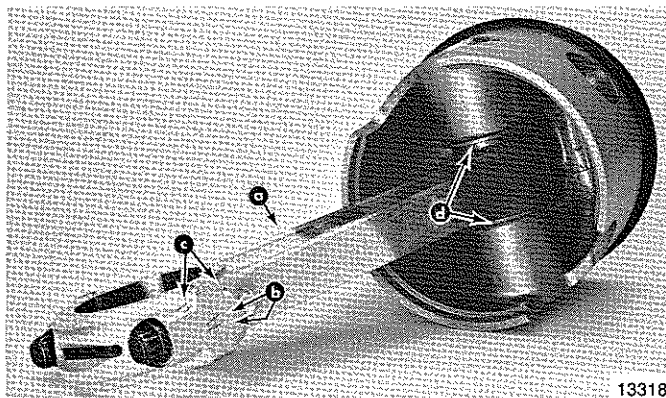


- a - Powerhead Stand (C-91-30591A1)
- b - Crankshaft
- c - Numbered Connecting Rod
- d - Number Marked on Cylinder Block
- e - Connecting Rod Cap
- f - Connecting Rod Bearings and Cages

Figure 9. Crankshaft and Connecting Rods

- a - Piston Ring Expander (C-91-24697)
- b - Piston

Figure 11. Piston Ring Removal



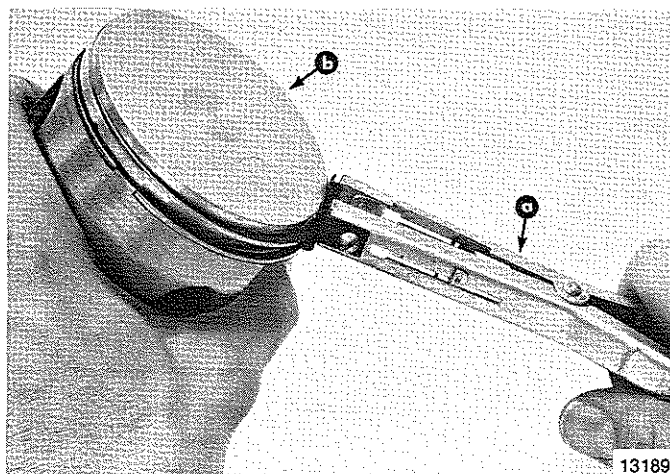
- a - Connecting Rod
- b - "Etched" Alignment Marks
- c - Alignment Bumps
- d - Locating Washers

Figure 10. Connecting Rod and Piston

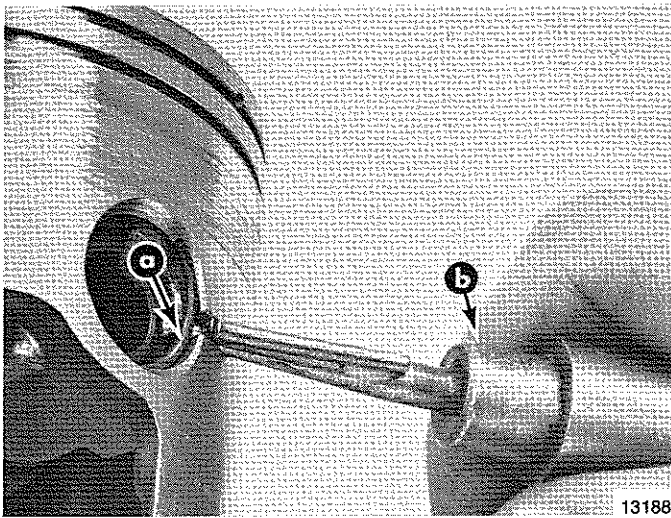
CAUTION: Immediately after removing piston assembly from cylinder block, reassemble its respective rod cap, being certain that "etched" alignment marks (Figure 10) are properly aligned.

CAUTION: It is recommended that NEW connecting rod bearings be installed during re-assembly, regardless of appearance, to assure lasting repair. If, for some reason, bearings must be re-used, keep them separate and identified so that they can be reassembled on the same crankpin throw and with the same connecting rod.

7. As each piston and connecting rod assembly is removed, remove piston rings from pistons with Piston Ring Expander (C-91-24697). (Figure 11) Discard piston rings.
8. After removing all pistons and connecting rods from cylinder block, inspect each piston, its respective connecting rod and piston pin bearings, as outlined in "Cleaning and Inspection", following.
9. If inspection shows that replacement of a piston is necessary, or if condition of wrist pin end of connecting rod is suspected of being bent, or that connecting rod is suspected of being bent, remove piston from connecting rod as outlined, following.



13189



a - Piston Pin Lockring b - Lockring Removal Tool (C-91-52952A1)

Figure 12. Removing Piston Pin Lockring

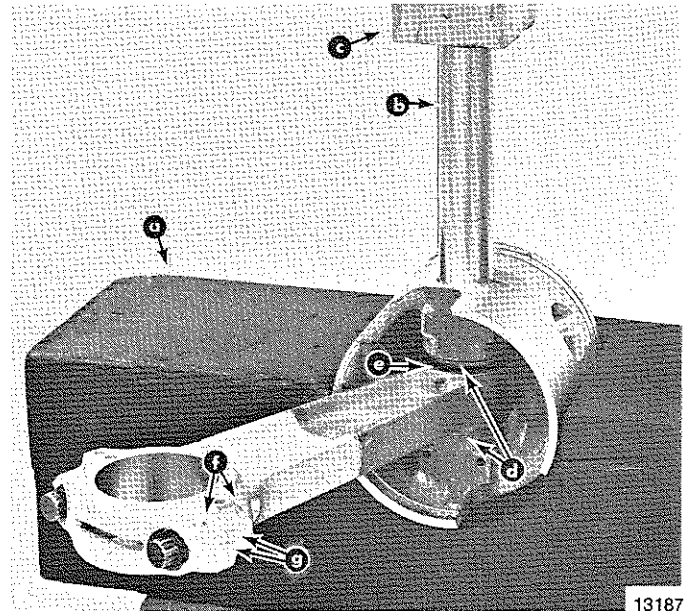
- a. Use an awl (or felt tip marker) to scribe a number on inside of piston skirt to match number (on connecting rod) that was scribed on rod when rod was removed from crankshaft.

SAFETY WARNING: Eye protection MUST BE WORN while removing piston pin lockring.

- b. Remove (and discard) piston pin lockrings from both ends of piston pin. (Figure 12) NEVER re-use piston pin lockrings.
- c. Heat dome of piston to approximately 190°F (88°C) with Torch Lamp (C-91-63209).
- d. Place piston and connecting rod in position on Piston Support Block (C-91-77005). (Figure 13)
- e. Remove piston pin from piston with Piston Pin Tool (C-91-74607A1) and an arbor press. (Figure 13)

- f. Remove piston pin needle bearings (29 per piston) and locating washers (2 per piston) from connecting rod.

CAUTION: If piston is removed from connecting rod, it is recommended that NEW piston pin needle bearings be installed during reassembly, regardless of appearance, to assure lasting repair. If, for some reason, bearings must be re-used, keep them separate and identified so that they can be reassembled on the same connecting rod and the same piston.



a - Piston Support Block (C-91-77005) d - Locating Washers
 b - Piston Pin tool (C-91-74607A1) e - Needle Bearings (Hidden)
 c - Arbor Press f - Alignment Bumps
 g - "Etched" Alignment Marks

Figure 13. Removing Piston from Connecting Rod

End Caps - Removal and Disassembly

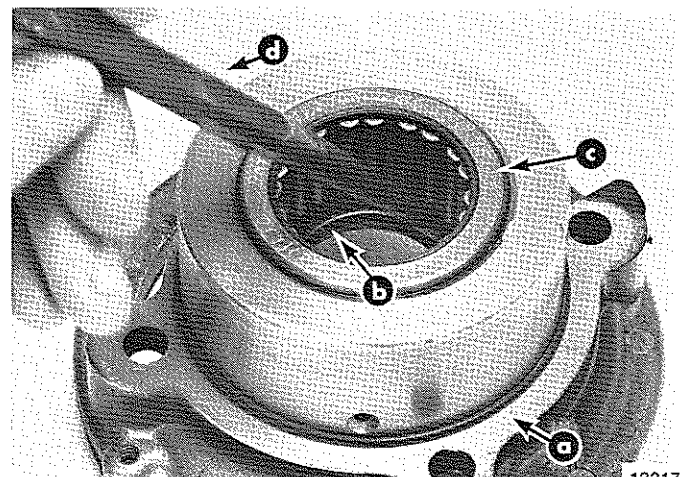
1. Remove bolts which secure upper and lower end caps to cylinder block. (Figure 6)

NOTE: These bolts were previously loosened to allow removal of crankshaft cover.

2. Remove upper and lower end caps from around crankshaft.
3. Remove (and discard) "O" ring from around each end cap. (Figure 14)
4. Drive oil seal(s) from each end cap with a suitable punch, as shown in Figure 14. Discard oil seals.
5. Inspect crankshaft roller bearing, which is installed in upper end cap, as outlined in "Cleaning and Inspection", following.

IMPORTANT: DO NOT remove crankshaft roller bearing from upper end cap, unless replacement of bearing is required.

6. If inspection determines that replacement of crankshaft roller bearing in upper end cap is required, press bearing from end cap with Drive Head (C-91-55919) and Driver Rod (C-91-37323), as shown in Figure 15.

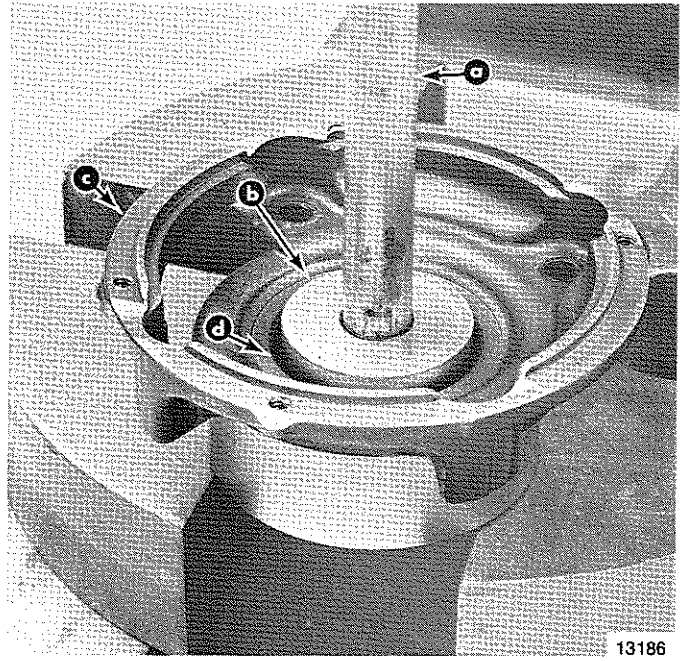


a - "O" Ring c - Crankshaft Roller Bearing
 b - Oil Seal d - Punch

Figure 14. Removing End Cap Oil Seal (Upper End Cap Shown)

- a - Driver Rod (C-91-37323)
- b - Driver Head (C-91-55919)
- c - Upper End Cap
- d - Crankshaft Roller Bearing (Hidden)

Figure 15. Removing Crankshaft Roller Bearing from Upper End Cap



13186

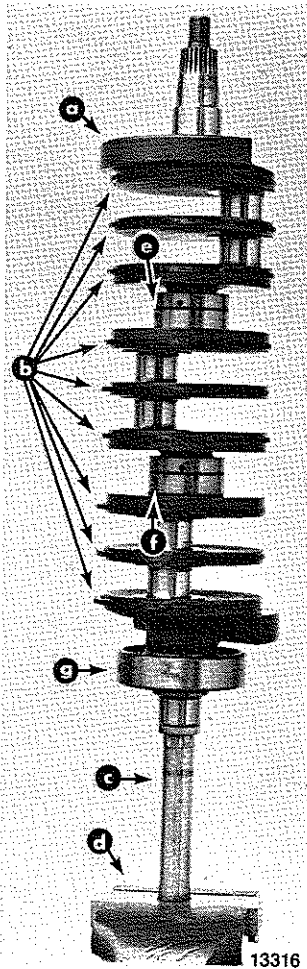
Crankshaft - Removal and Disassembly

- Lift crankshaft assembly from cylinder block and place assembly on Powerhead Stand (C-91-30591A1) mounted in a vise. (Figure 16)

IMPORTANT: DO NOT remove crankshaft sealing rings (Figure 16) from crankshaft, unless replacement of a sealing ring(s) is necessary. Usually, crankshaft sealing rings do not require replacement, unless broken.

- a - Crankshaft Assembly
- b - Crankshaft Sealing Rings
- c - Powerhead Stand (C-91-30591A1)
- d - Vise
- e - Upper Crankshaft Main Bearing (Arrow Pointing to Dowel Pin Hole)
- f - Lower Crankshaft Main Bearing (Arrow Pointing to Dowel Pin Hole)
- g - Crankshaft Ball Bearing

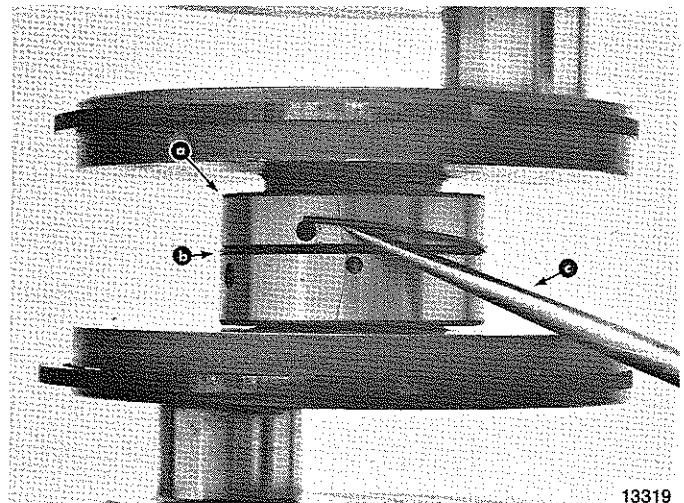
Figure 16. Crankshaft Assembly



13316

- a - Bearing Race
- b - Roller Bearings
- c - Bearing Cage
- d - Retaining Ring

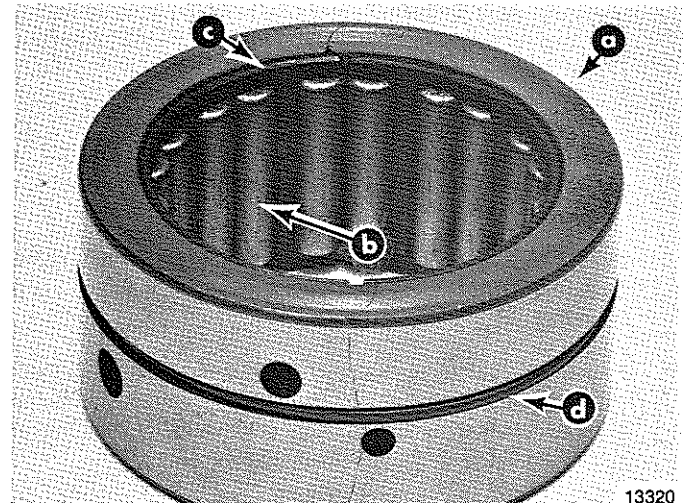
Figure 18. Crankshaft Main Bearing



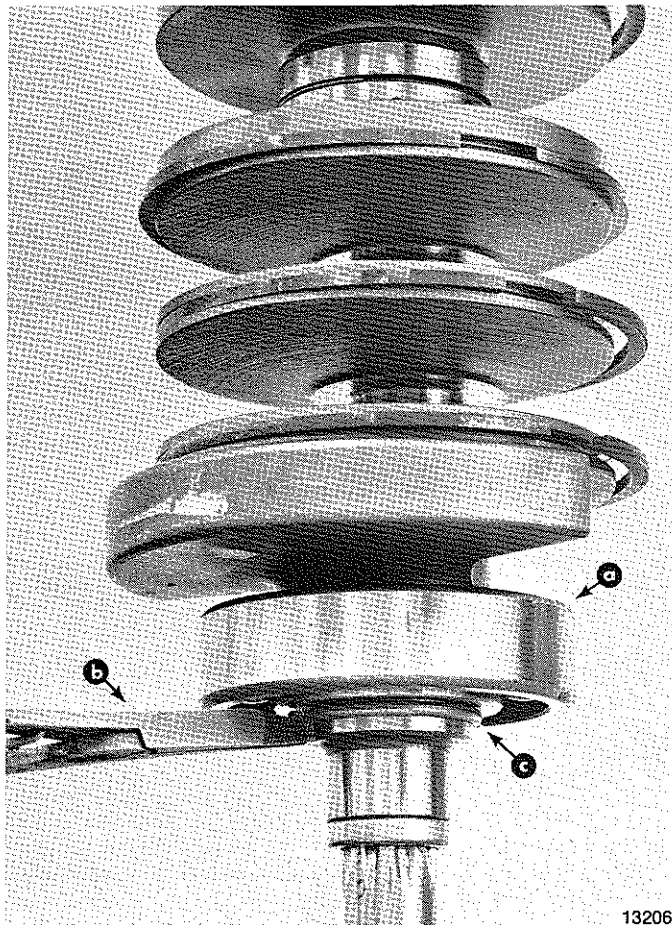
13319

- a - Upper Crankshaft Main Bearing
- b - Retaining Ring
- c - Awl

Figure 17. Crankshaft Main Bearing Retaining Ring Removal



13320



a - Crankshaft Ball Bearing
b - Snap Ring Pliers
c - Retaining Ring

Figure 19. Removing Crankshaft Ball Bearing Retaining Ring

IMPORTANT: When upper and lower main bearing races are separated, the rollers will be free. Care **MUST BE** taken not to allow rollers to fall from crankshaft and become lost.

2. Remove retaining ring from upper crankshaft main bearing race (Figure 17), then remove bearing race halves and roller bearings from crankshaft. (Figure 18)
3. Reassemble crankshaft bearing race halves with retaining ring (bearing race halves are a matched assembly). Keep main bearing roller bearings with corresponding bearing race. (Figure 18)

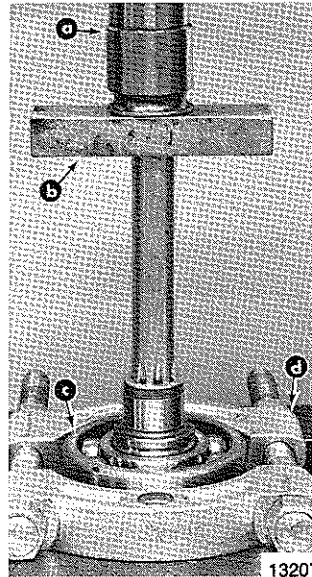
NOTE: Cleanliness is essential when handling roller bearings. Use care not to get dirt or lint on bearings. If bearings are to be re-used, store them in a marked container. DO NOT intermix

roller bearings from upper crankshaft main bearing with those from lower main bearing.

4. Remove lower crankshaft main bearing assembly (Figure 16) in the same manner as outlined in Steps 2 and 3, preceding.
5. Inspect crankshaft ball bearing, that is installed on lower end of crankshaft (Figure 16), as outlined in "Cleaning and Inspection", following.

IMPORTANT: DO NOT remove lower crankshaft ball bearing, unless replacement of bearing is required.

6. If inspection determines that replacement of lower crankshaft ball bearing is required, remove bearing as outlined, following.



a - Press
b - Powerhead Stand (C-91-30591A1)
c - Crankshaft Ball Bearing
d - Universal Puller Plate (C-91-37241)

Figure 20. Removing Crankshaft Ball Bearing

- a. Remove retaining ring (secures lower crankshaft ball bearing), using a suitable pair of snap ring pliers (expanding type). (Figure 19)

- b. Install Universal Puller Plate (C-91-37241) between crankshaft ball bearing and crankshaft counterweight. (Figure 20)

- c. Place crankshaft assembly in press and support under Universal Puller Plate.

- d. Install Powerhead Stand (C-91-30591A1) into end of crankshaft.

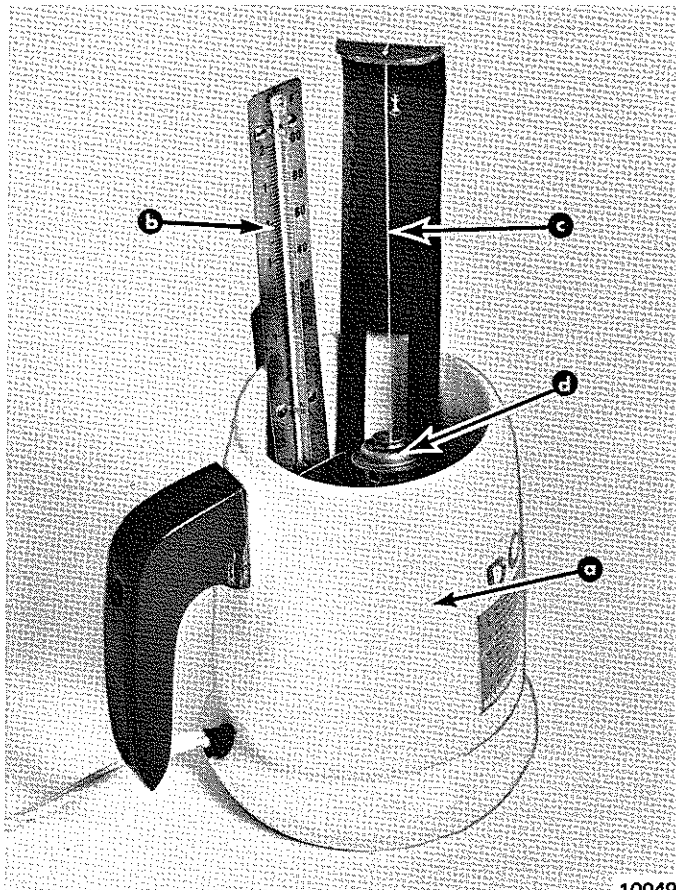
CAUTION: BE CAREFUL that, when crankshaft is pressed out of ball bearing, crankshaft is properly supported and is not allowed to drop on floor.

- e. Press crankshaft out of bearing as shown in Figure 20.

CLEANING and INSPECTION

Thermostats and Temperature Sender

1. Inspect thermostat covers and cylinder head covers (thermostat opening) for cracks and corrosion damage that could cause leakage. Replace parts as necessary.
2. Remove and discard gasket from each thermostat.
3. Wash thermostats with clean water.



10049

- | | |
|-----------------------|----------------|
| a - Thermostat Tester | c - Thread |
| b - Thermometer | d - Thermostat |

Figure 1. Testing Thermostat

4. Using a thermostat tester, similar to the one shown in Figure 1, test each thermostat as follows:
 - a. Open thermostat valve, then insert a thread between valve and thermostat body. Allow valve to close against thread.
 - b. Suspend thermostat (from thread) and thermometer inside tester (Figure 1) so that neither touches the container. Bottom of thermometer must be even with bottom of thermostat to obtain correct temperature of thermostat opening.
 - c. Fill thermostat tester with water to cover thermostat.
 - d. Plug tester into electrical outlet.
 - e. Observe temperature at which thermostat begins to open. (Thermostat will drop off thread, that was installed in Step "a", when it starts to open.) Thermostat must begin to open when temperature reaches 140°-145°F (60°-63°C).
 - f. Continue to heat water until thermostat is completely open.
 - g. Unplug thermostat tester.

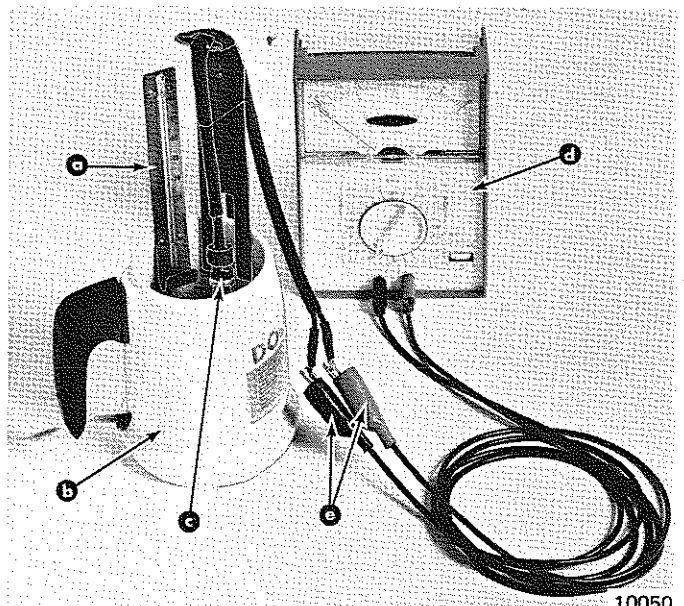
- h. Replace thermostat, if it fails to open at the specified temperature, or if it does not fully open.

NOTE: BE SURE that water in thermostat tester is allowed to cool sufficiently [below 130°F (56°C)] before testing the other thermostat.

5. Clean metal surface of temperature sender (area which contacts cylinder head).
6. Clean terminal rings at ends of temperature sender wires to assure good electrical contacts.

NOTE: Electrical switch in temperature sender is designed to "close" if temperature of powerhead reaches a predetermined point. If switch in temperature sender closes, a circuit, that activates an alarm horn, then is completed.

7. Using a thermostat tester similar to the one shown in Figure 2, test temperature sender as follows:
 - a. Turn VOA Meter (C-91-62562) to Rx1K range (same as Rx1000). Short the meter leads together and adjust pointer to 0 (zero) ohms position by adjusting the meter "zeroing" (Ω) thumb wheel. Separate the test leads.
 - b. Connect a test lead to each temperature sender wire. VOA meter must have a scale reading of " ∞ " (no continuity) that would indicate electrical switch in sender is "open". If meter has a scale reading other than " ∞ ", sender should be replaced.
 - c. With meter still connected to temperature sender, suspend sender and a thermometer inside thermostat tester (Figure 2) so that neither touches the container. Bottom of thermometer must be even with bottom of temperature sender to obtain correct temperature of sender operation.



10050

- | | |
|------------------------|---------------------|
| a - Thermometer | d - VOA Meter |
| b - Thermostat Tester | (C-91-62562) |
| c - Temperature Sender | e - VOA Meter Leads |

Figure 2. Testing Temperature Sender

- d. Fill thermostat tester with water to cover temperature sender.
- e. Plug thermostat tester into electrical outlet.
- f. Observe temperature at which switch in temperature sender "closes". [VOA Meter must have a scale reading of 0 (zero) ohms.] Switch must "close" when temperature reaches 180°-200°F (82°-93°C).
- g. Unplug thermostat tester.
- h. As water in thermostat tester cools, observe temperature at which switch in temperature sender "opens". [VOA Meter must have a scale reading of "∞" (no continuity).] Switch must "open" when temperature drops to 160°-180°F (77°-82°C).
- i. Replace temperature sender if switch fails to "open" or "close" at the specified temperatures.

Cylinder Heads and Exhaust Covers

1. Thoroughly clean cylinder heads and gasket surfaces. Remove carbon deposits and "varnish" from cylinder heads (with a fine wire brush on a shaft attached to an electric drill or use carbon remover solution).
2. Inspect cylinder heads. Check for deep grooves, cracks and distortion which could cause compression leakage.
3. Check spark plug holes for stripped or damaged threads.
4. Inspect internal surface of cylinder heads for possible damage (as a result of piston or foreign material striking cylinder heads).

NOTE: Piston striking cylinder head could be an indication that connecting rod bearings (either end) are failing.

5. Replace cylinder head(s) as necessary.
6. Thoroughly clean gasket surfaces of cylinder head covers. Check covers for deep grooves, cracks and distortion that could cause water leakage. Replace cover(s) as necessary.
7. Thoroughly clean gasket surfaces of exhaust divider plate and exhaust manifold cover.
8. Inspect exhaust divider plate and exhaust manifold cover for deep grooves, cracks or distortion that could cause leakage. Replace parts as necessary.

Cylinder Block and Crankcase Cover

IMPORTANT: Crankcase cover and cylinder block are a matched, line-bored assembly and never should be mismatched by using a different crankcase cover or cylinder block.

CAUTION: If crankcase cover or cylinder block is to be submerged in a very strong cleaning solution, it will be necessary to remove the crankcase cover/cylinder block bleed system from crankcase cover/cylinder block to prevent damage to hoses and check valves.

1. Thoroughly clean cylinder block and crankcase cover. Be sure that all sealant and old gaskets are removed from matching surfaces. Be certain that carbon deposits are removed from exhaust ports.
2. Inspect cylinder block and crankcase cover for cracks or fractures.
3. Check gasket surfaces for nicks, deep grooves, cracks and distortion that could cause compression leakages.
4. Check all water and oil passages in cylinder block and crankcase cover to be sure that they are not obstructed and that plugs are in place and tight.

IMPORTANT: The cylinders of a 225 HP engine are chrome and cannot be rebored or efficiently honed. (Honing of a chrome cylinder is not necessary or recommended.)

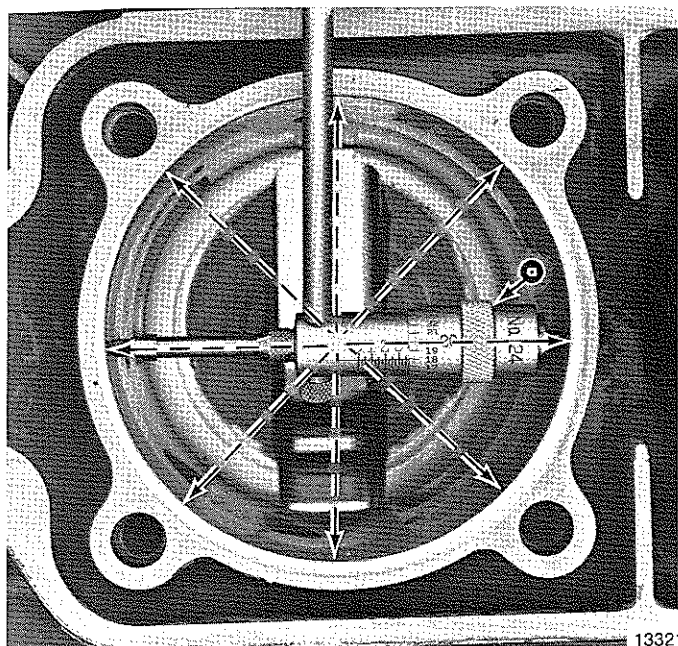
5. Carefully inspect chrome surfaced cylinder bores for signs of flaking, grooving, scoring or other damage.

IMPORTANT: DO NOT mistake porosity for a damaged cylinder.

6. If chrome surface is flaking, or if a groove or any other mark penetrates the chrome surface down to the aluminum

portion of cylinder block, cylinder block and crankcase cover must be replaced.

7. To determine if a groove or any other mark in cylinder wall penetrates chrome surface down to the aluminum portion of cylinder block, apply a small amount of muratic acid (or toilet bowl cleaner) over the groove or mark. DO NOT allow the muratic acid (or toilet bowl cleaner) to contact the aluminum portion of cylinder block. If a groove or mark penetrates the chrome surface, a "fizzing" action (or "bubbling" action) will appear, thus indicating that aluminum is being dissolved.



a - Inside Micrometer

Figure 3. Measuring Cylinder Bores

8. If a piston(s) is scored and has transferred aluminum to cylinder walls, remove the aluminum, clean the cylinder walls and inspect cylinders for further damage, as follows:
 - a. Remove all loose aluminum deposits from cylinder wall with a stiff bristle brush.
 - b. Apply a small amount of muratic acid (or toilet bowl cleaner) onto the aluminum deposits. [DO NOT allow muratic acid (or toilet bowl cleaner) to contact the aluminum portion of cylinder block.] A "fizzing" action will appear, thus indicating that aluminum is being dissolved.
 - c. Leave the acid on the aluminum deposit for one to 2 minutes, then wash cylinder thoroughly with hot water

and detergent.

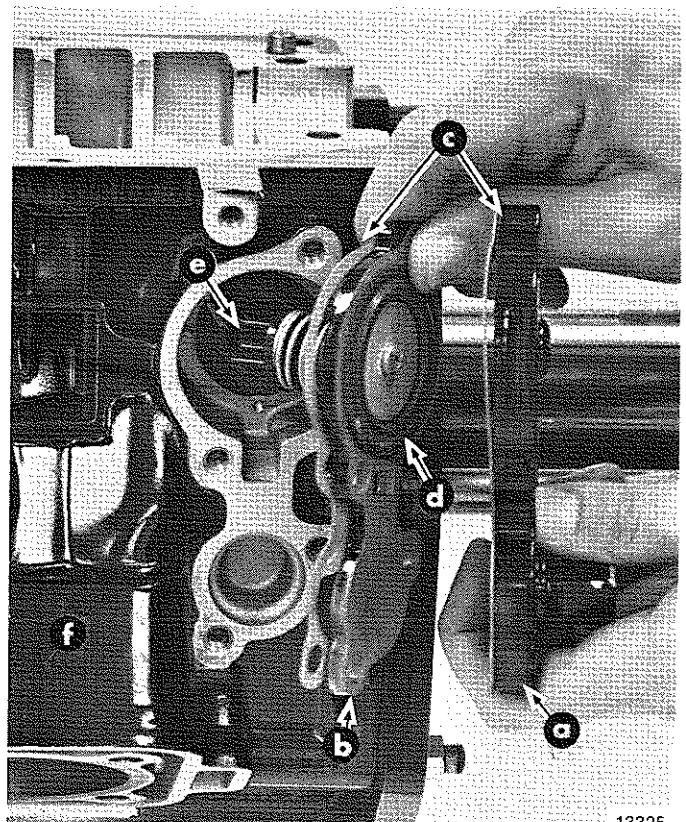
- d. Steps "b" and "c" may require repeating several times before all the aluminum deposits are gone.
- e. Check each cylinder for an out-of-round ("egg-shaped") condition. Using an inside micrometer or telescopic gauge, as shown in Figure 3, take 4 measurements ¼" (6.35mm) from top of each cylinder bore 45° from each other. A .006" (0.152mm) or less out-of-round is acceptable. If out-of-round is more than .006", cylinder block and crankcase cover **MUST BE** replaced.
- f. After cleaning and inspection, cylinder bores should be swabbed several times with light engine oil and a clean cloth.

Idle Shutoff Valve

1. If not yet removed, remove idle shutoff valve cover, valve plate and poppet valve from the starboard side of cylinder block. (Figure 4)
2. Discard gaskets and clean all gasket surfaces.
3. Inspect all gasket surfaces for nicks, deep grooves, cracks and distortion that could cause leakage.
4. Replace diaphragm by removing screw and washer which secure diaphragm to poppet valve. Discard old diaphragm and install new diaphragm. Secure new diaphragm to poppet valve with washer and screw. Be sure that poppet valve compression spring and diaphragm are properly installed.
5. Using new gaskets, reinstall idle shutoff valve plate assembly and valve cover on cylinder block. (Figure 4) Secure with bolts tightened evenly and torqued to specification shown on Page 4A-1.

- | | |
|------------------------------|--------------------------------------|
| a - Idle Shutoff Valve Cover | e - Poppet Valve |
| b - Idle Shutoff Valve Plate | f - Starboard Side of Cylinder Block |
| c - Gaskets | |
| d - Diaphragm | |

Figure 4. Idle Shutoff Valve



13325

Pistons

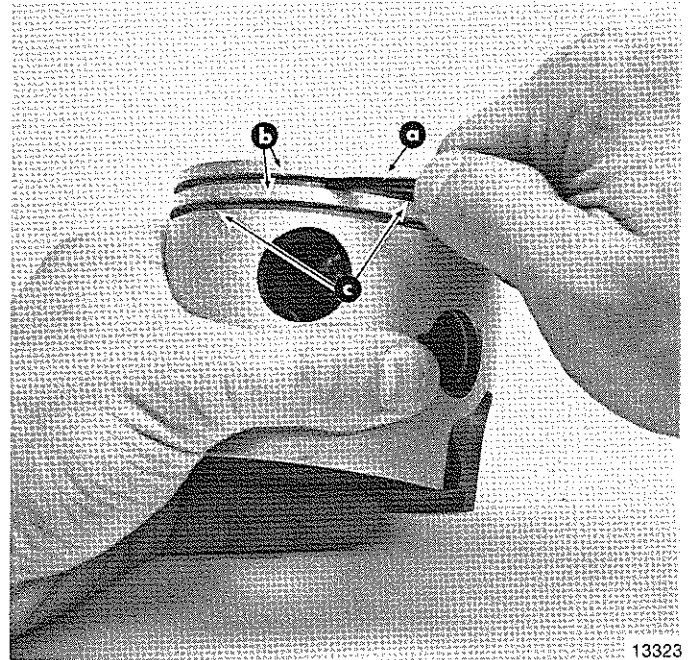
IMPORTANT: If engine was submerged while engine was running, piston pin and/or connecting rod may be bent. If piston pin is bent, piston must be replaced. (Piston pins are not sold separately because of matched fit into piston.) If piston pin is bent, connecting rod must be checked for straightness (refer to "Connecting Rods", following, for checking straightness).

1. Check pistons for scoring, cracks, metal damage and cracked or worn piston pin bosses. Replace piston(s), if any of these conditions is found.
2. Thoroughly clean pistons. Remove carbon deposits and "varnish" from pistons with a soft wire brush or carbon remover solution. DO NOT burr or round machined edges. Clean (polish) piston skirt with crocus cloth.
3. After thoroughly cleaning pistons, use a micrometer to check each piston for size and round. Pistons must be measured as described, following:
 - a. Measure outside of piston $\frac{1}{2}$ " (12.7mm) up from bottom of piston in line with piston pin and at right angle (90°) to piston pin. Measurement taken must be 3.372 " (85.649mm).

CAUTION: DO NOT use an automotive-type ring groove cleaner to clean piston ring grooves. This type tool could loosen piston ring locating pins.

4. Clean ring grooves with recessed end of a broken ring. (Figure 5) DO NOT burr or round machined edges.

5. Inspect piston ring grooves for wear, burn and distortion. Inspect piston ring locating pins (one located in each piston ring groove) for tightness. (Figure 5) Replace pistons as necessary.



a - Broken Piston Ring c - Piston Ring Locating Pins
b - Piston Ring Grooves

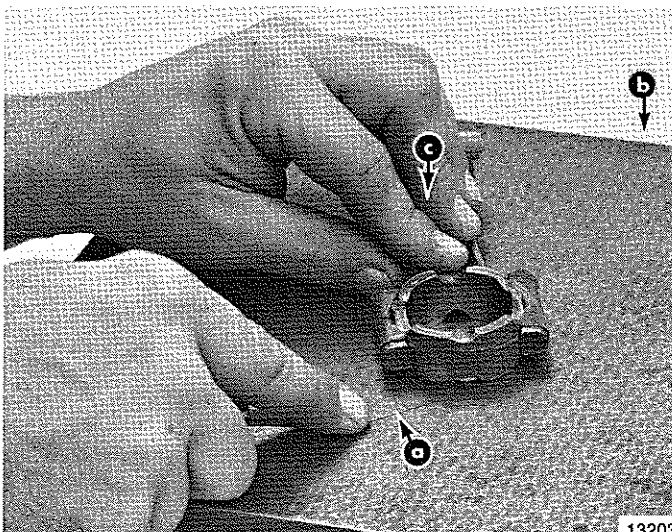
Figure 5. Cleaning Piston Ring Grooves

Connecting Rods

1. Check connecting rods for alignment by placing rods on a surface plate. (Figure 6) If light can be seen under any portion of machined surfaces, if rod has a slight wobble on plate, or if a $.002$ " (0.051mm) feeler gauge can be inserted between any machined surface and surface plate, rod is bent and must be discarded.

2. Carefully inspect connecting rod bearings for rust or signs of bearing failure. Replace bearings as necessary.

CAUTION: DO NOT intermix new and used bearings. If replacement of some bearings is required, replace all bearings at that location.

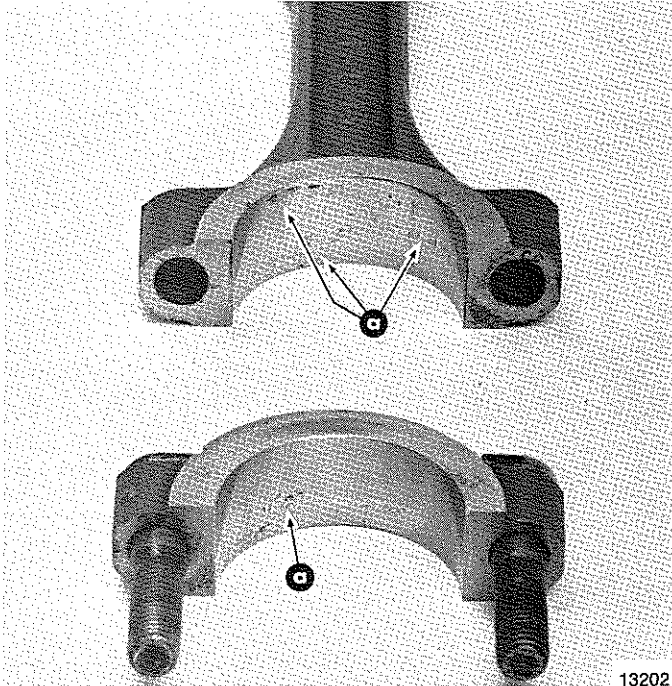


a - Feeler Gauge c - Even Downward Pressure
b - Surface Plate

Figure 6. Checking Connecting Rod Alignment

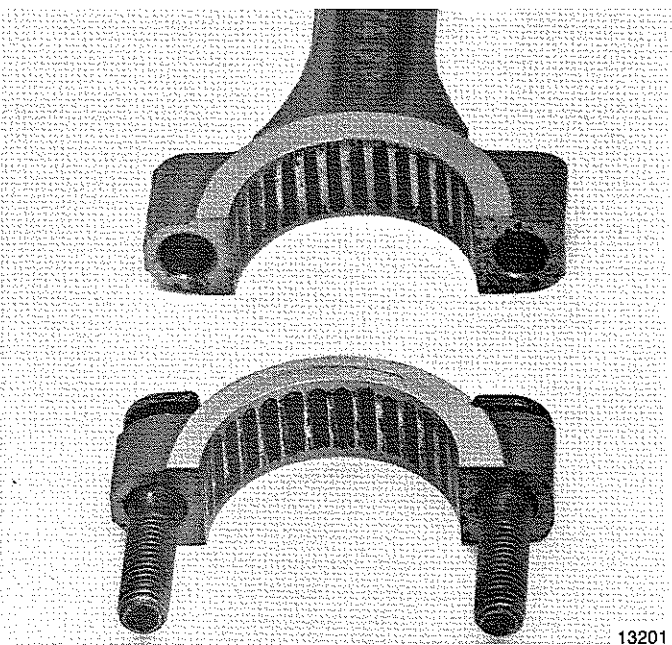
3. Inspect crankshaft end and piston pin end bearing surfaces of connecting rod for the following:
 - a. Rust: Rust formation on bearing surfaces causes uneven pitting of surface(s). (Figure 7)
 - b. Water Marks: When bearing surfaces are subjected to water contamination, a bearing surface "etching" occurs. This etching resembles the size of the bearing. (Figure 8)
 - c. Spalling: Spalling is the loss of bearing surface, and it resembles flaking or chipping. Spalling will be most evident on the thrust portion of the connecting rod in line with the "I" beam. General bearing surface deterioration could be caused by or accelerated by improper lubrication. (Figure 9)
 - d. Chatter Marks: Chatter marks are the result of a combination of low speed-low load-cold water temperature operation, aggravated by inadequate lubrication and/or improper fuel. Under these conditions, the crankshaft journal is hammered by the connecting rod. As ignition occurs in the cylinder, the piston pushes the connecting

rod with tremendous force, and this force is transferred to the connecting rod journal. Since there is little or no load on the crankshaft, it bounces away from the connecting rod. The crankshaft then remains immobile for a split second until the piston travel causes the connecting rod to catch up to the waiting crankshaft journal, then hammers it. The repetition of this action causes a rough bearing surface(s) which resembles a tiny washboard. (Figure 10) In some instances, the connecting rod crankpin bore becomes highly polished. During operation, the engine will emit a "whirr" and/or "chirp" sound when it is accelerated rapidly from idle speed to approximately 1500 RPM, then quickly returned to idle. If the preceding conditions are found, replace both the crankshaft and connecting rod(s).



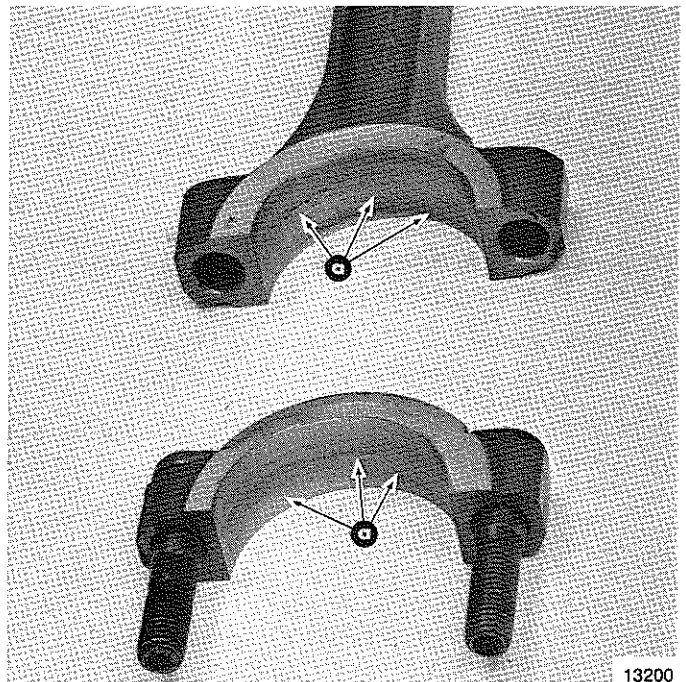
a - Pitting

Figure 7. Connecting Rod with Rust Pitting



13201

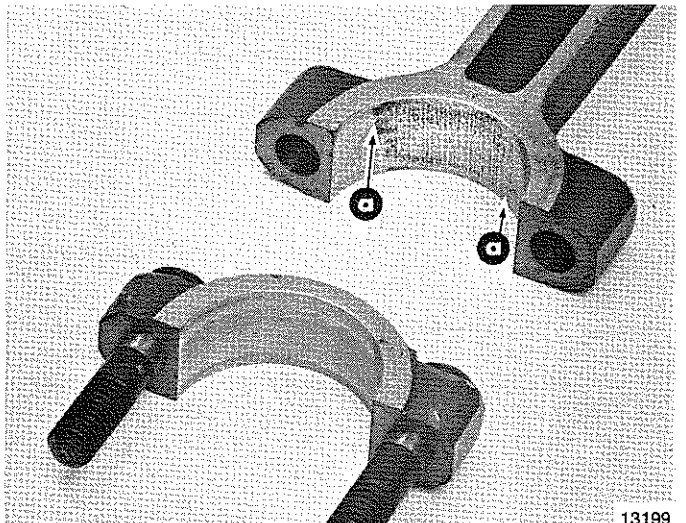
Figure 8. Connecting Rod with Water Marks



13200

a - Spalling

Figure 9. Connecting Rod with Spalling



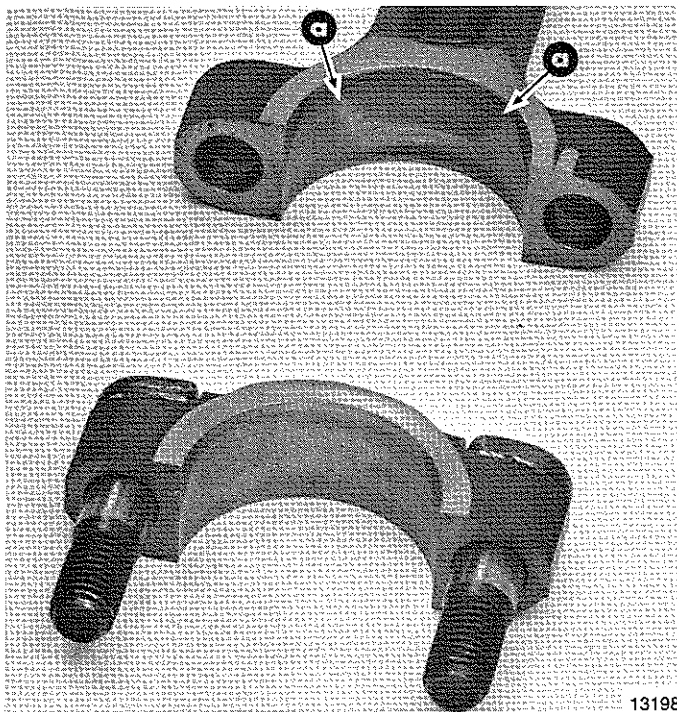
13199

a - Chatter Marks between Arrows

Figure 10. Connecting Rod with Chatter Marks

- e. Uneven Wear: Uneven wear could be caused by a bent connecting rod. (Figure 11)
 - f. Overheating: Overheating is visible as a bluish bearing surface color that is caused by inadequate lubrication or excessive RPM.
4. If necessary, clean connecting rod bearing surfaces, as follows:
- a. Be sure that "etched" marks on knob side of connecting rod (crankshaft end) are perfectly aligned with "etched" marks on connecting rod cap. Tighten connecting rod cap attaching bolts securely. (Figure 12)

CAUTION: Crocus cloth MUST BE USED to clean bearing surface at crankshaft end of connecting rod. DO NOT use any other type of abrasive cloth.

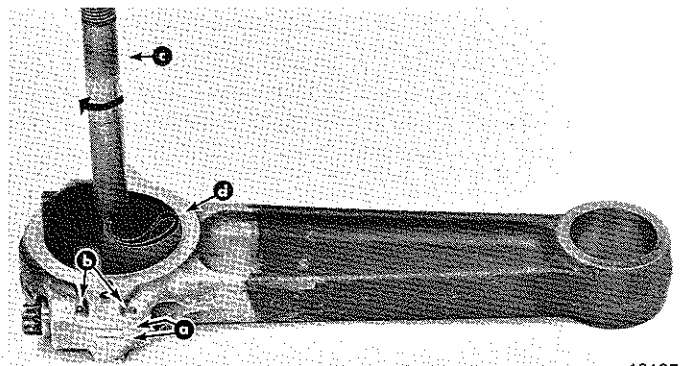


13198

a - Uneven Wear between Arrows

Figure 11. Connecting Rod with Uneven Wear

- b. Clean **CRANKSHAFT END** of connecting rod by using **CROCUS CLOTH** placed in a slotted $\frac{3}{8}$ " (9.5mm) diameter shaft, as shown in Figure 12. Check shaft in a drill press and operation press at high speed while keeping connecting rod at a 90° angle to slotted shaft.



13197

- a - "Etched" Alignment Marks
 b - Alignment Bumps (Knobs)
 c - Slotted $\frac{3}{8}$ " (9.5mm) Diameter Shaft
 d - Crocus Cloth

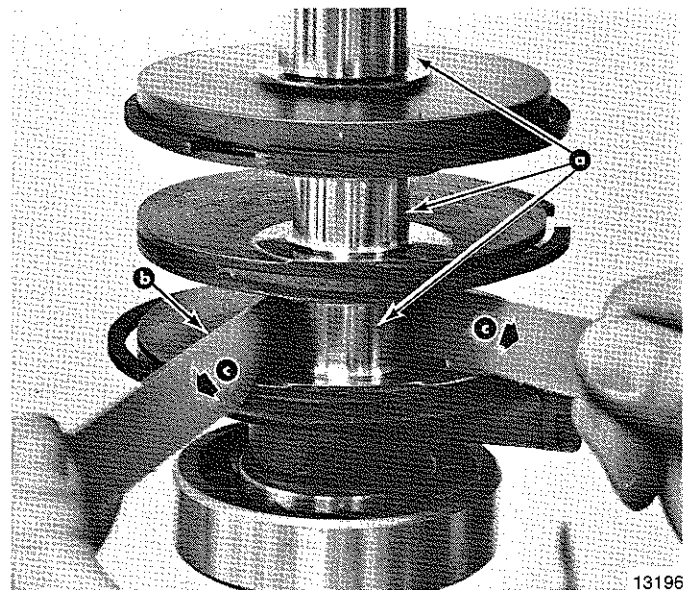
Figure 12. Cleaning Connecting Rod Bearing Surface (Crankshaft End Shown)

Crankshaft

1. Inspect crankshaft to drive shaft splines for wear. (Replace crankshaft, if necessary.)
2. Check crankshaft for straightness. (Replace as necessary.)
3. Inspect crankshaft oil seal surfaces. Sealing surfaces must not be grooved, pitted or scratched. (Replace as necessary.)
4. Check all crankshaft bearing surfaces for rust, water marks, chatter marks, uneven wear and/or overheating. (Refer to "Connecting Rods" in Step 3, preceding.)
5. If necessary, clean crankshaft surfaces with crocus cloth, as shown in Figure 13.

SAFETY WARNING: DO NOT spin-dry crankshaft ball bearing with compressed air.

6. Thoroughly clean (with solvent) and dry crankshaft and crankshaft ball bearing. Recheck surfaces of crankshaft. Replace crankshaft, if surfaces cannot be properly "cleaned up". If crankshaft will be re-used, lubricate surfaces of crankshaft with light oil to prevent rust. **DO NOT** lubricate crankshaft ball bearing at this time.



13196

- a - Crankshaft Journals
 b - Crocus Cloth
 c - Work Cloth "Back-and-Forth"

Figure 13. Cleaning Crankshaft Surfaces

Crankshaft (and End Cap) Bearings

1. After cleaning crankshaft, grasp outer race of crankshaft ball bearing (installed on lower end of crankshaft) and attempt to work race back-and-forth. There should not be excessive play.
2. Lubricate ball bearing with light oil. Rotate outer bearing race. Bearing should have smooth action and no rust stains. If ball bearing sounds or feels "rough" or has "catches", remove and discard bearing. (Refer to "Powerhead Removal and Disassembly - Crankshaft Removal and Disassembly", preceding.)
3. Thoroughly clean (with solvent) and dry crankshaft centermain roller bearings. Lubricate bearings with light oil.
4. Thoroughly inspect centermain roller bearings. Replace bearings if they are rusted, fractured, worn, galled or badly discolored.
5. Clean (with solvent) and dry crankshaft roller bearing that is installed in upper end cap. Lubricate bearing with light oil.
6. Thoroughly inspect upper end cap roller bearing. If roller bearing is rusted, fractured, worn, galled or badly discolored, remove bearing from upper end cap and discard. (Refer to "Powerhead Removal and Disassembly - End Caps Removal and Disassembly", preceding.)

CAUTION: DO NOT intermix halves of upper and lower crankshaft centermain roller bearings. Replace bearings in pairs only.

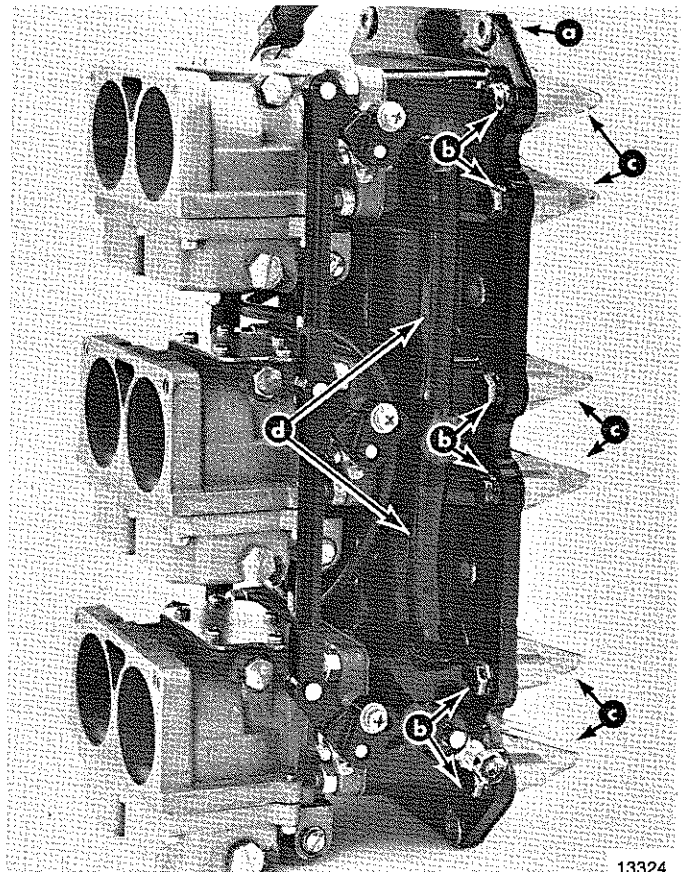
Intake Manifold and Reed Blocks

IMPORTANT: DO NOT remove reeds from reed blocks, unless replacement is necessary.

1. Remove bolts (Figure 14), which secure reed blocks to intake manifold, and remove reed blocks from manifold.
2. Thoroughly clean intake manifold gasket from intake manifold and reed blocks. Check machined surface of reed blocks and intake manifold for deep grooves, cracks and distortion that could cause leakage. Replace parts as necessary.
3. Check intake manifold balance tubes and fittings (Figure 14) for cuts or cracks in tubes and for loose fittings. Replace or tighten, if necessary.
4. Check for wear (indentations) on face of each reed block. Replace block(s), if reed(s) has made indentations.
5. Check for chipped and broken reeds.
6. Check reeds to be sure that they are tight against reed block. Replace all reeds that do not fit tight against block.
7. Install new reeds as outlined in "Powerhead Reassembly", following.

a - Intake Manifold
b - Bolts (Reed Blocks, 6 Each Side)
c - Reed Blocks
d - Balance Tubes (Both Sides)

Figure 14. Intake Manifold



13324

POWERHEAD REASSEMBLY and INSTALLATION

General

Before proceeding with powerhead reassembly, be sure that all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in "Cleaning and Inspection", preceding. Parts, which have not been properly cleaned (or which are questionable), can severely damage an otherwise perfectly good powerhead within the first few minutes of operation. All new powerhead gaskets MUST BE installed during reassembly.

During reassembly, lubricate parts with Quicksilver Formula 50-D 2-Cycle Outboard Lubricant whenever "light oil" is specified or Quicksilver Multipurpose Lubricant whenever "grease" is specified. Quicksilver part numbers of lubricants, sealers and locking compounds and tools are listed in "Powerhead General Information", preceding.

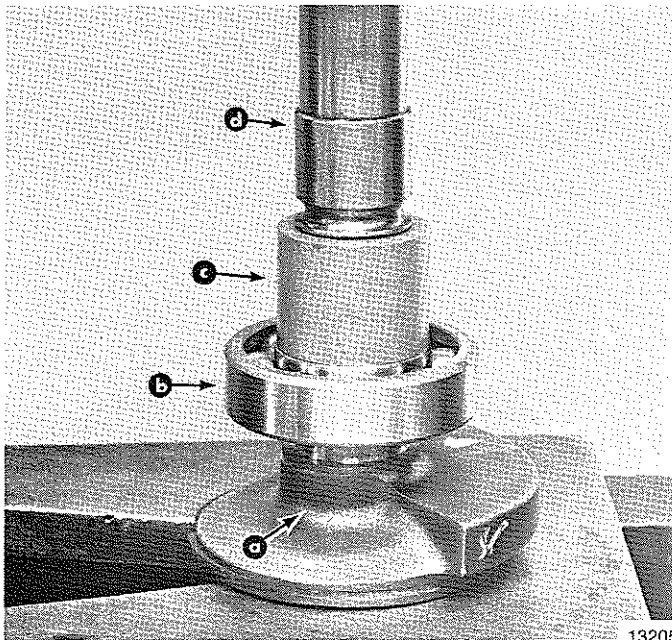
A torque wrench is essential for correct reassembly of powerhead. DO NOT attempt to reassemble powerhead without using a torque wrench. Attaching bolts for covers, housings and cylinder heads MUST BE torqued by tightening bolts in 3 progressive steps (following specified torque sequence) until specified torque is reached (see "Example", following).

EXAMPLE: If cylinder head attaching bolts require a torque of 30 ft. lbs. (4.15mkg), a) tighten all bolts to 10 ft. lbs. (1.38mkg), following specified torque sequence, b) tighten all bolts to 20 ft. lbs. (2.77mkg), following torque sequence, then finally c) tighten all bolts to 30 ft. lbs., following torque sequence.

Powerhead torques for the 225 HP V-6 model are listed in "Powerhead General Information", Page 4A-1.

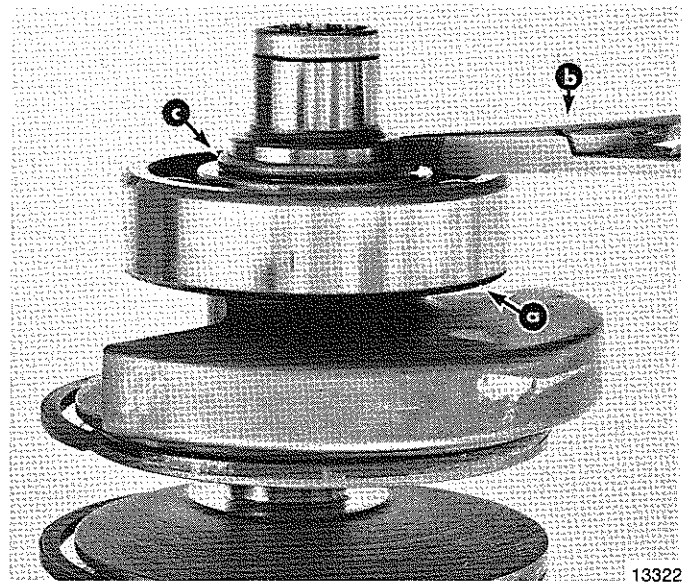
Crankshaft - Reassembly and Installation

1. If removed, reinstall a new crankshaft ball bearing onto drive shaft end of crankshaft, as follows:
 - a. Support crankshaft assembly in press between counterweights and directly under lower crankshaft end. (Figure 1)
 - b. Press ball bearing on crankshaft, using a suitable mandrel. (Figure 1) Press only on inner race of bearing. Be sure that bearing is seated firmly against counterweight.
 - c. Remove crankshaft assembly from press.
 - d. Reinstall retaining ring, that secures crankshaft ball bearing, with a suitable pair of Snap Ring Pliers (C-91-24283, expanding type). (Figure 2)



a - Crankshaft Assembly (Drive Shaft End) c - Suitable Mandrel
b - Crankshaft Ball Bearing d - Press

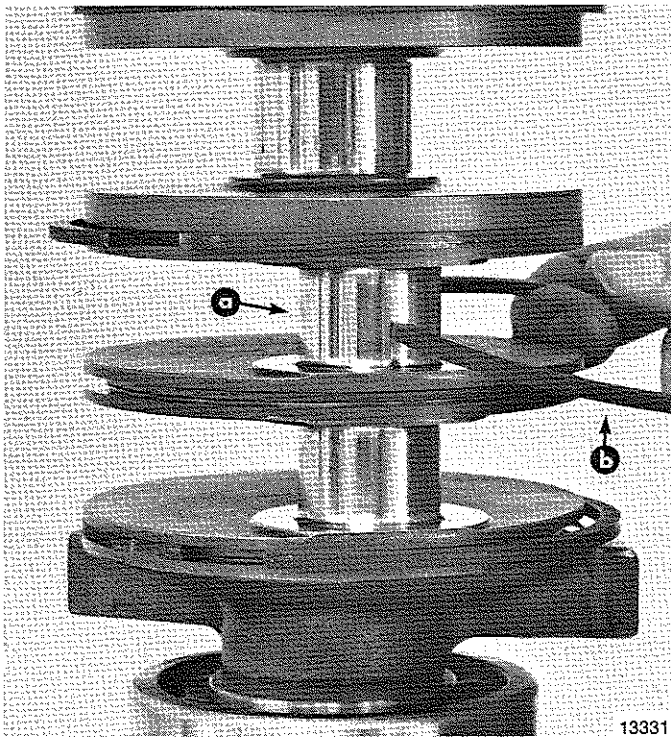
Figure 1. Install Ball Bearing onto Crankshaft



a - Crankshaft Ball Bearing b - Snap Ring Pliers
c - Retaining Ring

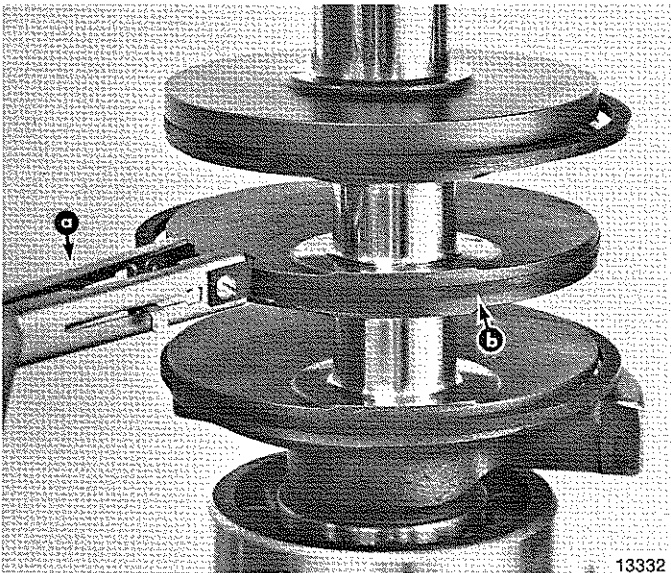
Figure 2. Crankshaft Ball Bearing Retaining Ring Installation

2. Place crankshaft assembly on Powerhead Stand (C-91-30591A1) mounted in a vise.
3. If removed, reinstall new crankshaft sealing ring(s), as follows:
 - a. Spread sealing ring enough to allow installation around the nearest crankshaft journal, then install around journal. (Figure 3)
 - b. Using Piston Ring Expander (C-91-24697), install crankshaft sealing ring into crankshaft groove. (Figure 4)
4. Install main bearing cages and rollers in main bearing halves. (Figure 5) Use Multipurpose Lubricant to hold cages and rollers in bearing halves.



a - Crankshaft Journal b - Crankshaft Sealing Ring

Figure 3. Installing Crankshaft Sealing Ring

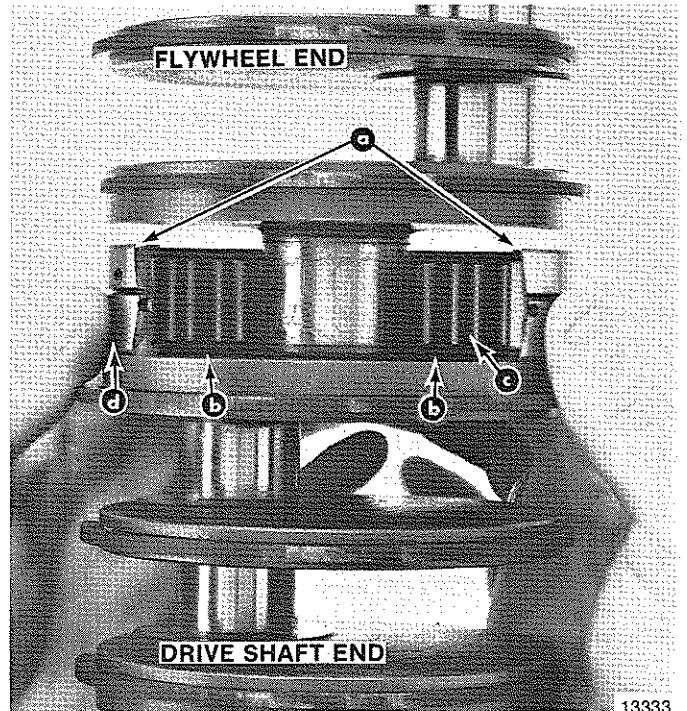


a - Piston Ring Expander (C-91-24697) b - Crankshaft Sealing Ring

Figure 4. Installing Crankshaft Sealing Ring into Groove

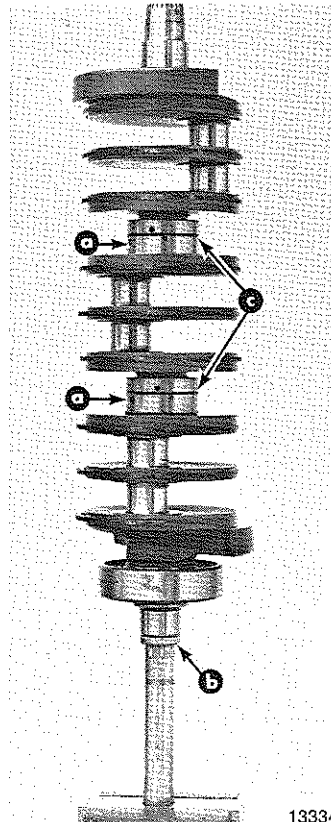
5. Install bearing race halves onto crankshaft with dowel pin hole (larger of the 3 holes in bearing race) toward drive shaft end of crankshaft. (Figure 5) Secure bearing race halves together with a retaining ring. (Figure 6)
6. Lubricate crankshaft sealing ring and crankshaft ball bearing with light oil.
7. Check cylinder block to be sure that crankshaft main bearing dowel pins are in place. If not in place, install new pins in cylinder block.
8. With all crankshaft sealing ring gaps positioned STRAIGHT-UP, place crankshaft assembly into cylinder

block. Be sure that drive shaft end of crankshaft is toward drive shaft end of cylinder block. Gently push crankshaft down into position and rotate main bearing races until dowel pin hole in races are aligned with dowel pins, then compress crankshaft sealing rings with fingers and push crankshaft the rest of the way down until properly seated in cylinder block. (Figure 7)



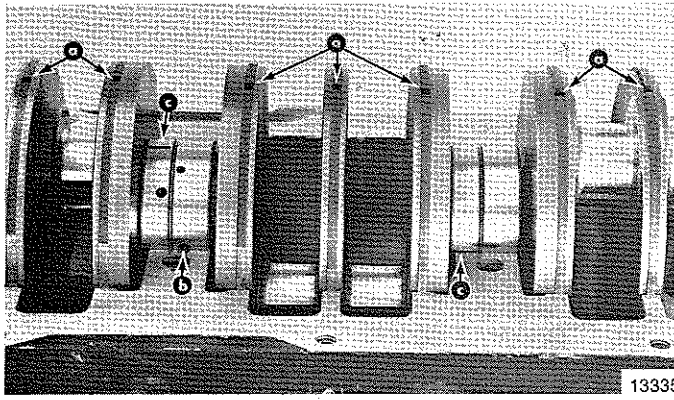
a - Main Bearing Race Halves c - Roller Bearings
b - Bearing Cages d - Dowel Pin Hole (Hidden)

Figure 5. Main Bearing Cages and Rollers Installed in Main Bearing Race Halves



a - Dowel Pin Hole
b - Drive Shaft End of Crankshaft
c - Retaining Ring

Figure 6. Main Bearings Installed on Crankshaft



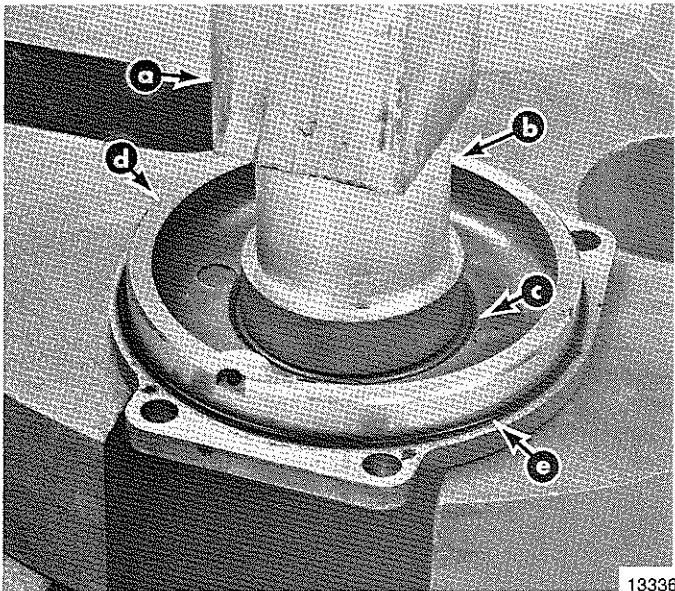
NOTE: To facilitate installation of cylinder block dowel pins in dowel pin holes of bearing races, 1) position bearing races with center of dowel pin holes aligned with edge of cylinder block (see bearing race on right side in Figure 7), 2) place a mark exactly at top of bearing races with a grease pencil, and 3) rotate each race until grease pencil mark is aligned with edge of cylinder block (see bearing race on left side in Figure 7). This will position dowel pin hole in bearing races very close to cylinder block dowel pins.

a - Crankshaft Sealing Ring Gaps b - Dowel Pin Hole
 Must Be Positioned Straight-Up c - Grease Pencil Mark

Figure 7. Installing Crankshaft

End Caps - Reassembly and Installation

1. Apply a thin bead of Loctite Type "A" to outer diameter (area which contacts end cap) on 2 lower end cap oil seals.
2. Using Driver Head (C-91-55919), press one oil seal into lower end cap [with lip of seal DOWN (away from cylinder block when installed)] until firmly seated on end cap shoulder. (Figure 8) Remove excess Loctite.
3. Press second oil seal into lower end cap (with lip of seal DOWN) until firmly seated on first oil seal. (Figure 8) Remove any excess Loctite.



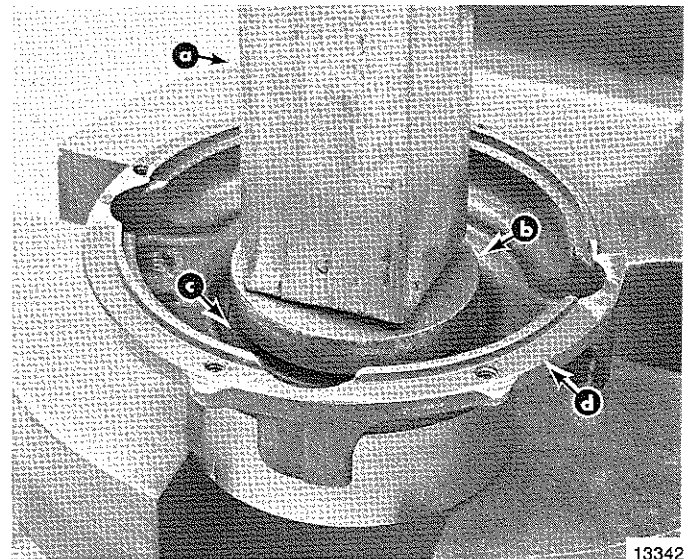
a - Press d - Lower End Cap
 b - Driver Head (C-91-55919) e - "O" Ring
 c - Oil Seal (Hidden)

Figure 8. Installing Oil Seals in Lower End Cap

4. Using light oil, lubricate lips of lower end cap oil seals, surface of end cap (that contacts cylinder block) and lower end cap "O" ring.

NOTE: The larger "O" ring is used with the lower end cap.

5. Install "O" ring (that was just lubricated) around lower end cap. (Figure 8)
6. Apply a thin bead of Loctite Type "A" to outer diameter (area that contacts end cap) of upper end cap oil seal.



a - Press c - Oil Seal (Hidden)
 b - Suitable Mandrel d - Upper End Cap

Figure 9. Installing Oil Seal in Upper End Cap

7. Using a suitable mandrel, press oil seal into upper end cap [with lip of seal DOWN (toward cylinder block when installed)] until seal surface is flush with surface of end cap. (Figure 9) Remove any excess Loctite.

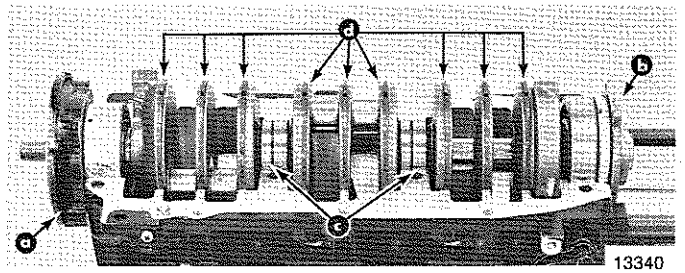
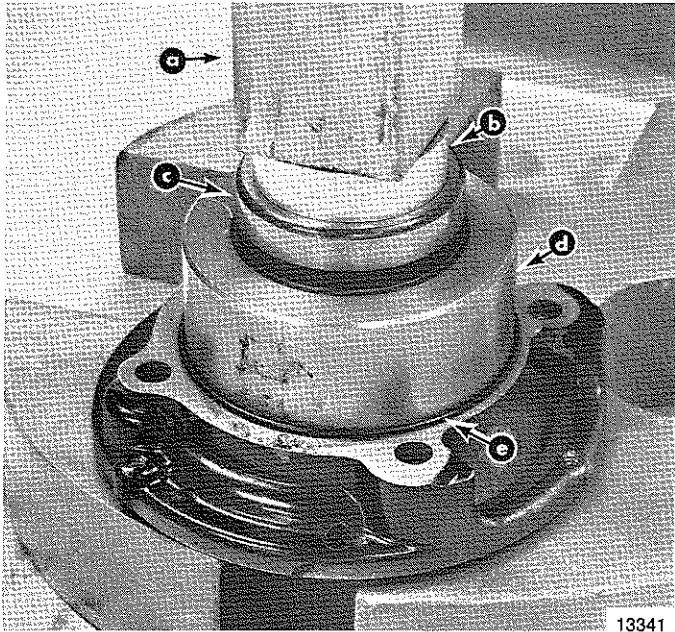
CAUTION: If end cap oil seal is pressed too far into upper end cap, end cap bleed passage could be restricted. Be sure that oil seal is properly installed.

8. If removed, reinstall crankshaft roller bearing into upper end cap, as shown in Figure 10. Press roller bearing into end cap until firmly seated against end cap shoulder.
9. Lubricate lip of upper end cap oil seal, end cap roller bearing, surface of end cap (that contacts cylinder block) and upper end cap "O" ring with light oil.

NOTE: The smaller "O" ring is used with the upper end cap.

10. Install "O" ring (that was just lubricated) around upper end cap. (Figure 10)

- Lubricate crankshaft ends (oil seal areas) with light oil, then install upper and lower end caps. (Figure 11) Secure end caps to cylinder block with attaching bolts. **DO NOT** tighten end cap bolts at this time.



- a - Upper End Cap c - Centermain Crankshaft Bearings
b - Lower End Cap d - Crankshaft Sealing Rings

Figure 11. Crankshaft and End Caps Installed

- a - Press d - Upper End Cap
b - Driver Head (C-91-55919) e - "O" Ring
c - Crankshaft Roller Bearing

Figure 10. Installing Crankshaft Roller Bearing into Upper End Cap

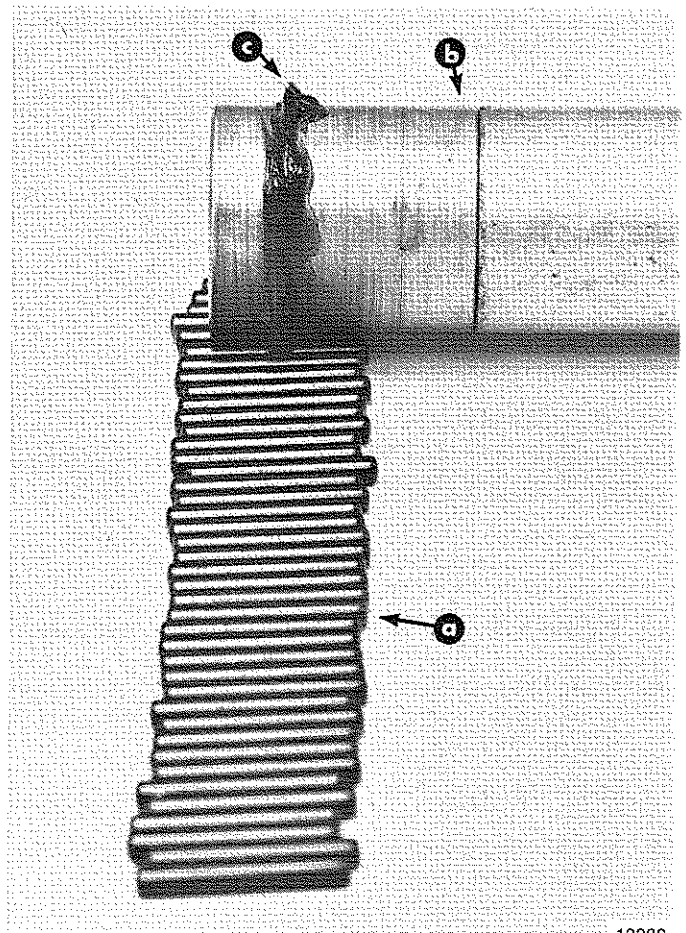
Connecting Rods and Pistons - Reassembly

- Place a clean piece of paper on bench and line up piston pin needle bearings (it is recommended that new bearings be used during reassembly), as shown in Figure 12.

NOTE: There are 29 piston pin needle bearings per piston.

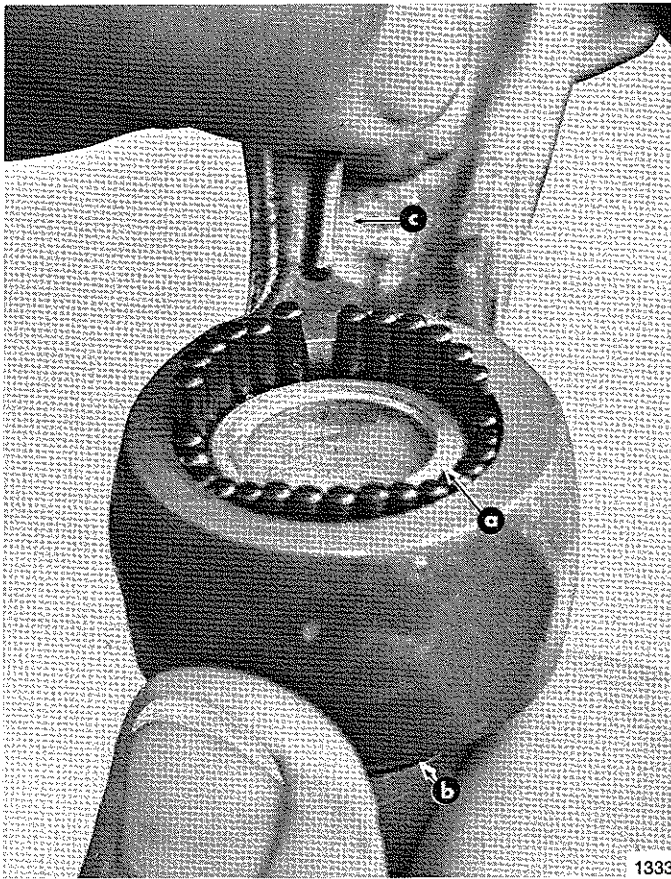
CAUTION: If it is necessary to re-use bearings from disassembly, never intermix new bearings with used bearings at the same connecting rod end. Never intermix needle bearings of one connecting rod with those of another connecting rod. Should one (or more) piston pin needle bearing of a connecting rod require replacement (or should one or more be lost), replace all of that connecting rod's piston pin needle bearings.

- Place a small amount of grease (Multipurpose Lubricant) on sleeve portion of Piston Pin Tool (C-91-74607A1) and roll tool over line-up bearings, as shown in Figure 12.
- Place lower locating washer on Piston Pin Tool (shoulder on washer toward bearings) and, leaving one or 2 bearings off sleeve, place sleeve portion of tool thru connecting rod. Add needle bearings, as necessary, until no more can be installed (29 needle bearings per connecting rod). (Figure 13)
- Place upper locating washer over sleeve portion of Piston Pin Tool (shoulder of washer toward bearings), then slide tool handle out of sleeve. (Sleeve and locating washers will maintain needle bearings in position in connecting rod.)
- Apply a light coat of oil onto each piston pin before installing into piston.
- Place piston in position on Piston Support Block (C-91-77005) with "UP" marked side of piston crown positioned down (toward piston support block). (Figure 14)



- a - Piston Pin Needle Bearings b - Piston Pin Tool
c - Grease

Figure 12. Installing Piston Pin Needle Bearings



13338

- a - Sleeve of Piston Pin Tool
- b - Locating Washer (Hidden)
- c - Needle Bearing Being Installed

Figure 13. Installing Piston Pin Needle Bearings

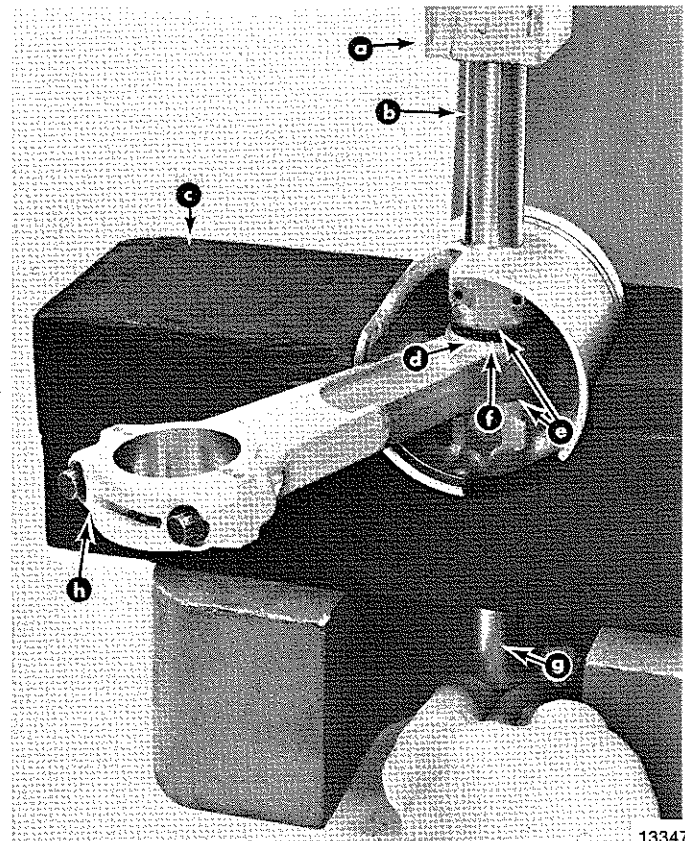
IMPORTANT: Different pistons are used for port and starboard cylinders. Pistons are marked "P" (port side) or "S" (starboard side) on piston crown. Pistons marked "P" must be installed in cylinder Nos. 2, 4 and 6, and pistons marked "S" must be installed in cylinder Nos. 1, 3 and 5.

7. Use Torch Lamp (C-91-63209) to heat piston dome to approximately 190°F (88°C). This will make piston pin installation easier.
8. While using one hand to hold sleeve, bearings and locating washers in place, insert connecting rod into position between piston pin bosses [2 alignment bumps on crankshaft end of connecting rod (Figure 14) must be toward "UP" marked side of piston crown], then install handle portion of Piston Pin Tool thru hole in Piston Support Block thru lower piston pin boss and into sleeve. (Figure 14)

9. While holding piston pin needle bearings in place with Piston Pin Tool, press piston pin into position (as far as possible) with an arbor press. (Figure 14) Use Piston Pin Tool (between arbor press and piston pin) to position piston pin the rest of the way into piston.

SAFETY WARNING: Eye protection MUST BE WORN while installing piston pin lockrings.

CAUTION: DO NOT re-use piston pin lockrings. Use only new lockrings and make sure that they are properly seated in piston grooves.

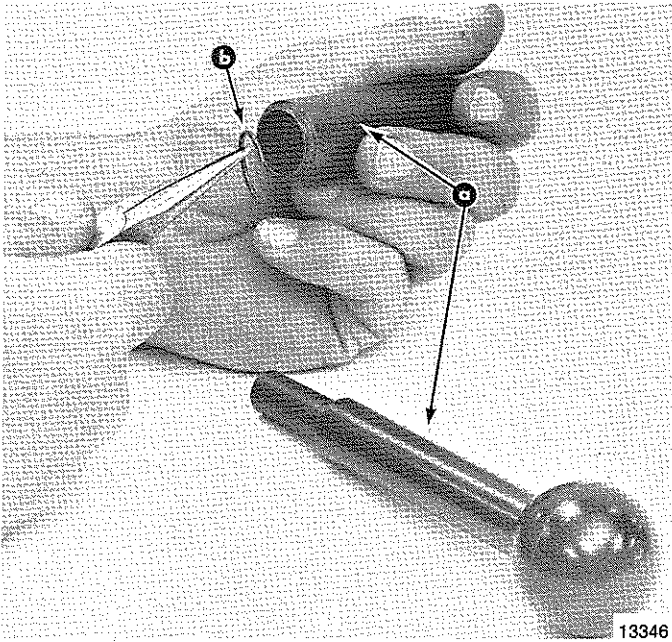


13347

- a - Press
- b - Piston Pin
- c - Piston Support Block (C-91-77005)
- d - Piston Pin Needle Bearings
- e - Locating Washers
- f - Sleeve Portion of Piston Pin Tool (Hidden)
- g - Piston Pin Tool
- h - 2 Alignment Bumps (Hidden) Must Be toward "UP" Marked Side of Piston Crown

Figure 14. Installing Piston onto Connecting Rod

10. Install new piston pin lockrings (one at each end of piston pin) with Lockring Installation Tool (C-91-77109A1), as shown in Figures 15 and 16. Double-check that lockrings are properly seated in piston grooves.

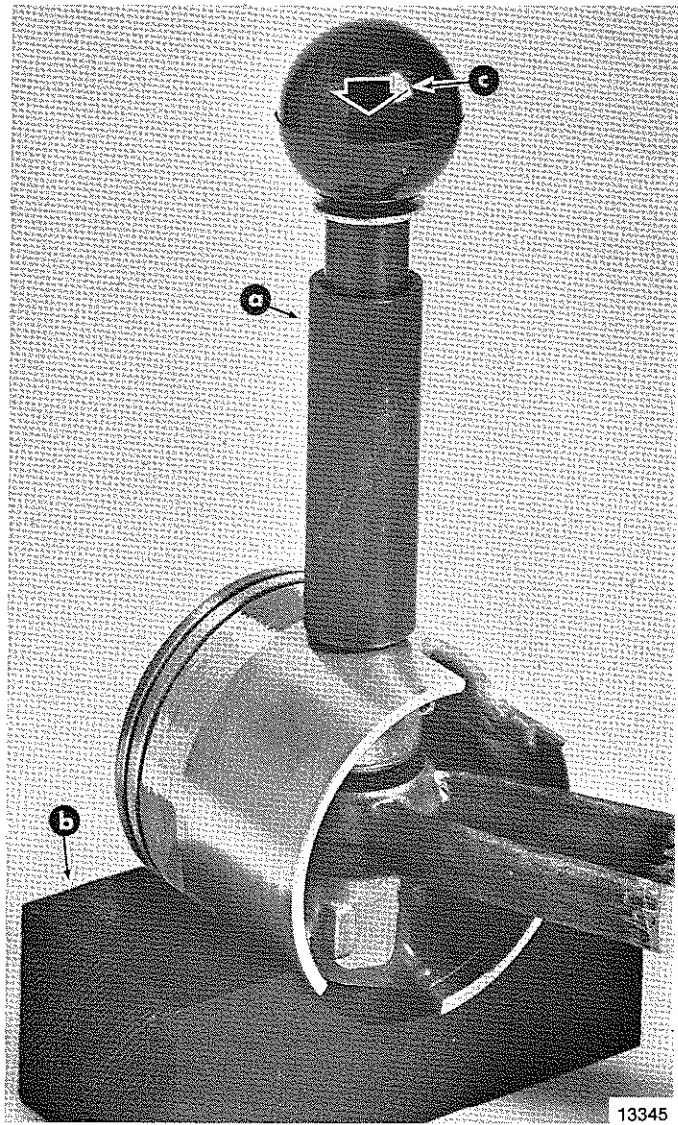


a - Lockring Installation Tool (C-91-77109A1) b - Lockring

Figure 15. Placing Lockring into Lockring Tool

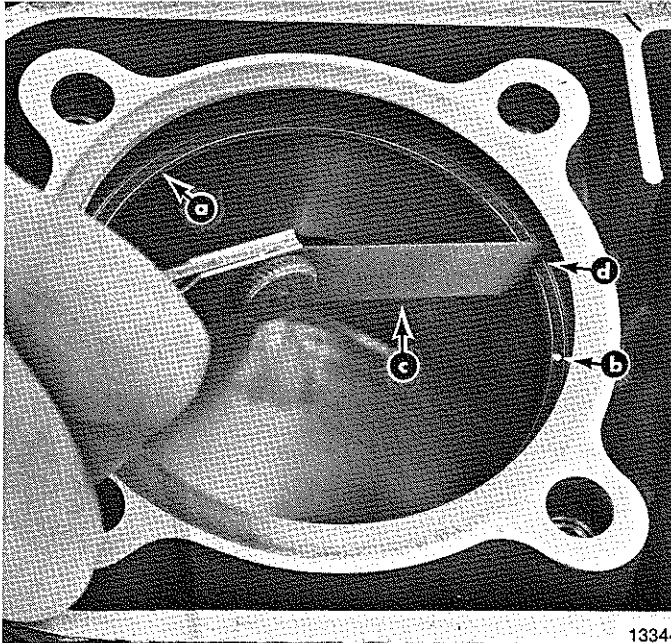
a - Lockring Installation Tool b - Piston Support Block
 c - Push Down

Figure 16. Installing Lockring into Piston 



Checking Piston Ring End Gap and Installing Rings onto Pistons

1. Insert each new piston ring (one at a time) into the bore of its respective cylinder. Position piston ring about $\frac{1}{2}$ " (12.7mm) into cylinder, using a piston to assure proper positioning of ring.



13344

- | | |
|---|-------------------------|
| a - Piston Ring | c - Feeler Gauge |
| b - Dot ("Pip" Mark) on Side of Piston Ring | d - Piston Ring End Gap |

Figure 1. Checking Piston Ring End Gap

2. Check end gap of each piston ring with a feeler gauge. (Figure 1) End gap must be within .018" to .025" (0.46mm to 0.64mm). If end gap is greater, check other new piston rings in cylinder bore until rings (within tolerance) are found. If end gap is less than tolerance, and another ring within tolerance cannot be found, it may be necessary to file some material from piston ring end (at gap). If it is necessary to file a piston ring, be sure that all rough edges are removed after filing.

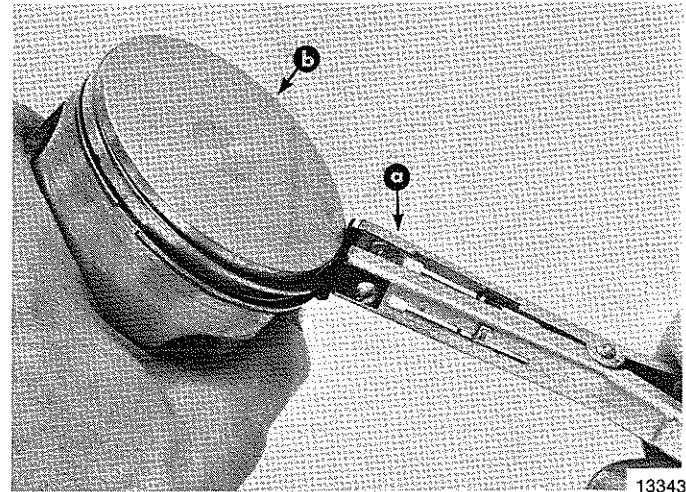
3. Continue to check piston ring gaps (as outlined, preceding) until new piston rings (within tolerance) have been found for each cylinder.
4. Remove piston rings from cylinder bores.

IMPORTANT: Piston rings, that are checked in No. 1 cylinder, MUST BE installed on No. 1 piston. Rings, which are checked in No. 2, MUST BE installed on No. 2 piston, etc.

5. Using Piston Ring Expander (C-91-24697), install No. 1 piston rings on No. 1 piston, No. 2 piston rings on No. 2 piston, etc. (Figure 2) Piston rings MUST BE installed on piston with DOT on SIDE of PISTON RING toward piston dome (crown). (Figure 1)

IMPORTANT: Piston rings MUST BE properly installed on pistons.

6. Check piston rings to be sure that they rotate freely in ring grooves. If a ring does not rotate freely, condition must be corrected BEFORE installing piston assembly into cylinder block.



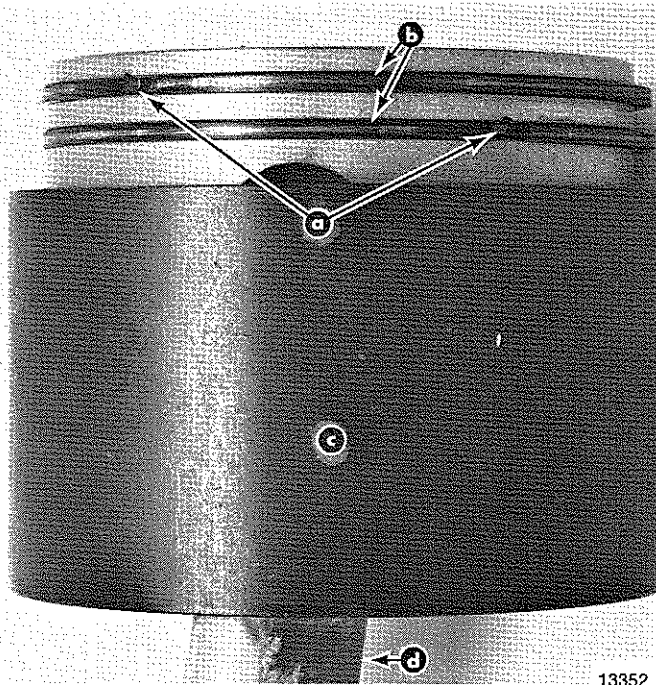
13343

- | | |
|---------------------------------------|------------|
| a - Piston Ring Expander (C-91-24697) | b - Piston |
|---------------------------------------|------------|

Figure 2. Piston Ring Installation

Piston Assembly Installation

1. Install Powerhead Stand (C-91-30591A1) into drive shaft end of crankshaft. Use Powerhead Stand to turn crankshaft to desired positions when attaching connecting rods to crankshaft.
2. Install each piston into cylinder block, as follows:
 - a. Lubricate piston rings, piston skirt, piston pin needle bearings and respective cylinder wall with light oil.



13352

- | | |
|---|--|
| a - Piston Ring Locating Pin
(One in Each Ring Groove) | c - Piston Ring Compressor
(C-91-85534) |
| b - Piston Rings | d - Connecting Rod |

Figure 3. Piston Ring Compressor Being Installed

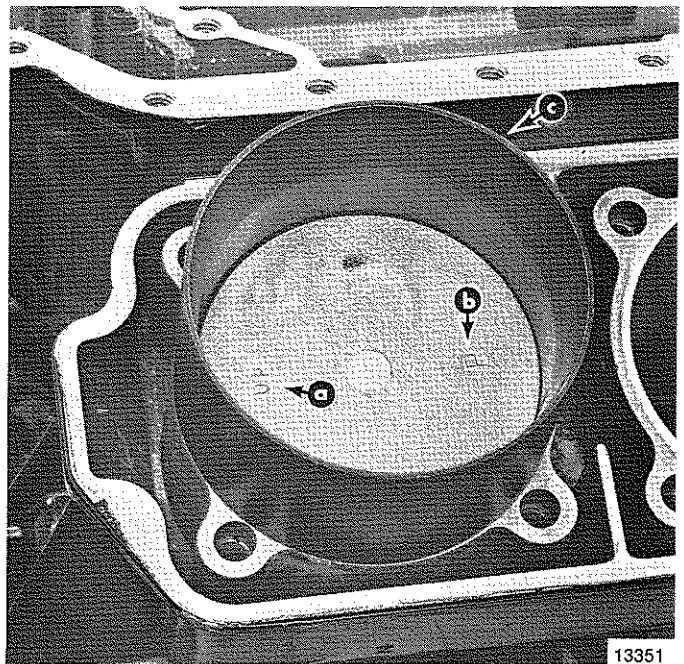
- b. Rotate each piston ring so that locating pin in ring groove is positioned at piston ring end gap. (Figure 3)
- c. Install Piston Ring Compressor (C-91-85534) around connecting rod and into position over piston rings, as shown in Figure 3.

CAUTION: Piston rings MUST BE properly positioned with locating pins between piston ring end gaps.

- d. Check that number, scribed on connecting rod during disassembly, matches cylinder number in which piston is to be installed [i.e., connecting rod, that is marked "1", must be installed in No. 1 cylinder, etc].
- e. Remove 2 bolts and connecting rod cap from piston/rod assembly to be installed.

- | |
|--------------------------------------|
| a - Connecting Rod |
| b - Bearing Cage and Roller Bearings |

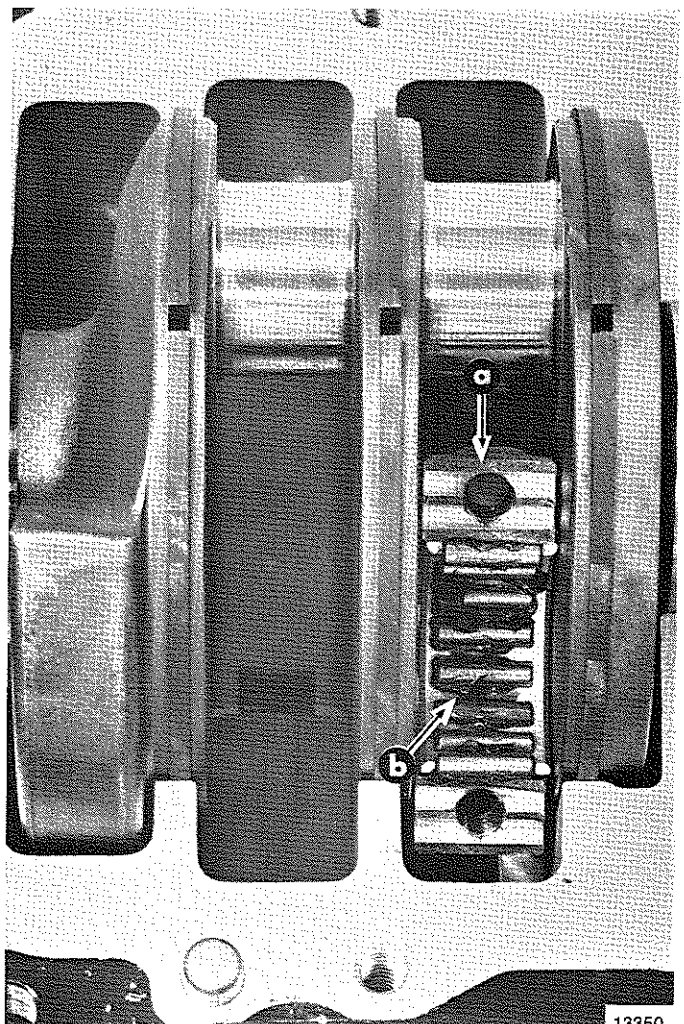
Figure 5. Installing Connecting Rod Bearings



13351

- | |
|--|
| a - "UP" Marked on Piston Crown |
| b - Stamped Letter ("P" or "S") on Piston Crown (Dome) |
| c - Piston Ring Compressor |

Figure 4. Installing Piston into Cylinder



13350

- f. Install piston assembly into its respective cylinder so that side of piston with "UP" (marked on piston crown, Figure 4) is toward flywheel end of powerhead. After aligning connecting rod with cylinder block opening, push on crown of piston until piston is installed into bore of cylinder, and piston ring compressor falls off.

IMPORTANT: Pistons must be installed in correct cylinder with "UP" side of pistons toward flywheel end of powerhead. (This will position large hole in piston skirt directly opposite exhaust port.) Pistons are marked "P" (port side) or "S" (starboard side) on piston crown. (Figure 4) Pistons, that are marked "P", must be installed in cylinder Nos. 2, 4 and 6, and pistons marked "S" must be installed in cylinder Nos. 1, 3 and 5.

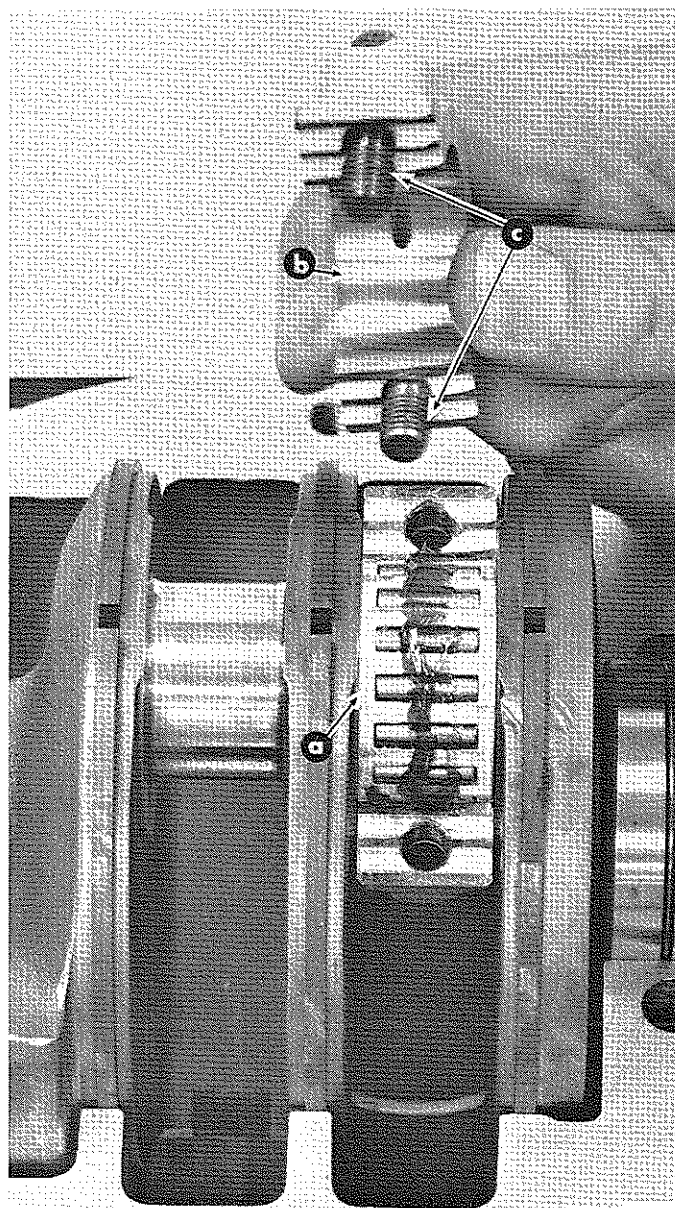
CAUTION: If it is necessary to re-use connecting rod roller bearings from disassembly, never intermix new bearings with used bearings at the same connecting rod end. Never intermix roller bearings from one connecting rod with those of another connecting rod. Should one (or more) piston pin roller bearing of a connecting rod require replacement (or should one or more be lost), replace all of that connecting rod's roller bearings.

- g. Apply a coating of grease (Multipurpose Lubricant) to bearing surface of connecting rod, then install bearing cage and roller bearings into grease. (Figure 5)
- h. Bring connecting rod up to crankshaft journal.
- i. Apply a coating of grease to crankshaft journal, then install other bearing cage and remaining roller bearings into grease. (Figure 6)
- j. Clean connecting rod bolts with solvent and dry with compressed air.
- k. Apply a drop of Loctite Type "A" to threads of each connecting rod bolt.
- l. Install connecting rod cap, being sure that alignment marks (bumps and etched marks - Figure 7) on connecting rod and cap are properly aligned. Install connecting rod bolts as far as possible by hand, then check alignment between rod cap and rod, as shown in Figure 7.

NOTE: Alignment of connecting rod cap and connecting rod can be checked by moving pencil point back-and-forth on chamfered corners between rod cap and rod. (Figure 7) If a ridge is felt, rod cap is misaligned. Misalignment must be corrected before proceeding.

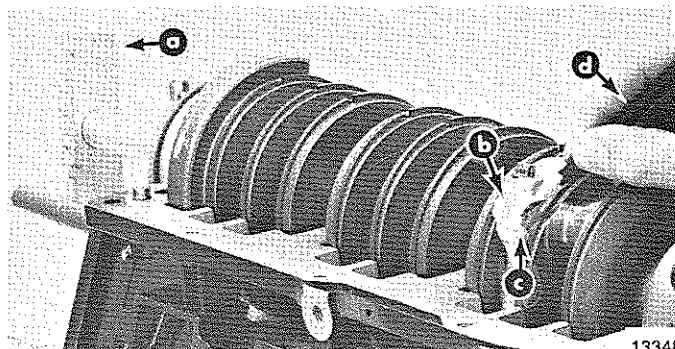
- m. Tighten connecting rod bolts (using a 5/16"-12 point socket) evenly in 3 progressive steps until torqued to 30 ft. lbs. (4.15mkg). Recheck alignment between rod cap and rod, as shown in Figure 7.
 - n. Check that all roller bearings have been installed by inserting a small tool thru slot in connecting rod cap and rotating cage. Be careful not to scratch bearings.
 - o. Repeat procedures in Steps "a" thru "n", preceding, for remaining cylinders.
3. Check piston rings for spring tension by inserting a screwdriver thru exhaust port and pressing on each piston ring. (Figure 8) If no spring tension exists (ring fails to return to position), it is likely that the ring was broken during

installation. Use caution not to burr piston rings during inspection. Replace only piston rings that may have been broken.



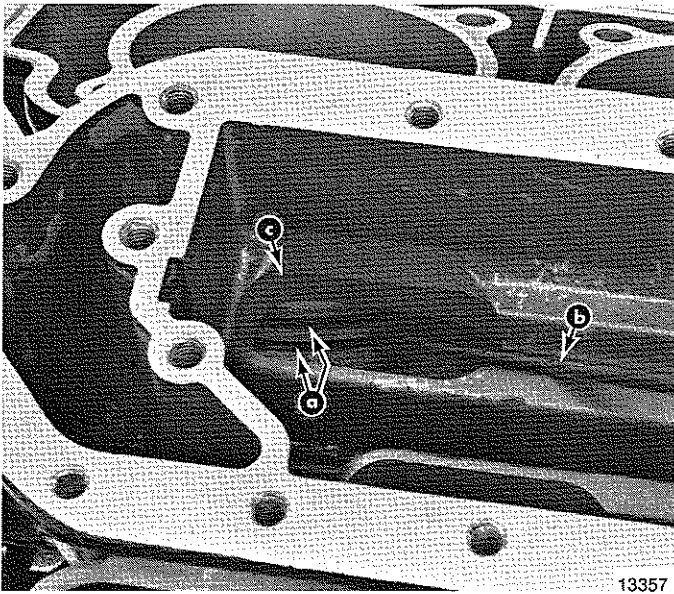
a - Bearing Cage and Roller Bearings b - Connecting Rod Cap
c - Connecting Rod Bolts

Figure 6. Installing Connecting Rod Bearings



a - Powerhead Stand (C-91-30591A1) c - Chamfered Corner
b - "Etched" Alignment Marks d - Pencil

Figure 7. Installing Connecting Rod Cap

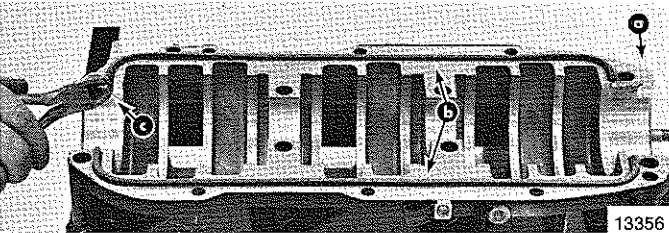


13357

a - Piston Rings b - Screwdriver c - Exhaust Port

Figure 8. Checking Piston Rings

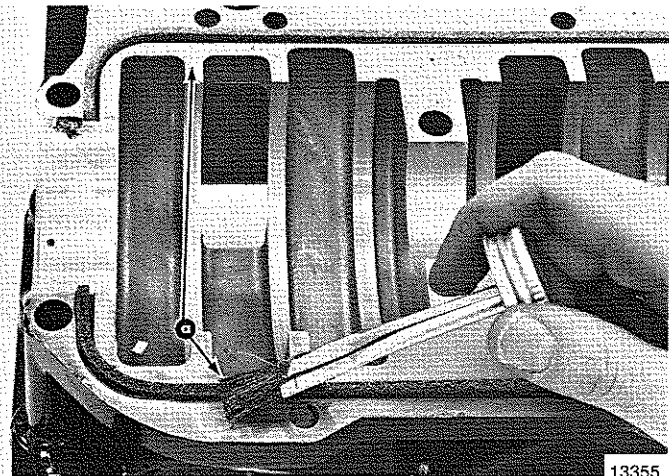
4. Using Powerhead Stand (C-91-30591A1), rotate crankshaft several times to assure free operation (no binds and/or catches).
5. Thoroughly clean machined, mating surfaces of crankcase cover and cylinder block with solvent to remove all oil.
6. Install gasket strips into grooves in crankcase cover, then trim end of each gasket strip flush with edge of cover, as shown in Figure 9.
7. Apply a THIN, even coat of Permatex 2C-12 on crankcase cover and cylinder block. (Figure 10)



13356

a - Crankcase Cover c - Trim End of Each Gasket Strip as Necessary
b - Gasket Strips

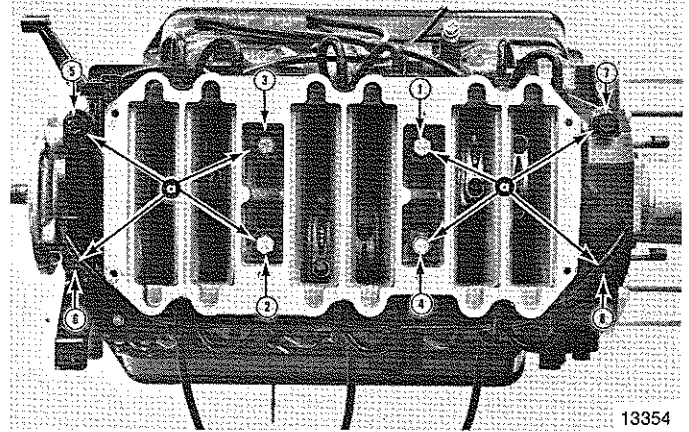
Figure 9. Trimming Crankcase Cover Gaskets



13355

a - Apply Permatex 2C-12 to These Surfaces

Figure 10. Applying Sealer to Crankcase Cover

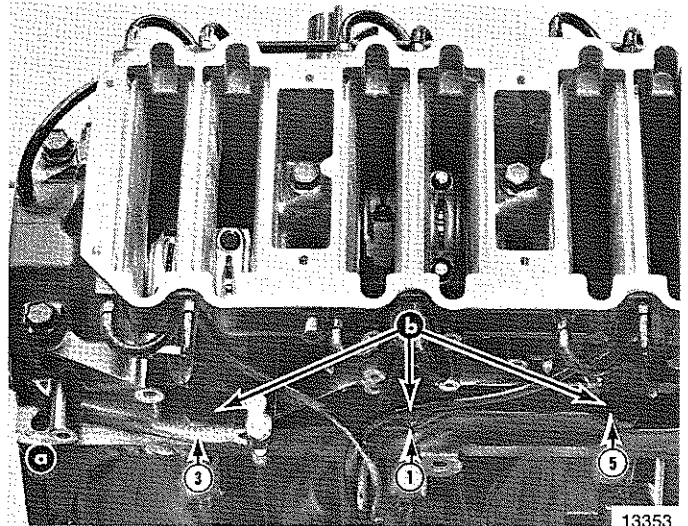


13354

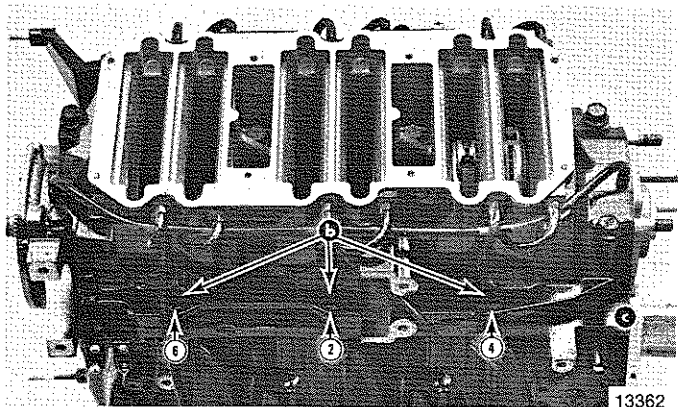
a - Large Crankcase Cover Attaching Bolts

Figure 11. Installing Crankcase Cover

8. Place crankcase cover in position on cylinder block. Secure crankcase cover with 8 large bolts. Turn bolts in (following torque sequence in Figure 11) a LITTLE at-a-time, compressing crankshaft seal rings until crankcase cover has been drawn down to cylinder block. Tighten 8 large crankcase cover bolts evenly in 3 progressive steps (following torque sequence in Figure 11) until each bolt is torqued to specification listed on Page 4A-1.



13353



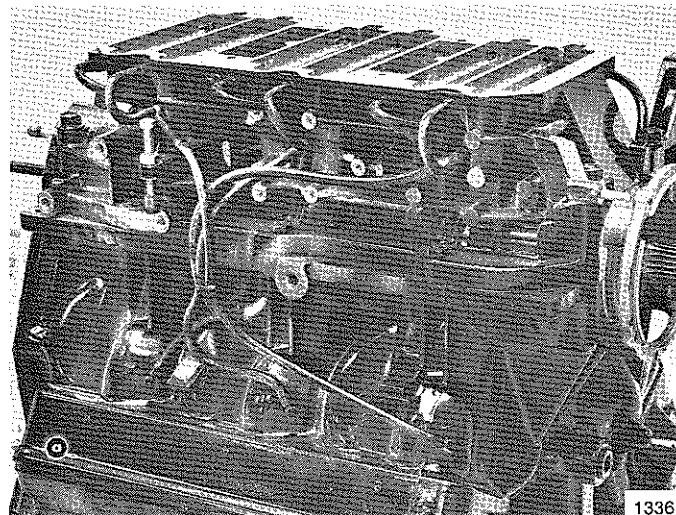
13362

a - Port Side of Crankcase Cover (Top Figure)
b - Small Crankcase Cover Bolts
c - Starboard Side of Crankcase Cover (Bottom Figure)

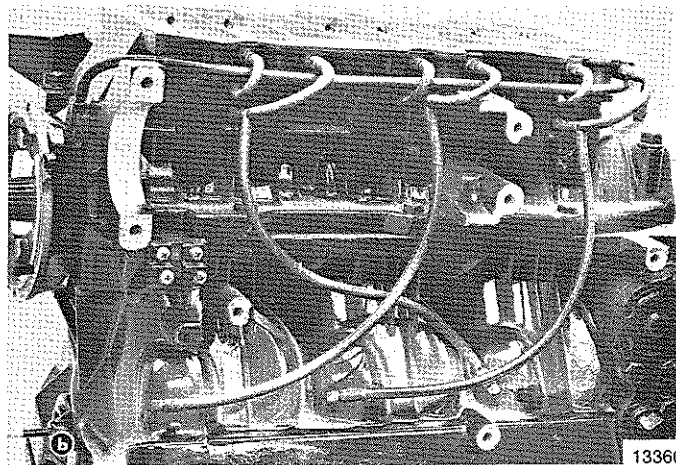
Figure 12. Installing Crankcase Cover

9. Install 6 small crankcase cover bolts and tighten evenly in 3 progressive steps until each bolt is torqued to specification. (Figure 12)
10. Install bolts which secure upper and lower end caps to crankcase cover. Tighten end cap attaching bolts evenly until lower end cap bolts and upper end cap bolts are torqued to specifications.
11. Wipe off any excess sealer that may have come out from between crankcase cover and cylinder block.
12. Using Powerhead Stand, rotate crankshaft several times to assure free operation (no binds and/or catches).
13. Route, connect and secure bleed hoses, as shown in Figures 13 and 14.

IMPORTANT: Bleed hoses MUST BE correctly routed as shown in Figures 13 and 14. If bleed hoses are connected to wrong cylinder, engine will not operate properly. Install bleed hoses all-the-way onto fittings.



13361



13360

- a - Port Side (Top Figure)
- b - Starboard Side (Bottom Figure)

Figure 13. Bleed Hose Routing and Connections 

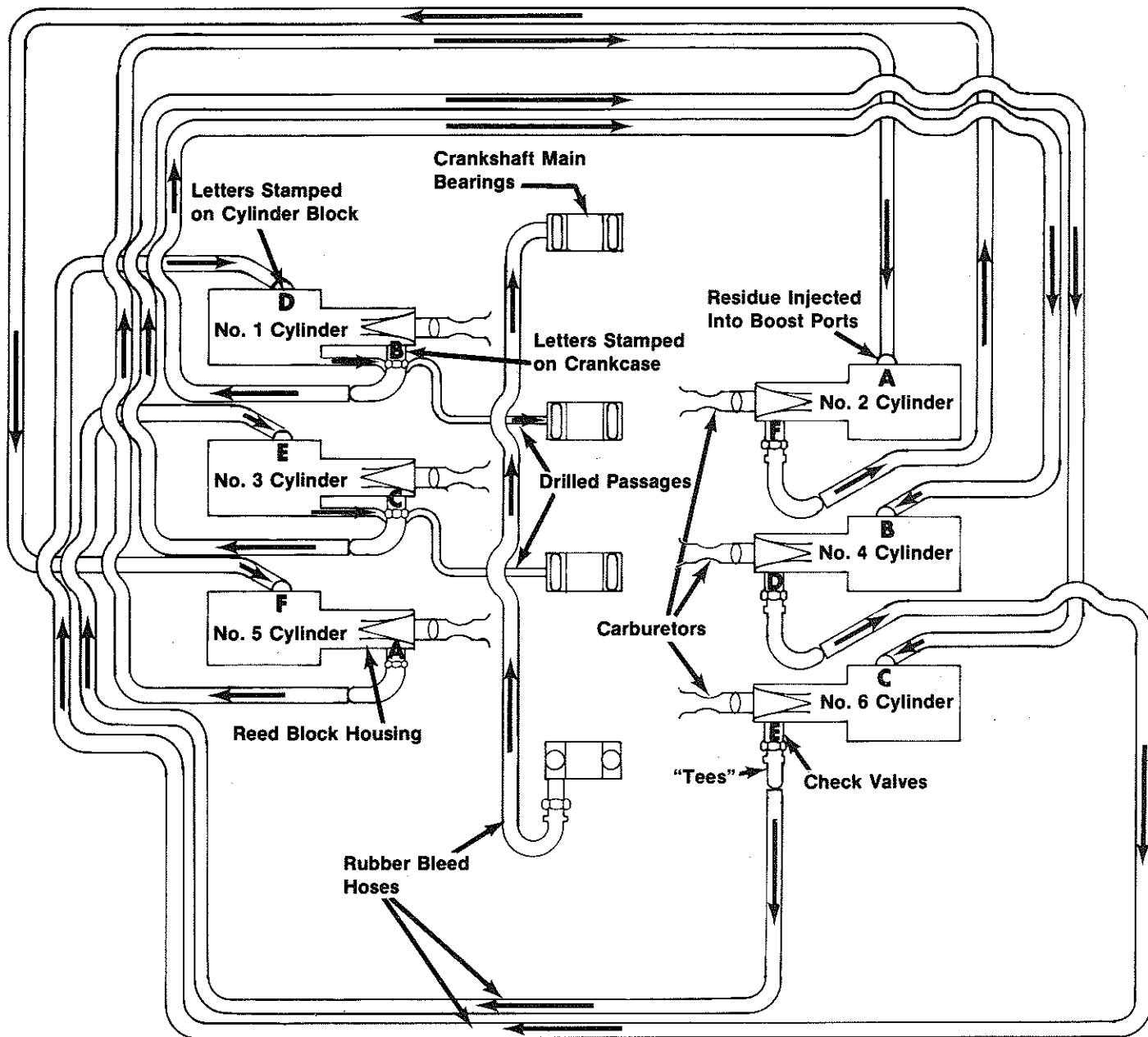


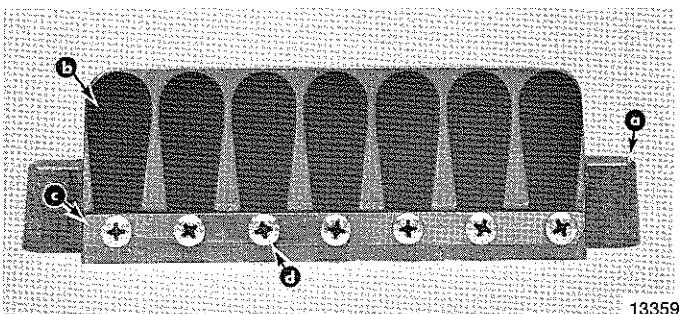
Figure 14. Bleed System

Reed Blocks and Intake Manifold - Reassembly and Installation

1. If removed, install new reeds onto reed block housing, as shown in Figure 1. Torque phillips head screws to 25 in. lbs. (29kg-cm).

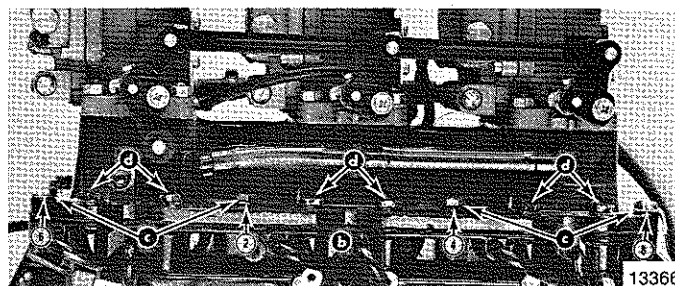
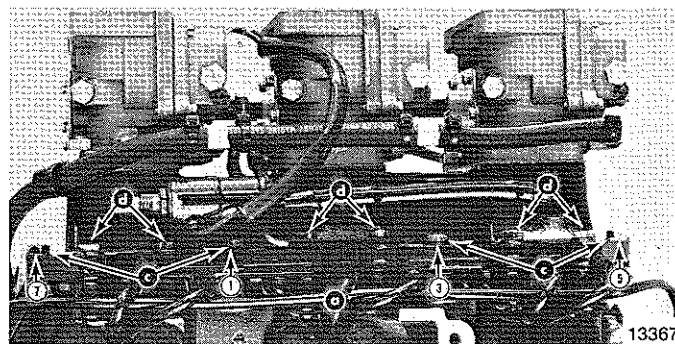
NOTE: Because of offset holes in reeds, it is impossible to turn reeds over on reed block housing.

2. Refer to "Cleaning and Inspection", preceding, and recheck reeds and reed block.
3. Install a new gasket on intake manifold. (Figure 2)
4. Secure reed block housings and intake manifold gasket to manifold with 12 bolts (2 per reed block housing). Tighten bolts finger-tight.



a - Reed Block Housing c - Retainer Plate
b - Reeds d - Phillips Head Screw

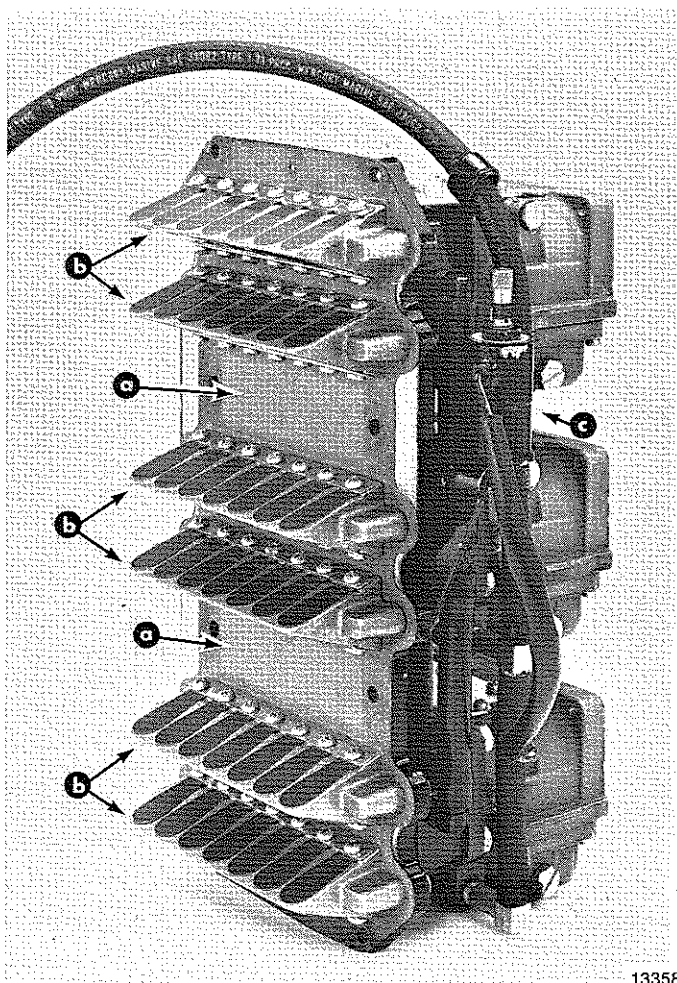
Figure 1. Reed Block Housing Assembly



a - Starboard Side (Top Figure)
b - Port Side (Bottom Figure)
c - Intake Manifold Attaching Bolts
d - Reed Block Housing Attaching Bolts

Figure 3. Intake Manifold Installation

5. Place intake manifold in position on crankcase cover and secure with attaching bolts. (Figure 3) Following torque sequence in Figure 3, tighten intake manifold attaching bolts in 3 progressive steps until torqued to specification shown on Page 4A-1.
6. Torque reed block housing attaching bolts (Figure 3) to specification.



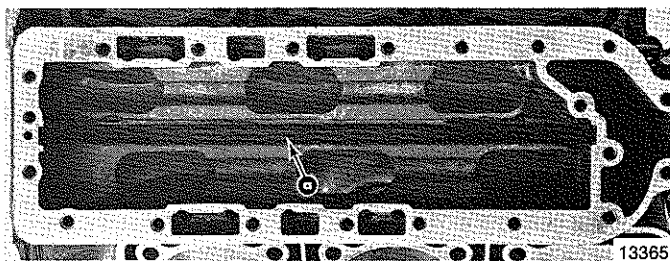
a - Intake Manifold Gasket
b - Reed Block Housing Assemblies
c - Carburetor Enricher

Figure 2. Intake Manifold Assembly

Exhaust Covers and Cylinder Heads - Installation

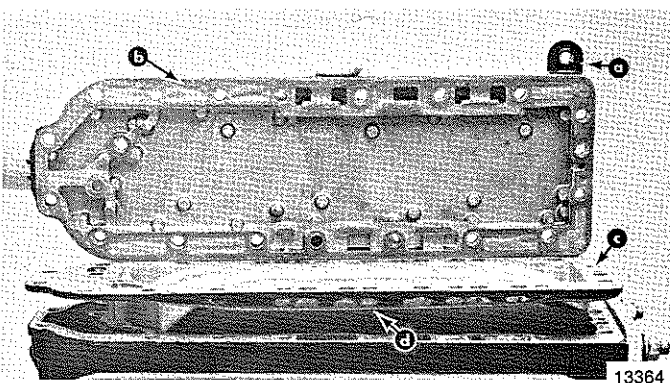
CAUTION: New gaskets **MUST BE** properly installed to allow correct water flow thru power-head.

1. Place exhaust divider plate seal into cylinder block slot (between exhaust ports). (Figure 4)
2. Place a divider plate gasket on each side of exhaust divider plate. (Figure 5) Be sure that gaskets are properly installed so that holes in gaskets are aligned with holes in divider plate. Install exhaust divider plate (with gaskets) into place on cylinder block.
3. Position exhaust manifold cover over exhaust divider plate. (Figure 5) Secure exhaust manifold cover and divider plate with attaching bolts, then tighten bolts in 3 progressive steps (following torque sequence in Figure 6) until bolts are torqued to specification shown on Page 4A-1.



a - Exhaust Divider Plate Seal

Figure 4. Exhaust Divider Plate Seal Installed



- | | |
|--|--|
| a - Exhaust Manifold Cover | c - Exhaust Divider Plate |
| b - Gasket (Exhaust Manifold Cover to Exhaust Divider Plate) | d - Gasket (Exhaust Divider Plate to Cylinder Block) |

Figure 5. Exhaust Manifold Cover and Divider Plate

NOTE: One of the exhaust manifold cover attaching bolts has a "J" clip on it. Place "J" clip at location shown in Figure 7.

4. Place cylinder head gasket over starboard side of cylinders with numbered side of gasket up (away from cylinder block). (Figure 7)

IMPORTANT: Cylinder head gasket **MUST BE** installed correctly.

5. Place cylinder head over starboard side cylinders so that hole for temperature sender is toward flywheel end of cylinder block. (Figure 8)
6. Install temperature sender (with bracket) into starboard side cylinder head, as shown in Figure 8.

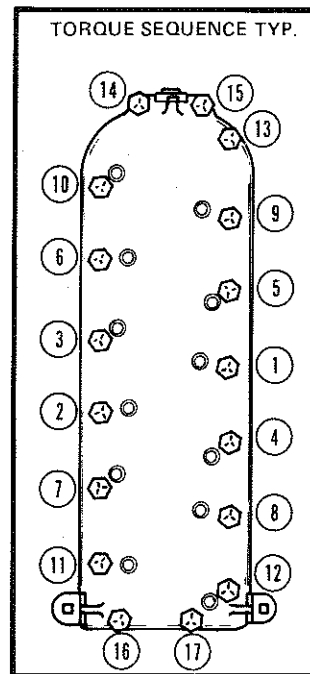
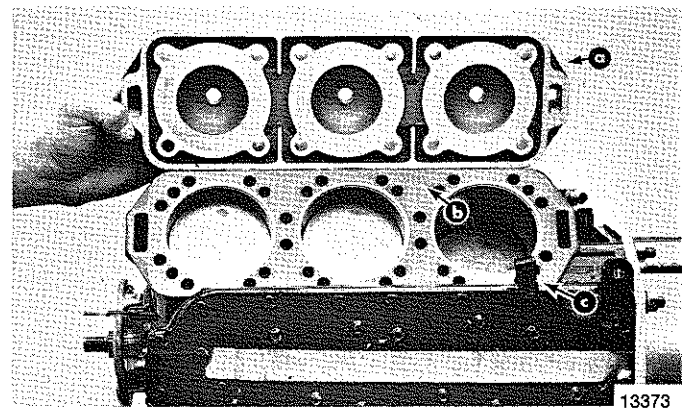
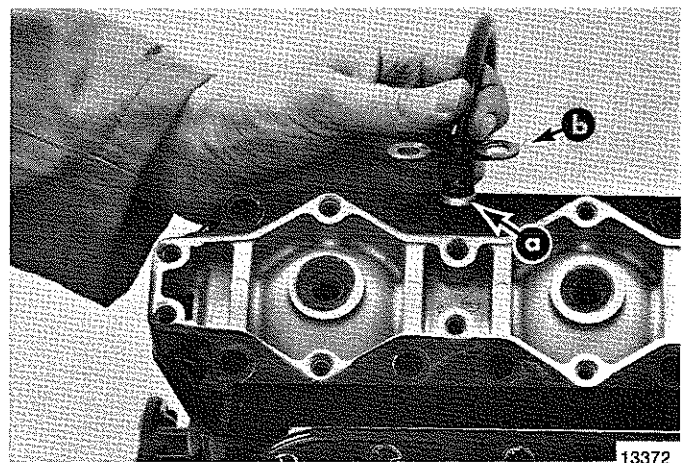


Figure 6. Exhaust Manifold Cover Torque Sequence



- | |
|---|
| a - Cylinder Head |
| b - Numbered Side of Cylinder Head Gasket |
| c - "J" Clip |

Figure 7. Cylinder Head Gasket



- | | |
|------------------------|-------------|
| a - Temperature Sender | b - Bracket |
|------------------------|-------------|

Figure 8. Installing Cylinder Head and Temperature Sender

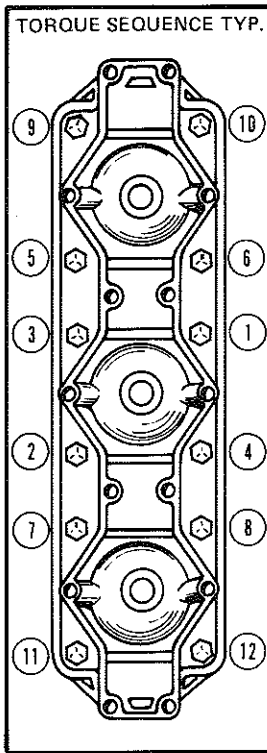
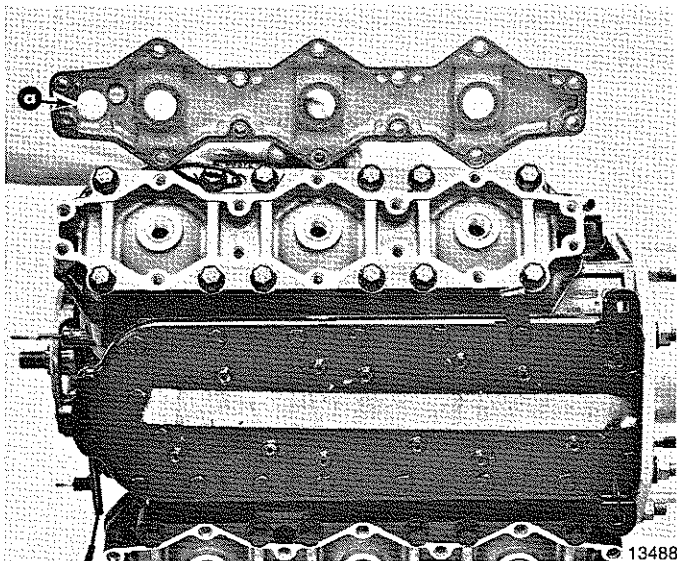


Figure 9. Cylinder Head Torque Sequence

7. Install bolts which secure starboard cylinder head to cylinder block. Torque cylinder head bolts in 3 progressive steps (following torque sequence in Figure 9) until bolts are torqued to specification.
8. Install cylinder head gasket and cylinder head over port side cylinders. Secure with bolts and use torque procedure in Step 7, preceding. Refer to Steps 4, 5 and 7, preceding. Port side cylinder head DOES NOT have a temperature sender. (Figure 8)
9. Install a cylinder head cover gasket and cylinder head cover on each cylinder head. Install covers with thermostat openings toward flywheel end of powerhead. (Figure 10)

NOTE: Each of the cylinder head covers has one attaching bolt that secures a "J" clip. Place "J" clips in locations shown in Figure 12.



a - Thermostat Opening

Figure 10. Cylinder Head Cover Installation

10. Install cylinder head cover bolts with "J" clips placed at proper locations. Torque cylinder head cover bolts in 3 progressive steps (following torque sequence in Figure 11) until bolts are torqued to specifications.
11. Install thermostat gasket around each thermostat so that shoulder on gasket will be toward cylinder head cover when installed. (Figure 12)
12. Install thermostat (with gasket), then thermostat covers (with water distribution hoses) onto cylinder head covers. (Figure 12) Secure thermostat covers with attaching bolts and torque bolts to specification.
13. Secure water distribution hoses in "J" clips and connect hose to fitting on idle shutoff valve. Secure all water distribution hose connections with sta-straps.
14. Refer to Figure 13 for water flow schematic.

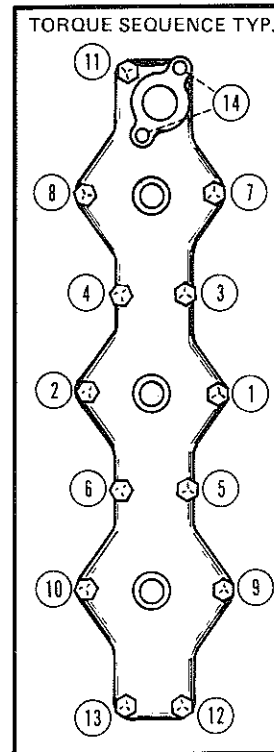
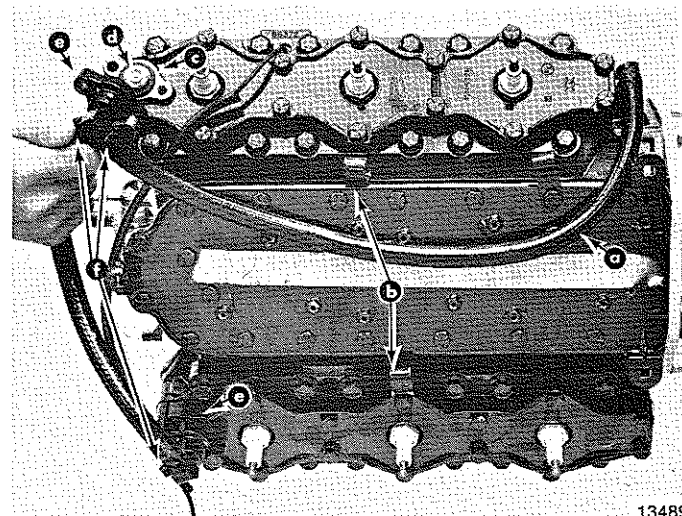


Figure 11. Cylinder Head Cover Torque Sequence



a - Water Distribution Hose
 b - "J" Clip
 c - Thermostat Gasket
 d - Thermostat
 e - Thermostat Covers
 f - Sta-Strap

Figure 12. Thermostat Installation

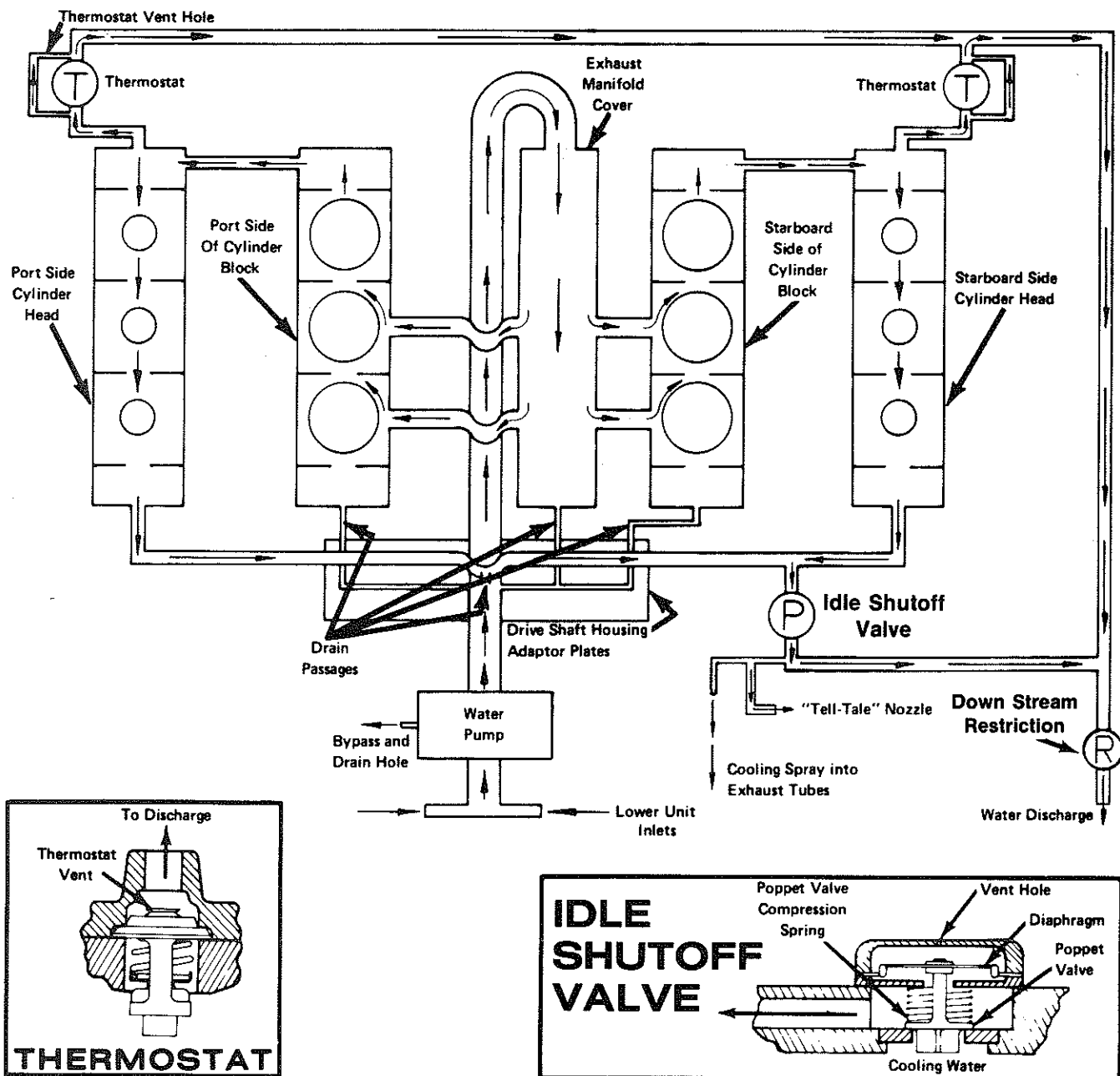


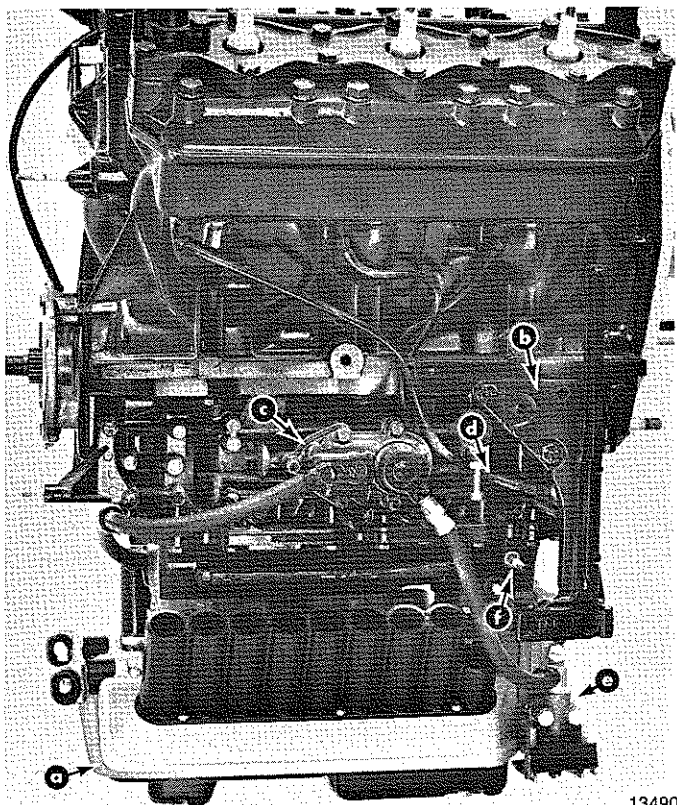
Figure 13. Cooling System (Water Flow)

Accessories, Flywheel and Powerhead - Installation

1. Place air box onto carburetors and secure with 6 attaching screws. (Figure 1)
2. Place control cable anchor bracket on the port side of powerhead and secure with 3 attaching bolts. Tighten bolts securely. (Figure 1)

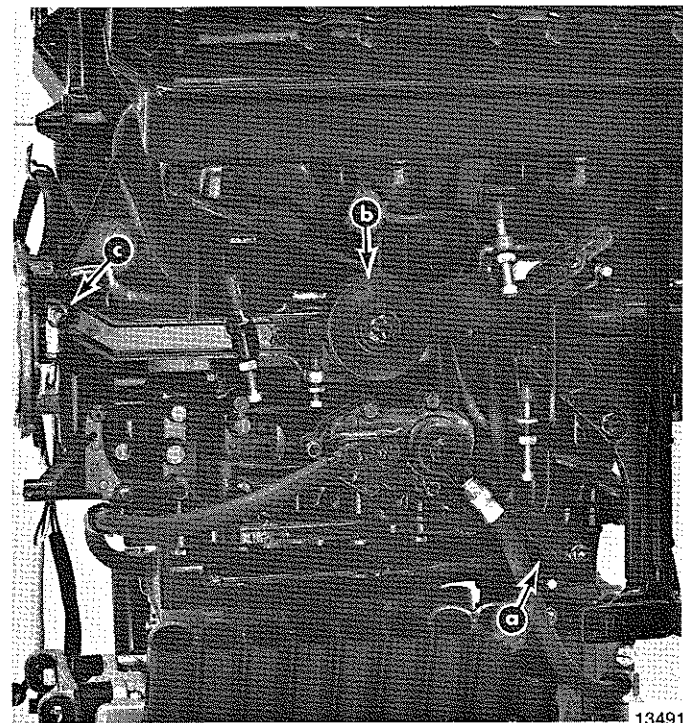
NOTE: It is recommended that new gaskets and diaphragm be used when reinstalling fuel pump on powerhead.

3. Connect pulse hose (from fuel pump assembly) to fitting on port side of powerhead. (Figure 1)
4. Position fuel pump assembly on the port side of powerhead and secure with 5 attaching screws. (Figure 1) Before tightening attaching screws to specifications (shown on Page 4A-1), be sure that bleed hoses (which are routed behind fuel pump) are not pinched. Torque attaching screws to 25 in. lbs. (29kg-cm).
5. Secure check unit adaptor to bracket on air box with 2 attaching bolts. (Figure 1) Tighten bolts securely.
6. Apply a small amount of Multipurpose Lubricant on throttle cam anchor stud. (Figure 1)
7. Position spark/throttle lever assembly on the port side of powerhead and secure with attaching bolt and 2 flat washers (one on each side of spark/throttle lever assembly). (Figure 2) DO NOT tighten attaching bolt at this time.



- | | |
|----------------------------------|------------------------------|
| a - Air Box | d - Pulse Hose |
| b - Control Cable Anchor Bracket | e - Check Unit Adaptor |
| c - Fuel Pump Assembly | f - Throttle Cam Anchor Stud |

Figure 1. Air Box, Fuel Pump and Control Cable Anchor Bracket Installed



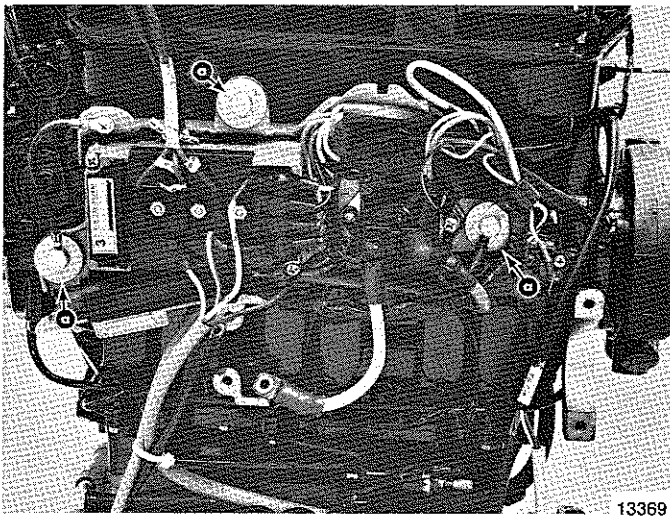
- | | |
|-----------------------------------|-----------------------------|
| a - Throttle Cam | c - Trigger Linkage Locknut |
| b - Spark/Throttle Lever Assembly | |

Figure 2. Spark/Throttle Lever Assembly Installed

8. Using a nylon bushing on the inside and one on the outside, install throttle cam onto stud, as shown in Figure 2. Thread a self-locking nut on stud and tighten nut until the throttle cam's back-and-forth effect increases, then back nut off $\frac{1}{8}$ -turn.

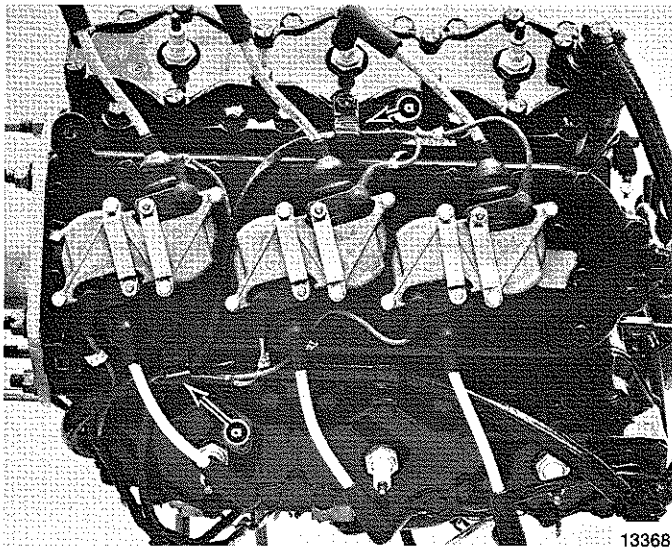
SAFETY WARNING: DO NOT tighten throttle cam attaching locknut securely against throttle cam. Throttle cam must be free to swivel on stud.

9. Tighten spark/throttle lever assembly attaching bolt securely.
10. Place trigger assembly in upper end cap and secure trigger linkage to spark/throttle lever with a self-locking nut. (Figure 2) Torque locknut to 25 in. lbs.
11. Reattach ignition plate to starboard side of powerhead and secure with 3 bolts, 3 lockwashers, 6 flat washers, 6 rubber mounts and 3 metal spacers, as shown in Figure 3. Tighten bolts securely.
12. Position secondary ignition coils on exhaust manifold cover (Figure 4), apply a drop of Loctite Type "A" on threads of coil attaching screws and secure coils to cover with screws. Tighten attaching screws securely.
13. Secure secondary ignition coil wiring in "J" clips, as shown in Figure 4.



a - Bolt, Lockwasher, Flat Washers (One against Powerhead and One against Lockwasher), 2 Rubber Mounts (One on Each Side of Ignition Plate) and a Metal Spacer

Figure 3. Ignition Plate Installation



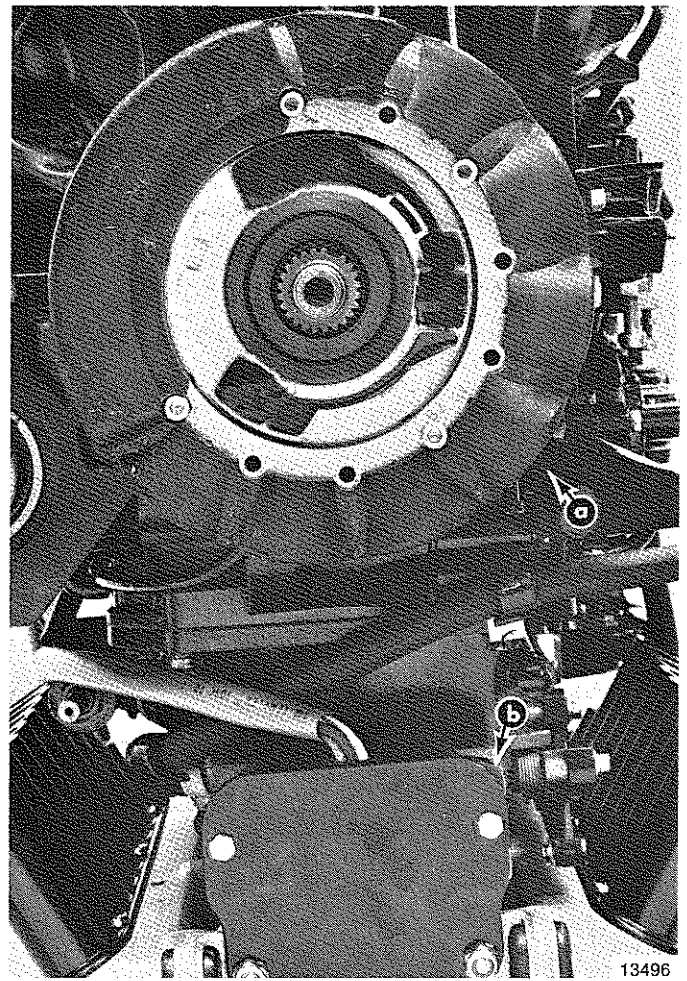
a - "J" Clip

Figure 4. Secondary Ignition Coils Secured to Exhaust Manifold Cover

14. Place a drop of Loctite Type "A" on threads of stator attaching screws. Place stator assembly in position on upper end cap and secure with attaching screws. (Figure 5) Torque attaching screws to specification.
15. Secure high speed spark advance module onto air box bracket with 2 self-locking nuts. (Figure 5)
16. Remove 2 phillips head screws, which secure the 2 switch boxes to ignition plate, then lift the top switch box away from the bottom one.
17. Connect 3 wires (in black sleeve) from trigger assembly to proper terminals on inner switch box. (Figure 6) Install rubber boots over terminals.

- | | |
|-------------------------|-------------------------------|
| a - Outer Switch Box | d - Brown Trigger Wire |
| b - Violet Trigger Wire | e - Harness with Black Sleeve |
| c - White Trigger Wire | |

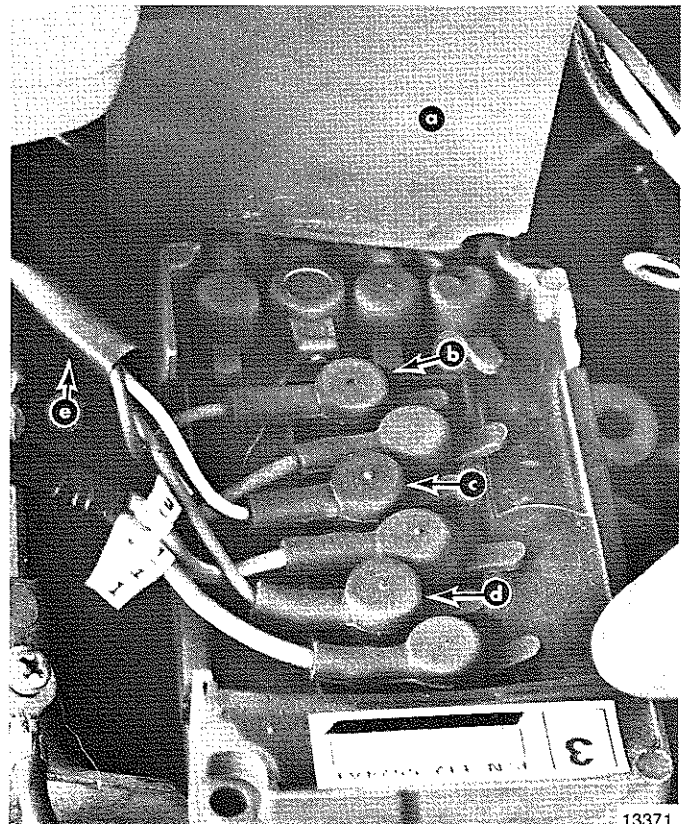
Figure 6. Trigger Harness with Black Sleeve Connected to Inner Switch Box



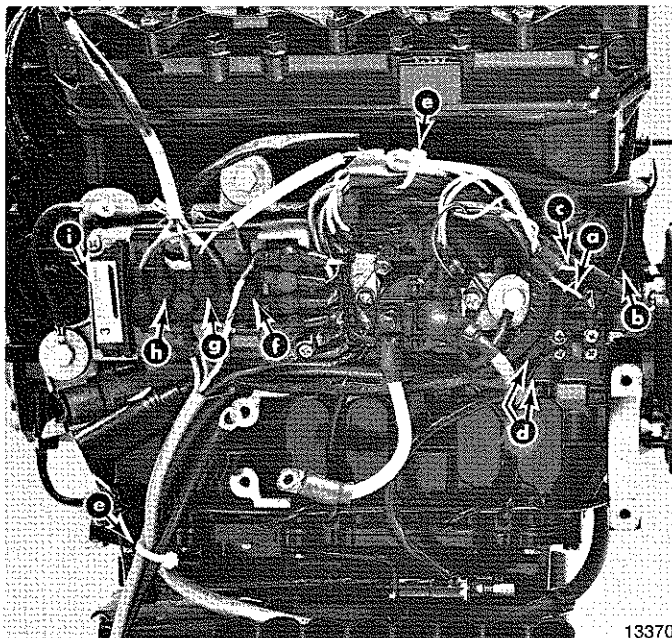
a - Stator

b - High Speed Spark Advance Module

Figure 5. Stator and High Speed Spark Advance Module Installed



18. Secure outer and inner switch boxes to ignition plate with 2 phillips head screws and spacers. (Figure 7) Tighten screws securely.
19. Connect 3 wires (in yellow sleeve) from trigger assembly to proper terminals on outer switch box. (Figure 7) Install rubber boots over terminals.
20. Secure tan wire (from ignition plate harness) and black wire (from temperature sender) to the top terminal block with a phillips head screw. (Figure 7) DO NOT secure wires with the same screw that secures terminal block to powerhead.
21. Secure yellow/black wire (from ignition plate harness) and one of the black wires (from carburetor enricher) to the bottom terminal block with a phillips head screw. (Figure 7) DO NOT secure yellow/black wire to terminal block with the same screw that secures terminal block to powerhead. Secure the second black wire (from carburetor enricher) to terminal block with the same screw that secures terminal block to powerhead.
22. Secure trigger assembly wiring harness, stator assembly wiring harness and ignition plate wiring harness to ignition plate with a sta-strap, as shown in Figure 7.

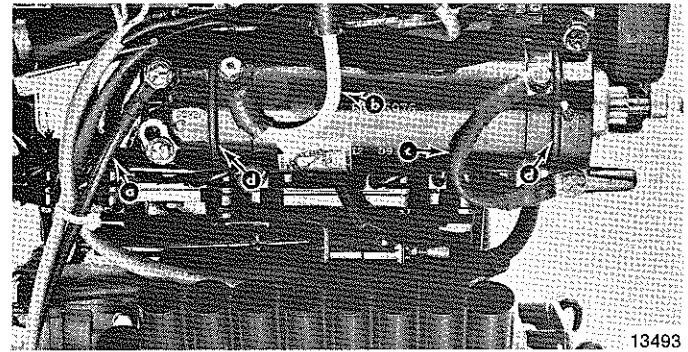


- | | |
|-------------------------------------|-------------------------|
| a - Tan Wire | f - Violet Trigger Wire |
| b - Temperature Sender Black Wire | g - White Trigger Wire |
| c - Yellow/Black Wire | h - Brown Trigger Wire |
| d - Carburetor Enricher Black Wires | i - Outer Switch Box |
| e - Sta-Straps | |

Figure 7. Ignition Plate

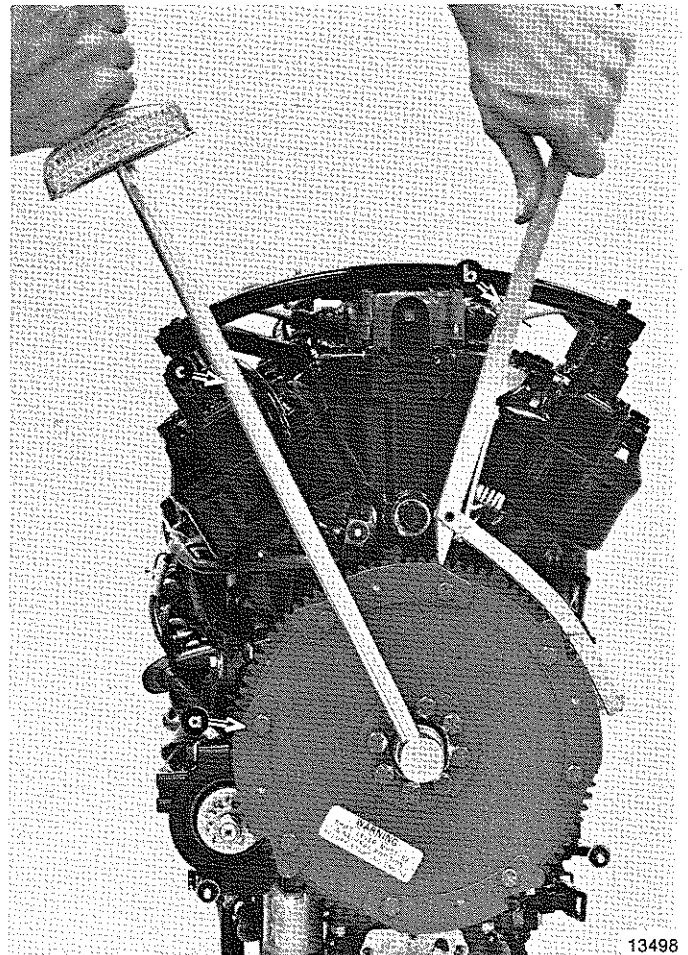
23. Place a rubber collar on both ends of starter motor (Figure 8) and position starter motor on brackets on the starboard side of powerhead.
24. Secure starter motor to starboard side of powerhead with 2 anchor brackets and 4 attaching bolts. (Figure 8) Be sure that battery ground cable is secured to bottom anchor bracket and starter motor ground cable is secured to top anchor bracket. Tighten attaching bolts to specification shown on Page 4A-1.

25. Secure yellow positive (+) cable (from starter solenoid) to terminal on starter motor with a lockwasher and nut. (Figure 8) Tighten nut securely.
26. Reinstall flywheel onto crankshaft. Secure flywheel with flat washer and locknut. While holding flywheel with Flywheel Holder (C-91-52344), torque flywheel locknut to specification. (Figure 9)



- | | |
|---|-------------------|
| a - Battery Ground Cable | c - Starter Motor |
| b - Yellow Positive (+) Starter Motor Cable | d - Rubber Collar |

Figure 8. Starter Motor Installed



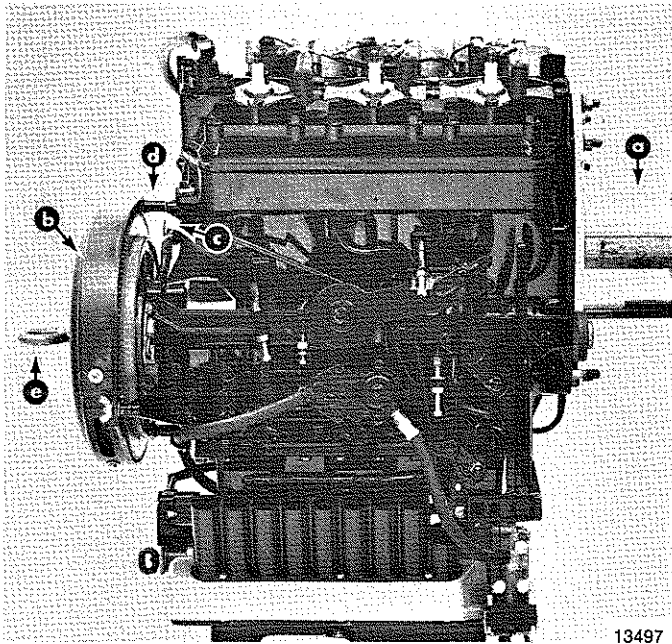
- | | |
|----------------------------------|-------------------|
| a - Flywheel | c - Torque Wrench |
| b - Flywheel Holder (C-91-52344) | |

Figure 9. Torquing Flywheel Locknut

27. Place a "J" clip over flywheel cover stud that is closest to cylinder heads, then secure trigger assembly wiring harness with clip. (Figure 10) Slide a plastic spacer over stud.
28. Reinstall flywheel cover. Secure cover with flat washers, rubber mounts and wing nuts. (Figure 10)
29. Install Lifting Eye (C-91-75132) into flywheel.

SAFETY WARNING: BE SURE that Lifting Eye is threaded into flywheel as far as possible BEFORE lifting powerhead.

30. Using a hoist, lift powerhead high enough to allow removal of powerhead from repair stand. Remove powerhead from repair stand, being careful not to damage drive shaft housing gasket surface of powerhead.
31. Place a new gasket around powerhead studs and into position on base of powerhead.
32. Apply a small amount of Multipurpose Lubricant onto drive shaft splines.
33. Use hoist to lower powerhead onto drive shaft housing. It may be necessary to turn flywheel (aligning crankshaft splines with drive shaft splines) so that powerhead will be fully installed.

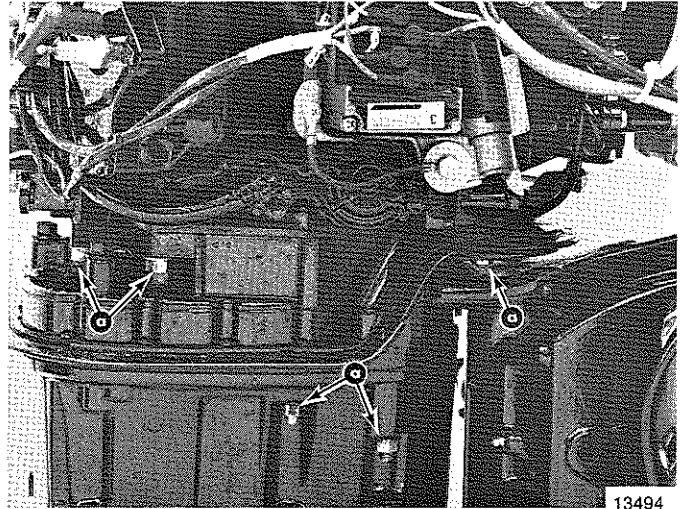


- | | |
|--------------------|-----------------|
| a - Powerhead | c - "J" Clip |
| Repair Stand | d - Spacer |
| b - Flywheel Cover | e - Lifting Eye |

Figure 10. Powerhead on Repair Stand

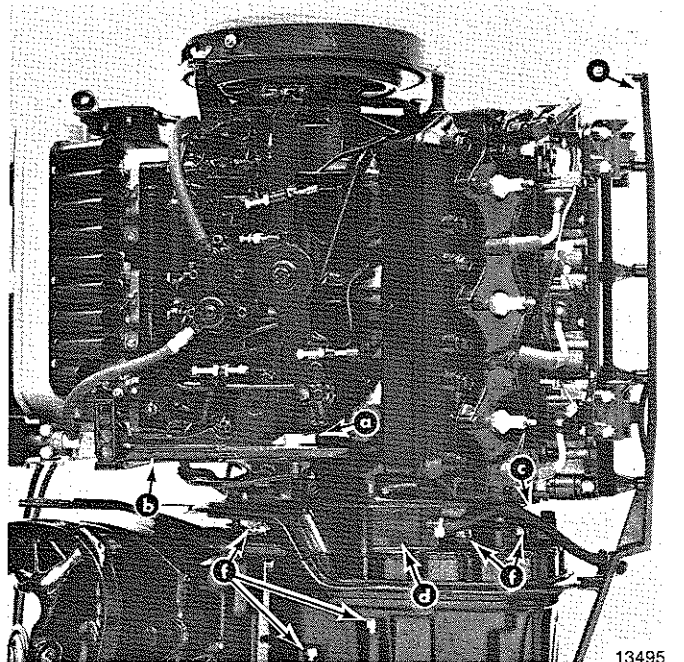
34. Install 10 flat washers and 10 locknuts which secure powerhead to exhaust extension plate/drive shaft housing. (Figures 11 and 12) Torque locknuts in 3 progressive steps until torqued to specification.
35. Disconnect hoist from Lifting Eye and remove Lifting Eye from flywheel.
36. Reinstall plastic cap into center of flywheel cover.
37. Reinstall rear cowl support bracket onto exhaust manifold cover and secure with 3 flat washers and 3 locknuts. (Figure 12) Tighten locknuts securely.

38. Reconnect "tell-tale" hose (from rear cowl support cowl) to fitting on exhaust plate assembly. (Figure 12) Secure hose to fitting with a sta-strap.
39. With spring and guide block installed on shift link rod, insert shift link rod into control cable anchor bracket. Guide block must be installed with anchor pin forward. (Figure 12)
40. Secure shift link rod assembly with wear plate, latch, flat washer and locknut. Thread locknut onto shift link rod until 2 or 3 threads are exposed beyond top of nut. DO NOT tighten locknut.
41. Follow procedure in Section 2 of this Service Manual for "Timing/Synchronizing/Adjusting" of the engine.



- a - Powerhead Attaching Locknuts and Flat Washers

Figure 11. Powerhead (Starboard Side)

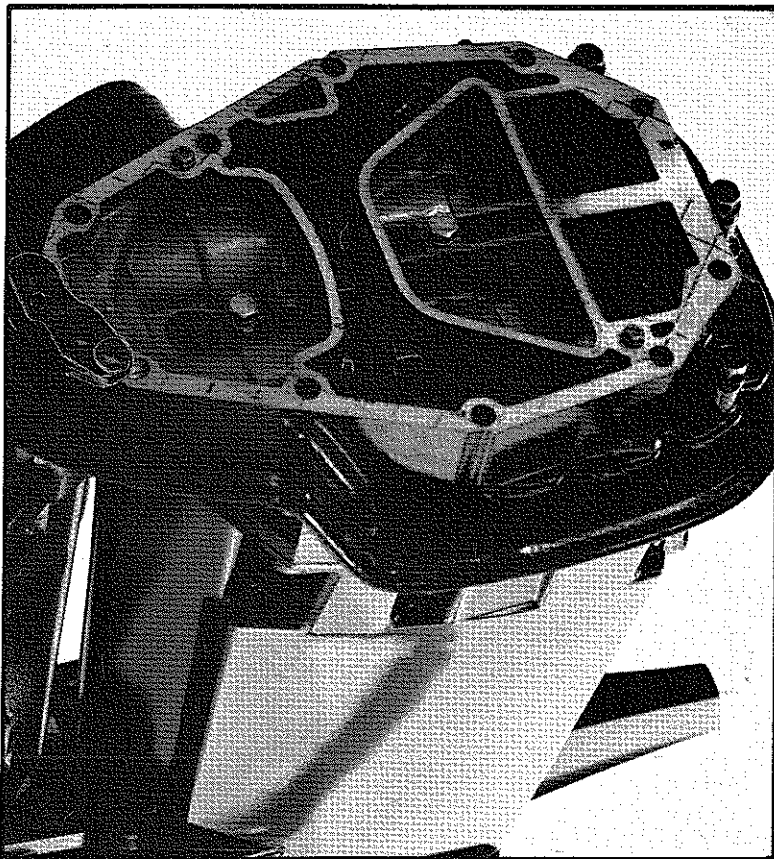


- | | |
|----------------------------------|---|
| a - Shift Cable Latch Assembly | e - Rear Cowl Support Bracket |
| b - Control Cable Anchor Bracket | f - Powerhead Attaching Locknuts and Flat Washers |
| c - "Tell-Tale" Hose | |
| d - Exhaust Plate Assembly | |

Figure 12. Powerhead (Port Side)

V-6 OUTBOARDS

Lower Unit



Mid-Section

SECTION

5

PART

A

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Torque Specifications

Fastener Location	Torque
Hydraulic Line Fittings	60 In. Lbs. (69kg-cm)
Manifold Cover Mounting Screw	60 In. Lbs. (69kg-cm)
Manifold Cover Mounting Screw	24 In. Lbs. (28kg-cm)
Trim Cylinder Pivot Bolt	40 Ft. Lbs. (5.5mkg)
Shock Mount (Upper) to Steering Arm Nut	50 Ft. Lbs. (6.92mkg)
Shock Mount (Lower) to Swivel Pin Yoke Nut	50 Ft. Lbs. (6.92mkg)
Shock Mount (Lower) Retainer	160 In. Lbs. (184kg-cm)
Stop Strap Bolt Locknut	40 Ft. Lbs. (5.5mkg)

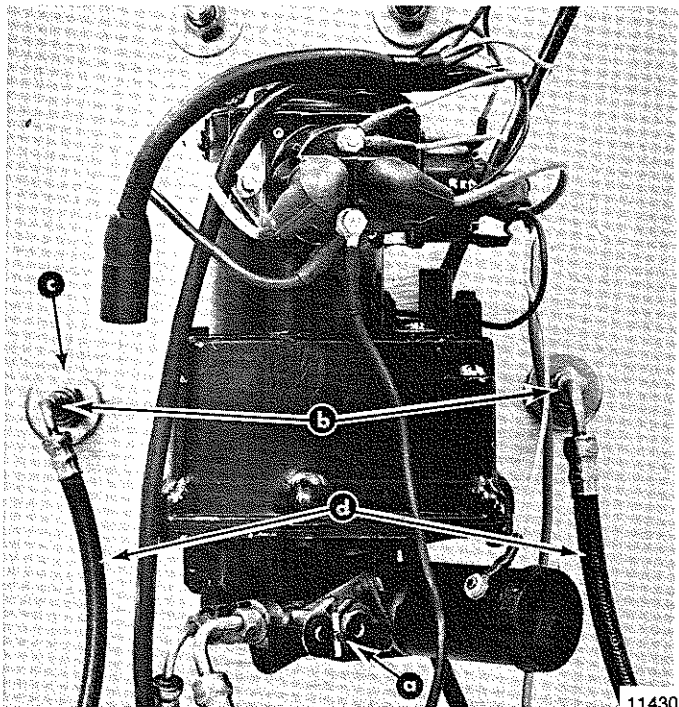
Trim Cylinders

REMOVAL and DISASSEMBLY

SAFETY WARNING: When working around an outboard, follow these 3 steps:

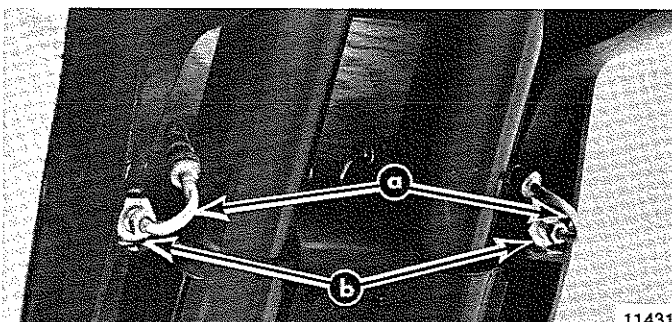
1. Disconnect battery leads from battery.
2. Be sure that remote control wiring harness is connected to engine wiring harness. (Engine can be started with/or without remote control wiring harness connected to engine wiring harness, but engine cannot be shut off unless harnesses are connected together.)
3. Turn ignition key to "OFF" position and remove key from switch.

NOTE: These trim cylinder removal and installation instructions are outlined as though the engine were still connected to the boat. These instructions also can be followed if the engine is removed from the boat.



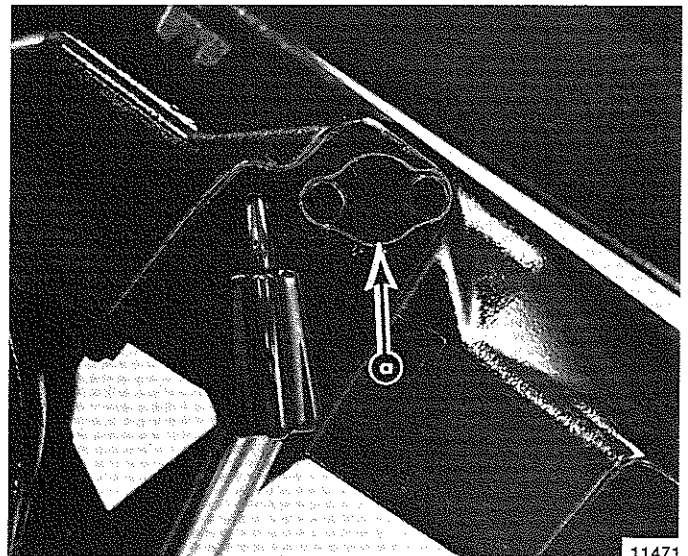
a - Release Valve Control Knob c - Locknut and Flat Washer
b - Hydraulic Connectors d - Hydraulic Hose

Figure 1. Hydraulic Pump and Hose Connections



a - Hydraulic Hoses b - Hydraulic Connectors

Figure 2. Hydraulic Hoses and Hydraulic Connectors

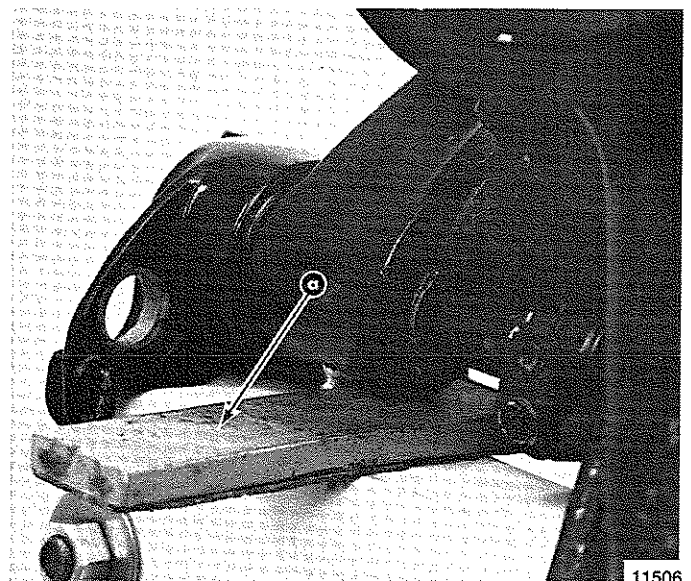


a - Trim Cylinder Pin Cover

Figure 3. Location of Trim Cylinder Pin Cover (One Each Side)

1. Shift engine into neutral.
2. Trim engine to full up position and engage tilt lock lever.
3. Turn release valve control knob (Figure 1) full left (counterclockwise). This will release hydraulic pressure.
4. Place a large drain pan under trim cylinders.
5. Disconnect hydraulic hoses from hydraulic connectors (in clamp brackets). (Figure 2)
6. Remove 4 bolts, which secure trim cylinder pin covers to swivel bracket, and remove covers. (Figure 3)

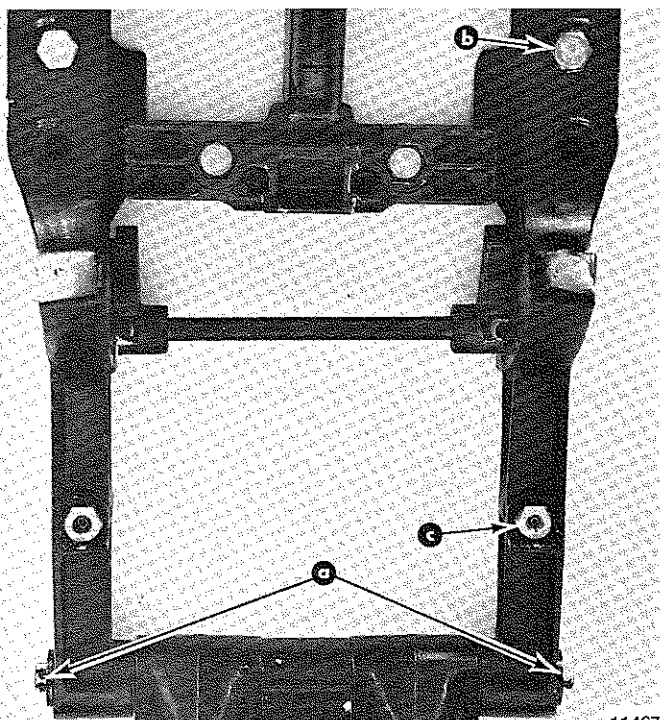
NOTE: When trim cylinder pins are removed, the cylinders are free to swing out and down against boat. Care should be taken not to allow cylinders to strike boat.



a - Wedge

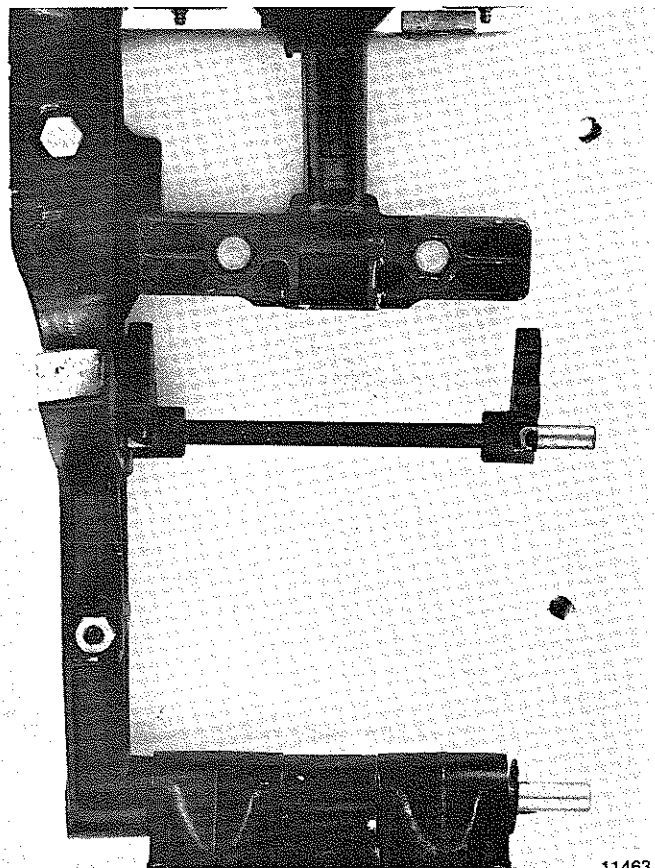
Figure 4. Supporting Swivel Bracket

7. Remove trim cylinder pins by threading a bolt into each pin, then pull outward on bolt. (DO NOT allow cylinders to swing out and down against boat.)
8. If possible, remove steering cable from engine, while engine is connected to boat, and also remove tilt tube nut.



- 11467
- a - Trim Cylinder Shaft Bolts
 - b - Starboard Clamp Bracket Mounting Bolt
 - c - Hydraulic Connector

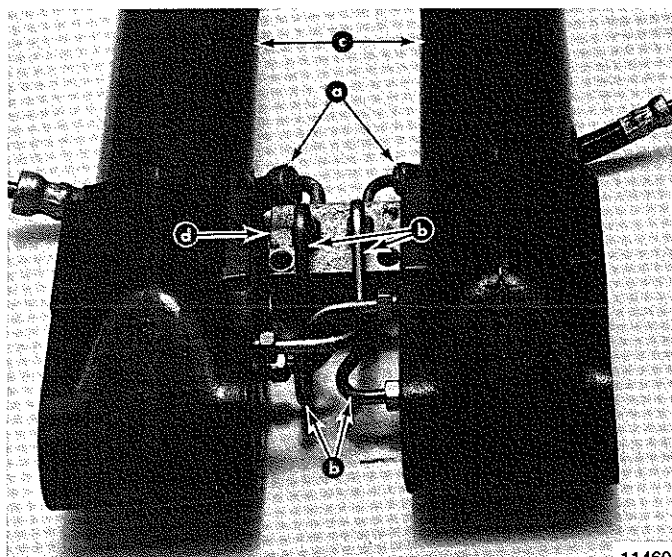
Figure 5. V-6 Clamp Brackets



11463
Figure 6. Starboard Clamp Bracket Removed

If steering cable cannot be removed from engine, while engine is connected to boat, proceed as follows:

- a. Remove cotter pin and locking sleeve from cable.
 - b. Remove grease fitting from cable.
 - c. Unthread attaching nut from tilt tube and slide nut down cable.
 - d. Unthread tilt tube nut from tilt tube and slide nut down cable.
9. Remove trim limit switch connector from starboard clamp bracket.
 10. Place a wedge (wood or metal) between transom and swivel bracket for support. (Figure 4)
 11. Remove 2 bolts and flat washers which secure trim cylinder shaft to clamp brackets. (Figure 5)
 12. Remove starboard clamp bracket mounting bolt and hydraulic connector (which protrudes thru starboard clamp bracket). (Figure 5)
- NOTE: When starboard clamp bracket is removed (Figure 6), trim cylinders are free and may fall. Care should be taken not to allow cylinders to fall.*
13. Remove starboard clamp bracket from engine. If cable is still attached to engine, slide it down steering cable.
 14. Remove trim cylinders from port clamp bracket.
 15. Remove trim cylinder shaft from cylinders.
 16. Remove 3 screws which secure hydraulic manifold cover and trim cylinder spacer between cylinders.
 17. Remove hydraulic tubes from cylinders.



- 11460
- a - Hydraulic Hoses
 - b - Hydraulic Tubes
 - c - Hydraulic Cylinders
 - d - Hydraulic Manifold

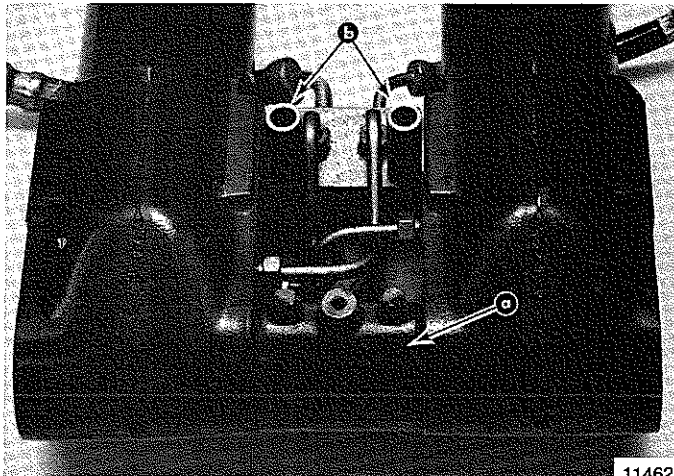
Figure 7. Routing and Connections of Hydraulic Hoses and Tubes

REASSEMBLY and INSTALLATION

CAUTION: When connecting hydraulic fitting to manifold and cylinders, be extremely careful not to damage the fittings (by cross-threading or over-tightening) nor to allow contaminants of any kind to enter fittings.

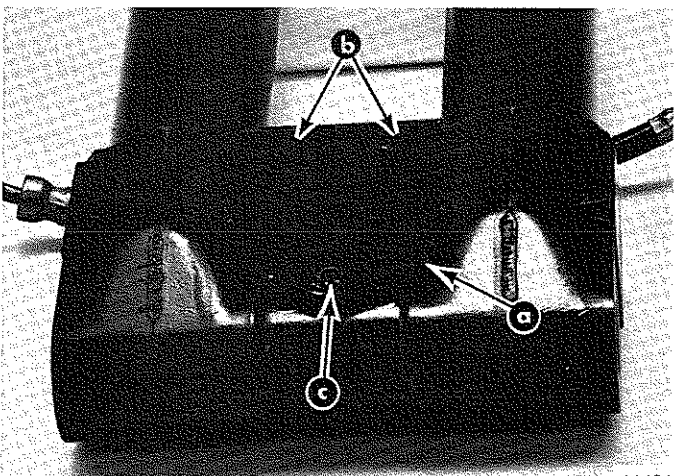
1. Connect hydraulic hoses and tubes to hydraulic manifold and trim cylinders. (Figure 7) Torque all nuts (on hoses and tubes) to 60 in. lbs. (69kg-cm). DO NOT cross-thread or over-tighten nuts.

2. Position trim cylinder spacer so that it is on the same side of trim cylinders as the hydraulic hoses. (Figure 8)
3. Position manifold cover spacers on hydraulic manifold over thru holes in manifold. (Figure 8)
4. Place hydraulic manifold cover over manifold and insert 2 screws (1/4-20x2 3/4") thru cover, spacers and manifold and thread them into trim cylinder spacer. (Figure 9) Torque screws to 60 in. lbs. (69kg-cm).
5. Insert screw (10-24x 1/2") thru manifold cover and thread it into trim cylinder spacer. (Figure 9) Torque screw to 24 in. lbs. (28kg-cm).
6. Apply a thin coat of Multipurpose Lubricant onto the large outside diameter of trim cylinder shaft.
7. Insert trim cylinder shaft thru trim cylinders so that the end of shaft (end with a woodruff key slot) is protruding thru the starboard trim cylinder, as shown in Figure 10.
8. Place a shim onto each end of trim cylinder shaft. (Figure 10)
9. Place woodruff key into slot on end of trim cylinder shaft. (Figure 10)
10. Position trim cylinders so that the trim cylinder shaft (end without woodruff key) is protruding into the port clamp bracket. (Figure 11)
11. Apply Loctite No. 35 (C-92-59328) onto thread of a trim cylinder shaft bolt. Thread bolt (with flat washer) into trim



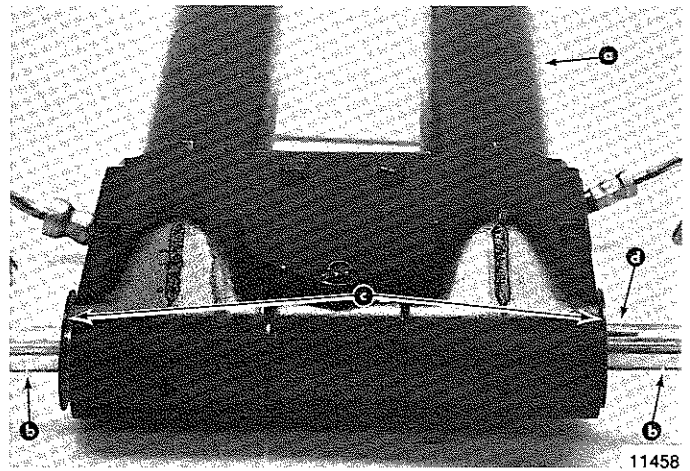
a - Trim Cylinder Spacer b - Manifold Cover Spacers

Figure 8. Position of Trim Cylinder Spacer and Manifold Cover Spacers



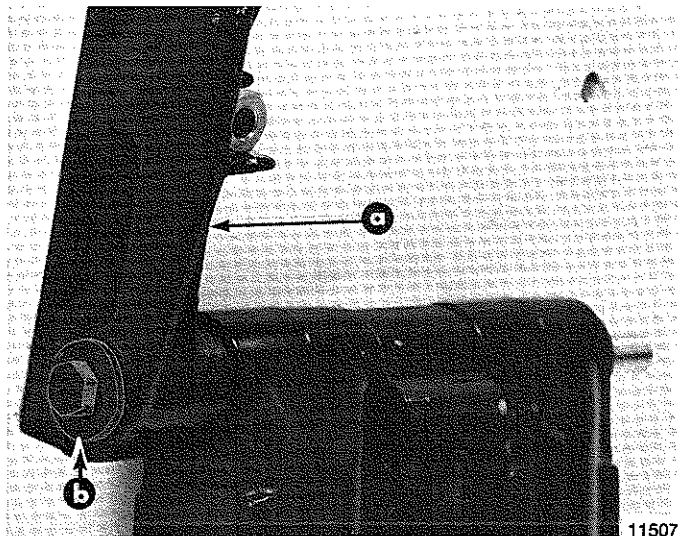
a - Hydraulic Manifold Cover b - Two Screws (1/4-20x2-3/4")
c - One Screw (No. 10-24x1/2")

Figure 9. Hydraulic Manifold Cover Installed



a - Starboard Trim Cylinder c - Shims
b - Trim Cylinder Shaft d - Woodruff Key

Figure 10. Trim Cylinder Shaft Installed in Trim Cylinders



a - Port Clamp Bracket b - Bolt and Flat Washer

Figure 11. Trim Cylinders Connected to Port Clamp Bracket

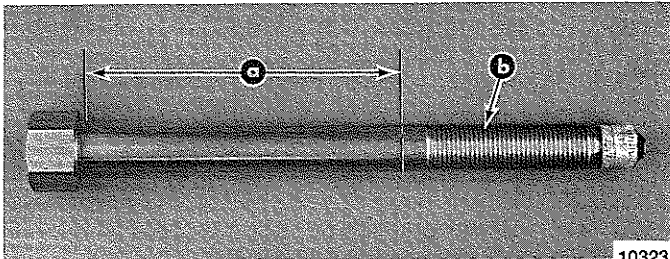
- cylinder shaft that is protruding into the port clamp bracket. (DO NOT tighten bolt at this time.)
12. Reinstall the starboard clamp bracket. (Be sure to align woodruff key on the trim cylinder shaft with keyway in starboard clamp bracket.)
 13. Apply Loctite No. 35 onto the threads of second trim cylinder shaft bolt. Thread bolt (with flat washer) into trim cylinder shaft that is protruding in starboard clamp bracket.
 14. Torque both trim cylinder shaft bolts to 40 ft. lbs. (5.5 mkg).
 15. Apply marine sealer to hydraulic connector within area shown in Figure 12. DO NOT apply marine sealer to threads of hydraulic connector.

CAUTION: Be extremely careful, when installing hydraulic connector, not to damage the hydraulic connector nor to allow contaminants of any kind to enter connector.

16. Pull starboard clamp bracket just far enough away from boat transom to place an "O" ring between clamp bracket

and transom, then insert hydraulic connector thru clamp bracket, "O" ring and transom. (Figure 13)

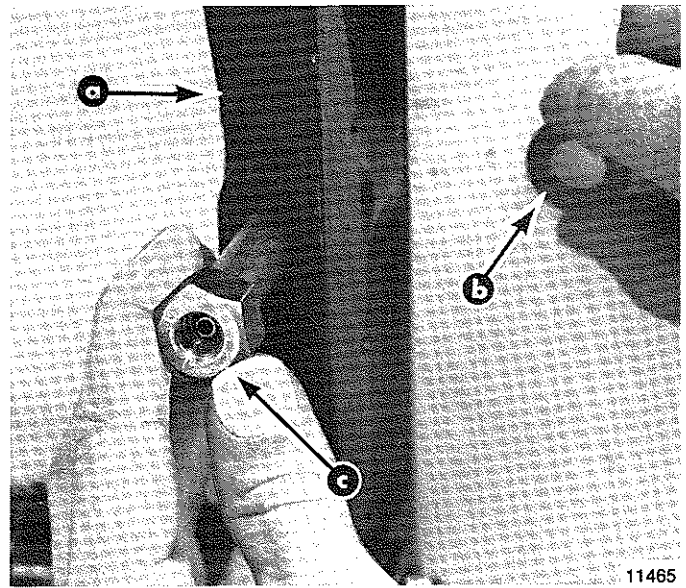
17. Secure hydraulic connector to boat transom with a flat washer and locknut, as shown in Figure 1. Tighten locknut securely.
18. Reconnect hydraulic hose (from trim pump) to connector. (Figure 1)
19. Insert a mounting bolt [$\frac{1}{2} \times 6$ " (12.7mmx15.2cm)] thru previously used hole in starboard clamp bracket and boat transom. Secure bolt to boat transom with flat washer and locknut. Tighten locknut securely.



- a - Apply Marine Sealer to This Area; DO NOT Apply to Threads
 b - Apply Light Oil to Threads

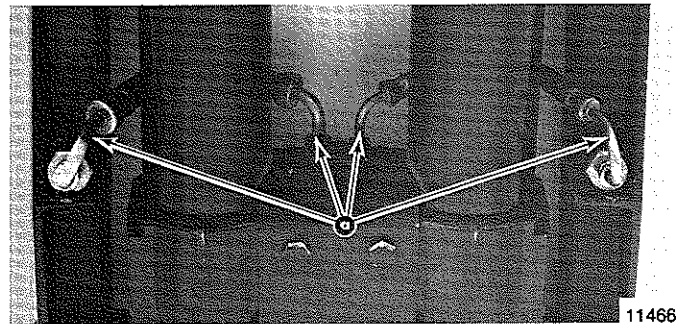
Figure 12. Hydraulic Connector

20. Thread tilt tube nut onto tilt tube and tighten nut [DO NOT exceed 20 ft. lbs. (2.8mkg)], then back nut off $\frac{1}{4}$ -turn.
21. Reinstall trim limit switch connector in starboard clamp bracket.
22. Reinstall steering cable and grease fitting on steering cable, if fitting was removed.
23. Pull trim cylinder rams out until the end of rams reaches up into swivel bracket.
24. Apply a thin coat of Multipurpose Lubricant onto each trim cylinder pin.
25. Insert a trim cylinder pin into each side of swivel bracket and thru the end of trim cylinder ram.
26. Position a trim cylinder pin cover over each pin and secure covers to swivel bracket with bolts. Torque cover bolts to 60 in. lbs. (69kg-cm).



- a - Starboard Clamp Bracket
 b - "O" Ring
 c - Hydraulic Connector

Figure 13. Installing Hydraulic Connector



- a - Trim Cylinder Hoses

Figure 14. Trim Cylinder Hoses Connected to Hydraulic Connector

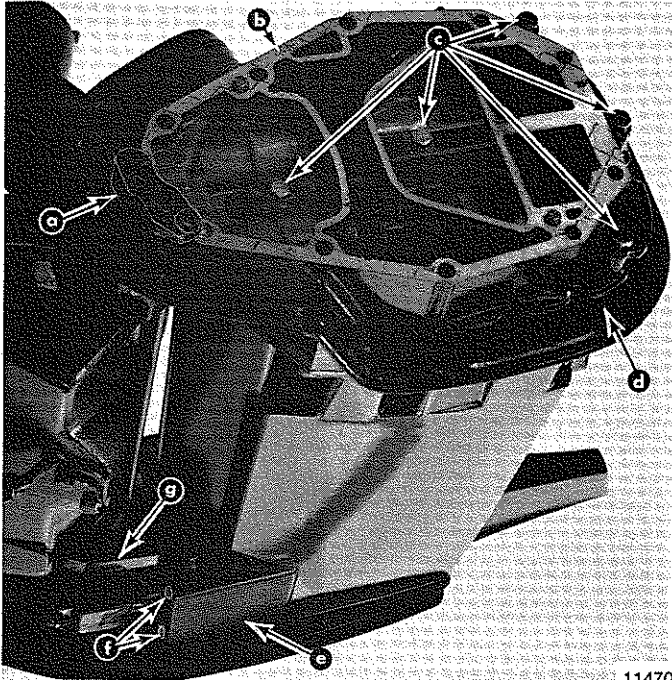
27. Connect hoses to hydraulic connectors. (Figure 14) Torque nuts (on hoses) to 60 in. lbs. (6.9kg-cm). DO NOT cross-thread or over-tighten hose fittings.

Drive Shaft Housing and Dyna-Float Suspension

Refer to "Powerhead Removal" Section to Remove Powerhead. Refer to "Lower Unit Removal" in This Section and Remove Lower Unit.

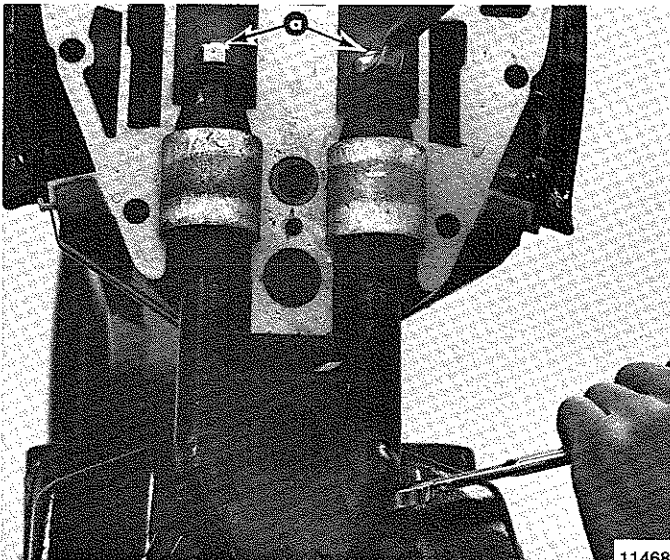
REMOVAL and DISASSEMBLY

1. Remove shift shaft (Figure 1) from drive shaft housing by pulling straight up on shaft.
2. Remove 5 bolts which secure exhaust extension plate to drive shaft housing. (Figure 1) After bolts are removed, lift exhaust extension plate off drive shaft housing.



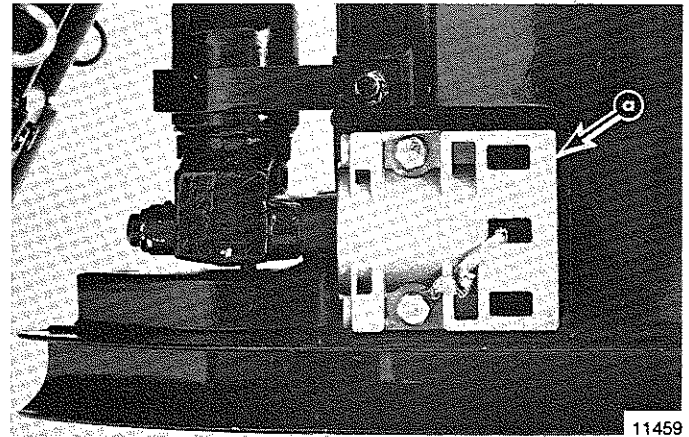
- a - Shift Shaft
 b - Exhaust Extension Plate
 c - Exhaust Plate to Drive Shaft Housing Bolts
 d - Drive Shaft Housing Plate
 e - Lower Mount Cover (One Each Side)
 f - Lower Mount Cover Screws
 g - Stop Strap

Figure 1. Port View of V-6, Less Powerhead and Lower Unit



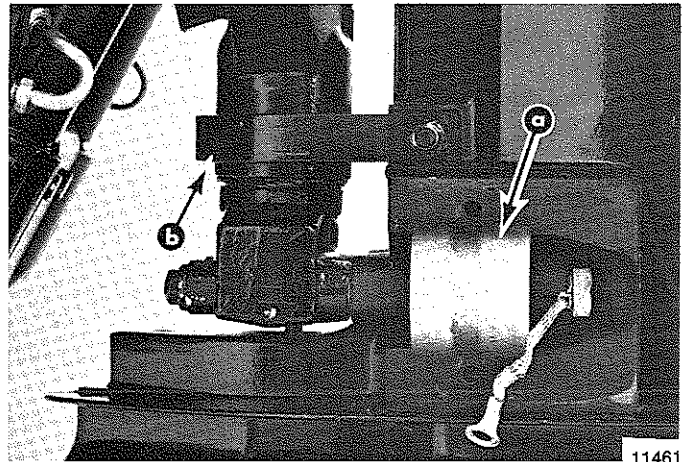
- a - Upper Mount Nuts

Figure 2. Upper Dyna-Float Suspension Mounts



- a - Lower Mount Retainer (One Each Side)

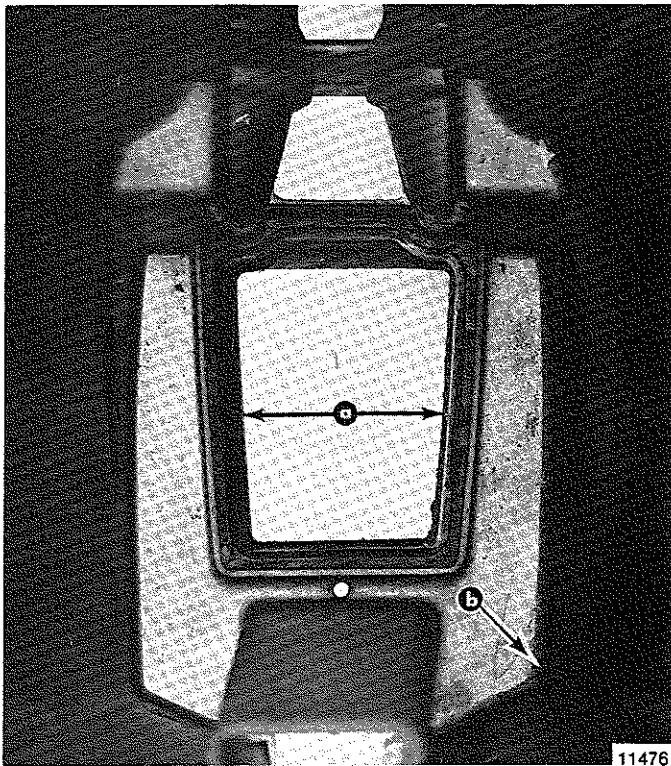
Figure 3. Lower Dyna-Float Suspension Mount (One Each Side)



- a - Lower Mount (One Each Side)
 b - Stop Strap

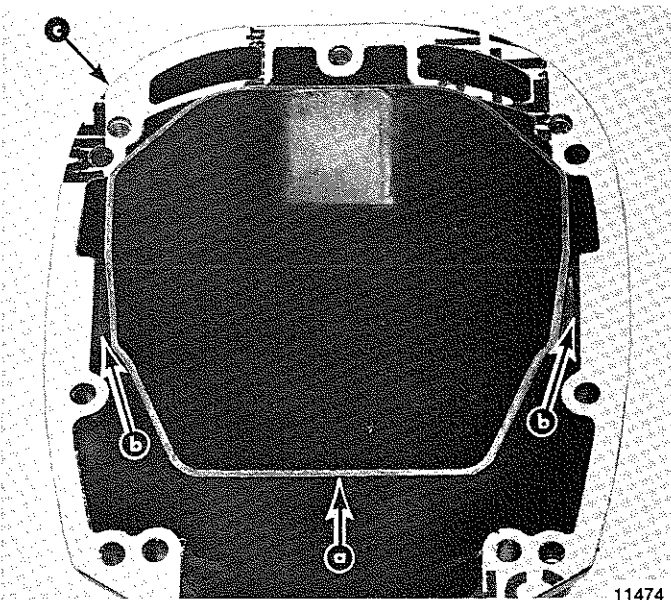
Figure 4. Lower Dyna-Float Suspension Mount

3. Remove upper mount nuts and flat washers. (Figure 2)
4. Remove screws, which secure lower mount covers (Figure 1) to drive shaft housing, then remove covers.
5. Remove bolts, which secure lower mount retainers (Figure 3) to drive shaft housing, and remove retainers.
6. Remove rubber caps from lower mount bolts.
7. Remove lower mount nuts. (Figure 4)
8. Remove nut and bolt, that secure stop strap (Figure 4) to drive shaft housing, and remove strap.
9. Remove drive shaft housing from swivel bracket by pulling alternately from top to bottom on housing.
10. Remove upper and lower mounts by lifting them out of drive shaft housing.
11. Lift drive shaft housing plate off housing.
12. If exhaust diffuser is secured to housing plate with nuts and washers, remove nuts and washers, then remove diffuser.
13. Pull exhaust tube out of drive shaft housing.
14. Remove all gaskets and gasket material from drive shaft housing and related components.



a - Drive Shaft Housing b - Exhaust Tube Seal

Figure 5. Exhaust Tube Seal Installed



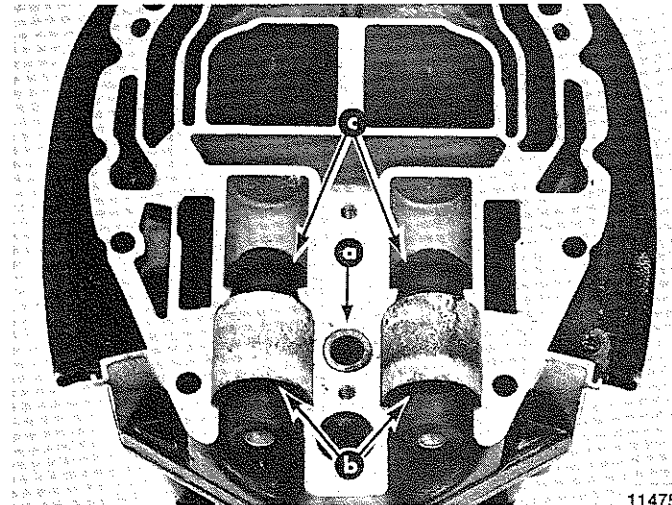
a - Exhaust Tube b - Exhaust Tube Boots (under Gasket)
c - Gasket

Figure 6. Exhaust Tube Installed

REASSEMBLY and INSTALLATION

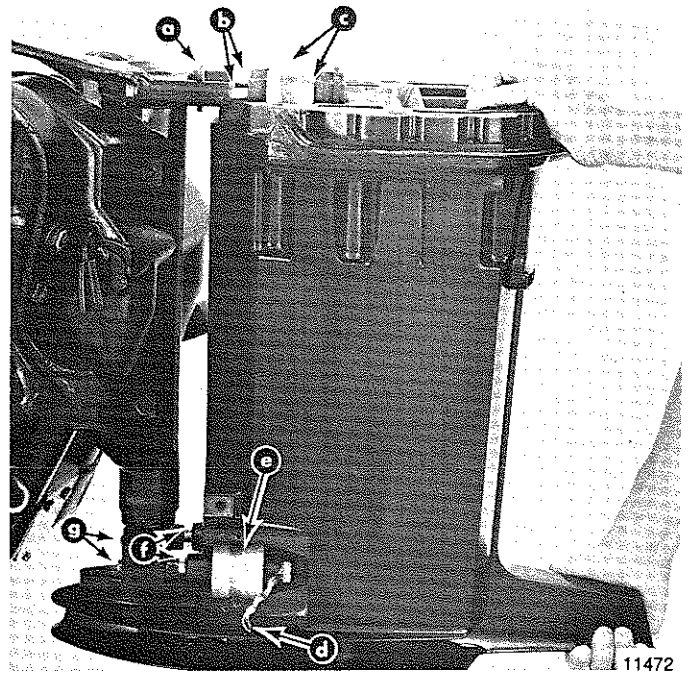
1. Apply a thin coat of Multipurpose Lubricant onto inside portion of exhaust tube seal.
2. Install exhaust tube seal into drive shaft housing with tapered side of seal facing up. (Figure 5)
3. Push exhaust tube boots onto tabs on each side of exhaust tube. (Figure 6)
4. Position exhaust tube in drive shaft housing and push down on tube until boots rest in grooves on inside of housing. (Figure 6)

5. Position drive shaft housing to plate gasket on top of housing. (Figure 6)
6. If equipped with a 2-piece drive shaft housing plate, install an exhaust diffuser gasket and exhaust diffuser onto plate, then secure both to plate with 6 washers and locknuts.
7. Position drive shaft housing plate on top of housing.
8. Apply a small amount of Multipurpose Lubricant onto water tube seal.
9. Install water tube seal into drive shaft housing plate with plastic end of seal facing up. (Figure 7)
10. Apply a thin coat of Perfect Seal onto metal portion of upper dyna-float mounts.
11. Position mounts on drive shaft housing plate, as shown in Figure 7.
12. Install a rubber washer onto each upper mount, as shown in Figure 7.



a - Water Tube Seal (Plastic End) b - Dyna-Float Mounts
c - Rubber Washers

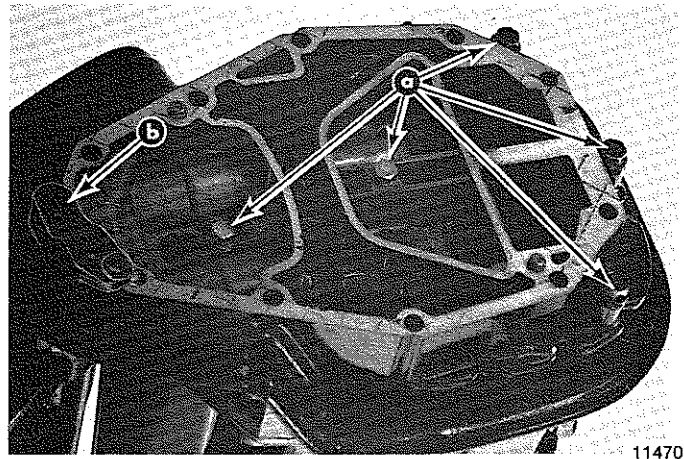
Figure 7. Upper Dyna-Float Mounts Installed



a - Bumper c - Upper Dyna-Float Mounts
b - Upper Mounting Bolts d - Ground Strap (Only One Side)
e - Lower Dyna-Float Mount (One Each Side)
f - Flat Washers g - Lower Mounting Bolts

Figure 8. Drive Shaft Housing Installation

13. Install a ground strap (Figure 8) onto one of the lower mount mounting bolts.
14. Insert a mounting bolt thru the short end of each lower mount. (Figure 8)
15. Position a mount on each lower side of drive shaft housing, as shown in Figure 8.
16. Install a flat washer over each lower mounting bolt. (Figure 8)
17. Position a bumper on steering arm between mounting bolts, as shown in Figure 8.
18. Start upper mounting bolts in upper mounts and align lower mounting bolts with holes in swivel pin yoke. Slide drive shaft housing up against yoke and bumper. (Figure 8)
19. Secure upper mounts to steering arm with flat washers and self-locking nuts. Torque nuts to 50 ft. lbs. (6.9mkg).
20. Secure lower mounts to swivel pin yoke with self-locking nuts. Torque nuts to 50 ft. lbs. Place a rubber cap over each lower mounting bolt head.
21. Install lower mount retainers and secure each retainer with 2 bolts. (Secure ground strap with the nearest retainer bolt.) Torque bolts to 160 in. lbs. (184kg-cm).
22. Install lower mount covers and secure each cover with 2 screws.
23. Install stop strap and secure with a bolt and locknut. Torque nut to 40 ft. lbs. (5.5mkg).



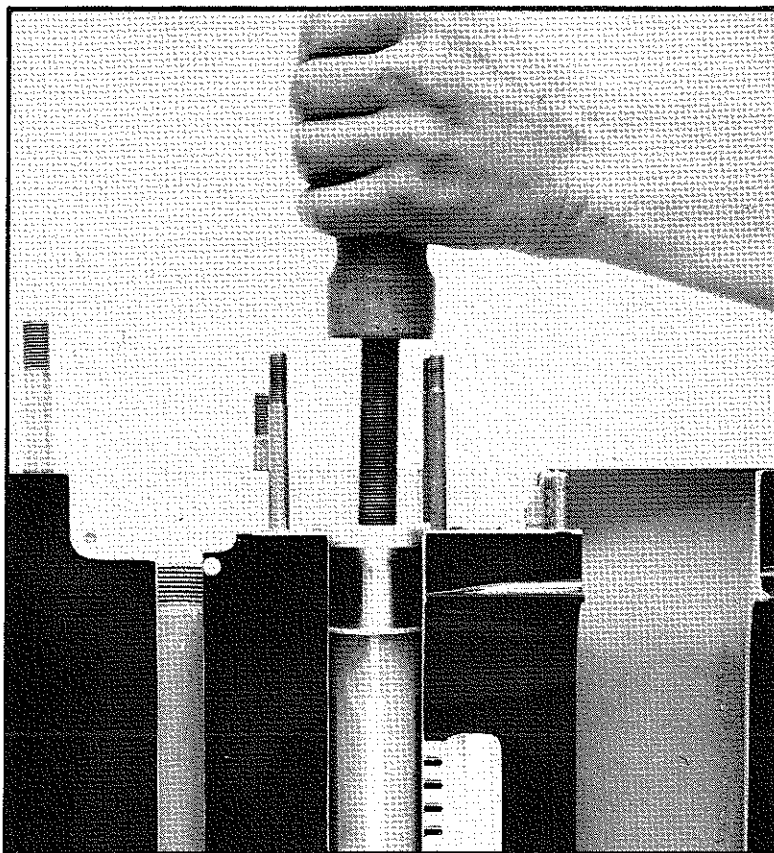
11470
a - Exhaust Plate to Drive Shaft Housing Bolts b - Shift Shaft

Figure 9. Exhaust Plate and Shift Shaft Installed

24. Position gasket on top of drive shaft housing plate.
25. Install exhaust extension plate on drive shaft housing and secure with 5 bolts. (Figure 9)
26. Install plastic bushing onto shift shaft and insert shift shaft into drive shaft housing. (Figure 9)

V-6 OUTBOARDS

Lower Unit



Cam-Shift

SECTION

5

PART

B

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GENERAL INFORMATION

GEAR HOUSING IDENTIFICATION

To identify a cam-shift gear housing, follow Step "1" or "2", as follows:

1. With gear housing connected to engine —
 - a. Shift engine into reverse gear.
 - b. Try to turn propeller shaft in a counterclockwise direction.
 - c. A Cam-Shift gear housing propeller shaft will not ratchet when turned counterclockwise in reverse gear. An E-Z shift gear housing propeller shaft will ratchet in a counterclockwise direction.

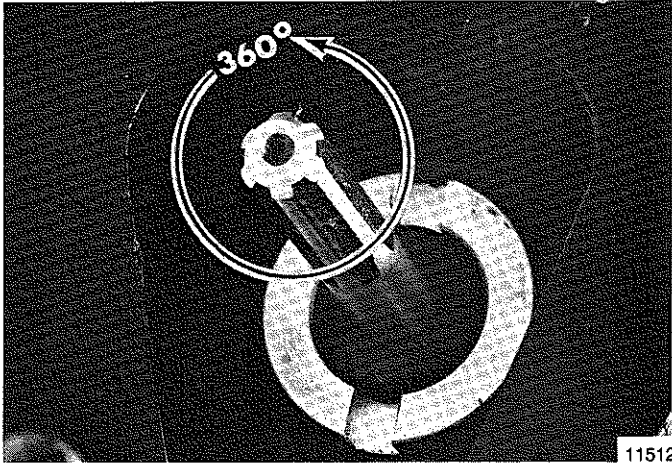


Figure 1. Cam-Shift Gear Housing

2. With gear housing removed from engine -
 - a. Looking down at gear housing from the leading edge, turn shift shaft (Figure 1) in a counterclockwise direction.

- b. The shift shaft in a cam-shift gear housing will turn 360°. (Figure 1) The shift shaft in an E-Z shift gear housing will not rotate 360°.

SPECIAL TOOLS REQUIRED for DISASSEMBLY and REASSEMBLY of CAM-SHIFT GEAR HOUSING

Tool Description	Part No.
Shift Shaft Bushing Tool	C-91-31107
Gear Housing Cover Nut Tool	C-91-61069
Bearing Carrier Removal Tool	C-91-46086A1
Puller Bolt	C-91-85716
Slide Hammer Puller	C-91-34569A1
Bearing Removal and Installation Kit	C-91-31229A5
Pilot	C-91-36571
Puller Rod	C-91-31229
Puller Plate	C-91-29310
Puller Head	C-91-38628
Universal Puller Plate	C-91-37241
Drive Shaft Nut Wrench	C-91-34377A1
Lubrication Sleeve Removal Tool	C-91-39281
Oil Seal Driver	C-91-31108
Forward Gear Bearing Tool	C-91-86943
Bearing Driver Cup	C-91-87120
Drive Shaft Tapered Bearing Driver	C-91-87119
Lubrication Sleeve Driver	C-91-39238
Bearing Cup Driver	C-91-34379
Pinion Gear Shimming Tool	C-91-74776
Backlash Indicator Rod	C-91-78473

GENERAL SERVICE RECOMMENDATIONS

There may be more than one way to "disassemble" or "re-assemble" a particular part(s), therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly-reassembly sequence. (Figures 2A and 2B) It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to "reassembly and installation" of that component in the reassembly part of this section. Use the "Index" (on back of section divider) to find correct page number.

Threaded parts are right hand (RH), unless otherwise indicated.

If water or metal particles are present in gear lubricant, gear

housing should be completely disassembled (Figures 2A and 2B), cleaned and inspected.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, be sure that no water is present in air line.

BEARINGS

Upon disassembly of gear housing, all bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes thru the bearing. DO NOT spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with Formula 50 Oil. DO NOT lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches and bearing race side wear. Work inner bearing race in-and-out, while holding outer race, to check for side wear.

When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from overheating. Always replace tapered bearings as a set.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooving, imbedded particles, uneven wear and/or discoloration from overheating. The shaft and bearing must be replaced, if the conditions described are found.

SHIMS

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to

correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

SEALS

As a normal procedure, all "O" rings and oil seals **SHOULD BE REPLACED** without regard to appearance. To prevent leakage around oil seals, apply Loctite Type "A" to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply Multipurpose Lubricant to all "O" rings and oil seal lips.

To prevent corrosion damage after reassembly, apply Perfect Seal to external surfaces of bearing carrier and cover nut threads prior to installation. **DO NOT** allow Perfect Seal to enter bearings or "O" ring area.

TORQUE SPECIFICATIONS

Gear Housing Assembly Fastener Location	Size	Torque
Water Pump Nuts	1/4-28	30 In. Lbs. (35kg-cm)
Water Pump Nuts	5/16-24	40 In. Lbs. (46kg-cm)
Water Pump Screw	1/4-20	20 In. Lbs. (23kg-cm)
Bearing Carrier Nut	4-3/8"-16	210 Ft. Lbs. (29.04mkg)
Pinion Nut	5/8-18	70 Ft. Lbs. (9.68mkg)
Gear Housing to Drive Shaft Housing Nuts	3/8-16	55 Ft. Lbs. (7.61mkg)
Gear Housing to Drive Shaft Housing Nuts/Bolts	7/16-20	65 Ft. Lbs. (8.99mkg)
Trim Tab Screw	7/16-14	25 Ft. Lbs. (3.46mkg)

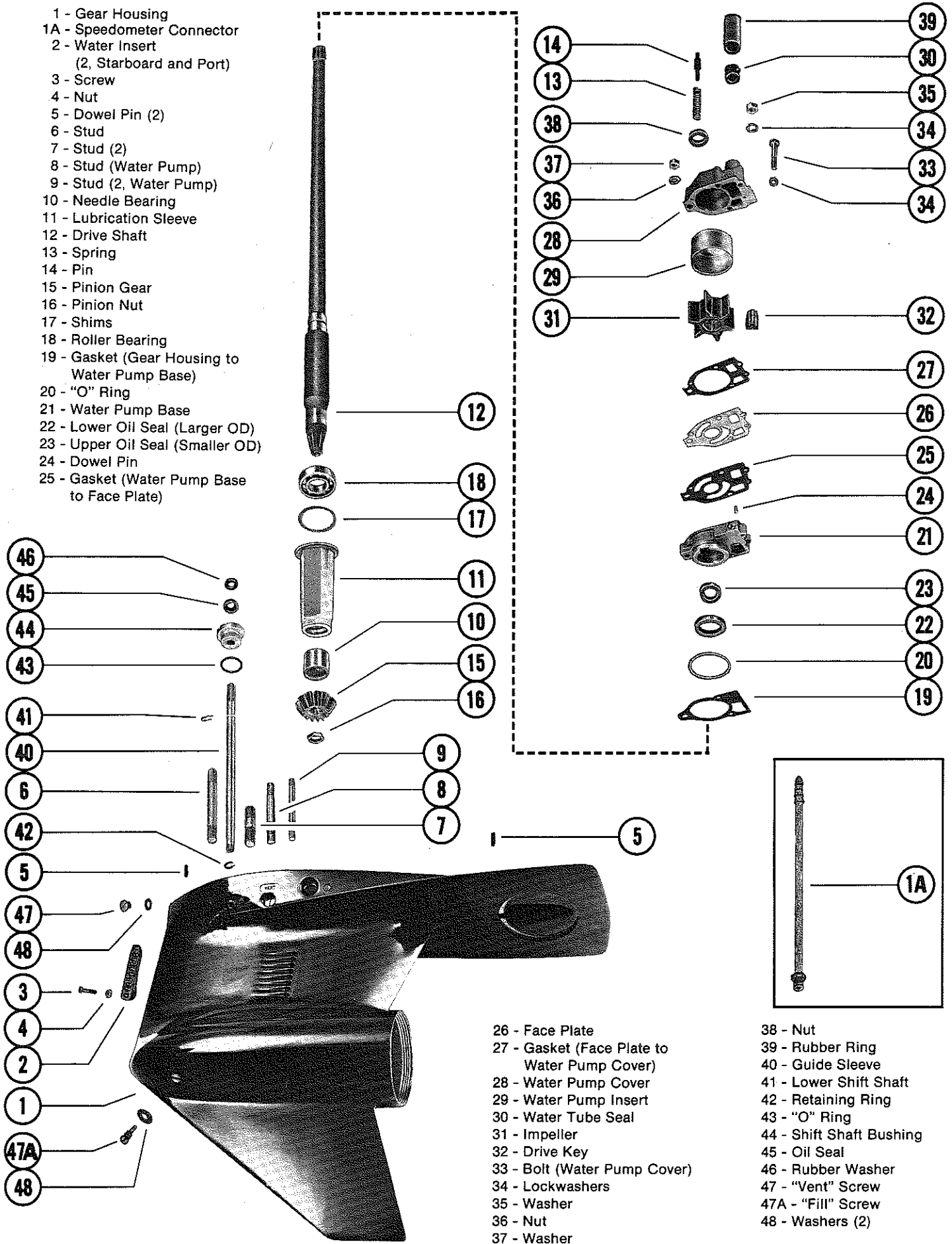


Figure 2A. Cam-Shift Gear Housing Assembly (Drive Shaft and Water Pump Components)

- 49 - Shift Cam
- 50 - Cam Follower
- 51 - Guide Block
- 52 - Spring and Slide
- 53 - Shim(s)
- 54 - Tapered Bearing
(Forward Gear)
- 55 - Needle Bearing (2)
- 56 - Forward Gear
- 57 - Sliding Clutch Ratchet
- 58 - Cross Pin
- 59 - Retainer Spring
- 60 - Propeller Shaft
- 61 - Reverse Gear
- 62 - Thrust Ring
- 63 - Ball Bearing (Reverse Gear)
- 64 - "O" Ring
- 65 - Bearing Carrier
- 66 - Needle Bearing
- 67 - Oil Seals
- 68 - Bearing Carrier Key
- 69 - Tab Washer
- 70 - Cover
- 71 - Trim Tab
- 72 - Screw
- 73 - Washer (2)
- 74 - Nut (2)
- 75 - Screw
- 76 - Thrust Hub
- 77 - Splined Washer
- 78 - Tab Washer
- 79 - Propeller Nut

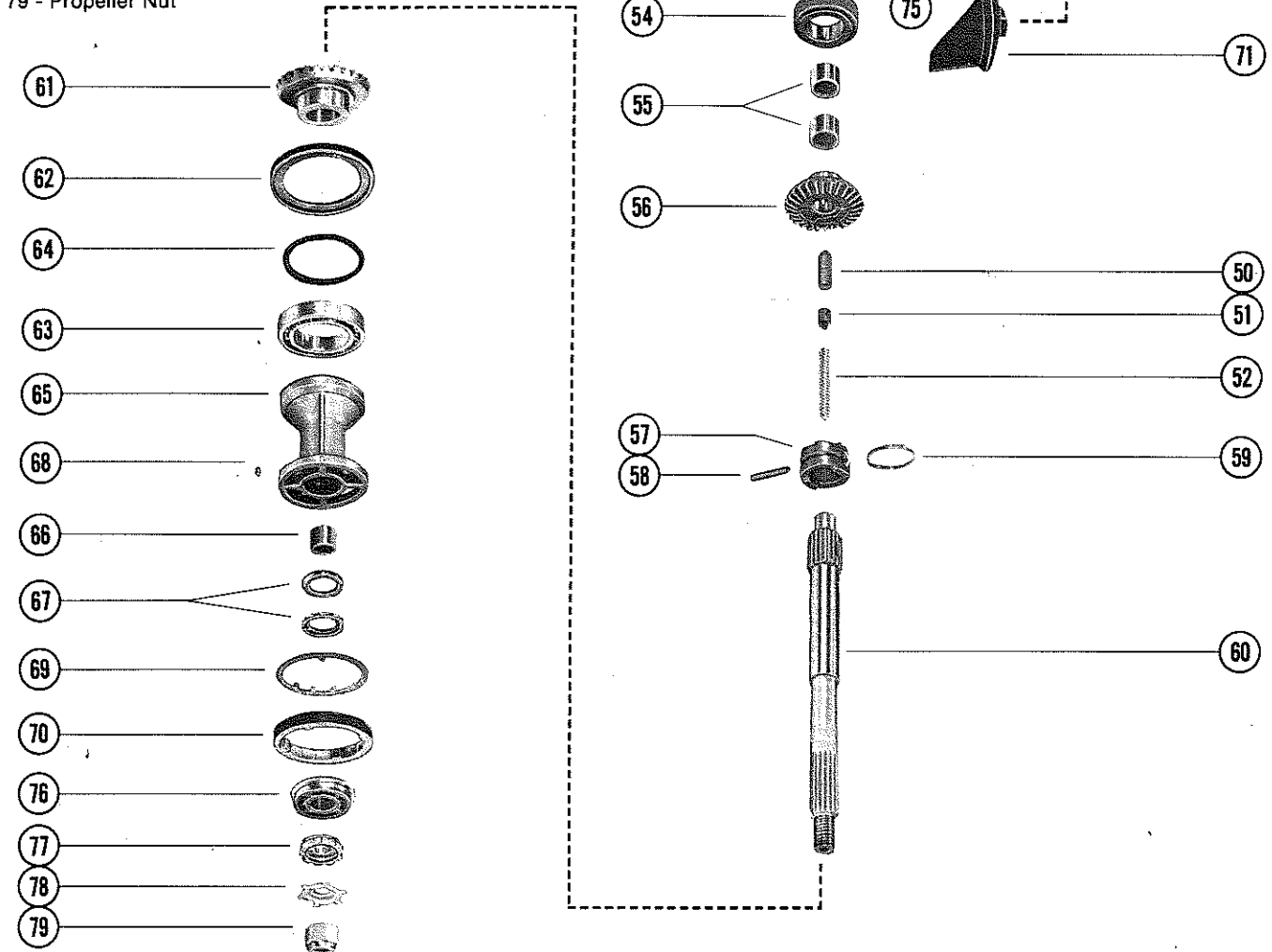


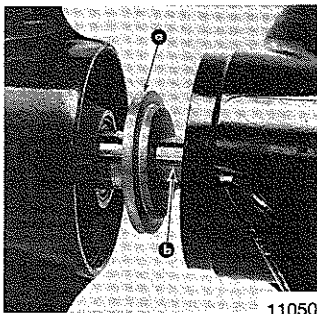
Figure 2B. Cam-Shift Gear Housing Assembly (Propeller Shaft Components)

REMOVAL, DISASSEMBLY, CLEANING and INSPECTION Cam-Shift Gear Housing

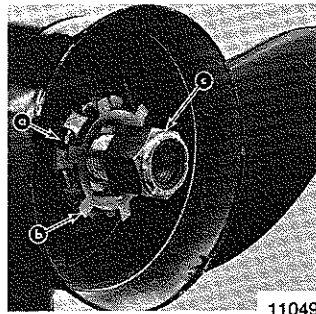
REMOVAL

SAFETY WARNING: Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from drive shaft housing.

1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.
2. Shift engine into forward gear position.

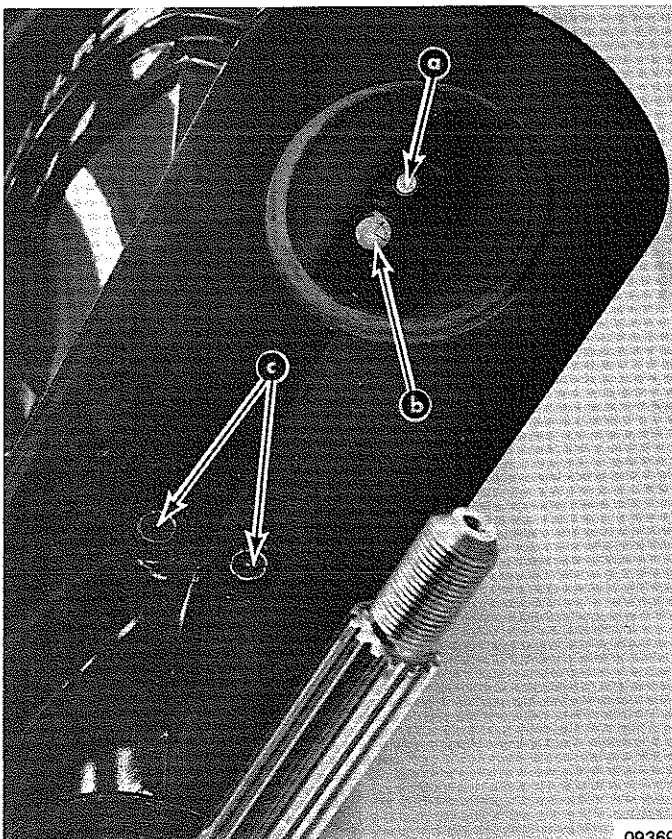


a - Thrust Hub (Forward)
b - Propeller Shaft



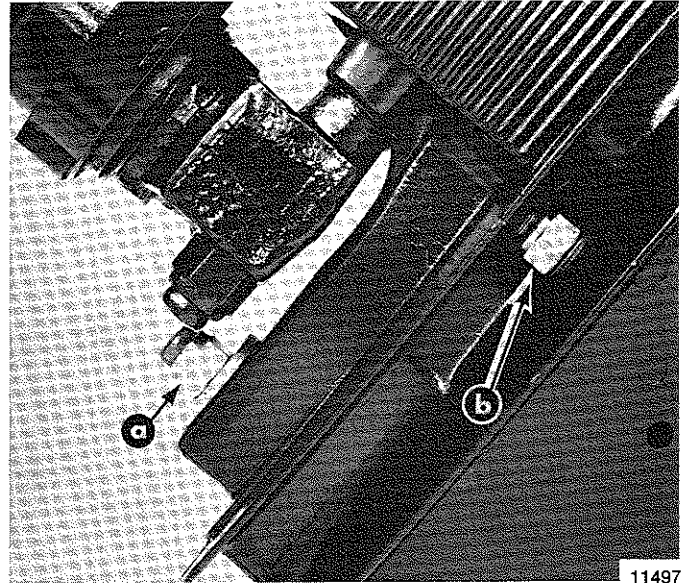
a - Rear Thrust Hub
b - Tab Washer
c - Propeller Nut

Figure 3. Propeller Removal



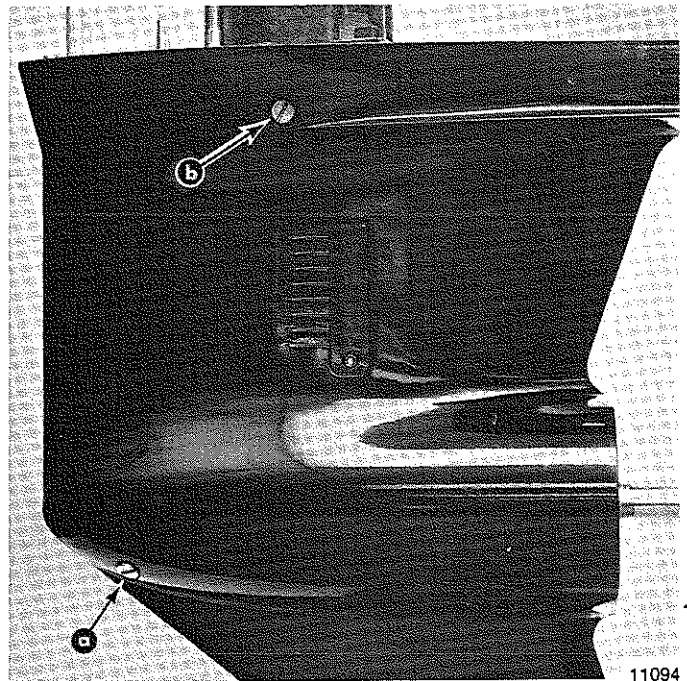
a - Bolt (Secures Trim Tab) b - Bolt (Inside Trim Tab Cavity)
c - Locknuts and Washers

Figure 4. Gear Housing Removal



a - Front Mounting Locknut
b - Side Mounting Locknut (One Each Side)

Figure 5. Gear Housing Removal



a - "Fill" Screw b - "Vent" Screw

Figure 6. Gear Housing

3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (aft), then remove propeller locknut, tab washer, thrust hub (aft), propeller and thrust hub (forward) from propeller shaft. (Figure 3)
5. Mark gear housing and trim tab so that trim tab can be re-installed in the same position. Remove plastic cap at rear edge of drive shaft housing. Unthread bolt, that secures trim tab, and remove trim tab from gear housing.

6. Once trim tab is removed, remove bolt from inside trim tab cavity. (Figure 4)
7. Remove 2 locknuts and washers from bottom middle of anti-cavitation plate. (Figure 4)
8. Remove locknut and special washer from the front gear housing mounting stud. (Figure 5)
9. Loosen the side mounting locknuts. (Figure 5) (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or drive shaft housing could be damaged.)
10. Pull gear housing away from drive shaft housing as far as the loosened nuts (in Step 9) will allow, then remove loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)
11. Pull gear housing from drive shaft housing.

DRAINING LUBRICANT from GEAR HOUSING

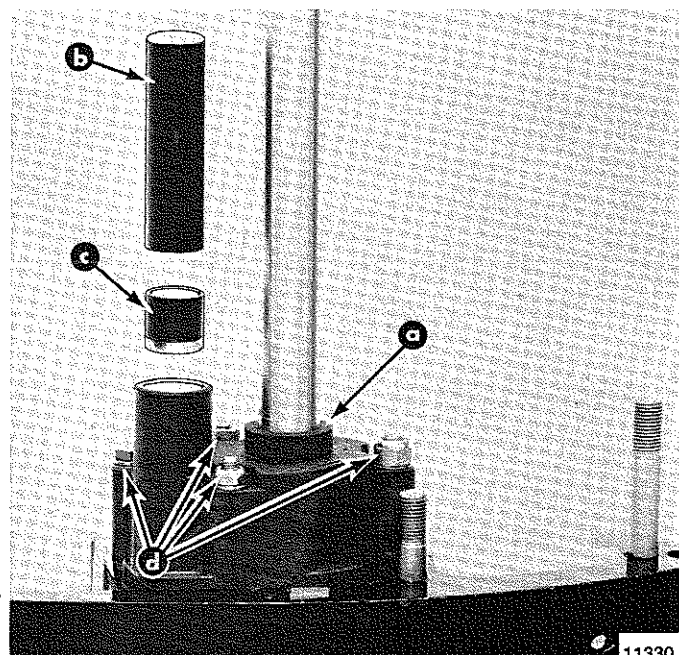
1. Place gear housing in a suitable holding fixture or vise with the drive shaft in a vertical position, as shown in Figure 6.
2. Position a clean drain pan under gear housing and remove "Fill" and "Vent" screws (Figure 6) from gear housing.
3. Catch a small amount of gear lubricant on a finger, then rub finger and thumb together to check for metal particles. Also check magnetic "Fill" plug for metal particles. (Presence of metal particles indicates need for complete disassembly of gear housing.)
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. (Presence of water in gear lubricant indicates the need for complete disassembly and inspection of oil seals, seal surfaces, "O" rings and gear housing.)

Water Pump

REMOVAL/DISASSEMBLY

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

1. Slide rubber centrifugal slinger up and off drive shaft. (Figure 7)
2. Remove water tube guide and seal (Figure 7) from water



a - Centrifugal Slinger b - Water Tube Guide
c - Water Tube Seal d - Nuts, Bolts and Washers To Be Removed

Figure 7. Water Pump Cover Removal

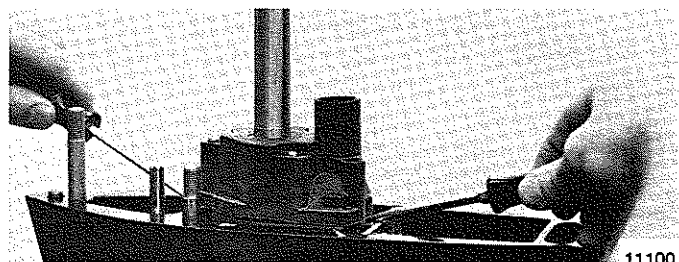


Figure 8. Water Pump Cover Removal

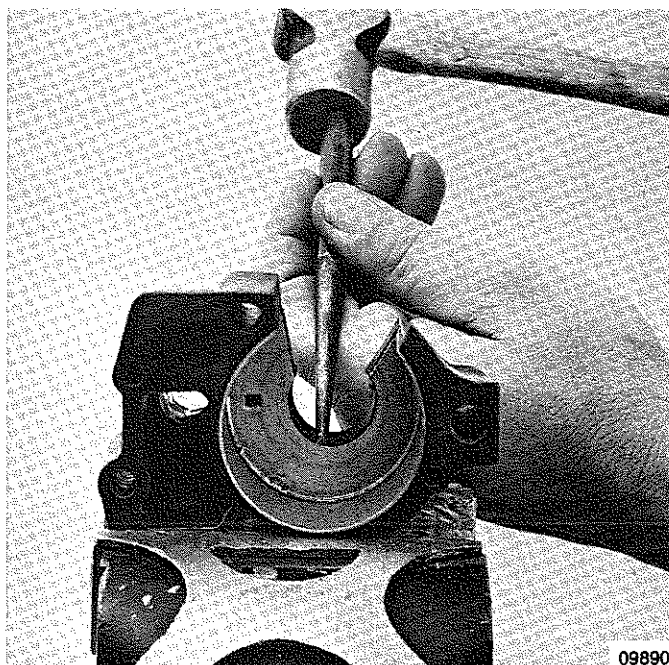


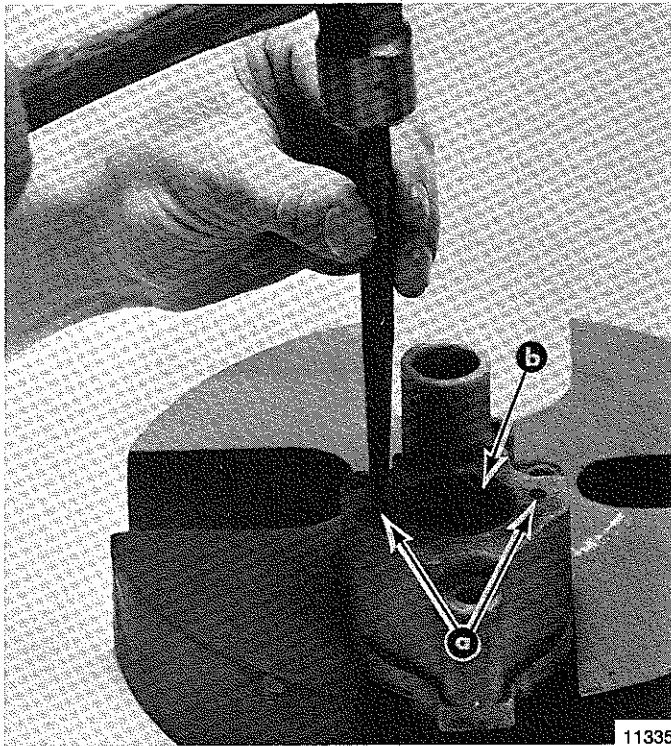
Figure 9. Water Pump Insert Removal

3. Remove (and retain) 3 nuts, one bolt and all washers which secure water pump cover to gear housing. (Figure 7)
4. Using 2 pry bars, positioned as shown in Figure 8, lift water pump cover up and off drive shaft.
5. Inspect water pump cover and insert, as outlined in "Cleaning and Inspection", following.
6. If inspection of water pump insert determines that replacement is required, follow Step "a" or "b" (immediately following) to remove insert from water pump cover.

NOTE: Try Step "a" first. If insert cannot be removed with Step "a", use Step "b".

- a. Drive water pump insert out of water pump cover with a punch and hammer, as shown in Figure 9.
- b. Drill two 3/16" (4.8mm) diameter holes thru the top of water pump cover (but not thru insert) at locations shown in Figure 10. Drive insert out of cover with a punch and hammer, as shown in Figure 10.

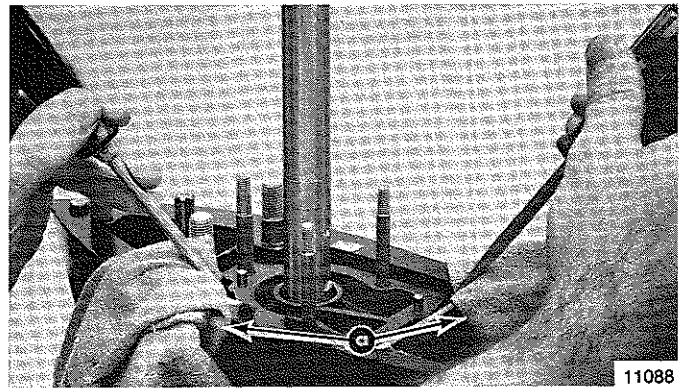
7. Remove impeller from drive shaft. (It may be necessary to use a punch and hammer to drive impeller upward on drive shaft. In extreme cases, it may be necessary to split hub of impeller with a hammer and chisel.)
8. Once impeller is removed, remove impeller drive pin from drive shaft.
9. Remove water pump face plate and both gaskets (one above and one below face plate) from water pump base.



a - Drill 2 Holes at These Locations
b - Seal (Not on All Water Pump Covers)

Figure 10. Water Pump Insert Removal

10. Using 2 pry bars (positioned and padded as shown in Figure 11), lift water pump base up and off drive shaft.
11. Remove (and discard) "O" ring from "O" ring groove on water pump base.



a - Pads

Figure 11. Water Pump Base Removal

12. Using a screwdriver, pry oil seals out of water pump base from gear housing side of base.

CLEANING and INSPECTION

1. Clean all water pump parts with solvent and dry with compressed air.
2. Inspect water pump cover and base for cracks and distortion (from overheating).
3. Inspect face plate and water pump insert for grooves and/or rough surfaces.

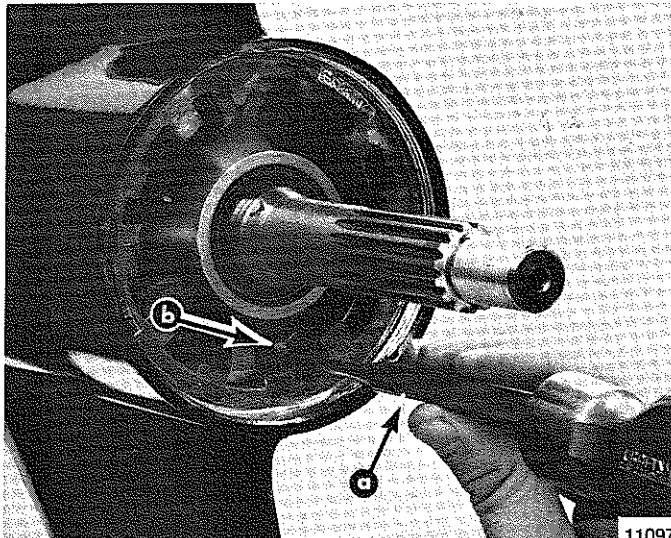
IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

Bearing Carrier and Propeller Shaft

REMOVAL

CAUTION: Two types of gear housings are used on V-6 engines. Although the outside appearance is identical, internally they are different. Because of the difference internally, gear housings **MUST BE** disassembled differently. Read "Gear Housing Identification" in "General Information" (preceding) before removing bearing carrier or propeller shaft.

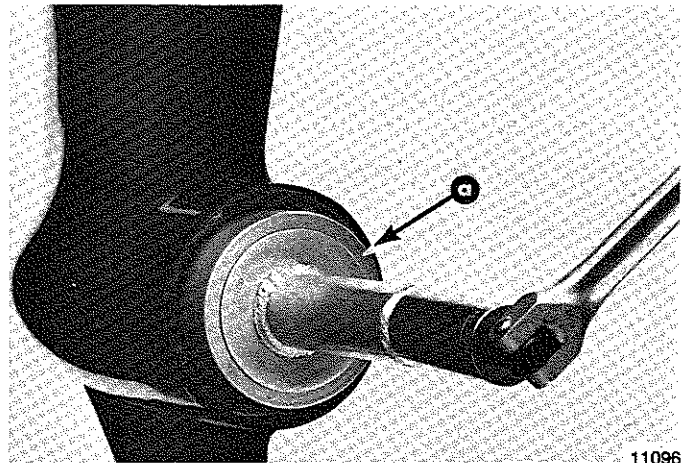


a - Punch

b - Tab of Tab Washer

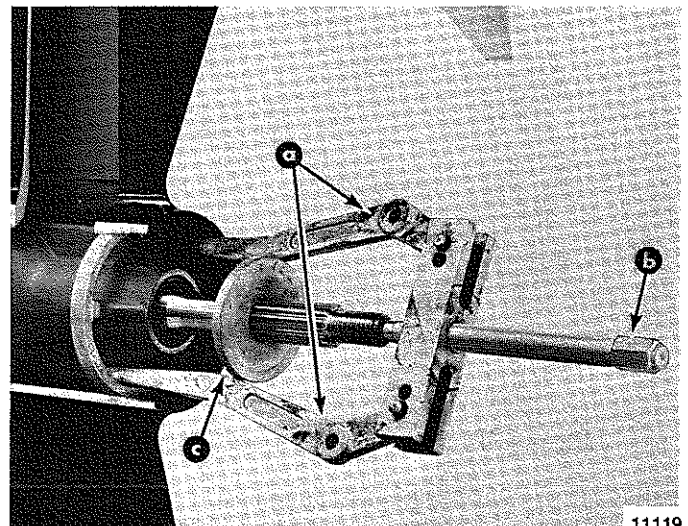
Figure 1. Bending Lock Tab Away from Cover Nut

1. Bend cover nut lock tab out of cover nut recess. (Figure 1)
2. Remove gear housing cover nut with Cover Nut Tool (C-91-61069).
3. After cover nut has been removed, remove lock tab washer from gear housing.
4. Use Long Puller Jaws (C-91-46086A1) and Puller Bolt (C-91-85716), as shown in Figure 3, to remove bearing carrier. (Use propeller thrust hub to maintain outward pressure on puller jaws.)



a - Cover Nut Tool (C-91-61069)

Figure 2. Cover Nut Removal



a - Long Puller Jaws (C-91-46086A1)

b - Puller Bolt (C-91-85716)

c - Thrust Hub

Figure 3. Bearing Carrier Removal

NOTE: When bearing carrier is removed from gear housing, the bearing carrier alignment key will slide out with it.

5. Propeller shaft is now free and can be lifted out of gear housing.

Bearing Carrier

CLEANING/INSPECTION

IMPORTANT: It is recommended that all seals and "O" rings be replaced (as a normal repair procedure) to assure effective repair.

CAUTION: DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

1. Clean bearing carrier with solvent and dry with compressed air.
2. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See "Propeller Shaft Inspection", following.)
3. Inspect reverse gear to pinion gear wear pattern (should be even and smooth). If not, replace reverse gear and pinion gear.
4. Check clutch jaws on reverse gear for damage. If damage is found on clutch jaws, replace reverse gear.
5. Apply light oil to reverse gear bearing. Rotate reverse gear bearing while checking bearing for rough spots and/or catches. Push in and pull out on reverse gear to check for bearing side wear. Replace bearing if any of the listed conditions exist.

DISASSEMBLY

1. Remove (and discard) "O" ring from between bearing carrier and thrust washer.

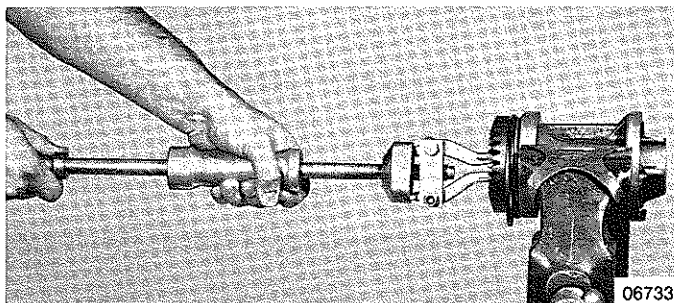
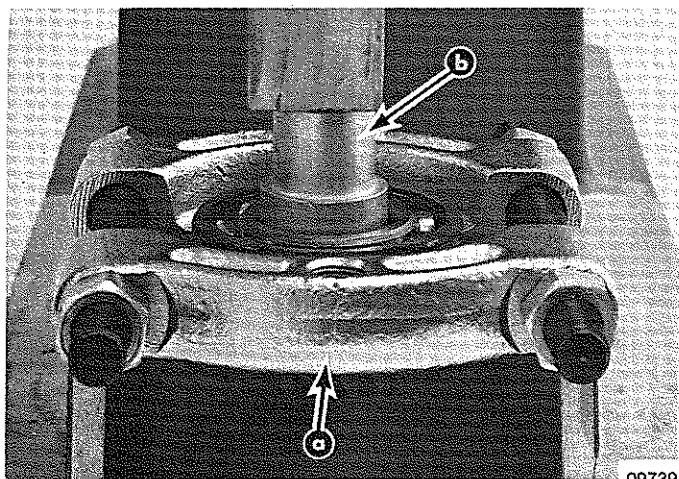
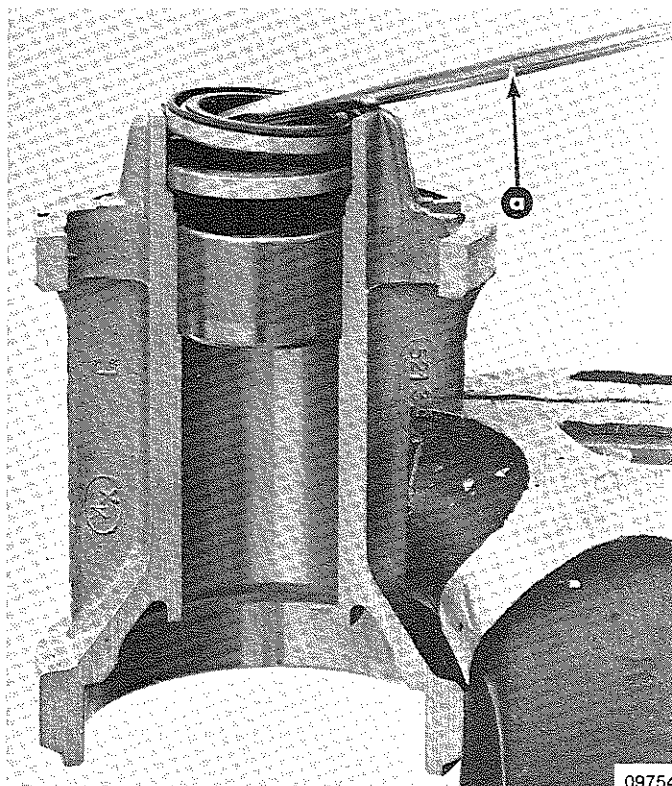


Figure 4. Removing Reverse Gear and Bearing from Bearing Carrier



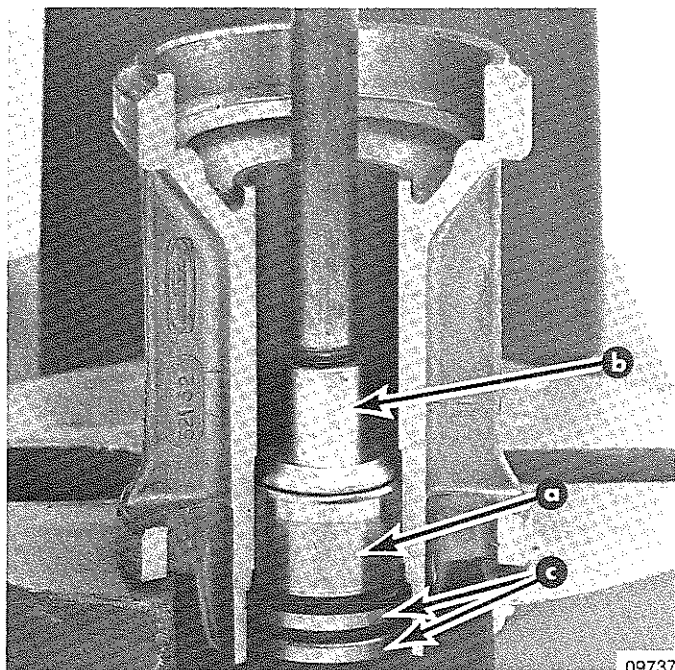
a - Universal Puller Plate b - Mandrel

Figure 5. Removing Reverse Gear Bearing from Reverse Gear



a - Pry Bar

Figure 6. Removing Propeller Shaft Oil Seals



a - Propeller Shaft Needle Bearing b - Mandrel c - Oil Seals

Figure 7. Propeller Shaft Needle Bearing and Oil Seals Removal

2. If inspection of reverse gear or reverse gear bearing determines that replacement of gear or bearing is required, remove gear and bearing as follows:
 - a. Position bearing carrier in a soft jaw vise. (Figure 4)
 - b. Use Slide Hammer (C-91-34569A1), as shown, and remove reverse gear.

- c. If reverse gear bearing has remained in bearing carrier, use slide hammer to remove the bearing in the same method used to remove the reverse gear (Step "b").
 - d. If reverse gear bearing remains attached to reverse gear, install Universal Puller Plate (C-91-37241), as shown in Figure 5, and position puller plate, gear and bearing on a press with gear side down. Use a suitable mandrel and press gear out of bearing. (Figure 5)
3. Propeller shaft oil seals can be removed (a) either by using a pry bar, as shown in Figure 6, or (b) pressing seals out when propeller shaft needle bearing is pressed out of bearing carrier. (Figure 7)

NOTE: Unless propeller shaft needle bearing is to be replaced, DO NOT use Step 3-b.

4. If inspection of propeller shaft needle bearing determines that replacement of bearing is required, use Universal Bearing Removal and Installation Tool (C-91-31229A1), as shown in Figure 7, to press bearing and seals out of bearing carrier.

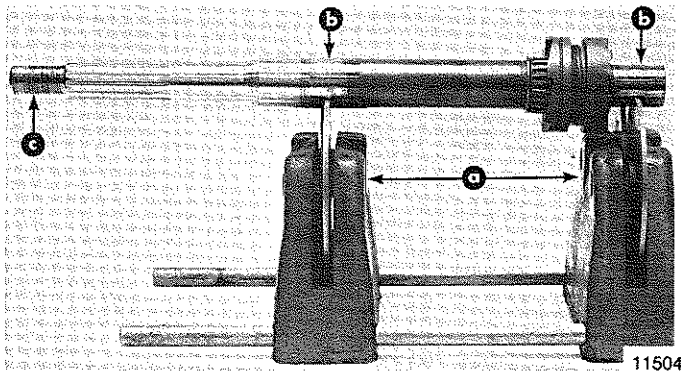
NOTE: Reverse gear must be removed from bearing carrier before propeller shaft needle bearing can be removed.

Propeller Shaft

CLEANING/INSPECTION

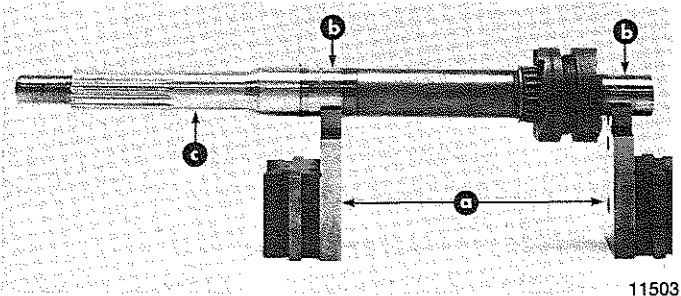
NOTE: Cam follower (in end of propeller shaft) is free and will fall out. Care should be taken not to lose cam follower.

1. Clean propeller shaft assembly with solvent and dry with compressed air.
2. Inspect bearing carrier oil seal surfaces for grooves. Run fingernail across seal surface to check for grooves. Replace shaft if groove is found.
3. Visually check bearing surfaces of propeller shaft for pitting, grooves, scoring, uneven wear or discoloration (bluish color) from overheating. Replace shaft and corresponding needle bearing, if any of the above conditions are found. (Bearing carrier needle bearing contacts propeller shaft just in front of oil seal surface. Forward gear bearing contacts propeller shaft in front of sliding clutch splines.)



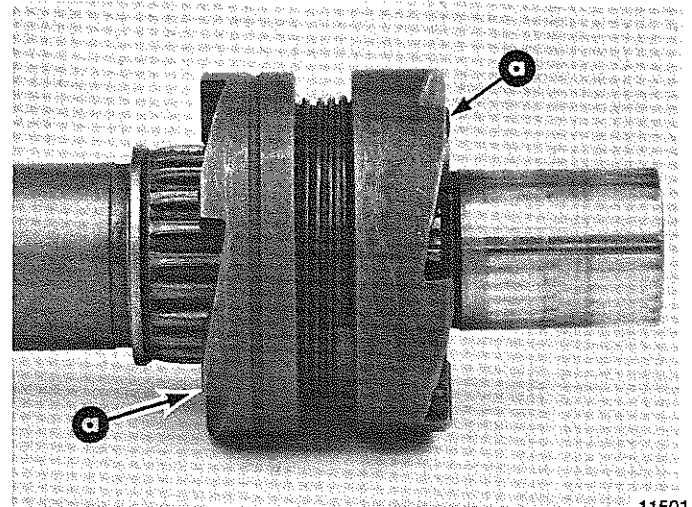
a - Balance Wheels b - Bearing Surfaces
c - Watch for "Wobble"

Figure 8. Checking Propeller Shaft Straightness with Balance Wheels



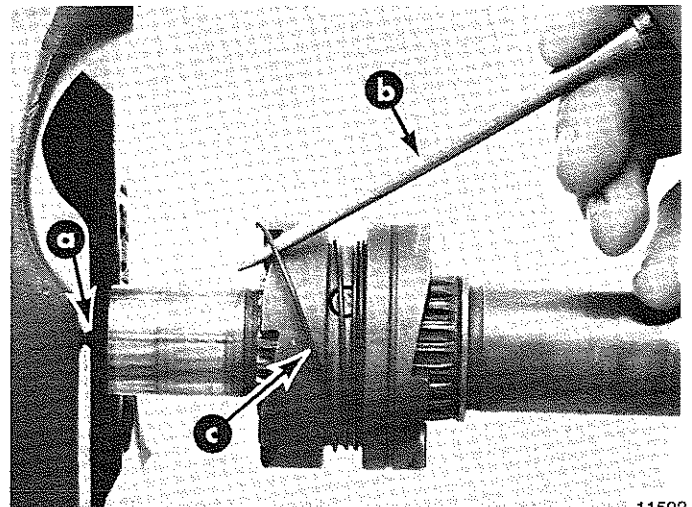
a - "Vee" Blocks b - Bearing Surfaces
c - Measure with Dial Indicator at This Point

Figure 9. Checking Propeller Shaft Straightness with "Vee" Blocks



a - Clutch Jaws

Figure 10. Sliding Clutch Inspection



a - Cam Follower b - Awl c - Cross Pin Retainer Spring

Figure 11. Cross Pin Retainer Spring Removal

4. Inspect propeller shaft splines for wear and/or corrosion damage.
5. Check propeller shaft for straightness. Use either method, following:

Balance Wheels

Place propeller shaft on balance wheels, as shown in Figure 8. Rotate propeller shaft and observe propeller end of shaft for "wobble". Replace shaft if any "wobble" is observed.

"Vee" Blocks and Dial Indicator

Position propeller shaft needle bearing surfaces on "Vee" blocks. (Figure 9) Mount a dial indicator at front edge of propeller splines ("C" in Figure 9). Rotate propeller shaft. Dial indicator movement of more than .006" (.152mm) (or noticeable "wobble") is reason for replacement.

6. Inspect sliding clutch. Check reverse gear and forward gear clutch "jaws". (Figure 3) Rounded "jaws" indicate need for replacement and is caused by one or more of the following:
 - a. Improper shift cable adjustment.
 - b. Improper shift habits of operator(s) (shift from neutral to reverse gear too slowly).
 - c. Engine idle speed too high (while shifting).
7. Check condition of cam follower. If it shows wear (pitting, scoring or rough surface), replace cam follower and shift cam.

DISASSEMBLY

1. Position propeller shaft cam follower against a solid surface. (Figure 11)
2. Insert a thin blade screwdriver or awl under first coil (from front) of cross pin retainer spring. (Figure 11)
3. Rotate propeller shaft to unwind spring from sliding clutch. (DO NOT over-stretch spring.) (Figure 11)

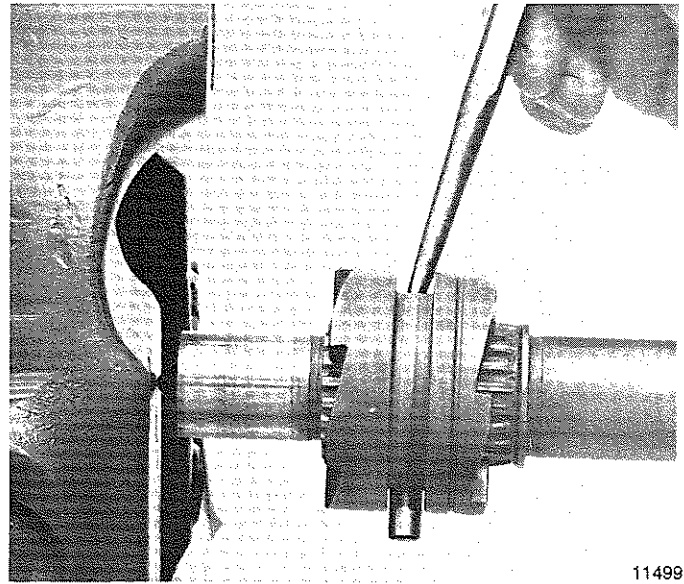


Figure 12. Cross Pin Removal

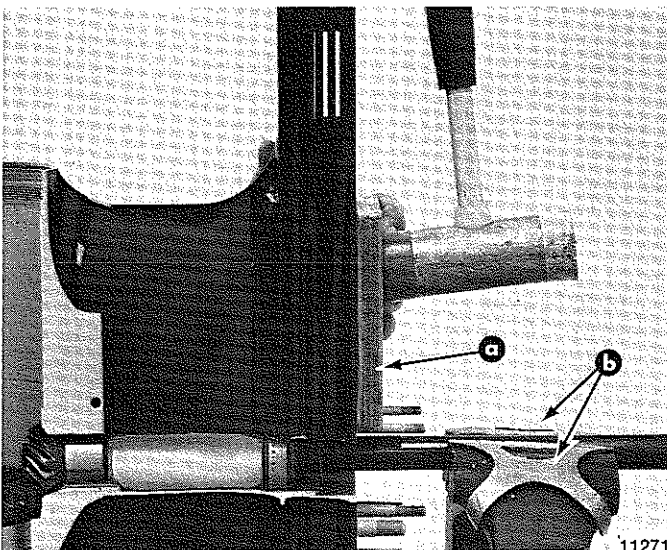
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4. Push against cam follower. Use a punch or awl to push cross pin out of sliding clutch. (Figure 12)
5. Release pressure against cam follower.
6. Tip propeller shaft to allow cam follower, guide block and spring to slide out of propeller shaft.

Pinion Gear and Drive Shaft

REMOVAL

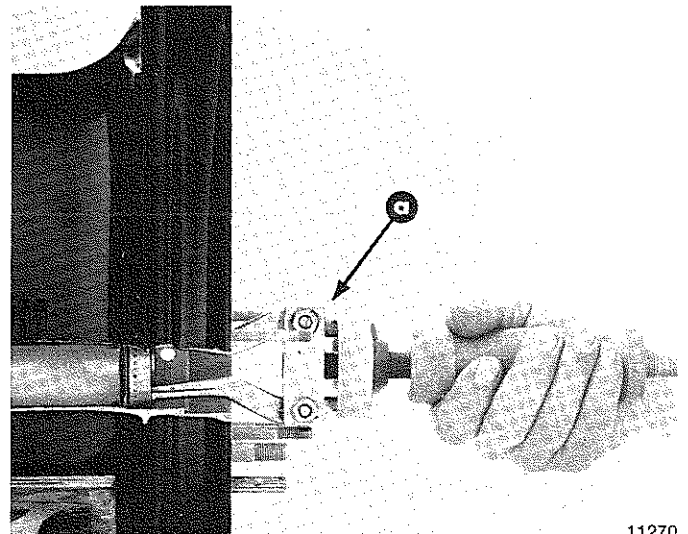
1. Place Drive Shaft Nut Wrench (C-91-34377A1) over drive shaft splines.
2. Use a socket and flex handle to hold pinion nut. (Pad area of gear housing, where flex handle will make contact, to prevent damage to gear housing.)
3. Use a socket and flex handle on drive shaft nut wrench to loosen pinion gear nut. Remove pinion nut and drive shaft nut wrench.
4. Remove gear housing from vise and position as shown in Figure 1. Be sure to use soft jaw vise covers (Figure 1) and clamp as close as possible to water pump studs.



a - Wooden Block b - Soft Jaw Vise Covers

Figure 1. Removing Drive Shaft

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a - Slide Hammer

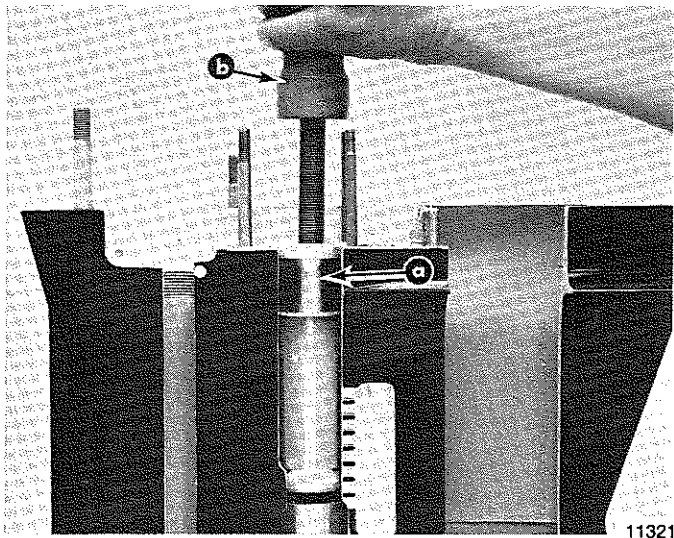
Figure 2. Drive Shaft Tapered Bearing Removal

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5. Place a block of wood on gear housing matching surface. (Figure 1) Use a mallet and carefully tap gear housing away from drive shaft.

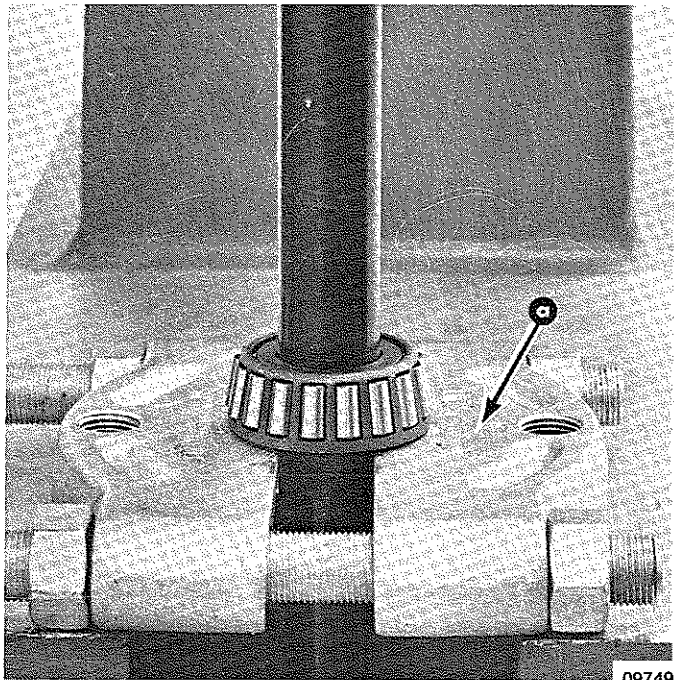
CAUTION: DO NOT strike gear housing solidly with a mallet or allow gear housing to fall.

6. Reach into gear housing and remove pinion gear.
7. Use a Slide Hammer (C-91-34569A1) to remove drive shaft tapered bearing race. (Figure 2) Retain shim(s) (found under race) for reassembly.
8. Thread Lubrication Sleeve Removal Tool (C-91-39281) into lubrication sleeve (left hand thread) and thread end



a - Lubrication Sleeve Removal Tool (C-91-39281)
b - Slide Hammer Puller

Figure 3. Lubrication Sleeve Removal



a - Universal Puller Plate

Figure 4. Removing Drive Shaft Tapered Bearing

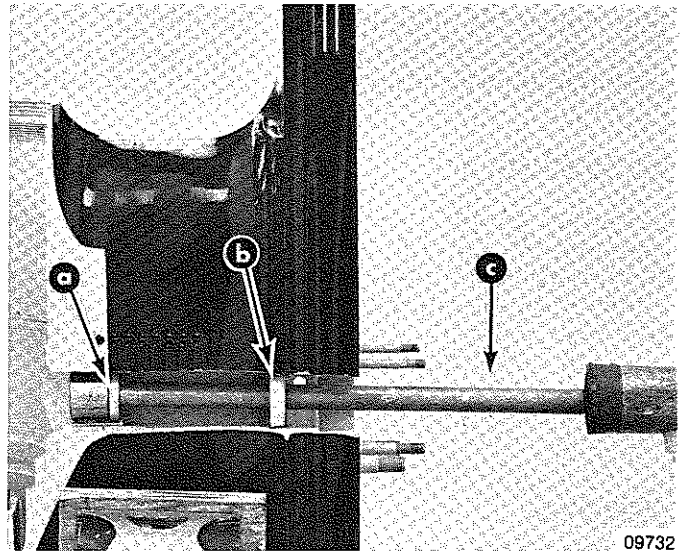
of Slide Hammer Puller (C-91-34569A1) into sleeve tool to remove lubrication sleeve. (Figure 3)

9. If inspection determines that replacement of drive shaft tapered bearing is required, remove bearing from drive shaft, as follows:
 - a. Place Universal Puller Plate (C-91-37241) over water pump side of tapered bearing.
 - b. Place puller plate and drive shaft on a press (Figure 4) and press drive shaft out of bearing.

NOTE: Forward gear is positioned free in gear housing and must be lifted out before Step 10 is performed.

10. If inspection of drive shaft needle bearing surface determines that replacement of needle bearing (Figure 5) is required, remove bearing from gear housing, as follows:
 - a. Use a suitable driver head, pilot and mandrel from Bearing Removal and Installation Kit (C-91-31229A1). (Figure 5)
 - b. Remove drive shaft needle bearing by striking driver head with a mallet.

NOTE: Discard drive shaft needle bearing after removal. (Bearing cannot be re-used.)



a - Mandrel b - Pilot c - Driver Head

Figure 5. Removing Drive Shaft Needle Bearing

CLEANING/INSPECTION

1. Clean drive shaft, tapered bearing race and pinion gear with solvent. Dry with compressed air. **DO NOT** spin drive shaft bearing dry.
2. Inspect pinion gear for pitting, grooves, scoring, uneven wear and discoloration from overheating. If any of the above conditions are found, replace pinion gear.
3. Inspect drive shaft needle bearing surface (area just above pinion gear splines) for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. If any of the preceding conditions are found, replace drive shaft and drive shaft needle bearing.
4. Inspect drive shaft to crankshaft splines for wear. Replace drive shaft, if wear is excessive.
5. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration from overheating. If any of the preceding conditions are found, always replace tapered bearing and race.
6. Inspect water pump base oil seal surface for grooves. Replace drive shaft, if any grooves are found.

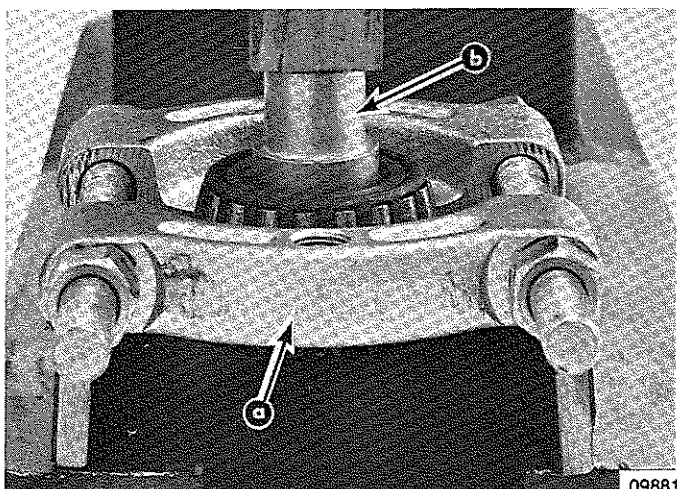
Forward Gear

REMOVAL/DISASSEMBLY

NOTE: Forward gear can be removed from gear housing only after drive shaft and pinion gear have been removed.

1. Reach into gear housing and lift out forward gear.

IMPORTANT: DO NOT remove tapered bearing or needle bearings from forward gear, unless replacement of bearings is required. (Bearings cannot be re-used after they have been removed.)



a - Universal Puller Plate

b - Mandrel

Figure 6. Removing Tapered Bearing from Forward Gear

2. If inspection determines that replacement of forward gear tapered bearing is required, remove bearing from gear and bearing race from gear housing (tapered bearing **MUST BE** replaced as a set), as follows:
 - a. Install Universal Puller Plate (C-91-37241) between forward gear and tapered bearing. (Figure 6)
 - b. Place forward gear, bearing and puller plate on a press (Figure 6) and press gear out of bearing with a suitable mandrel.
 - c. Use Slide Hammer (C-91-34569A1) to remove forward gear tapered bearing race. (Figure 7)
 - d. After forward gear tapered bearing race is removed from gear housing, lift out and retain shims which were behind bearing race.
3. If inspection determines that replacement of propeller shaft needle bearings in forward gear is required, remove bearings from gear, as follows:
 - a. Clamp forward gear securely in a soft jaw vise.
 - b. Drive propeller shaft needle bearings out of gear (from toothed side of gear) with a punch and hammer.



a - Slide Hammer

b - Tapered Bearing Race

Figure 7. Forward Gear Tapered Bearing Race Removal

CLEANING/INSPECTION

1. Clean forward gear and bearings with solvent and dry with compressed air.

CAUTION: DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

2. Inspect gear teeth for pitting, grooves, scoring, uneven wear and discoloration from overheating. Replace gear, if any of these conditions are found.
3. Check clutch jaws on forward gear for damage. Replace forward gear if damage is found.
4. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration from overheating. If any of these conditions are found, replace tapered bearing (on forward gear) and race. (Always replace tapered bearings as a set.)
5. To determine condition of propeller shaft needle bearings (in forward gear), inspect propeller shaft forward gear needle bearing surface, as outlined in "Propeller Shaft Inspection", preceding.

Shift Shaft

REMOVAL

NOTE: The propeller shaft, drive shaft and forward gear assembly must be removed before removal of shift shaft and shift cam.

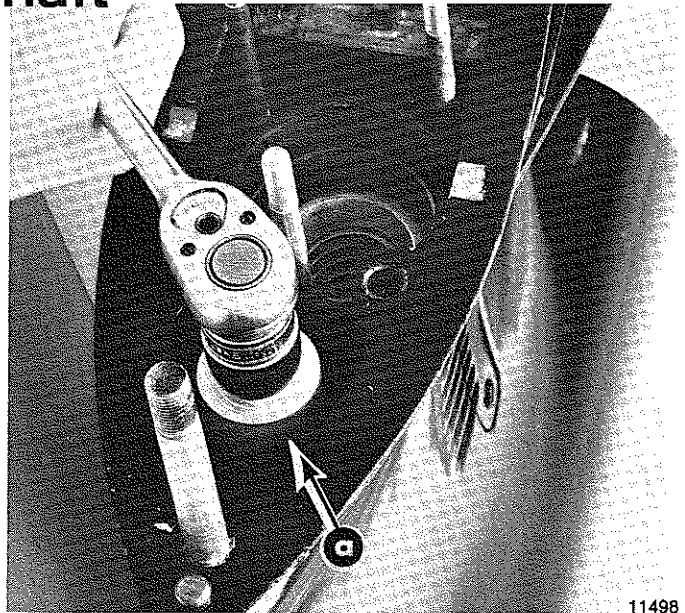
1. Use Shift Shaft Bushing Tool (C-91-31107) to unthread shift shaft bushing (Figure 7), then remove bushing.
2. After bushing is removed, lift shift shaft out of gear housing.
3. Once shift shaft is removed, the shift cam is free and can be removed from propeller shaft cavity.

CLEANING/INSPECTION (Shift Shaft, Bushing and Cam)

1. Clean all parts (shift shaft, bushing and cam) with solvent and dry with compressed air.
2. Inspect shift cam for wear on shift ramps.
3. Inspect shift shaft for grooves at shift shaft bushing seal surface. Also check for wear and/or corrosion damage on upper and lower splines.
4. Inspect shift shaft bushing for corrosion damage.
5. Inspect shift shaft bushing oil seal for wear or cuts.

NOTE: If shift shaft bushing is equipped with 2 oil seals, and seals need to be replaced, order a new shift shaft bushing assembly. Seals in a 2 seal shift shaft bushing are not replaceable.

6. Check "E" clip for damage. Replace clip if damaged.



a - Shift Shaft Bushing Tool (C-91-31107)

Figure 8. Shift Shaft Bushing Removal

DISASSEMBLY (Shift Shaft and Bushing)

1. Remove (and discard) "O" ring from shift shaft bushing.
2. Remove (and discard) oil seal by prying it out or driving it out with a punch and hammer.
3. If inspection determines that replacement is required, remove (and discard) "E" ring.

Gear Housing

CLEANING/INSPECTION

1. Clean gear housing with solvent and dry with compressed air.
2. Check gear housing carefully for impact damage.
3. Check for loose fitting bearing cups and needle bearings.

4. Inspect bearing carrier cover nut retainer threads in gear housing for corrosion damage and/or stripped threads.
5. Check labyrinth seal (series of ridges and grooves aft of cover nut retainer threads). This seal prevents exhaust gases from escaping over blades of propeller.

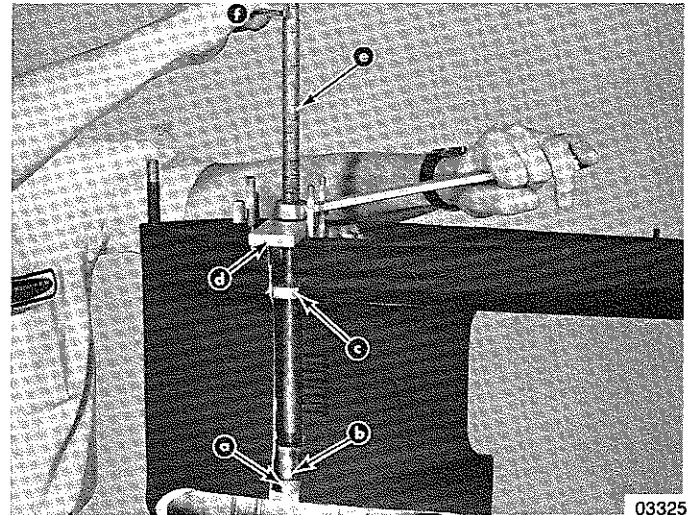
REASSEMBLY and INSTALLATION

Drive Shaft Needle Bearing

REASSEMBLY/INSTALLATION

CAUTION: If drive shaft needle bearing failure has occurred, and original bearing case has turned in the gear housing, gear housing must be replaced. Loose fitting needle bearing will move out of position and cause repeated failures.

1. Apply a thin coat of Multipurpose Lubricant to drive shaft needle bearing bore in gear housing.
2. By way of propeller shaft cavity, place needle bearing in drive shaft bore with numbered side of bearing facing up drive shaft bore.
3. Install and seat needle bearing with the following tools from Bearing Removal and Installation Kit (C-91-31229A1): Puller Rod and Nut (C-91-31229), Pilot (C-91-36571), Plate (C-91-29310) and Puller Head (C-91-38628), as shown in Figure 1. Pull bearing up into bore until it bottoms on gear housing shoulder. (DO NOT use excessive force.)



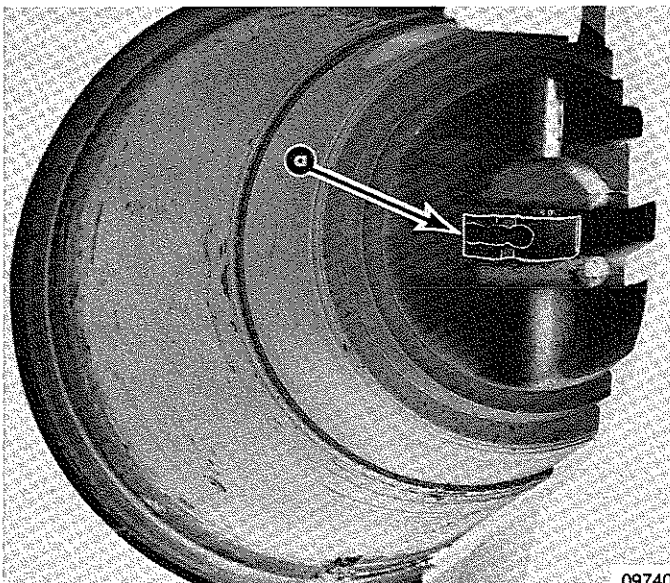
a - Puller Head c - Pilot e - Puller Rod
b - Bearing d - Plate f - Hold

Figure 1. Installing Drive Shaft Needle Bearing

Lower Shift Shaft and Bushing

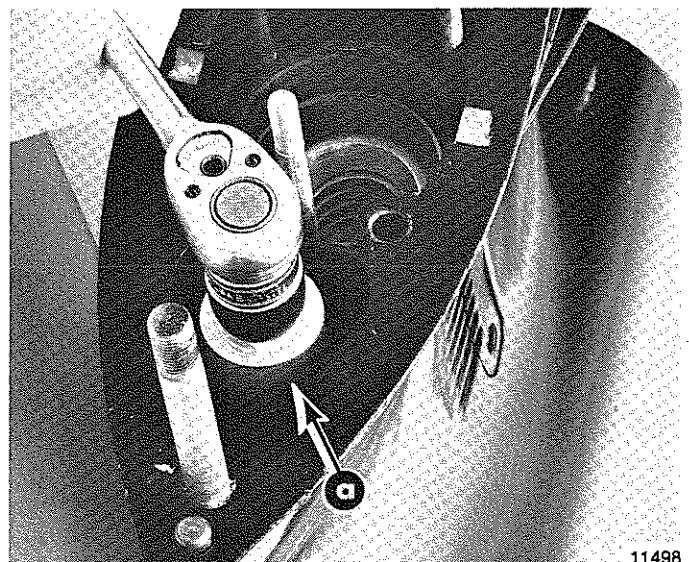
REASSEMBLY/INSTALLATION

1. Position shift shaft bushing on a press with threaded side down.
2. Apply a small amount of Loctite Type "A" to outside diameter of oil seal.
3. Press oil seal into shift shaft bushing with lip of seal up.
4. Wipe off any excess Loctite from oil seal and bushing.
5. Place rubber washer against oil seal.
6. Install "O" ring over threads and up against shoulder of bushing.
7. Lubricate "O" ring and oil seal with Multipurpose Lubricant.
8. Install "E" clip into groove in lower shift shaft.



a - Longer Side

Figure 2. Shift Cam Position



a - Shift Shaft Bushing Tool

Figure 3. Shift Shaft Bushing Installation

9. Position shift cam into forward portion of gear housing between cast webbing. Ramps on shift cam must be visible from rear of gear housing [longer side if cam (reverse ramp) must be toward left side of gear housing (fill screw hole side)]. (Figure 2)
10. Place lower shift shaft (short spline end) into shift shaft cavity. Rotate shift shaft to engage splines into splines of shift cam.
11. Apply a light coat of Perfect Seal to threads of shift shaft bushing. (DO NOT allow Perfect Seal to contact bushing, oil seal or "O" ring.)
12. Place shift shaft bushing over shift shaft and start threads of bushing into gear housing by hand.
13. Finish tightening shift shaft bushing with Shift Shaft Bushing Tool (C-91-31107). (Figure 3)

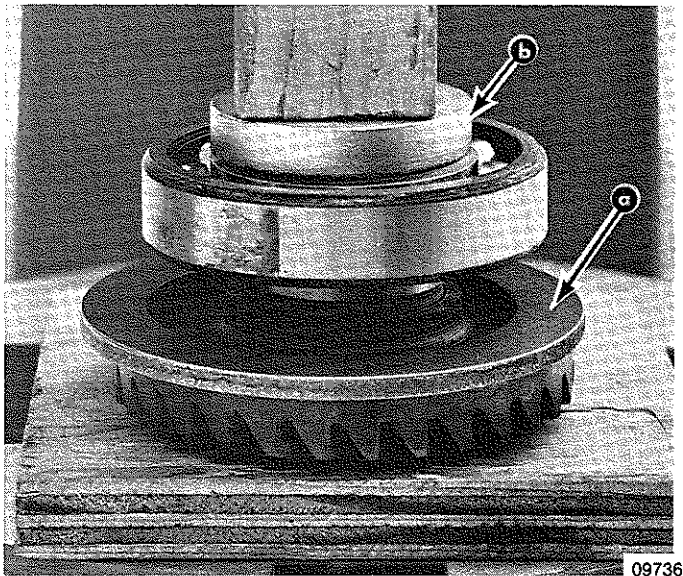
Bearing Carrier

REASSEMBLY

1. Place reverse gear on a press with gear teeth facing down.

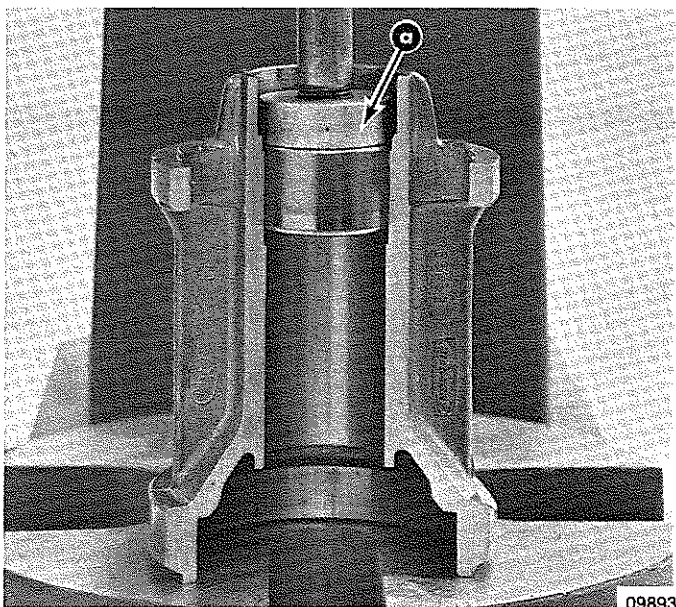
IMPORTANT: The reverse gear thrust washer has a tapered outside diameter so that one side is larger than the other. The larger diameter of washer must be toward reverse gear.

2. Place thrust washer over gear with the larger outside diameter down toward gear. (Figure 4)
3. Apply a light coat of Multipurpose Lubricant onto inside diameter of reverse gear ball bearing.
4. Position ball bearing over gear (with numbered side of bearing up).
5. Press ball bearing onto gear with a suitable mandrel (Figure 4) until firmly seated. (Be sure to press only on



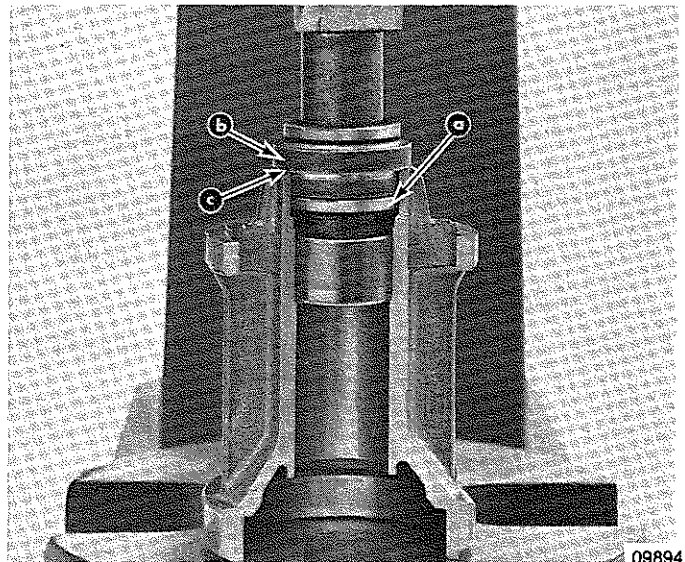
a - Thrust Washer b - Mandrel

Figure 4. Reverse Gear Bushing Installation



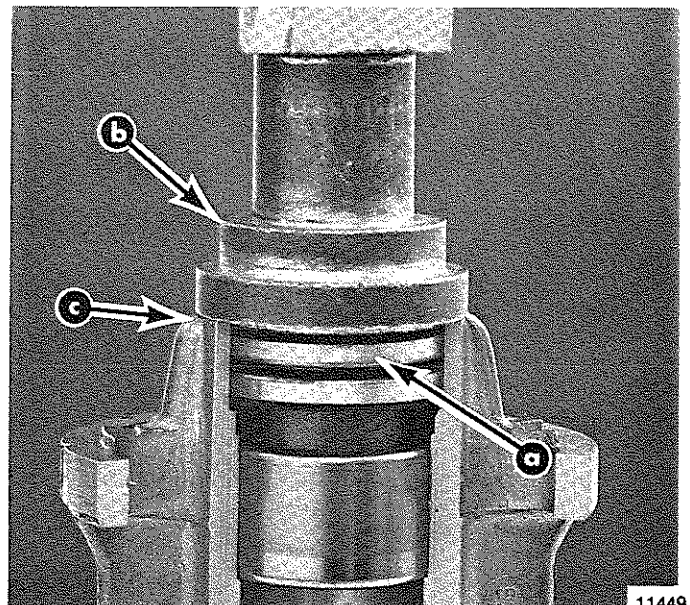
a - Mandrel

Figure 5. Installing Propeller Shaft Needle Bearing into Bearing Carrier



a - Oil Seal (Lip of Seal Down) b - Oil Seal Driver c - Seated

Figure 6. Propeller Shaft Oil Seal Installation (Inner Seal)



a - Oil Seal (Lip of Seal Up) b - Oil Seal Driver
c - Seated

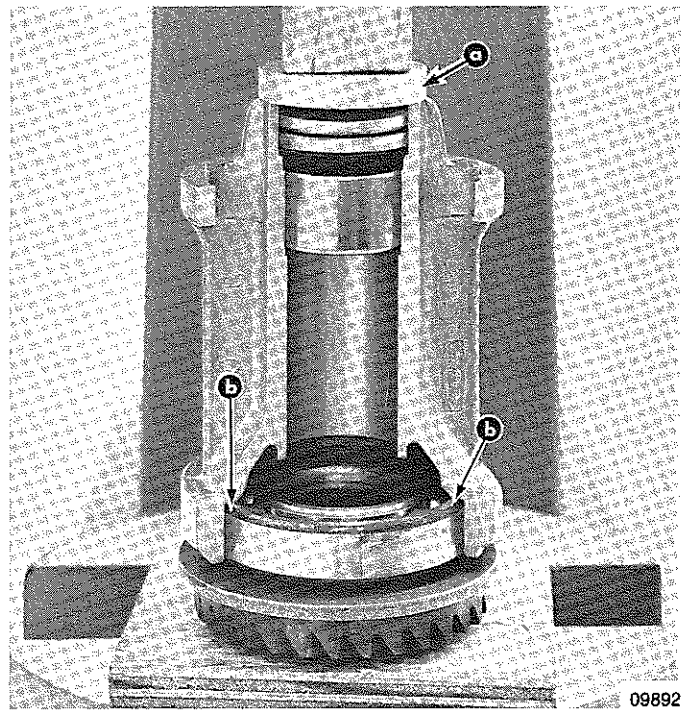
Figure 7. Propeller Shaft Oil Seal Installation (Outer Seal)

- inner race of bearing and so that bearing is firm against gear.)
6. Apply a light coat of Multipurpose Lubricant onto outside diameter of propeller shaft needle bearing.
7. Place propeller shaft needle bearing into aft end of bearing carrier with numbered side toward aft end.
8. Use a suitable mandrel and press needle bearing into bearing carrier. (Figure 5)
9. Apply Loctite Type "A" to outer diameter of propeller shaft oil seals.
10. Place one seal on longer shoulder side of Oil Seal Driver (C-91-31108) with lip of seal away from shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier. (Figure 6)

11. Place second seal on short shoulder side of seal driver with lip of seal toward shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier. (Figure 7)
12. Wipe off excess Loctite.
13. Apply a light coat of Multipurpose Lubricant onto the outside diameter of reverse gear ball bearing.
14. Place bearing carrier over reverse gear and bearing assembly. Press bearing carrier onto bearing. (Figure 8)
15. Place "O" ring over bearing carrier and position it between bearing carrier and thrust washer.
16. Lubricate oil seals and "O" ring with Multipurpose Lubricant.

a - Mandrel
b - Seated

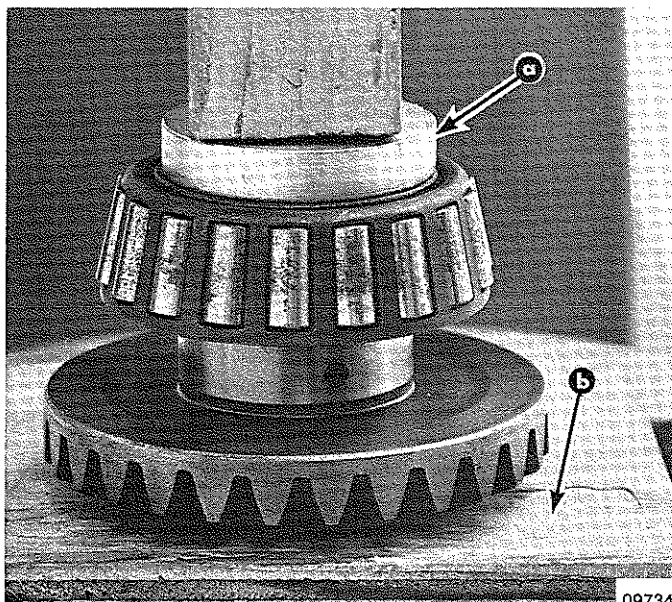
Figure 8. Installing Bearing Carrier onto Reverse Gear



Forward Gear

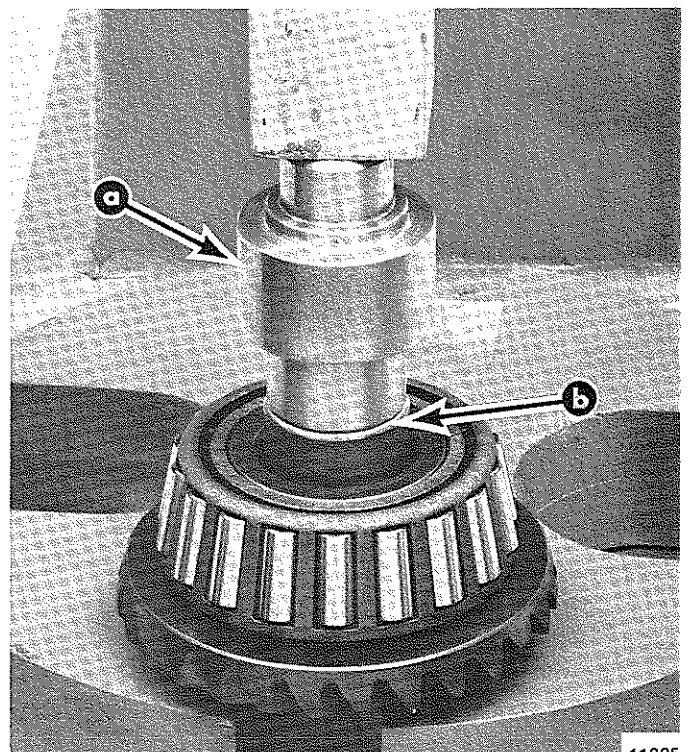
REASSEMBLY

1. Place forward gear on a press with gear teeth down.
2. Apply a light coat of Multipurpose Lubricant onto the inside diameter of forward gear tapered bearing.
3. Position forward gear tapered bearing over gear, as shown in Figure 9.
4. Press bearing onto gear until firmly seated. (Be sure to press only on inner race of bearing and that bearing is firm against the gear.)
5. Apply a light coat of Multipurpose Lubricant to bore in center of forward gear.
6. Place one forward gear needle bearing on longer shoulder side of Forward Gear Bearing Tool (C-91-86943) with



a - Mandrel b - Wooden Block

Figure 9. Forward Gear Tapered Bearing Installation



a - Forward Gear Bearing Tool (C-91-86943)
b - Numbered Side of Needle Bearing

Figure 10. Forward Gear Needle Bearing Installation

numbered side of bearing toward shoulder. (Figure 10) Press bearing into forward gear until bearing tool bottoms against gear.

7. Place second needle bearing on short shoulder side of bearing tool with numbered side of bearing toward shoulder. Press bearing into forward gear until bearing tool bottoms against gear.

Forward Gear Bearing Race

INSTALLATION

1. Place shim(s) (retained from disassembly) into gear housing. If shim(s) were lost or a new gear housing is being used, start with approximately .010" (0.254mm).
2. Apply a light coat of Multipurpose Lubricant to forward gear bearing race bore in gear housing.
3. Position tapered bearing race squarely over bearing bore in front portion of gear housing. (Figure 11)
4. Place Bearing Driver Cup (C-91-87120) over tapered bearing race.

NOTE: A used propeller shaft is recommended for use in Step 5.

5. Place propeller shaft into hole in center of bearing driver cup.
6. Install bearing carrier assembly over propeller shaft and lower it into gear housing. Bearing carrier acts as a pilot to assure proper bearing race alignment.
7. Thread a nut onto propeller shaft to protect propeller shaft threads.
8. Use a mallet to drive propeller shaft against bearing driver cup until tapered bearing race is seated against shim(s).
9. Remove nut from propeller shaft, then remove bearing carrier and propeller shaft from gear housing. Lift bearing driver cup out of gear housing.
10. Apply a light coat of oil on tapered bearing race, then place forward gear assembly into tapered bearing race.

a - Tapered Bearing Race
b - Bearing Driver Cup
c - Shim(s)

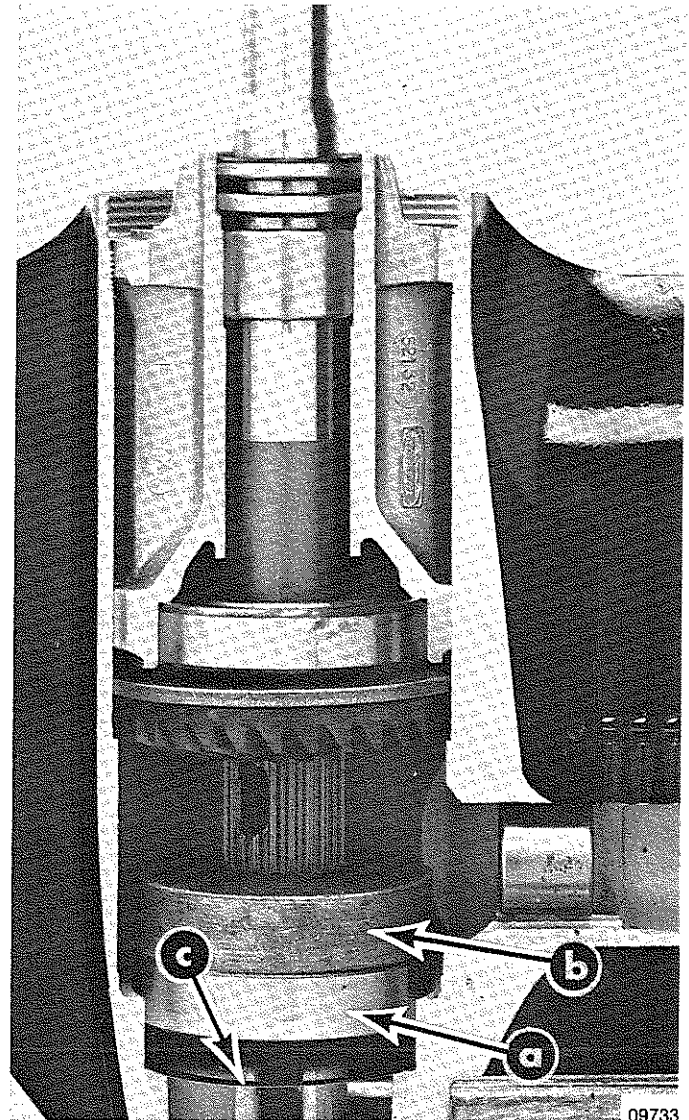
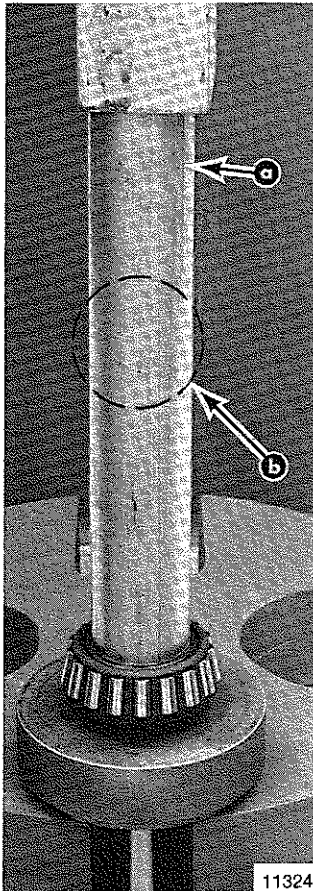


Figure 11. Installing Forward Gear Bearing Race →

Drive Shaft and Pinion Gear

REASSEMBLY/INSTALLATION

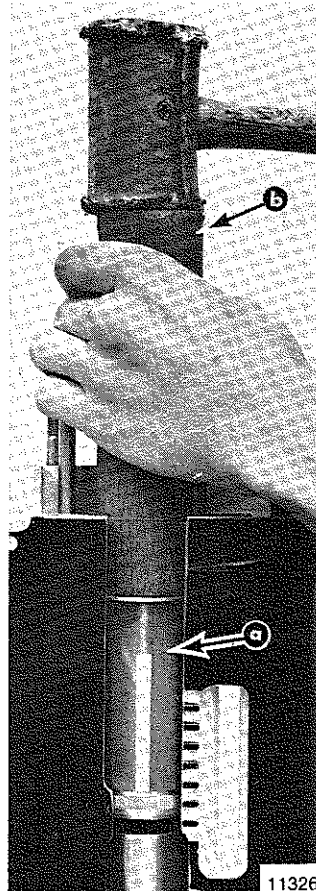
1. Apply a light coat of Multipurpose Lubricant onto the inside diameter of drive shaft tapered bearing.



11324
a - Drive Shaft Tapered Bearing Driver (C-91-87119)
b - Pinion Gear End of Drive Shaft

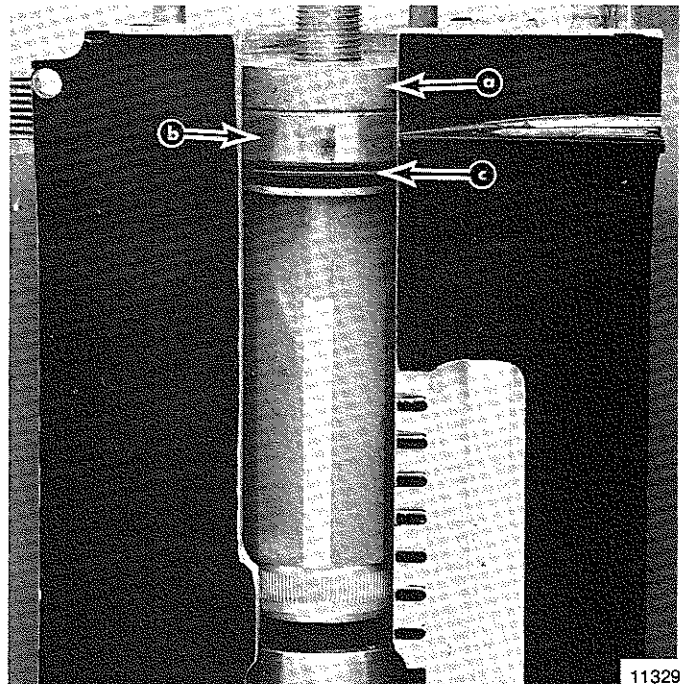
Figure 1. Drive Shaft Tapered Bearing Installation

2. Position drive shaft tapered bearing over pinion gear end of drive shaft with tapered end of bearing toward pinion end of drive shaft. (Figure 1)
3. Use Drive Shaft Tapered Bearing Driver (C-91-87119) and press bearing onto drive shaft until it is firmly seated against shoulder on drive shaft. (Figure 1)
4. Position lubrication sleeve in drive shaft bore so that flats in bore align with flats on sleeve and notch in top of sleeve is toward leading edge of gear housing.
5. Use Lubrication Sleeve Driver (C-91-39238) and press sleeve into bore until it is just below tapered bearing shim(s) surface. (Figure 2) (DO NOT use excessive force to install sleeve, as this could distort sleeve.)



11326
a - Lubrication Sleeve Driver (C-91-39238)

Figure 2. Lubrication Sleeve Installation



11329
a - Bearing Cup Driver b - Tapered Bearing Race c - Shim(s)

Figure 3. Tapered Bearing Race Installation

6. Place shim(s) (retained from disassembly) into gear housing drive shaft bearing bore. If shim(s) were lost or a new gear housing is being used, start with approximately .010" (0.254mm).
7. Use Bearing Cup Driver (C-91-34379) in conjunction with Bearing Removal and Installation Kit (C-91-31229A1) to press tapered bearing race into drive shaft tapered bearing bore until firmly seated against shim(s). (Figure 3)
8. Position pinion gear in gear housing below drive shaft bore with teeth of pinion gear meshed with teeth of forward gear.
9. Insert drive shaft into drive shaft bore while holding pinion gear as described in Step 6. Rotate drive shaft to align and engage drive shaft splines with pinion gear splines.
10. Continue to insert drive shaft into gear housing until drive shaft tapered bearing is against bearing race.
11. Place a small amount of Loctite Type "A" onto threads of pinion gear nut and install nut on drive shaft with flat side of nut away from pinion gear.
12. Use a socket and flex handle to hold pinion nut (pad area where flex handle will contact gear housing while torquing nut).
13. Place Drive Shaft Nut Wrench (C-91-34377A1) over crankshaft end of drive shaft. Use a torque wrench to torque pinion nut to figure listed in "Specifications" section.

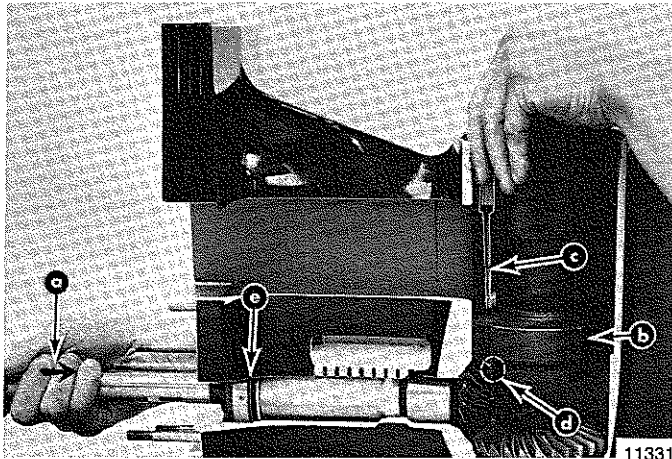
IMPORTANT: Wipe any excess Loctite from pinion nut and pinion gear.

Pinion Gear Depth and Forward Gear Backlash

DETERMINING PINION GEAR DEPTH

NOTE: Read entire shimming procedure before attempting any change in shim thickness.

1. Carefully clean reverse gear shoulder and diameter of propeller shaft cavity.
2. Insert Pinion Gear Shimming Tool (C-91-74776) into propeller shaft cavity until it bottoms-out on reverse gear shoulder.
3. Align access slot in shimming tool with nose of pinion gear.
4. Rotate drive shaft a few times with down pressure applied to seat drive shaft tapered bearing. Apply 15 lbs. (6.8kg) of pressure down on drive shaft and hold it stationary while performing Step 5.



- a - 15 Lbs. of Pressure in Direction of Arrow
- b - Shimming Tool
- c - Feeler Gauge
- d - Obtain .025" Clearance between Shimming Tool and Pinion Gear
- e - Add or Subtract Shim(s) Here

Figure 4. Determining Pinion Gear Depth

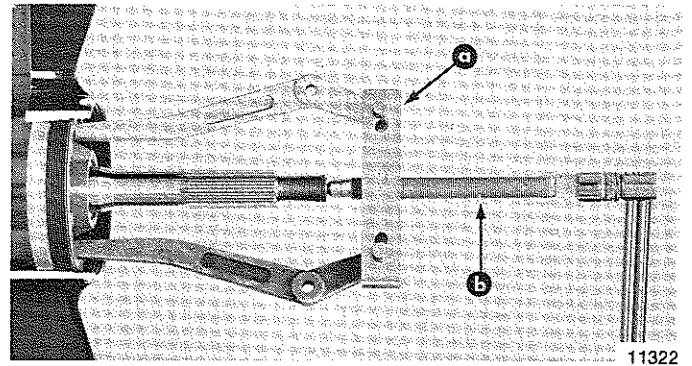
5. Determine pinion gear depth by inserting a feeler gauge thru access slot in shimming tool. (Figure 4)
6. If clearance between shimming tool and pinion gear is .025" (0.64mm), pinion gear depth is correct.
7. If clearance between shimming tool and pinion gear is above or below .025", reshim drive shaft tapered bearing race to raise or lower pinion gear, as follows:
 - a. Remove pinion gear retainer nut.
 - b. Remove drive shaft and drive shaft tapered bearing race.
 - c. Remove or add an amount of shim(s) sufficient to correct pinion gear depth. **EXAMPLE:**

Pinion gear depth is020" (0.51mm)
 Add005" (0.13mm)
 Pinion gear depth will be025" (0.64mm)

Pinion gear depth is030" (0.76mm)
 Subtract005" (0.13mm)
 Pinion gear depth will be025" (0.64mm)
 - d. Reassemble as instructed in "Drive Shaft and Pinion Gear Reassembly/Installation", immediately preceding.

DETERMINING FORWARD GEAR BACKLASH

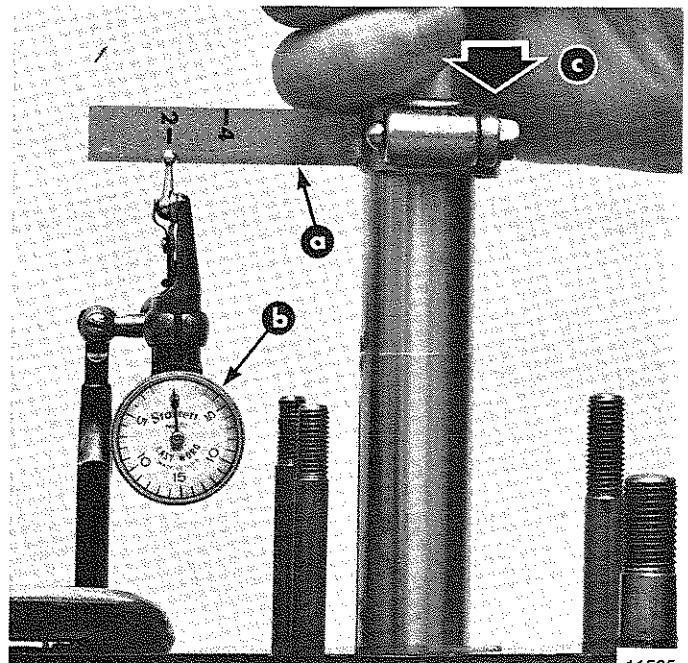
IMPORTANT: Bearing carrier must be assembled to provide a pilot for propeller shaft.



- a - Bearing Carrier Removal Tool (C-91-46086A1)
- b - Puller Bolt (C-91-85716)

Figure 5. Apply 45 In. Lbs. of Torque on Puller Bolt

1. Insert propeller shaft into position in gear housing. (DO NOT place shift cam on propeller shaft.)
2. Place bearing carrier into gear housing and thread cover nut against bearing carrier. (It is not necessary to torque cover nut against bearing carrier.)
3. Attach Bearing Carrier Removal Tool (C-91-46086A1) and Puller Bolt (C-91-85716) onto gear housing, as shown in Figure 5.
4. Torque puller bolt against propeller shaft to 45 in. lbs. (52kg-cm). Turn drive shaft 2 or 3 revolutions with the load applied to propeller shaft. This will seat forward gear bearing.
5. Fasten dial indicator to gear housing and Backlash Indicator Tool (C-91-78473) to drive shaft. (Figure 6)
6. Recheck torque on puller bolt (45 in. lbs.).
7. Position dial indicator pointer to line up with No. 2 on backlash indicator tool.
8. Hold pressure down on drive shaft. Lightly turn drive shaft back-and-forth. (No movement should be noticed at pro-



- a - Backlash Indicator Tool
- b - Dial Indicator
- c - Apply Pressure in Direction of Arrow

Figure 6. Checking Gear Backlash

- PELLER SHAFT.) Dial indicator registers amount of backlash, which must be .008" to .013" (0.20mm to 0.33mm).
9. If backlash is less than .008" or more than .013", reshim forward gear as follows:
 - a. Remove dial indicator, backlash indicator tool and bearing carrier removal tool.
 - b. Remove cover nut, bearing carrier and propeller shaft.
 - c. Remove pinion gear retainer nut, then drive shaft.

- d. Remove forward gear and forward gear bearing race.
- e. Remove or add a sufficient amount of shim(s) in front of forward gear bearing race to correct backlash.

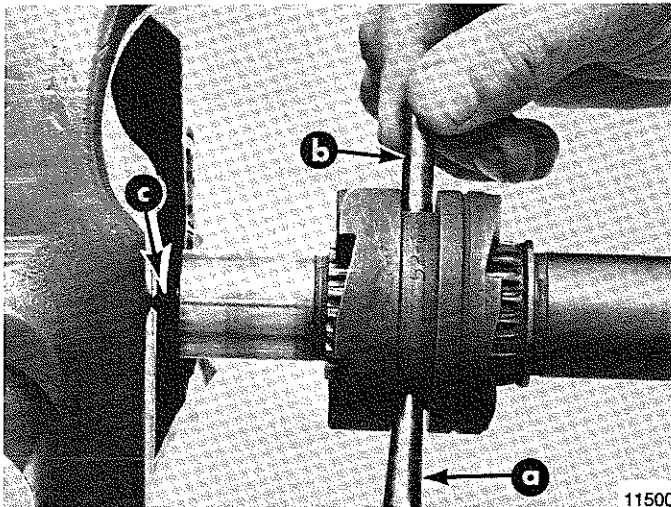
NOTE: By adding or subtracting .001" (0.025mm) shim, the backlash will change approximately .0015" (0.038mm).

- f. Reassemble per installation instructions and recheck backlash per instructions.

Propeller Shaft

REASSEMBLY/INSTALLATION

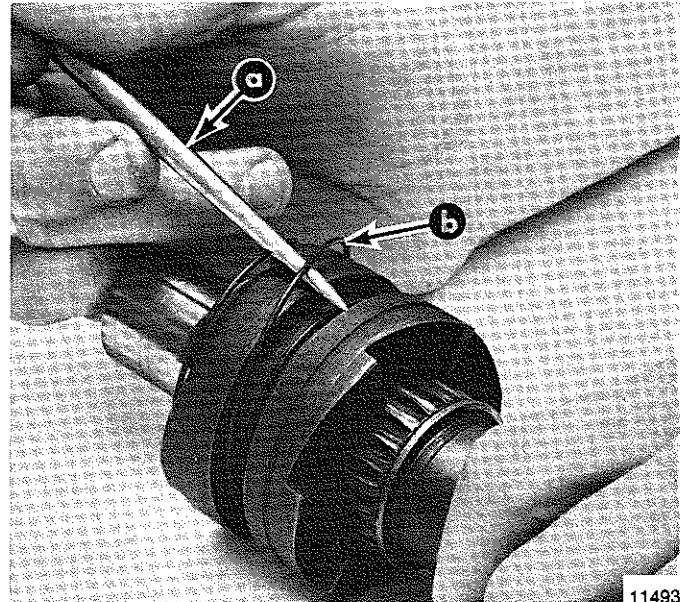
1. Position sliding clutch over clutch splines with grooved ring (on sliding clutch) toward propeller end of propeller shaft and with cross pin hole aligned with cross pin slot in propeller shaft.
2. Insert spring into end of propeller shaft.
3. Insert guide block (stepped end) into front end of propeller shaft with cross pin hole aligned with cross pin hole in sliding clutch.



a - Punch b - Cross Pin c - Cam Follower

Figure 7. Installing Sliding Clutch Cross Pin

4. Insert flat end of cam follower into front end of propeller shaft.
5. Place cam follower against a solid object and push against



a - Awl b - Spring

Figure 8. Installing Crosspin Retainer Spring

6. Use a punch to align guide block crosspin opening with sliding clutch crosspin hole. Remove punch and insert crosspin. Release pressure on spring.
7. Install crosspin retainer spring over sliding clutch. (Figure 8) DO NOT over-stretch spring.
8. Remove cam follower. Place a dab of Multipurpose Lubricant into end of propeller shaft and install cam follower (flat end first).
9. Place propeller shaft into center of forward gear assembly.

Bearing Carrier

INSTALLATION

1. Lubricate "O" ring (Figure 9) on bearing carrier with Multipurpose Lubricant.
2. Apply a light coat of Perfect Seal to outside diameter of bearing carrier (where carrier contacts gear housing). (DO NOT allow Perfect Seal to contact "O" ring or bearings.)

NOTE: When performing Step 3, rotate drive shaft clockwise (viewed from top) to mesh pinion gear with reverse gear.

3. Position bearing carrier over propeller shaft and slide it into gear housing. (Be sure to align bearing carrier keyway with gear housing keyway.)
4. Push bearing carrier in as far as possible by hand, then install bearing carrier key.
5. Place tab washer against bearing carrier.
6. Apply Perfect Seal to threads of cover nut and install cover nut in gear housing (make sure that the words, "OFF-ON", and arrows are visible).
7. Start cover nut a few turns by hand, then, using Cover Nut Tool (C-91-61069) and torque wrench (Figure 9), torque cover nut to specifications shown under "Specifications" on Page 5B-2.
8. Bend one lock tab into cover nut (only one will align).

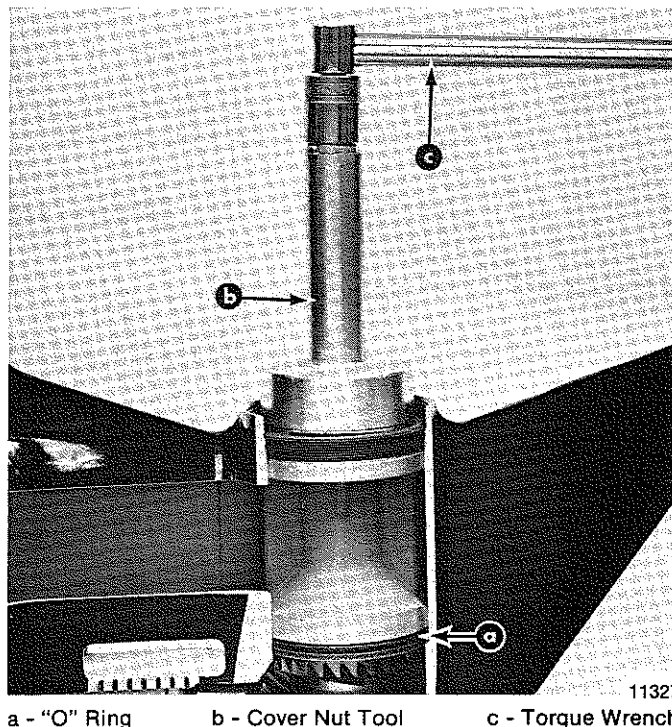
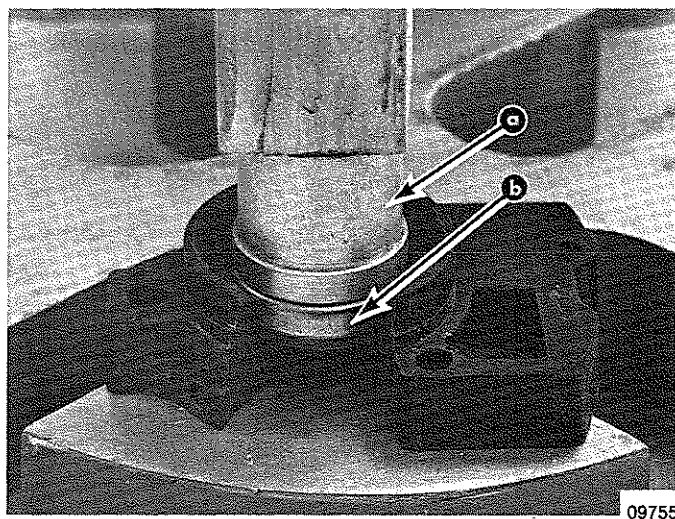


Figure 9. Bearing Carrier Installation

Water Pump

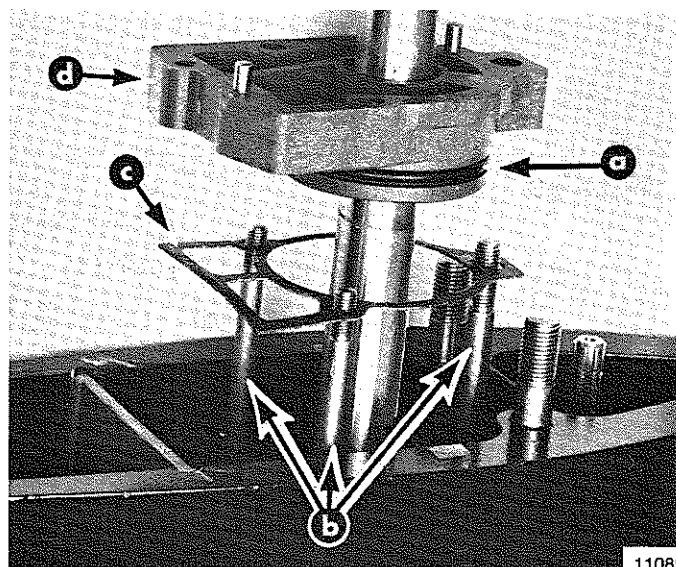
REASSEMBLY/INSTALLATION

1. Install oil seals into water pump base (Figure 1), as follows:
 - a. Place water pump base on a press. (Figure 1)
 - b. Just before installing each seal apply Loctite Type "A" to outside diameter of oil seal.
 - c. With a suitable mandrel, press the smaller diameter oil seal into pump base with lip of oil seal toward impeller side of base.
 - d. With a suitable mandrel, press the larger diameter oil seal into pump base with lip of oil seal toward gear housing side of base.



a - Mandrel b - Oil Seal (Smaller OD)

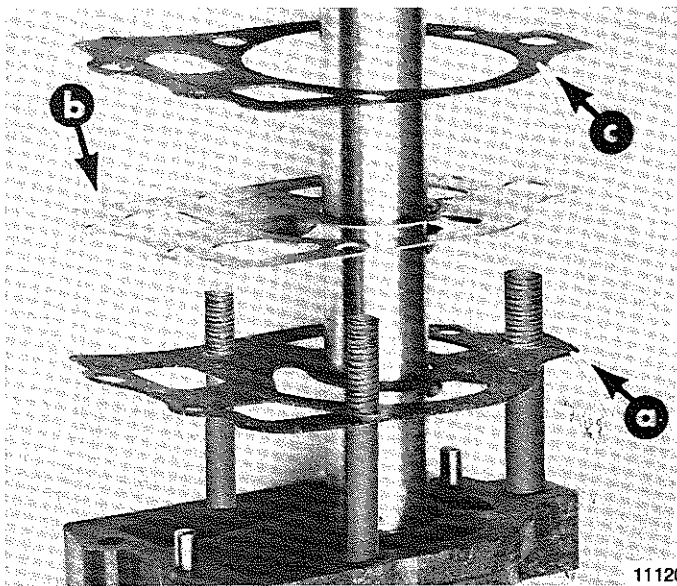
Figure 1. Installing Smaller OD Oil Seal in Water Pump Base



a - "O" Ring c - Gasket
b - Mounting Studs d - Water Pump Base

Figure 2. Water Pump Base and Gasket Installation

- e. Wipe any excess Loctite from oil seals and water pump base.
2. Install "O" ring into "O" ring groove of water pump base. (Figure 2)
 3. Lubricate "O" ring and oil seals with Multipurpose Lubricant.
 4. Install a new water pump base gasket over water pump mounting studs (Figure 2) and install water pump base.



11120
 a - Gasket (Water Pump Base to Face Plate) b - Face Plate
 c - Gasket (Face Plate to Water Pump Cover)

Figure 3. Face Plate and Gaskets Installation

5. Install the following in order: Pump base to face plate gasket, face plate and face plate to pump cover gasket. (Figure 3) Gaskets and face plate are indexed by dowel pin location and must be installed correctly.
6. Place impeller drive key on flat of drive shaft. Hold key on drive shaft with a dab of Multipurpose Lubricant.

IMPORTANT: When completing gear housing repair, that requires removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use the impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

7. Slide impeller down drive shaft to impeller drive key. Align drive key with keyway in the center hub of impeller, and slide impeller over drive key.

CAUTION: A visual inspection of impeller drive key MUST BE made to determine that drive key is on flat of drive shaft after impeller is installed. If key has moved off flat of drive shaft, repeat Steps 6 and 7.

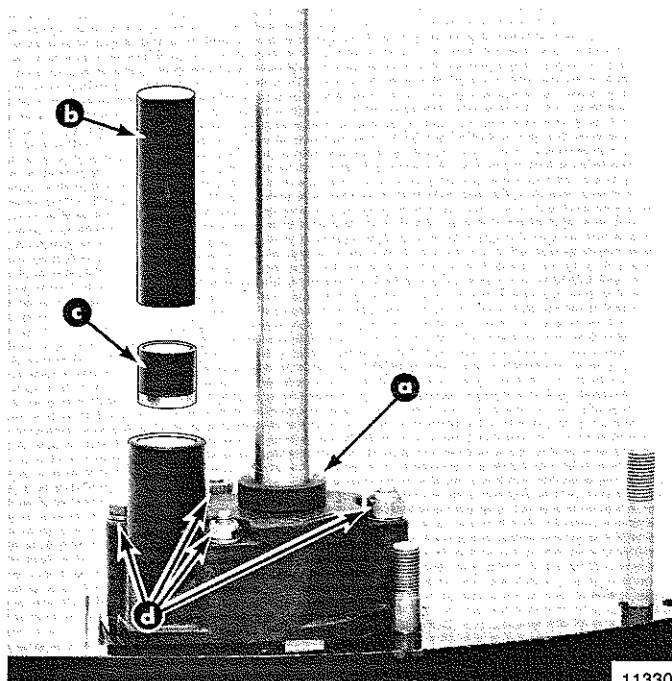
8. If removed, install new water pump insert into pump cover as follows:
 - a. Apply Perfect Seal to water pump insert area of pump cover.
 - b. Install water pump insert into pump cover, being sure that tab on insert enters recess in pump cover.
 - c. Wipe any excess Perfect Seal from insert and cover.

NOTE: If 2 holes were drilled in top of water pump cover to aid in removal of insert, fill holes with G.E. Silicone Sealer or equivalent.

9. Install water tube seal (Figure 4) into pump cover, being sure that plastic side of seal goes into cover first.
10. Reinstall water tube guide into water pump cover.
11. Apply a light coat of Multipurpose Lubricant on inside of water pump insert.
12. Position assembled water pump cover over drive shaft and lower over water pump studs. Rotate drive shaft in a clockwise direction (viewed from top), while pushing down on pump cover to ease impeller entry into cover.
13. Install water pump cover retainer washers, nuts and bolt.
14. Tighten bolt and nuts evenly to specified torque under "Specifications" on Page 5B-2.

CAUTION: DO NOT over-torque nuts and bolt, as this could cause cover to crack during operation.

15. Install centrifugal slinger over drive shaft and down against pump cover.



11330
 a - Centrifugal Slinger
 b - Water Tube Guide
 c - Water Tube Seal
 d - Nuts, Bolts and Washers

Figure 4. Water Tube Seal Installation

Gear Lubricant Filling Instructions

1. Remove any gasket material from "Fill" and "Vent" screws and gear housing.
2. Install new gaskets on "Fill" and "Vent" screws.

IMPORTANT: Never apply lubricant to gear housing without first removing "Vent" screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing thru "Fill" hole with Super-Duty Gear Lubricant until lubricant flows out of "Vent" hole, and no air bubbles are visible.
4. At this point, drain approximately one fluid ounce (30cc) from gear housing to permit expansion of lubricant.
5. Install "Vent" screw into "Vent" hole.
6. Remove grease tube (or hose) from "Fill" hole and quickly install "Fill" screw into "Fill" hole.

Installing Gear Housing to Drive Shaft Housing

SAFETY WARNING: Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto drive shaft housing.

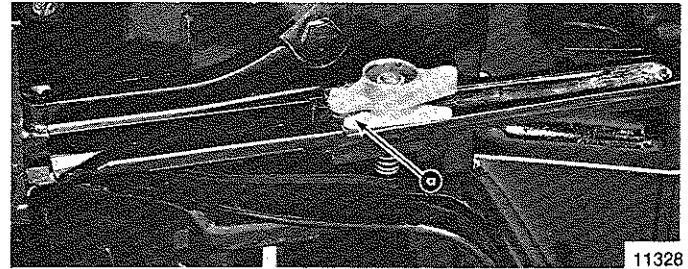
1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of Multipurpose Lubricant onto drive shaft splines.

CAUTION: DO NOT use excessive lubricant on top of drive shaft to crankshaft splines. Excess grease, that is trapped in clearance space, will not allow drive shaft to fully engage with crankshaft. Subsequently, tightening the gear housing nuts (while excess grease is on top of drive shaft) will load the drive shaft/crankshaft and damage either or both the powerhead and gear housing. Top of drive shaft is to be wiped free of grease.

3. Apply a light coat of Multipurpose Lubricant onto shift shaft splines. (DO NOT use grease on top of shift shaft.)
4. Apply a thin bead of G. E. Silicone Sealer (obtained locally) against the top of exhaust divider plate.
5. Insert trim tab bolt into hole in rear of gear housing to drive shaft housing machined surface.
6. Shift gear housing into forward gear and place guide block anchor pin (Figure 5) into forward gear position.
7. Position gear housing so that the drive shaft is protruding into drive shaft housing.

NOTE: If, while performing Step 8, the drive shaft splines will not align with crankshaft splines, place a propeller onto propeller shaft and turn it counterclockwise as the gear housing is being pushed toward drive shaft housing.

8. Move gear housing up toward drive shaft housing, while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of drive shaft housing). Start a nut on these studs and tighten finger-tight.



a - Guide Block Anchor Pin

Figure 5. Guide Block Anchor Pin in Forward Gear Position

10. Start bolt at rear of gear housing inside trim tab recess. DO NOT tighten bolt at this time.
11. Recheck shift shaft spline engagement and correct if necessary.
12. Evenly tighten 2 nuts which were started in Step 9. Torque to listing under "Specifications" on Page 5B-2.
13. After 2 nuts (located on either side of drive shaft housing) are tightened, check shift operation as follows:
 - a. Place guide block anchor pin into forward gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate clockwise.
 - b. Place guide block anchor pin into neutral position. Propeller shaft should rotate freely clockwise/counterclockwise.
 - c. Place guide block anchor pin into reverse gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate counterclockwise.

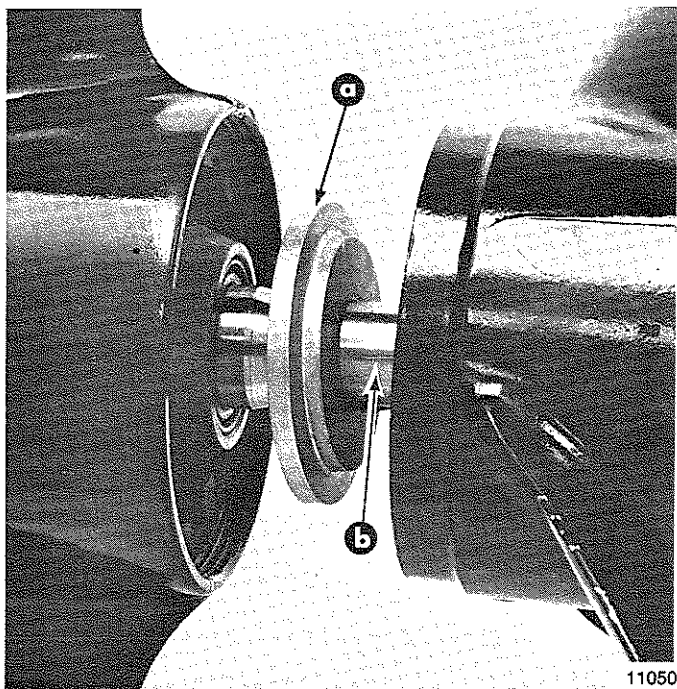
IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

14. Install washers and nuts onto studs (located on bottom center of anti-cavitation plate) and torque to specification.
15. Install special flat washer and nut on stud at leading edge of drive shaft housing and torque to specification.
16. Torque bolt (started in Step 10) to specification.
17. Install trim tab, adjust to position in which it had previously been installed, and tighten securely.
18. Install plastic cap into trim tab bolt opening at rear edge of drive shaft housing.

Propeller Installation

SAFETY WARNING: When installing or removing propeller, because of the motor's ease in starting, be sure that the remote control is in neutral position and that the key switch is "OFF". Place a block of wood between the anti-cavitation plate and propeller to prevent accidental motor starting and to protect hands from propeller blades while removing or installing nut.

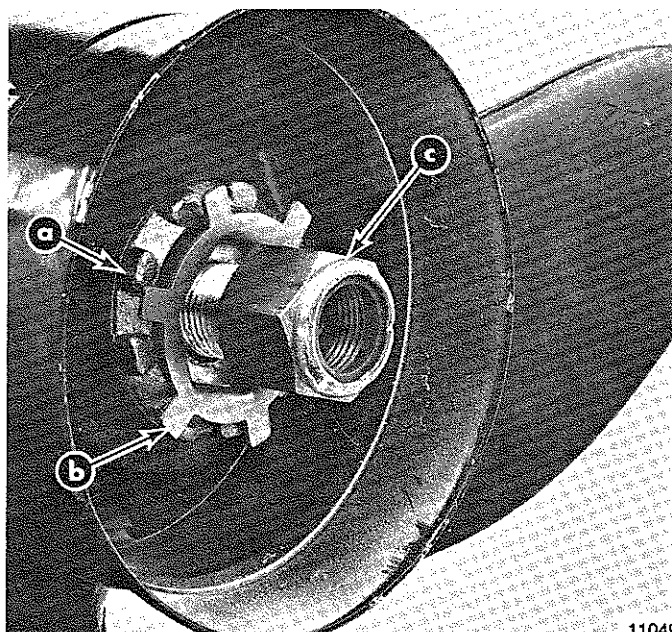
1. Apply a liberal coat of Perfect Seal to propeller shaft splines.



a - Forward Thrust Hub b - Propeller Shaft

Figure 6. Propeller Installation

2. Place forward thrust hub over propeller shaft with shoulder side into propeller. (Figure 6)
3. Place propeller on propeller shaft and slide it up against thrust hub.
4. Place rear thrust hub, tab washer and propeller nut on propeller shaft. (Figure 7)



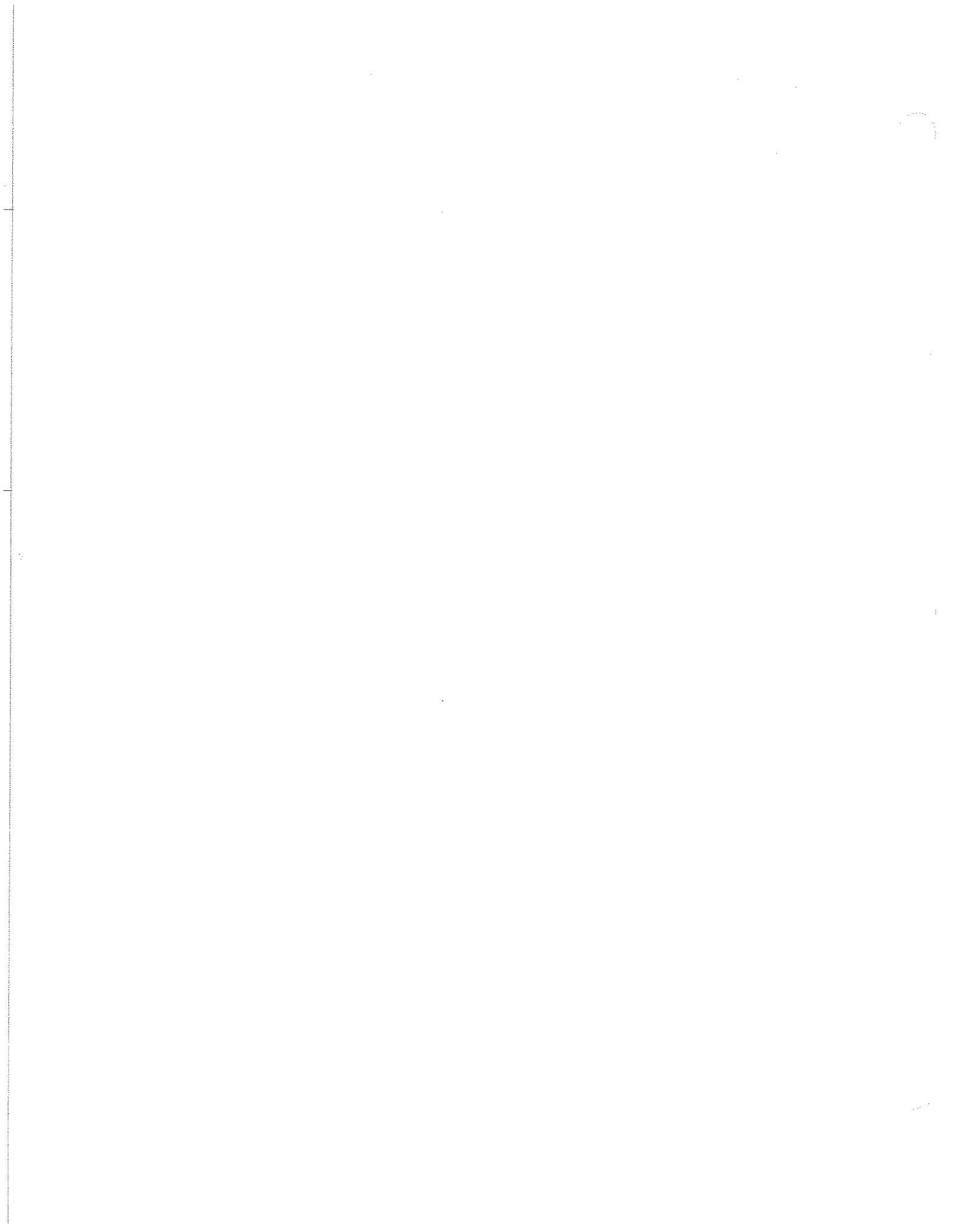
a - Rear Thrust Hub b - Tab Washer c - Propeller Nut

Figure 7. Propeller Nut and Tab Washer

5. Thread propeller nut on propeller shaft until nut is recessed into tab washer.
6. After propeller nut is recessed into tab washer, tighten nut securely [minimum of 55 ft. lbs. (7.6mkg) torque].
7. Bend 3 of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (Figure 7) (If tab washer tabs do not align with slots, continue to tighten propeller nut to obtain alignment. DO NOT loosen nut to align tabs.)

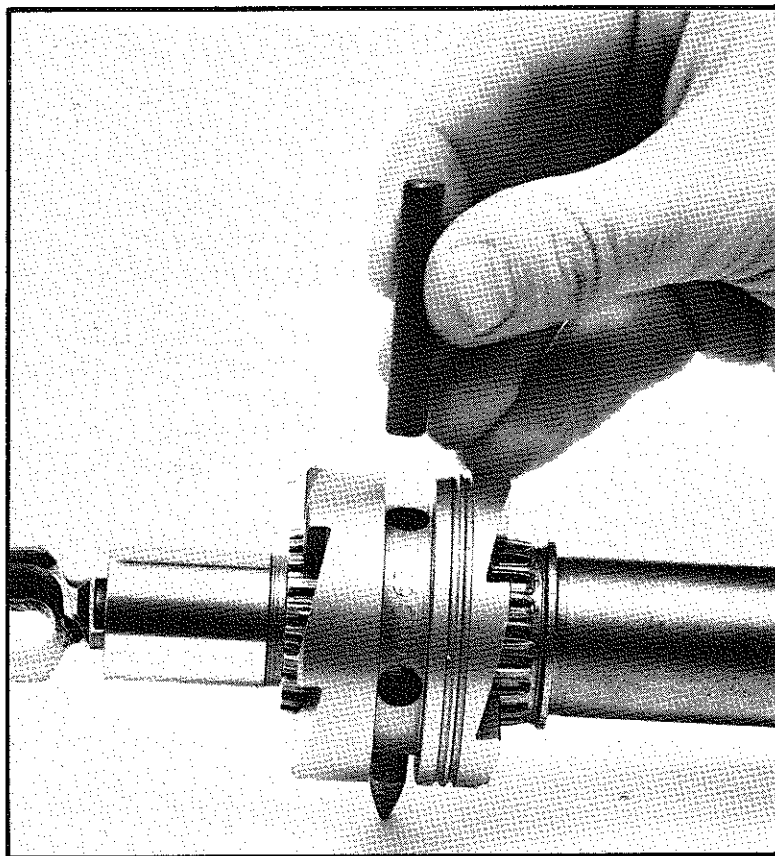
CAUTION: DO NOT misinterpret propeller shaft movement with propeller movement. If propeller and propeller shaft together move forward-and-aft, this is normal; however, propeller should not move forward-and-aft on propeller shaft.

8. After first use, retighten propeller nut and again secure with tab washer (Steps 6 and 7, above). Propeller should be checked periodically for tightness, particularly if stainless steel propellers are used.



V-6 OUTBOARDS

Lower Unit



E-Z Shift

SECTION

5

PART

C

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GENERAL INFORMATION

GEAR HOUSING IDENTIFICATION

To identify an E-Z Shift gear housing follow Step "1" or "2":

1. With gear housing connected to engine —
 - a. Shift engine into reverse gear.
 - b. Try to turn propeller shaft in a counterclockwise direction.
 - c. An E-Z shift gear housing propeller shaft will ratchet when turned in a counterclockwise direction. A Cam-Shift gear housing propeller shaft will not ratchet when turned in a counterclockwise direction.
2. With gear housing removed from engine
 - a. Shift gear housing into neutral position.
 - b. Turn shift shaft either side of neutral. The shift shaft in a E-Z Shift gear housing will turn only 30° either side of neutral. (Figure A) The shift shaft in a Cam-Shift gear housing will rotate 360° when turned counterclockwise.

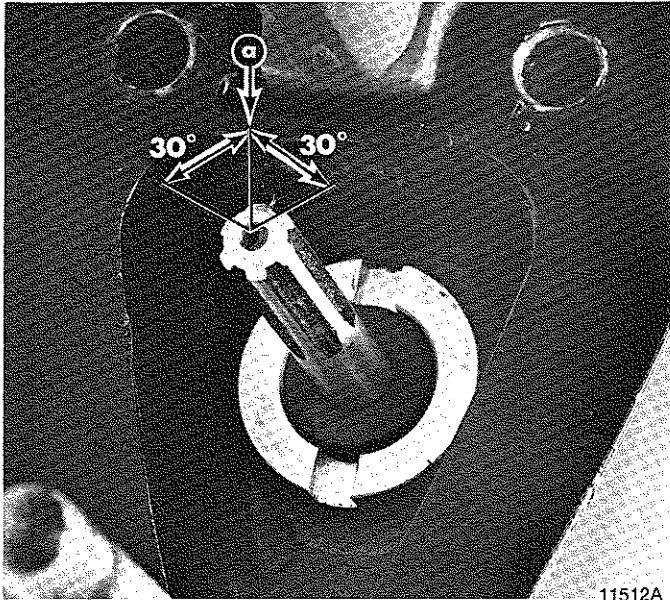


Figure A. E-Z Shift Gear Housing

SPECIAL TOOLS REQUIRED for DISASSEMBLY and REASSEMBLY of E-Z SHIFT GEAR HOUSING

Tool Description	Part No.
Shift Shaft Bushing Tool	C-91-31107
Gear Housing Cover Nut Tool	C-91-61069
Bearing Carrier Removal Tool	C-91-46086A1
Puller Bolt	C-91-85716
Slide Hammer Puller	C-91-34569A1
Bearing Removal and Installation Kit	C-91-31229A5
Pilot	C-91-36571
Puller Rod and Nut	C-91-31229
Puller Plate	C-91-29310
Puller Head	C-91-38628
Universal Puller Plate	C-91-37241
Cross Pin Tool	C-91-86642
Drive Shaft Nut Wrench	C-91-34377A1
Lubrication Sleeve Removal Tool	C-91-39281
Oil Seal Driver	C-91-31108
Forward Gear Bearing Tool	C-91-86943
Bearing Driver Cup	C-91-87120
Drive Shaft Tapered Bearing Driver	C-91-87119
Lubrication Sleeve Driver	C-91-39238
Bearing Cup Driver	C-91-34379
Pinion Gear Shimming Tool	C-91-74776
Backlash Indicator Rod	C-91-78473

GENERAL SERVICE RECOMMENDATIONS

There may be more than one way to "disassemble" or "re-assemble" a particular part(s), therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary until cleaning and inspection reveals that dis-assembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly -reassembly sequence. (Figures 1 and 2) It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to "reassembly and installation" of that component in the reassembly part of this section. Use the "Index" (on back of section divider) to find correct page number.

Threaded parts are right hand (RH), unless otherwise indicated.

If water or metal particles are present in gear lubricant, gear

housing should be completely disassembled (Figures 2A and 2B), cleaned and inspected.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, be sure that no water is present in air line.

BEARINGS

Upon disassembly of gear housing, all bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes thru the bearing. DO NOT spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with Formula 50 Oil. DO NOT lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches and bearing race side wear. Work inner bearing race in-and-out, while holding outer race, to check for side wear.

When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from overheating. Always replace tapered bearings as a set.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooving, imbedded particles, uneven wear and/or discoloration from overheating. The shaft and bearing must be replaced, if the conditions described are found.

SHIMS

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to

correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

SEALS

As a normal procedure, all "O" rings and oil seals **SHOULD BE REPLACED** without regard to appearance. To prevent leakage around oil seals, apply Loctite Type "A" to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply Multipurpose Lubricant to all "O" rings and oil seal lips.

To prevent corrosion damage after reassembly, apply Perfect Seal to external surfaces of bearing carrier and cover nut threads prior to installation. **DO NOT** allow Perfect Seal to enter bearings or "O" ring area.

TORQUE SPECIFICATIONS

Gear Housing Assembly Fastener Location	Size	Torque
Water Pump Nuts	1/4-28	30 In. Lbs. (35kg-cm)
Water Pump Nuts	5/16-24	40 In. Lbs. (46kg-cm)
Water Pump Screw	1/4-20	20 In. Lbs. (23kg-cm)
Bearing Carrier Nut	4-3/8"-16	210 Ft. Lbs. (29.04mkg)
Pinion Nut	5/8-18	70 Ft. Lbs. (9.68mkg)
Gear Housing to Drive Shaft Housing Nuts	3/8-16	55 Ft. Lbs. (7.61mkg)
Gear Housing to Drive Shaft Housing Nuts/Bolts	7/16-20	65 Ft. Lbs. (8.99mkg)
Trim Tab Screw	7/16-14	25 Ft. Lbs. (3.46mkg)

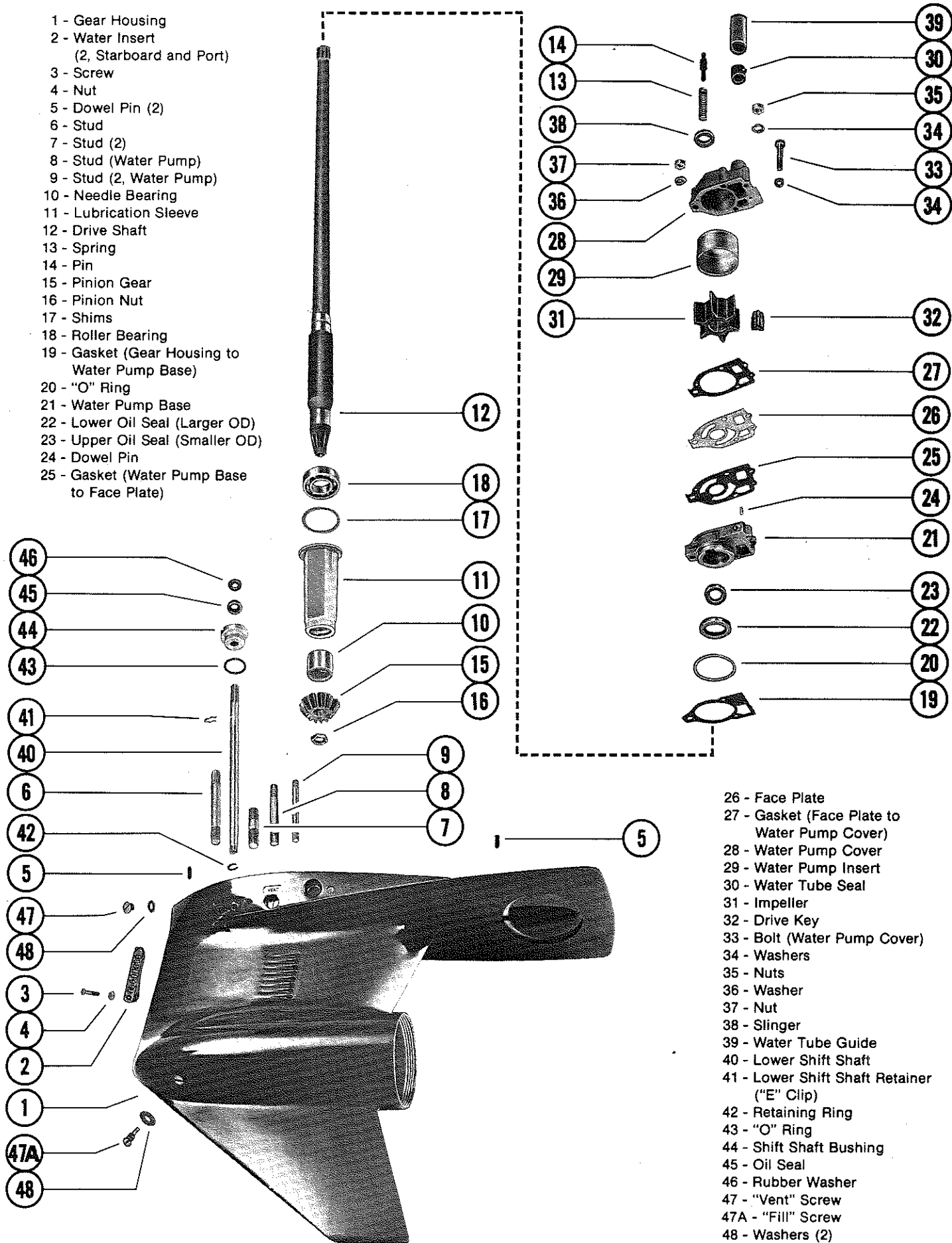
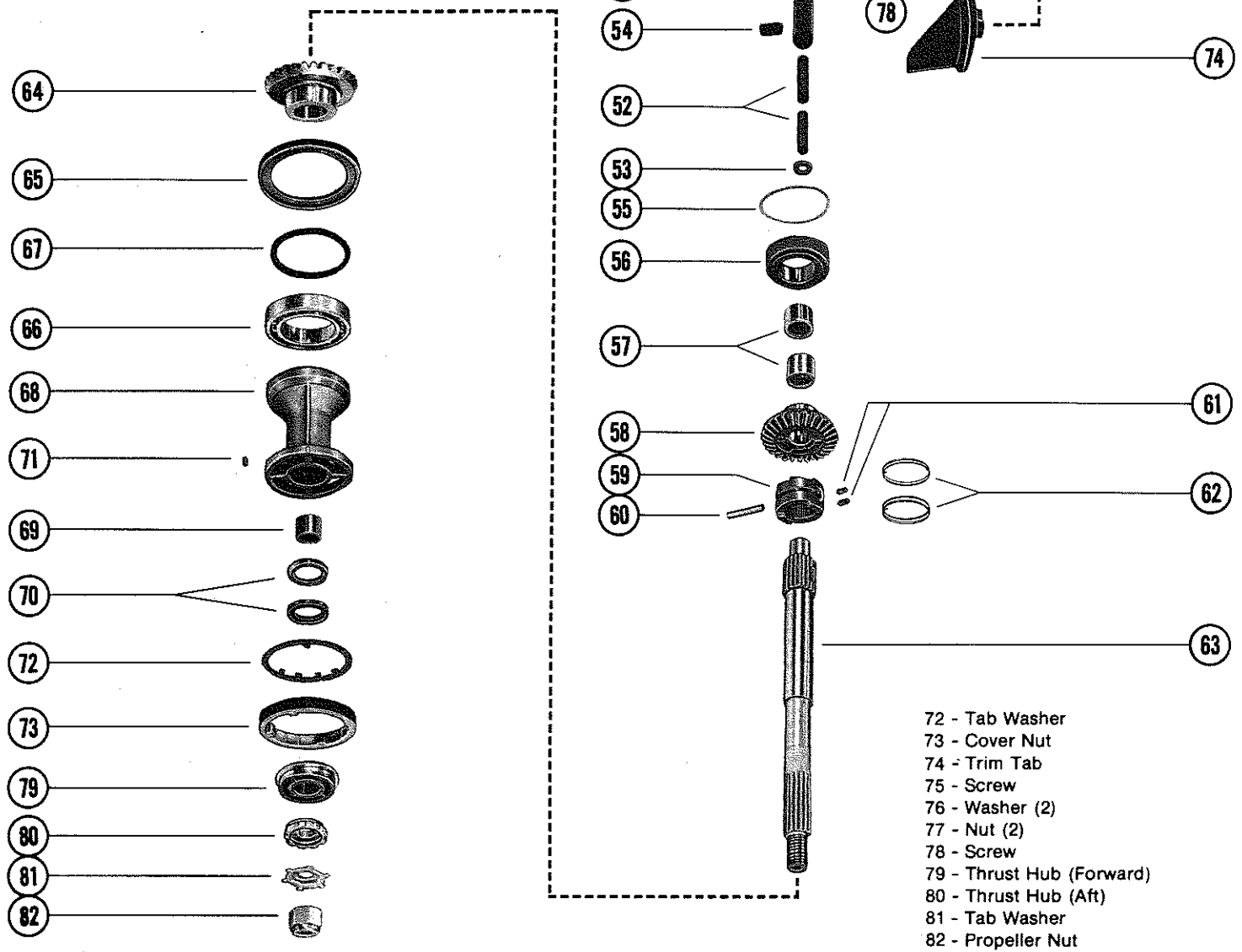


Figure 1. E-Z Shift Gear Housing Assembly (Drive Shaft and Water Pump Components)

- 1 - Gear Housing
- 49 - Shift Cam
- 50 - Cam Follower
- 51 - Clutch Actuator Rod
- 52 - Compression Springs
- 53 - Compression Spring Washers
- 54 - Locator Pin
- 55 - Shim
- 56 - Roller Bearing
- 57 - Needle Bearings
- (Forward Gear)
- 58 - Forward Gear
- 59 - Sliding Clutch
- 60 - Cross Pin
- 61 - Detent Pins
- 62 - Retaining Springs
- 63 - Propeller Shaft
- 64 - Reverse Gear
- 65 - Thrust Ring
- 66 - Ball Bearing (Reverse Gear)
- 67 - "O" Ring
- 68 - Bearing Carrier
- 69 - Needle Bearing
- 70 - Oil Seals
- 71 - Bearing Carrier Key



- 72 - Tab Washer
- 73 - Cover Nut
- 74 - Trim Tab
- 75 - Screw
- 76 - Washer (2)
- 77 - Nut (2)
- 78 - Screw
- 79 - Thrust Hub (Forward)
- 80 - Thrust Hub (Aft)
- 81 - Tab Washer
- 82 - Propeller Nut

Figure 2. E-Z Shift Gear Housing Assembly (Propeller Shaft Components)

REMOVAL, DISASSEMBLY, CLEANING and INSPECTION

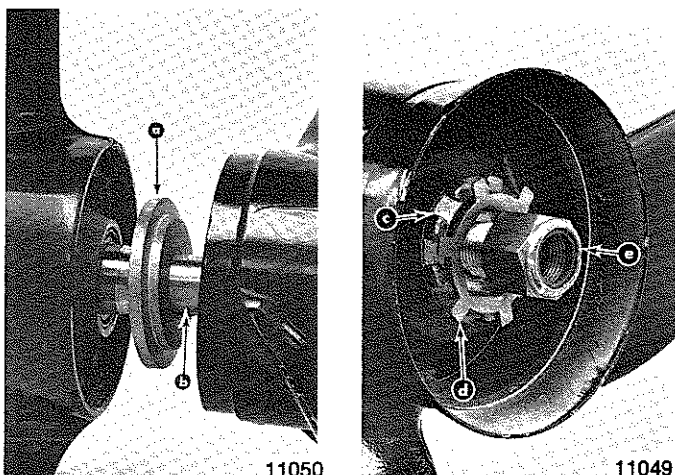
E-Z Shift Gear Housing

REMOVAL

SAFETY WARNING: Disconnect high tension leads from spark plugs and remove spark plugs from engine before removing gear housing from drive shaft housing.

1. Disconnect high tension leads from spark plugs and remove spark plugs from engine.

CAUTION: Gear housing **MUST BE** in neutral position and shift shaft **MUST BE** removed from gear housing **BEFORE** propeller shaft can be removed from gear housing.



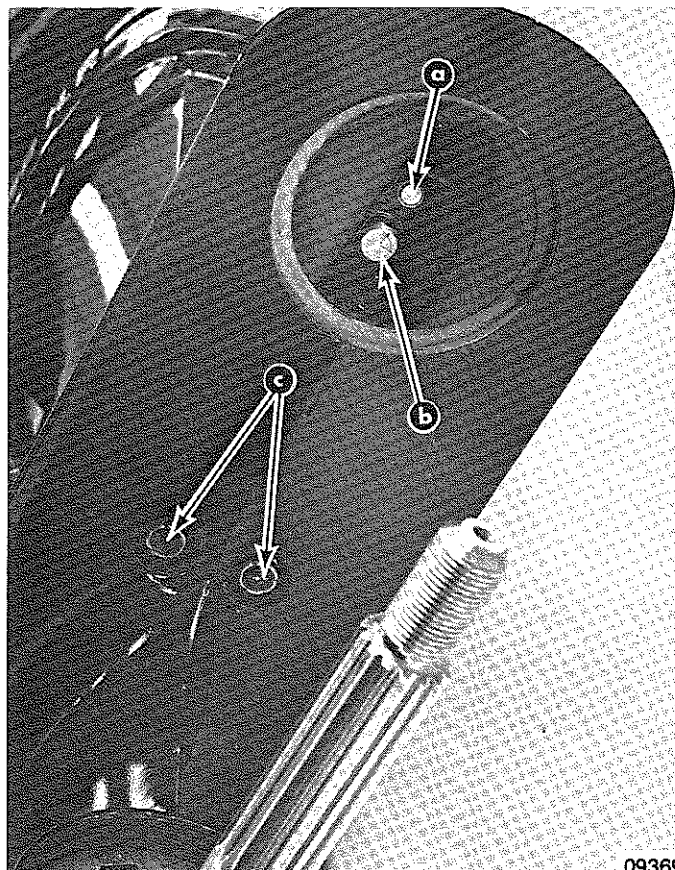
11050
a - Thrust Hub (Forward)
b - Propeller Shaft

11049
c - Rear Thrust Hub
d - Tab Washer

e - Propeller Nut

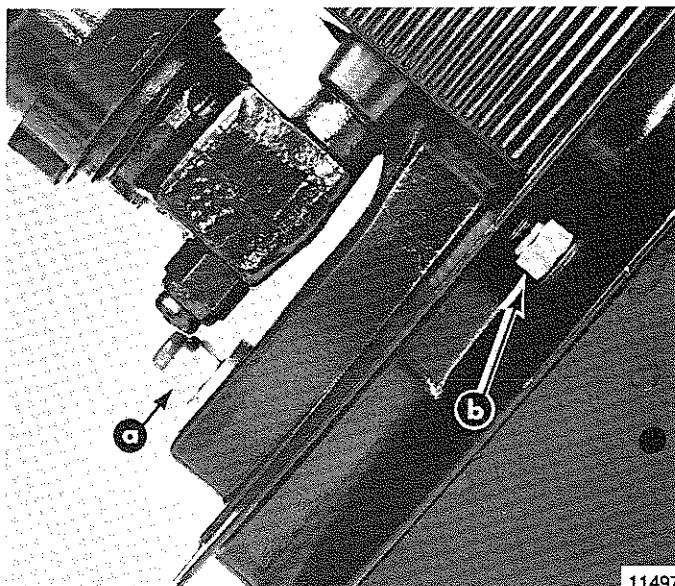
Figure 3. Propeller Removal

2. Shift engine into neutral position.
3. Tilt engine to full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (aft), then remove propeller locknut, tab washer, thrust hub (aft), propeller and thrust hub (forward) from propeller shaft. (Figure 3)
5. Mark gear housing and trim tab so that trim tab can be re-installed in the same position. Remove plastic cap at rear edge of drive shaft housing, then unthread bolt that secures trim tab and remove trim tab from gear housing.
6. Once trim tab is removed, remove bolt from inside of trim tab cavity. (Figure 4)
7. Remove 2 locknuts from bottom middle of anti-cavitation plate. (Figure 4)
8. Remove locknut from the front gear housing mounting stud. (Figure 5)
9. Loosen the side mounting locknuts. (Figure 5) (DO NOT attempt to remove one nut before opposite side is loosened sufficiently, or drive shaft housing could be damaged.)
10. Pull gear housing away from drive shaft housing as far as the loosened nuts (in Step 9) will allow, then remove



09369
a - Bolt (Secures Trim Tab)
b - Bolt (Inside Trim Tab Cavity) c - Locknuts and Washers

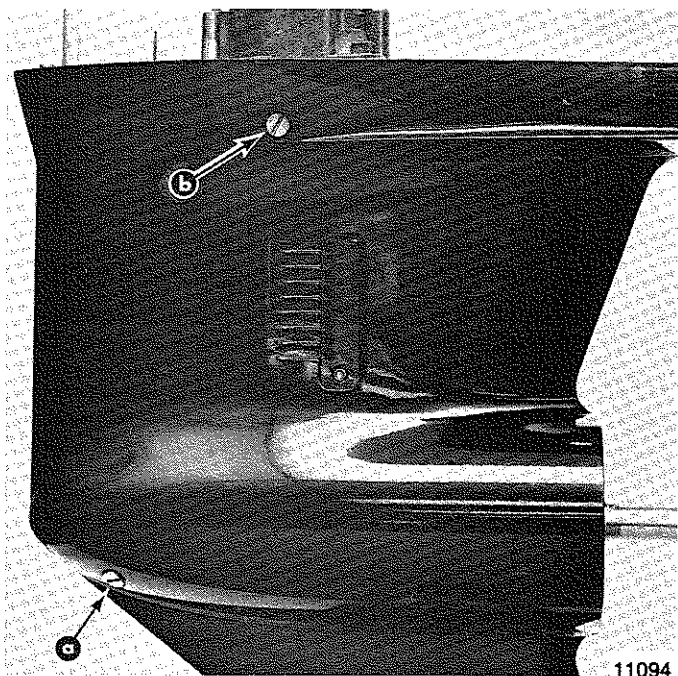
Figure 4. Gear Housing Removal



11497
a - Front Mounting Locknut
b - Side Mounting Locknut (One Each Side)

Figure 5. Gear Housing Removal

loosened nuts. (DO NOT allow gear housing to fall, as it now is free.)



11. Pull gear housing from drive shaft housing.

DRAINING LUBRICANT from GEAR HOUSING

1. Place gear housing in a suitable holding fixture or vise with the drive shaft in a vertical position, as shown in Figure 6.
2. Position a clean drain pan under gear housing and remove "Fill" and "Vent" screws (Figure 6) from gear housing.
3. Catch a small amount of gear lubricant on a finger, then rub finger and thumb together to check for metal particles. Also check magnet "Fill" plug for metal particles. (Presence of metal particles indicates need for complete disassembly of gear housing.)
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. (Presence of water in gear lubricant indicates the need for complete disassembly and inspection of oil seals, seal surfaces, "O" rings and gear housing.)

a - "Fill" Screw
b - "Vent" Screw

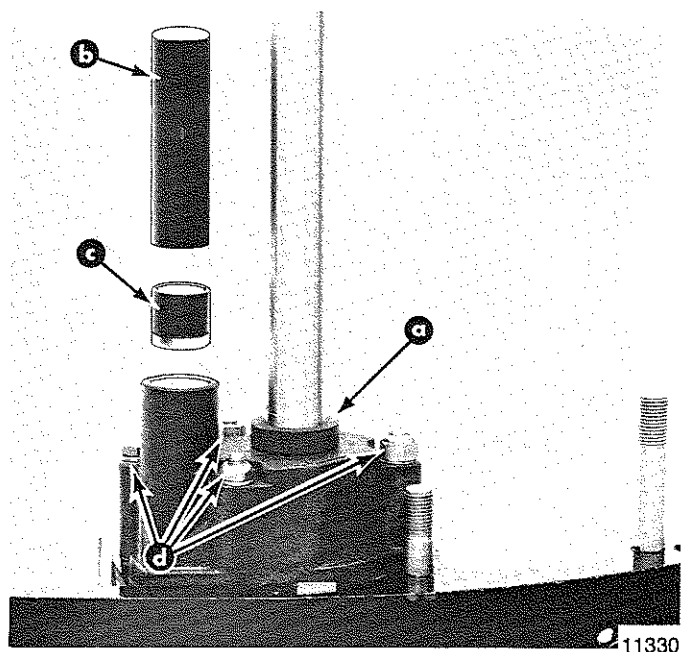
Figure 6. Gear Housing

Water Pump

REMOVAL and DISASSEMBLY

IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

1. Slide rubber centrifugal slinger up and off drive shaft. (Figure 7)
2. Remove water tube guide and seal (Figure 7) from water pump cover. (Retain guide for reassembly and discard seal.)
3. Remove (and retain) 3 nuts, one bolt and all washers which secure water pump cover to gear housing. (Figure 7)



a - Centrifugal Slinger c - Water Tube Seal
b - Water Tube Guide d - Nuts, Bolt and Washers To Be Removed

Figure 7. Water Pump Cover Removal

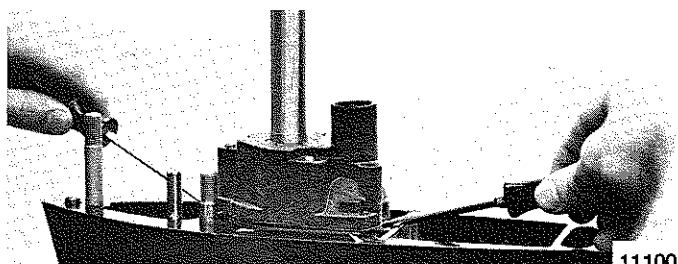


Figure 8. Water Pump Cover Removal

4. Using 2 pry bars, positioned as shown in Figure 8, lift water pump cover up and off drive shaft.
5. Inspect water pump cover and insert, as outlined in "Cleaning and Inspection", following.
6. If inspection of water pump insert determines that replacement is required, follow Step "a" or "b" (immediately following) to remove insert from water pump cover.

NOTE: Try Step "a" first. If insert cannot be removed with Step "a", use Step "b".

- a. Drive water pump insert out of water pump cover with a punch and hammer, as shown in Figure 9.
- b. Drill two 3/16" (4.8mm) diameter holes thru the top of water pump cover (but not thru insert) at locations shown in Figure 10. Drive insert out of cover with a punch and hammer, as shown in Figure 10.
7. Remove impeller from drive shaft. (It may be necessary to use a punch and hammer to drive impeller upward on drive shaft. In extreme cases, it may be necessary to split hub of impeller with a hammer and chisel.)
8. Once impeller is removed, remove impeller drive key from drive shaft.
9. Remove water pump face plate and both gaskets (one above and below face plate) from water pump base.
10. Using 2 pry bars, positioned and padded as shown in Figure 11, lift water pump base up and off drive shaft.

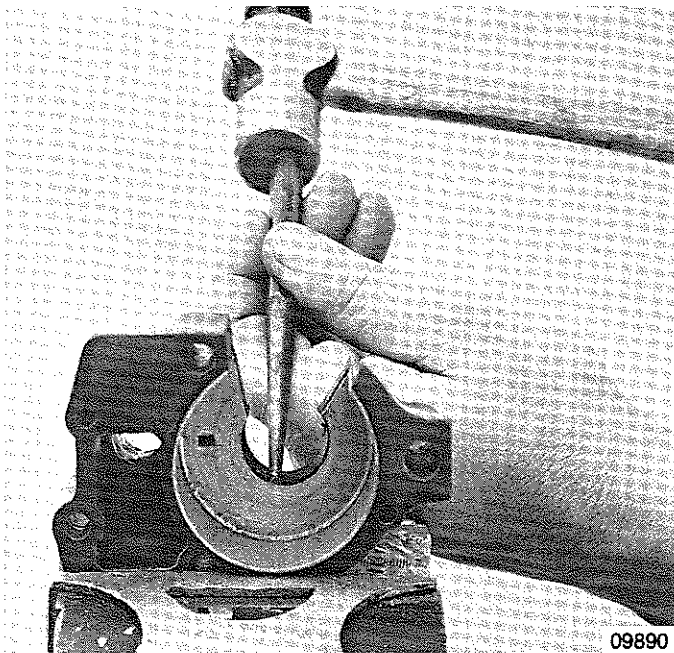
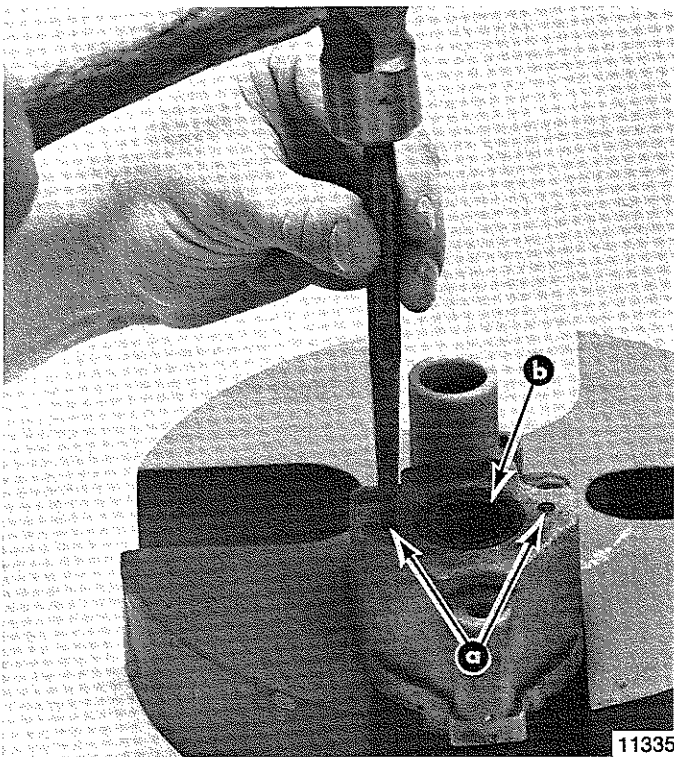


Figure 9. Water Pump Insert Removal



a - Pads

Figure 11. Water Pump Base Removal

CLEANING and INSPECTION

1. Clean all water pump parts with solvent and dry with compressed air.
2. Inspect water pump cover and base for cracks and distortion (from overheating).
3. Inspect face plate and water pump insert for grooves and/or rough surfaces.

IMPORTANT: When completing gear housing repairs, that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.

4. Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.
5. Inspect impeller bonding to impeller hub.
6. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

- a - Drill Two Holes at These Locations
- b - Seal (Not on All Water Pump Covers)

Figure 10. Water Pump Insert Removal

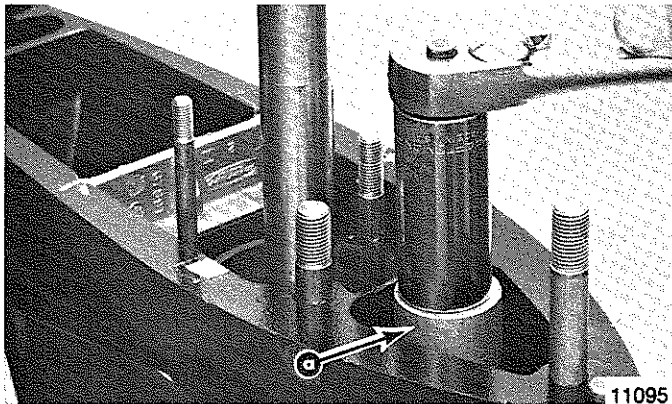
Bearing Carrier and Propeller Shaft

REMOVAL

CAUTION: Two types of gear housings (Cam-Shift and E-Z Shift) are used on V-6 engines. Although the outside appearance is identical, internally they are different. Because of the difference internally, gear housings **MUST BE** disassembled differently. Read "Gear Housing Identification" in "General Information", preceding, before removing bearing carrier or propeller shaft.

CAUTION: Gear housing **MUST BE** in neutral position, and shift shaft **MUST BE** removed from gear housing before propeller shaft can be removed from gear housing.

1. Place gear housing in a suitable holding fixture or vise with propeller shaft in a horizontal position.



a - Shift Shaft Bushing Tool (C-91-31107)

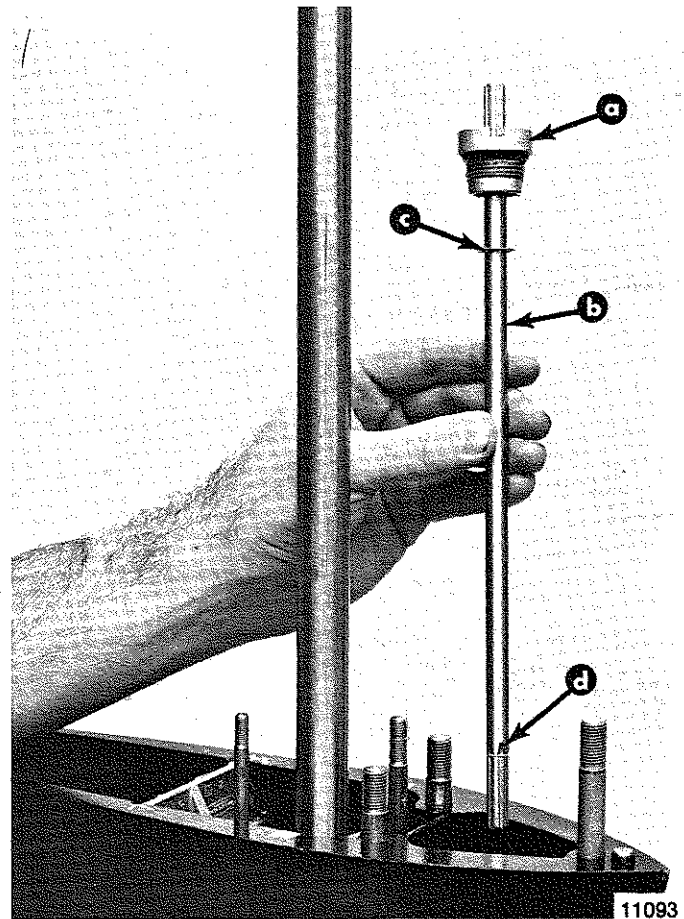
Figure 1. Unthreading Shift Shaft Bushing

2. Use Shift Shaft Bushing Tool (C-91-31107) to unthread shift shaft bushing. (Figure 1) (DO NOT remove bushing from shift shaft at this time.)

IMPORTANT: Prior to removal of shift shaft from gear housing, recheck that gear housing is in neutral position.

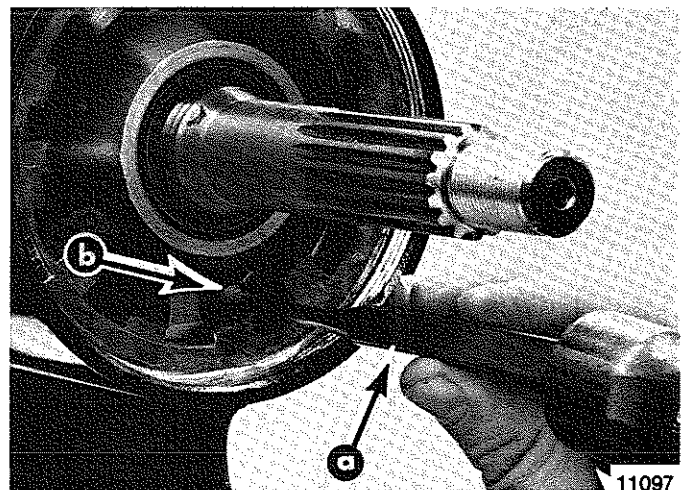
3. With gear housing in neutral, pull shift shaft out of gear housing. (Figure 2) If necessary, use a pliers to pull shift shaft out of gear housing. If pliers are used to pull shift shaft out, wrap a strip of soft metal (aluminum) around splines before clamping pliers. DO NOT turn shaft (clockwise OR counterclockwise) while pulling shaft out. (For further information on shift shaft, see "Shift Shaft Cleaning/Inspection and Disassembly".)
4. Bend cover nut lock tab out of cover nut recess. (Figure 3)
5. Remove gear housing cover nut with Cover Nut Tool (C-91-61069). (Figure 4)
6. After cover nut has been removed, remove lock tab washer from gear housing.

CAUTION: Once bearing carrier is removed from gear housing, extreme care **MUST BE** taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.



a - Shift Shaft Bushing
b - Shift Shaft
c - "E" Ring
d - Retaining Ring

Figure 2. Shift Shaft Removal

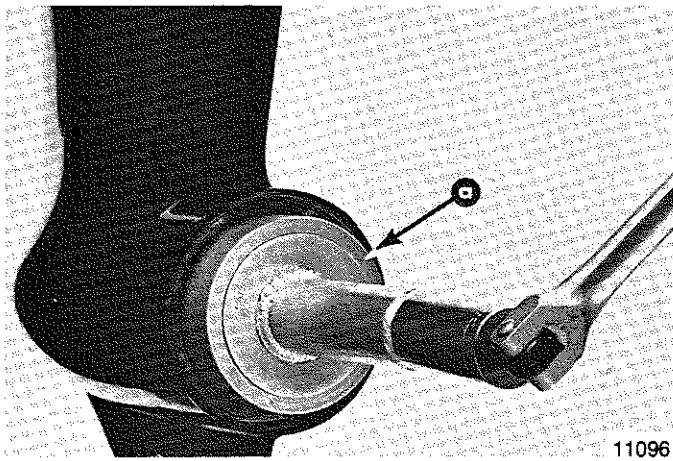


a - Punch
b - Tab of Tab Washer

Figure 3. Bending Lock Tab away from Cover Nut

7. Use long Puller Jaws (C-91-46086A1) and Puller Bolt (C-91-85716), as shown in Figure 5, to remove bearing carrier. (Use propeller thrust hub to maintain outward pressure on puller jaws.)

NOTE: When bearing carrier is removed from gear housing, the bearing carrier alignment key will come out with it.

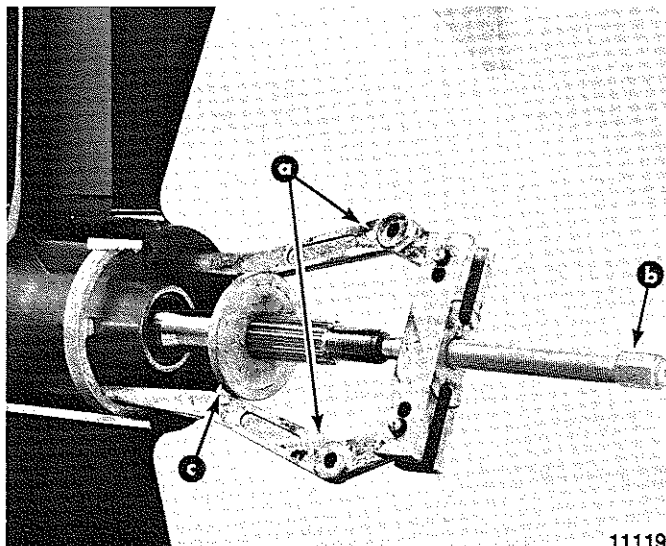


a - Cover Nut Tool (C-91-61069)

Figure 4. Cover Nut Removal

CAUTION: Propeller shaft, cam follower and shift cam, in most cases, will come out of gear housing by simply pulling outward on propeller shaft. **DO NOT FORCE** shaft sideways or **ATTEMPT TO PULL** with a slide hammer or any mechanical puller.

8. Remove propeller shaft, cam follower and shift cam by pulling shaft straight out of gear housing. (DO NOT JERK propeller shaft.) If propeller shaft will not come out, proceed with Step "a" or "b", following:
 - a. Push propeller shaft back into place against the forward gear. Visually inspect location of shift cam by looking down shift shaft hole (illuminated with a flashlight). If splined hole in shift cam is visible, reinstall shift shaft and rotate shift shaft to neutral position. Remove shift shaft, then remove propeller shaft as instructed in Step 8, immediately preceding.
 - b. Push propeller shaft back into place against forward gear. Slide bearing carrier back into gear housing (to



a - Long Puller Jaws (C-91-46086A1)
b - Puller Bolt (C-91-85716)
c - Thrust Hub

Figure 5. Bearing Carrier Removal

support propeller shaft). Place gear housing on its left side (viewed from rear) and strike upper leading end of gear housing with a rubber mallet. This will dislodge the shift cam from cam follower into a clearance pocket in left side of gear housing. Remove bearing carrier and pull propeller shaft out of gear housing.

NOTE: If Step 8-b was used to remove propeller shaft, the shift cam can be retrieved after removal of forward gear.

CLEANING/INSPECTION - BEARING CARRIER

IMPORTANT: It is recommended that all seals and "O" rings be replaced (as a normal repair procedure) to assure effective repair.

1. Clean bearing carrier with solvent and dry with compressed air.

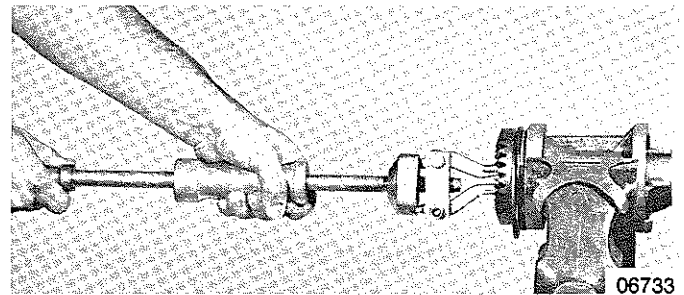
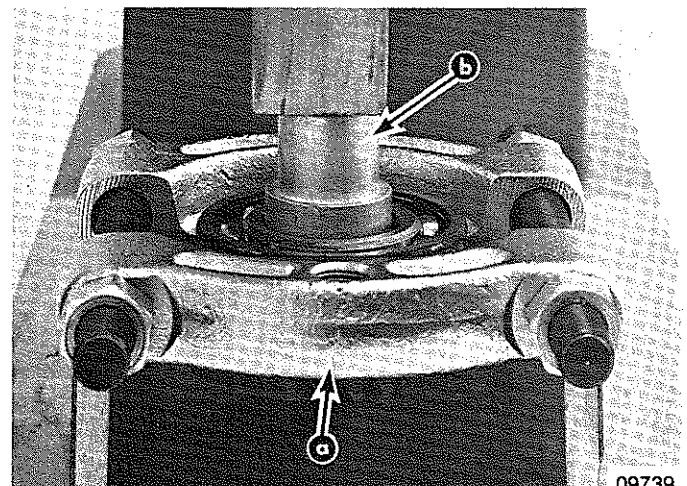


Figure 6. Removing Reverse Gear and Bearing from Bearing Carrier



a - Universal Puller Plate

b - Mandrel

Figure 7. Removing Reverse Gear Bearing from Reverse Gear

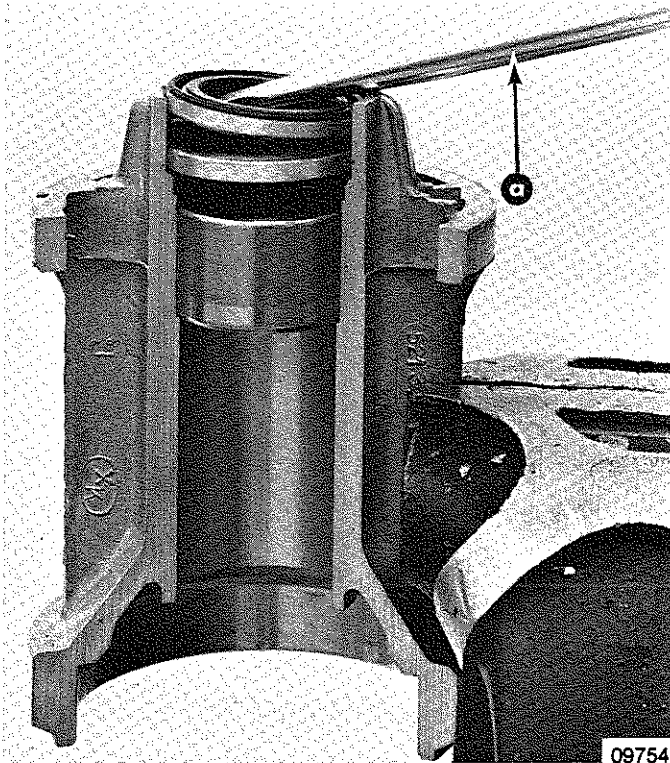
CAUTION: DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

2. Bearing carrier propeller shaft needle bearing condition is determined by propeller shaft bearing surface condition. (See "Propeller Shaft Inspection".)
3. Inspect reverse gear to pinion gear wear pattern (should be even and smooth). If not, replace reverse gear and pinion gear.
4. Check clutch jaws on reverse gear for damage. Replace reverse gear, if damage is found on clutch jaws.
5. Apply light oil to reverse gear bearing. Rotate reverse gear bearing while checking bearing for rough spots and/or catches. Push in and pull out on reverse gear to check for

bearing side wear. Replace bearing if any of the listed conditions exist.

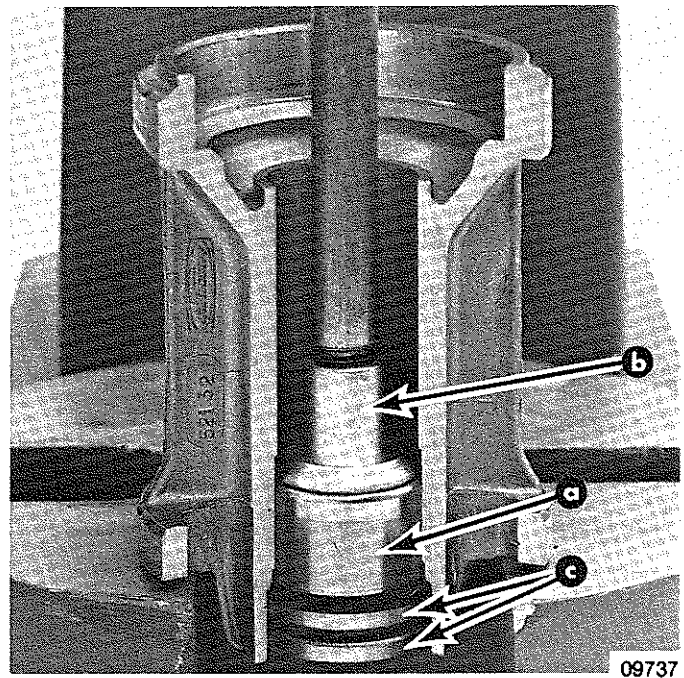
DISASSEMBLY - BEARING CARRIER

1. Remove and discard "O" ring from between bearing carrier and thrust washer.
2. If inspection of reverse gear or reverse gear bearing determines that replacement of gear or bearing is required, remove gear and bearing as follows:
 - a. Position bearing carrier in a soft jaw vise, as shown in Figure 6.
 - b. Use Slide Hammer (C-91-34569A1), as shown in Figure 6, and remove reverse gear.
 - c. If reverse gear bearing remains attached to reverse gear, install Universal Puller Plate (C-91-37241), as shown in Figure 7, and position puller plate, gear and bearing on a press with gear side down. Use a suitable mandrel and press gear out of bearing. (Figure 7)



a - Pry Bar

Figure 8. Removing Propeller Shaft Oil Seals



a - Propeller Shaft Needle Bearing
b - Mandrel
c - Oil Seals

Figure 9. Propeller Shaft Needle Bearing and Oil Seals Removal

- d. If reverse gear bearing has remained in bearing carrier, use slide hammer to remove bearing in the same method as was used to remove reverse gear (Step "b").
3. Propeller shaft oil seals can be removed either by (a) using a pry bar, as shown in Figure 8, or (b) pressing seals out when propeller shaft needle bearing is pressed out of bearing carrier. (Figure 9)

NOTE: Unless propeller shaft needle bearing is going to be replaced, do not use Step 3-b.

4. If inspection of propeller shaft needle bearing determines that replacement of bearing is required, use Universal Bearing Removal and Installation Tool (C-91-31229A1), as shown in Figure 9, to press bearing and seals out of bearing carrier.

NOTE: Reverse gear must be removed from bearing carrier before propeller shaft needle bearing can be removed.

Shift Shaft

CLEANING and INSPECTION

1. Clean shift shaft and bushing with solvent and dry with compressed air.
2. Check shift shaft splines on both ends for wear and/or corrosion damage.
3. Inspect shift shaft for groove(s) at shift shaft bushing seal surface.
4. Inspect shift shaft bushing for corrosion damage.
5. Inspect shift shaft bushing oil seal for wear and/or cuts.

NOTE: Oil seal in shift shaft bushing should be replaced as a normal repair procedure. If shift shaft bushing is equipped

with 2 oil seals, and seals need to be replaced, order a new shift shaft bushing assembly. Oil seals in a 2 seal shift shaft bushing are not replaceable.

6. Check "E" clip and retaining ring for damage. Replace if damaged.

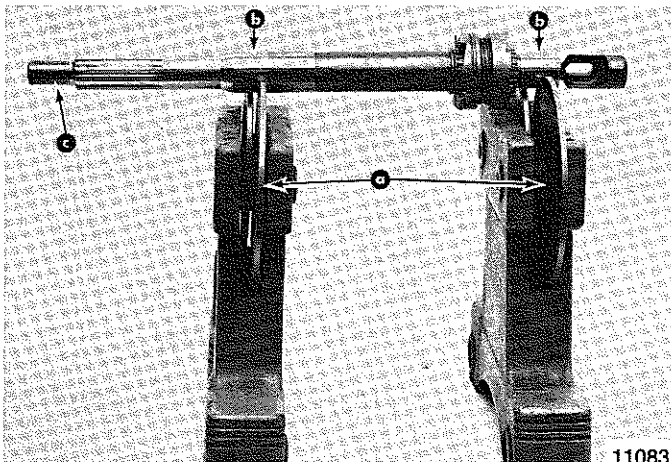
DISASSEMBLY

1. Remove (and discard) shift shaft bushing oil seal by prying it out or driving it out with a punch and hammer.
2. Remove "E" clip and retaining ring if inspection determines that replacement is required.

Propeller Shaft

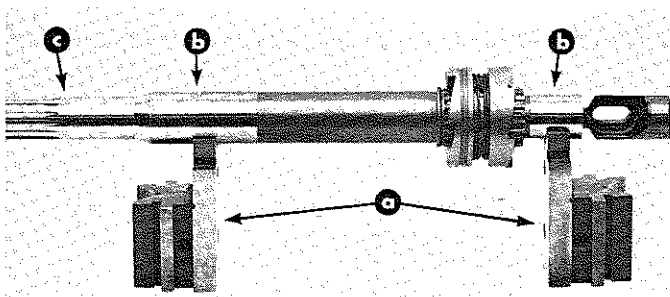
INSPECTION

1. Clean propeller shaft assembly with solvent and dry with compressed air.
2. Inspect bearing carrier oil seal surfaces for grooves. Run fingernail across seal surface to check for groove. Replace shaft if groove is found.
3. Visually check bearing surfaces of propeller shaft for pitting, grooves, scoring, uneven wear or discoloration (bluish color) from overheating. Replace shaft and corresponding needle bearing if any of the above conditions are found. (Bearing carrier needle bearing contacts propeller shaft just in front of oil seal surface. Forward gear bearing contacts propeller shaft in front of sliding clutch splines.)
4. Inspect propeller shaft splines for wear and/or corrosion damage.



a - Balance Wheels b - Bearing Surfaces
c - Watch for "Wobble"

Figure 1. Checking Propeller Shaft Straightness with Balance Wheels



a - "Vee" Blocks b - Bearing Surfaces
c - Measure with Dial Indicator at This Point

Figure 2. Checking Propeller Shaft Straightness with "Vee" Blocks

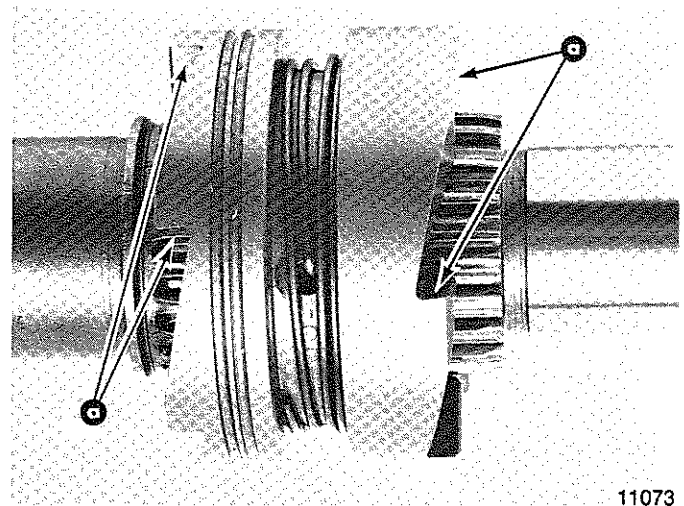
5. Check propeller shaft for straightness. Use either method, following:

Balance Wheels

Place propeller shaft on balance wheels, as shown in Figure 1. Rotate propeller shaft and observe propeller end of shaft for "wobble". Replace shaft if any "wobble" is observed.

"Vee" Blocks and Dial Indicator

Position propeller shaft roller bearing surfaces on "vee" blocks. (Figure 2) Mount a dial indicator at front edge of



a - Clutch "Jaws"

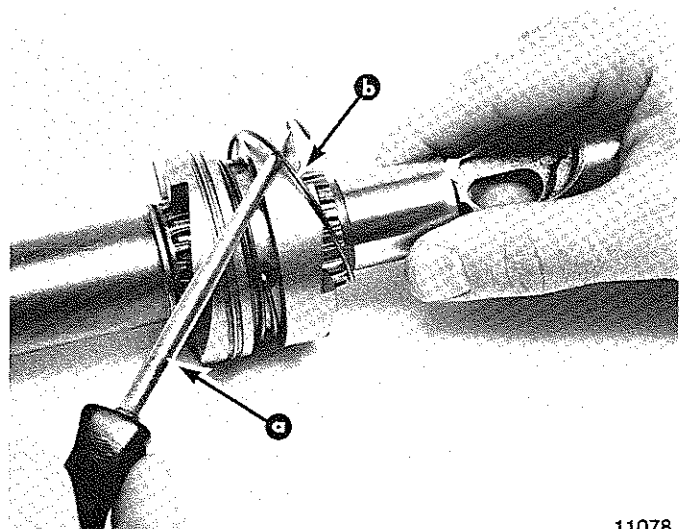
Figure 3. Sliding Clutch Inspection

propeller splines ("C" in Figure 2). Rotate propeller shaft. Dial indicator movement of more than .006" (.152mm) (or noticeable "wobble") is reason for replacement.

6. Inspect sliding clutch. Check reverse gear and forward gear clutch "jaws". (Figure 3) Rounded "jaws" indicate one or more of the following:
 - a. Improper shift cable adjustment.
 - b. Improper shift habits of operator(s) (shift from neutral to reverse gear too slowly).
 - c. Engine idle speed too high (while shifting).
7. Check condition of cam follower. If it shows wear (pitting, scoring or rough surface), replace cam follower and shift cam.

DISASSEMBLY

1. Remove shift cam from cam follower.
2. Insert a thin blade screwdriver or awl under first coil of cross pin retainer spring and rotate propeller shaft to unwind spring from sliding clutch. (Figure 4) DO NOT overstretch spring.



a - Awl

b - Cross Pin Retainer Spring

Figure 4. Cross Pin Retainer Spring Removal

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- Remove the second cross pin retainer spring from sliding clutch in the same way as in Step 2.

CAUTION: Detent pins are free and can fall out of sliding clutch. Care MUST BE taken not to lose pins.

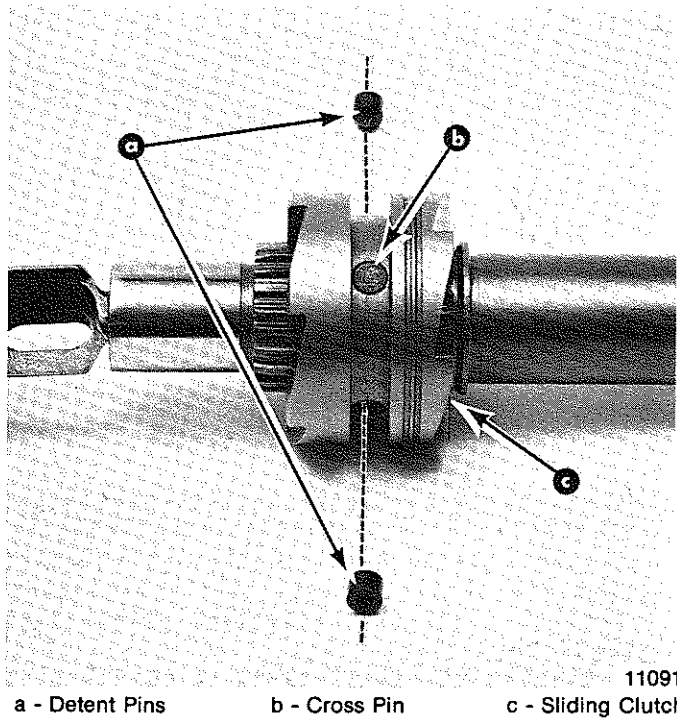


Figure 5. Detent Pins Removal

- Detent pins (Figure 5) are free and can be removed from sliding clutch at this time.
- Push cross pin out of sliding clutch and propeller shaft with a punch. (Figure 6)
- Pull sliding clutch off propeller shaft.
- Pull cam follower and clutch actuator rod out of propeller shaft. (Figure 7) **DO NOT** force cam follower up-or-down or side-to-side when pulling from propeller shaft.
- Once cam follower and clutch actuator rod are removed from propeller shaft, lift rod out of cam follower.

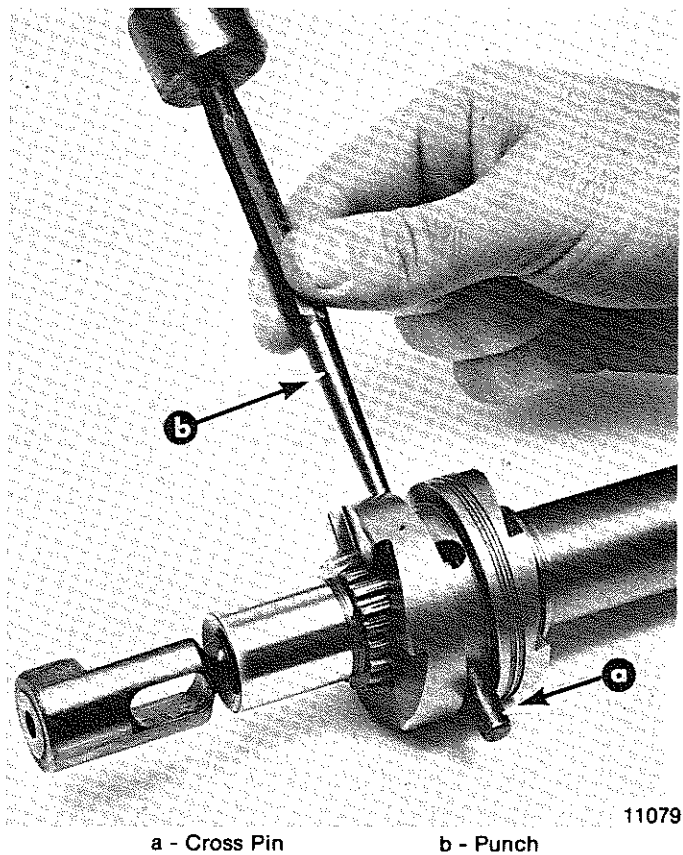


Figure 6. Cross Pin Removal

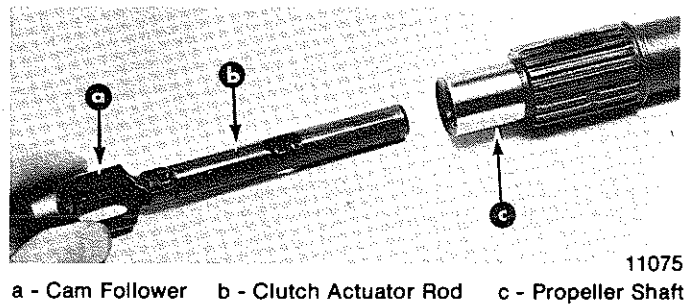


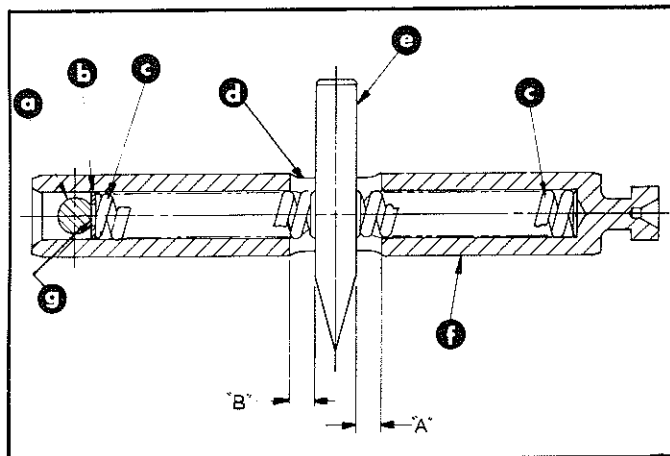
Figure 7. Cam Follower and Clutch Actuator Rod Removal

Clutch Actuator Rod

CLEANING and INSPECTION

CAUTION: Care MUST BE taken when handling clutch actuator rod. The locating pin (Figure 8) is free and will fall out, allowing compression springs and shims to fall out.

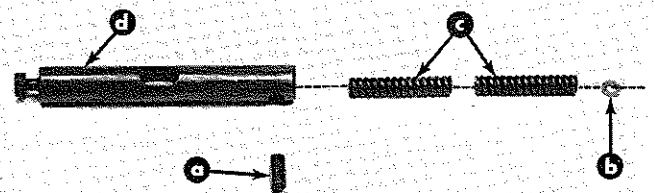
1. Clean clutch actuator rod in solvent and dry with compressed air.
2. Insert Cross Pin Tool (C-91-86642) between compression springs in elongated slot in clutch rod. (Figure 8)



- | | |
|---|---------------------------------|
| a - Spring Locating Pin | d - Elongated Slot |
| b - Shim Washer | e - Cross Pin Tool (C-91-86642) |
| c - Compression Spring | f - Clutch Actuator Rod |
| g - Shim Washer Must Rest on Flat Side of Spring Locating Pin | |

NOTE: "A" and "B" Measurements Must Be Equal within 1/64" [.016" (0.4mm)].

Figure 8. Determining Spring Condition



- | | |
|--------------------|-------------------------|
| a - Locating Pin | c - Compression Springs |
| b - Shim Washer(s) | d - Clutch Actuator Rod |

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Figure 9. Compression Springs Removed

3. Compress both springs by forcing cross pin tool back-and-forth in elongated slot. This will release any initial set from springs.
4. Measure distance from each end of elongated slot to the near side of cross pin tool. (Figure 8) The measurements taken must be equal within 1/64" [.016" (0.4mm)].
5. If measurements (taken in Step 4) are not equal to within 1/64", disassembly of clutch actuator rod must be performed to determine the reason. [Reasons for unequal measurements may be a broken spring, a spring of reduced length (see Step 6) or the wrong spring shimming.]
6. If disassembly is performed on clutch actuator rod, spring length must be 1.535" to 1.560" [1-17/32" to 1-9/16" (38.9mm to 39.7mm)].

DISASSEMBLY

IMPORTANT: Keep a record of shim amounts and location during disassembly of clutch actuator rod to aid in reassembly.

1. Push locating pin (Figure 9) out of clutch actuator rod.
2. After locating pin is removed, compression springs and shim(s) are free to fall out of clutch actuator rod. (Figure 9)
3. Refer to Step 6 in "Clutch Actuator Rod-Inspection" for spring length requirements.

Pinion Gear and Drive Shaft

REMOVAL

1. Place Drive Shaft Nut Wrench (C-91-34377A1) over drive shaft splines.
2. Use a socket and flex handle to hold pinion nut. (Pad area of gear housing, where flex handle will make contact, to prevent damage to gear housing.)
3. Use a socket and flex handle on drive shaft nut wrench to loosen pinion gear nut. Remove pinion nut and drive shaft nut wrench.
4. Remove gear housing from vise and reposition it as shown in Figure 1. Be sure to use soft jaw vise covers (Figure 1) and clamp as close as possible to water pump studs.

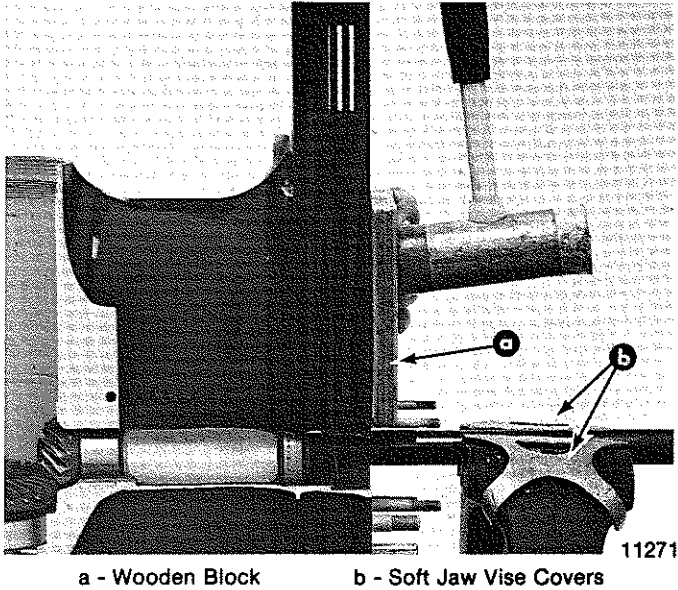


Figure 1. Removing Drive Shaft

5. Place a block of wood on gear housing matching surface. (Figure 1) Use a mallet and carefully tap drive shaft away from gear housing.

CAUTION: DO NOT strike gear housing hard with the mallet or allow gear housing to fall.

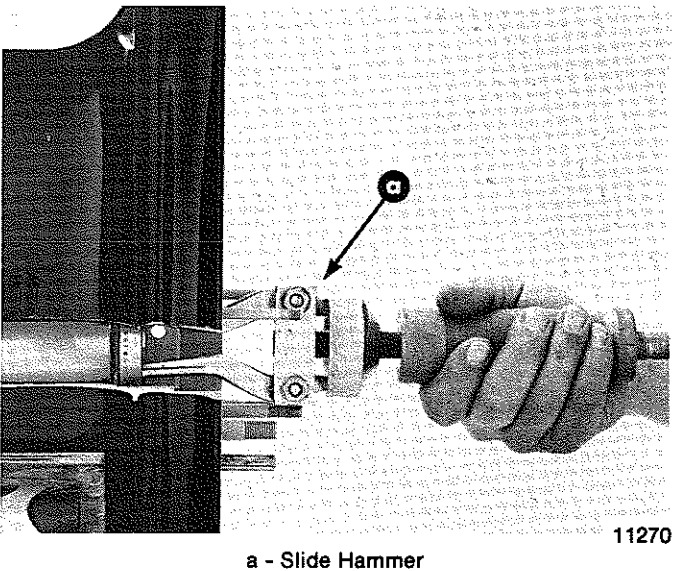
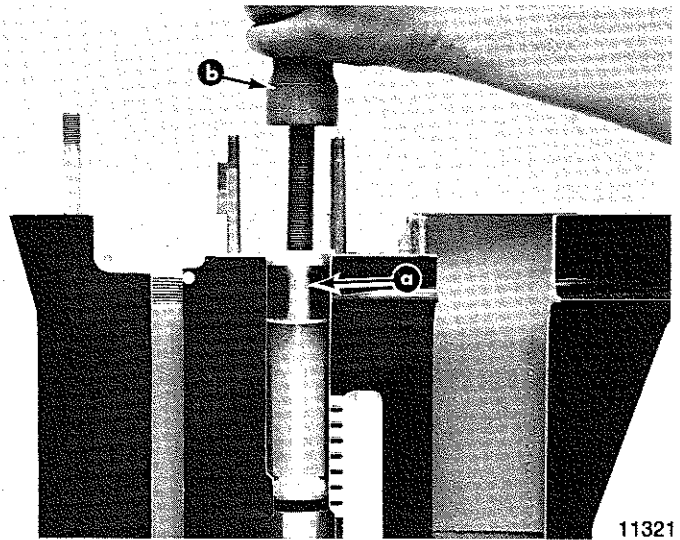


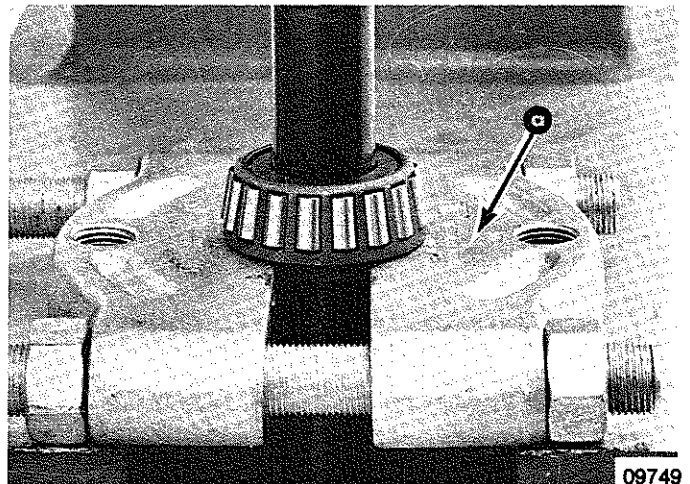
Figure 2. Drive Shaft Tapered Bearing Removal



a - Lubrication Sleeve Removal Tool (C-91-39281)
b - Slide Hammer Puller

Figure 3. Lubrication Sleeve Removal

6. Reach into gear housing and remove pinion gear.
7. Use a Slide Hammer (C-91-34569A1) to remove drive shaft tapered bearing race. (Figure 2) Retain shim(s).
8. Thread Lubrication Sleeve Removal Tool (C-91-39281) into lubrication sleeve (left hand thread) and thread end of



a - Universal Puller Plate

Figure 4. Removing Drive Shaft Tapered Bearing

Slide Hammer Puller (C-91-34569A1) into sleeve tool to remove lubrication sleeve. (Figure 3)

9. If inspection determines that replacement of drive shaft tapered bearing is required, remove bearing from drive shaft as follows:
 - a. Place Universal Puller Plate (C-91-37241) over water pump side of tapered bearing.
 - b. Place puller plate and drive shaft in a press (Figure 4) and press drive shaft out of bearing.

NOTE: Forward gear is positioned free in gear housing and must be lifted out before Step 10 is performed.

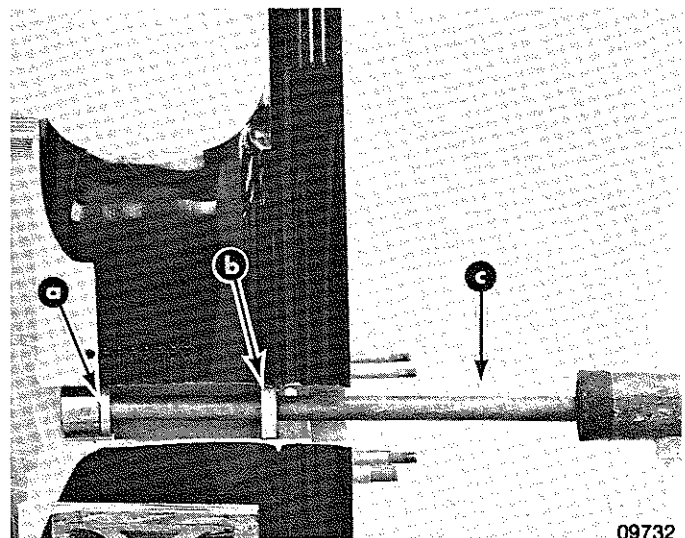
10. If inspection of drive shaft needle bearing surface determines that replacement of needle bearing (Figure 5) is required, remove bearing from gear housing as follows:

- a. Use a suitable driver head, pilot and mandrel from Bearing Removal and Installation Kit (C-91-31229A1). (Figure 5)
- b. Remove drive shaft needle bearing by striking driver head with a mallet.

NOTE: Discard drive shaft needle bearing after removal. (Bearing cannot be re-used.)

CLEANING and INSPECTION

1. Clean drive shaft, tapered bearing race and pinion gear with solvent. Dry with compressed air. **DO NOT** spin drive shaft bearing.
2. Inspect pinion gear for pitting, grooves, scoring, uneven wear and discoloration from overheating. Replace pinion gear, if any of the above conditions are found.
3. Inspect drive shaft needle bearing surface (area just above pinion gear splines) for pitting, grooves, scoring, uneven wear and/or discoloration from overheating. Replace drive shaft and drive shaft needle bearing, if any of the preceding conditions are found.
4. Inspect drive shaft to crankshaft splines for wear. Replace drive shaft if wear is excessive.
5. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration from overheating. Always



a - Mandrel b - Pilot c - Driver Head

Figure 5. Removing Drive Shaft Needle Bearing

replace tapered bearing and race, if any of the preceding conditions are found.

6. Inspect water pump base oil seal surface for grooves. Replace drive shaft if any grooves are found.

Forward Gear

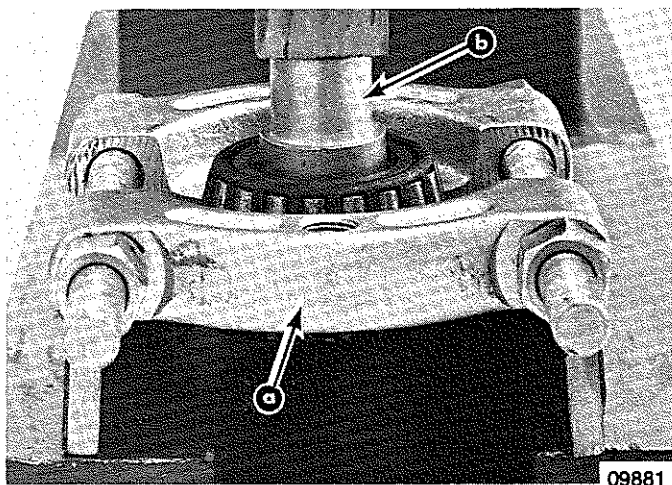
REMOVAL and DISASSEMBLY

NOTE: Forward gear only can be removed from gear housing after drive shaft and pinion gear have been removed.

1. Reach into gear housing and lift out forward gear.

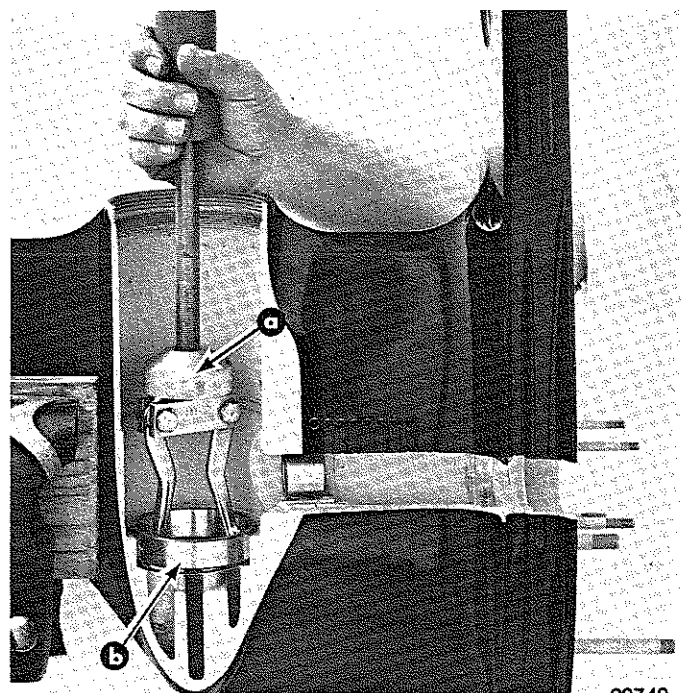
IMPORTANT: DO NOT remove tapered bearing or needle bearings from forward gear, unless replacement of bearings is required. (Bearings cannot be re-used after they have been removed.)

2. If inspection determines that replacement of forward gear tapered bearing is required, remove bearing from gear and bearing race from gear housing (tapered bearings **MUST BE** replaced as a set), as follows:
 - a. Install Universal Puller Plate (C-91-37241) between forward gear and tapered bearing. (Figure 6)



a - Universal Puller Plate b - Mandrel

Figure 6. Removing Tapered Bearing from Forward Gear



a - Slide Hammer b - Tapered Bearing Race

Figure 7. Forward Gear Tapered Bearing Race Removal

- b. Place forward gear, bearing and puller plate on a press (Figure 6) and press gear out of bearing with a suitable mandrel.
- c. Use Slide Hammer (C-91-34569A1) to remove forward gear tapered bearing race. (Figure 7)
- d. After forward gear tapered bearing race is removed from gear housing, lift out and retain shims which were behind bearing race.

3. If inspection determines that replacement of propeller shaft needle bearings in forward gear is required, remove bearing from gear as follows:
 - a. Clamp forward gear in a soft jaw vise securely.
 - b. From toothed-side of gear, drive propeller shaft needle bearings out of gear with a punch and hammer.

CLEANING and INSPECTION

1. Clean forward gear and bearings with solvent and dry with compressed air.

CAUTION: DO NOT spin bearings dry with compressed air, as this could cause bearing to score.

2. Inspect gear teeth for pitting, grooves, scoring, uneven wear and for discoloration (from overheating). Replace gear if any of these conditions are found.
3. Check clutch jaws on forward gear for damage. Replace forward gear if damage is found.
4. Inspect tapered bearing race for pitting, grooves, scoring, uneven wear and discoloration (from overheating). Replace tapered bearing (on forward gear) and race if any of these conditions are found. (Always replace tapered bearing as a set.)
5. To determine condition of propeller shaft needle bearings (in forward gear), inspect propeller shaft forward gear needle bearing surface as outlined in "Propeller Shaft Inspection".

Gear Housing

CLEANING and INSPECTION

1. Clean gear housing with solvent and dry with compressed air.
2. Check gear housing carefully for impact damage.
3. Check for loose fitting bearing cups and needle bearings.

4. Inspect bearing carrier cover nut retainer threads in gear housing for corrosion damage and/or stripped threads.
5. Check labyrinth seal (series of ridges and grooves aft of cover nut retainer threads). This seal prevents exhaust gases from escaping over blades of propeller.

REASSEMBLY and INSTALLATION

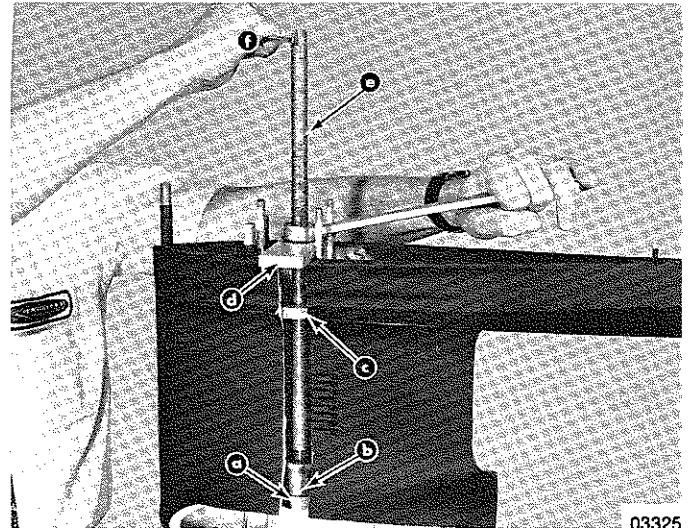
E-Z Shift Gear Housing

Drive Shaft Needle Bearing

REASSEMBLY/INSTALLATION

CAUTION: If drive shaft needle bearing failure has occurred, and original bearing case has turned in the gear housing, gear housing must be replaced. Loose fitting needle bearing will move out of position and cause repeated failures.

1. Apply a thin coat of Multipurpose Lubricant to drive shaft needle bearing bore in gear housing.
2. By way of propeller shaft cavity, place needle bearing in drive shaft bore with numbered side of bearing facing up drive shaft bore.
3. Install and seat needle bearing with the following tools from Bearing Removal and Installation Kit (C-91-31229A1): Puller Rod and Nut (C-91-31229), Pilot (C-91-36571), Plate (C-91-29310) and Puller Head (C-91-38628), as shown in Figure 1. Pull bearing up into bore until it bottoms on gear housing shoulder. (DO NOT use excessive force.)



a - Puller Head
b - Bearing

c - Pilot
d - Plate

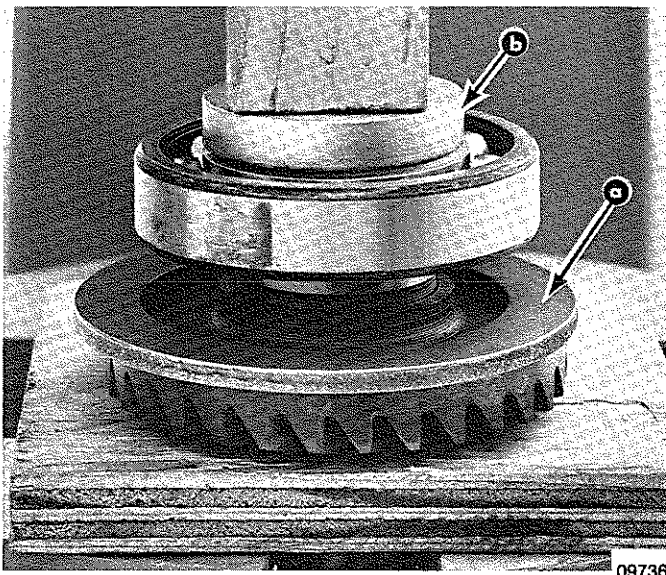
e - Puller Rod
f - Hold

Figure 1. Installing Drive Shaft Needle Bearing

Bearing Carrier

REASSEMBLY

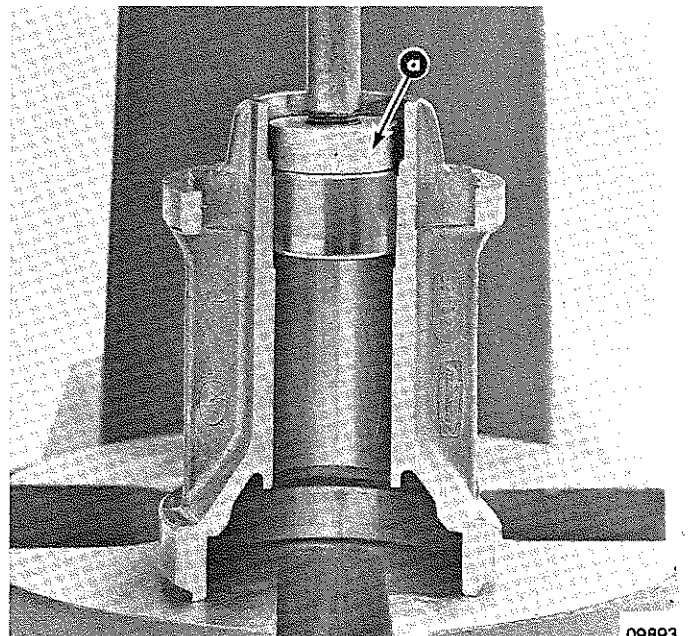
1. Place reverse gear on a press with gear teeth facing down.
IMPORTANT: The reverse gear thrust washer has a tapered outside diameter so that one side is larger than the other. The larger outside diameter of washer must be toward reverse gear.
2. Place thrust washer over gear with the larger outside diameter down toward gear. (Figure 2)
3. Apply a light coat of Multipurpose Lubricant onto inside diameter of reverse gear ball bearing.



a - Thrust Washer

b - Mandrel

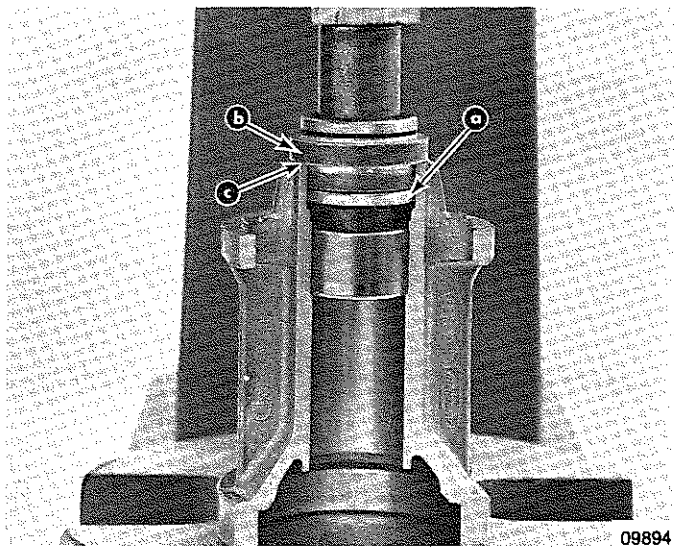
Figure 2. Reverse Gear Bearing Installation



a - Mandrel

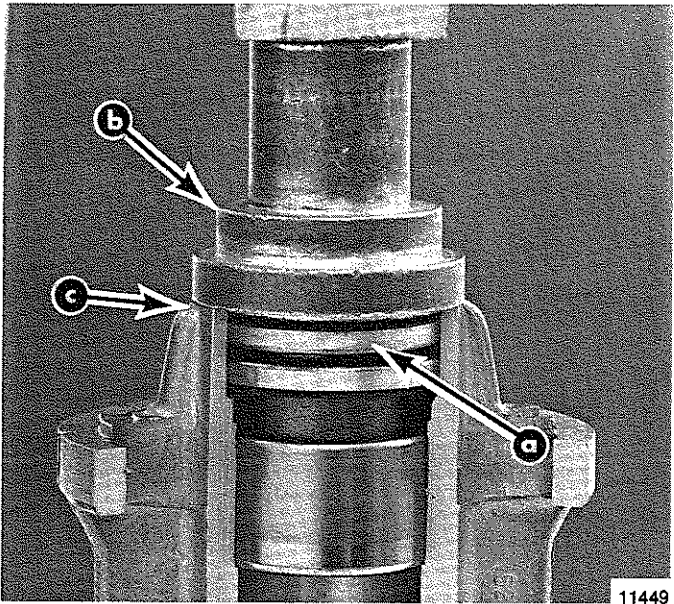
Figure 3. Installing Propeller Shaft Needle Bearing into Bearing Carrier

4. Position ball bearing over gear (with numbered side of bearing up).
5. Press ball bearing onto gear with a suitable mandrel (Figure 2) until firmly seated. (Be sure to press only on inner race of bearing and that bearing is firm against gear.)
6. Apply a light coat of Multipurpose Lubricant onto outside diameter of propeller shaft needle bearing.



a - Oil Seal (Lip of Seal Down) b - Oil Seal Driver c - Seated

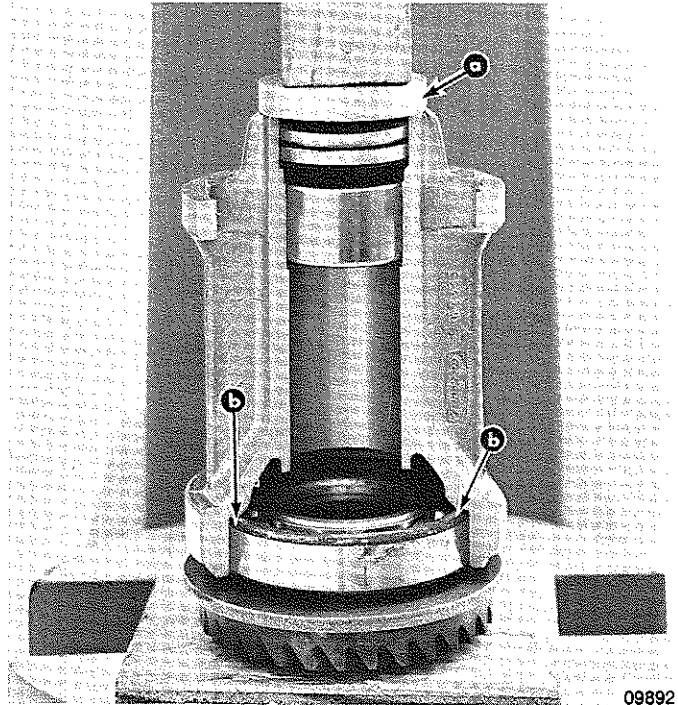
Figure 4. Propeller Shaft Seal Oil Seal Installation (Inner Seal)



a - Oil Seal (Lip of Seal Up)
b - Oil Seal Driver
c - Seated

Figure 5. Propeller Shaft Oil Seal Installation (Outer Seal)

7. Place propeller shaft needle bearing into aft end of bearing carrier with numbered side toward aft end.
8. Use a suitable mandrel and press needle bearing into bearing carrier. (Figure 3)
9. Apply Loctite Type "A" to outer diameter of propeller shaft oil seals.
10. Place one seal on longer shoulder side of Oil Seal Driver (C-91-31108) with lip of seal away from shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier. (Figure 4)



a - Mandrel b - Seated

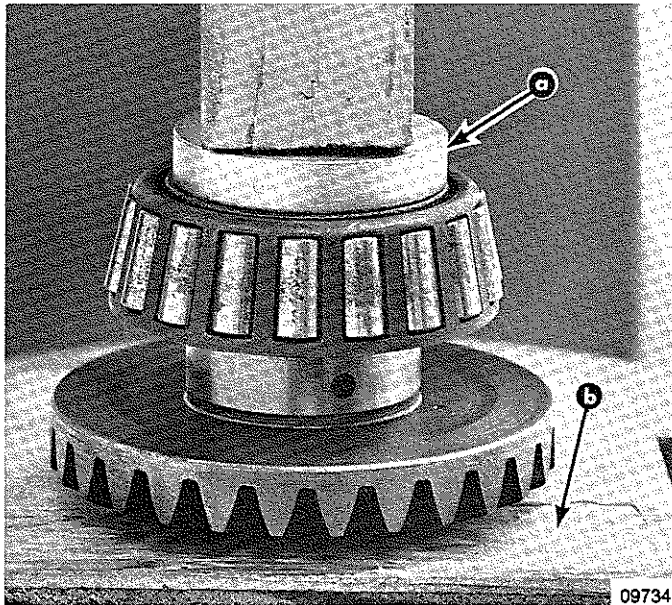
Figure 6. Installing Bearing Carrier onto Reverse Gear

11. Place second seal on short shoulder side of seal driver with lip of seal toward shoulder. Press seal into bearing carrier until seal driver bottoms against bearing carrier. (Figure 5)
12. Wipe off excess Loctite.
13. Apply a light coat of Multipurpose Lubricant onto the outside diameter of reverse gear ball bearing.
14. Place bearing carrier over reverse gear and bearing assembly. Press bearing carrier onto bearing. (Figure 6)
15. Place "O" ring over bearing carrier and position it between bearing carrier and thrust washer.
16. Lubricate oil seals and "O" ring with Multipurpose Lubricant.

Forward Gear

REASSEMBLY

1. Place forward gear on a press with gear teeth down.
2. Apply a light coat of Multipurpose Lubricant onto the inside diameter of forward gear tapered bearing.
3. Position forward gear tapered bearing over gear, as shown in Figure 7.

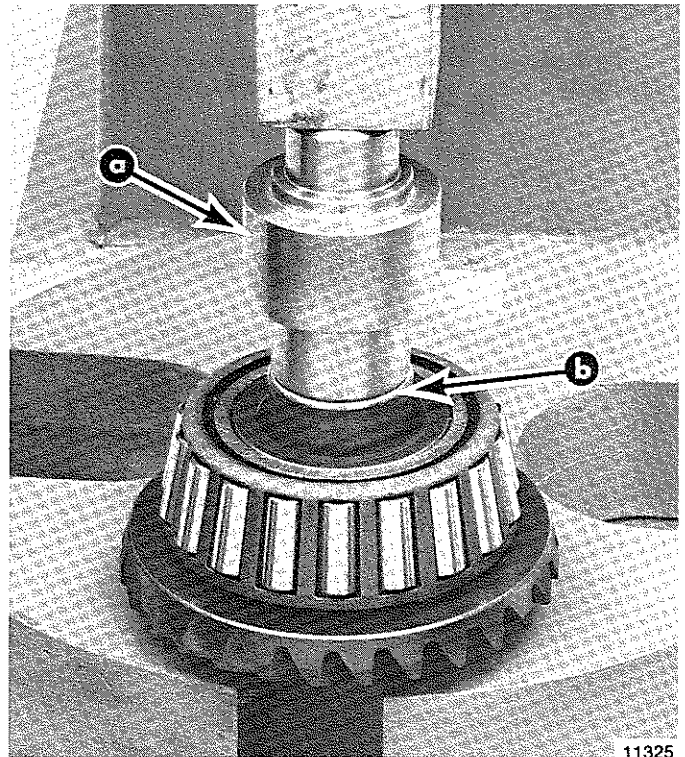


a - Mandrel

b - Wooden Block

Figure 7. Forward Gear Tapered Bearing Installation

4. Press bearing onto gear until firmly seated. (Be sure to press only on inner race of bearing and that bearing is firm against the gear.)
5. Apply a light coat of Multipurpose Lubricant to bore in center of forward gear.
6. Place one forward gear needle bearing on longer shoulder side of Forward Gear Bearing Tool (C-91-86943) with num-



a - Forward Gear Bearing Tool (C-91-86943)

b - Numbered Side of Needle Bearing

Figure 8. Forward Gear Needle Bearing Installation (Inner Bearing)

- bered side of bearing toward shoulder. (Figure 8) Press bearing into forward gear until bearing tool bottoms against gear.
7. Place second needle bearing on short shoulder side of bearing tool with numbered side of bearing toward shoulder. Press bearing into forward gear until bearing tool bottoms against gear.

Forward Gear Bearing Race

INSTALLATION

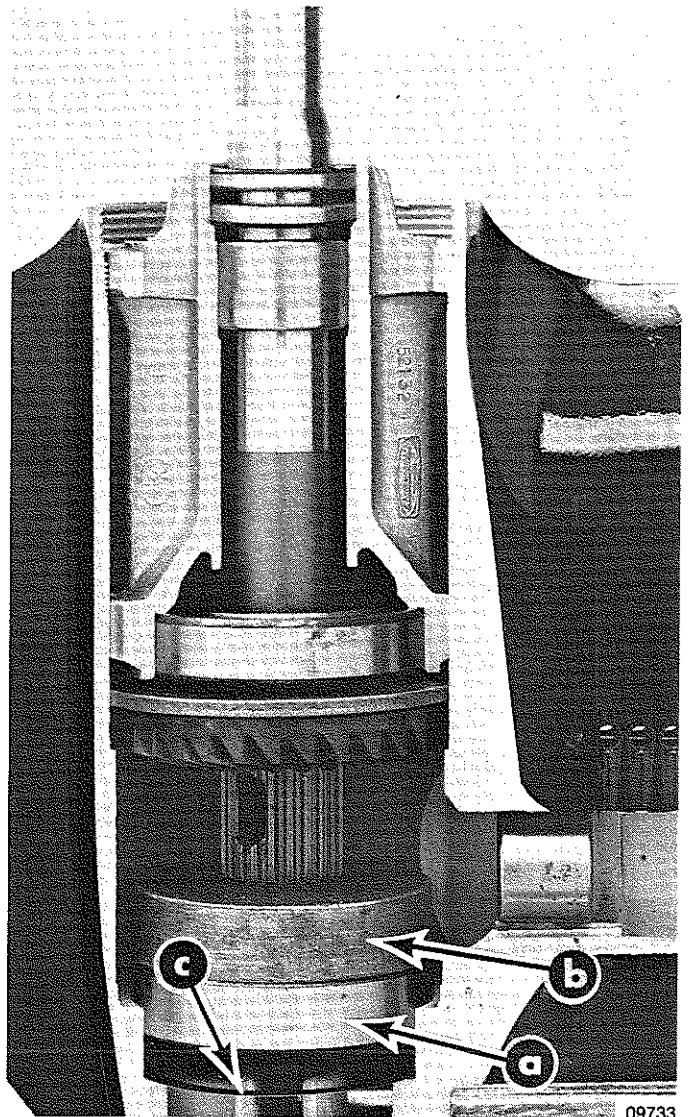
1. Place shim(s) (retained from disassembly) into gear housing. If shim(s) were lost or a new gear housing is being used, start with approximately .010" (0.254mm).
2. Apply a light coat of Multipurpose Lubricant to forward gear bearing race bore in gear housing.
3. Position tapered bearing race squarely over bearing bore in front portion of gear housing. (Figure 9)
4. Place Bearing Driver Cup (C-91-87120) over tapered bearing race.

NOTE: A used propeller shaft is recommended for use in Step 5. If it is necessary, however, to use the propeller shaft that will be installed in gear housing, the propeller shaft must be disassembled. (Refer to "Propeller Shaft Disassembly", preceding.)

5. Place propeller shaft into hole in center of bearing driver cup.
6. Install bearing carrier assembly over propeller shaft and lower it into gear housing. Bearing carrier acts as a pilot to assure proper bearing race alignment.
7. Thread a nut onto propeller shaft to protect propeller shaft threads.
8. Use a mallet to drive propeller shaft against bearing driver cup until tapered bearing race is seated against shim(s).
9. Remove nut from propeller shaft, then remove bearing carrier and propeller shaft from gear housing. Lift bearing driver cup out of gear housing.
10. Apply a light coat of oil on tapered bearing race, then place forward gear assembly into forward bearing race.

- a - Tapered Bearing Race
- b - Bearing Driver Cup
- c - Shim(s)

Figure 9. Installing Forward Gear Bearing Race 

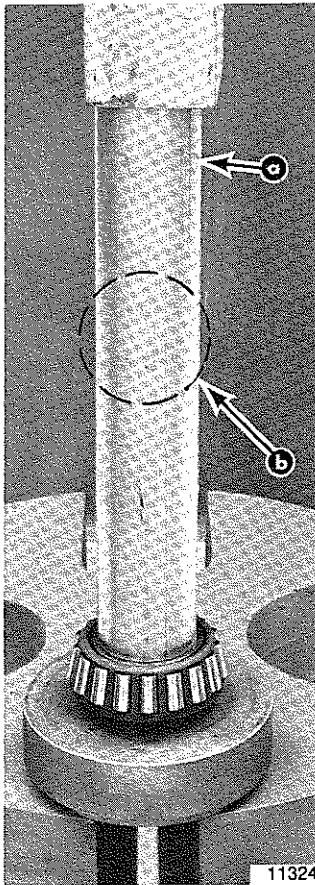


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Drive Shaft and Pinion Gear

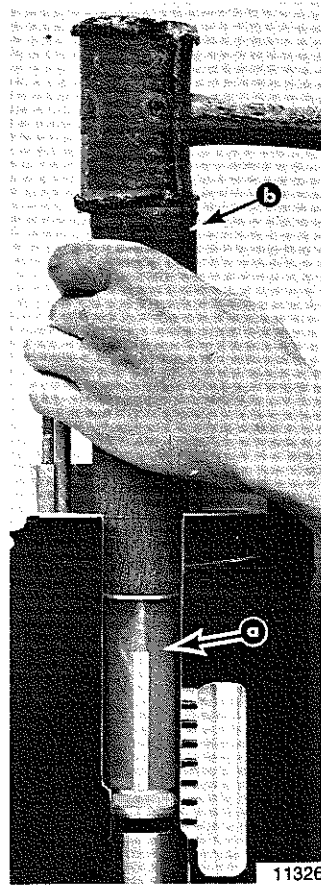
REASSEMBLY/INSTALLATION

1. Apply a light coat of Multipurpose Lubricant onto the inside diameter of drive shaft tapered bearing.



11324
a - Drive Shaft Tapered Bearing Driver (C-91-87119)
b - Pinion Gear End of Drive Shaft

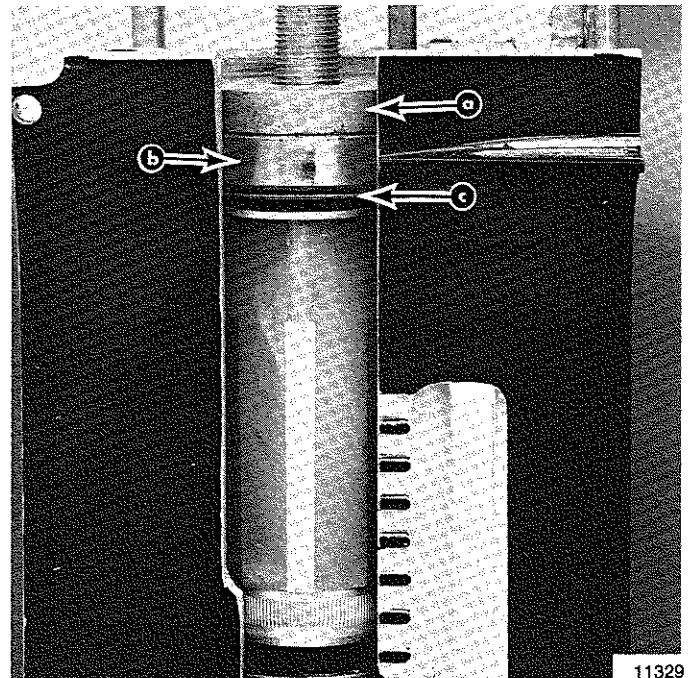
Figure 1. Drive Shaft Tapered Bearing Installation



11326
a - Lubrication Sleeve
b - Lubrication Sleeve Driver (C-91-39238)

Figure 2. Lubrication Sleeve Installation

2. Position drive shaft tapered bearing over pinion gear end of drive shaft with tapered end of bearing toward pinion end of drive shaft. (Figure 1)
3. Use Drive Shaft Tapered Bearing Driver (C-91-87119) and press bearing onto drive shaft until it is firmly seated against shoulder on drive shaft. (Figure 1)
4. Position lubrication sleeve in drive shaft bore so that flats in bore align with flats on sleeve and notch in top of sleeve is toward leading edge of gear housing.
5. Use Lubrication Sleeve Driver (C-91-39238) and press sleeve into bore until it is just below tapered bearing shim(s) surface. (Figure 2) (DO NOT use excessive force to install sleeve, as this could distort sleeve.)



11329
a - Bearing Cup Driver
b - Tapered Bearing Race
c - Shim(s)

Figure 3. Tapered Bearing Race Installation

6. Place shim(s) (retained from disassembly) into gear housing drive shaft bearing bore. If shim(s) were lost or a new gear housing is being used, start with approximately .010" (0.254mm).
7. Use Bearing Cup Driver (C-91-34379) in conjunction with Bearing Removal and Installation Kit (C-91-31229A1) to press tapered bearing race into drive shaft tapered bearing bore until firmly seated against shim(s). (Figure 3)
8. Position pinion gear in gear housing below drive shaft bore with teeth of pinion gear meshed with teeth of forward gear.
9. Insert drive shaft into drive shaft bore while holding pinion gear as described in Step 8. Rotate drive shaft to align and engage drive shaft splines with pinion gear splines.
10. Continue to insert drive shaft into gear housing until drive shaft tapered bearing is against bearing race.
11. Place a small amount of Loctite Type "A" onto threads of pinion gear nut and install nut on drive shaft with flat side of nut away from pinion gear.
12. Use a socket and flex handle to hold pinion nut (pad area where flex handle will contact gear housing while torquing nut).
13. Place Drive Shaft Nut Wrench (C-91-34377A1) over crankshaft end of drive shaft. Use a torque wrench to torque pinion nut to figure listed in "Specifications" section.

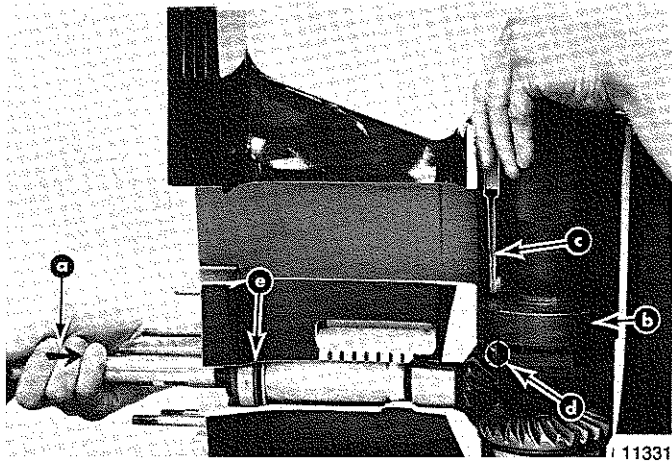
IMPORTANT: Wipe any excess Loctite from pinion nut and pinion gear.

Pinion Gear Depth and Forward Gear Backlash

DETERMINING PINION GEAR DEPTH

NOTE: Read entire shimming procedure before attempting any change in shim thickness.

1. Carefully clean reverse gear shoulder and diameter of propeller shaft cavity.
2. Insert Pinion Gear Shimming Tool (C-91-74776) into propeller shaft cavity until it bottoms-out on reverse gear shoulder.
3. Align access slot in shimming tool with nose of pinion gear.
4. Rotate drive shaft a few times with down pressure applied to seat drive shaft tapered bearing. Apply 15 lbs. (6.8kg) of pressure down on drive shaft and hold it stationary while performing Step 5.



- a - 15 Lbs. of Pressure in Direction of Arrow
- b - Shimming Tool
- c - Feeler Gauge
- d - Obtain .025" Clearance between Shimming Tool and Pinion Gear
- e - Add or Subtract Shim(s) Here

Figure 4. Determining Pinion Gear Depth

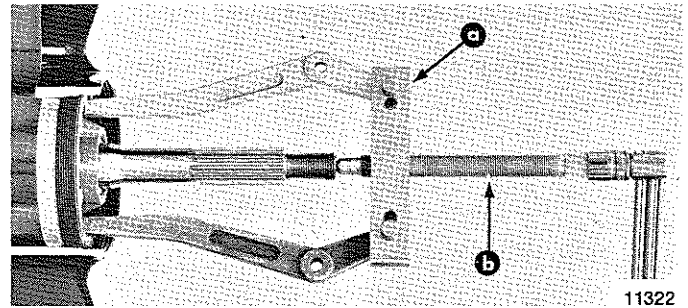
5. Determine pinion gear depth by inserting a feeler gauge thru access slot in shimming tool. (Figure 4)
6. If clearance between shimming tool and pinion gear is .025" (0.64mm), pinion gear depth is correct.
7. If clearance between shimming tool and pinion gear is above or below .025", reshim drive shaft tapered bearing race to raise or lower pinion gear, as follows:
 - a. Remove pinion gear retainer nut.
 - b. Remove drive shaft and drive shaft tapered bearing race.
 - c. Remove or add an amount of shim(s) sufficient to correct pinion gear depth. **EXAMPLE:**

Pinion gear depth is020" (0.51mm)
 Add005" (0.13mm)
 Pinion gear depth will be025" (0.64mm)

Pinion gear depth is030" (0.76mm)
 Subtract005" (0.13mm)
 Pinion gear depth will be025" (0.64mm)
 - d. Reassemble as instructed in "Drive Shaft and Pinion Gear Reassembly/Installation", immediately preceding.

DETERMINING FORWARD GEAR BACKLASH

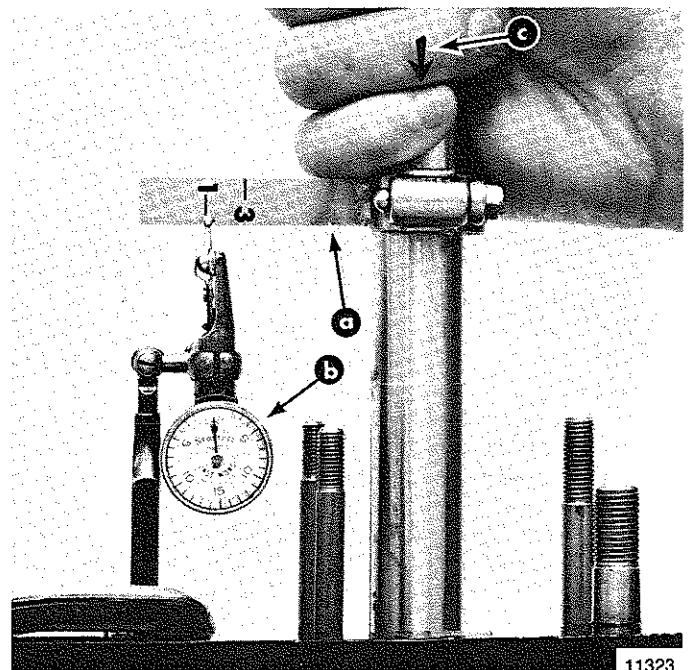
IMPORTANT: Bearing carrier must be assembled to provide a pilot for propeller shaft.



- a - Bearing Carrier Removal Tool (C-91-46086A1)
- b - Puller Bolt (C-91-85716)

Figure 5. Apply 45 In. Lbs. of Torque on Puller Bolt

1. Insert propeller shaft into position in gear housing. (DO NOT place shift cam on propeller shaft.)
2. Place bearing carrier into gear housing and thread cover nut against bearing carrier. (It is not necessary to torque cover nut against bearing carrier.)
3. Attach Bearing Carrier Removal Tool (C-91-46086A1) and Puller Bolt (C-91-85716) onto gear housing, as shown in Figure 5.
4. Torque puller bolt against propeller shaft to 45 in. lbs. (52kg-cm). Turn drive shaft 2 or 3 revolutions with the load applied to propeller shaft. This will seat forward gear bearing.
5. Fasten dial indicator to gear housing and Backlash Indicator Tool (C-91-78473) to drive shaft. (Figure 6)
6. Recheck torque on puller bolt (45 in. lbs.).
7. Position dial indicator to line up with the No. "1" on backlash indicator tool, if gear ratio is 1.86:1 (15 teeth on pinion gear), or the No. "2" on backlash indicator tool, if gear ratio is 2:1 (14 teeth on pinion gear).
8. Hold pressure down on drive shaft. Lightly turn drive shaft back-and-forth. (No movement should be noticed at pro-



- a - Backlash Indicator Tool
- b - Dial Indicator
- c - Apply Pressure in Direction of Arrow

Figure 6. Checking Gear Backlash (1.86:1 Gear Ratio Shown)

pellor shaft.) Dial indicator registers amount of backlash, which must be .008" to .013" (0.20mm to 0.33mm).

9. If backlash is less than .008" or more than .013", reshim forward gear as follows:
 - a. Remove dial indicator, backlash indicator tool and bearing carrier removal tool.
 - b. Remove cover nut, bearing carrier and propeller shaft.
 - c. Remove pinion gear retainer nut, then drive shaft.

- d. Remove forward gear and forward gear bearing race.
- e. Remove or add a sufficient amount of shim(s) in front of forward gear bearing race to correct backlash.

NOTE: By adding or subtracting .001" (0.025mm) shim, the backlash will change approximately .0015" (0.038mm).

- f. Reassemble per installation instructions and recheck backlash per instructions.

Clutch Actuator Rod

REASSEMBLY/SHIMMING

1. Insert 2 compression springs into clutch actuator rod, followed by a shim washer. (Figure 7)
2. Place a small amount of Multipurpose Lubricant on locating pin (Figure 7), then position pin in cross-hole in end of clutch actuator rod with flat side of pin toward shim washer. (Figure 8)

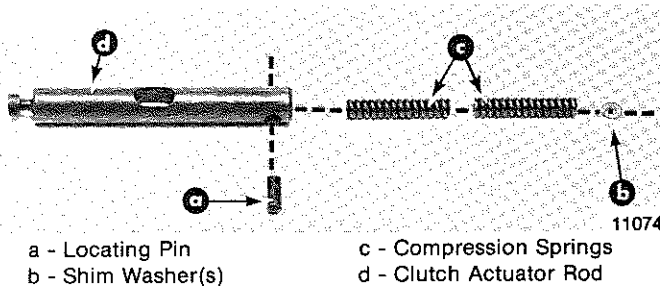
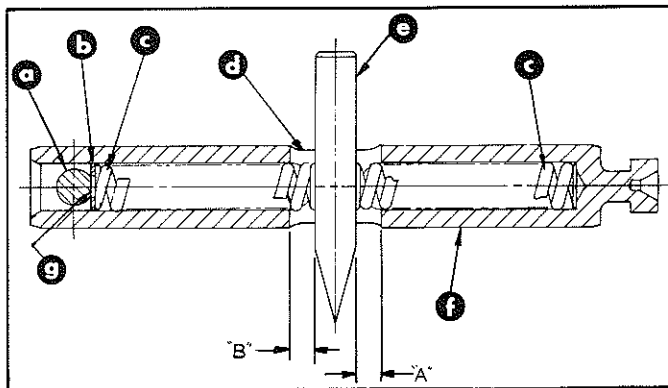


Figure 7. Clutch Actuator Rod Sub-Assembly Sequence



- a - Spring Locating Pin
- b - Shim Washer
- c - Compression Spring
- d - Elongated Slot
- e - Cross Pin Tool (C-91-86642)
- f - Clutch Actuator Rod
- g - Shim Washer MUST Rest on Flat Side of Spring Locating Pin

NOTE: "A" and "B" Measurements MUST BE Equal within 1/64" [0.016" (0.4mm)].

Figure 8. Clutch Actuator Rod Assembly

3. Insert Cross Pin Tool (C-91-86642) between compression springs in elongated slot in clutch actuator rod. (Figure 8)
4. Compress both springs by forcing cross pin tool back-and-forth in elongated slot. This will release any initial set from springs.

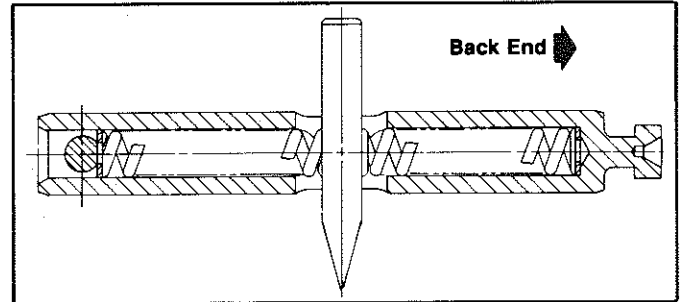


Figure 9. Clutch Actuator Rod with One Additional Shim Washer Added to Back End

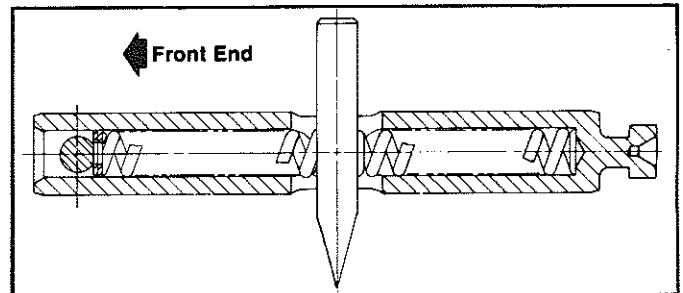


Figure 10. Clutch Actuator Rod with One Additional Shim Washer Added to Front End

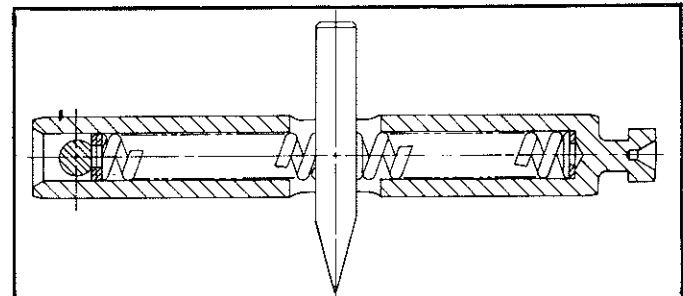


Figure 11. Clutch Actuator Rod with One Additional Shim Washer Added to Each End

5. Measure distance from each end of elongated slot to the near side of cross pin tool. (Figure 8) The measurements taken must be equal within 1/64" (0.4mm).
6. If measurements taken in Step 5 are not equal to within 1/64", remove locating pin and reshim compression spring, as indicated in Figures 9, 10 and 11, to obtain the measurement needed.

Shift Shaft Bushing Reassembly

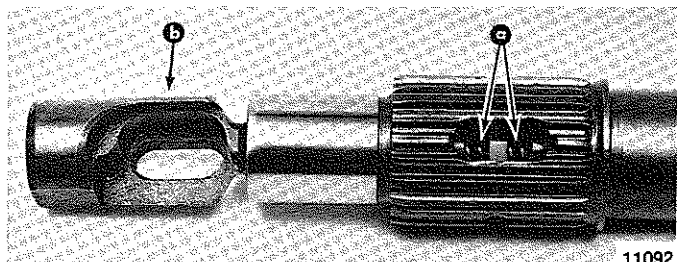
1. Position shift shaft bushing on a press with threaded side down.
2. Apply Loctite Type "A" to outside diameter of oil seal.
3. Press oil seal into shift shaft bushing with lip of seal up.
4. Wipe any excess Loctite from oil seal and bushing.

5. Place rubber washer against oil seal.
6. Install "O" ring over threads and up against shoulder of bushing.
7. Lubricate "O" ring and oil seal with Multipurpose Lubricant.

Propeller Shaft

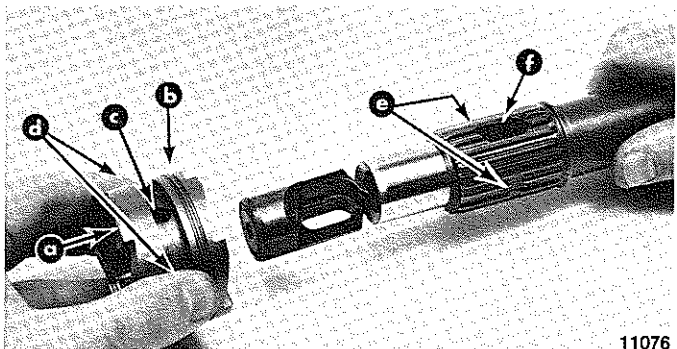
REASSEMBLY/INSTALLATION

1. Insert clutch actuator rod part way into end of propeller shaft, then install cam follower onto the end of rod and push rod the rest of the way into propeller shaft. Align cross pin slot in actuator rod with cross pin slot in propeller shaft. (Figure 1)



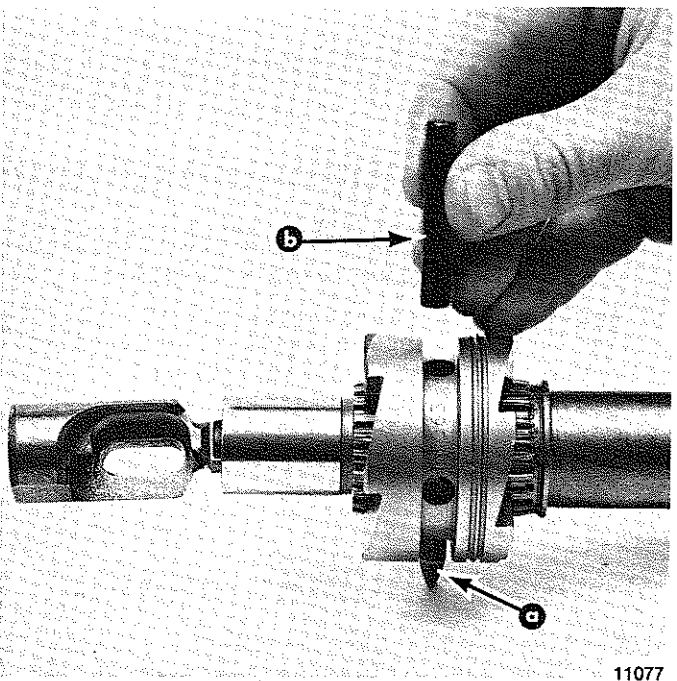
a - Compression Springs b - Cam Follower

Figure 1. Clutch Actuator Rod Installed into Propeller Shaft



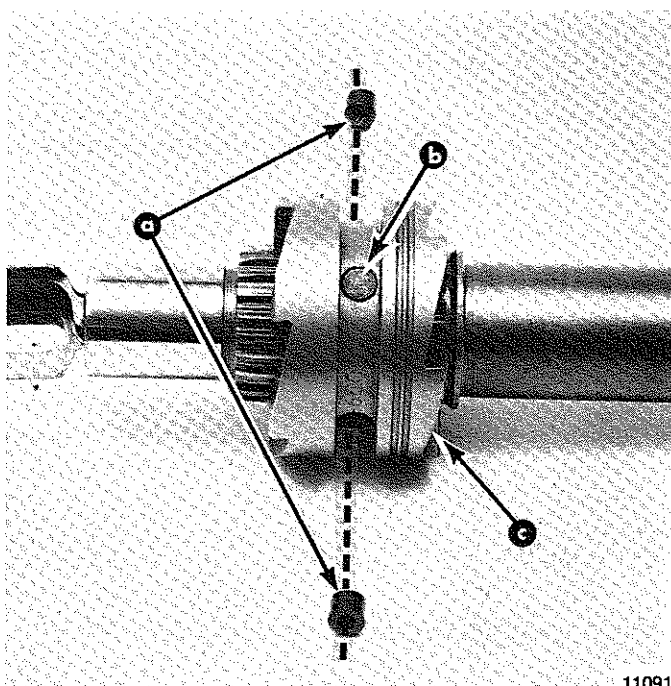
a - Sliding Clutch d - Detent Hole (Behind Finger and Thumb)
b - Grooved Rings e - Detent Notch (One on Each Side)
c - Cross Pin Hole f - Cross Pin Slot

Figure 2. Installing Sliding Clutch onto Propeller Shaft



a - Cross Pin Tool (C-91-86642) b - Cross Pin

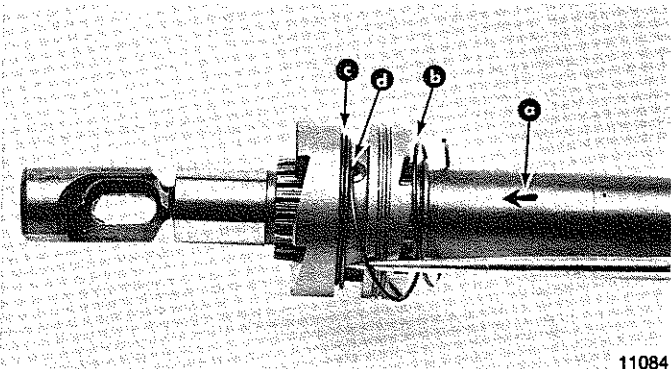
Figure 3. Installing Cross Pin



a - Detent Pins b - Cross Pin c - Sliding Clutch

Figure 4. Detent Pin Installation

2. Position sliding clutch onto propeller shaft with grooved rings (on sliding clutch) toward propeller end of propeller shaft. (Figure 2) Cross pin hole and detent holes (in sliding clutch) must line up with cross pin slot and detent notches on propeller shaft. (Figure 2)
3. Insert Cross Pin Tool (C-91-86642) (Figure 3) thru sliding clutch, propeller shaft and actuator rod. (Be sure that cross pin tool is between compression springs.)
4. Insert cross pin (Figure 3) thru sliding clutch, propeller shaft and actuator rod, forcing cross pin tool out. Be sure that flat sides of cross pin are toward compression springs. Cross pin must be flush on both ends with sliding clutch.



a - The Line of "Sight"
b - Forward Retaining Spring (Wound Counterclockwise around Clutch)
c - Rear Retaining Spring (Wound Clockwise around Clutch)
d - Tang End of Spring

IMPORTANT: Springs MUST NOT Overlap Each Other.

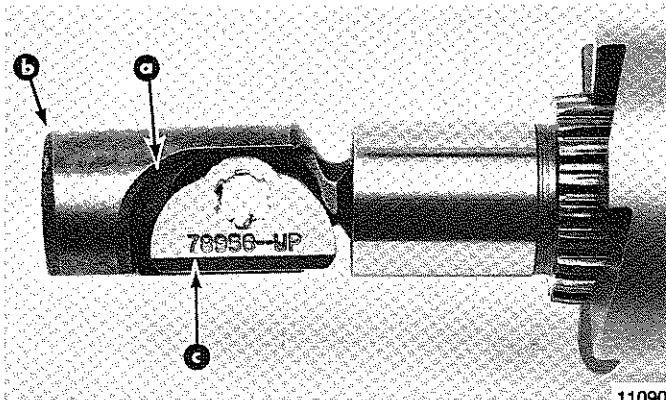
Figure 5. Cross Pin Retaining Springs Installation

5. Apply a small amount of Multipurpose Lubricant on each detent pin. Position a detent pin in each detent pin hole of sliding clutch with rounded end of pins toward propeller shaft. (Figure 4)

- Install cross pin retaining springs onto sliding clutch (Figure 5), as follows:

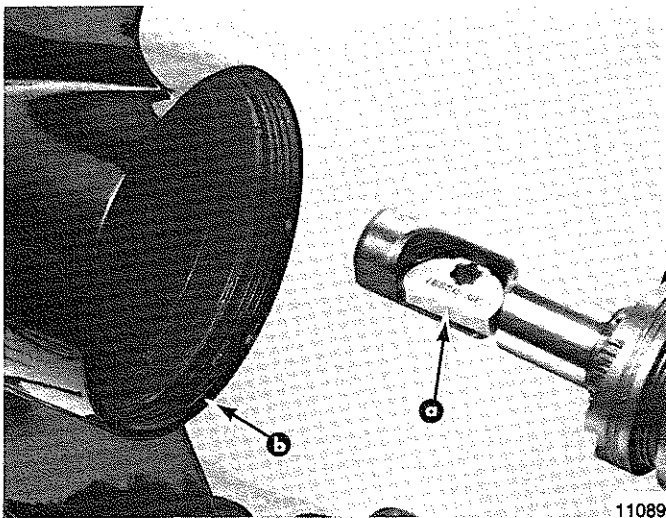
IMPORTANT: DO NOT over-stretch retaining springs when installing them onto sliding clutch.

- Installing first spring
 - Insert tang end of spring into a detent pin.
 - Spirally wrap spring into groove on sliding clutch.
 - Position spring in groove so that straight end of spring is against the side of groove.
 - Installing second spring
 - Insert tang end of spring into the opposite detent pin that was used in Step a-1.
 - Spirally wrap spring into groove on sliding clutch in the opposite direction that the first spring was wound.
 - Position spring in groove so that straight end of spring is against the side of groove and not overlapping the first spring.
- Place gear housing in a soft jaw vise with the drive shaft in a vertical position.



a - Cam Pocket b - Cam Follower c - Shift Cam

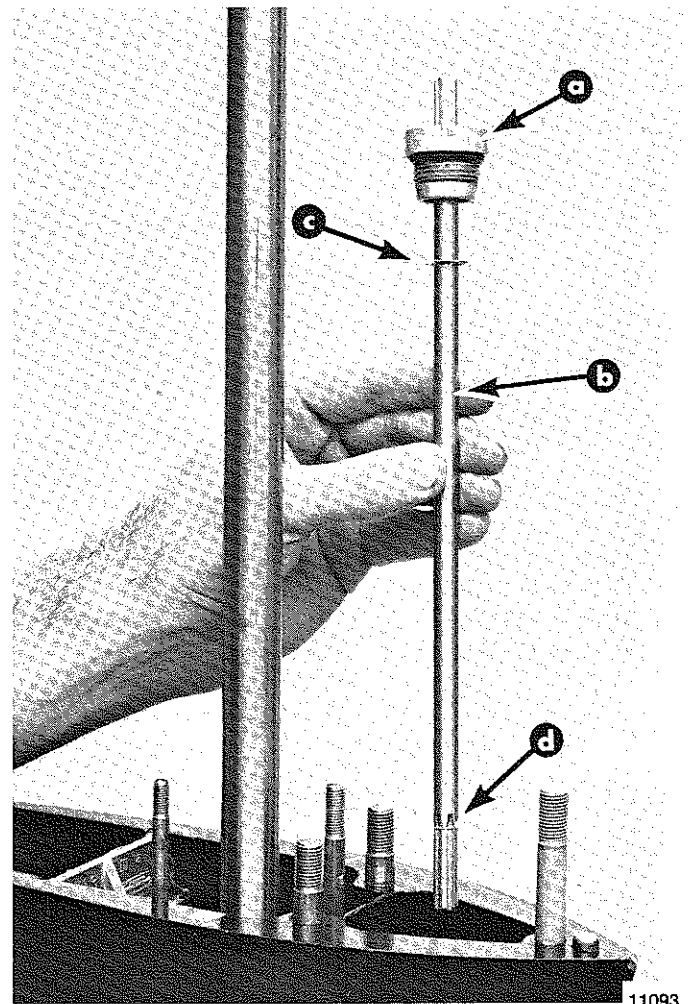
Figure 6. Shift Cam Installed on Cam Follower



a - Shift Cam (Position as Shown) b - Gear Housing

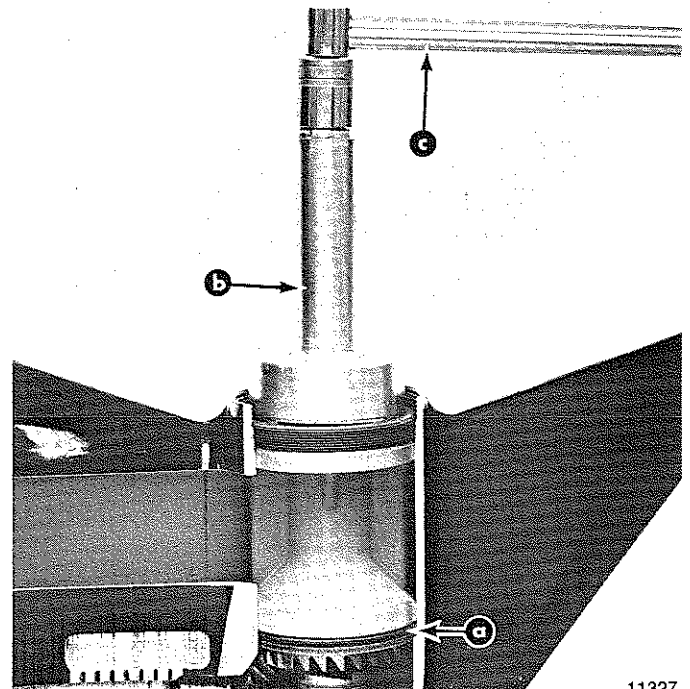
Figure 7. Installing Propeller Shaft into Gear Housing

- Coat cam pocket (Figure 6) of cam follower with Multi-purpose Lubricant.
- Place shift cam into cam pocket of cam follower with numbered side of cam facing up, as shown in Figure 6.
- With shift cam positioned as shown in Figure 7, insert propeller shaft thru forward gear until shaft bottoms out.



a - Shift Shaft Bushing c - "E" Ring
b - Shift Shaft d - Round Retaining Ring

Figure 8. Shift Shaft Installation



a - "O" Ring b - Cover Nut Tool c - Torque Wrench

Figure 9. Bearing Carrier Installation

CAUTION: Until bearing carrier is installed into gear housing, extreme care **MUST BE** taken not to apply any side force on propeller shaft. Side force on propeller shaft may break the neck of the clutch actuator rod.

IMPORTANT: Prior to installation of shift shaft, verify that the round retaining ring and "E" ring (Figure 8) are in position and secure.

11. Insert shift shaft down shift shaft hole (of gear housing) and thru shift cam and cam follower. (It may be necessary to rotate shift shaft back-and-forth slightly for it to enter shift cam.)
12. Apply a light coat of Perfect Seal to threads of shift shaft bushing. (DO NOT allow Perfect Seal to contact bushing oil seals or "O" ring.) (Thread bushing into position, but do not tighten down at this time.)
13. Lubricate "O" ring (Figure 9) on bearing carrier with Multipurpose Lubricant.
14. Apply a light coat of Perfect Seal to outside diameter of bearing carrier (where carrier contacts gear housing).

(DO NOT allow Perfect Seal to contact "O" ring or bearings.)

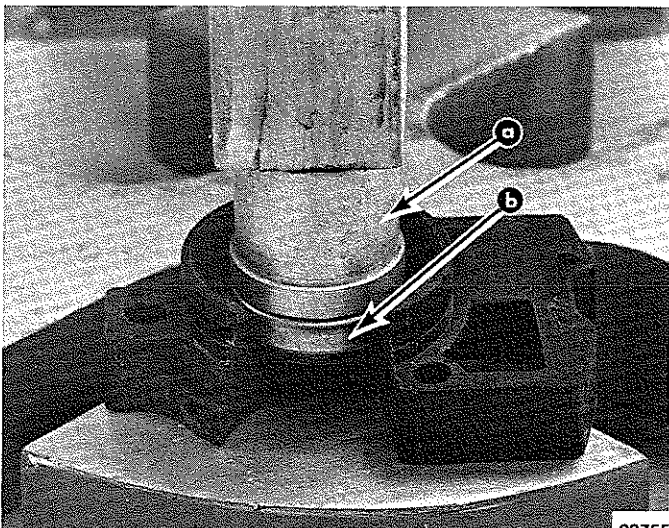
NOTE: When performing Step 15, rotate drive shaft clockwise (viewed from top) to mesh pinion gear with reverse gear.

15. Position bearing carrier over propeller shaft and slide it into gear housing. (Be sure to align bearing carrier keyway with gear housing keyway.)
16. Push bearing carrier in as far as possible by hand, then install bearing carrier key.
17. Place tab washer against bearing carrier.
18. Apply Perfect Seal to threads of cover nut and install cover nut in gear housing (make sure that the words, "OFF-ON", and arrows are visible).
19. Start cover nut a few turns by hand, then, using Cover Nut Tool (C-91-61069) and torque wrench (Figure 9), torque cover nut to specifications shown in "Specification" section.
20. Bend one lock tab into cover nut (only one will align).
21. Use Shift Shaft Bushing Tool (C-91-31107) and tighten shift shaft bushing securely.

Water Pump

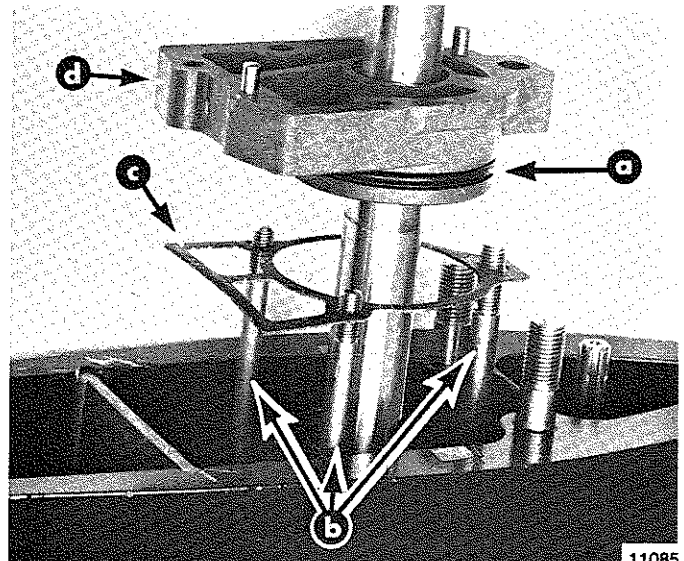
REASSEMBLY/INSTALLATION

1. Install oil seals into water pump base (Figure 1), as follows:
 - a. Place water pump base on a press. (Figure 1)
 - b. Just before installing each seal apply Loctite Type "A" to outside diameter of oil seal.
 - c. With a suitable mandrel, press the smaller diameter oil seal into pump base with lip of oil seal toward impeller side of base.
 - d. With a suitable mandrel, press the larger diameter oil seal into pump base with lip of oil seal toward gear housing side of base.
 - e. Wipe any excess Loctite from oil seals and water pump base.
2. Install "O" ring into "O" ring groove of water pump base. (Figure 2)
3. Lubricate "O" ring and oil seals with Multipurpose Lubricant.



a - Mandrel b - Oil Seal (Smaller OD)

Figure 1. Installing Smaller OD Oil Seal in Water Pump Base

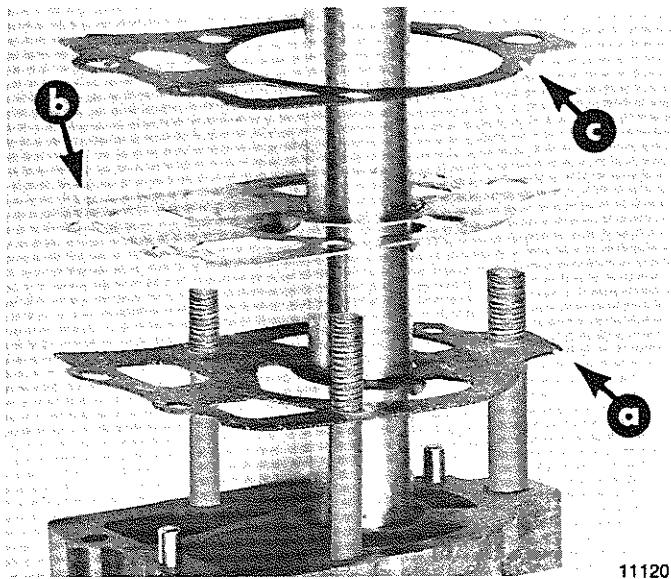


a - "O" Ring c - Gasket
b - Mounting Studs d - Water Pump Base

Figure 2. Water Pump Base and Gasket Installation

4. Install a new water pump base gasket over water pump mounting studs (Figure 2) and install water pump base.
5. Install the following in order: Pump base to face plate gasket, face plate and face plate to pump cover gasket. (Figure 3) Gaskets and face plate are indexed by dowel pin location and must be installed correctly.
6. Place impeller drive key on flat of drive shaft. Hold key on drive shaft with a dab of Multipurpose Lubricant.

IMPORTANT: When completing gear housing repair, that requires removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use the impeller, DO NOT install in reverse to original rotation, or premature impeller failure will occur.



11120

- a - Gasket (Water Pump Base to Face Plate) b - Face Plate
c - Gasket (Face Plate to Water Pump Cover)

Figure 3. Face Plate and Gaskets Installation

7. Slide impeller down drive shaft to impeller drive key. Align drive key with keyway in the center hub of impeller, and slide impeller over drive key.

CAUTION: A visual inspection of impeller drive key MUST BE made to determine that drive key is on flat of drive shaft after impeller is installed. If key has moved off flat of drive shaft, repeat Steps 6 and 7.

8. If removed, install new water pump insert into pump cover as follows:
 - a. Apply Perfect Seal to water pump insert area of pump cover.
 - b. Install water pump insert into pump cover, being sure that tab on insert enters recess in pump cover.
 - c. Wipe any excess Perfect Seal from insert and cover.

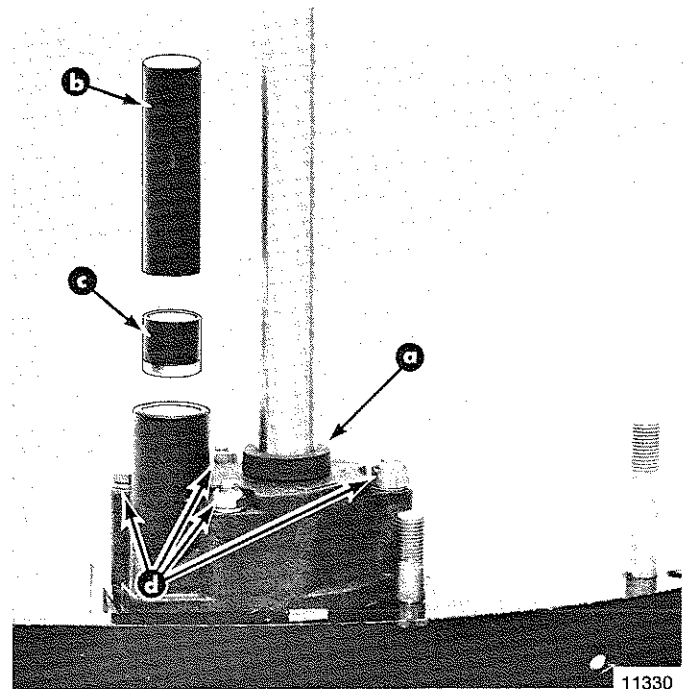
NOTE: If 2 holes were drilled in top of water pump cover to aid in removal of insert, fill holes with G.E. Silicone Sealer or equivalent.

9. Install water tube seal (Figure 4) into pump cover, being sure that plastic side of seal goes into cover first.

10. Reinstall water tube guide into water pump cover.
11. Apply a light coat of Multipurpose Lubricant on inside of water pump insert.
12. Position assembled water pump cover over drive shaft and lower over water pump studs. Rotate drive shaft in a clockwise direction (viewed from top), while pushing down on pump cover to ease impeller entry into cover.
13. Install water pump cover retainer washers, nuts and bolt.
14. Tighten bolt and nuts evenly to specified torque in "Specifications" section.

CAUTION: DO NOT over-torque nuts and bolt, as this could cause cover to crack during operation.

15. Install centrifugal slinger over drive shaft and down against pump cover.



11330

- a - Centrifugal Slinger
b - Water Tube Guide
c - Water Tube Seal
d - Nuts, Bolts and Washers

Figure 4. Water Tube Seal Installation

Gear Lubricant Filling Instructions

1. Remove any gasket material from "Fill" and "Vent" screws and gear housing.
2. Install new gaskets on "Fill" and "Vent" screws.

IMPORTANT: Never apply lubricant to gear housing without first removing "Vent" screw, or gear housing cannot be filled because of trapped air. Fill gear housing ONLY when housing is in a vertical position.

3. Slowly fill housing thru "Fill" hole with Super-Duty Gear Lubricant until lubricant flows out of "Vent" hole and no air bubbles are visible.
4. At this point, drain approximately one fluid ounce (30cc) from gear housing to permit expansion of lubricant.
5. Install "Vent" screw into "Vent" hole.
6. Remove grease tube (or hose) from "Fill" hole and quickly install "Fill" screw into "Fill" hole.

Installing Gear Housing to Drive Shaft Housing

SAFETY WARNING: Disconnect high tension leads from spark plugs and remove spark plugs from engine before installing gear housing onto drive shaft housing.

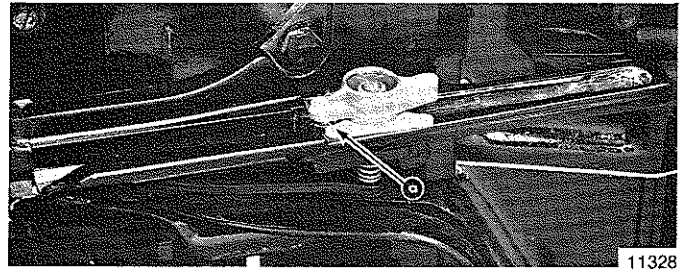
1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of Multipurpose Lubricant onto drive shaft splines.

CAUTION: DO NOT use excessive lubricant on top of drive shaft to crankshaft splines. Excess grease, that is trapped in clearance space, will not allow drive shaft to fully engage with crankshaft. Subsequently, tightening the gear housing nuts (while excess grease is on top of drive shaft) will load the drive shaft/crankshaft and damage either or both the powerhead and gear housing. Top of drive shaft is to be wiped free of grease.

3. Apply a light coat of Multipurpose Lubricant onto shift shaft splines. (DO NOT use grease on top of shift shaft.)
4. Apply a thin bead of G. E. Silicone Sealer (obtained locally) against the top of exhaust divider plate.
5. Insert trim tab bolt into hole in rear of gear housing to drive shaft housing machined surface.
6. Shift gear housing into forward gear and place guide block anchor pin (Figure 5) into forward gear position.
7. Position gear housing so that the drive shaft is protruding into drive shaft housing.

NOTE: If, while performing Step 8, the drive shaft splines will not align with crankshaft splines, place a propeller onto propeller shaft and turn it counterclockwise as the gear housing is being pushed toward drive shaft housing.

8. Move gear housing up toward drive shaft housing, while aligning shift shaft splines and water tube with water tube guide (in water pump cover).
9. Place flat washers onto studs (located on either side of drive shaft housing). Start a nut on these studs and tighten finger-tight.



a - Guide Block Anchor Pin

Figure 5. Guide Block Anchor Pin in Forward Gear Position

10. Start bolt at rear of gear housing inside trim tab recess. DO NOT tighten bolt at this time.
11. Recheck shift shaft spline engagement and correct if necessary.
12. Evenly tighten 2 nuts which were started in Step 9. Torque to listing in "Specifications" section.
13. After 2 nuts (located on either side of drive shaft housing) are tightened, check shift operation as follows:
 - a. Place guide block anchor pin into forward gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate clockwise.
 - b. Place guide block anchor pin into neutral position. Propeller shaft should rotate freely clockwise/counterclockwise.
 - c. Place guide block anchor pin into reverse gear position. Rotate flywheel clockwise (viewed from top); propeller shaft should rotate counterclockwise.

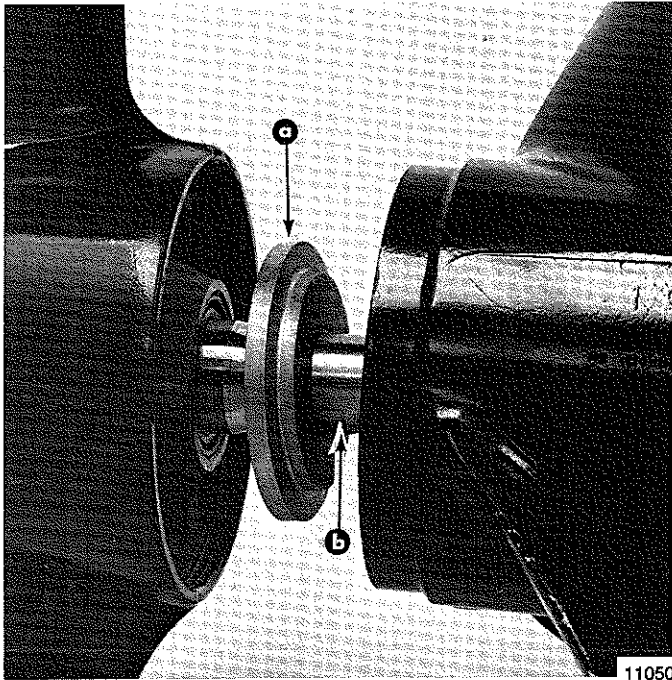
IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

14. Install washers and nuts onto studs (located on bottom center of anti-cavitation plate) and torque to specification.
15. Install special flat washer and nut on stud at leading edge of drive shaft housing and torque to specification.
16. Torque bolt (started in Step 10) to specification.
17. Install trim tab, adjust to position in which it had previously been installed, and tighten securely.
18. Install plastic cap into trim tab bolt opening at rear edge of drive shaft housing.

Propeller Installation

SAFETY WARNING: When installing or removing propeller, because of the motor's ease in starting, be sure that the remote control is in neutral position and that the key switch is "OFF". Place a block of wood between the anti-cavitation plate and propeller to prevent accidental motor starting and to protect hands from propeller blades while removing or installing nut.

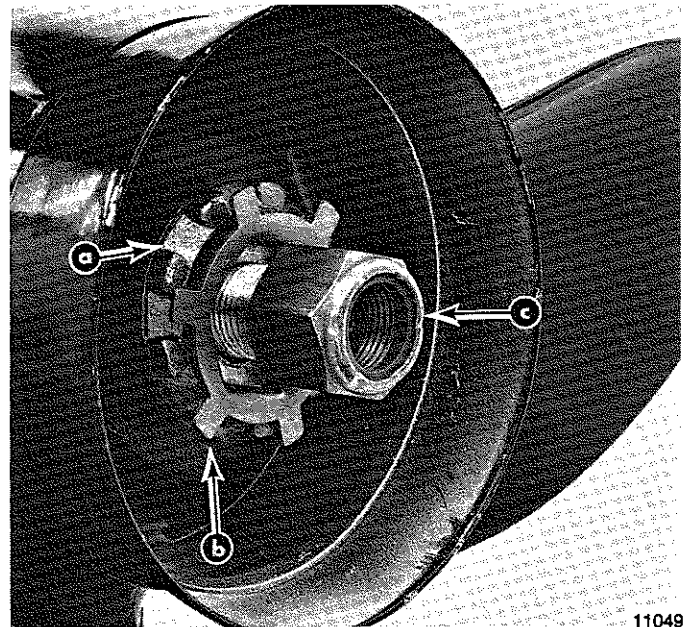
1. Apply a liberal coat of Perfect Seal to propeller shaft splines.



a - Forward Thrust Hub b - Propeller Shaft

Figure 6. Propeller Installation

2. Place forward thrust hub over propeller shaft with shoulder side into propeller. (Figure 6)
3. Place propeller on propeller shaft and slide it up against thrust hub.
4. Place rear thrust hub, tab washer and propeller nut on propeller shaft. (Figure 7)



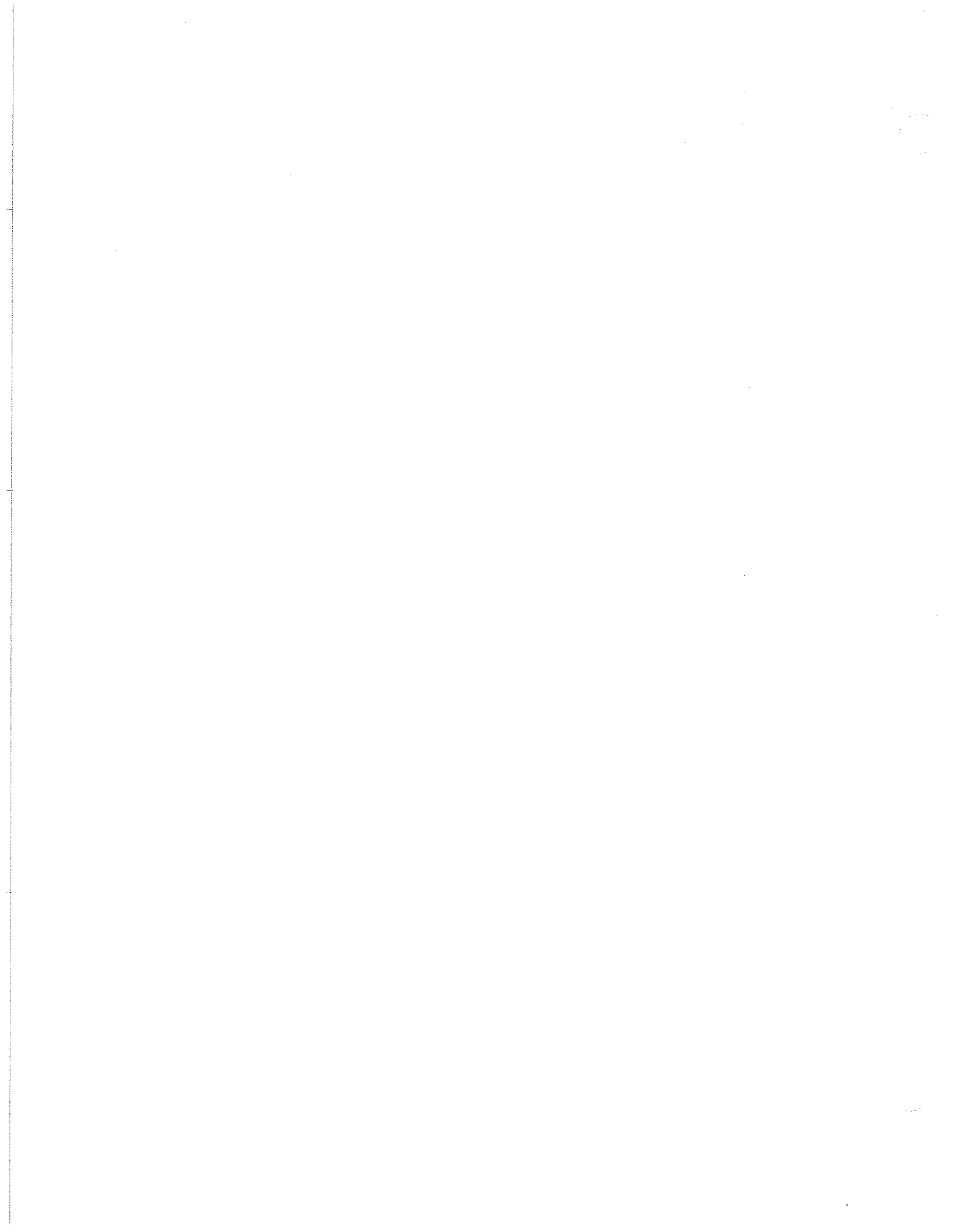
a - Rear Thrust Hub b - Tab Washer c - Propeller Nut

Figure 7. Propeller Nut and Tab Washer

5. Thread propeller nut on propeller shaft until nut is recessed into tab washer.
6. After propeller nut is recessed into tab washer, tighten nut securely [minimum of 55 ft. lbs. (7.6mkg) torque].
7. Bend 3 of the tabs of tab washer down in grooves of rear thrust hub to secure propeller nut. (Figure 7) (If tab washer tabs do not align with slots, continue to tighten propeller nut to obtain alignment. DO NOT loosen nut to align tabs.)

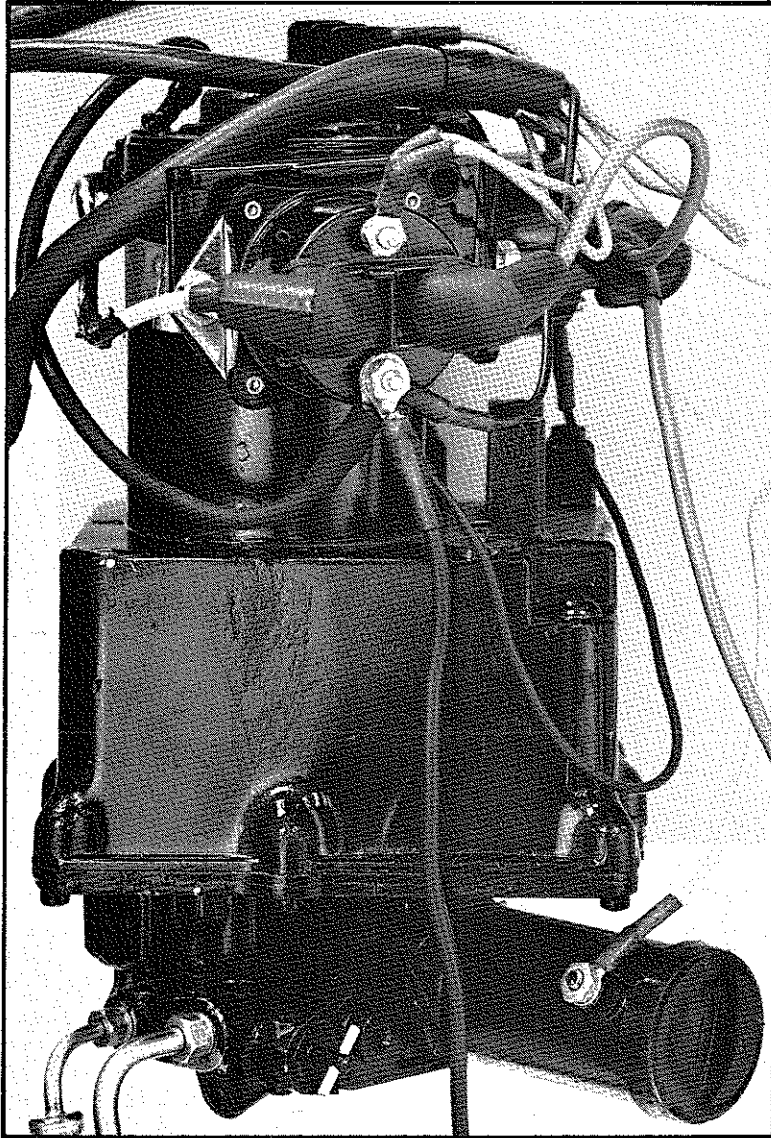
CAUTION: DO NOT misinterpret propeller shaft movement with propeller movement. If propeller and propeller shaft together move forward-and-aft, this is normal; however, propeller should not move forward-and-aft on propeller shaft.

8. After first use, retighten propeller nut and again secure with tab washer (Steps 6 and 7, above). Propeller should be checked periodically for tightness, particularly if stainless steel propellers are used.



V-6 OUTBOARDS

Power Trim



SECTION

6

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POWER TRIM

DESCRIPTION

1. The Power Trim system consists of the hydraulic pump (contains electric motor), oil reservoir, oil pump and valve body, plus 2 hydraulic trim cylinders (mounted on engine) which are connected to pump with hydraulic hoses. Engine is trimmed up by both trim cylinders pushing up on the engine swivel bracket.
2. The remote control is equipped with trim switches, that are used for trimming engine "up" and "down" while engine is under power, and a trailer switch that is used to tilt engine up for trailering, docking or shallow water operation.

OPERATION

1. Operating "Up" trim switch will actuate the "up" pump solenoid and close the electric motor circuit. The electric motor will drive the oil pump, thus forcing oil into the "up" side of the trim cylinders and trimming the engine up until the button is released or until the trim limit cutout switch opens the circuit and stops engine swivel bracket within the limits of the clamp bracket supporting flanges.
2. Operating "Down" trim switch will actuate the "down" pump solenoid and close the pump motor circuit (pump motor will run in the opposite direction). The motor will drive the oil pump and force oil into the "down" side of the trim cylinders and trim engine down to desired position.
3. Operating "trailer" switch will actuate the "up" pump solenoid and close the pump motor circuit. The pump motor will drive the oil pump and force oil into the "up" side of the trim cylinders. The trailering circuit bypasses the trim limit switch so that the engine can be tilted up for trailering, docking or shallow water operation. See "Caution", following.

CAUTION: If engine will be operated in shallow water with engine trimmed beyond trim limit cut-out, follow these precautions:

1. **DO NOT** operate engine above idle RPM. (When engine is trimmed beyond trim limit cut-out, the swivel bracket will have no side support.)
2. **Check that water level is above water intake ports.** (Should water level fall below water intake ports, damage from overheating or water pump impeller damage could occur.)

NOTE: If the "Down" or "Trailer" switch remains depressed after engine reaches its end of travel, an overload cut-out switch will open and pump motor will stop. To prevent cut-out switch from opening, it is recommended that switches be released as soon as engine reaches end of travel. If cut-out switch should open, do not depress switch(es) for approximately one minute. After this period of time, cut-out switch will close (reset itself) and pump again may be opened.

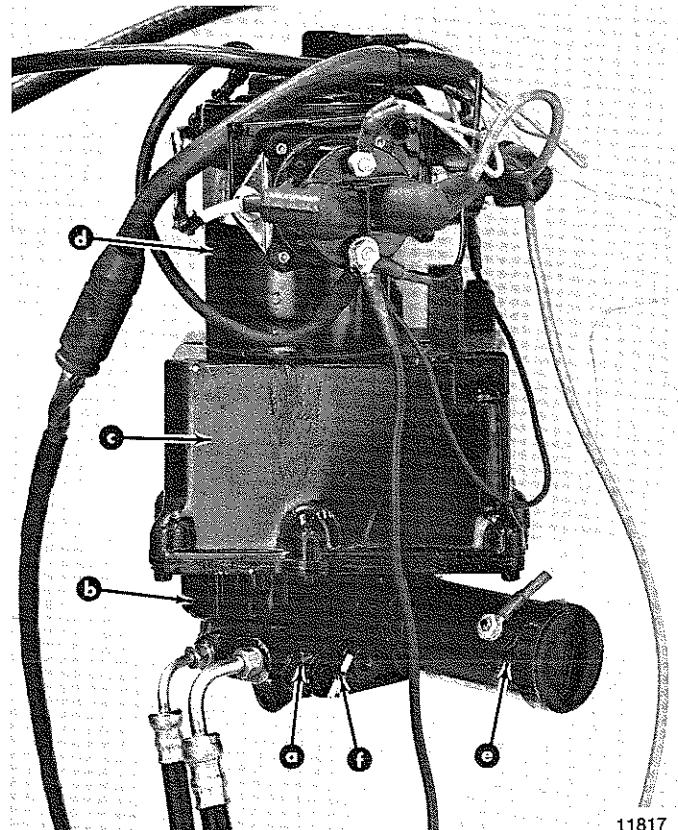
REVERSE LOCK OPERATION

When remote control is shifted into reverse, a switch mounted in remote control is triggered, thus actuating the reverse lock solenoid which hydraulically locks the trim system to prevent engine from kicking up because of propeller thrust.

TILTING ENGINE UP and DOWN MANUALLY

The engine can be raised or lowered manually by turning release valve control knob (Figure 1) to full left (counter-clockwise). Return release valve control knob to full right (clockwise) in order to operate Power Trim. See "Caution", following.

CAUTION: Release valve control knob must be returned to normal operating position to allow reverse lock to operate; turn control knob to full right (clockwise).



- a - Control Valve Assembly
- b - Valve Body and Gear Assembly
- c - Pump Reservoir
- d - Pump Motor
- e - Reverse Lock Solenoid
- f - Release Valve Control Knob

Figure 1. Hydraulic Trim Pump

CHECKING HYDRAULIC PUMP OIL LEVEL and FILLING

Check hydraulic system oil level periodically, as follows:

1. Tilt outboard to full "down" position.
2. Remove "Fill" screw. (Figure 1) Fill to "Full" mark on dipstick with a high-quality, name brand SAE 10W-30 or 10W-40 automotive oil. DO NOT over-fill.

NOTE: In tropical areas, single-viscosity SAE 30 oil may be used.

3. Reinstall "Fill" screw.

BLEEDING HYDRAULIC SYSTEM

1. Tilt outboard to full "down" position.
2. Remove "Fill" screw and fill pump, following filling instructions.
3. Bleed air from hydraulic system by operating trim system several times thru entire trim tilt range, while maintaining fluid level in pump reservoir. Check fluid level in pump when engine is in full "down" position. Reinstall "Fill" screw.

TRIM CYLINDER REMOVAL and INSTALLATION

Refer to Section 5, "Lower Unit".

WIRING CONNECTIONS

Refer to wiring diagram in Section 2.

TROUBLESHOOTING

GENERAL

When a problem is encountered with the Power Trim system, the first step in troubleshooting is to define whether the malfunction is in the electrical system or in the hydraulic system.

Refer to the following problems and determine which system is at fault. After determining in which system the failure has occurred, more detailed checks and tests then can be performed to isolate the exact cause of the problem.

Trouble Chart

Problem	Possible Cause	Corrective Action
Engine will not trim up or down.	Release valve control knob not completely closed.	Valve must be turned completely clockwise.
	Oil level low; air in system.	Check for leaks, fill reservoir and bleed system.
	Determine if hydraulic pump motor operates when trim button is depressed.	If motor operates, perform hydraulic system "up" and "down" pressure tests. If motor does not operate, refer to electrical troubleshooting.
Engine trims up, will not trim down.	Determine if hydraulic pump motor operates when "Down" trim button is depressed.	If motor operates, perform hydraulic system "down" pressure test. If motor does not operate, refer to electrical troubleshooting.
Engine trims down, will not trim up.	Determine if hydraulic pump motor operates when "Up" trim button is depressed.	If motor operates, perform hydraulic system "up" pressure test. If motor does not operate, refer to electrical troubleshooting.
Engine will not return completely to "down" position or returns part way with jerky motion	Air in system.	Check for leaks, fill reservoir and bleed system.
	Internal cylinder(s) leaks.	Perform trim cylinder pressure test.
Engine thumps when shifted.	Air in system.	Check for leaks, fill reservoir and bleed system.
	Internal cylinder leaks.	Perform trim cylinder pressure test.
	Leaks in control valve assembly.	Perform hydraulic system "up" and "down" pressure tests.
Engine trails out when backing off throttle at high speed.	Air in system.	Check for leaks, fill reservoir and bleed system.
	Control valve assembly inoperative.	Replace control valve assembly.
	Internal cylinder leaks.	Perform trim cylinder pressure test.
Engine will not hold a trimmed position or will not remain tilted for extended period.	External leak (fittings or parts' leaks)	Tighten fittings or replace defective part(s).
	Internal cylinder leaks.	Perform trim cylinder pressure test.
	Pump check valve leak (high pressure).	Try cleaning check valve by operating system up and down several times to flush system. If flushing the system fails to correct problem, replace pump valve body assembly.
Engine will not hold in reverse.	Reverse lock valve solenoid inoperative.	Refer to electrical troubleshooting (see "Index").
	Internal cylinder leaks.	Perform trim cylinder pressure test ("Index").
	Reverse lock valve seat is bad.	Perform reverse lock valve test ("Index").

TESTING HYDRAULIC TRIM SYSTEM

(Using Test Gauge C-91-52915A3
with Conversion Kit C-91-52915A5)

Testing Pump "Up" Pressure, Pump "Down" Pressure and Trim Cylinder Pressure Test

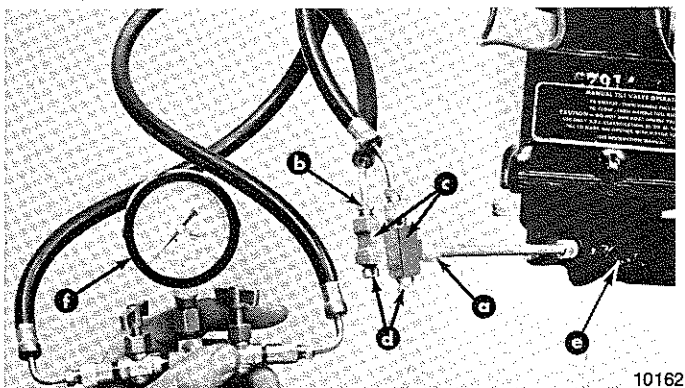
Test gauge may be connected at control valve (located on bottom of hydraulic pump) or at trim cylinder, depending upon accessibility of the 2 locations.

TEST GAUGE CONNECTION (As Tested at Control Valve)

1. Remove and cap "up" port and "down" port hoses from control valve.
2. Connect test gauge hoses to control valve assembly, as shown in Figure 1.
3. Check pump oil level. If necessary, fill reservoir to "Full" mark on dipstick. Use name brand SAE 10W-30 or 10W-40 automotive oil. DO NOT over-fill.

IMPORTANT: Test gauge hose connected to small diameter port (in control valve) is "up" pressure and will be referred to as "up" port hose and valve. Test gauge hose connected to large diameter port is "down" pressure and will be referred to as "down" port hose and valve.

4. Proceed with test desired, following.



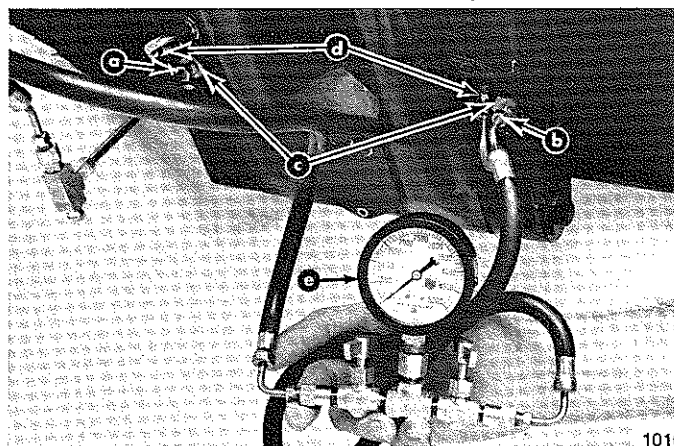
- | | |
|-------------------|-------------------------|
| a - "Down" Line | d - Plug (2) |
| b - "Up" Line | e - Manual Tilt Valve |
| c - T-Fitting (2) | f - Test Gauge Assembly |

Figure 1. Test Gauge Connected at Control Valve

TEST GAUGE CONNECTION (As Tested at Trim Cylinder)

NOTE: To test trim cylinders, gauge must be connected at control valve.

1. Remove "up" port and "down" port hose from hydraulic connector. (Figure 2)
2. Connect test gauge as shown in Figure 2.



- | | |
|-----------------------------|-------------------------|
| a - Large Diameter Port | d - Hoses Removed |
| b - Small Diameter Port | e - Test Gauge Assembly |
| c - Hydraulic Connector (2) | |

Figure 2. Test Gauge Connected at Cylinders

3. Check pump oil level. If necessary, fill reservoir to "Full" mark on dipstick. Use name brand SAE 10W-30 or 10W-40 automotive oil. DO NOT over-fill.

IMPORTANT: Test gauge hose connected to small diameter port is "up" pressure and will be referred to as "up" port hose and valve. Test gauge hose connected to large diameter port is "down" pressure and will be referred to as "down" port hose and valve.

4. Proceed with test desired, following.

Test Procedures

PUMP "UP" PRESSURE

1. Close "down" port valve and open "up" port valve.
2. Close manual tilt valve (clockwise) tightly. (Figure 1)
3. Run pump in "up" direction until pressure stops rising, as indicated on gauge. Pump output "up" pressure should be 3100 PSI (218kg/sq.cm) minimum while pump is running.
4. Stop pumping up. Gauge pressure will drop slightly, then hold steady. After stabilizing, pressure must hold steady.

Leakage indicates a failed check valve in pump or leaking manual tilt valve (located in control valve) and may result in failure to hold a trimmed position.

5. To determine which valve is defective, remove plug from trim gauge T-fitting (Figure 1) located in "down" line. Oil will drip out of T-fitting. Run pump in "up" direction. Oil should not flow from T-fitting (drip is normal). If oil flows, check to make sure that manual tilt valve is closed tightly. If oil still flows, manual tilt valve is defective. Replace

control valve assembly. If oil still flows from T-fitting while running pump in "up" direction, manual tilt valve is good and pump body must be replaced.

6. Replace defective parts and retest.
7. If pump body and control valve test OK, proceed to trim cylinder check.

NOTE: If manual tilt valve tests bad, it is possible that valve (located in pump body) is bad also. It may be necessary to retest "up" pressure after replacing control valve assembly.

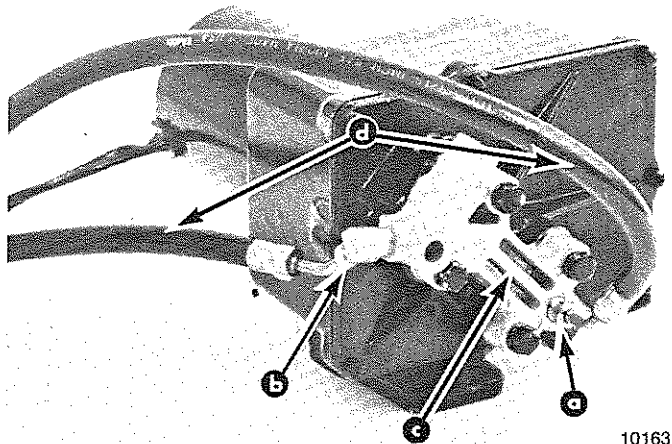
PUMP "DOWN" PRESSURE

NOTE: Readings in this test are "regulated" systems "down" pressure (not actual pump "down" pressure).

1. Check that plugs are installed in T-fittings, as shown in Figure 1.
2. Close "up" port valve and open "down" port valve.
3. Close manual tilt valve (clockwise) tightly.
4. Run pump in "down" direction and note gauge reading. Reading should be 1200 PSI (84kg/sq.cm) minimum while pump is running. If pump "down" pressure is low, down check valve (located in pump body) or down pilot check valve (located in control valve assembly) is defective.
5. To determine which valve is defective, replace control valve assembly and retest. If pump "down" pressure still is low, pump body must be replaced.

NOTE: If replacement control valve is not available, adaptor (supplied in test gauge kit) may be substituted. Adaptor is installed as shown in Figure 3.

6. Replace defective part and retest system.
7. If pump "down" pressure tests OK, but engine will not trim down, slide valve (located in pump body) is defective. Replace pump body.



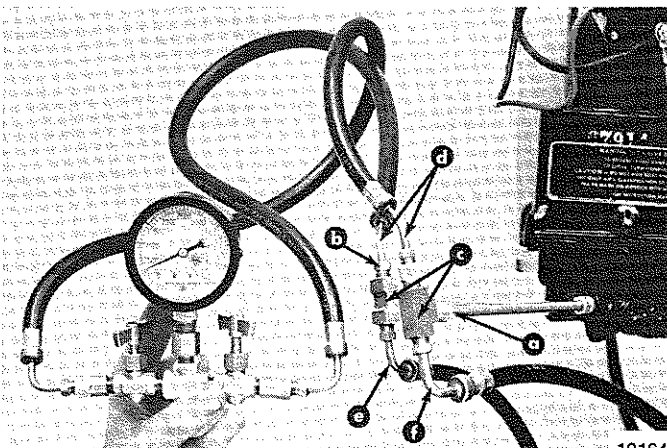
- a - "Up" Pressure Connection
- b - "Down" Pressure Connection
- c - Adaptor
- d - Test Gauge Hoses

Figure 3. Adaptor Installed on Pump

TRIM CYLINDER PRESSURE CHECK

IMPORTANT: Before performing cylinder check, first determine if pump "up" pressure is OK. Check "up" pressure, preceding. **DO NOT** remove test gauge after "up" pressure test is completed. Continue with Step 1, following.

1. Open both valves at test gauge to release pressure.
2. Connect hoses (removed from control valve assembly) to appropriate T-fitting, as shown in Figure 4.



- a - "Down" Line
- b - "Up" Line
- c - T-Fitting
- d - Test Gauge Hoses
- e - "Up" Line (Removed from Control Valve Assembly)
- f - "Down" Line (Removed from Control Valve Assembly)

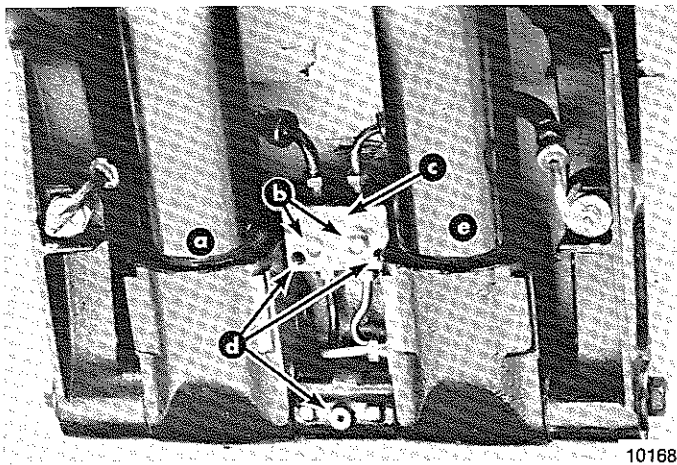
Figure 4. Cylinder Test Gauge Connection

3. Open "up" port valve and close "down" port valve.
4. Close manual tilt valve tightly.
5. Run pump in "up" direction until full tilt position is obtained and pressure stops rising, as indicated on gauge. Pump output "up" pressure should be 3100 PSI (218kg/sq.cm) minimum while pump is running.
6. Stop pumping up. Gauge pressure will drop slightly, then hold steady. After stabilizing, pressure must hold steady.
7. If pressure does not hold (leaks down), determine which cylinder is leaking, as follows.

CAUTION: Failure to lock engine in "up" position may cause engine to tilt down rapidly and result in bodily injury.

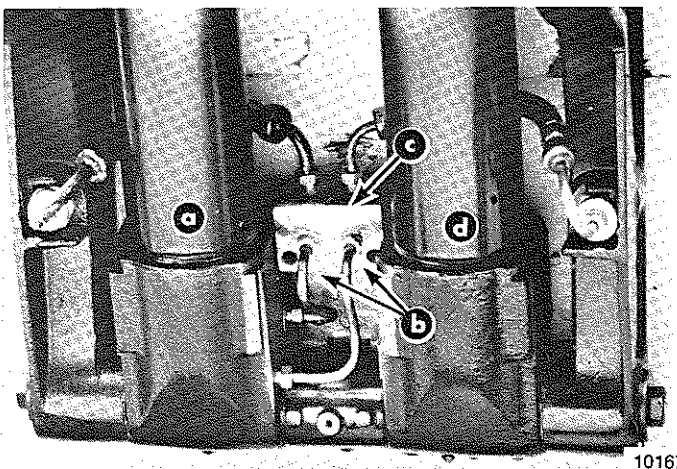
- a. Position tilt stop lever to lock engine in full "up" position.
- b. Remove distribution block cover. (Figure 5)
- c. Run pump in "down" direction momentarily to release any pressure that may be in system, as indicated on gauge.
- d. Isolate port (left) cylinder by removing 2 lines (located between distribution block and port cylinders). Plug holes (located in distribution block) from which lines were removed. (Figure 2)
- e. Run pump in "up" direction. Gauge should read as indicated in Step 4 and 5, preceding. If pressure holds (tests OK), starboard (right) cylinder is OK. Replace or repair port cylinder. If low pressure (leaking) starboard cylinder is defective, replace or repair starboard cylinder.

NOTE: If starboard (right) cylinder is found to be defective, port cylinder also may be defective and should be tested by isolating starboard cylinder. Remove starboard lines, plug holes in distribution block and install port lines as shown in Figure 6. Repeat test, preceding.



- a - Port (Left) Cylinder d - Cover Fastening Holes
 b - Plugs e - Starboard (Right) Cylinder
 c - Distribution Block

Figure 5. Testing Starboard (Right) Cylinder



- a - Port (Left) Cylinder c - Distribution Block
 b - Plugs (Hidden) d - Starboard (Right) Cylinder

Figure 6. Testing Port (Left) Cylinder

"UP" REVERSE VALVE TEST

NOTE: If trim system operates properly, except that it will not trim up when shifted into reverse, proceed with the following test.

1. Position engine in full "down" position. Position shift handle (on remote control) in reverse with ignition key switch in "On" position, but engine not running.
2. Run pump in "up" direction. If engine fails to trim up, the "up" reverse valve (located in control valve assembly) is defective. Replace control valve.

REVERSE LOCK VALVE

Test with Boat in Water

1. Shift remote control handle into reverse and accelerate. Trim position should hold. If engine tilts up, check for

voltage at reverse lock solenoid terminal, as follows:

- a. Position shift handle on remote control into reverse with ignition key switch in "On" position, but engine not running.
 - b. Connect voltmeter to reverse lock solenoid terminal and negative (-) terminal on battery. Reading should be 12 volts. No voltage indicates that switch in remote control or wiring is defective. If voltage is OK, replace reverse lock valve solenoid.
2. If engine still does not hold trim position under reverse thrust, reverse lock valve seat (located in control valve assembly) is bad. Replace control valve assembly.

Test with Boat out of Water

1. If boat is out of water, trim engine to a convenient position (approximately ¼-trim). With ignition key in "On" position, but engine not running, you should NOT be able to lift engine by hand. If engine can be lifted by hand, check for voltage at reverse lock solenoid terminal, as follows:
 - a. Position shift handle on remote control into reverse with ignition key switch in "On" position, but engine not running.
 - b. Connect voltmeter to reverse lock solenoid terminal and negative (-) terminal on battery. Reading should be 12 volts. No voltage indicates that switch in remote control or wiring is defective. If voltage is OK, replace reverse lock valve solenoid.
2. If engine still does not hold trim position, reverse lock valve seat (located in control valve assembly) is bad. Replace control valve assembly.

TEST GAUGE REMOVAL (As Tested at Control Valve)

1. Remove test gauge hoses from control valve assembly.
2. Remove caps from hydraulic system "up" port and "down" port hoses.
3. Install "up" port hose to "up" port and "down" port hose to "down" port.
4. Operate trim system and check for leaks at all connections.

TEST GAUGE REMOVAL (As Tested at Trim Cylinder)

CAUTION: Make sure that engine is locked in full "up" position before removing test gauge.

1. Remove test gauge hoses from hydraulic connectors.
2. Connect "up" port and "down" port hoses to their respective hydraulic connectors.
3. Operate trim system and check for leaks at all connections.

TROUBLESHOOTING POWER TRIM ELECTRICAL SYSTEM

Before troubleshooting the Power Trim electrical system, check the following:

1. Check that plug-in connectors are fully engaged and that terminals are free of corrosion.

2. Check for disconnected wires and make sure that wire connections are tight and free of corrosion.

3. Make certain that battery is fully charged.

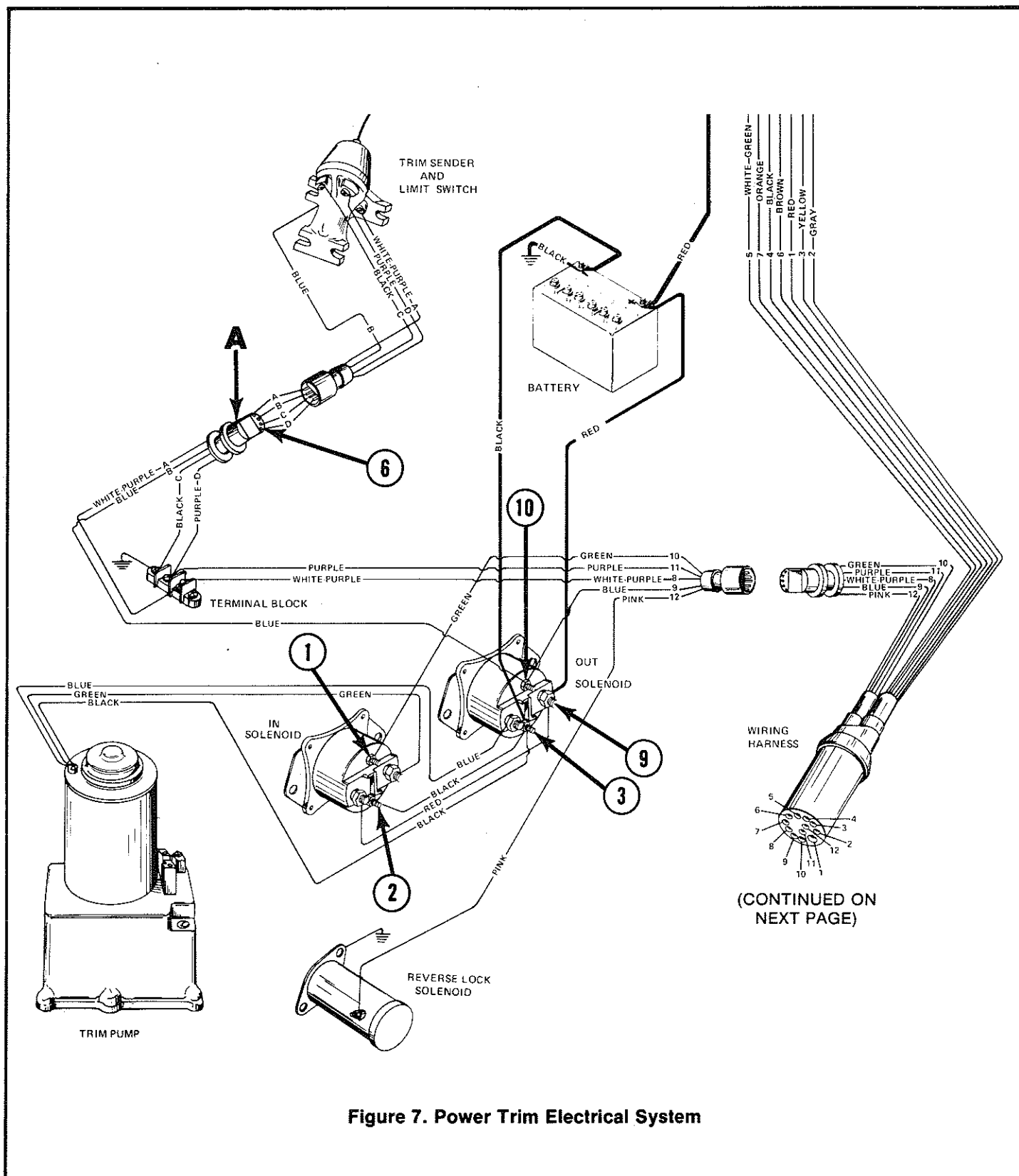


Figure 7. Power Trim Electrical System

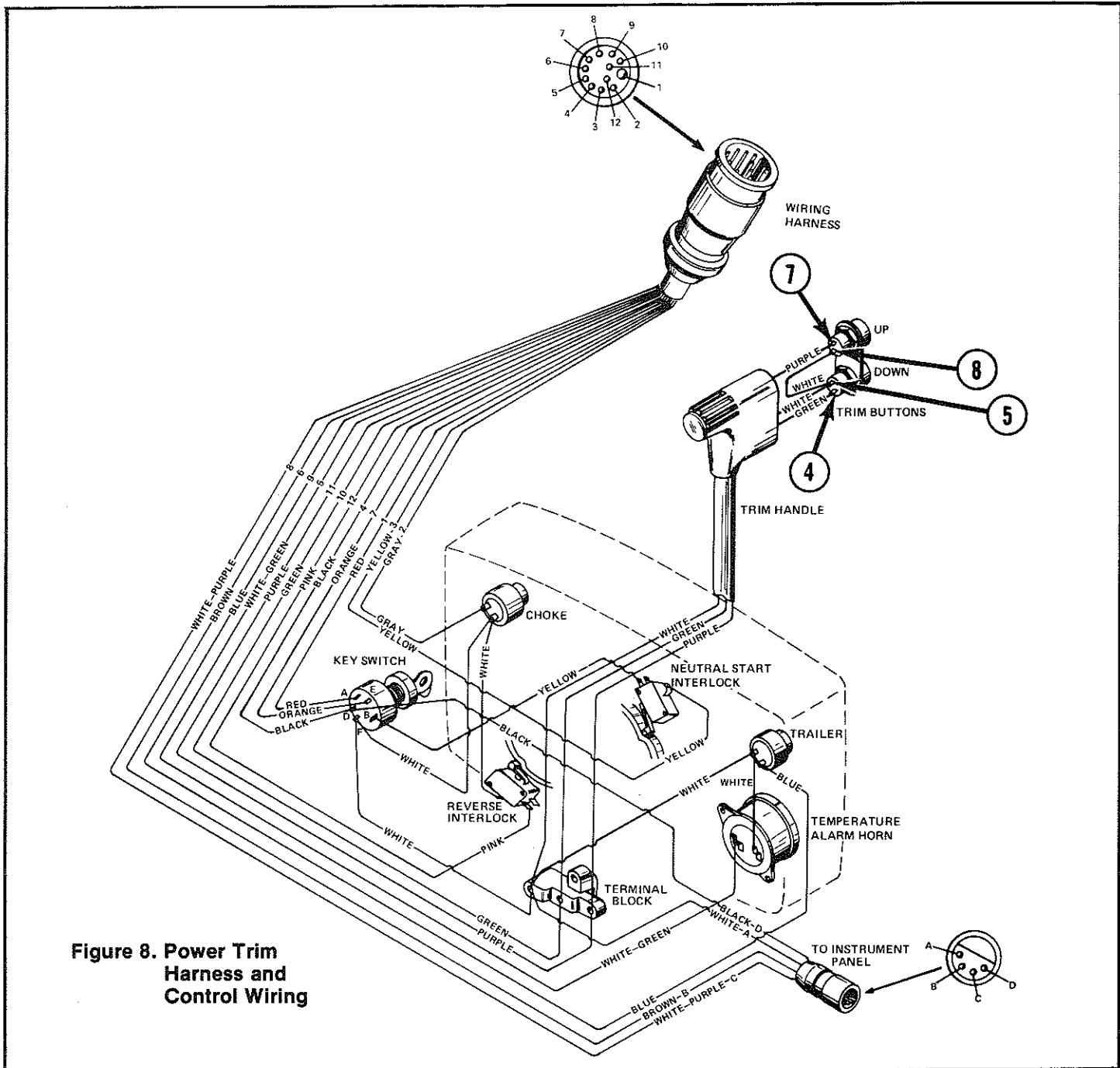


Figure 8. Power Trim Harness and Control Wiring

Troubleshooting the "Trailer" Circuit (When "Up" Trim Circuit Is OK)

- | |
|--|
| Use an ohmmeter (Rx1 scale) and check continuity of blue wire between Point 10 and trailer button. If no continuity, wire is open. |
| If blue wire is OK, check continuity across trailer button terminals with button depressed. If no continuity is indicated, trailer button is faulty. |
| Check white wire to trailer button for open or disconnected terminal. |

Troubleshooting the "Down", "Up" and "Trailer" Circuits (All Circuits Inoperative)

Connect voltmeter red lead to Point 9 in Figure 7 and black lead to Point 3. Battery voltage should be indicated.

No Voltage Indicated

- a. Check red and black leads to battery for poor connections or open circuit.
- b. Check battery charge.

Battery Voltage Indicated

Turn ignition key to "On" position. Connect red lead to Point 10. Depress trailer button. If battery voltage is indicated, test trim pump motor. If no voltage is indicated, check all harness connectors and test ignition switch. Refer to ignition switch test (see "Index").

If ignition switch is good, use a ohmmeter (Rx1 scale) and check continuity of red wire between ignition switch and (+) terminal on engine. See wiring diagram. If no continuity, red wire is open.

If ignition switch and red wire are good, check white wires in remote control housing for opens or disconnected terminals.

Troubleshooting the "Down" Trim Circuit (When "Up" Circuit Is OK)

- a. Connect voltmeter red lead to Point 1 and black lead to Point 2 in Figure 7.
- b. Turn ignition key to "On" position.
- c. Depress the "Down" trim button. Battery voltage should be indicated.

Battery Voltage Indicated

- a. Check "In" solenoid terminals for loose or corroded connections.
- b. Test solenoid. Refer to solenoid test (see "Index").

No Voltage Indicated

Connect voltmeter black lead to Point 3 (Figure 7). Depress "Down" trim button. If battery voltage is indicated, black jumper wire between solenoids is open.

No Voltage Indicated

Connect voltmeter red lead to Point 4 (Figure 8). Depress "Down" trim button. If battery voltage is indicated, green wire is open between Points 4 and 1.

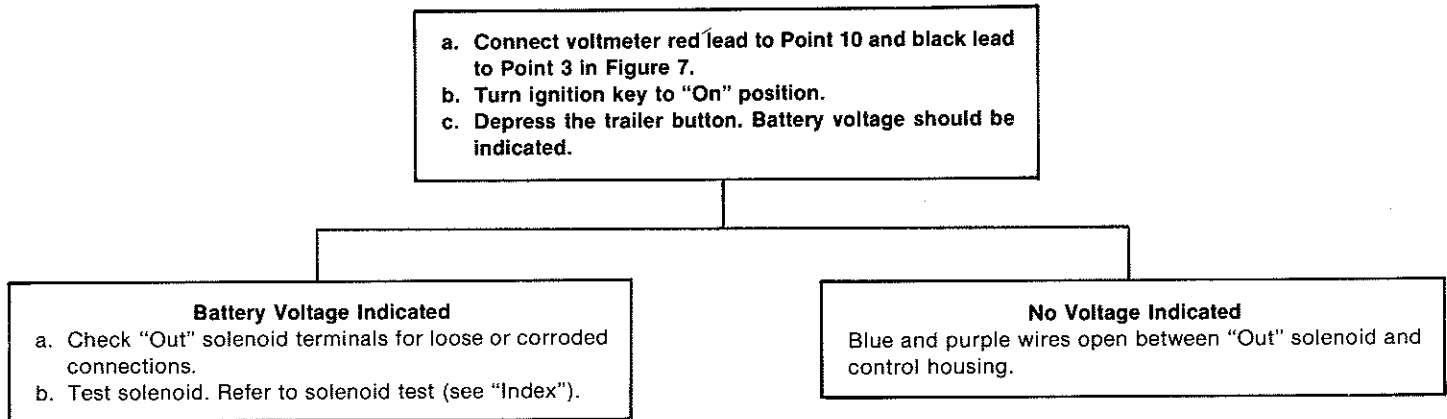
No Voltage Indicated

Connect voltmeter red lead to Point 5 (Figure 8). If battery voltage is indicated, trim button is faulty. No battery voltage: White wire is open between trim switches.

Troubleshooting the "Up" Trim Circuit (When "Trailer" Circuit Works)



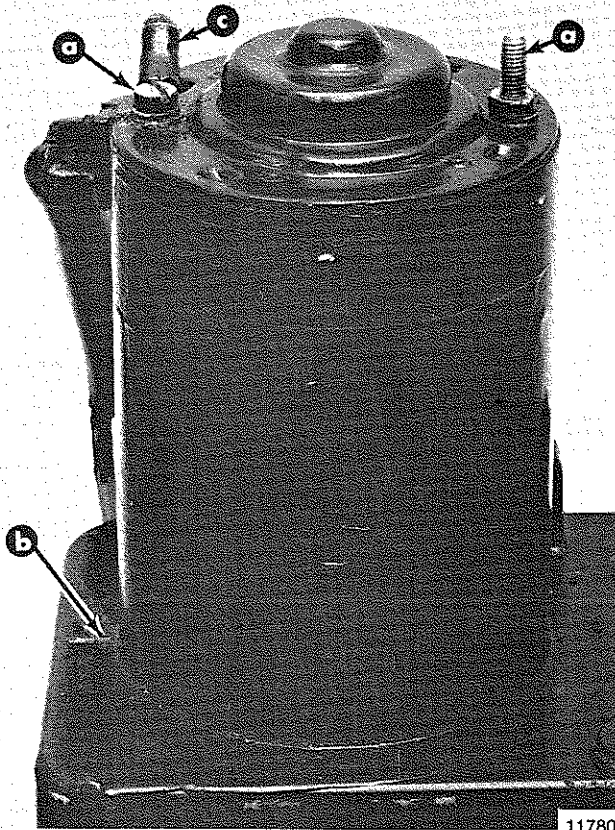
Troubleshooting the "Up" and "Trailer" Circuits (Both Circuits Inoperative; "Down" Circuit Is OK)



Hydraulic Trim Pump Motor

DISASSEMBLY

1. Observe alignment marks (Figure 4) on motor frame and reservoir. If no marks exist, scribe marks to assist in re-assembly.
2. Remove 2 thru bolts (Figure 1) from commutator end plate.
3. Lift commutator end plate from motor frame. Retain brush springs and steel ball (Figure 5) from end of armature shaft.
4. Lift motor frame off armature.
5. Pull armature shaft (Figure 6) out of reservoir. Retain thrust washer(s) from shaft. Reassemble washers in same order.



- a - Thru Bolt
- b - Alignment Marks
- c - Ground Wire

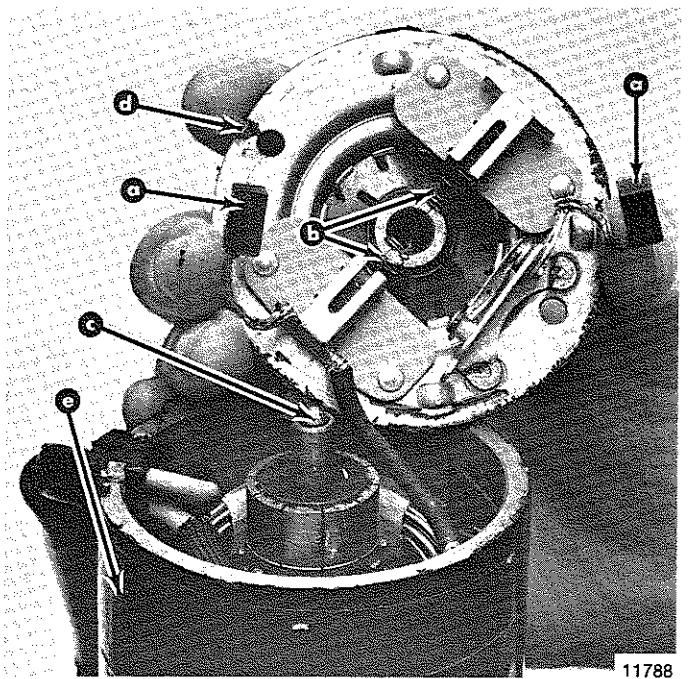
Figure 4. Hydraulic Trim Pump Motor

TESTING

1. Check and clean armature as follows:
 - a. If commutator is worn, it can be turned down on an armature conditioner tool or on a lathe.
 - b. If not worn badly, clean commutator with "00" sandpaper.

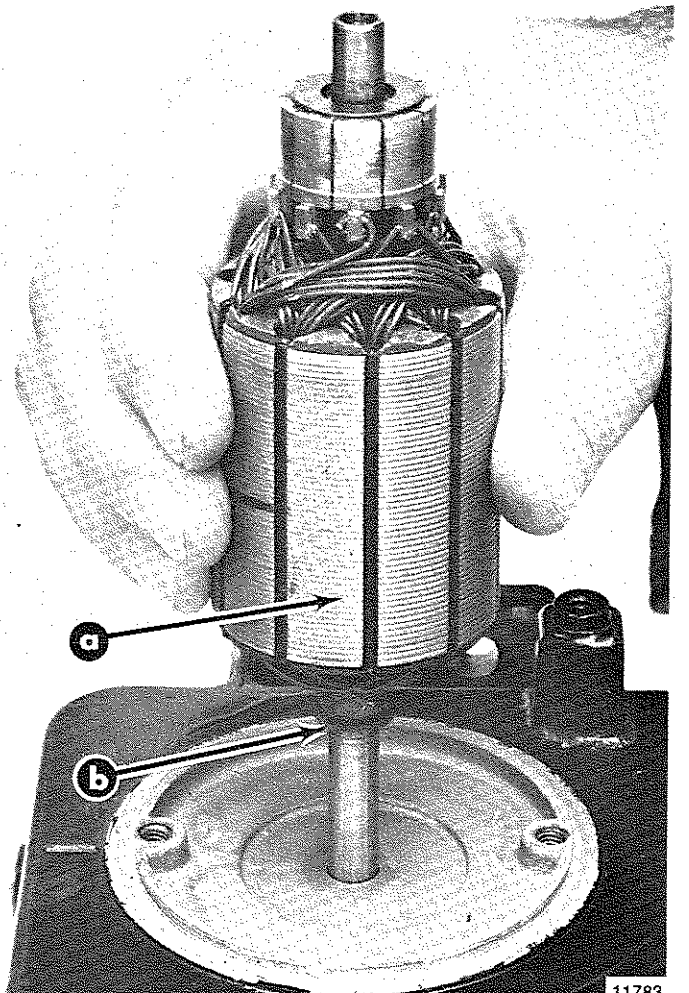
- a - Armature
- b - Thrust Washer(s); Reassemble in Same Order

Figure 6. Removing Armature



- a - Motor Brush
- b - Brush Springs
- c - Steel Ball
- d - Alignment Tab
- e - Motor Frame

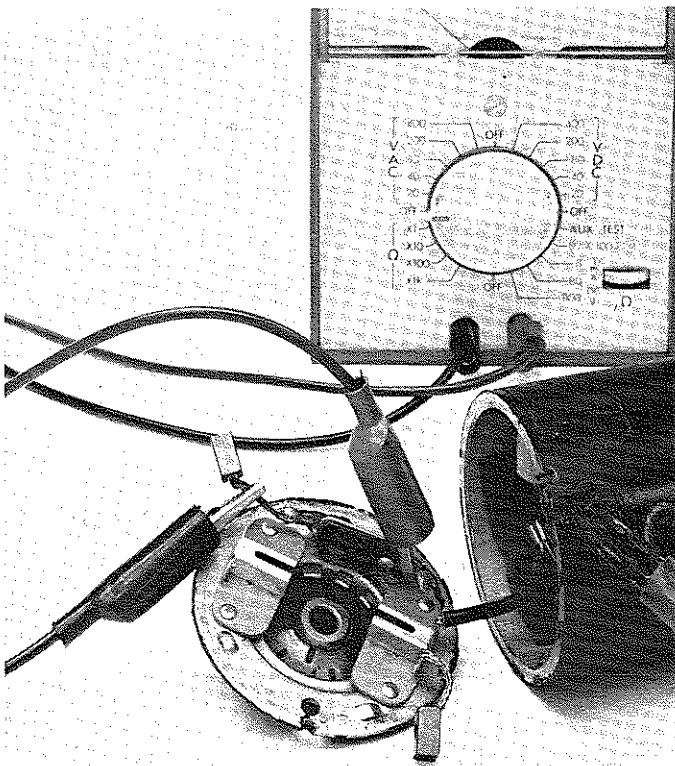
Figure 5. Lifting Commutator End Plate from Motor Frame



- c. Check armature on a growler. (Follow growler manufacturer test instructions.) Any indication of shorts or open windings requires replacement of armature.
2. Brush replacement is recommended if brushes are pitted, chipped or worn to less than 1/4" (6.4mm). If necessary, replace brushes as follows:

CAUTION: Solder, that is used to install new brushes, must be rosin core and have a melting point above 350°F+ (177°C+). Use a soldering gun to solder. DO NOT use a torch.

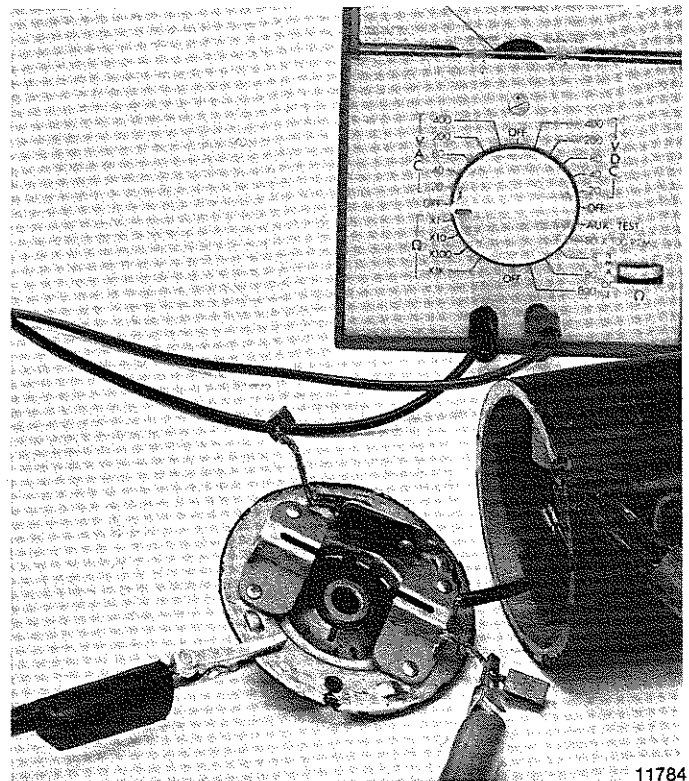
- a. Cut old brush shunt at point where shunt is connected.
- b. Solder new brush shunt to connection point, using rosin core solder 40-60 tin lead alloy or an equivalent rosin core solder that has a melting point above 350°F+. DO NOT use acid core solder, because of corrosive action of acid.
3. Inspect commutator end plate as follows:
 - a. Check thermal switch for full continuity. Connect leads of VOA meter (Rx1 scale) between brush pigtail and opposite end of thermal switch, as shown in Figure 7. If meter indicates no continuity or high resistance, replace end plate.
 - b. Use a VOA meter (Rx1 scale) and check for no continuity between brush pigtail and end plate (Figure 8) and between brush holders and end plate (Figure 9). If meter indicates continuity, replace end plate.



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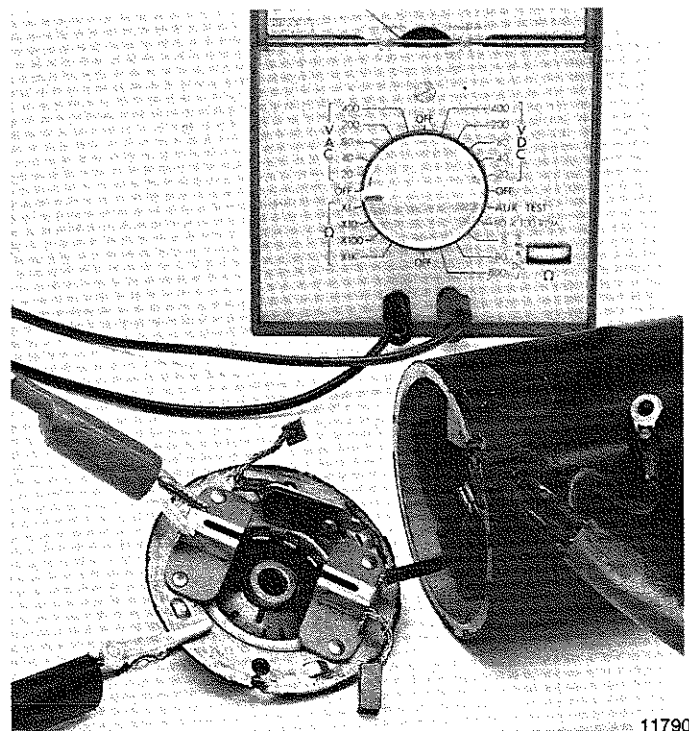
Figure 7. Checking between Brush Pigtail and Thermal Switch

4. Inspect frame and field assembly as follows:
 - a. Use a VOA meter (Rx1 scale) and check for full continuity between green (motor) wire and black jumper wire and between blue (motor) wire and black jumper. (Figure 10) If meter indicates no continuity or high resistance, replace frame and field assembly.



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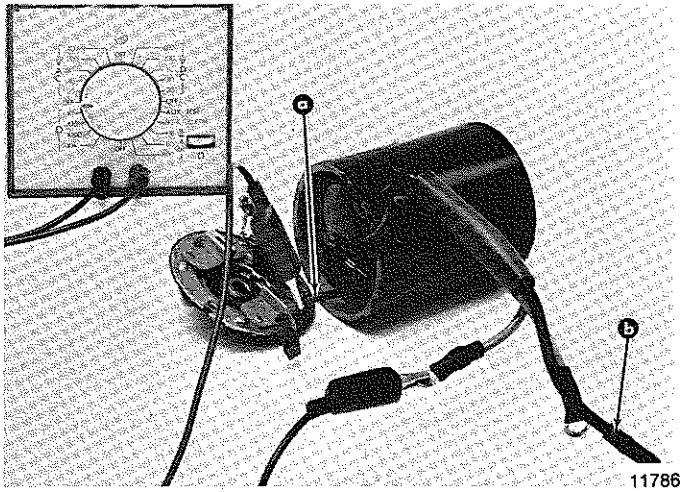
Figure 8. Checking between Brush Pigtails and End Plate



11790

Figure 9. Checking between Brush Holders and End Plate

- b. Use a VOA meter (Rx1 scale) and check for no continuity between black jumper wire (Figure 10) and frame. If meter indicates continuity, replace field and frame assembly.
- c. Use a VOA meter (Rx1 scale) and check for full continuity between black (motor) ground wire. (Figure 10) If no continuity, replace black ground wire.



- a - Black Jumper Wire
- b - Black (Motor) Ground Wire

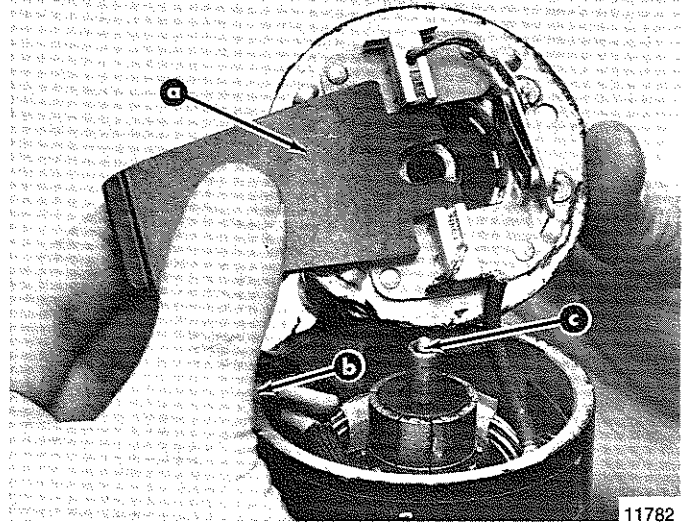
Figure 10. Checking between Motor Wire and Black Jumper Wire

REASSEMBLY

1. Place thrust washers (Figure 6) on armature shaft.
2. Install armature shaft into pump reservoir. Rotate armature to align flat sides on end of shaft with slot in valve body and gear assembly.
3. Install motor frame over armature, aligning mark on frame with mark on reservoir.
4. Place steel ball (Figure 11) onto end of armature shaft.
5. Place springs and brushes into brush holders. Spread brushes and hold in place with brush holder tool, as shown in Figure 11. Tool can be made by following instructions in Figure 12.
6. Align alignment tab (located on end plate, Figure 5) with slot in frame (Figure 11), then install end plate on frame. Secure end plate and frame to reservoir with thru bolts, including ground wire under one bolt.

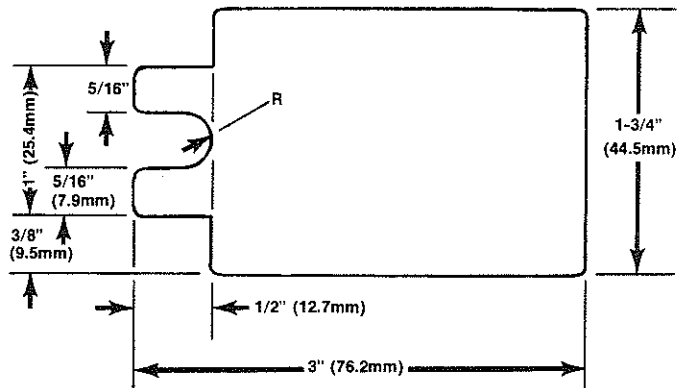
Figure 12. Brush Holder Tool 

7. Seal seams between motor frame and end plate and motor frame and pump reservoir with liquid neoprene. This will provide a seal. Allow to dry thoroughly, then repaint.



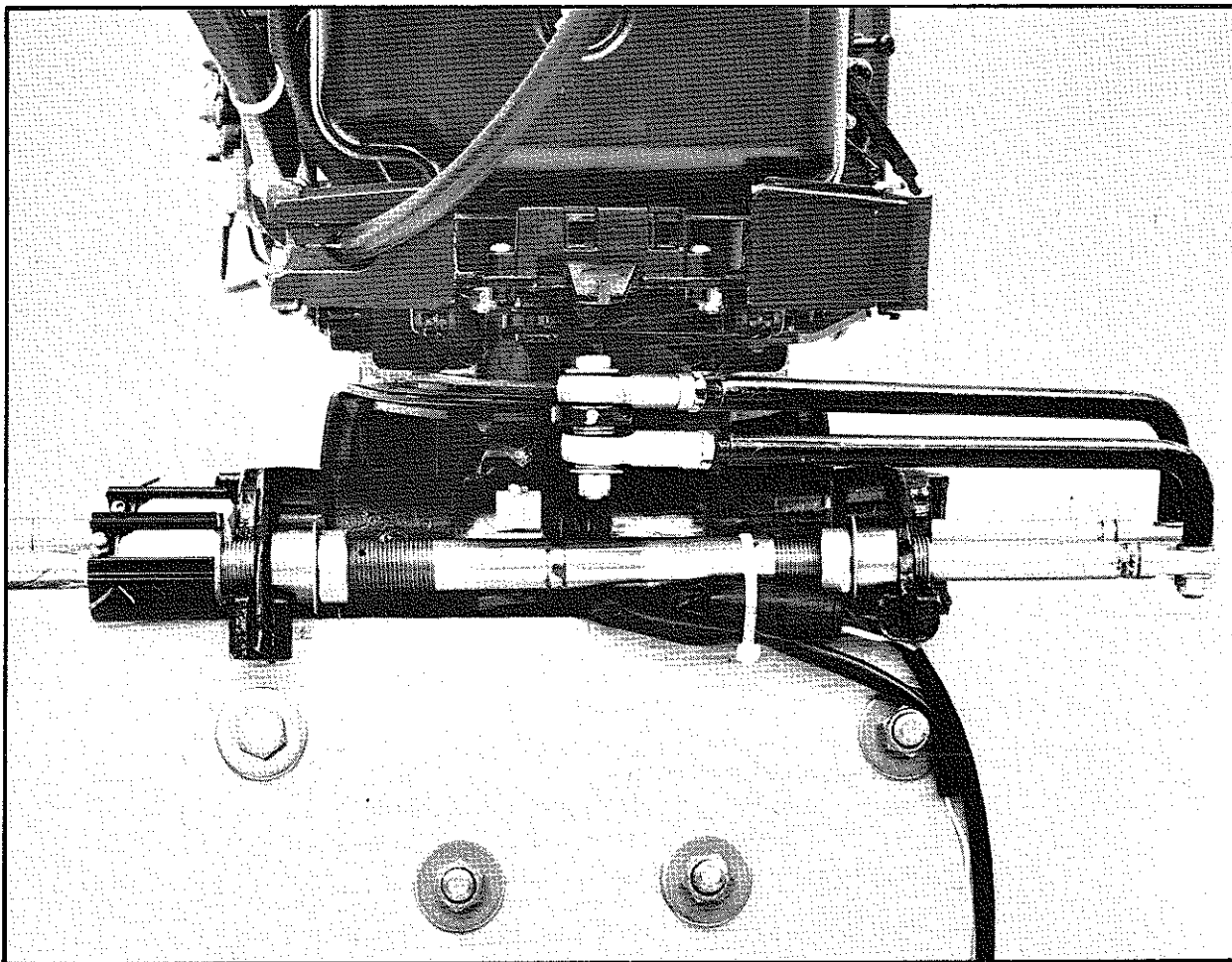
- a - Brush Holder Tool
- b - Slot; Insert Alignment Tab of End Plate (Figure 5) into This Slot
- c - Steel Ball

Figure 11. Installing Commutator End Plate



V-6 OUTBOARDS

Engine Attachments



Ride-Guide Steering and Remote Control Attachments

SECTION

PART

A

7

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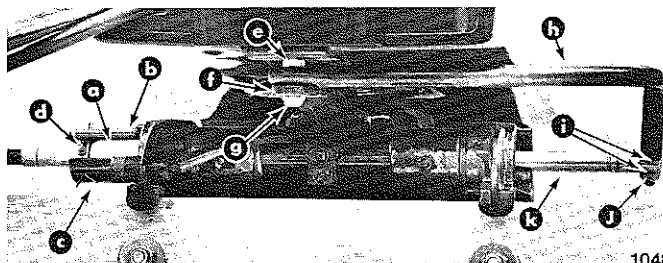
RIDE-GUIDE STEERING ENGINE ATTACHMENTS

Steering Link Rod and Ride-Guide Steering Cable Installation

On SINGLE ENGINE with SINGLE STEERING CABLE

1. Refer to installation instructions (shipped with steering cable) when installing steering cable to steering mount.
2. Connect steering link rod to engine steering arm with pivot bolt and locknut, as shown in Figure 1. Torque pivot bolt, then nut to 20 ft. lbs. (2.77mkg).
3. Lubricate inside of engine tilt tube (that will have steering cable installed to it) with Multipurpose Lubricant. Insert steering cable end thru tilt tube, then secure steering cable to engine tilt tube with steering cable attaching nut, as shown in Figure 1. Torque nut to 35-to-40 ft. lbs. (4.8-to-5.3mkg).
4. Install locking sleeve (supplied with steering cable) over steering cable attaching nut (Figure 1) and secure with cotter pin. Spread ends of cotter pin.

5. Attach steering link rod to steering cable end with 2 flat washers and locknut, as shown in Figure 1. Torque nut to 10 ft. lbs. (1.38mkg) maximum and back off ¼-turn.



- | | | |
|--------------------|--------------------|-----------------|
| a - Steering Cable | d - Grease Fitting | h - Link Rod |
| b - Locking Sleeve | e - Pivot Bolt | i - Flat Washer |
| c - Cotter Pin | f - Steering Arm | j - Locknut |
| | g - Locknut | k - Cable End |

Figure 1. Installing Steering Link Rod and Cable

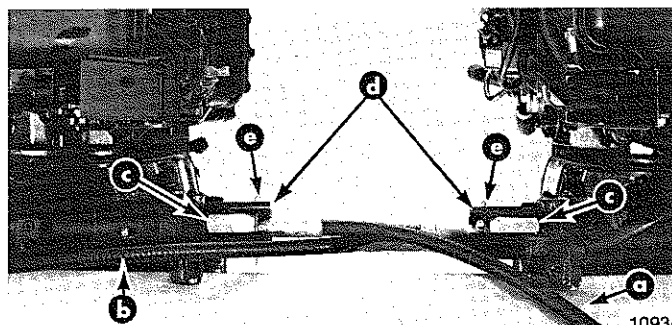
Dual Engine Ride-Guide Attachment Installation

NOTE: Use these instructions for reinstalling attaching kit, reconnecting steering cables and maintenance. Order instruction sheet Part No. C-90-77162 for complete installation instructions.

CONNECTING STEERING CABLES to ENGINES

IMPORTANT: Steering cables MUST BE installed into tilt tube of each engine before engines are mounted on transom.

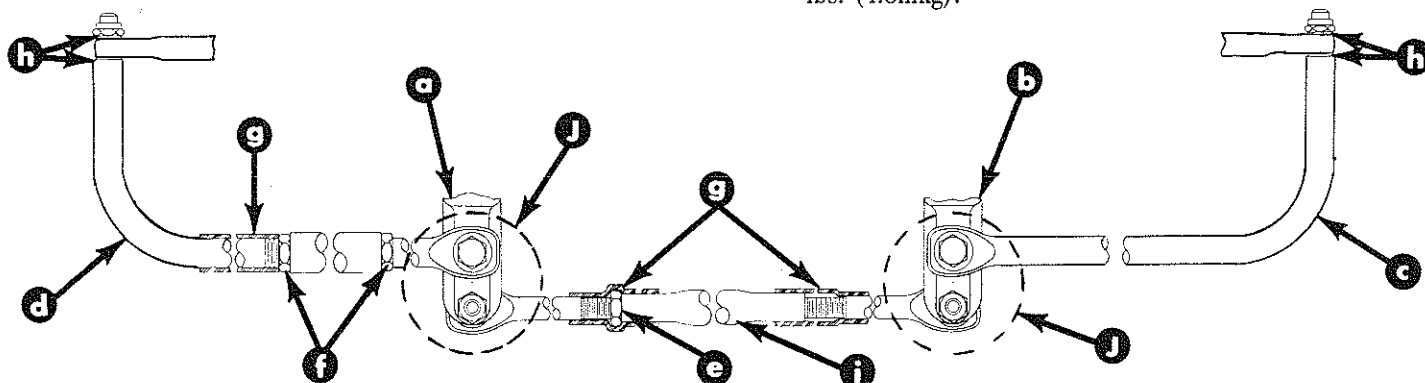
1. Lubricate inside of each engine's tilt tube with Multipurpose Lubricant.
2. Steering cable routed down the port side of boat must be installed into starboard engine tilt tube, and steering cable routed down the starboard side of boat must be installed into port engine tilt tube, crossing between engines as shown in Figure 2.



- | | | |
|------------------------------|--------------------|----------------|
| a - Port Steering Cable | c - Attaching Nuts | e - Cotter Pin |
| b - Starboard Steering Cable | d - Locking Sleeve | |

Figure 2. Ride-Guide Steering Cables Installed on Engines

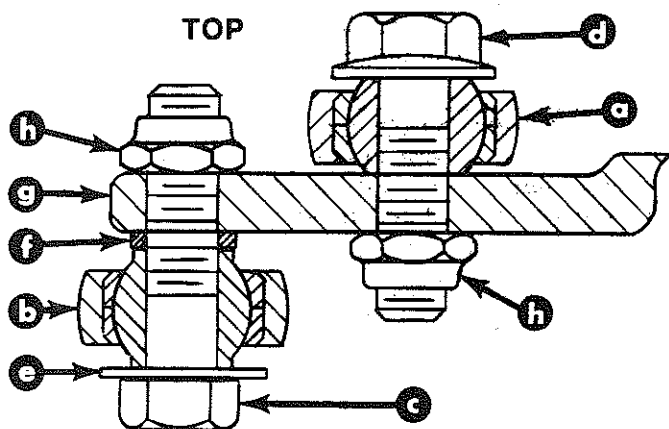
3. Secure steering cable to each engine with cable attaching nut. (Figure 2) Torque nuts (one on each cable) to 35 ft. lbs. (4.8mkg).



- | | | |
|---------------------------------|---|---|
| a - Starboard Steering Arm | e - "Jam" Nut (Steering Eye to Coupler); Torque to 20 Ft. Lbs. (2.8mkg) | g - Rubber Sleeves |
| b - Port Steering Arm | f - "Jam" Nuts (Starboard Steering Link Rod); Torque to 20 Ft. Lbs. | h - Flat Washers [5/8" (16mm) Outside Dia.] |
| c - Port Steering Link Rod | | i - Coupler |
| d - Starboard Steering Link Rod | | j - See Figure 4 for Parts' Sequence |

Figure 3. Attachment Parts' Sequence

4. Install a locking sleeve (supplied with each cable) over each steering cable attaching nut, as shown in Figure 2. Secure locking sleeve with cotter pin (Figure 2) and spread ends of cotter pins.



- a - Steering Link Rod
- b - Steering Eye and Coupler
- c - Pivot Bolt (3/8"-24x1-5/8"; 2 Req'd; Torque to 20 Ft. Lbs.)
- d - Pivot Bolt (3/8"-24x1-1/4"; 2 Req'd; Torque to 20 Ft. Lbs.)
- e - Flat Washer [1" (25.4mm) Outside Diameter]
- f - Flat Washer (5/8" Outside Diameter)
- g - Engine Steering Arm
- h - Locknuts (Torque to 20 Ft. Lbs.)

Figure 4. Attachment Parts' Sequence

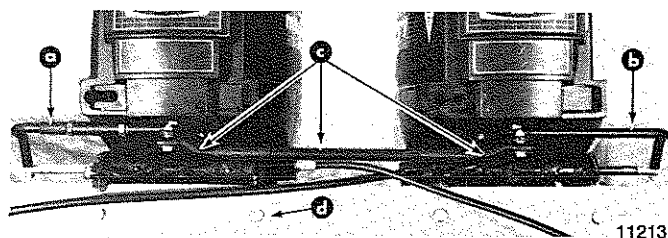
INSTALLING ATTACHMENT KIT TO ENGINES

IMPORTANT: If upper engine mounting bolts (Figure 5) are installed with threaded ends inside of boat transom, turn bolts so that heads of bolts are inside of transom. Retighten bolts.

NOTE: Lubricate pivot bolts and ball joints in link rods and steering eyes with Quicksilver Corrosion and Rust Preventive before assembling.

Port Steering Link Rod Installation

1. Connect port steering link rod (Figures 3 and 5) onto top side rear hole of port engine steering arm with a 3/8"-24x1 1/4" pivot bolt. Torque bolt to 20 ft. lbs. (2.8mkg), then thread self-locking nut (Figure 4) onto bolt and torque nut to 20 ft. lbs.



- a - Starboard Steering Link Rod
- b - Port Steering Link Rod
- c - Steering Eyes and Coupler
- d - Upper Engine Mounting Bolts (4) Must Be Installed so That Heads of Bolts Are Inside of Transom

Figure 5. Attachment Kit Installed on Engines

2. Lubricate hole in end of port steering cable with Multi-purpose Lubricant and assemble port steering link rod to steering cable end with a washer on both sides of steering

cable. (Figure 3) Thread a self-locking nut onto steering link rod and tighten nut until it seats [DO NOT exceed 10 ft. lbs. (1.4mkg)], then back nut off 1/4-turn.

Steering Eyes and Coupler Installation

1. Position engines so that both engines are facing straight forward. (Distance between centers of threaded pivot holes in engines' steering arms must be equal to distance between propeller shaft centers.)
2. Thread steering eyes into coupler and adjust centerline distance between eyes to dimension measured in Step 1. Exposed threads of steering eyes should be equal at both ends of coupler.

SAFETY WARNING: Both steering eyes MUST BE threaded into coupler 3/4" (19mm) minimum. Failure to adhere to this requirement could result in steering system failure.

3. Assemble steering eyes and coupler to bottom side front holes of steering arms with 3/8"-24x1 1/8" bolts, as shown in Figures 3 and 4.

IMPORTANT: With steering eyes and coupler installed and before tightening pivot bolts, check engine alignment. Distance between pivot bolts' centers and distance between propeller shaft centers must be equal for proper steering. If adjustment is necessary, remove pivot bolt from one steering eye and turn eye in or out to correct alignment. Both steering eyes MUST BE threaded into coupler 3/4" (19mm) minimum.

4. Torque pivot bolts to 20 ft. lbs. (2.8mkg), then thread self-locking nut onto bolts and torque nuts to 20 ft. lbs.

SAFETY WARNING: Both steering eyes MUST BE threaded into coupler 3/4" minimum, and jam nut (Figure 3) must be secured against coupler to prevent coupler from turning. Torque jam nut 20 ft. lbs.

5. Secure coupler from turning with jam nut. (Figure 6) Torque jam nut to 20 ft. lbs.
6. Position rubber sleeves (Figure 3) over threaded portions of steering eyes.

Starboard Steering Link Rod Installation

1. Connect starboard adjustable steering link rod (Figures 3 and 5) onto top side rear hole of starboard engine steering arm with a 3/8"-24x1 1/4" long pivot bolt. Torque bolt to 20 ft. lbs. (2.8mkg), then thread self-locking nut (Figure 7) onto bolt and torque nut to 20 ft. lbs.
2. Adjust steering link rod until the end fits thru steering cable end. Remove steering link rod from cable end and turn link rod 3 turns out of coupler tube (counterclockwise, looking from starboard side). Reinstall link rod into cable end, and steering now should be in tension-tension.

SAFETY WARNING: Both threaded sides of steering link rod MUST BE threaded into coupler 3/4" (19mm) minimum. Failure to adhere to this requirement could result in steering system failure.

3. After adjustments have been made as outlined in Step 2, secure link rod to steering cable as follows:
 - a. Lubricate hole in end of steering cable with Multipurpose Lubricant.
 - b. Assemble link rod to steering cable with a washer on both sides of steering cable. (Figure 3)
 - c. Thread a self-locking nut onto link rod and tighten nut until it seats [DO NOT exceed 10 ft. lbs. (1.4mkg)], then back nut off ¼-turn.
4. Secure link rod to coupler tube with jam nuts (Figure 3) and torque nuts to 20 ft. lbs. Position rubber sleeves over threaded portion of link rod. (Figure 3)

SAFETY WARNING: After installation is complete (and before operating engines), check that boat will turn right when steering wheel is turned right and that steering can be executed thru full range (left and right) at all tilt angles to assure interference-free movement.

NOTE: With dual engine installation, the engines are modified with larger trim tabs. If necessary, check position of trim tabs (following).

CHECKING TRIM TAB POSITION

1. Operate boat at normal cruiser throttle setting and adjust trim to a satisfactory setting. Turn steering wheel to left and right, noting in which direction wheel turns more easily.
2. If wheel turns more easily to left, then the trailing edge of trim tab must be turned to left (when viewing motor from behind). Reverse procedure, if boat turns more easily to right.
3. If position of trim tab is incorrect, adjust as follows:
 - a. Shift engine controls into neutral and turn ignition keys to "Off" position.

IMPORTANT: Trim tabs MUST BE set in the same position on both engines.

- b. Remove plastic cap from rear of drive shaft housing and loosen bolt and trim tab.

- c. Position trailing edge of trim tab to left (viewing motor from behind), if steering wheel turns more easily to left.
- d. Position trailing edge of trim tab to right (viewing motor from behind), if steering wheel turns more easily to right.
- e. Tighten both trim tab bolts securely and replace plastic caps.

MAINTENANCE INSTRUCTIONS

Lubrication and maintenance inspection must be performed at intervals specified, following:

Normal Service - Every 50 hours of operation or 60 days (whichever comes first)
***Severe Service - Every 25 hours of operation or 30 days (whichever comes first)**

**Operation in a salt water area is considered "severe service".*

1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

SAFETY WARNING: Core of steering cables (transom end) MUST BE fully retarded into cable housing before lubricating cables. If cables are lubricated while extended, hydraulic lock of cables could occur.

3. With core end of Ride-Guide steering cables (transom end) fully retarded, lubricate transom end of steering cable thru grease fitting with Multipurpose Lubricant.

NOTE: Ride-Guide Steering cables are lubricated at the factory and require no additional lubrication at initial installation.

4. Lubricate exposed portion of cable end with Multipurpose Lubricant and lubricate all pivot points with Quicksilver Corrosion and Rust Preventive.

Dual Steering Cable - Single Engine Attaching Kit

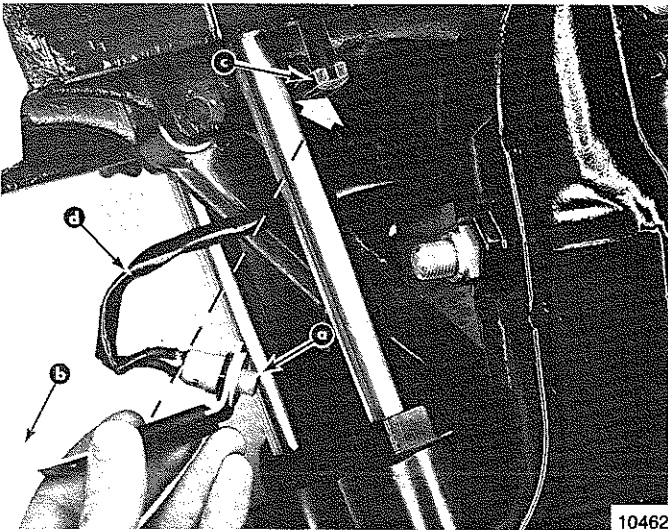
NOTE: Use these instructions for reinstalling attaching kit, reconnecting steering cables adjusting cable tension and maintenance. Order instruction sheet Part No. C-90-78851 for complete installation instructions.

TILT STOP SWITCH and SWITCH ACTUATOR

SAFETY WARNING: Tilt stop switch and switch actuator must be correctly installed and properly adjusted on engine to prevent engine from being tilted up too far and interfering with steering linkage.

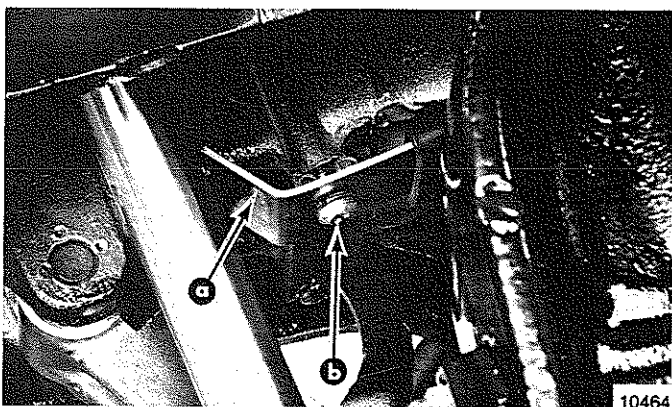
Tilt Stop Switch Installation

If removed, reinstall tilt stop on engine as shown in Figures 1 and 2.



- a - Tilt Stop Switch
- b - Tilt Stop Switch Bracket (Install to Starboard Side of Trim Limit Switch)
- c - Trim Limit Switch (Starboard Mounting Flange)
- d - Wire Harness - Route (along with Harness from Trim Limit Switch) below Engine Tilt Tube and on Top of Boat Transom

Figure 1. Installing Tilt Stop Switch



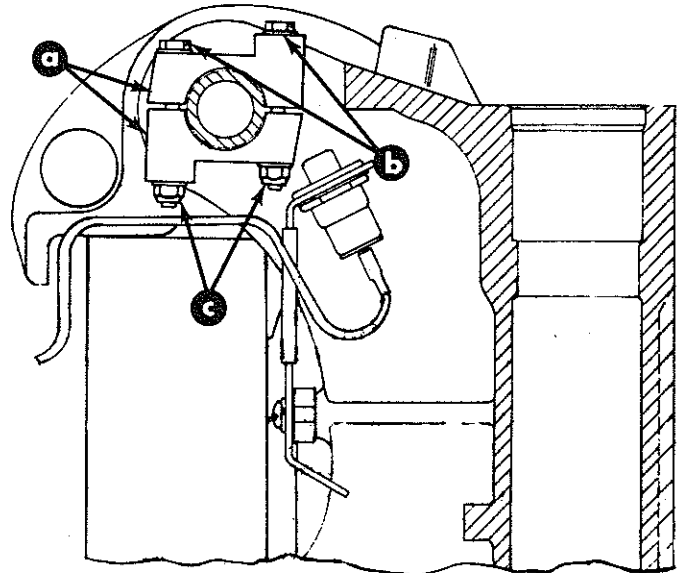
- a - Tilt Stop Switch Installed on Trim Limit Switch (Starboard) Mounting Flange
- b - Screw with Lockwasher (Tighten Securely)

Figure 2. Tilt Stop Switch Installed

Tilt Stop Switch Actuator Installation and/or Adjustment

CAUTION: Tilt stop switch actuator must be installed and properly adjusted on engine tilt tube so that actuator will actuate tilt stop switch and stop the upward tilt of engine before swivel bracket is tilted up beyond 5" (12.7cm) from transom bracket, or interference with steering linkage will occur.

1. Install both halves of tilt stop switch actuator on engine tilt tube, as shown in Figure 3. Secure both halves of actuator together with 2 screws, flat washers and locknuts (supplied with kit). Position actuator 1/8" (3.2mm) from trim limit switch clamp. (Figure 4) Tighten actuator snug (not tight) at this time. Be sure that actuator is able to rotate around engine tilt tube.



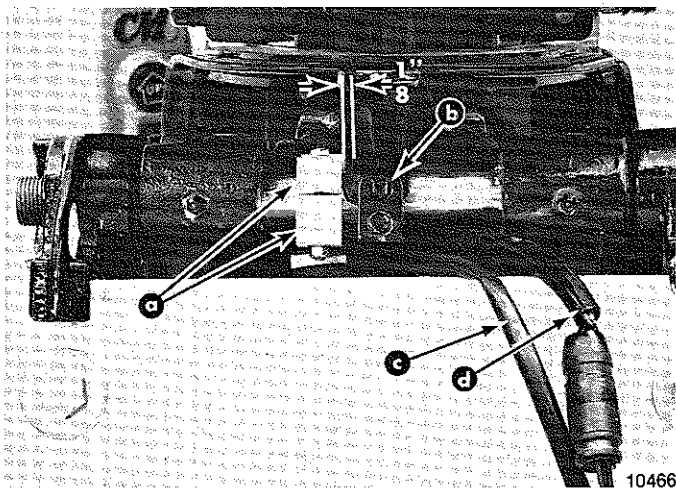
- a - Tilt Stop Switch Actuator - Halves
- b - Screw
- c - Locknut

Figure 3. Tilt Stop Switch Actuator Installed on Engine Tilt Tube

2. Adjust tilt stop switch actuator, as follows:

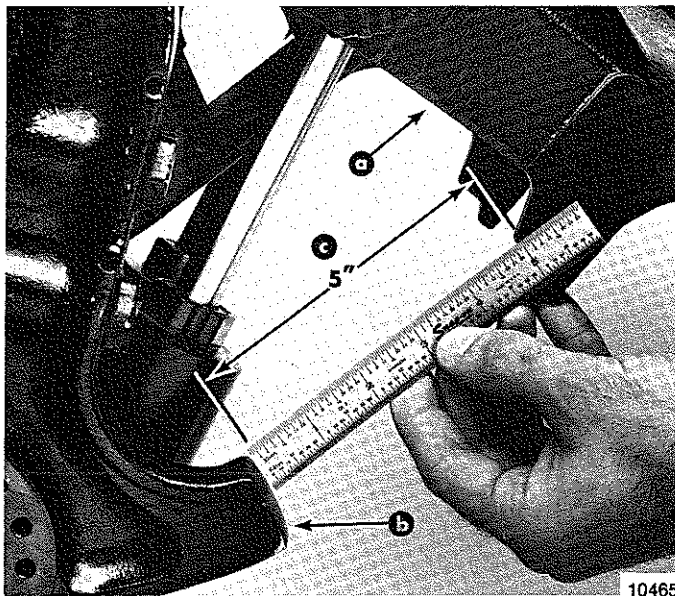
IMPORTANT: Remember that tilt stop switch actuator must be adjusted so that actuator will actuate tilt stop switch and stop upward tilt of engine before swivel bracket is 5" (12.7cm) beyond transom brackets.

- a. Lift engine up so that 5" space exists between swivel bracket and transom brackets, as shown in Figure 5.
- b. Rotate tilt stop switch actuator around tilt tube until actuator actuates tilt stop switch (switch will make a clicking noise when actuated).
- c. Without moving position of actuator, lower engine down and tighten both halves of actuator securely together to engine tilt tube. After tilt stop switch is wired, test and readjust actuator, if necessary.



a - Tilt Stop Switch Actuator (Properly Positioned)
 b - Trim Limit Switch Clamp c - Wire from Tilt Stop Switch
 d - Wire Harness from Trim Limit Switch

Figure 4. Tilt Stop Switch Actuator Positioned Correctly, 1/8" from Clamp



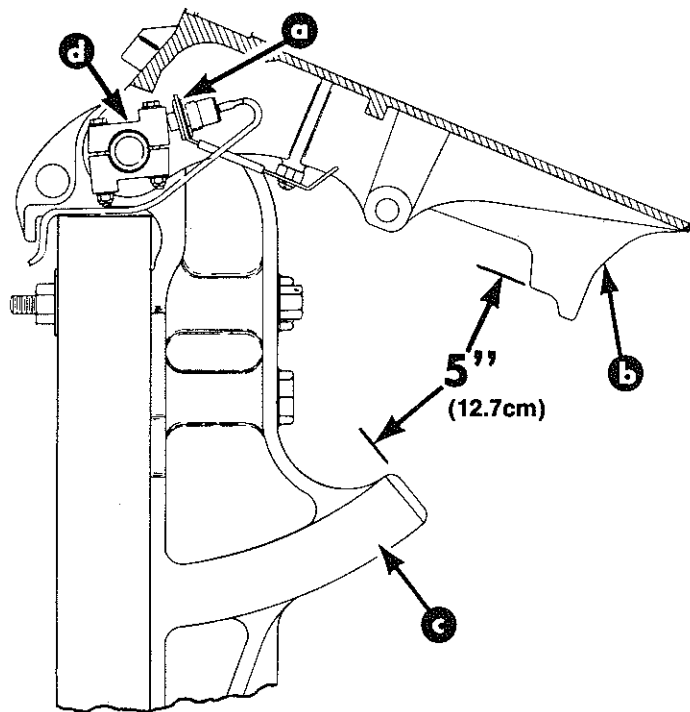
a - Swivel Bracket b - Transom Bracket
 c - Maximum Allowable Upward Tilt

Figure 5. Maximum Upward Tilt Measurement between Swivel Bracket and Transom Brackets

Tilt Stop Switch Wire Connections

1. Connect wires from tilt stop switch to hydraulic pump solenoid, as follows:

- a. Two blue wires are connected to same terminal on hydraulic pump solenoid. Remove only the blue wire from solenoid (which goes to 5-pin connector).
 - b. Connect white wire from tilt limit switch to same terminal from where blue wire was removed in Step "a". Secure white wire and existing blue wire to terminal on solenoid with lockwasher and hex nut, as shown in Figure 6.
 - c. Connect black wire from tilt limit switch to blue wire (from 5-pin connector) that was removed from solenoid in Step "a". Connect both wires together with screw and hex nut (supplied with kit). Apply Liquid Neoprene to connection, then slide rubber sleeve over connection, as shown in Figure 7.
2. Tilt engine up with hydraulic pump and check that tilt stop switch will stop upward tilt of engine so that swivel bracket is not tilted out beyond 5" from transom brackets. (Figure 6) If necessary, readjust and recheck tilt stop switch actuator to obtain 5" between swivel bracket and transom brackets.



a - Tilt Stop Switch (Actuated Position)
 b - Swivel Bracket c - Transom Bracket
 d - Tilt Stop Switch Actuator (Adjust so That Tilt Stop Switch Is Actuated with 5" Maximum between Swivel Bracket and Transom Brackets)

Figure 6. Adjusting Tilt Stop Switch Actuator (to Allow 5" Maximum Upward Tilt)

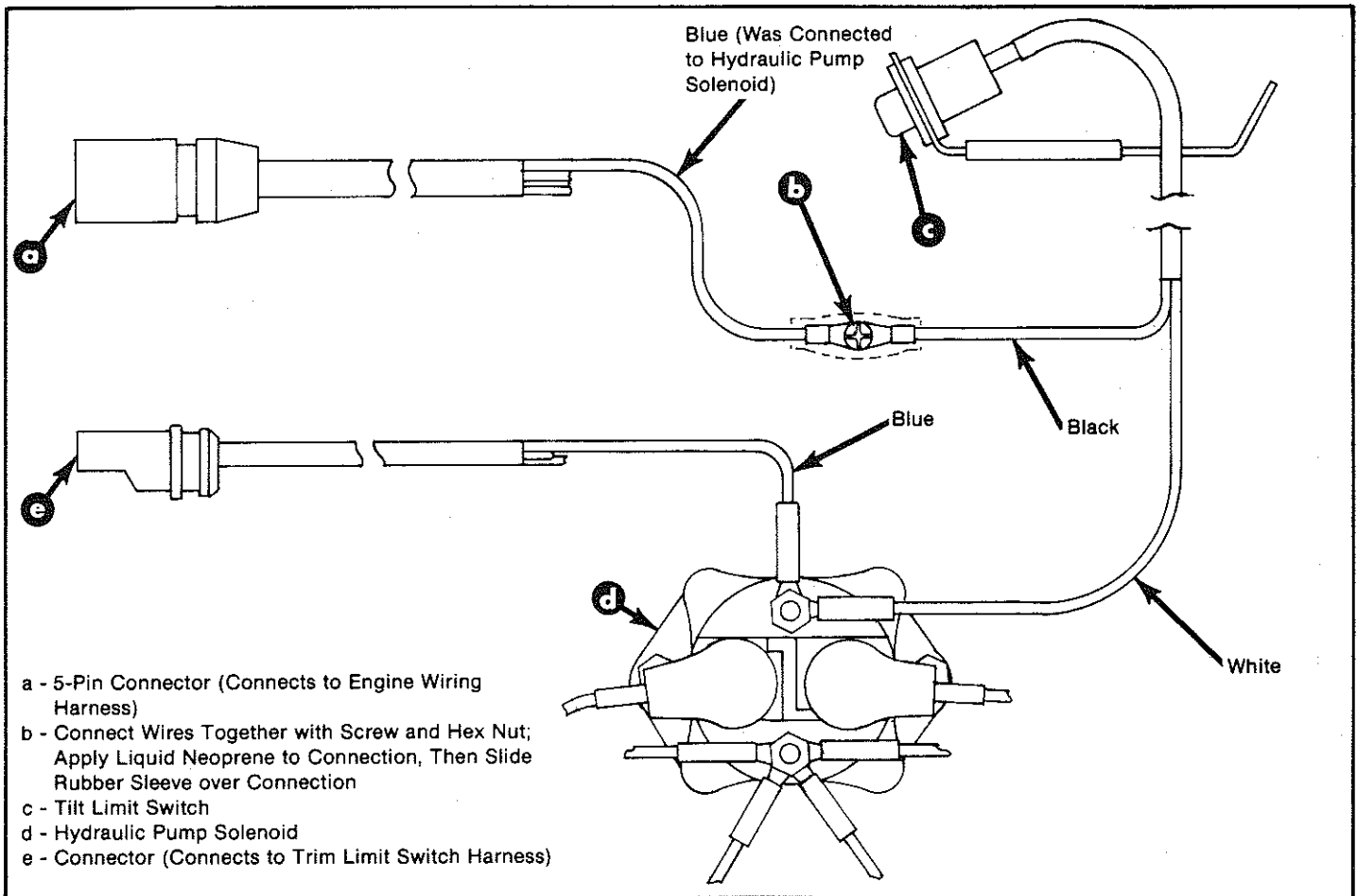
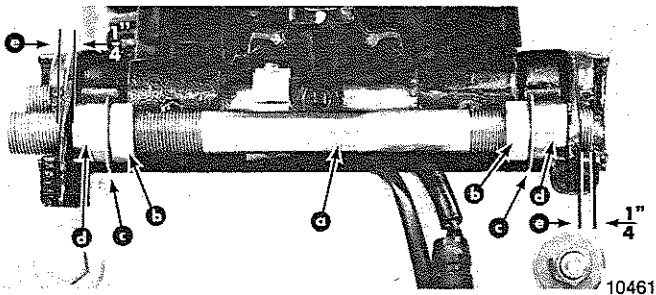


Figure 7. Tilt Limit Switch Connected to Hydraulic Pump

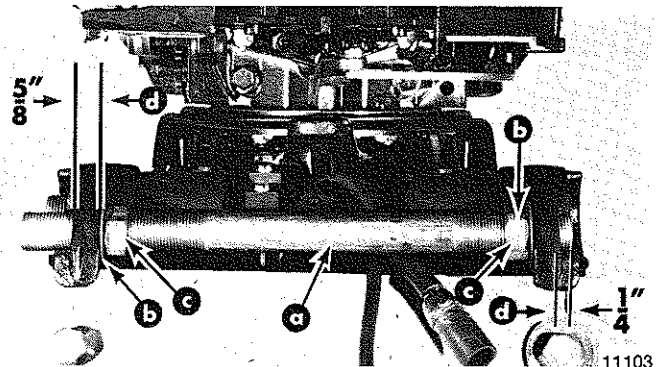
STEERING CABLE MOUNTING TUBE INSTALLATION

1. Lubricate engine tilt tube thru both grease fittings in swivel bracket with Multipurpose Lubricant.
2. If transom bracket rib is $\frac{1}{4}$ " (6.4mm) thick (Figure 8), install tube with 2 nuts, 2 locking flat washers and 2 spacers, as shown in Figure 8. Install tube so that longer, threaded end will be toward steering cable attaching side of engine. Adjust nuts on tube so that short threaded end of tube is extended $\frac{1}{4}$ " out from transom bracket. (Figure 8)



- a - Steering Cable Mounting Tube (Longer Threaded End toward Steering Cables)
- b - Nut (2)
- c - Locking Flat Washer (2)
- d - Spacer (2)
- e - Transom Bracket Rib ($\frac{1}{4}$ " Thick)

Figure 8. Steering Cable Mounting Tube Installed to Engine (with Transom Bracket Having a $\frac{1}{4}$ " Rib)



- a - Steering Cable Mounting Tube (Longer Threaded End toward Steering Cables)
- b - Locking Flat Washer
- c - Nut
- d - Transom Bracket Rib ($\frac{5}{8}$ " Thick)

Figure 9. Steering Cable Mounting Tube Installed to Engine (with Transom Brackets Having a $\frac{5}{8}$ " Rib)

NOTE: Spacers ("d" in Figure 8) are not used when kit is installed on engine with transom brackets having a $\frac{5}{8}$ " (16mm) rib, as shown in Figure 9.

3. If transom bracket rib is $\frac{5}{8}$ " (16mm) thick (Figure 9), install tube with 2 nuts and 2 locking flat washers, as shown in Figure 9. Install tube so that longer threaded end will be toward steering cable attaching side of engine. Adjust nuts on tube so that short threaded end of tube is extended $\frac{1}{4}$ " out from transom bracket, as shown in Figure 9.

STEERING CABLE INSTALLATION

1. Lubricate inside of engine tilt tube and inside of steering cable mounting tube with Multipurpose Lubricant. Insert ends of steering cables thru engine tilt tube and steering cable mounting tube, then secure each steering cable to tube with attaching nut, as shown in Figure 10. Torque attaching nuts to 35 to 40 ft. lbs. (4.8 to 5.3mkg).
2. Install locking sleeve (supplied with steering cable) over each steering cable attaching nut and secure with cotter pin. (Figure 10) Spread ends of cotter pins.

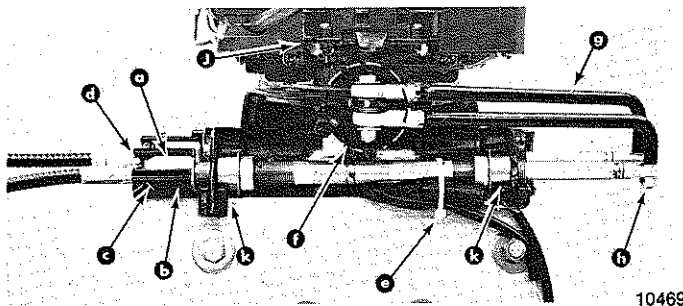
LINK ROD INSTALLATION

IMPORTANT: Steering link rod with longer bent end is installed on top of engine steering arm and installed to steering cable that is installed thru engine tilt tube.

1. Remove lower front cowl support bracket (Figure 10) from engine.

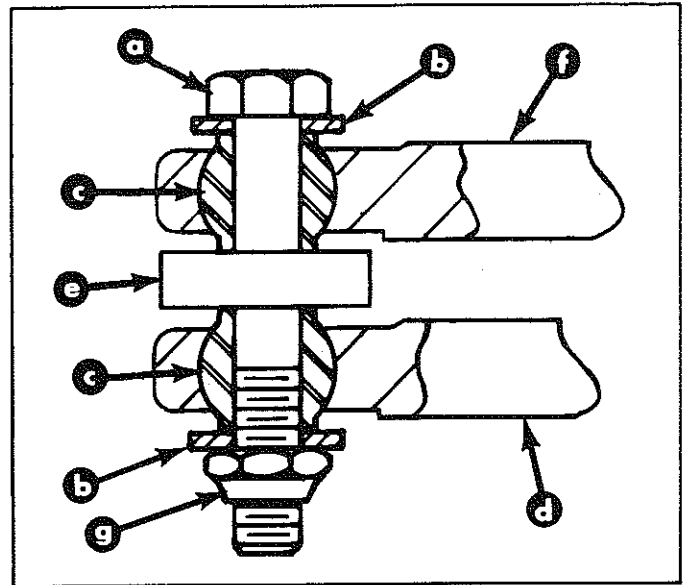
CAUTION: Pivot bolt (Figure 11) must be installed thru link rods and steering arm with threaded end of bolt facing down.

2. Lubricate pivot bolt and link rod ball joints (Figure 11) with Quicksilver Corrosion and Rust Preventive. Assemble steering link rods to engine steering arm, as shown in Figure 11. Torque locknut to 30 ft. lbs. (4.15mkg).
3. Lubricate inside of hole in end of each steering cable with Multipurpose Lubricant and assemble steering link rods to steering cables. (Figure 12) Be sure that steering link rod with longer bent end is installed to steering cable that is installed thru engine tilt tube. Tighten each locknut until nut seats [do not exceed 10 ft. lbs. (1.4mkg)], then back nut off ¼-turn.
4. Reinstall lower front cowl support bracket (Figure 10) to engine. Tighten mounting nuts securely.



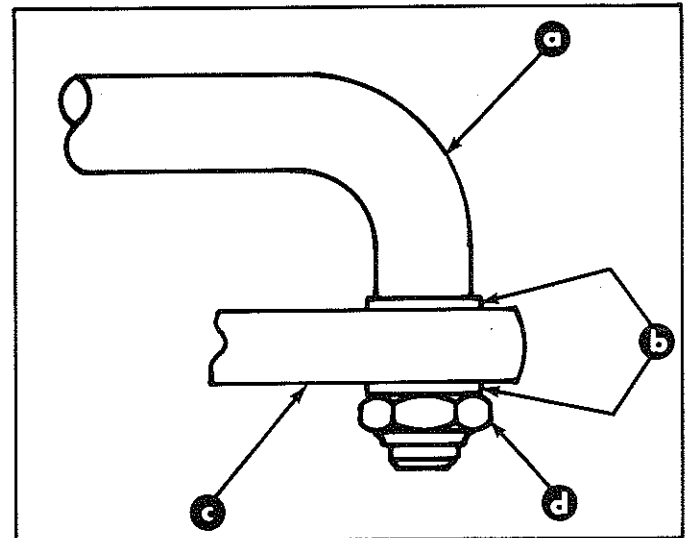
- 10469
- a - Steering Cable Attaching Nut
 - b - Locking Sleeve (2 Required)
 - c - Cotter Pin (2 Required)
 - d - Grease Fitting
 - e - Sta-Strap
 - f - See Figure 11 for Parts Sequence
 - g - Steering Link Rod (Longer Bent End)
 - h - See Figure 12 for Parts Sequence
 - j - Lower Front Cowl Support Bracket
 - k - Spacers (Not Used on Engines with Transom Brackets Having 5/8" Thick Ribs)

Figure 10. Dual Steering Cable - Single Engine Attaching Kit Installed



- a - Pivot Bolt (Threaded End Facing Down)
- b - Flat Washer [13/16" (20.6mm) OD]
- c - Ball Joint
- d - Steering Link Rod
- e - Engine Steering Arm
- f - Steering Link Rod (Longer Bent End)
- g - Locknut [Torque to 30 Ft. Lbs. (4.15mkg)]

Figure 11. Steering Link Rod Installed to Engine Steering Arm



- a - Steering Link Rods
- b - Flat Washer [5/8" (16mm) OD]
- c - Steering Cable End
- d - Locknut [Tighten until Nut Seats; DO NOT Exceed 10 Ft. Lbs. (1.4mkg), Then Back Nut Off 1/4-Turn]

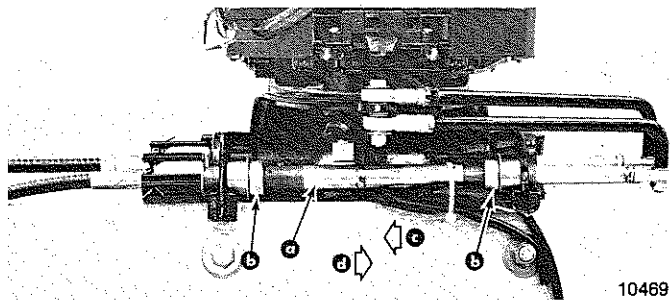
Figure 12. Steering Link Rods Installed to Steering Cables

STEERING CABLE(S) TENSION ADJUSTMENT

IMPORTANT: After this dual steering cable attachment kit is installed, there must be proper tension in forward mounted steering cable for this attachment kit to operate properly. Not enough tension will cause slack (or play) in steering system. Too much tension will cause steering cables to bind. See Step 1, following, for adjustment.

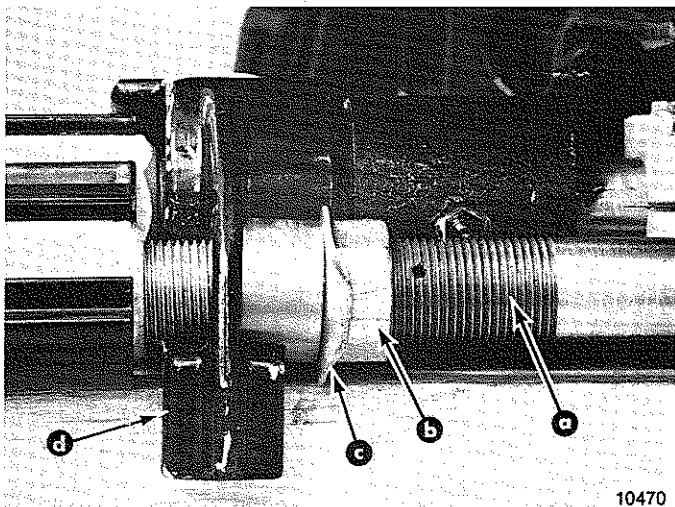
After this dual steering cable attachment kit is installed, check for proper tension in steering system, as follows:

1. Turn steering wheel thru full range and check for play or too much tension in steering system.



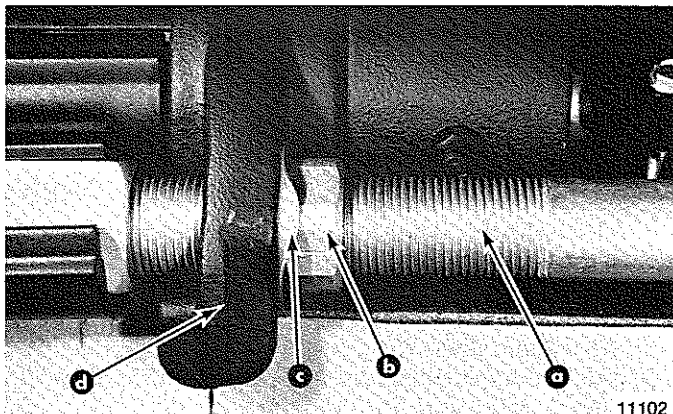
- a - Steering Cable Mounting Tube
- b - Nut (Loosen to Adjust Steering Cable Mounting Tube)
- c - Adjust Tube in This Direction to Remove Slack from Steering System
- d - Adjust Tube in This Direction to Reduce Tension from Steering System

Figure 13. Steering System Tension Adjustment



- a - Steering Cable Mounting Tube
- b - Nut
- c - Locking Flat Washer (Bend over and against Both Nuts, as Shown)
- d - Transom Bracket with 1/4" Rib

Figure 14. Nut (Each Side of Tube) Secured in Place by Bending Flat Washer over and against Nuts



- a - Steering Cable Mounting Tube
- b - Nut (One Each End)
- c - Locking Flat Washer (Bend over and against Each Nut)
- d - Transom Bracket with 5/8" Rib

Figure 15. Nut (Each Side of Tube) Secured in Place by Bending Flat Washer over and against Nuts

2. If too much slack (or play) exists in steering system, loosen nuts on steering cable mounting tube (Figure 13) and adjust tube away from end of steering cable (mounted thru tube), as shown in Figure 13. Retighten nuts and recheck steering system. Readjust if necessary.
3. If too much tension is present in steering system, loosen nuts on steering cable mounting tube (Figure 13) and adjust tube toward end of steering cable (mounted thru tube), as shown in Figure 13. Retighten nuts and recheck steering system. Readjust if necessary.
4. After proper tension is obtained, make sure that nuts on steering cable mounting tube are tight, then bend flat washers over and against nuts. (Figure 14 or 15)

SAFETY WARNING: After installation is complete (and before operating engine), check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering thru full range (left and right) at all tilt angles to assure interference-free movement.

MAINTENANCE INSTRUCTIONS

Maintenance inspection is owner's responsibility and must be performed at intervals specified.

- Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)**
- *Severe Service - Every 25 hrs. of operation or 30 days (whichever comes first)**

**Operation in a salt water area is considered "Severe Service".*

1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

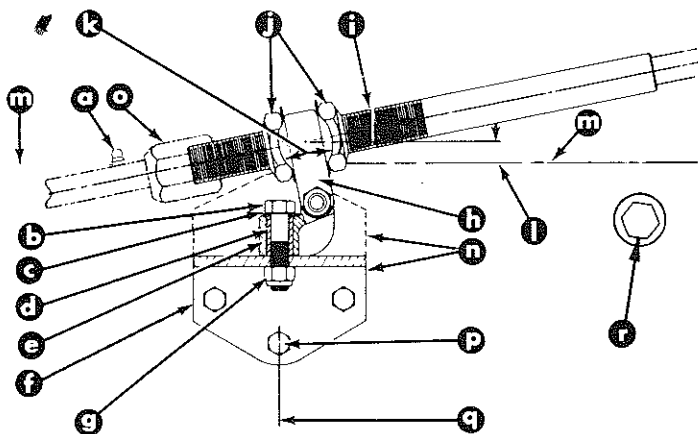
NOTE: Ride-Guide Steering cables are lubricated at the factory and require no additional lubrication at initial installation.

SAFETY WARNING: Core of each steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

3. With core of Ride-Guide Steering cables (transom end) fully retracted, lubricate transom end of steering cables thru grease fittings (Figure 10) with Multipurpose Lubricant.
4. Lubricate exposed portion of steering cable ends with Multipurpose Lubricant.
5. Lubricate steering link rods pivot points with Quicksilver Corrosion and Rust Preventive.
6. Lubricate engine tilt tube thru grease fittings in swivel bracket with Multipurpose Lubricant. If necessary, remove steering cable mounting tube from engine to gain access to grease fittings. If steering cable mounting tube is removed, reinstall tube and adjust tension between steering cables, following installation instructions for this kit.
7. Inspection and lubrication of steering head assembly (rotary or straight rack) should be performed once each year (by the product servicing dealer) or whenever steering mount and/or steering head are disassembled, or if steering effort has increased. Lubricate with Multipurpose Lubricant.

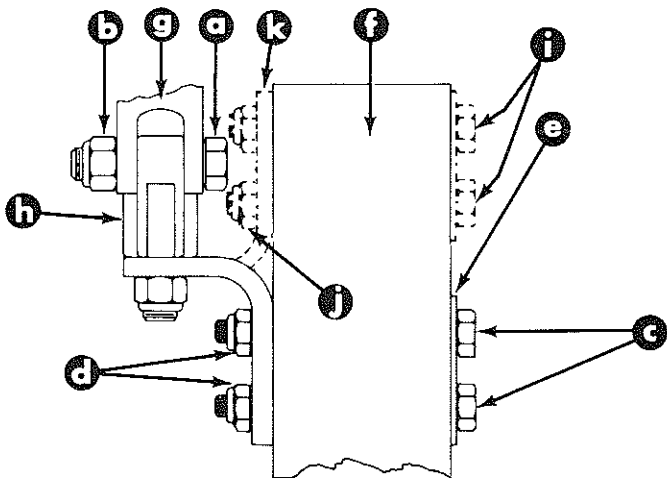
Transom Mounted Ride-Guide Kit

NOTE: Use these instructions for attaching steering cable and maintenance. Order instruction sheet Part No. C-90-74771 for complete installation instructions.



- a - Grease Fitting
- b - Bolt (7/16x1-3/4")
- c - Washer
- d - Spacer
- e - Pivot Block
- f - Transom Bracket
- g - Nut
- h - Yoke
- i - Cable Guide Tube
- j - Adjustment Nuts
- k - Tab Lock
- l - Centerline of Yoke (Up to 1/2" [12.7mm] above Transom)
- m - Top of Transom
- n - Optional Mounting
- o - Steering Cable Attaching Nut
- p - Bolts (5/16x3-1/4") and Nuts
- q - Centerline of Bracket to Centerline of Engine [15" (38cm)]
- r - Upper Engine Mounting Bolt

Figure 1. Transom Attachment (Viewed from Inside Boat)

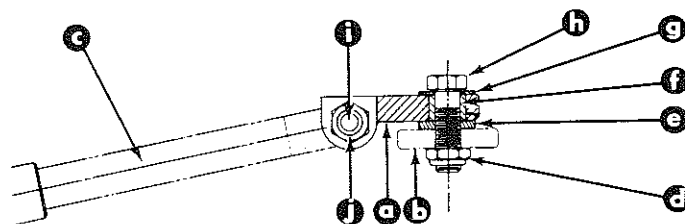


- a - Bolt (7/16x1-3/4")
- b - Nut
- c - Bolts (5/16x3-1/4")
- d - Nuts (10 Ft. Lbs. Torque)
- e - Backing Plate
- f - Transom
- g - Yoke
- h - Pivot Block
- i - Bolts (Optional Mounting) (Torque to 10 Ft. Lbs. [1.4mkg])
- j - Nuts (Optional Mounting)
- k - Mounting Bracket (Optional Mounting)

Figure 2. Transom Mount Bracket (Side View)

STEERING CABLE INSTALLATION

1. If upper engine mounting bolt ("r" in Figure 1) on side toward Ride-Guide kit is installed with threaded end inside of boat transom, turn bolt so that head of bolt is inside of transom. Retighten bolt.

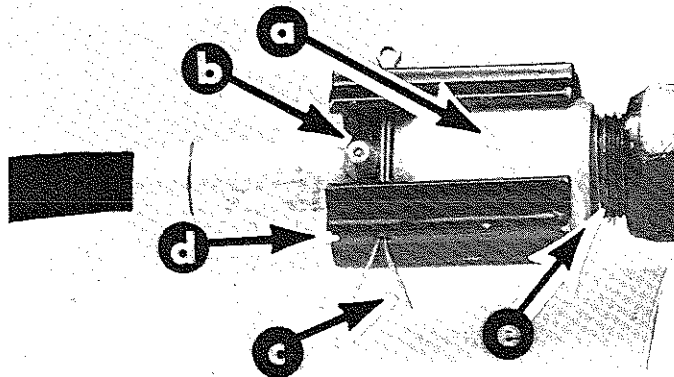


- a - Clevis
- b - Steering Arm (Engine)
- c - Steering Cable
- d - Nut
- e - Thick Washer
- f - Spacer
- g - Washer
- h - Bolt (3/8x1-1/4")
- i - Bolt (3/8x1-3/8")
- j - Nut

Figure 3. Clevis to Steering Arm

2. Lubricate steering cable end with Multipurpose Lubricant, install it thru the cable guide tube and start the cable nut.
3. Lubricate hole in clevis with Multipurpose Lubricant.
4. Install clevis to steering cable and secure it with a 3/8x1 1/2" bolt and nut as shown in Figure 3. Torque nut and bolt to 10 ft. lbs. (1.4mkg).
5. Install clevis to top of steering arm with a 3/8x1 1/4" bolt, washer, spacer, thick washer (thick washer must be placed between clevis and steering arm) and elastic stop nut, as shown in Figure 3. Torque the bolt (item "h" in Figure 3) to 20 ft. lbs. (2.8mkg), then the nut to 20 ft. lbs.
6. Center the steering wheel and then, by adjusting the nuts on the cable guide tube, center the engine. Torque the adjusting nuts to 35 ft. lbs. (4.8mkg) and bend a lock tab against a flat on each nut.
7. Secure steering cable to cable guide tube by torquing steering cable attaching nut (Figure 4) to 35 to 40 ft. lbs. (4.8 to 5.5mkg).
8. Install locking sleeve (supplied with steering cable) over steering cable attaching nut (Figure 4) and secure with cotter pin. Spread ends of cotter pin.

SAFETY WARNING: After installation is completed (and before operating engine), check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering thru full range (left and right) at all tilt angles to assure interference-free movement.



- a - Steering Cable Attaching Nut; Torque to 35 to 40 Ft. Lbs. (4.8 to 5.5mkg)
- b - Grease Fitting
- c - Cotter Pin
- d - Locking Sleeve
- e - Cable Guide Tube

Figure 4. Steering Cable Fastened to Cable Guide Tube

11174

MAINTENANCE INSTRUCTIONS

Maintenance inspection is owner's responsibility and must be performed at intervals specified.

Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)

***Severe Service - Every 25 hrs. of operation or 30 days (whichever comes first)**

**Operation in a salt water area is considered "Severe Service".*

1. Carefully check steering system components for wear. Replace worn parts.
2. Check steering system fasteners to be sure that they are torqued to correct specifications.

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

SAFETY WARNING: Core of steering cable (transom end) must be fully retracted into cable housing before lubricating cable. If cable is lubricated while extended, hydraulic lock of cable could occur.

3. With core of Ride-Guide Steering cable (transom end) fully retracted, lubricate transom end of steering cable thru grease fitting (Figure 4) and exposed portion of cable end with Quicksilver Multipurpose Lubricant. Lubricate all pivot points with SAE 30W engine oil.

REMOTE CONTROL INSTALLATION

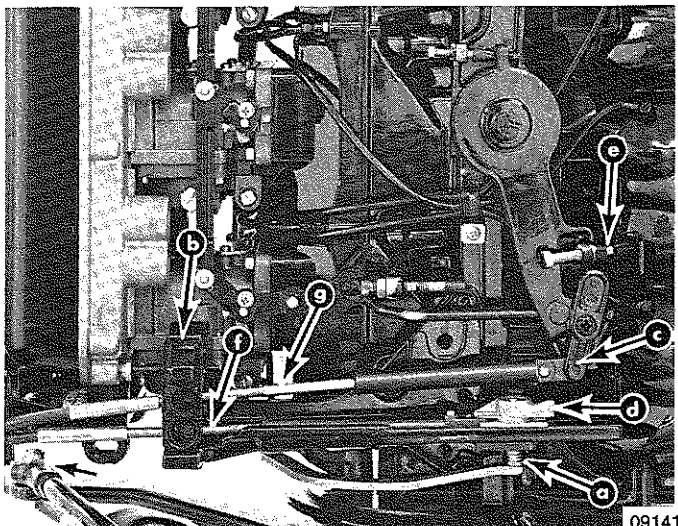
Attaching Control Cables to Engine

SHIFT CABLE INSTALLATION to ENGINE

1. Attach shift cable to engine first. Shift cable is the first cable to move when remote control handle is advanced from neutral position toward in-gear position.
2. Attach shift cable to engine as follows:

150 and 175 HP Models thru Serial No. 5363917

1. With remote control in neutral position and engine in neutral gear, attach end of shift cable to shift link guide block. (Figure 1)
2. Adjust cable anchor, as necessary, to obtain a slight preload toward reverse gear position when cable anchor is placed into engine anchor receptacle. Secure cable into receptacle, as shown in Figure 1.



- | | |
|------------------------------|-----------------------|
| a - Shift Link Guide Block | d - Shift Cable Latch |
| b - Engine Anchor Receptacle | e - Idle Stop |
| c - Throttle Lever | f - Shift Cable |
| g - Throttle Cable | |

Figure 1. Throttle - Shift Linkage

150 and 175 HP Models (Serial No. 5363918 and Above) and 200 HP Model

STEP 1: With engine in neutral position, slide guide block toward forward gear until resistance is felt, then mark center location of guide block pin on slide, as shown in Figure 2.

STEP 2: With engine in neutral position, slide guide block toward reverse gear until resistance is felt, then mark center location of guide block pin on slide. (Figure 2)

STEP 3: Measure distance between guide block pin location marks, made in Steps 1 and 2, then center guide block pin between marks, as shown in Figure 2. Without moving guide pin from this location, attach shift cable to pin and adjust cable anchor so that anchor slips freely into anchor receptacle. Secure cable anchor into receptacle. (Figure 1)

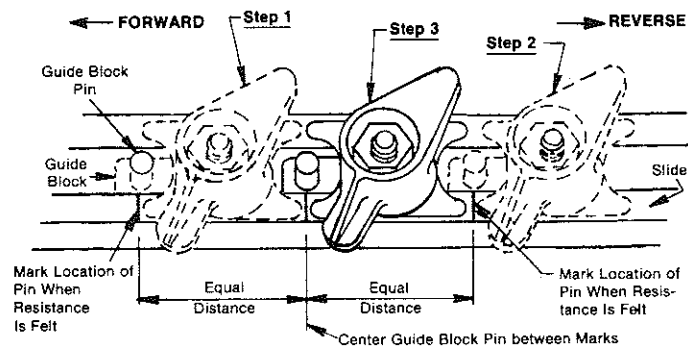


Figure 2. Centering Guide Block Pin for 150 and 175 HP Models (Serial No. 5363918 and Above) and 200 HP Models Shift Cable Installation

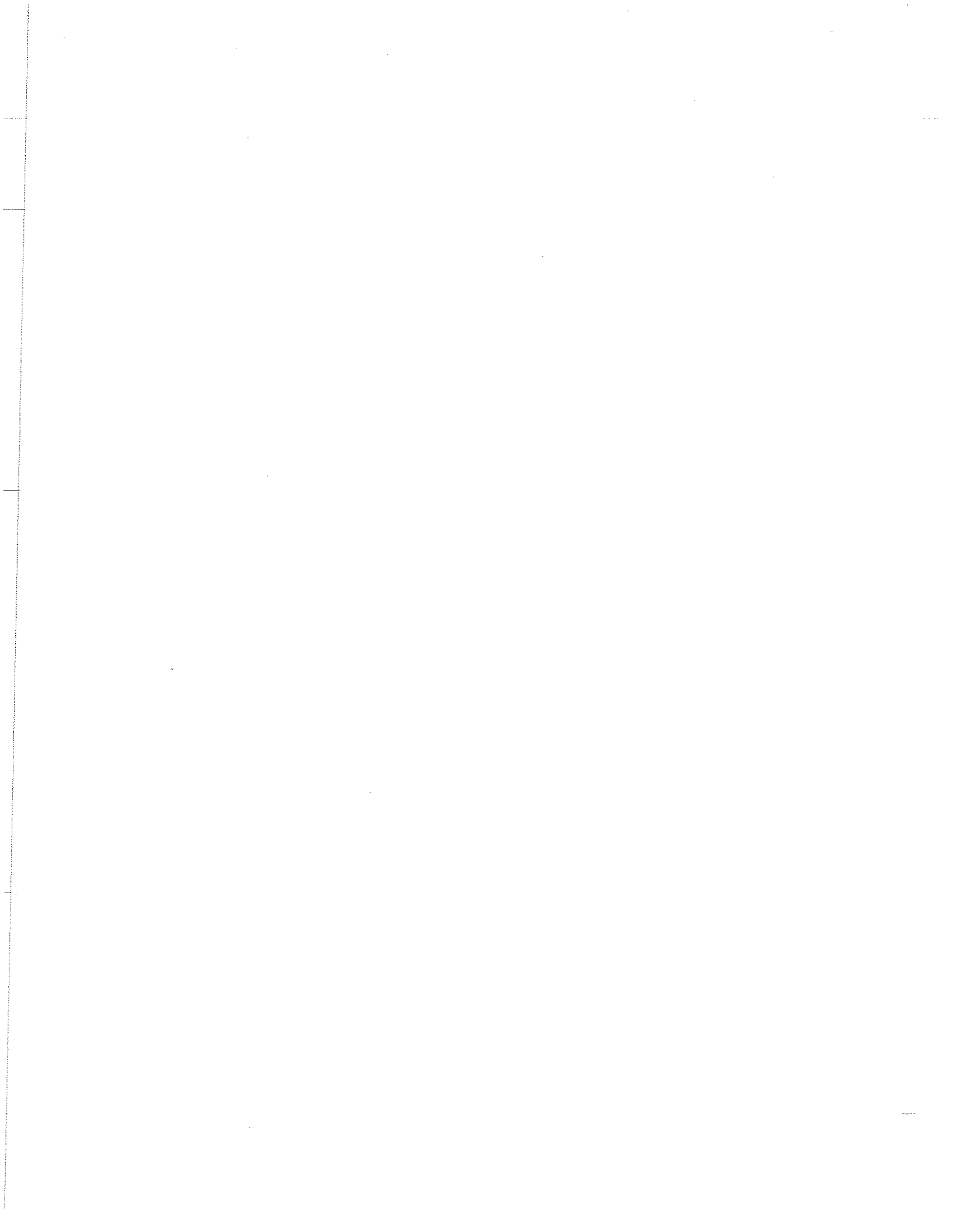
3. Check shift operation as follows:
 - a. Shift remote control to forward gear (when in forward gear, propeller shaft cannot be rotated in a counter-clockwise direction).
 - b. Shift remote control into neutral position without going past neutral detent in control housing. Propeller shaft should be free to rotate either direction without interference.
 - c. Shift remote control into reverse gear (while rotating propeller shaft). Propeller should NOT be free to rotate either direction.
 - d. Shift remote control into neutral without going past neutral detent in control housing. Propeller shaft should be free to rotate in either direction without interference.

THROTTLE CABLE INSTALLATION to ENGINE

1. Shift remote control into neutral position.
2. Adjust engine idle speed as specified in Section 2 (see "Index").
3. Attach throttle cable (Figure 1) to engine throttle lever anchor pin and secure with latch.
4. With end of throttle cable connected to throttle lever, hold throttle lever against idle stop. Adjust throttle cable barrel to slip into barrel retainer on cable anchor bracket with a very light preload of throttle lever against idle stop. Lock barrel in place.
5. Check preload on throttle cable by placing a thin piece of paper between idle stop screw and idle stop. Preload is correct when paper can be removed without tearing but has some drag on it. Readjust cable barrel, if necessary.

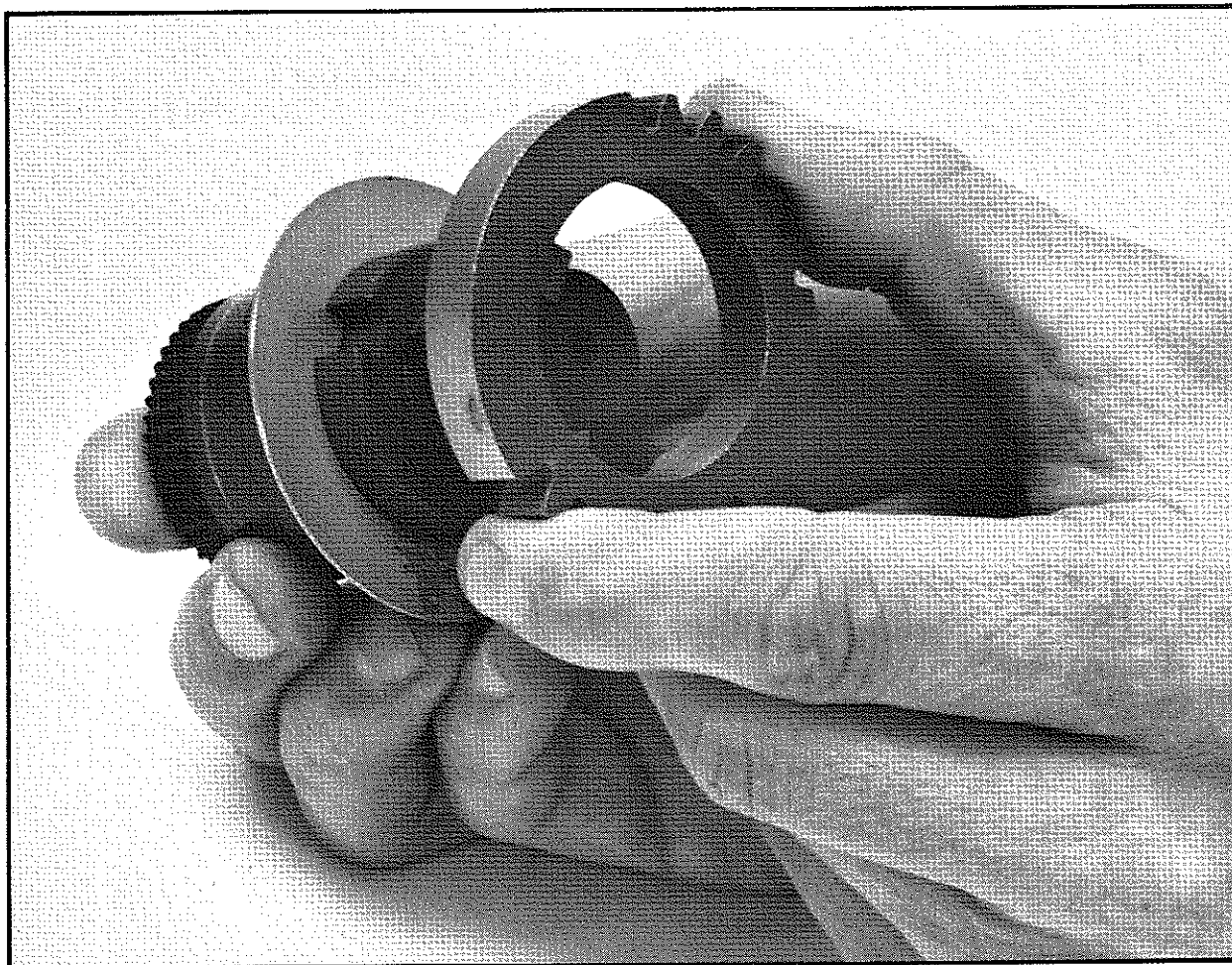
IMPORTANT: Excessive preload on throttle cable will cause difficulty when shifting from forward to neutral. (Readjust throttle cable barrel, if necessary.)

CAUTION: 150 and 175 HP Models (Serial No. 5363918 and Above) and 200 HP model idle MUST NEVER EXCEED 800 RPM in gear.



V-6 OUTBOARDS

Engine Attachments



Standard V-6 Remote Control Repair

SECTION
PART **B**

7

INDEX

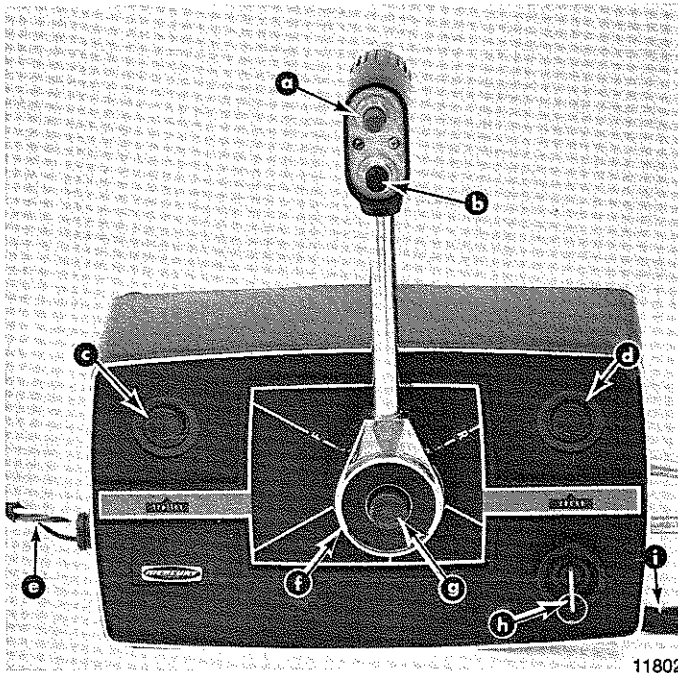
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Panel and Control Cables from Control ..	7B-1
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REMOTE CONTROL A-65640A10-thru-40

Removing Control Housing from Mounting Panel and Control Cables from Control

SAFETY WARNING: Before working on remote control or around engine, remove remote control wiring harness from engine, disconnect high tension leads from spark plugs and remove spark plugs from engine.

1. Turn ignition key to "Off" position and remove key from switch. Disconnect remote control wiring harness from engine wiring harness. Disconnect high tension leads from spark plugs and remove spark plugs from engine.



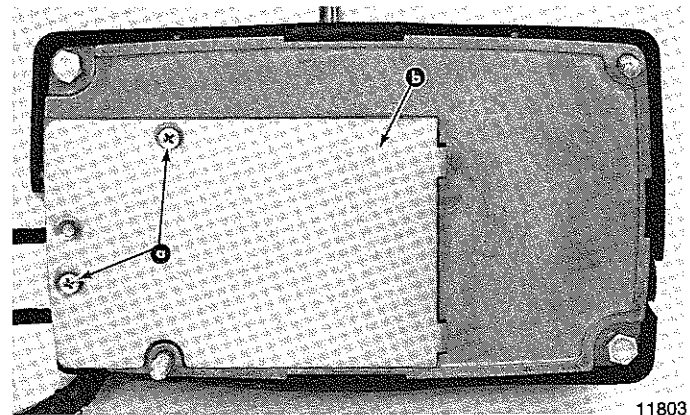
- 11802
- | | |
|--|-----------------------------------|
| a - Trim "Up" Button | f - Control Handle Hub Cover |
| b - Trim "Down" Button | g - Neutral Warmup Button |
| c - "Trawling" Button | h - Ignition Key |
| d - Choke Button | i - Remote Control Wiring Harness |
| e - Tachometer/Trim Indicator Wiring Harness | |

Figure 1. Remote Control

2. Disconnect tachometer/trim indicator wiring harness from receptacle in the forward side of control housing. (Figure 1)
3. Remove (and retain) 2 nuts and flat washers from mounting studs on back side of control housing.

CAUTION: Avoid cutting or damaging wiring harness on sharp fiberglass or plywood projections when removing remote control housing from mounting panel.

4. Pull remote control housing from mounting panel.
5. Place remote control handle in neutral position. (Figure 1)



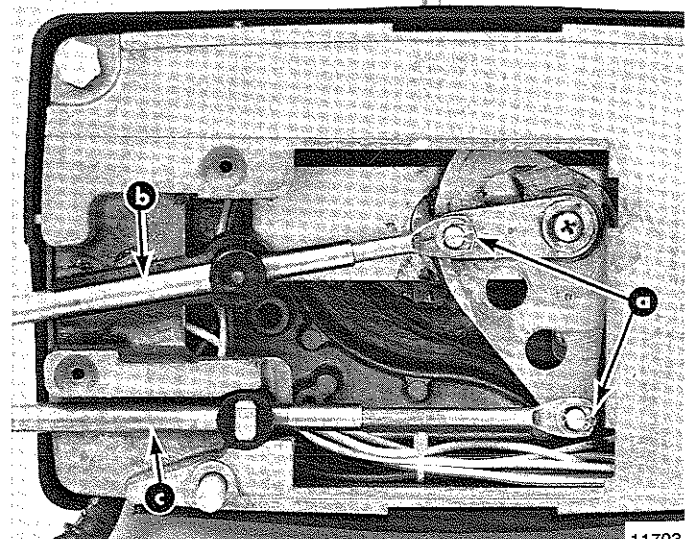
- 11803
- a - Screws b - Access Cover

Figure 2. Remote Control Access Cover

6. Remove (and retain) 2 screws from back side of control housing and lift off access cover. (Figure 2)
7. Remove cotter pins and flat washers that secure shift and throttle cables to control housing. (Figure 3) (Discard cotter pins but retain flat washers.)

NOTE: The throttle cable always is the top cable and the shift cable the bottom cable. (Figure 3)

8. Lift throttle cable and shift cable from remote control housing.



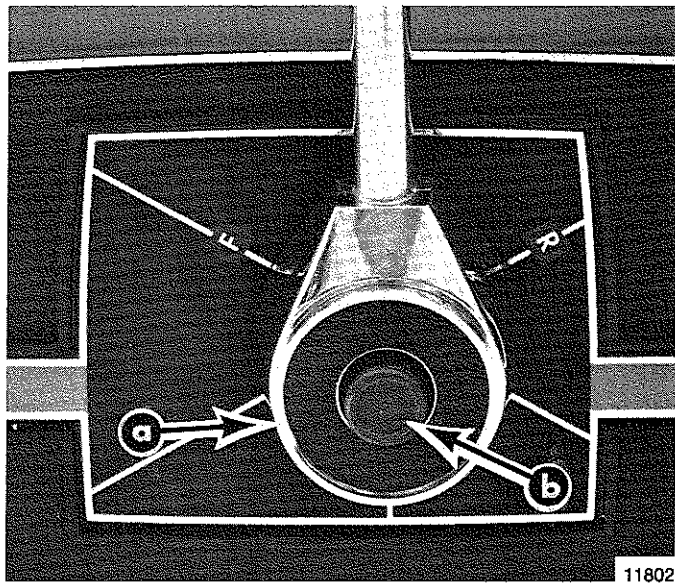
- 11793
- a - Cotter Pins and Flat Washers
b - Throttle Cable
c - Shift Cable

Figure 3. Control Cables

Shift and Throttle Components

DISASSEMBLY

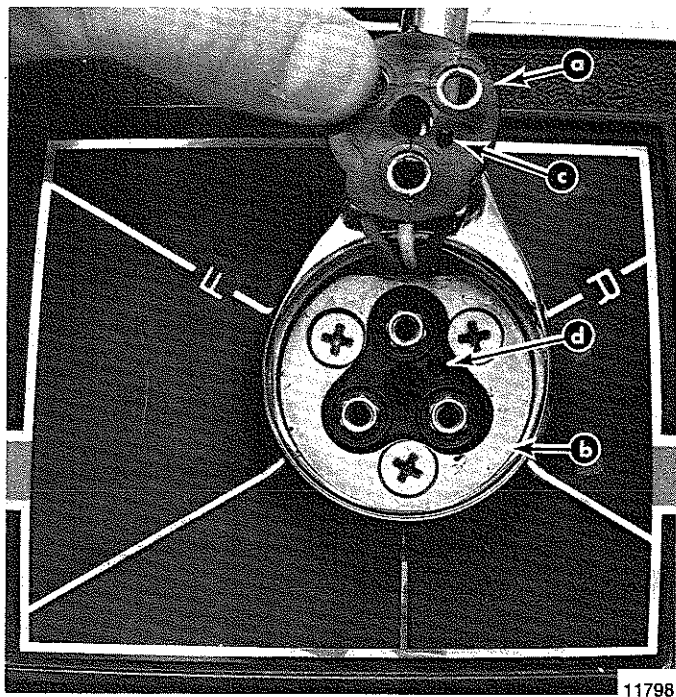
Refer to "Removing Control Housing from Mounting Panel and Control Cables from Control", preceding, and remove control housing from mounting panel and cables from control.



11802
a - Control Handle Hub Cover b - Neutral Warmup Button

Figure 4. Control Handle Hub

1. Remove control handle hub cover (Figure 4) from handle (cover pulls off).
2. Remove (by pulling outward) neutral warmup button and attached shaft from control handle hub. (Figure 4)

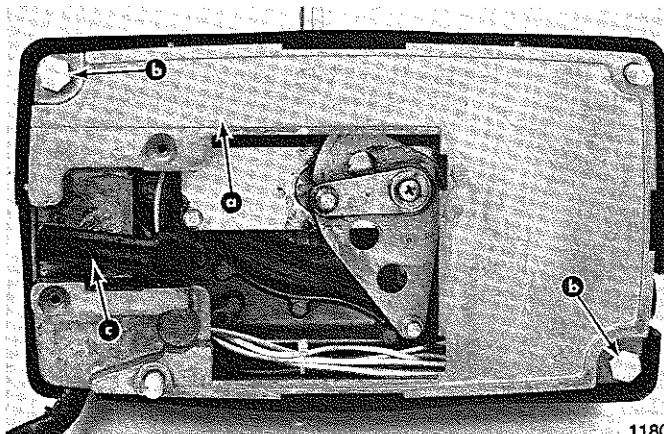


11798
a - Trim Wire Connector c - Alignment Tab
b - Control Handle Retainer Plate d - Hole for Alignment Tab

Figure 5. Control Handle Hub

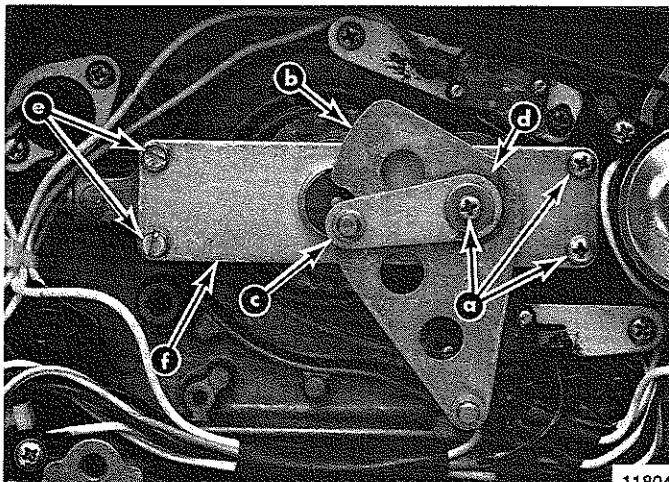
3. Remove 3 screws that secure trim wire connector (Figure 5) to trim wire plug (located in center of control handle).
4. Lift trim wire connector up and remove 3 screws that secure control handle retainer plate. (Figure 5) Remove retainer plate and control handle from splined control shaft.

NOTE: While performing the remainder of steps, support control housing so that weight of housing is not on the control shaft.



11805
a - Back Cover b - Bolts c - Throttle Cable Anchor Guide

Figure 6. Back View of Control Housing



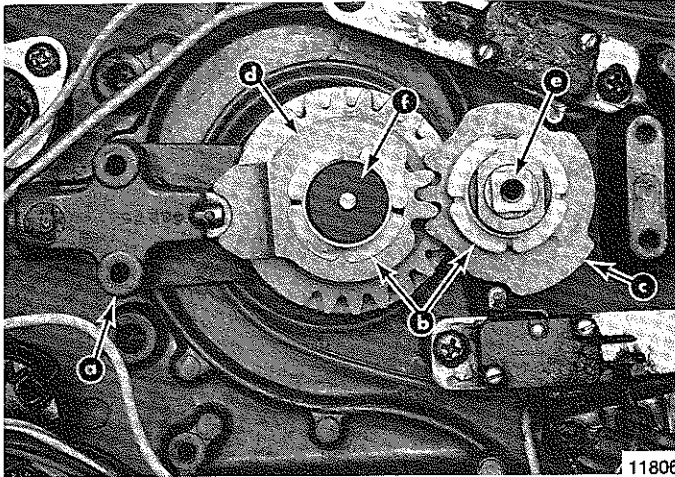
11804
a - Phillips Head Screws d - Plastic Flat Washer
b - Shift Lever e - Slotted Hex Head Screws
c - Throttle Lever f - Control Shaft Support Plate

Figure 7. Shift and Throttle Components

NOTE: Once access cover and control cables are removed from control housing, the throttle cable anchor guide (Figure 6) is free and can be lifted from control housing.

5. Remove 2 bolts, which secure the back cover to control housing (Figure 6), and remove cover from control housing.
6. Remove phillips head screw and flat washer which secure shift and throttle levers to control housing. (Figure 7) After screw is removed, remove throttle lever, plastic flat washer and shift lever from control housing.

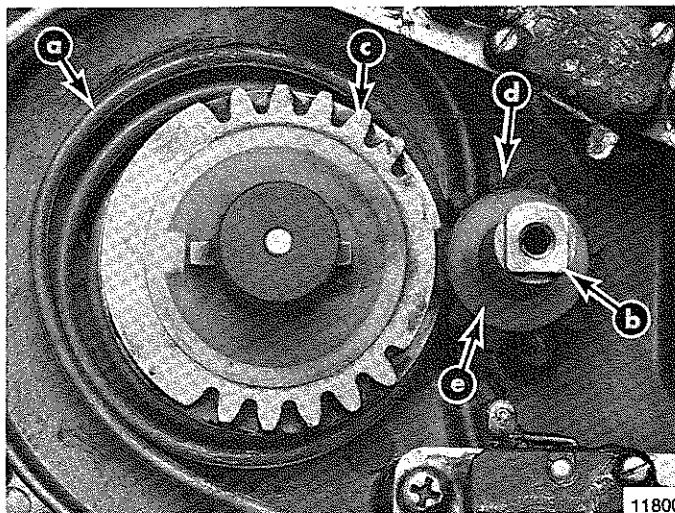
7. Pre-heat slotted hex head screws (Figure 7) to aid in screw removal, then remove screws from control housing with a 5/16" socket and ratchet wrench.
8. Remove 2 phillips head screws (Figure 7) that secure control shaft support plate to control housing, then lift plate from housing.



a - Detent Assembly c - Shift Pinion Gear e - Throttle Shaft
 b - Nylon Bushing d - Shift Gear f - Control Shaft Hub

Figure 8. Shift and Throttle Components

9. Remove remainder of shift and throttle components as follows (Figures 8 and 9):
 - a. Lift detent assembly from control housing.
 - b. Lift nylon bushings from control shaft hub and shift pinion gear.
 - c. Lift shift gear from control shaft hub.
 - d. Lift shift pinion gear from throttle shaft.

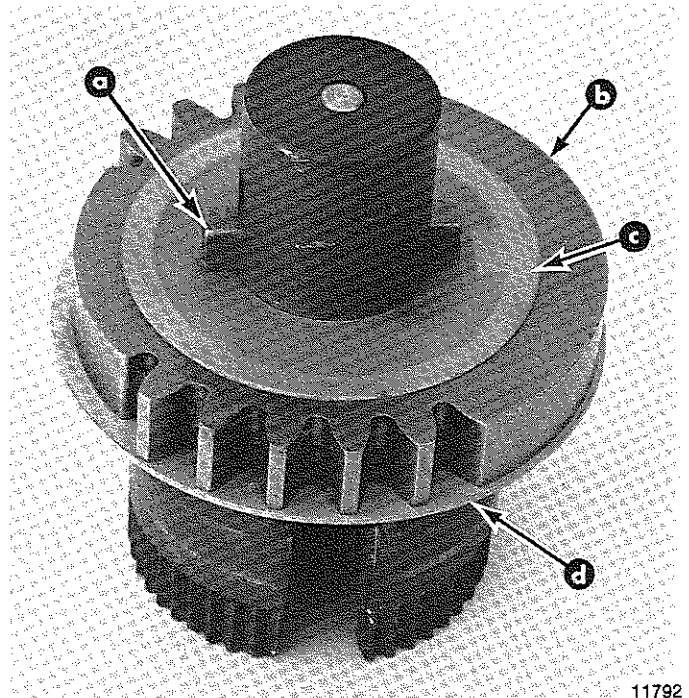


a - Trim Wiring c - Throttle Gear e - Plastic Flat Washer
 b - Throttle Shaft d - Throttle Pinion Gear

Figure 9. Shift and Throttle Components

- e. Pull throttle shaft (with attached throttle pinion gear and plastic flat washer) from control housing. (Once throttle shaft is removed, remove nylon bushing from control housing.)
- f. Pull upward on control shaft hub and remove trim wire plug (with attached trim wires) from hub. (After trim wire plug is removed from control shaft hub, attached trim wires can be disconnected from terminal block for replacement of trim wire plug.)

10. Disassemble control hub assembly by removing control hub key. After key has been removed, remove control hub pin and spring (from inside of control hub), nylon washer, throttle gear and control hub washer.



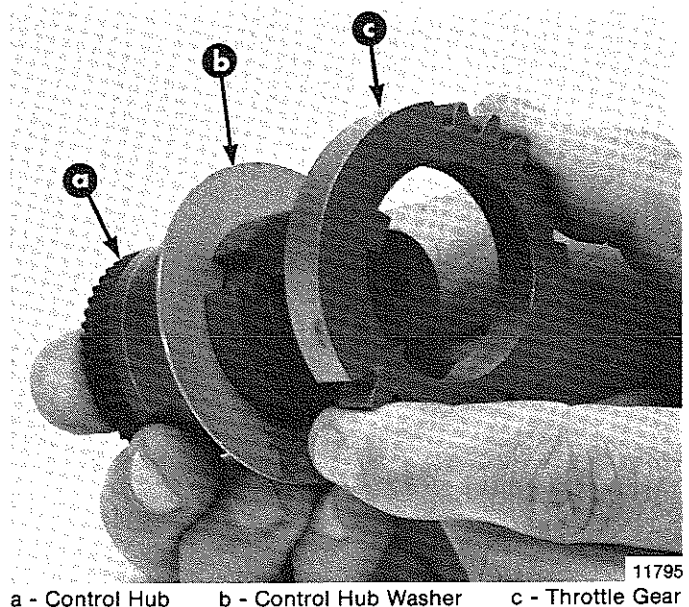
a - Control Hub Key c - Nylon Washer
 b - Throttle Gear d - Control Hub Washer

Figure 10. Control Hub Assembly

REASSEMBLY

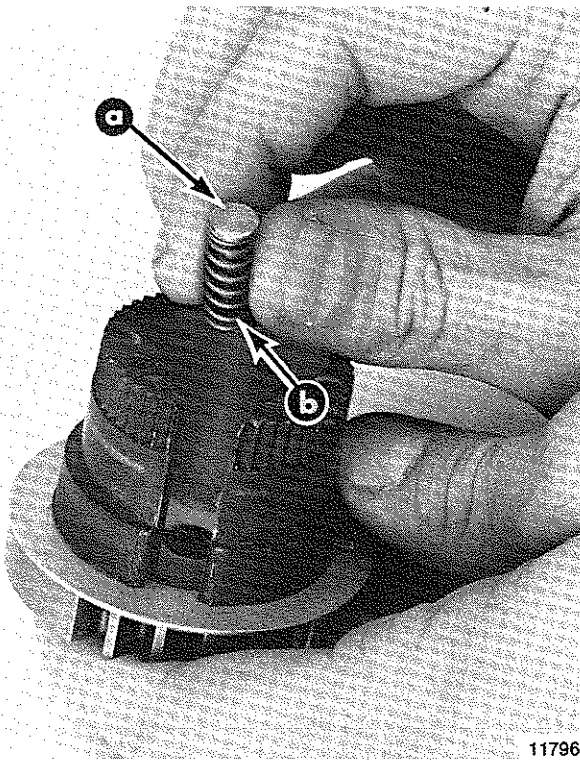
NOTE: During reassembly, lubricate parts with Multipurpose Lubricant whenever "grease" is specified.

1. Install control hub washer and throttle gear onto control hub. (Figure 11)
2. Install a nylon washer over control hub so that it is up against throttle gear. (Figure 10)



a - Control Hub b - Control Hub Washer c - Throttle Gear

Figure 11. Control Hub Washer and Throttle Gear Installation

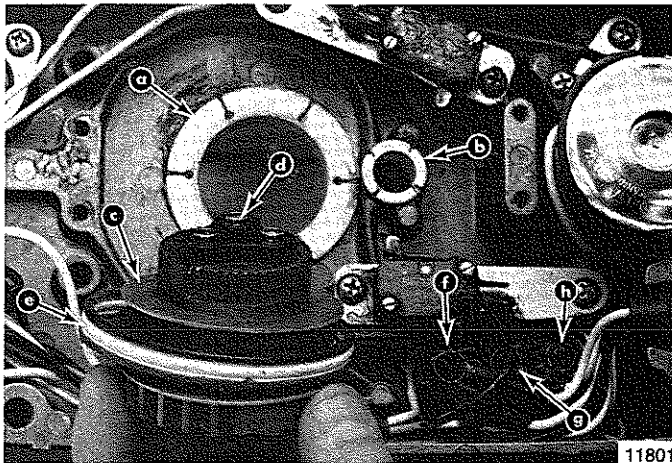


11796

a - Control Hub Pin b - Control Hub Spring

Figure 12. Control Hub Pin and Spring Installation

3. Insert control hub pin into control hub spring, then apply a small amount of grease onto pin and spring. Place spring and pin into center of control hub (spring first). (Figure 12)
4. Using a pinch, compress control hub spring and pin inside of control hub. With spring and pin compressed, insert control hub key into hub. Key must be centered in control hub. (Figure 10)
5. Apply a thin coat of grease onto control hub key, nylon washer, throttle gear and flat washer.
6. Install control hub bushing and throttle shaft bushing into control housing. (Figure 13) Apply a thin coat of grease onto bushings.



11801

a - Control Hub Bushing c - Retainer Plate
 b - Throttle Shaft Bushing d - Trim Wire Plug
 e - Trim Wires
 f - White Trim Wire Connected Here
 g - Green Trim Wire Connected Here
 h - Purple Trim Wire Connected Here

Figure 13. Control Hub Installation

7. If trim wires (which are attached to trim wire plug) are not connected to terminal block (in control housing), route and connect trim wires to terminal block, as shown in Figure 13.
8. Insert trim wire plug (with attached trim wires) into control hub so that trim wires are against control hub flat washer. (Figure 13)
9. Coil trim wires counterclockwise around control hub. Apply a thin coat of grease onto both sides of trim wire retainer plate, then install retainer plate onto control hub so that it is up against trim wires. (Figure 13)
10. Install control hub assembly into control housing. (Figure 13)

NOTE: While performing the remainder of steps, support control housing so that weight of housing is not on the control shaft.

11. If removed, install throttle pinion gear onto throttle shaft and secure to shaft with a retainer ring.
12. Apply a thin coat of grease onto entire throttle shaft and throttle pinion gear.
13. Install (and position) throttle shaft and throttle pinion gear in control housing, as shown in Figure 9.
14. Install a plastic flat washer over throttle shaft so that it is up against throttle pinion gear. (Figure 9) Apply a thin coat of grease onto plastic flat washer.
15. Apply a thin coat of grease onto shift pinion gear, then install gear onto throttle shaft. Apply a thin coat of grease onto nylon bushing and install bushing onto shift pinion gear. (Figure 8)
16. Apply a thin coat of grease onto entire shift gear. Install (and position) shift gear onto control hub assembly. Apply a thin coat of grease onto nylon bushing and install bushing onto shift gear. (Figure 8)
17. Apply a small amount of grease onto detent assembly's roller. Place detent assembly into position in control housing. (Figure 8)
18. Position control shaft support plate over control hub assembly, throttle shaft assembly and detent assembly. (Figure 7)
19. Apply Loctite Type "A" onto threads of two 10-32x1½" slotted hex head screws, then insert screws thru support plate and detent assembly and thread them into control housing. [Torque screws to 30 in. lbs. (35kg-cm).]
20. Apply Loctite Type "A" onto threads of two 10-16x7/16" phillips round-head, self-tapping screws, then insert screws thru support plate and thread them into control housing. (Tighten screws securely.)
21. Install shift lever, plastic flat washer and throttle lever onto throttle shaft. Apply a thin coat of grease onto plastic flat washer before installing it onto shaft. (Figure 7)
22. Apply Loctite Type "A" onto threads of a .190-32x½" phillips head screw. Thread screw with flat washer into throttle shaft to secure shift and throttle levers. [Torque screw to 25 in. lbs. (29kg-cm).]
23. Install back cover onto control housing and secure to housing with 2 bolts. (Figure 6) [Torque bolts to 100 in. lbs. (115kg-cm).]
24. Install control handle onto splined hub of control housing and move handle back-and-forth until detent (neutral) position is located. Re-set control handle so that handle is in a vertical position.
25. Position control handle retainer plate in-center of control handle. Secure retainer plate and control handle to splined control hub with 3 self-locking screws. (Torque screws to 25 in. lbs.) (Figure 5)

26. Position trim wire connector over trim wire plug so that alignment tab is inserted into hole in trim wire plug. (Figure 5) Secure connector to plug with 3 phillips head screws. [Torque screws to 10 in. lbs. (11.5kg-cm).] Apply Liquid Neoprene onto connection.

27. Install neutral warmup button (with attached shaft) into hole in center of control handle hub.
28. Install control handle hub cover onto control handle. (Figure 4)

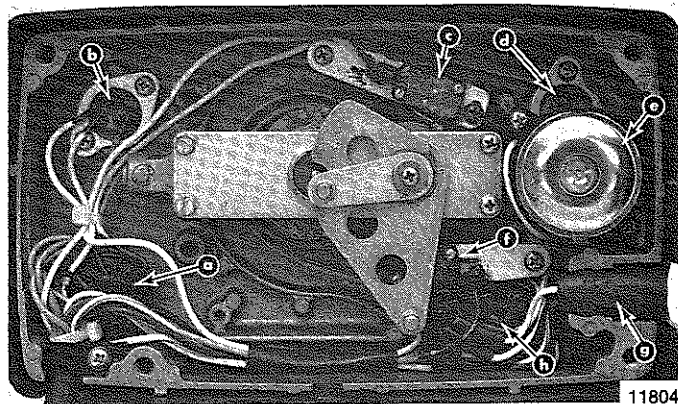
Remote Control Switches and Wiring Harness

REMOVAL

Refer to "Removing Control Housing from Mounting Panel and Control Cables from Control", preceding, and remove control housing from mounting panel and cables from control.

NOTE: Once access cover and control cables are removed from control housing, the throttle cable anchor guide (Figure 6) is free and can be lifted from control housing.

1. Remove 2 bolts, which secure the back cover to control housing (Figure 6), and remove cover from control housing.

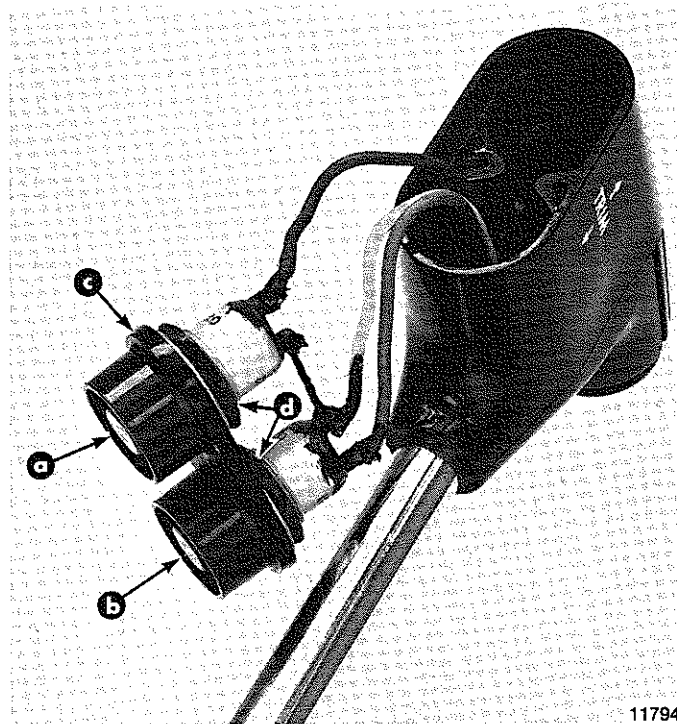


- | | |
|---------------------------|--|
| a - Ignition Switch | e - Temperature Horn |
| b - Choke Switch | f - Reverse Lock Switch |
| c - Neutral Safety Switch | g - Tachometer/Trim Indicator Receptacle |
| d - Trailer Switch | h - Terminal Block |

Figure 14. Remote Control Wiring

2. Ignition switch (Figure 14) removal:
 - a. Unthread ignition switch nut from front side of control housing.
 - b. Remove screw that secures remote control wiring harness to control housing.
 - c. Unsolder 7 wires which are secured to ignition switch.
 - d. Lift ignition switch from control housing.
3. Choke switch (Figure 14) removal:
 - a. Unsolder 3 wires that are secured to choke switch.
 - b. Remove 2 screws and retainer, which secure choke switch to control housing, then lift switch from control housing.
4. Neutral safety switch (Figure 14) removal:
 - a. Remove 2 screws, that secure neutral safety mounting plate to control housing, then lift plate and switch up.
 - b. Unsolder 2 wires that are secured to switch.
 - c. Remove 2 screws and locknuts which secure switch to mounting plate.
5. Temperature horn (Figure 14) removal:
 - a. Remove 2 screws that secure temperature horn cover to control housing.

- b. Unsolder 2 wires which are secured to the back side of temperature horn.
- c. Pull locking tabs back and push temperature horn out of cover.
6. Trailer switch (Figure 14) removal:
 - a. Remove 2 screws, that secure temperature horn cover to control housing, then move cover and horn out of the way.
 - b. Unsolder 3 wires which are secured to trailer switch.
 - c. Remove 2 screws and retainer that secure trailer switch to control housing.
 - d. Lift trailer switch from control housing.
7. Reverse lock switch (Figure 14) removal:
 - a. Move control handle to reverse gear position.
 - b. Remove 2 screws, which secure reverse lock switch mounting plate to control housing, then lift plate and switch up.
 - c. Unsolder 2 wires that are secured to switch.
 - d. Remove 2 screws and locknuts that secure switch to mounting plate.



- | | |
|--------------------------------|--------------|
| a - Trim "Up" Switch (Red) | c - Retainer |
| b - Trim "Down" Switch (Black) | d - Nuts |

Figure 15. Trim "Up" and "Down" Switches Removed from Control Handle

8. Trim switches ("Up" and "Down") (Figure 15) removal:
 - a. Remove 2 screws that secure switches inside of control handle.
 - b. Pull switches out of control handle.
 - c. Unsolder wires that are secured to switches [3 wires on the "Down" (black) switch and 2 wires on the "Up" (red) switch.]

- d. Unthread nuts from the back side of each switch and remove switches from retainer.

NOTE: To remove trim control wires from the inside of control housing, refer to "Shift and Throttle Components" (Disassembly), preceding.

INSTALLATION

1. Trim switches ("Up" and "Down") (Figure 15) installation:
 - a. If trim switches were removed from retainer, insert switches thru retainer and secure with washers and nuts.
 - b. Solder trim wires to trim switches, as shown in Figure 15 and 16. Apply Liquid Neoprene onto connections.
 - c. Position retainer (with attached trim switches) into control handle and secure with 2 phillips head screws.
2. Reverse lock switch (Figure 14) installation:
 - a. Secure switch to mounting plate with 2 screws and locknuts. Position mounting plate with attached switch in control housing and secure with 2 phillips head screws, as shown in Figures 8 and 14. **DO NOT** tighten screws securely at this time.
 - b. Solder pink wire to proper terminal on reverse lock switch, as shown in Figures 8, 14 and 16. (If pink wire is not soldered to the correct terminal, switch will not operate properly.)
 - c. Solder white wire (from choke switch) to proper terminal on reverse lock switch, as shown in Figures 8, 14 and 16. (If white wire is not soldered to the correct terminal, switch will not operate properly.)
 - d. Apply Liquid Neoprene over connections. Apply a thin coat of Anti-Corrosion Grease over entire reverse lock switch.
 - e. Shift control into reverse gear position. Position a .010" feeler gauge between roller (on switch) and cam on shift gear. Apply a slight amount of pressure toward shift gear on mounting plate, then tighten mounting plate screws securely. Remove feeler gauge.
3. Trailer switch (Figure 14) installation:
 - a. Install trailer switch into control housing and secure to housing with a retainer and 2 phillips head screws. Tighten screws securely.

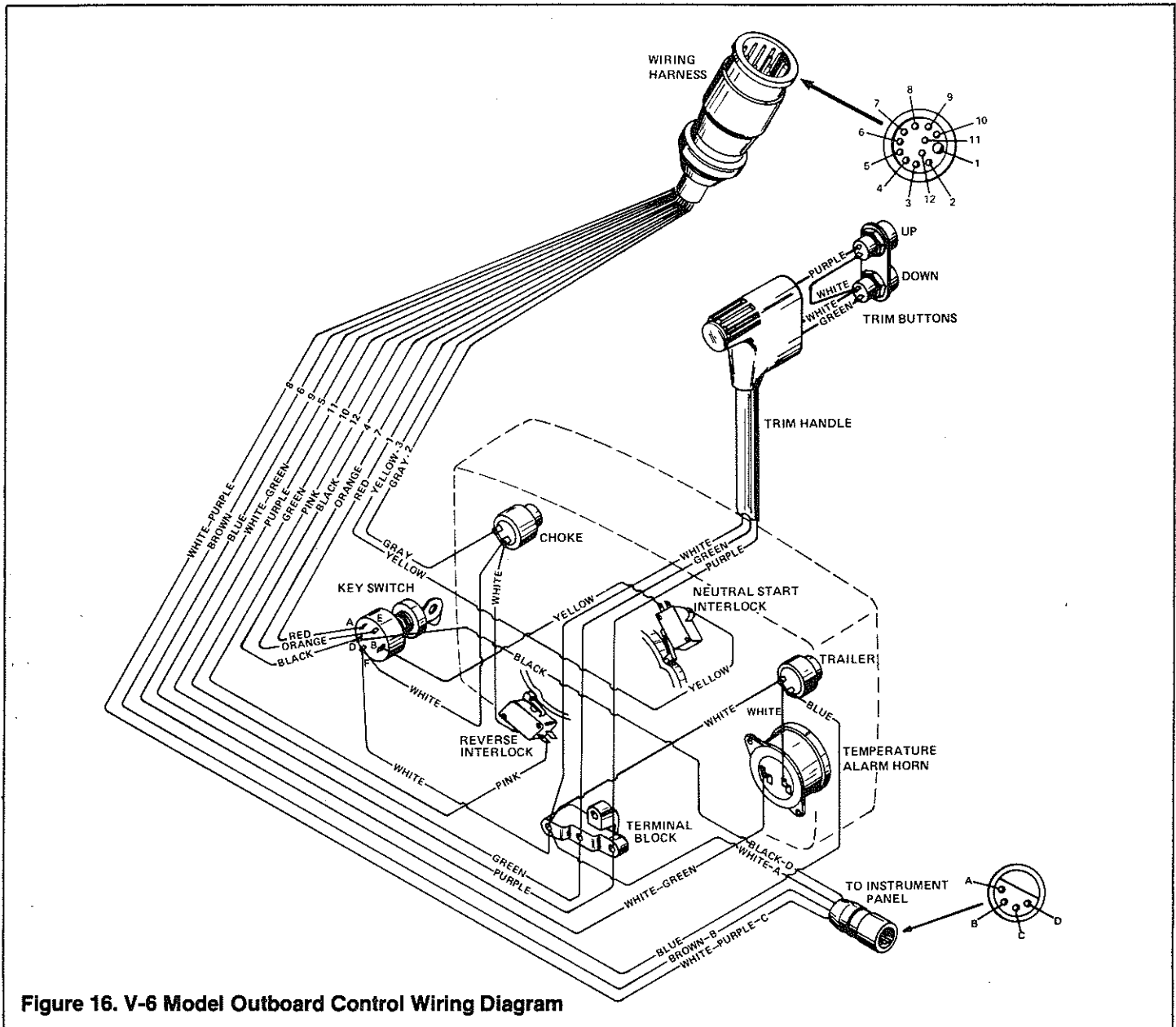
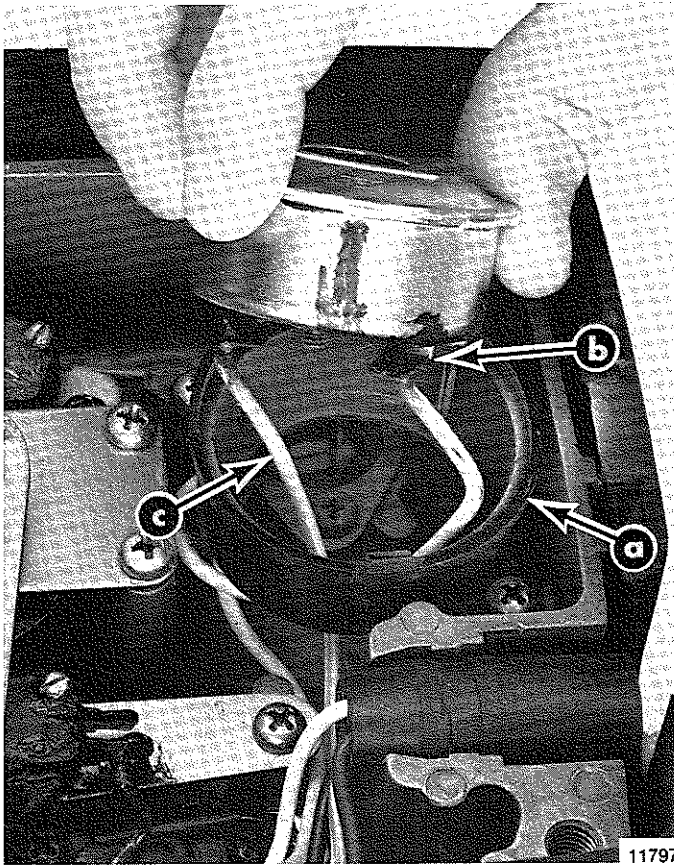


Figure 16. V-6 Model Outboard Control Wiring Diagram

- b. Solder a white wire (from control harness) and a white wire (from temperature horn) together onto either terminal on trailer switch.
- c. Solder a blue wire (from control harness) by itself onto the other trailer switch terminal.
- d. Apply Liquid Neoprene onto connections.
- e. Position temperature horn in control housing and secure with 2 screws.



a - Cover b - Terminal with Fiber Washer c - White/Green Wire

Figure 17. Temperature Horn Installation

4. Temperature horn (Figures 14 and 17) installation:
 - a. Position temperature horn cover in control housing and secure to housing with 2 screws.
 - b. Route white wire [from trailer switch (there are 2 white wires connected to trailer switch)] up thru temperature horn cover. Solder wire to terminal (on horn) that has a fiber washer between terminal and horn. (Figure 17)

- c. Route white/green wire (from control harness) up thru temperature horn cover. Solder wire to terminal on temperature horn.
 - d. Apply Liquid Neoprene onto connections.
 - e. Push temperature horn into cover so that it is positioned as shown in Figure 14.
5. Neutral safety switch (Figure 14) installation:
 - a. Secure switch to mounting plate with 2 screws and locknuts. Position mounting plate with attached switch in control housing and secure with 2 phillips head screws, as shown in Figures 8 and 14. **DO NOT** tighten screws securely at this time.
 - b. Solder yellow wire (from key switch) to proper terminal on neutral safety switch, as shown in Figures 8, 14 and 16. (If yellow wire is not soldered to the correct terminal, switch will not operate properly.)
 - c. Solder yellow wire (from wiring harness) to proper terminal on neutral safety switch, as shown in Figures 8, 14 and 16. (If yellow wire is not soldered to the correct terminal, switch will not operate properly.)
 - d. Apply Liquid Neoprene onto connections. Apply a thin coat of Anti-Corrosion Grease over entire neutral safety switch.
 - e. Shift control into reverse gear position. Position a .010" feeler gauge between roller (on switch) and cam on shift gear. Apply a slight amount of pressure toward shift gear on mounting plate, then tighten mounting plate screws securely. Remove feeler gauge.
 6. Choke switch (Figure 14) installation:
 - a. Install choke switch into control housing and secure to housing with a retainer and 2 phillips head screws. Tighten screws securely.
 - b. Solder a white wire (from key switch) and a white wire (from reverse lock switch) together onto either terminal on choke switch.
 - c. Solder a gray wire (from wiring harness) by itself onto the other choke switch terminal.
 - d. Apply Liquid Neoprene onto connections.
 7. Ignition switch (Figure 14) installation:
 - a. Position ignition switch in control housing so that terminal marked "E" is toward choke switch. Secure ignition switch to housing with nut. Tighten nut securely.
 - b. Solder correct wires to correct terminals as indicated in Figure 16.
 - c. Apply Liquid Neoprene onto connections.
 - d. Secure wiring harness to control housing with clamp, flat washer and screw.
 8. Install back cover onto control housing and secure to housing with 2 bolts. (Figure 6) [Torque bolts to 100 in. lbs. (115kg-cm).]

Remote Control Cables Installation and Control Housing Mounting

1. If remote control access cover is installed onto control, remove 2 screws, that secure access cover to control housing, and remove cover.
2. Place control handle in neutral (detent) position.

IMPORTANT: Check throttle and shift cables before installing in control housing to ensure that set screws in cable end guides are tight. Torque set screws to 20 to 25 in. lbs. (23 to 29kg-cm).

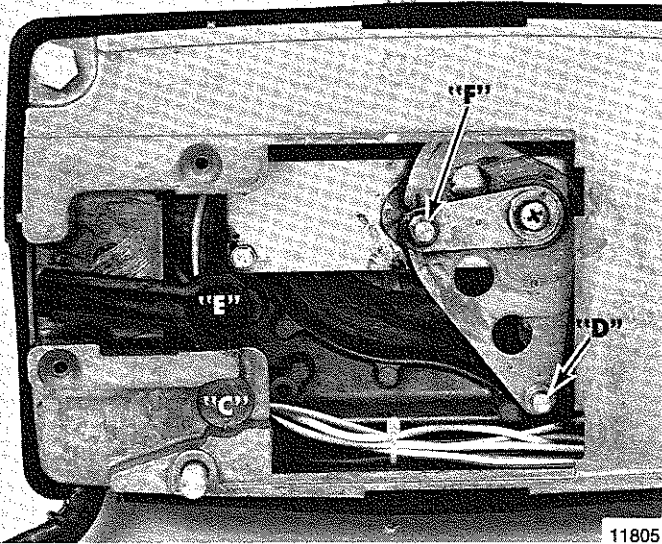
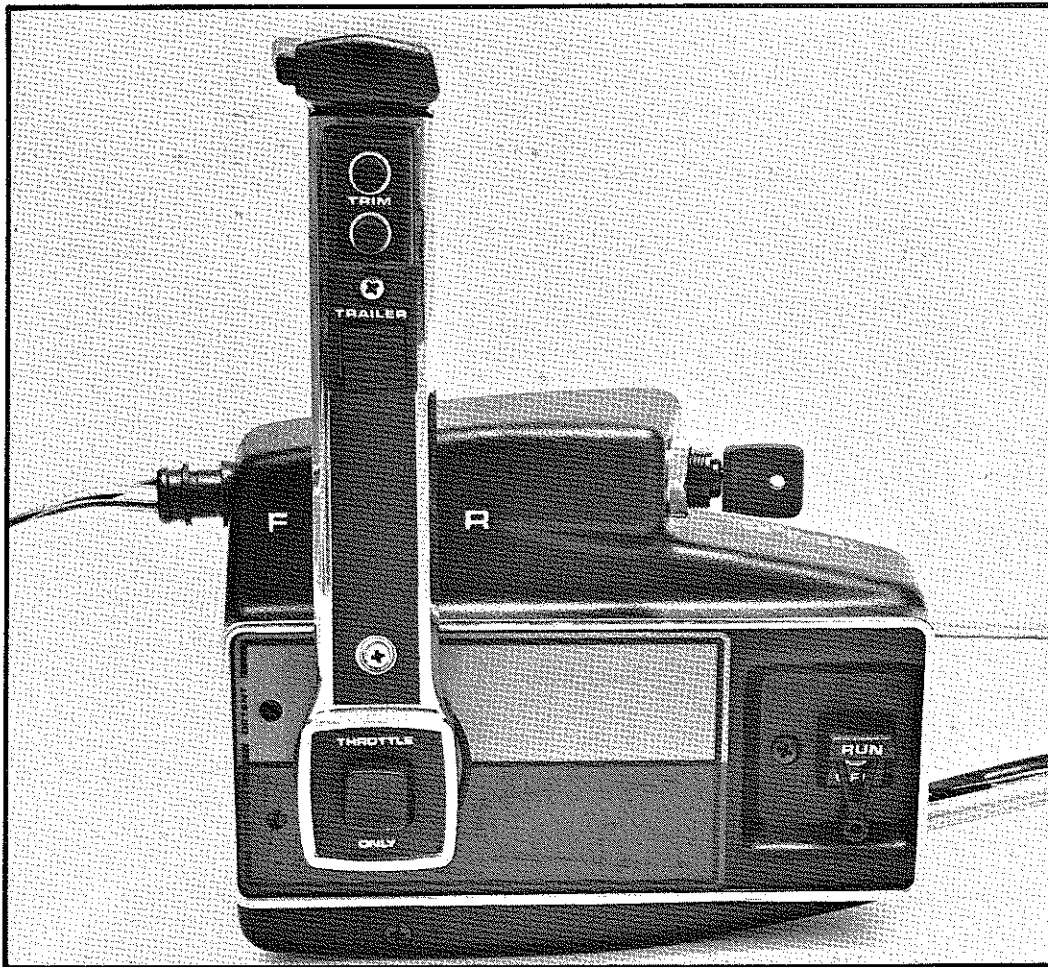


Figure 18. Cable Recess and Pins

3. Pull ends of control cables (ends to be installed in remote control) out of cable housings to end of travel. Apply a light coat of Multipurpose Lubricant (or equivalent) onto extended portion of control cables. Be sure to apply lubricant onto end of each control cable.
4. Apply a light amount of Multipurpose Lubricant to pins "F" and "D" in Figure 18.
5. Place shift cable anchor into recess "C" and place end of cable over pin "D". Secure cable end to pin with washer and cotter pin. (Figures 18 and 3) Bend back both ends of cotter pin.
6. Place throttle cable anchor into recess "E" and place end of cable over pin "F". Secure cable end to pin with washer and cotter pin. (Figures 18 and 3) Bend back both ends of cotter pin.
7. Install access cover and secure to control housing with 2 phillips head screws. Tighten screws securely.
8. Position remote control housing so that mounting studs are thru holes in mounting panel and secure control with washers and locknuts. Tighten nuts securely.
9. Plug tachometer/trim indicator harness connector into tachometer receptacle (lower front) of remote control with indexed connectors aligned.
10. Plug remote control wiring harness into engine harness and secure connection with a spring-type clamp.
11. Connect trim wiring harness (from remote control) to receptacle on trim pump and secure with clamp.
12. Connect trim limit switch wiring connections together.
13. Attach harnesses and control cables to side of boat, making sure that wiring and connections are kept out of bilge water. **DO NOT** place any attaching devices closer than 36" (91cm) to remote control.

V-6 OUTBOARDS

Engine Attachments



“Commander” Deluxe Remote Control

SECTION
PART **C**

7

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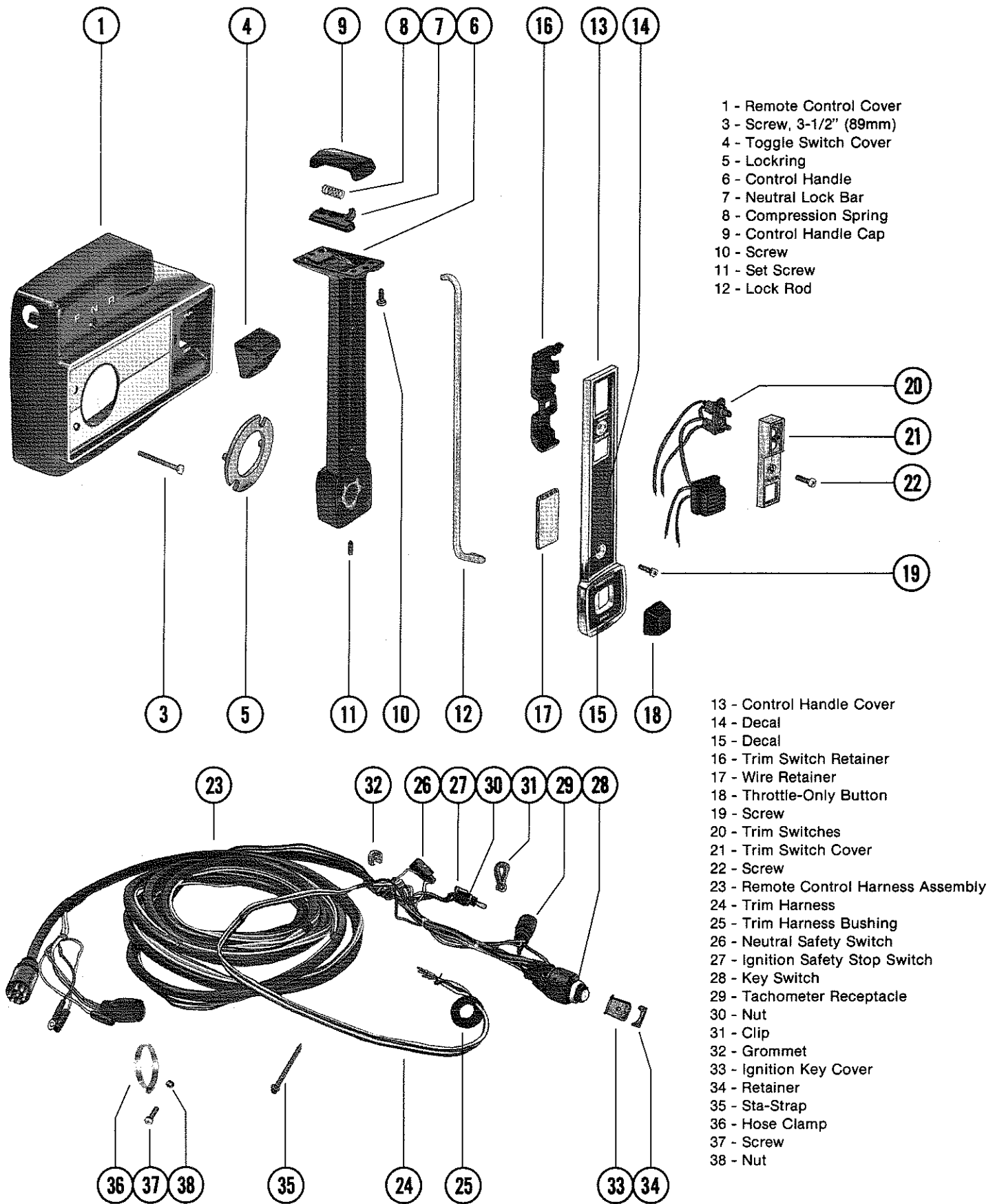
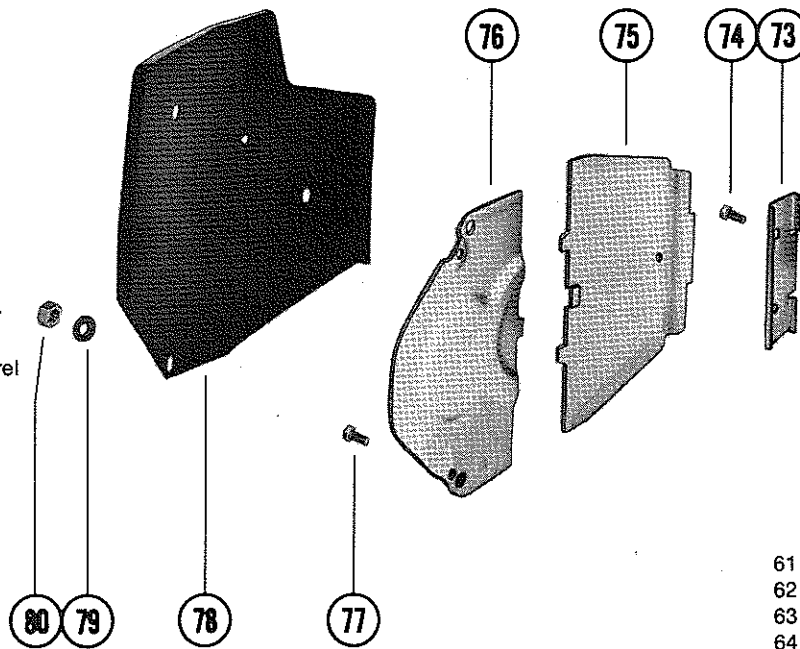


Figure 1. Remote Control

- 39 - Retaining Clip
- 40 - Screw
- 41 - Set Screw
- 42 - Screw
- 43 - Grommet
- 44 - Compression Spring
- 45 - Compression Spring
- 46 - Detent Ball Follower
- 47 - Detent Ball
- 50 - Wiring Harness Retainer
- 51 - Throttle-Only Shaft
- 52 - Throttle-Only Shaft Barrel
- 53 - Throttle-Only Shaft Pin
- 54 - Retaining Ring
- 55 - Shift Gear
- 56 - Shift Gear Ball - Inner
- 57 - Shift Gear Pin
- 58 - Shift Gear Ball - Outer
- 59 - Shift Gear Spring
- 60 - Shift Pinion Gear



- 61 - Bushing
- 62 - Shift Lever
- 63 - Cable Fastener
- 64 - Nut
- 65 - Step Washer
- 66 - Bearing Plate Assembly
- 67 - Nut
- 68 - Screw
- 69 - Cable Fastener
- 70 - Nut
- 71 - Compression Spring
- 72 - Throttle Lever Assembly
- 73 - Cable Retainer
- 74 - Screw
- 75 - Cover
- 76 - Cover
- 77 - Screw
- 78 - Cover
- 79 - Washer
- 80 - Nut

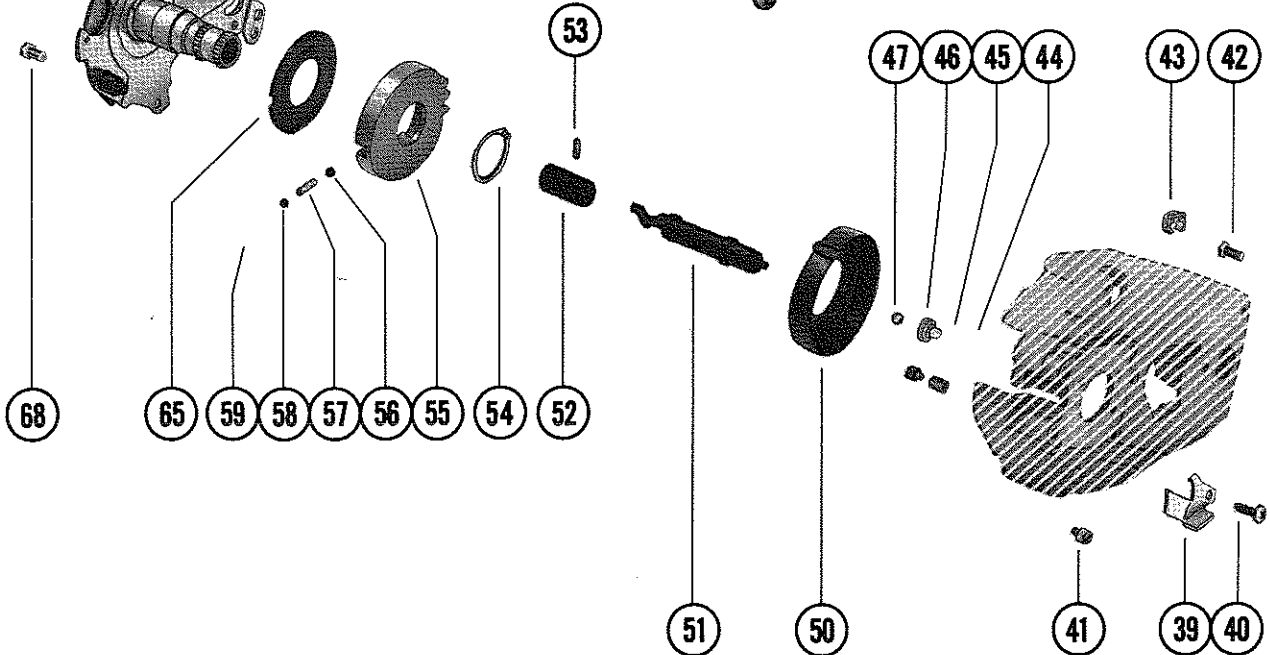
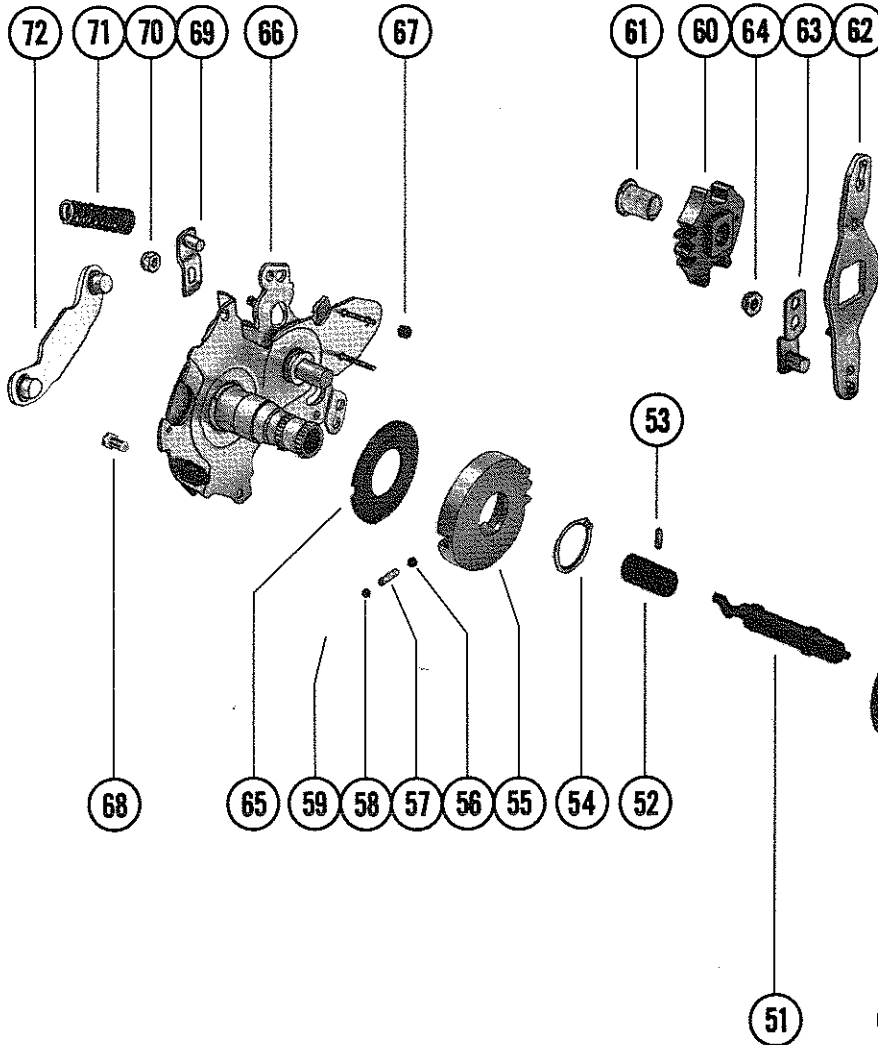


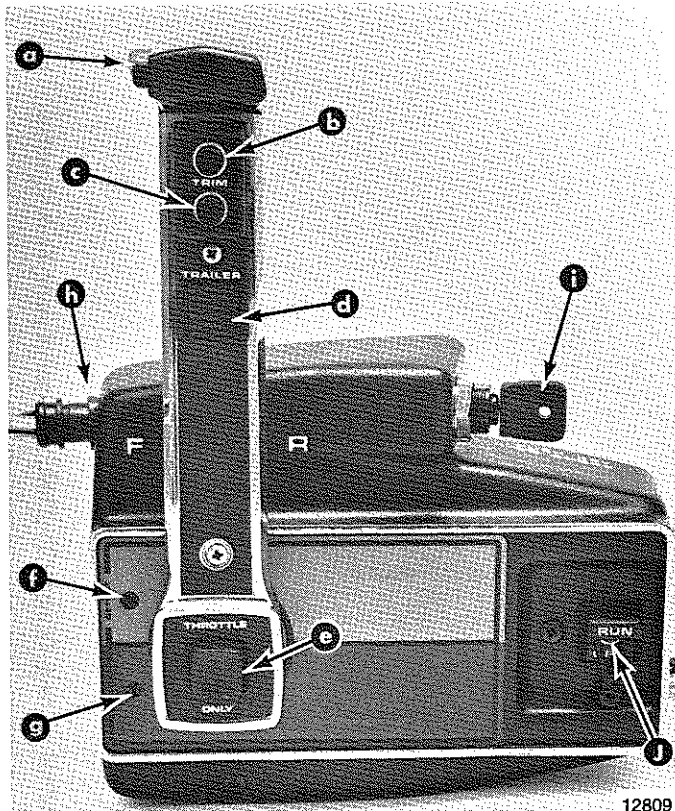
Figure 2. Remote Control

"COMMANDER" DELUXE REMOTE CONTROL

Disassembly and Reassembly

REMOVING CONTROL HOUSING from MOUNTING PANEL and CONTROL CABLES from CONTROL

SAFETY WARNING: Before working around remote control or around engine, remove remote control wiring harness from engine and disconnect high tension leads from spark plugs.

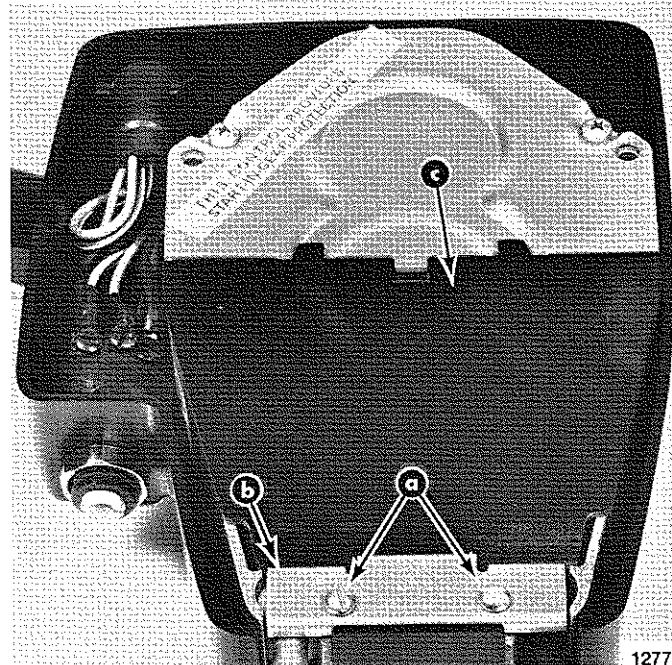


- a - Neutral Lock Bar
- b - Trim "Up" Button
- c - Trim "Down" Button
- d - Trailer Button
- e - Throttle-Only Button
- f - Detent Adjustment Screw
- g - Control Handle Friction Screw
- h - Tachometer Wiring Harness Receptacle
- i - Ignition Switch
- j - Ignition Safety Stop Switch

Figure 4. Remote Control

1. Turn ignition key to "Off" position and remove key from switch. Disconnect remote control wiring harness from engine and trim pump. Disconnect high tension leads from spark plugs.
2. Place control handle into neutral detent position.
3. Disconnect tachometer wiring harness from receptacle in the forward side of control housing. (Figure 4)
4. Remove (and retain) 3 locknuts, flat washers and screws which secure control housing to mounting panel.

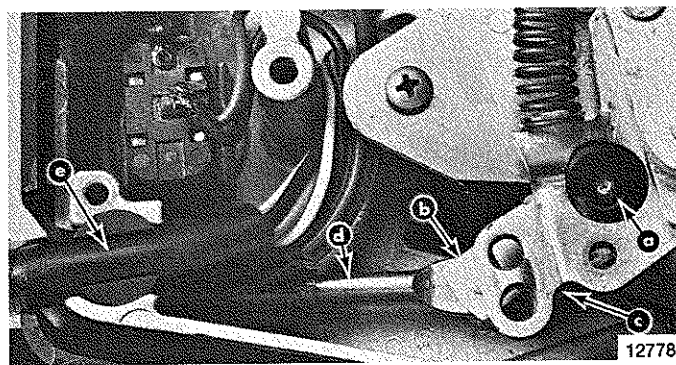
CAUTION: Avoid cutting or damaging wiring harness on sharp fiberglass or projections when removing remote control housing from mounting panel.



- a - Screws
- b - Cable Retainer
- c - Access Cover

Figure 5. Access Cover and Cable Retainer

5. Pull remote control housing from mounting panel and remove plastic cover from back side of control housing.
6. Remove (and retain) 2 screws, which secure cable retainer to control housing, then lift cable retainer and access cover from housing. (Figure 5)

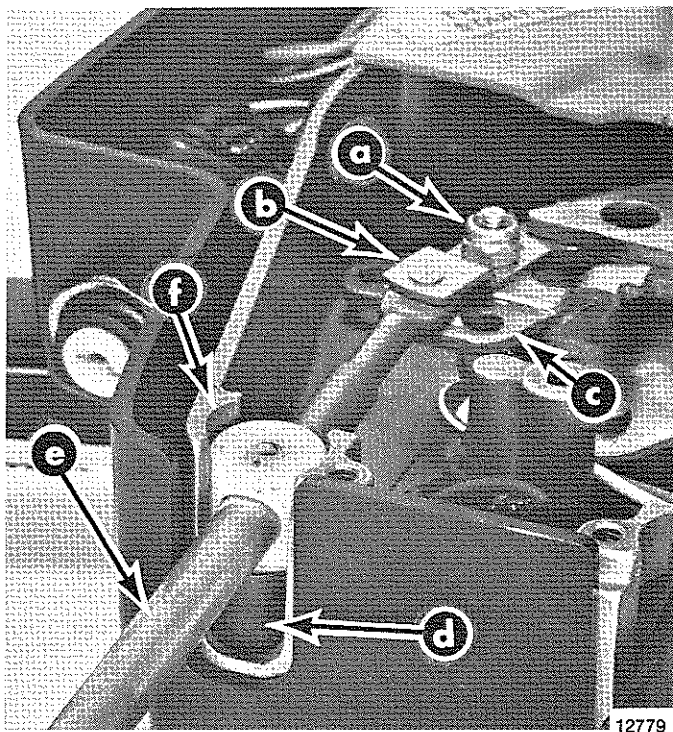


- a - Retainer Nut (Cable Fastener)
- b - Cable Fastener
- c - Shift Lever
- d - Shift Cable
- e - Wiring Harness

Figure 6. Shift Cable Installed

7. Remove shift cable (Figure 6) from control housing, as follows:
 - a. Depress neutral lock bar and position control handle into full "reverse".
 - b. Loosen (not necessary to remove) cable fastener nut.
 - c. Move control handle to reverse idle detent and raise cable fastener to free shift cable from shift lever.
 - d. Lift wiring harness out of cable anchor barrel recess, then remove shift cable from control housing.
8. Remove throttle cable (Figure 7) from control housing, as follows:

- a. Position control handle into neutral detent. Loosen (not necessary to remove) cable fastener nut and raise fastener to free throttle cable from throttle lever.
- c. Lift throttle cable from barrel recess.



- | | |
|-----------------------------------|--------------------|
| a - Retainer Nut (Cable Fastener) | d - Grommet |
| b - Cable Fastener | e - Throttle Cable |
| c - Throttle Lever | f - Barrel Recess |

Figure 7. Throttle Cable Installed

SHIFT and THROTTLE COMPONENTS - DISASSEMBLY

Refer to "Removing Control Housing from Mounting Panel and Control Cables from Control", preceding, and remove control housing from mounting panel and cables from control.

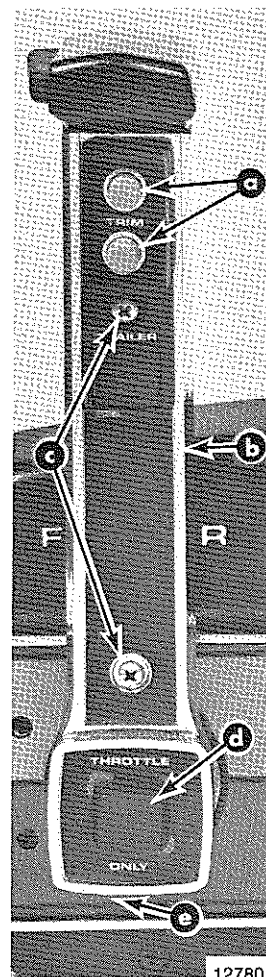
1. Position control handle in neutral detent.

NOTE: There are three (3) detent positions in the control handle movement; neutral is the center detent.

2. Remove 2 phillips head screws (Figure 8) which secure control handle cover and trim buttons to handle.
3. Lift control handle cover (with trim buttons) off control handle, then unsnap and remove wire retainer. (Figure 9) Once wire retainer is removed, unplug trim wires and remove control handle cover from control.
4. Pull throttle-only button off throttle-only shaft. (Figure 9)
5. Straighten trim wires so that they protrude straight-out from control handle hub.

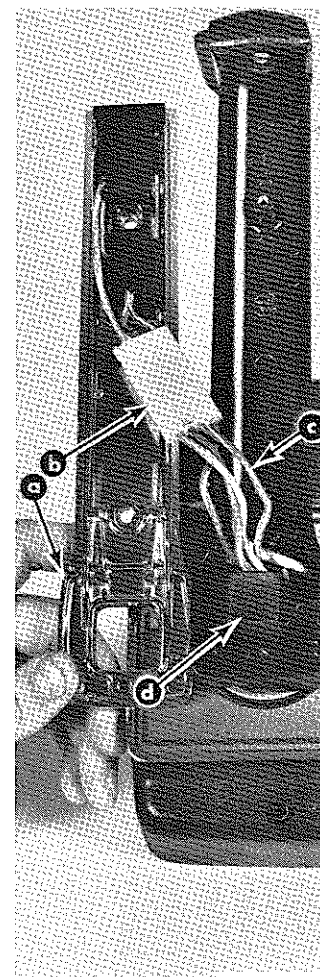
CAUTION: Be extremely careful, when removing control handle from control shaft, so that trim wires are not cut or otherwise damaged.

6. Loosen control handle set screw (Figure 8) enough to allow removal of control handle and remove control handle from control shaft.
7. Lift locking (Figure 10) from control housing.



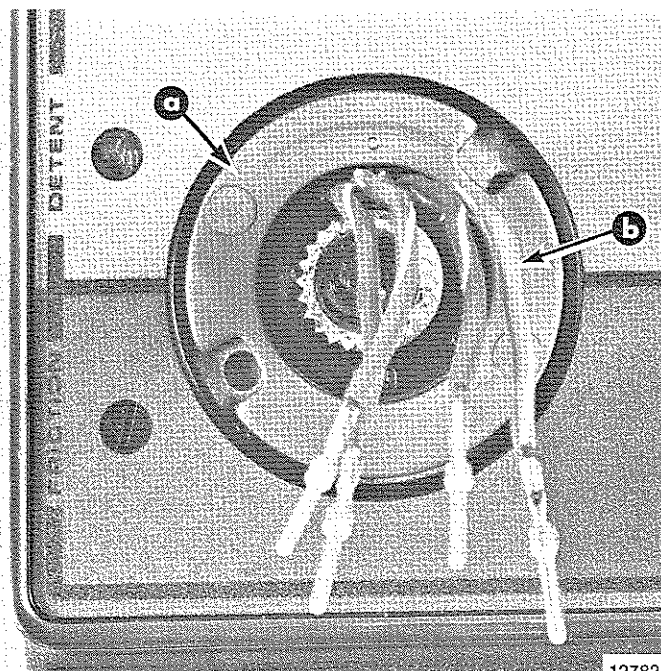
- | |
|--|
| a - Trim Buttons |
| b - Control Handle Cover |
| c - Phillips Head Screws |
| d - Throttle-Only Button |
| e - Location of Control Handle Set Screw |

Figure 8. Control Handle



- | |
|---------------------------|
| a - Control Handle Cover |
| b - Wire Retainer |
| c - Trim Wires |
| d - Throttle-Only Buttons |

Figure 9. Remote Control Handle Cover Removed

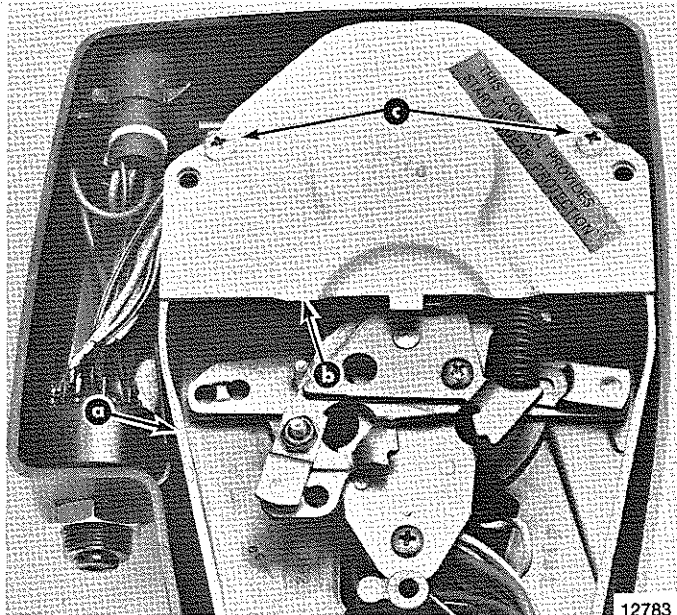


- | | |
|--------------|----------------|
| a - Lockring | b - Trim Wires |
|--------------|----------------|

Figure 10. Lockring Installed

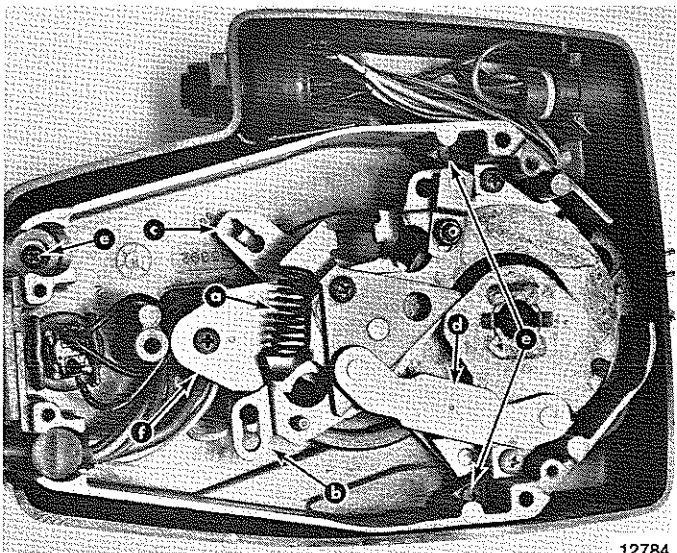
NOTE: While performing the remaining steps, support control housing so that the weight of the housing is not on the control shaft.

8. Remove 2 phillips head screws, which secure the back cover to control module (Figure 11), and remove cover from control module.
9. Temporarily install control handle onto splined control shaft.
10. Position control handle into full forward and remove control handle.

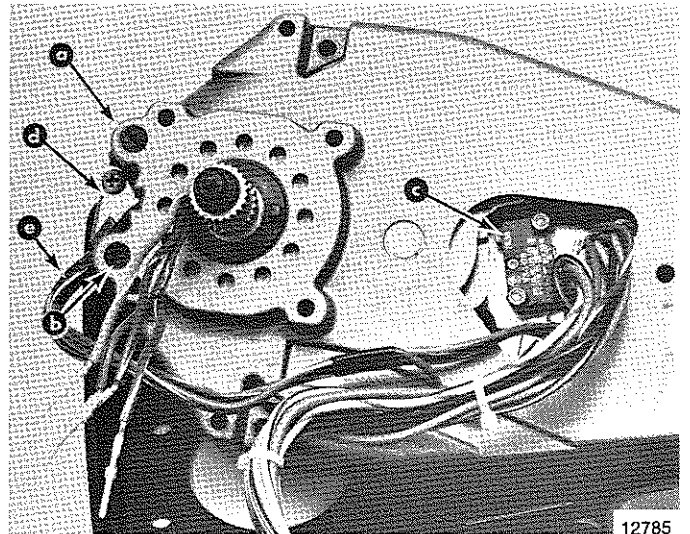


a - Control Module b - Back Cover c - Phillips Head Screws
Figure 11. Back View of Control

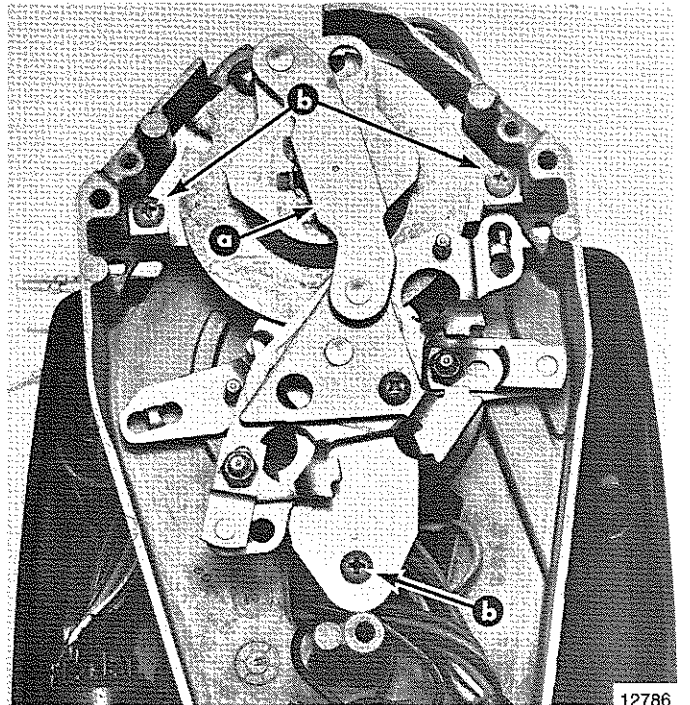
11. Remove compression spring (Figure 12) from throttle lever.
12. Remove 3 phillips head screws, that secure control module to plastic control housing (Figure 12), and lift control module out of plastic control housing.



a - Compression Spring c - Shift Lever
 b - Throttle Lever d - Throttle Link Assembly
 e - Phillips Head Screws (Control Module to Plastic Control Housing)
 f - Bearing Plate Assembly
Figure 12. Back View of Control with Control Module Cover Removed



a - Detent Adjustment Screw c - Neutral Safety Switch
 b - Control Handle Friction Screw d - Retaining Clip
 e - Trim Wires
Figure 13. Remote Control Module



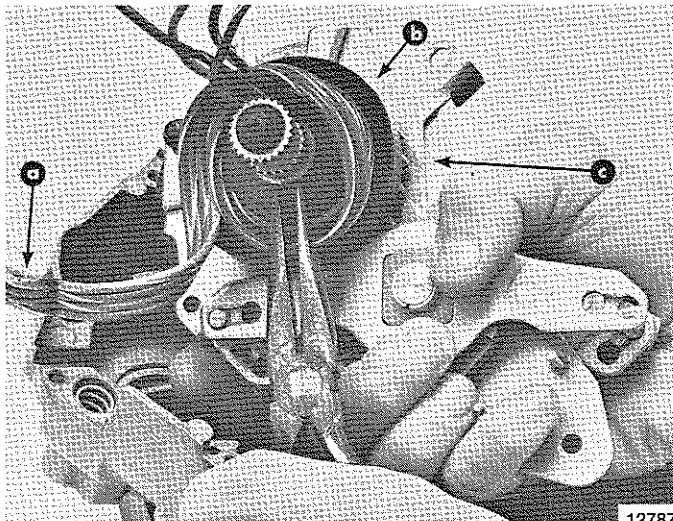
a - Throttle Link Assembly
 b - Phillips Head Screws (Bearing Plate Assembly to Control Module Housing)
Figure 14. Back View of Control

13. Thread detent adjustment screw and control handle friction screw (Figure 13) out of control module until they are flush with control module casing.

NOTE: It is not necessary to remove detent adjustment screw or control handle friction screw, unless replacement of screw(s) is required.

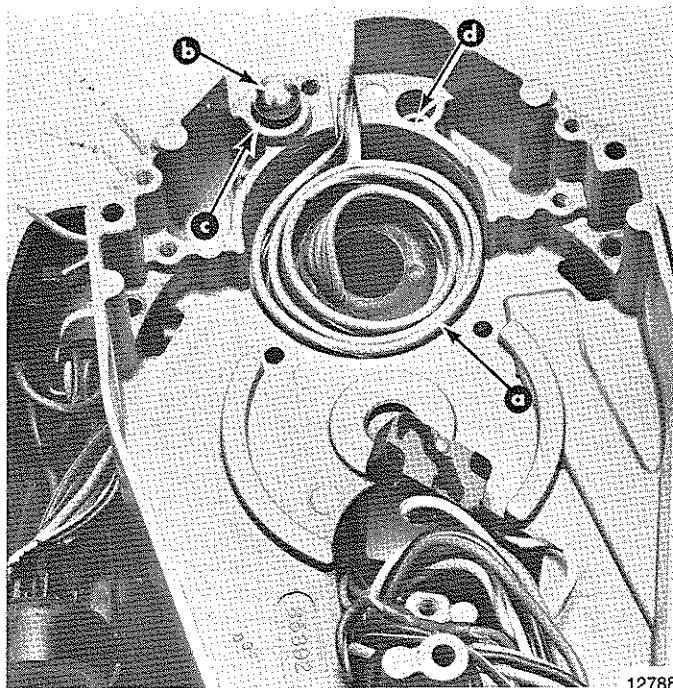
14. Remove 2 locknuts, which secure neutral safety switch to bearing plate assembly (Figure 13), and pull neutral safety switch away from bearing plate assembly.
15. Remove phillips head screw, that secures retaining clip (Figure 13) to control module, and remove retaining clip, shift gear spring and shift gear ball from control module.

16. Temporarily install control handle onto splined control shaft.
17. Position control handle in neutral detent, then remove control handle.
18. Pull throttle link assembly (Figure 14) from module.
19. Remove 3 phillips head screws (Figure 14) which secure bearing plate assembly to control module housing.
20. Slowly lift bearing plate assembly out of control module housing until trim wires can be removed from control shaft, as shown in Figure 15.



a - Trim Wires b - Trim Wire Retainer
c - Bearing Plate Assembly

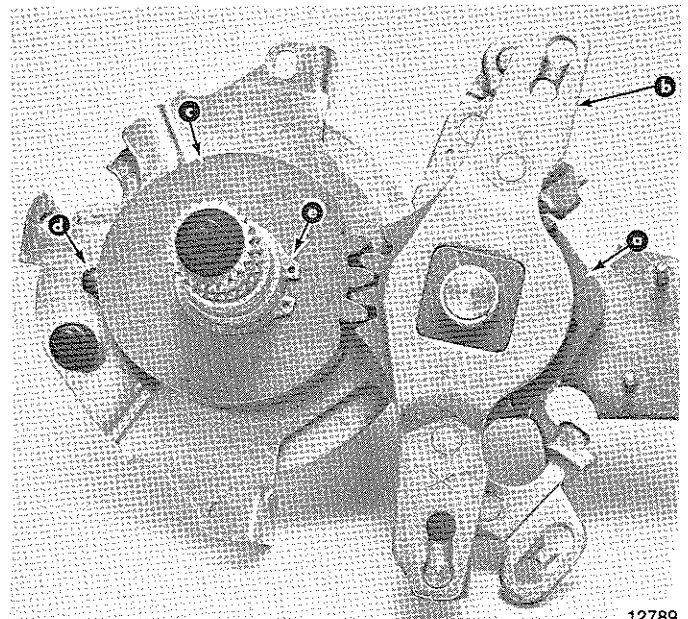
Figure 15. Bearing Plate Assembly Removal



a - Trim Wires b - Detent Ball c - Detent Ball Follower
d - Location of Control Handle Friction Sleeve (if It Is Not Part of Friction Pad)

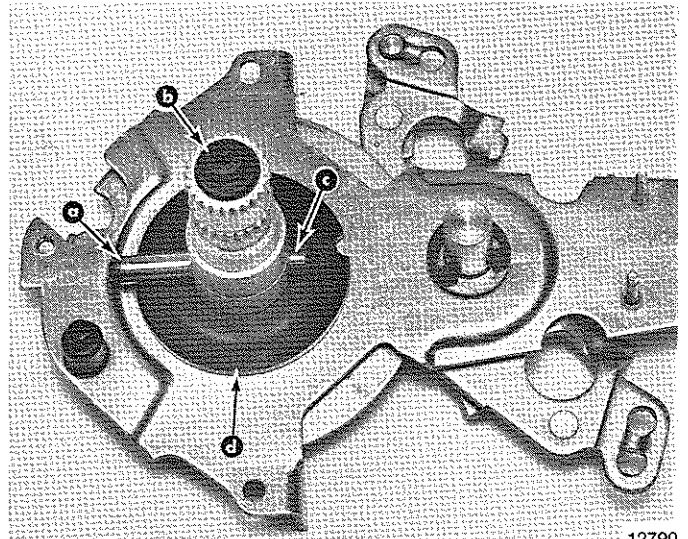
Figure 16. Control Module with Bearing Plate Assembly Removed

21. Remove trim wires and trim wire retainer from bearing plate assembly and position trim wires back into control module housing, as shown in Figure 16.
22. Remove detent ball, detent ball follower and 2 compression



a - Shift Pinion Gear c - Shift Gear
b - Shift Lever d - Shift Gear Pin
e - Retaining Ring

Figure 17. Bearing Plate Assembly



a - Shift Gear Pin c - Throttle-Only Shaft Pin
b - Throttle-Only Shaft d - Step Washer

Figure 18. Bearing Plate with Shift Gear and Shift Pinion Gear Removed

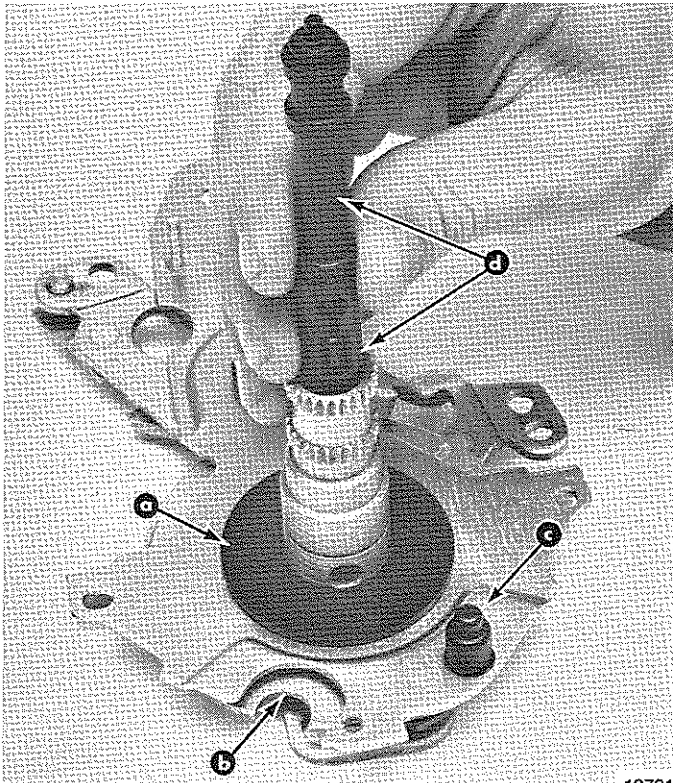
- springs (located beneath follower) from control module housing. (Figure 16)
23. If it is not part of the friction pad, remove control handle friction sleeve (Figure 16) from control module housing.
 24. Lift shift pinion gear (with attached shift lever) from bearing plate. (Figure 17)

NOTE: Shift lever is pressed onto shift pinion gear. DO NOT remove lever from gear, unless replacement of lever or gear is required.

25. Remove retaining ring (Figure 17), that secures shift gear to control shaft, and remove shift gear from control shaft.
26. Once shift gear is removed, remove shift gear pin, shift gear ball (inner), throttle-only shaft pin and throttle-only shaft from control shaft. (Figure 18)

SHIFT and THROTTLE COMPONENTS - REASSEMBLY

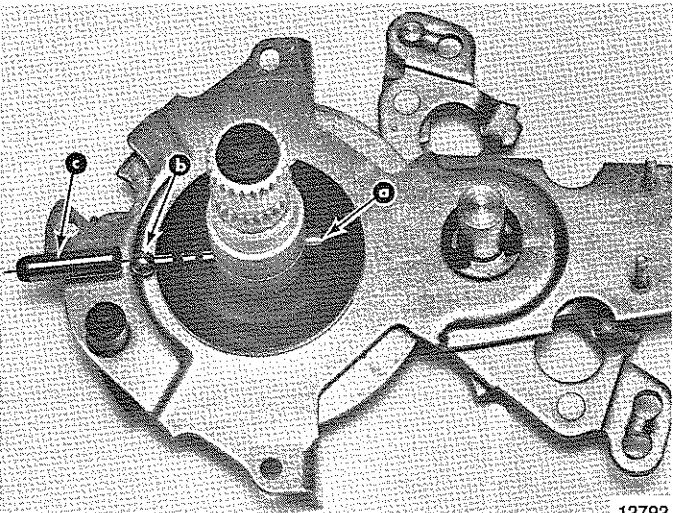
NOTE: During reassembly, lubricate parts with Multipurpose Lubricant whenever "grease" is specified.



12791

a - Step Washer c - Control Handle Friction Pad
b - Neutral Detent Notch d - Throttle-Only Shaft and Barrel

Figure 1. Throttle-Only Shaft and Barrel Installation



12792

a - Throttle-Only Shaft Pin c - Shift Gear Pin
b - Shift Gear Ball [Smallest of the Three (3) Balls Removed during Disassembly]

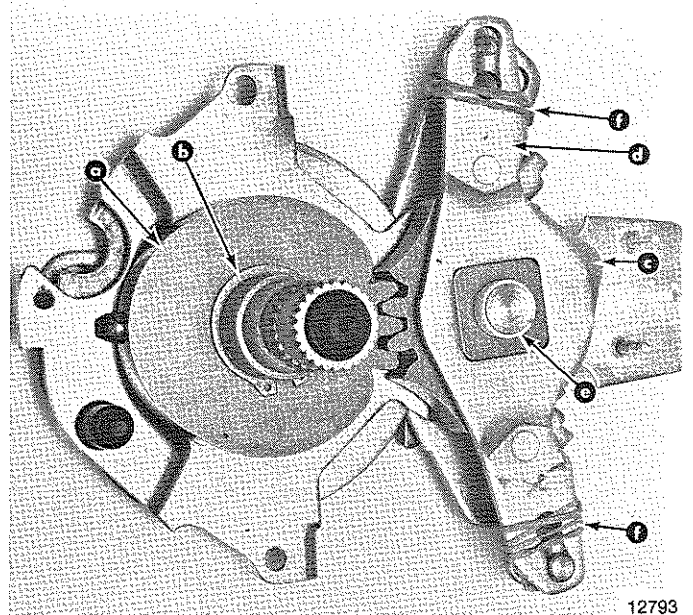
Figure 2. Throttle-Only Shaft Pin, Shift Gear Ball and Shift Gear Pin Installation

1. Apply a thin coat of grease onto step washer and install washer over control shaft with steps of washer down against bearing plate, as shown in Figure 1.
2. Rotate control shaft until neutral detent notch is at the position shown in Figure 1.

3. Apply a thin coat of grease onto throttle-only shaft and barrel, then install shaft into barrel.
4. Install throttle-only shaft and barrel into control shaft so that the wide slot in barrel is on the same side as the neutral detent notch and the control handle friction pad. (Figure 1)
5. Apply a thin coat of grease onto throttle-only shaft pin, then insert pin into control shaft and hole in throttle-only shaft barrel. (Figure 2)

NOTE: Throttle-only shaft pin is properly installed when throttle-only shaft cannot be removed.

6. Apply a thin coat of grease onto the smallest of the three (3) balls which was removed during disassembly. (Figure 2)
7. Insert shift gear ball into control shaft and hole in throttle-only shaft barrel. (Figure 2)
8. Apply a thin coat of grease onto shift gear pin and insert pin into control shaft with rounded end of pin away from control shaft. (Figure 2)



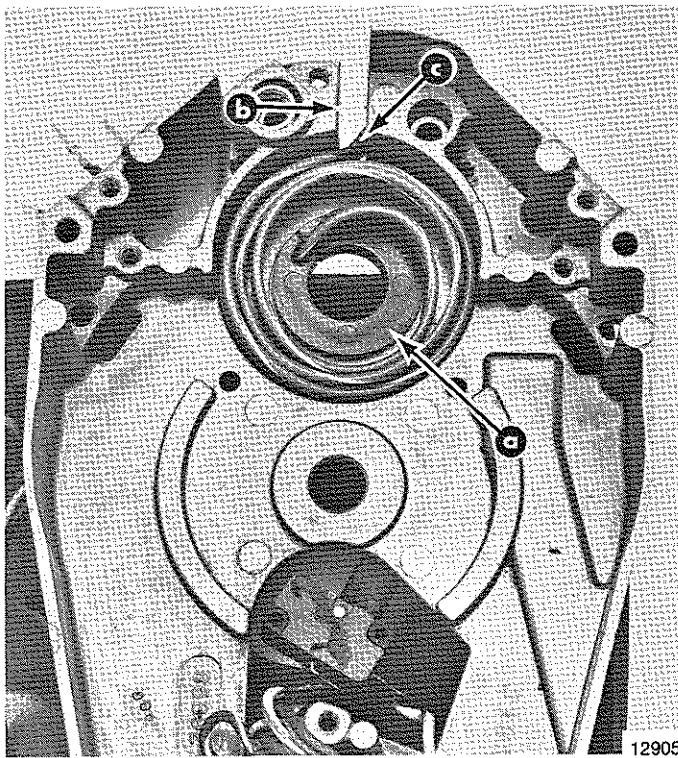
12793

a - Shift Gear d - Shift Lever
b - Retaining Ring e - Bushing
c - Shift Pinion Gear f - Rubber Band

Figure 3. Bearing Plate Assembly Ready for Installation into Control Module Housing

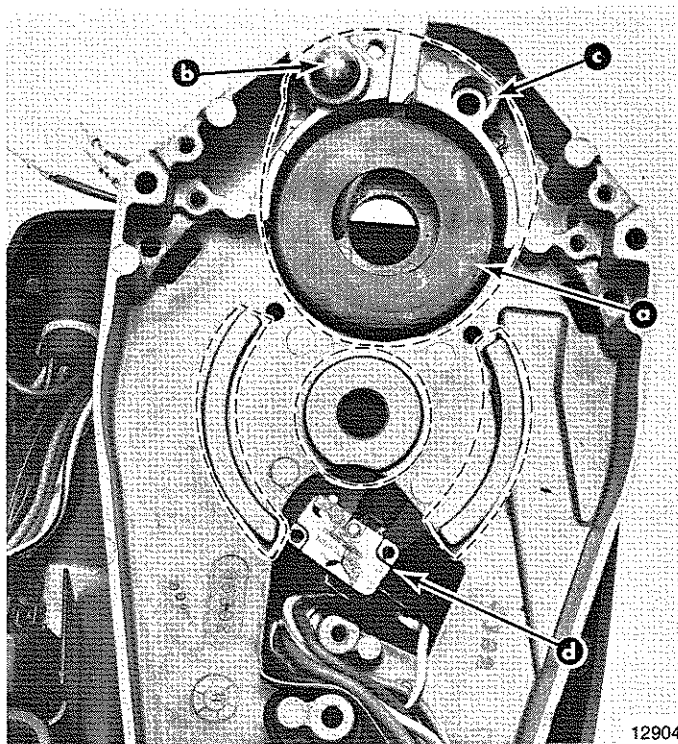
9. Apply a thin coat of grease onto entire shift gear.
10. Install shift gear onto control shaft and secure in place with a retaining ring, as shown in Figure 3.
11. If shift lever was removed from shift pinion gear, press lever onto gear so that it is as shown in Figure 3.
12. Apply a thin coat of grease onto entire shift pinion gear and bushing. Install bushing into gear and gear onto bearing plate, as shown in Figure 3.
13. Using 2 rubber bands, hold shift pinion gear onto bearing plate. (Figure 3)
14. Apply a light coat of grease into recess of control module housing where trim harness will be positioned. (Figure 4)
15. Coil trim harness inside of control module housing, as shown in Figure 4.

IMPORTANT: Black line across trim harness MUST BE positioned in control module housing at the exact point shown in Figure 4.



12905
 a - Trim Harness Bushing b - Trim Harness Slot
 c - Position of Black Line on Trim Harness when Harness Is Properly Installed

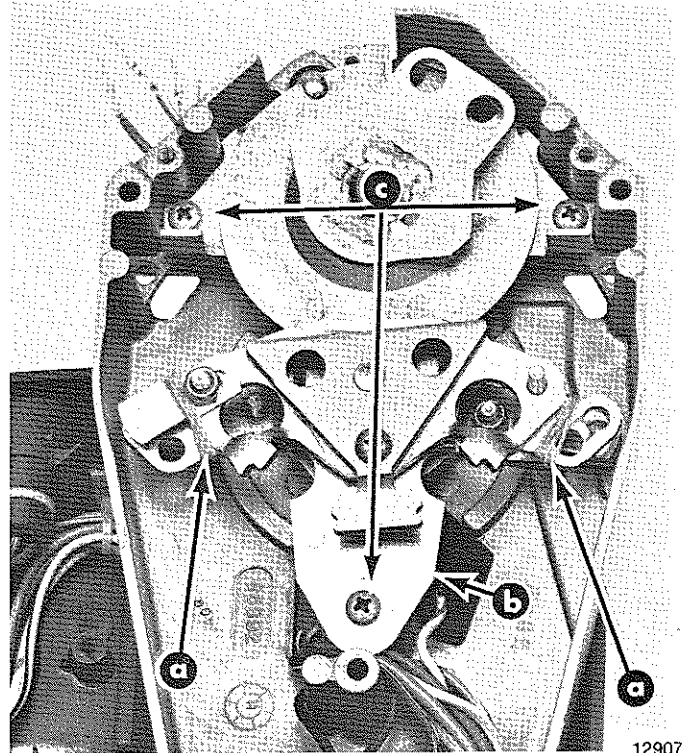
Figure 4. Trim Harness Installation



12904
 a - Trim Harness Retainer
 b - Detent Adjustment Springs (2), Follower and Ball
 c - Control Handle Friction Sleeve (if Equipped)
 d - Neutral Safety Switch

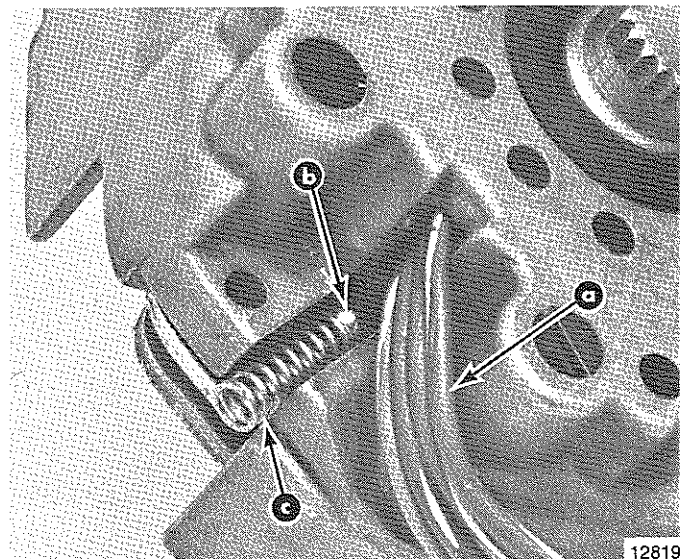
Figure 5. Trim Harness Retainer Installed, Detent Adjustment Springs (2), Follower and Ball Installed, Control Handle Friction Sleeve (if Equipped) Installed and Control Module Wiring Ready for Installation of Bearing Plate

16. Install detent adjustment springs (2), follower and ball into control module housing. (Figure 5) If control handle friction sleeve is not part of friction pad, install sleeve into control module housing. (Figure 5)
17. Apply a light coat of grease onto areas of control module housing that is outlined in Figure 5.
18. With rubber bands still holding shift lever and shift pinion gear onto bearing plate (Figure 5 and 6), install bearing plate assembly into control module housing and secure with 3 phillips head screws. (Figure 6)
19. After bearing plate assembly is secured into place in control module housing, remove rubber bands.



12907
 a - Rubber Bands b - Bearing Plate Assembly
 c - Phillips Head Screws

Figure 6. Bearing Plate Assembly Installation



12819
 a - Trim Wires b - Shift Gear Ball c - Shift Gear Spring

Figure 7. Shift Gear Ball and Shift Gear Spring Installation

20. Apply a light coat of grease onto shift gear ball and spring. (Figure 7)
21. Turn control module over and position shift gear ball and spring in control module, as shown in Figure 7.
22. Secure shift gear ball spring and trim wire to control module with retaining clip and phillips head screw, as shown in Figure 8.
23. Install neutral safety switch onto bearing plate assembly and secure with 2 self-locking nuts, as shown in Figure 8.
24. Remove ignition switch and tachometer receptacle from plastic control housing. While holding switch, receptacle and harnesses against module, as shown in Figure 9, install module into plastic control housing.

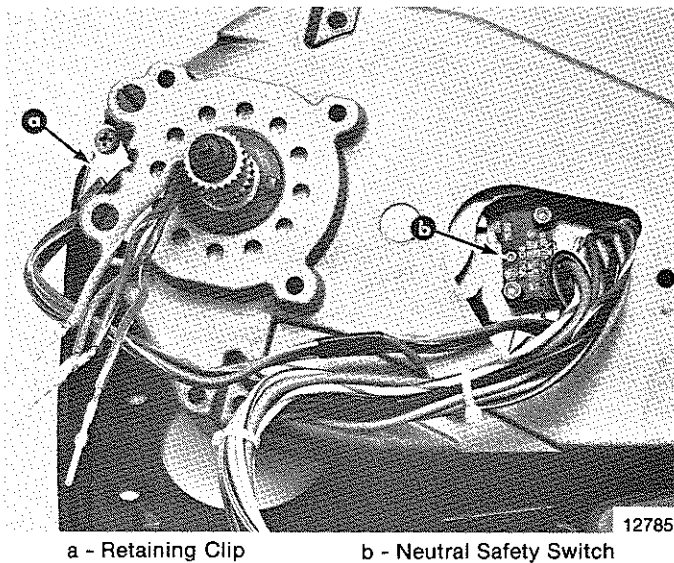


Figure 8. Shift Gear Ball and Spring Retaining Clip and Neutral Safety Switch Installed

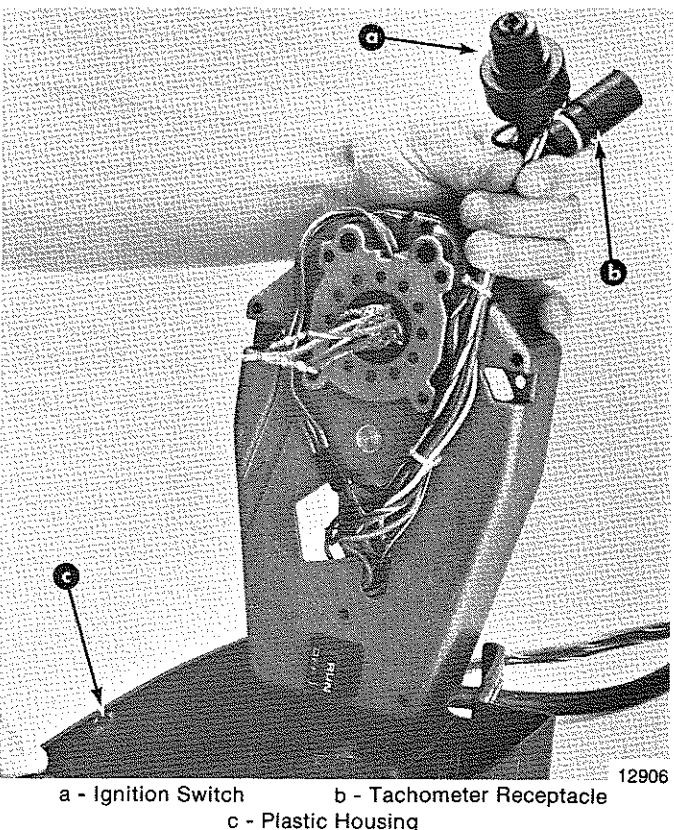
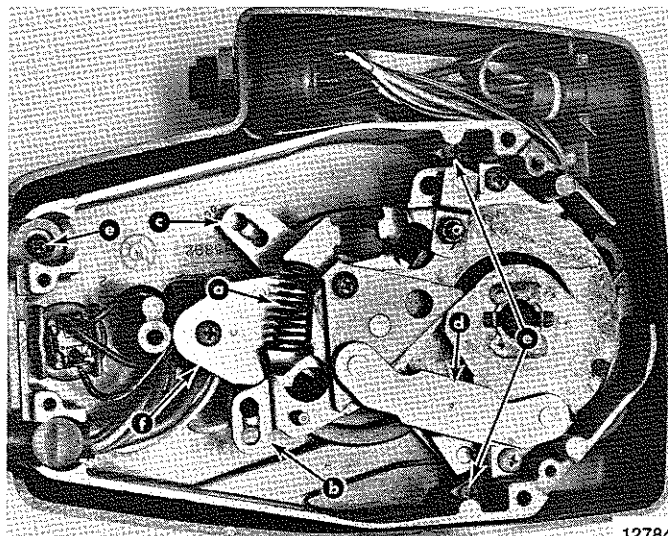
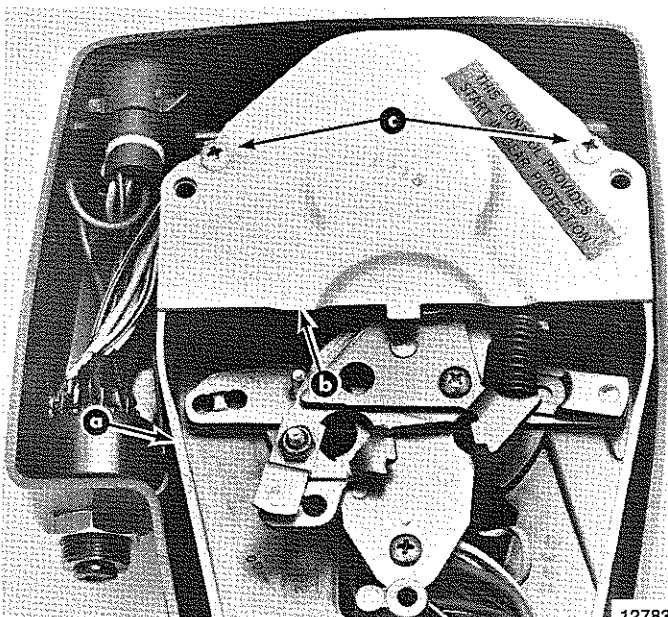


Figure 9. Position of Wiring Harness for Control Module Installation



a - Compression Spring c - Shift Lever
b - Throttle Lever d - Throttle Link Assembly
e - Phillips Head Screws (Control Module to Plastic Control Housing)
f - Bearing Plate Assembly

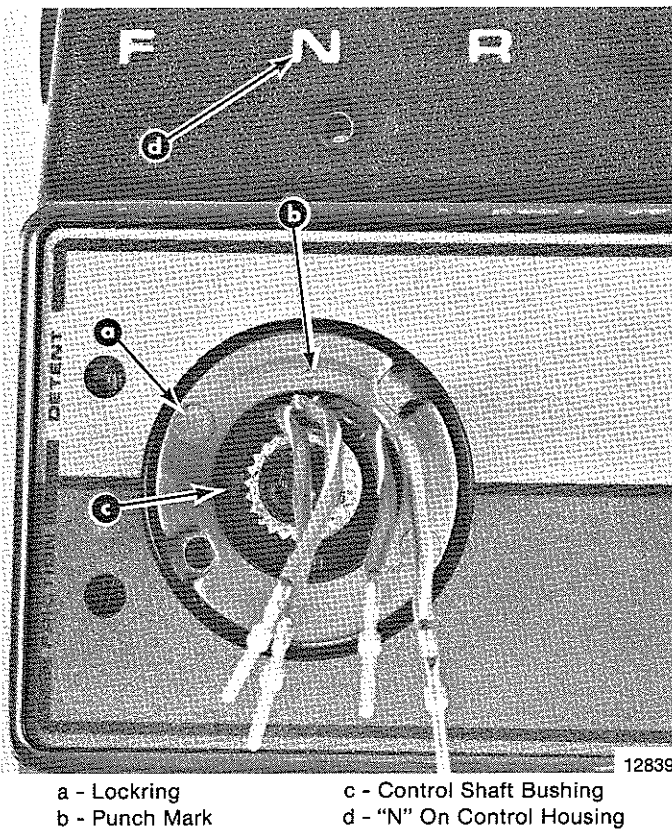
Figure 10. Back View of Control With Cover Removed



a - Control Module b - Back Cover
c - Phillips Head Screws (Torque to 60 In. Lbs.)

Figure 11. Rear View of Control with Cover Installed

25. Secure control module to plastic control housing with 3 phillips head screws. (Figure 10)
26. Reinstall ignition switch and tachometer receptacle back into plastic control housing. (Figure 10)
27. Temporarily install control handle onto control shaft, move handle to full "Forward" position and remove handle.
28. Apply a thin coat of grease onto throttle link assembly, then install throttle link assembly into control module, as shown in Figure 10.
29. Install compression spring into control module. (Figure 10)
30. Temporarily install control handle onto control shaft, move handle to neutral detent and remove handle.
31. Apply a light coat of grease onto the inside half of control module back cover. Install cover onto control module and secure with 2 phillips head screws. (Figure 11) Torque screws to 60 in. lbs. (69kg-cm).



a - Lockring
b - Punch Mark
c - Control Shaft Bushing
d - "N" On Control Housing

Figure 12. Lockring Installed for "Standard Positioning" of Control Handle

NOTE: For "standard positioning" of control handle (handle is lined-up with "N" on remote control housing when control handle is in neutral), the punch mark on lockring is in line with "N" on remote control housing, as shown in Figure 12.

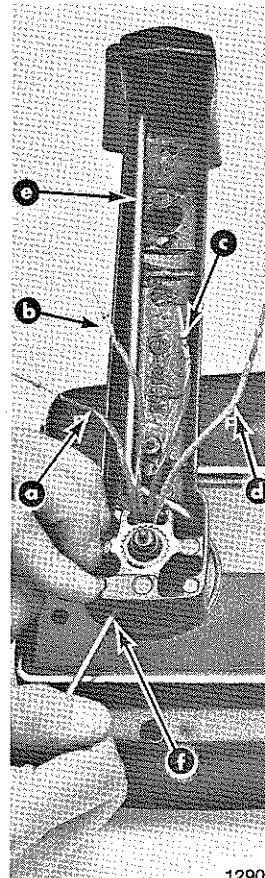
32. Apply a light coat of grease onto entire lockring, then install lockring onto control so that the punch mark (on lockring) is on the top side of control shaft and in line with "N" on control housing, as shown in Figure 12.

CAUTION: Be extremely careful when installing control handle onto control shaft not to pinch, cut or damage trim wires.

33. Insert trim wires thru control handle so that wires are as shown in Figure 13. Now install control handle onto control shaft so that neutral lock rod (Figure 13) will fall into notch in back side of control handle.
34. While holding down on control handle (at hub of handle), torque set screw to 60 in. lbs.

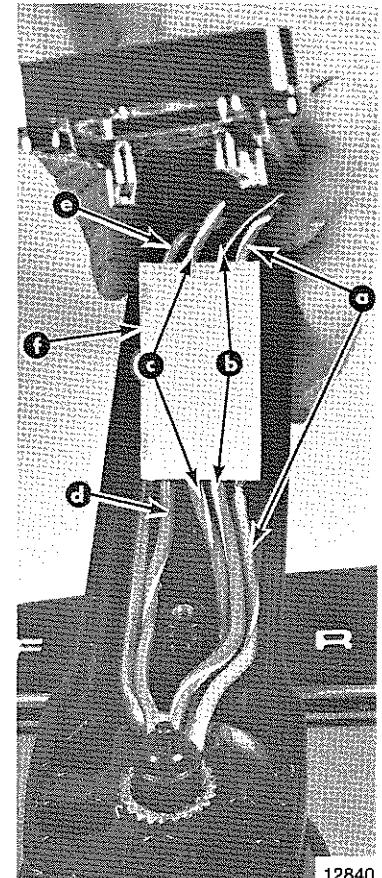
SAFETY WARNING: Control handle set screw MUST BE torqued to specifications. Failure to tighten set screw securely could allow control handle to disengage, with subsequent loss of throttle and shift control.

35. Connect wires from remote control to wires from trim buttons (Figure 14) and secure connections together with wire retainer.
36. Position trim wires as shown in Figure 14 and install control handle cover onto handle. Secure cover to handle with 2 phillips head screws.
37. Push throttle-only button thru control handle hub and onto throttle-only shaft.



a - Brown/White Wire
b - Purple/White Wire
c - Blue/White Wire
d - Green/White Wire
e - Neutral Lock Rod
f - Set Screw Location

Figure 13. Tightening Control Handle Set Screw



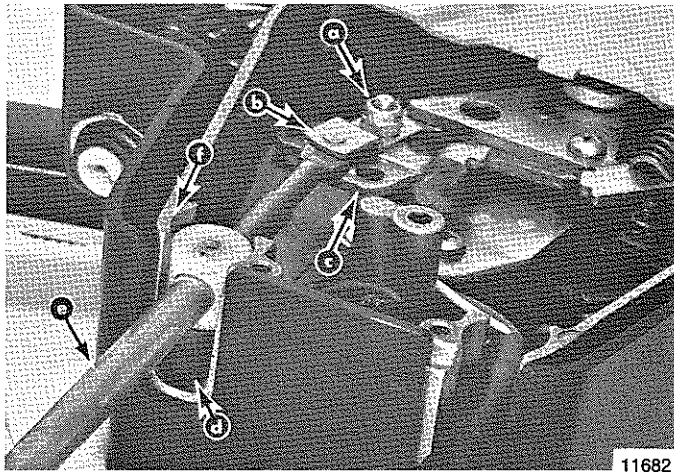
a - Green/White Wire
b - Purple/White Wire
c - Blue/White Wire
d - Brown/White Wire
e - Red/Purple Wire
f - Wire Retainer

Figure 14. Trim Wire Connections and Positioning

Remote Control Cable Installation and Control Housing Mounting

THROTTLE CABLE INSTALLATION

1. Position control handle in neutral detent.
2. Place a grommet into throttle cable barrel recess. (Figure 1)
3. Position throttle cable anchor barrel in barrel recess on top of grommet. (Figure 1)
4. Loosen cable fastener nut. (Figure 1) (It is not necessary to remove nut.)



11682

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|-----------------------------------|--------------------|
| a - Retainer Nut (Cable Fastener) | d - Grommet |
| b - Cable Fastener | e - Throttle Cable |
| c - Throttle Lever | f - Barrel Recess |

Figure 1. Throttle Cable Installed

5. Pull end of throttle cable (end to be installed in remote control) out of cable housing to end of travel. Apply a light coat of Multipurpose Lubricant onto extended portion of control cable. Be sure to apply lubricant onto end of control cable.
6. Lift cable fastener and insert pin (on cable fastener) thru the hole in end of throttle cable and hole at the end of throttle lever. (Figure 1)

CAUTION: Before tightening cable fastener nut, be sure that pin (on cable fastener) is completely thru cable end and throttle lever. A pin, that is partially thru cable and throttle lever, may cause cable fastener to bend when the nut is tightened.

7. Torque cable fastener nut to 20 to 25 in. lbs. (23 to 29kg-cm).

SHIFT CABLE INSTALLATION

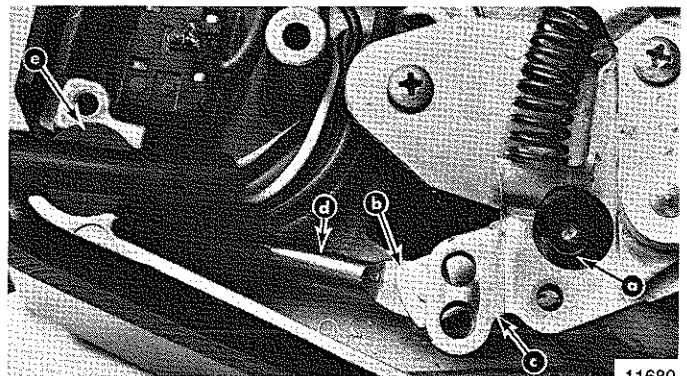
1. Position control handle into full reverse.
2. Lift wiring harness and grommet out of anchor barrel recess. (Figure 2)
3. Position shift cable anchor barrel in barrel recess.
4. Loosen cable fastener nut. (Figure 2) (It is not necessary to remove nut.)
5. Pull end of shift cable (end to be installed in remote control) out of cable housing to end of travel. Apply a light coat of Multipurpose Lubricant onto extended portion of

control cable. Be sure to apply lubricant onto end of control cable.

6. Move control handle to reverse idle detent.
7. Lift cable fastener and insert pin (on cable fastener) thru the hole in end of shift cable and hole at the end of shift lever. (Figure 2)

CAUTION: Before tightening cable fastener nut, be sure that pin (on cable fastener) is completely thru cable end and shift lever. A pin, that is partially thru cable and shift lever, may cause cable fastener to bend when the nut is tightened.

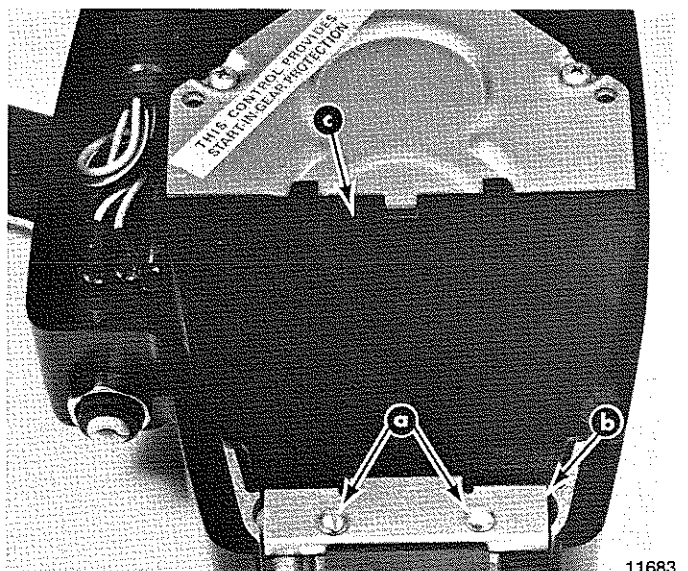
8. Move control handle to full reverse position and torque cable fastener nut to 20 to 25 in. lbs. (23 to 29 kg-cm).
9. Position wiring harness so that grommet (on harness) is over shift cable anchor barrel. (Figure 2)
10. Position access cover and cable retainer onto back side of control and secure both to control with 2 screws. (Figure 3) Torque screws to 60 in. lbs. (69kg-cm).



11680

- | | |
|-----------------------------------|-----------------|
| a - Retainer Nut (Cable Fastener) | c - Shift Lever |
| b - Cable Fastener | d - Shift Cable |
| e - Wiring Harness Grommet | |

Figure 2. Shift Cable Installed



11683

- | | | |
|------------|--------------------|------------------|
| a - Screws | b - Cable Retainer | c - Access Cover |
|------------|--------------------|------------------|

Figure 3. Access Cover and Cable Retainer Installed

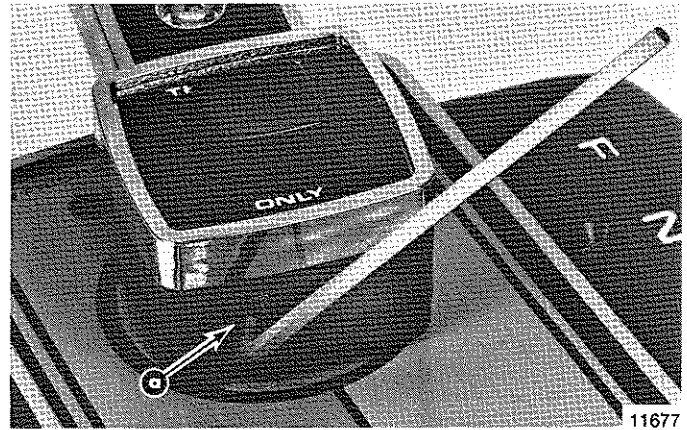
MOUNTING CONTROL HOUSING

1. Place plastic cover onto back side of remote control and 3 mounting screws thru the front side of control.
2. Position remote control so that mounting screws are thru mounting holes drilled in mounting panel and secure control with washers and nuts. Tighten nuts securely.

IMPORTANT: To prevent a load or bind on control cables, that will result in hard shifting or sticky throttle action, secure cables straight-away and at least 3 ft. (91.4cm) from control housing.

3. Secure control cables to boat with clamps, "D" washers and screws straight-away and at least 3 ft. from control housing.
4. Route wiring harness down the side of boat, fastening harness to boat with sta-straps. Be sure that wiring does not rub or get pinched and that it does not come in contact with bilge water.
5. Place control handle into full forward position. Check control handle set screw. (Figure 7) Set screw **MUST BE** torqued to 60 in. lbs. (69kg-cm).

SAFETY WARNING: Control handle set screw MUST BE torqued to specification. Failure to tighten set screw securely could allow control handle to disengage, with subsequent loss of throttle and shift control.



a - Set Screw Location

Figure 4. Control Handle Set Screw

