

CHRYSLER Outboard

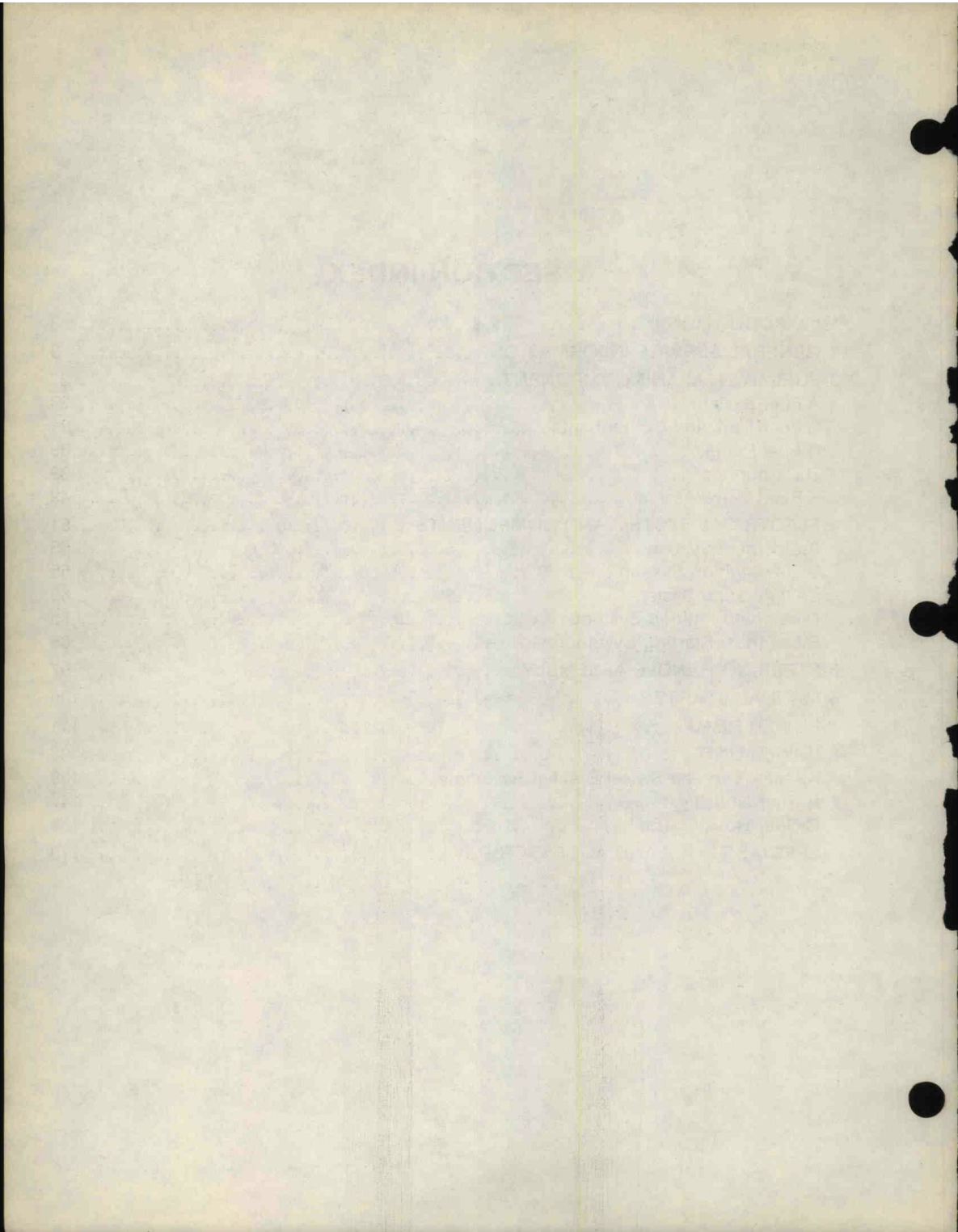
SERVICE MANUAL

9.9, 15 H.P. AND 250 SAILOR
OUTBOARD MOTORS

MARINE DIVISION, CHRYSLER CORPORATION

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Section

1

INTRODUCTION

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Section 2

INTRODUCTION



GENERAL INFORMATION

This manual provides the technician with information and instructions for servicing and repairing the Chrysler 9.9, 15 Horsepower and 250 Sailor outboard motor. In order to become familiar with the motor, it is urged that the technician study the procedures and illustrations in this manual and use them as a reference when performing repair or maintenance operations. In addition to this manual, the Owners Guide should also be consulted to insure familiarity with all operating procedures.

This manual is divided into sections. Each section pertains to a certain component or operational system of the motor.

The information, specifications and illustrations in this publication are based on the information in effect at the time this manual was printed. Continued improvement and advancement of product design may cause changes to this motor which may not be included in this manual. Each publication is reviewed and revised, as required, in an effort to update and included these changes in later editions.

Whenever a question arises regarding this motor, or this publication, please consult Chrysler Marine Service Department for the latest available information. Write to:

Marine Division, Chrysler Corporation
Publications Manager
105 N Marine Dr.
Hartford, Wisconsin, 53027

SAFETY

This notation preceding warnings in the text signifies important precautionary steps which, if not properly followed, could result in personal injury or death. The purpose of these warnings is to offer the benefit of experience in regard to the hazards which are encountered in normal service procedures. It is urged that the reader take advantage of this information to prevent possible injury to himself or bystanders.

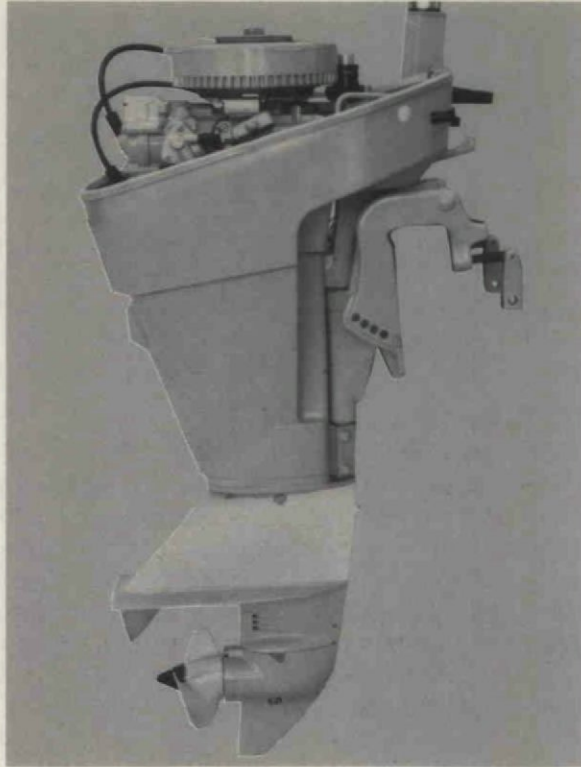
SPECIAL TOOLS

Chrysler Marine has developed many tools to aid and assist disassembly and reassembly operations. These tools are illustrated in this manual, in many cases in actual use. Special Tools for each section are listed at the beginning of the section. A complete list is at the back of the manual. Refer to the Special Tool Catalog for description and ordering instructions for these tools.

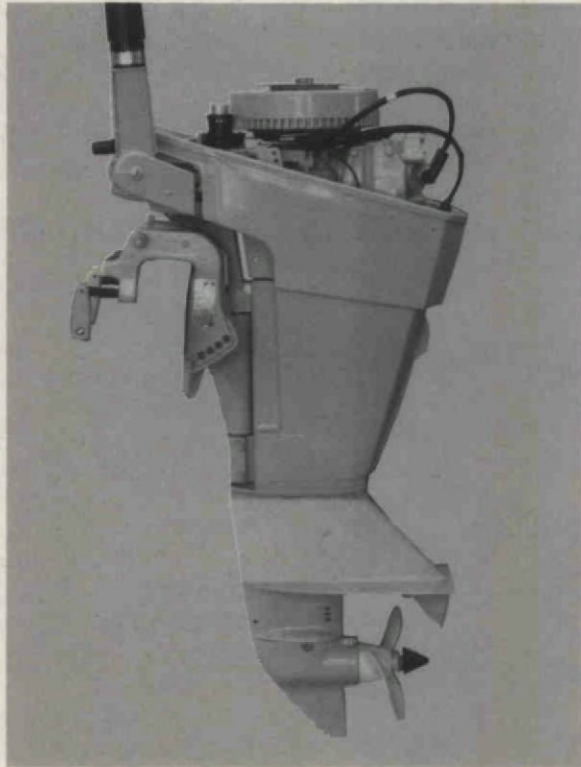
OUTBOARD MOTOR NOMENCLATURE

Throughout this manual reference will be made to Starboard or Port side. These words are used because "right" and "left" are very confusing when referring to the sides of an outboard motor. Starboard refers to the right hand while facing the bow (front) of the boat; Port refers to the left. Figure 1 and 2.

Metric equivalents are included throughout the manual. They are parenthesized and printed adjacent to the English measure, eg., .032" (0.81mm).

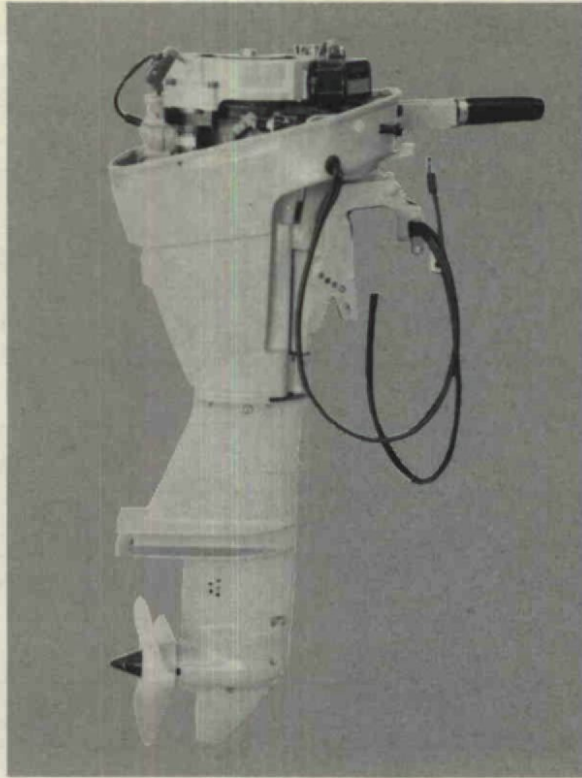


STARBOARD

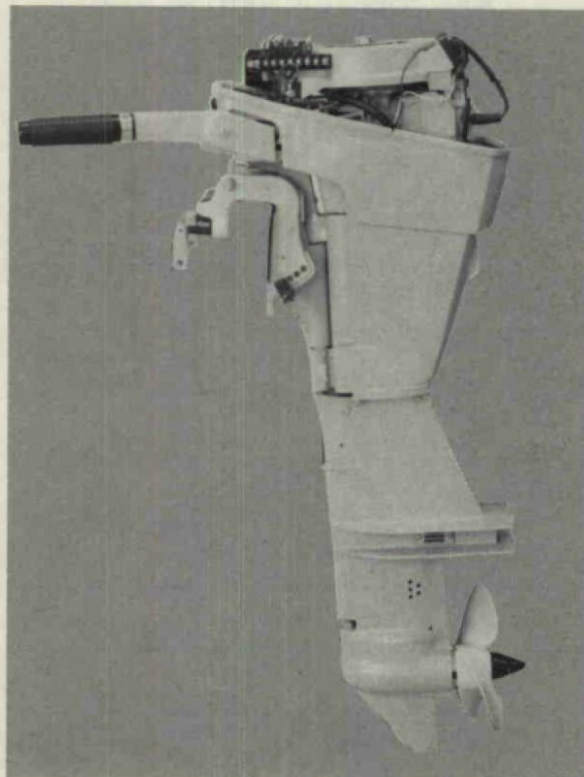


PORT

Figure 1. Starboard and Port Side Views of 9.9 & 15 H.P. Outboard.



STARBOARD



PORT

Figure 2. Starboard and Port Side Views of 250 Sailor Outboard.

GENERAL SERVICE INFORMATION

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CLARK'S SERVICE INFORMATION
MAY 1950

GENERAL SERVICE INFORMATION

MOTOR IDENTIFICATION

Figure 1 illustrates the motor serial number and model number which are located on the identification plate attached to the port stern bracket. Always indicate these numbers in all correspondence to properly identify the motor and to ensure that the correct parts are obtained when ordered.

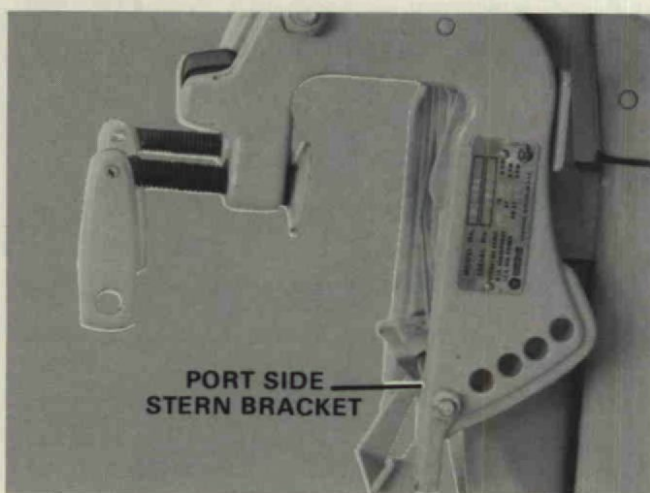


Figure 1. Location of Motor Identification Plate.

FUEL AND LUBRICANTS

Use 85 Octane Minimum	
1st preference	Lead free
2nd preference	Regular leaded
3rd preference	Premium leaded
Do Not Use	
<ul style="list-style-type: none"> • Low octane white gas • Naptha or lamp gas • Any fuel not intended for modern gasoline engine. 	

Table 1. Fuel Use.

Fuel Selection. Automotive gasoline lead free, regular leaded or premium leaded having a minimum octane number of 85 may be used. See Table 1.

WARNING

Gasoline is extremely flammable and highly explosive under certain conditions. Do not fill fuel tank while motor is running. Do not smoke or allow open flames or sparks near boat when refueling. Mix fuel in a well ventilated area.

Outboard Oil. Use Chrysler Outboard Oil which is a BIA certified TC-W Oil. When Chrysler Outboard Oil is not available, the following may be used:

Next choice — Any other BIA Certified TC-W Oil

For emergency — High quality SAE-40 Heavy Duty outboard oil.

Fuel — Outboard Oil Mix. When buying pre-mixed fuel make sure 50 to 1 ratio is used. To mix fuel with outboard oil proceed as follows:

1. Wipe accumulated dirt from around fuel tank cap prior to removing.
2. Use fresh gasoline and strain all fuel through a fine mesh strainer.
3. Pour one (1) gallon of gasoline into an empty fuel tank.
4. Determine proper amount of outboard oil, see Table 3, and pour into fuel tank. Mix thoroughly. Add balance of gasoline.

CAUTION

Repeated use of additive compounds such as, "break-in" oils, "tune-up" compounds, "tonics", "friction reducing" compounds, etc., is not recommended.

Types of lubricants. Three types of lubricants are used when complete lubrication of the motor is performed. See Table 4.

RATIO	FUEL QUANTITY	OIL QUANTITY	
25/1 or 4% Oil	1 Gallon (3.8 l)	1/3 Pint (.158 l)	5.3 Oz. (.158 l)
	6 Gal. (5 Imp. Gal.) (23 l)	2 Pints (.946 l)	32 Oz. (.946 l)
	12 Gal. (10 Imp. Gal.) (46 l)	4 Pints (1.892 l)	64 Oz. (1.892 l)
50/1 or 2%	1 Gallon (3.8 l)	1/6 Pint (.079 l)	2.6 Oz. (.079 l)
	6 Gal. (5 Imp. Gal.) (23 l)	1 Pint (.473 l)	16 Oz. (.473 l)
	12 Gal. (10 Imp. Gal.) (46 l)	2 Pints (.946 l)	32 Oz. (.946 l)

Table 2. Fuel Ratio Conversion.

OIL TYPE	BREAK IN		AFTER BREAK-IN	
	Break-In Ratio	Break-In Period	Pleasure	Heavy Duty
Chrysler Outboard Oil or any BIA Certified TCW Oil	25/1 or 4% Oil	5 IMP. Gal. 6 Gal.** (23 l)	50/1 or 2% Oil	50/1 or 2% Oil
Other	25/1 or 4% Oil	5 IMP. Gal. 6 Gal.** (23 l)	50/1 or 2% Oil	25/1 or 4% Oil

* Additive recommended - first tank full
** Momentary bursts of full throttle operation

Table 3. Fuel/Oil Mixture Requirements.

Gear Housing	Chrysler Marine Gear Lube (High quality non corrosive, E.P. 90 outboard gear lube can be substituted).
Lube Fittings and Points	Chrysler Marine Lubricant No. T-2961 (RyKon #2EP). Waterproof marine grease or all purpose auto chassis lubricant can be substituted.
Propeller Shaft	Chrysler Marine Lubricant No. T-2987-1 Anti-seize compound.

Table 4. Types of Lubricants Used for Complete Lubrication.

Location	Lubricant	Frequency	
		Freshwater	Salt water
Gear Housing	Chrysler Marine Gear Lube	*30 hrs.	*30 hrs.
Starter Pinion Gear	Chrysler Marine Lubricant No. T2961	30 days	15 days
Carburetor & Choke Linkage	Chrysler Marine Lubricant No. T2961	60 days	30 days
Shift Linkage	Chrysler Marine Lubricant No. T2961	60 days	30 days
Clamp Screws	Chrysler Marine Lubricant No. T2961	60 days	30 days
Swivel Bracket and Tilt Lock	Chrysler Marine Lubricant No. T2961	60 days	30 days
Steering Arm (Gears)	Chrysler Marine Lubricant No. T2961	60 days	30 days
Propeller Shaft	Chrysler Marine Lubricant No. T2987-1	60 days	30 days

* Check at 30 hrs., replace every 100 hrs. (6) six months or at least once per season prior to storage.

Table 5. Lubrication Intervals.

LUBRICATION POINTS

General. To insure proper operation of this motor, all points requiring lubrication must be serviced with the correct lubricant at the proper time interval. Refer to Table 5 and proceed as follows:

Gear Housing Lubricant Level Check. To check level of lubricant in gear housing place motor in normal operating position and proceed as follows:



WARNING

Disconnect spark plug high tension leads to prevent accidental starting.

1. Inspect for water contamination as follows:

A. Loosen, DO NOT REMOVE, gear housing, fill plug. Figure 2.

B. Allow a small amount of lubricant to drain. If water is present, it will drain prior to the lubricant.

NOTE

If water is present, refer to "Gear Housing" Section for pressure testing procedure. Replace drain plug.

2. Remove vent plug. Lubricant level should be even with bottom of vent hole. Figure 2.

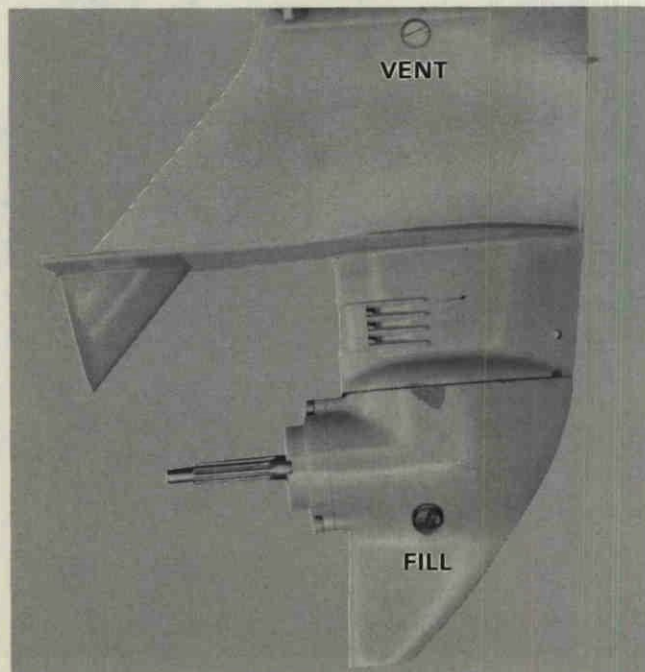


Figure 2. Location of Vent and Fill Plugs.

Adding Gear Housing Lubricant. To add lubricant to gear housing place motor in normal operating position and proceed as follows:

1. Remove fill plug and washer and insert nozzle of tube into fill hole. Figure 2.

2. Remove vent plug and washer.

3. Add lubricant until it appears at vent hole.

4. Install vent plug and washer.

5. Remove nozzle, install fill plug and washer. Wipe off excess lubricant.

Starter Pinion Gear. To lubricate starter pinion gear proceed as follows:

1. Wipe old lubricant from pinion and starter spool tube.

2. Apply light coating of lubricant with a small brush to gear teeth and spool tube.

3. Pull starter rope slowly until pinion gear engages flywheel ring gear and apply grease to bottom of spool tube. Figure 3.

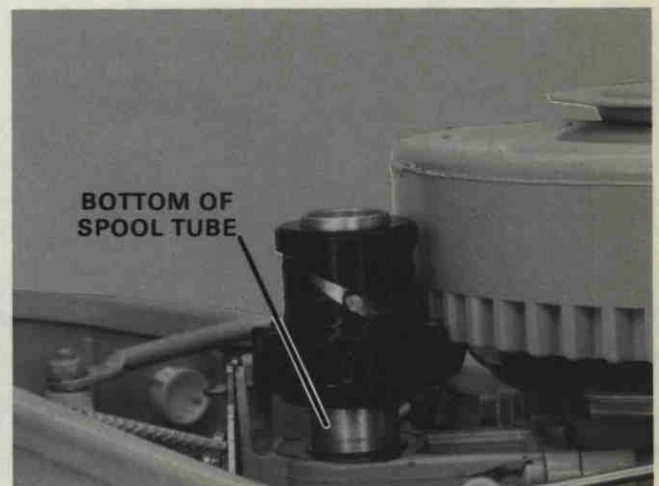


Figure 3. Lubricating Starter Pinion Gear.

Carburetor And Choke Linkage. To lubricate carburetor and choke linkage, apply light coating of lubricant with a small brush to throttle link and choke link pivot points. Figure 4.

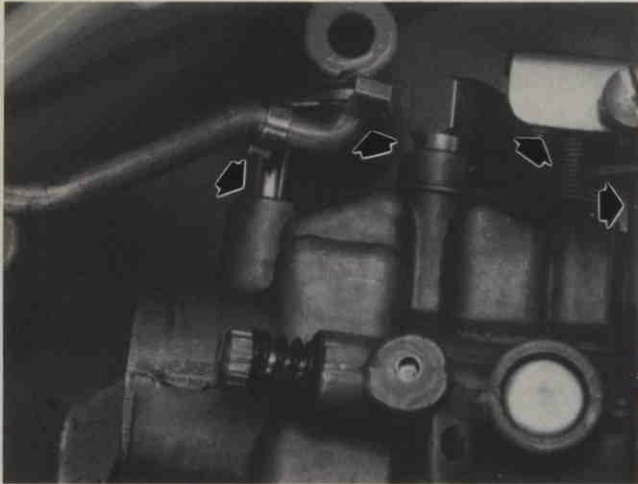


Figure 4. Lubricating Throttle and Choke Link.

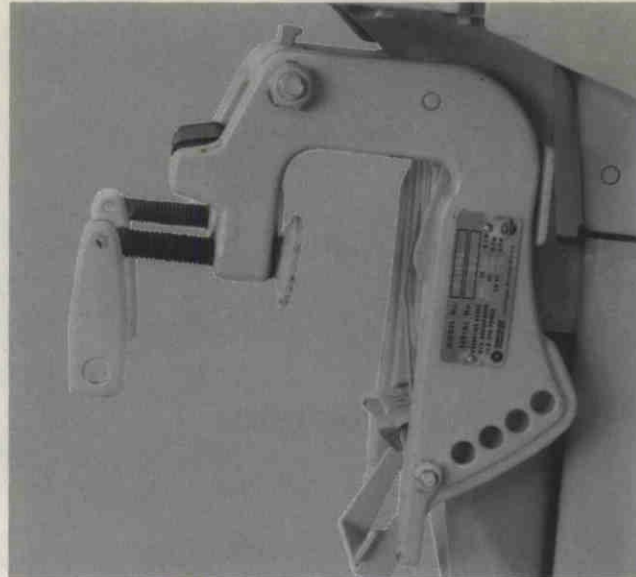


Figure 6. Lubricating Clamp Screws.

Shift Linkage. To lubricate shift linkage apply a light coating of lubricant with a small brush to shift linkage pivot points. Figure 5.

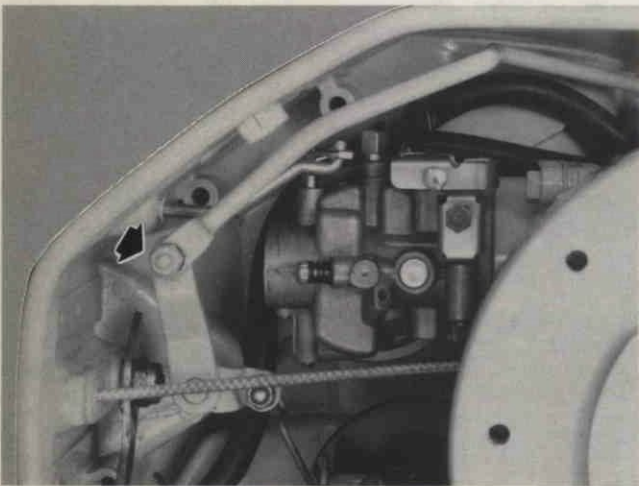


Figure 5. Lubricating Shift Linkage.

Clamp Screws. Thoroughly clean old accumulated lubricant and dirt from clamp screw threads. Turn screws in and out while applying lubricant with a small brush. Figure 6.

Swivel Bracket And Tilt Lock. To lubricate swivel bracket and tilt lock proceed as follows:

1. Tilt motor up and lock in position. Figure 7.
2. Clean lube fitting. Pump lubricant into fitting until it begins to appear at both ends of king pin. Wipe off excess lubricant.
3. Wipe clean and apply a light coating of lubricant to areas indicated in Figure 7.

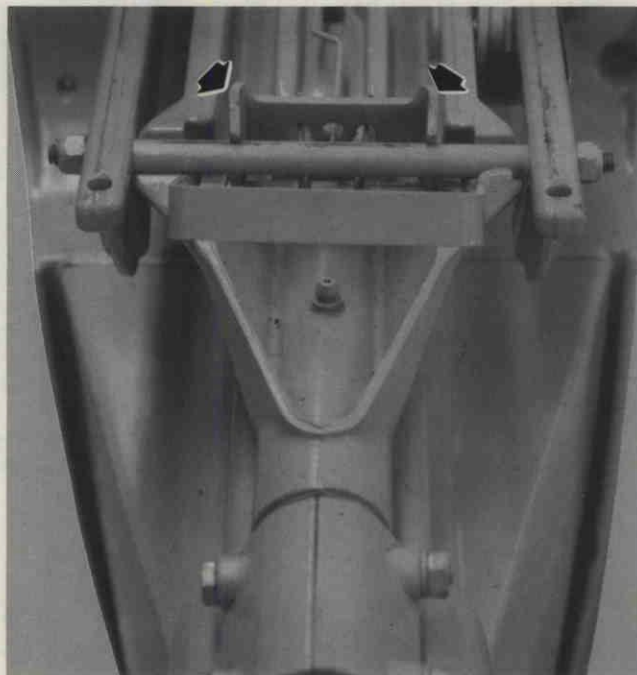


Figure 7. Lubricating Swivel Bracket.

Steering Arm. Clean steering arm lube fitting. Hold grease gun tightly to fitting and pump until lubricant begins to appear at each end, Figure 8. Wipe off excess lubricant.

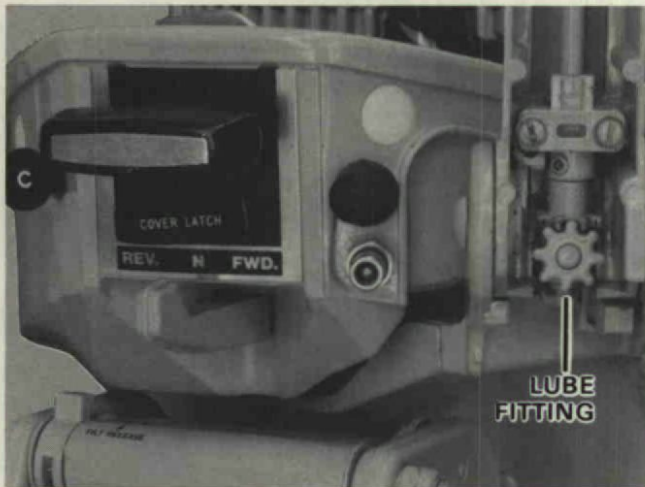


Figure 8. Lubricating Steering Arm.

Stern Bracket Bolt. Clean stern bracket bolt, lube fitting. Pump lubricant into fitting until it begins to appear at both ends of swivel bracket (see Figure 9). Wipe off excess lubricant.

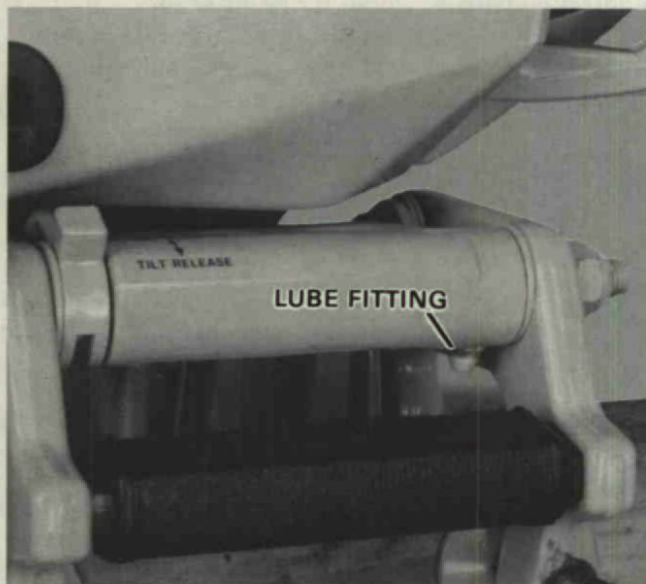


Figure 9. Lubricating Stern Bracket Bolt.

Propeller Shaft. To lubricate propeller shaft proceed as follows:

1. Remove cotter pin and nut securing propeller to propeller shaft.
2. Remove seal (Sailor models only) and push pin from propeller hub.
3. Slide propeller from splined shaft. If propeller is frozen to shaft, tap gently with a block of wood to loosen.
4. Clean splined shaft and propeller hub bore thoroughly.
5. Lubricate propeller shaft splines with anti-seize lubricant (Special Tool No. T 2987-1). Figure 10.
6. Re-install propeller.

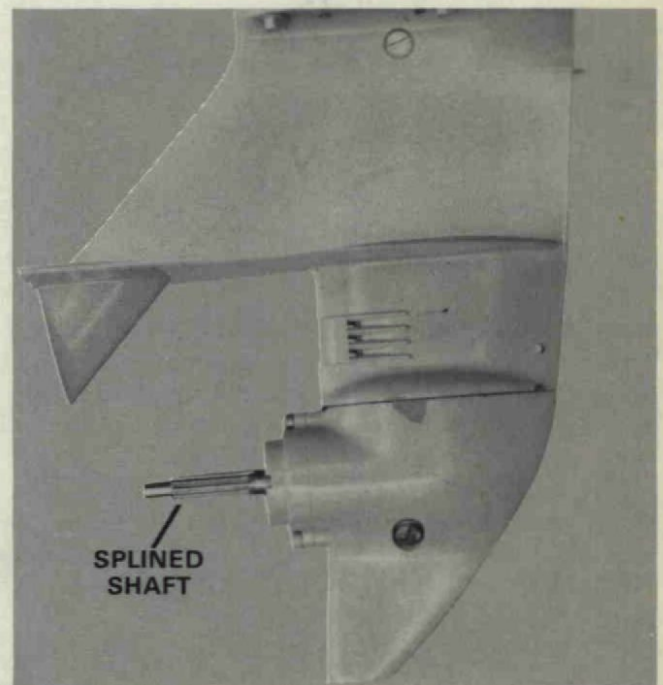


Figure 10. Lubricating Propeller Shaft.

BREAK-IN

Break-in-Procedure. Follow the break-in procedure as follows:

1. Mix correct amount of CHRYSLER OUTBOARD OIL with each gallon of gasoline, refer to Table 3, Section I, "Fuel/Oil Mixture Requirements".

NOTE

If CHRYSLER OUTBOARD OIL is not used, a break-in additive may be required.

2. For the first 5 - 10 minutes, operate motor in gear at fast idle (under 2000 RPM). Check operation of water pump and cooling system. Refer to Section 8 for water pump operation.

3. DO NOT EXCEED 3500 RPM (1/2 throttle) for one (1) hour. During the second hour, motor should be operated at 3/4 throttle with occasional bursts to wide open throttle of one (1) to two (2) minute duration.

4. Avoid continuous full throttle operation for extended periods during the next four (4) hours.

NOTE

A minimum of 6 gallons of "Break-in" gasoline/oil mix must be used before switching to 50/1 or 2% oil.

SUBMERGED MOTOR

Motor Running When Submerged - Fresh or Salt Water. Do not make any attempt to start. Disassemble completely, inspecting each part for damage. Internal damage is common when running engines are submerged.

Motor Submerged - Fresh Water. If motor is recovered within a few hours, is not damaged mechanically and is free of abrasive dirt inside, try to start following these instructions:

1. Remove spark plugs. Turn flywheel slowly by hand to expel water from crankcase and cylinder.
2. Dry and install spark plugs.
3. Dry ignition components and spray with Special Tool No. T 8969 lubricant and water displacer.
4. Drain fuel lines and carburetor.
5. If fuel tank was submerged, drain all fuel from tank, flush with fresh fuel until all water is removed.
6. Start engine, keep it running for one (1) hour or until all parts are thoroughly warmed and remaining water has evaporated from internal parts.

Motor Submerged - Salt Water. Motors submerged in salt water are put back in service much the same as fresh water; however, a precautionary note is added to stop damaging corrosion.

CAUTION

Upon retrieval, immediately flush motor inside and out with fresh water. Spray entire power head with Special Tool No. T 8969, lubricant and water displacer.

Proceed with steps 1 - 6 "Motor Submerged - Fresh Water".

MOTOR STORAGE

Preparation For Storage. To prepare the motor for storage for extended periods, proceed as follows:

1. Run the engine until it is thoroughly warmed up.
2. Place gear shift in "Neutral" and allow engine to run at fast idle. Remove fuel line from fuel tank. Using a rust preventative oil, rapidly inject oil into carburetor air intake for a period of ten (10) to twenty (20) seconds before engine stops. The above procedures will coat the interior of the crankcase with a protective coating of oil.
3. Remove boat and outboard from water. Drain all fuel from lines and carburetor.
4. Disconnect battery and remove spark plugs. Put an ounce of Chrysler Outboard Oil into each spark plug hole. Turn flywheel by hand several times to distribute the oil. This will lubricate the pistons, rings and cylinder walls and expel water from the cooling system. Reinstall spark plugs.
5. Drain and refill lower gear housing as outlined under "Lubrication Points".
6. Lubricate all moving parts as outlined under "Lubrication Points".
7. Clean exterior of engine. Apply a marine-type wax to protect the finish and prevent rust or corrosion.
8. Remove propeller and apply coating of T 2987-1 anti-seize compound on propeller shaft. Re-install propeller.
9. Store engine in an upright position in a dry, well-ventilated area.

Preparation For Use After Storage. To prepare the motor for use after it has been in storage, proceed as follows:

1. Remove spark plugs. Clean or replace as required.

2. Check lubricant in lower gear housing.
3. Lubricate all moving parts as outlined under "Lubrication".
4. Clean exterior of engine. Apply a marine-type wax to protect the finish.
5. Check condition of battery (if so equipped).
6. Follow standard operating procedures.

TUNE-UP

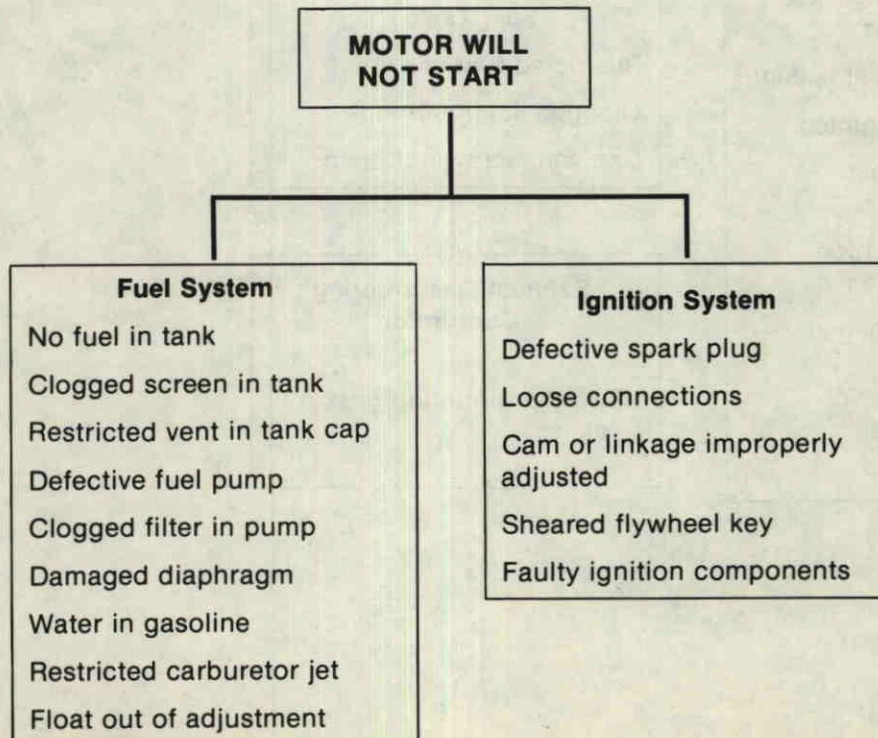
General. Any time a motor is brought in for a tune-up, talk to the owner about the general performance of the motor. What, if any, specific problems he is having; and what size and type boat the motor is used on. Write this information on the work order. If the motor is under warranty, check the owner's Registration Card for validity. Tune-ups are not covered under warranty.

Prior to proceeding with the tune-up, check your service bulletin collection for possible changes and/or tips applicable to this motor.

Tune-Up Check List. Check the motor visually for any obvious damage. Consult the troubleshooting chart for aid in diagnosing. Begin a systematic tune-up procedure as follows:

1. REMOVE AND INSPECT PLUGS. Clean or replace as necessary; if a problem is suspected, refer to Section 4.
2. INSPECT AND TEST IGNITION SYSTEM. Check for spark at both cylinders.
3. INSPECT CARBURETOR. Section 3D.
4. INSPECT FUEL PUMP. Remove and clean fuel filter.
5. INSPECT PROPELLER. Check propeller condition, also if it is the correct pitch.
6. PRESSURE TEST GEAR HOUSING. If pressure doesn't hold see Section 8.
7. DRAIN AND REFILL GEAR HOUSING. Lubricate Motor. Refer to Lubrication Intervals Table 5.
8. REPLACE WATER PUMP IMPELLER. This should be replaced yearly.
9. TANK TEST. Make the following adjustments in a test tank:
 - A. Check throttle pick-up adjustment.
 - B. Adjust carburetor.
 - C. Adjust idle stop.
 - D. Check water pump operation.

TROUBLESHOOTING GUIDE



TROUBLESHOOTING GUIDE (CON'T)

LOSS OF POWER (Ignition OK)

Power Head

Carb and throttle cam not synchronized
Air leak at cylinder head gasket
Warped cylinder head
Excessive carbon build up
Stuck or damaged piston ring
Scored cylinder or piston

Overheating Power Head

Exhaust cover gasket leaking
Cylinder mounting gasket improperly installed
Cylinder head gasket leaking
Water intakes obstructed
Water Pump air bleed restricted
Water passages or tube obstructed
Pump impeller damaged
Impeller plate worn
Pump body worn
Pump seals worn

Carburetor

Improper fuel mixture
Improper carburetor adjustment
Choke not adjusted properly
Air leak at carburetor gasket
Inlet needle and seat worn or stuck
Incorrect float setting
Broken reed valves (backfires)
Altitude horsepower loss (See Table 6)

Fuel Tank

Restricted fuel line
Clogged screen in tank
Cap vent screw not open

Exhaust Gas Entering Carburetor

Cylinder mounting gasket leaking

Lower Unit

Bent propeller (vibration)
Exhaust outlet clogged
No lubricant
Bent gear housing

Exhaust Gases Entering Cooling System

Damaged water tube seal
Cylinder mounting gasket leaking
Head gasket leaking

ENGINE SPECIFICATIONS

9.9 H.P. & 250 SAILOR

B.I.A. H.P.	9.9 @ 4750 RPM	Bore and Stroke	2-3/16 x 1-3/4 (5.53 x 4.46 cm)
I.S.O. Power	7.00 KW @ 4750 RPM	Displacement	13.15 cu. in. (216 cc)
Recommended Operating Range	4250-5250 RPM	Compression	115-125 PSI (8.10 - 8.80 kg/cm ²)
Idle RPM in Gear	750 Max.	Spark Plug	Champion L-4J - U.S.A. Champion RL-4J - Canada
Test Wheel	T 8342 (9.9) - (5400 RPM) T 2955A (250 Sailor) - (5350 RPM)	Spark Plug Gap	.030" (0.76 mm)
Engine Type	2 cycle, 2 cylinder	Point Gap	.020" (0.50 mm)

15 H.P.

B.I.A. H.P.	15 @ 5100 RPM	Bore and Stroke	2-1/4 x 1-15/16 (5.72 x 4.92 cm)
I.S.O. Power	10.6 KW @ 5100 RPM	Displacement	15.41 cu. in. (252.5 cc)
Recommended Operating Range	4600-5600 RPM	Compression	125-135 PSI (8.80 - 9.50 kg/cm ²)
Idle RPM in Gear	750 Max.	Spark Plug	Champion L-4J - U.S.A. Champion RL-4J - Canada
Test Wheel	T 8952 (5000 RPM)	Spark Plug Gap	.030" (0.76 mm)
Engine Type	2 cycle, 2 cylinder	Point Gap	.020" (0.50 mm)

TORQUE CHART SPECIAL ITEMS

Connecting Rod Screw 80 in. lbs. (91 kg/cm)	Motor Leg to Power Head Screw 160 in. lbs. (183 kg/cm)
Cylinder Head Bolts 130 in. lbs. (149 kg/cm)	Steering Handle & Magneto Control Shaft Set Screw 55 in. lbs. (63 kg/cm)
Exhaust Port Cover Screw 90 in. lbs. (103 kg/cm)	Transfer Port Cover Screws 90 in. lbs. (103 kg/cm)
Flywheel Nut 45-50 ft. lbs. (6.21-6.89 kg/m)	Gear Shift Arm Pin 30 in. lbs. (34 kg/cm)
Gear Housing Upper to Motor Leg Bolts 130 in. lbs. (149 kg/cm)	Stern Bracket Bolt 125 in. lbs. (144 kg/cm)
Gear Housing Upper to Lower, Bolts & Nuts 120 in. lbs. (137 kg/cm)	Fuel Pump Body Screws 30 in. lbs. (34 kg/cm)

STANDARD HARDWARE

Screw or Nut Size	Torque		
6-32	9 in. lbs. (10 kg/cm)	12-24	45 in. lbs. (51 kg/cm)
8-32	20 in. lbs. (23 kg/cm)	1/4-20	70 in. lbs. (80 kg/cm)
10-24	30 in. lbs. (34 kg/cm)	5/16-18	160 in. lbs. (185 kg/cm)
10-32	35 in. lbs. (40 kg/cm)	3/8-16	270 in. lbs. (310 kg/cm)

CAPACITIES

Standard Gear Housing 5 oz. (0.15 liters)	Fuel Tank 6 gallons (23 liters)
Sailor Gear Housing 24 oz. (0.71 liters)	

ELECTRICAL SPECIFICATIONS

ALTERNATOR OUTPUT

1.0 Amp (min.) @ 2000 RPM (Cut-in Speed)
 3.5 Amp (min.) @ 4000 RPM (Cut-in RPM 1000 Max.)
 (Above readings with battery voltage at 12.5 V.)

STARTER PERFORMANCE

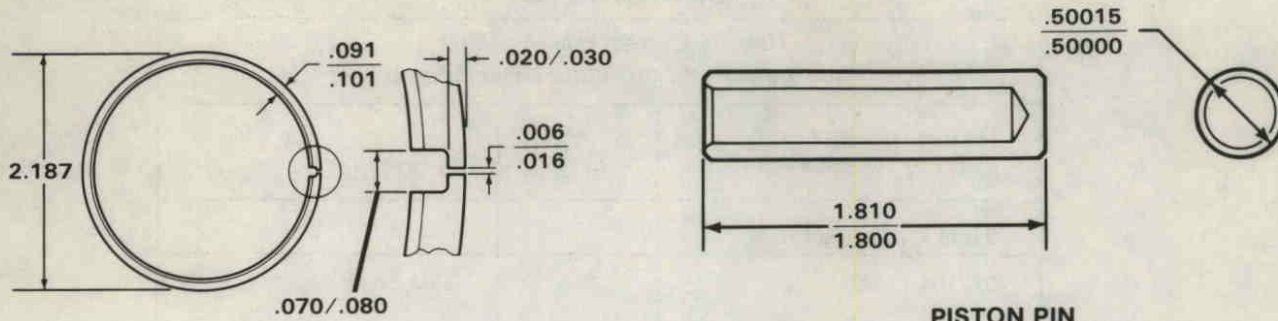
Cranking speed, full compression 400 RPM (min.)
 Cranking current draw, 40 - 70 Amps w/Battery
 voltage @ 10V. minimum

CARBURETOR

Use the Correct Main Fuel Jet to Compensate for Altitude Horsepower		
MAIN FUEL JET PART NUMBER	SIZE	ALTITUDE
9.9 H.P., 250 Sailor		
012101 (STD)	.045	Sea Level — 3,000 ft.
012284	.043	3,000 - 6,000 ft.
012370	.041	6,000 ft. & up
15 H.P.		
011722 (STD)	.055	Sea Level — 3,000 ft.
011765	.053	3,000 - 6,000 ft.
011764	.051	6,000 ft. & up.

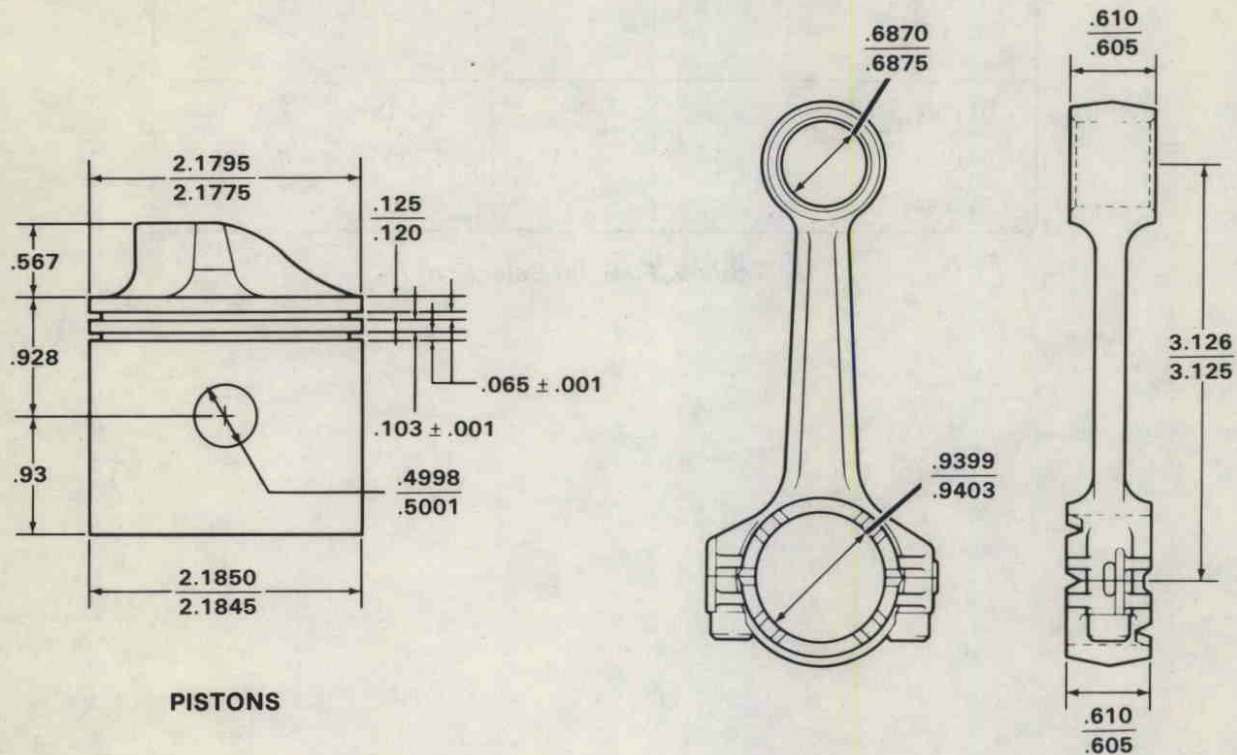
Table 6. Fuel Jet Selection

9.9 H.P. & 250 SAILOR



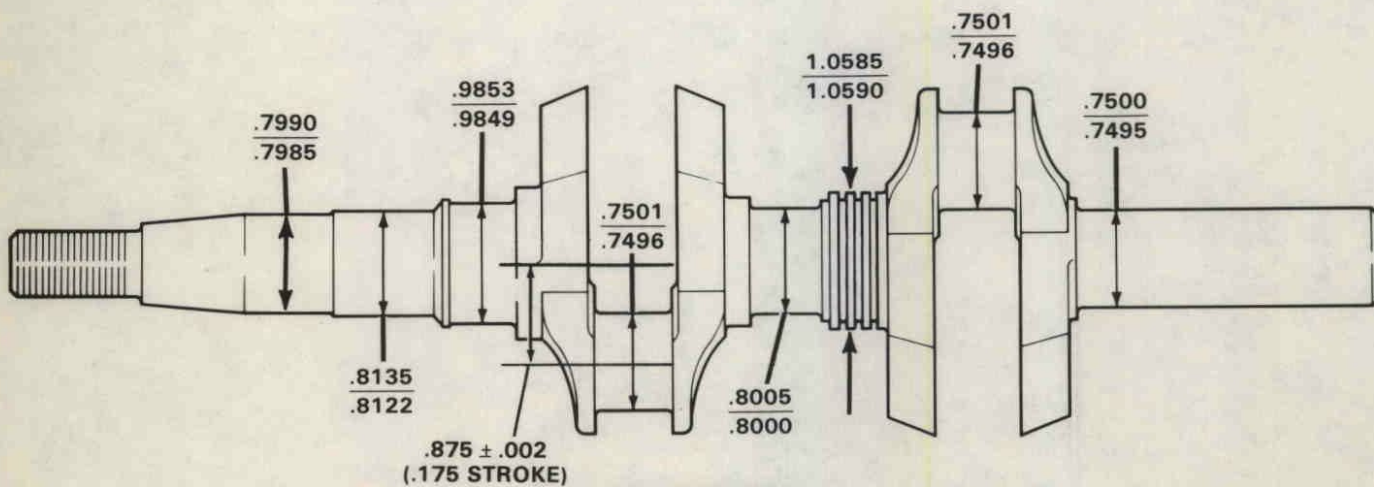
PISTON RING (@ GAUGE DIA.)

PISTON PIN



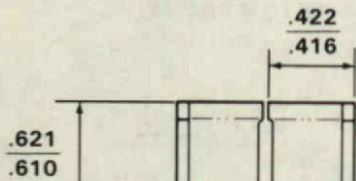
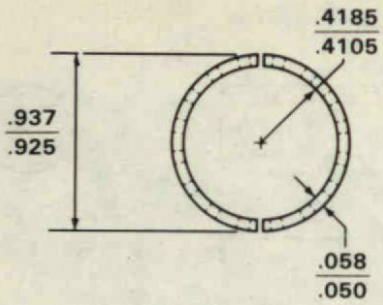
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CONNECTING RODS

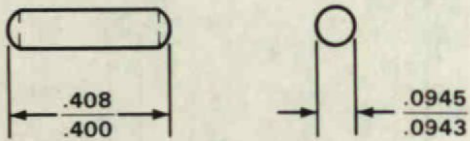


CRANKSHAFT

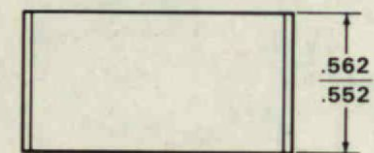
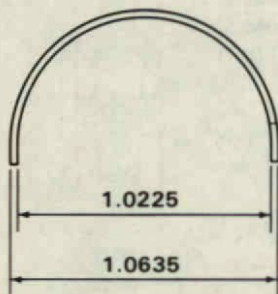
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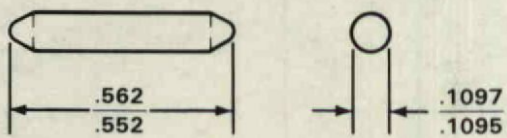
CAGE CRANK PIN ROLLER



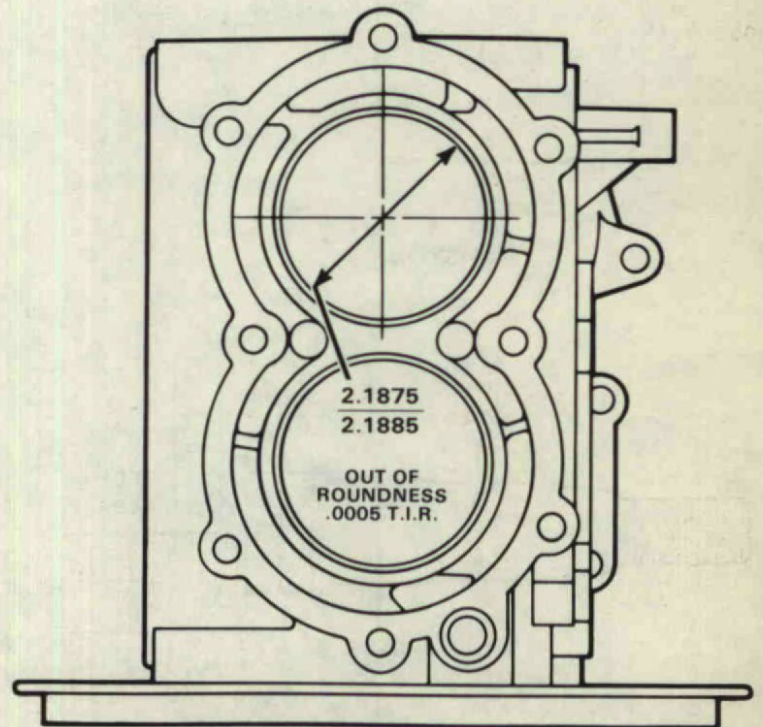
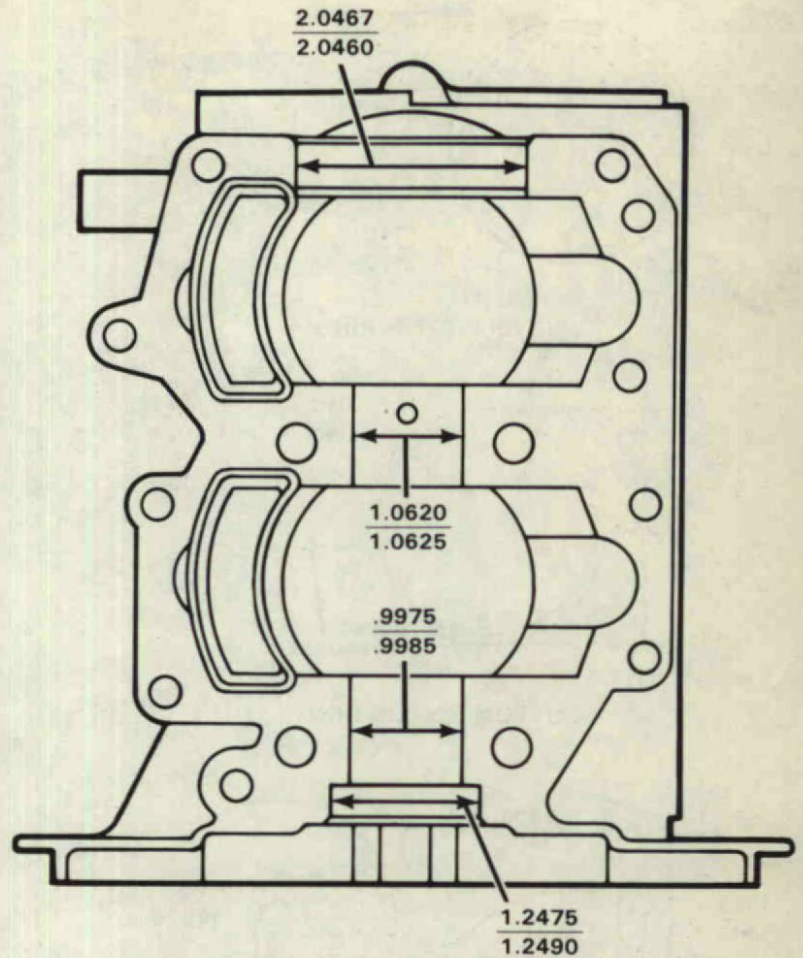
ROLLER (CRANKPIN)



LINER (CENTERMAIN BEARING)

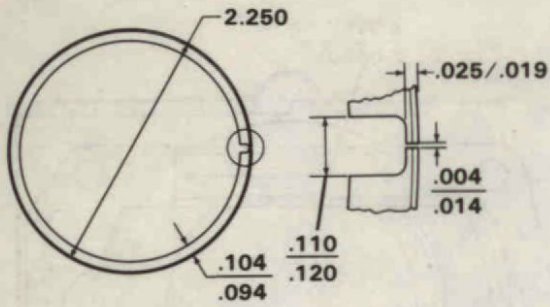


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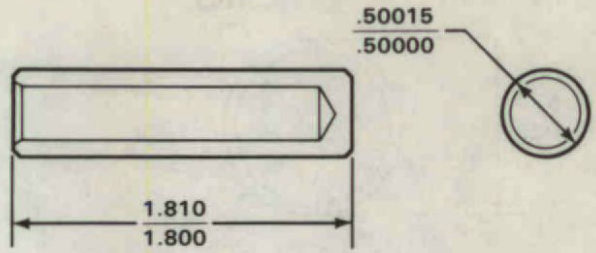


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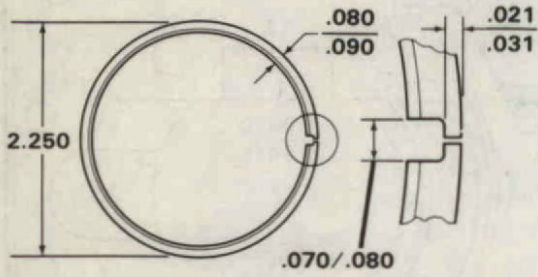
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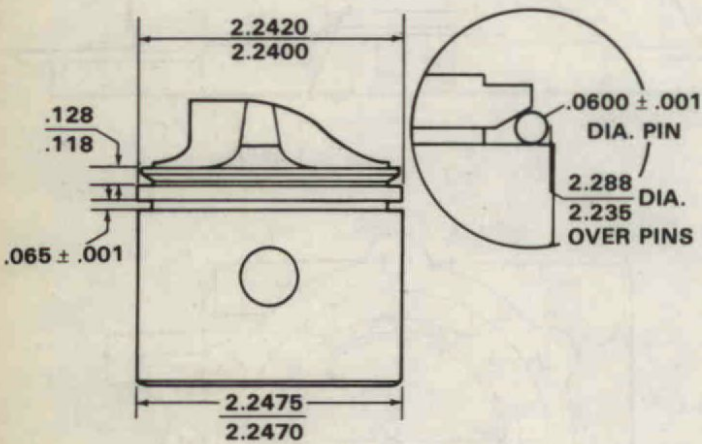
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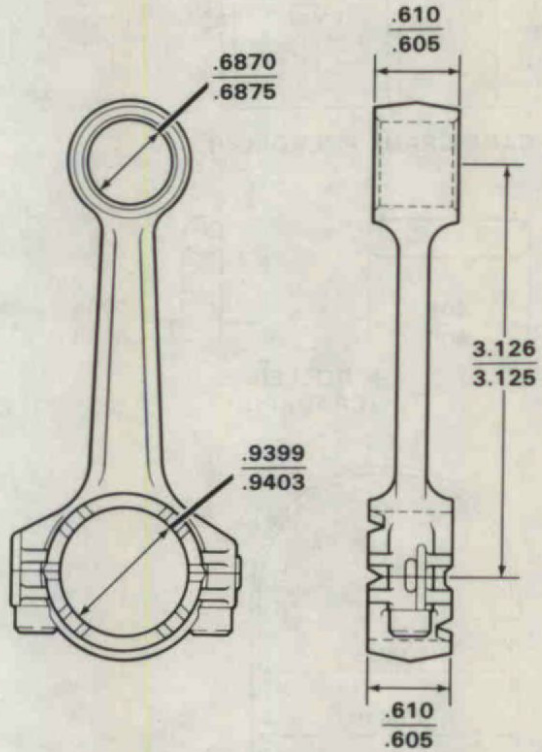
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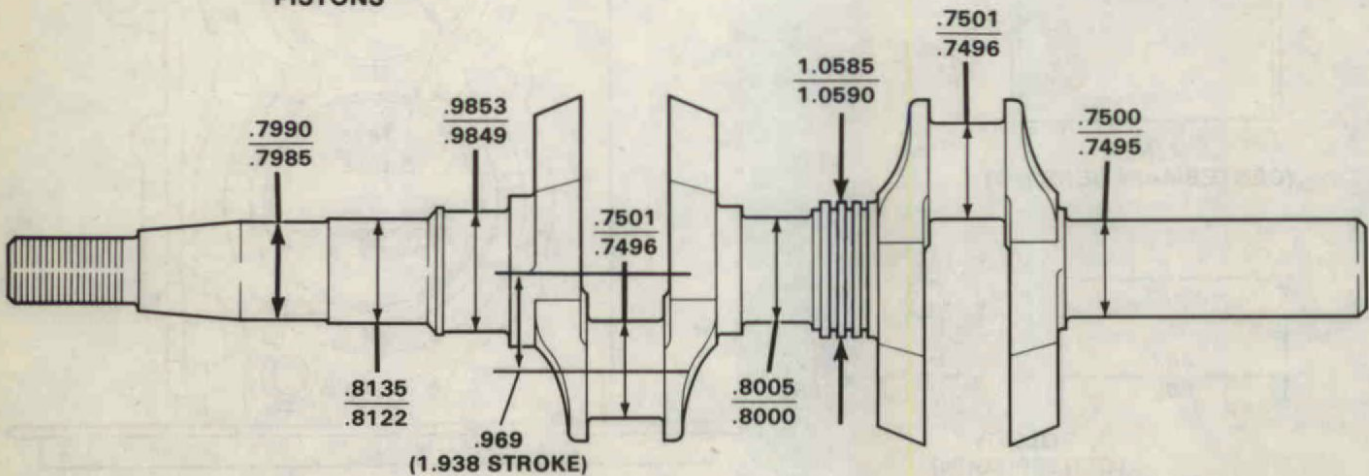
BOTTOM PISTON RING



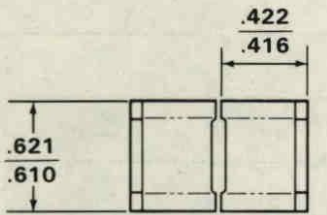
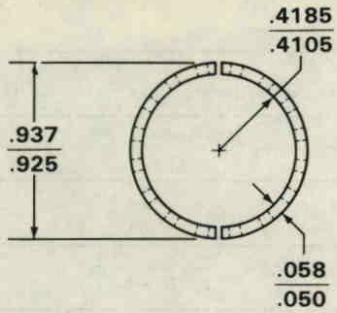
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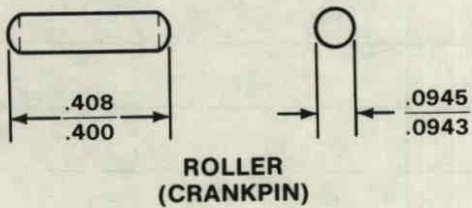
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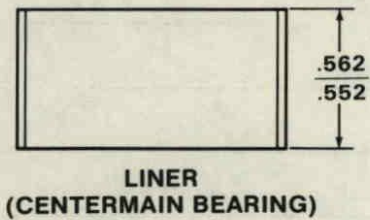
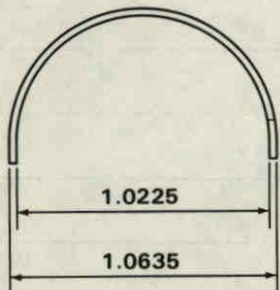
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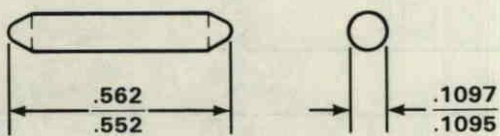
CAGE CRANK PIN ROLLER



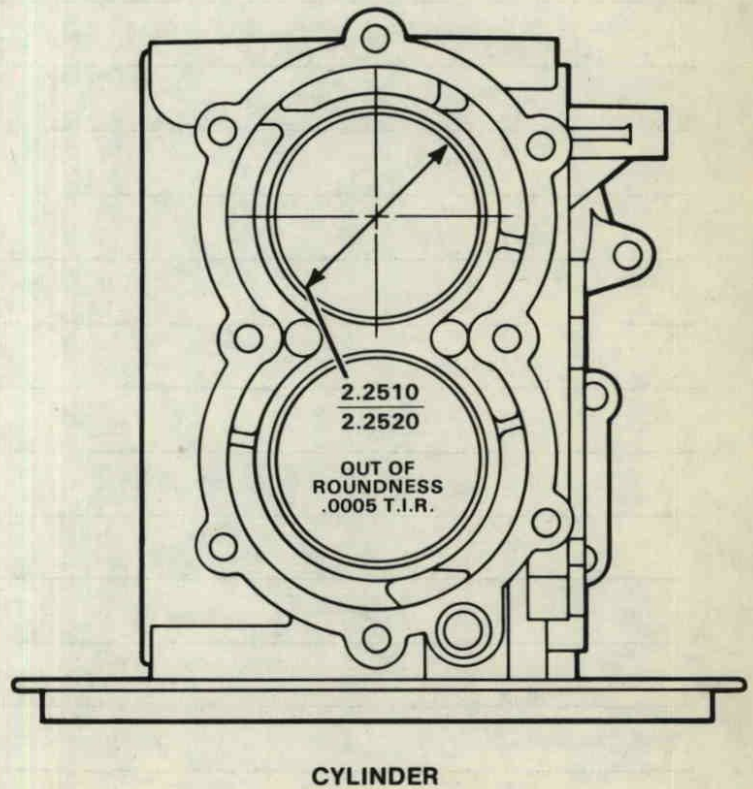
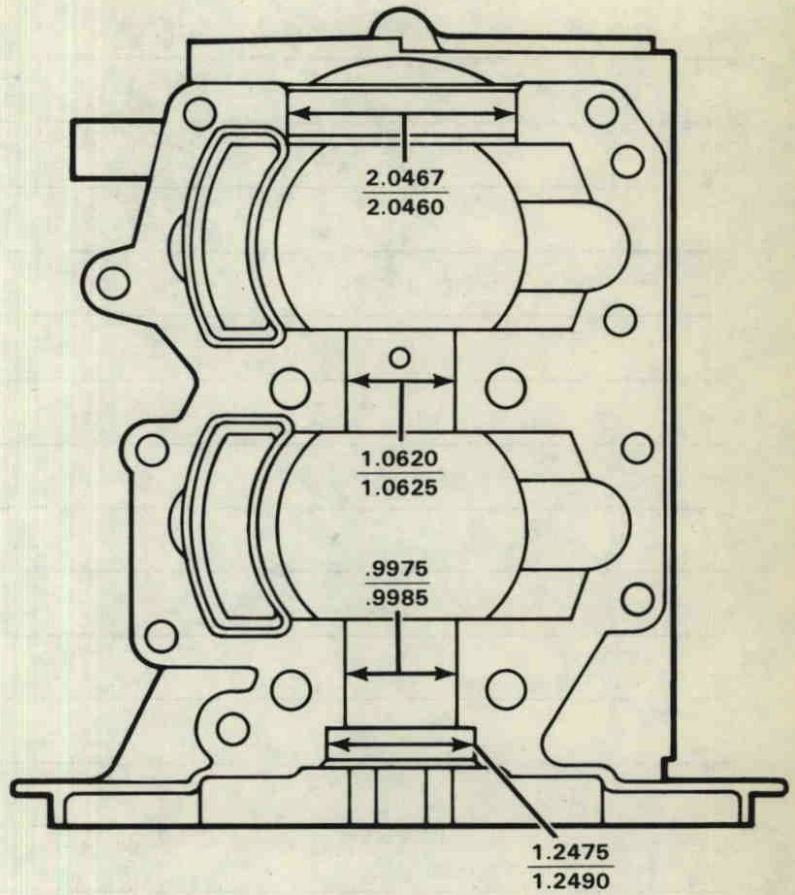
ROLLER
(CRANKPIN)



LINER
(CENTERMAIN BEARING)



ROLLER
(CENTER MAIN)



CYLINDER

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SPECIAL TOOLS

Section	Part No.	Description	Use
3C - FUEL PUMP	T 8900	Hose Clamp Pliers	To remove and install fuel hose clamps
3D - CARBURETOR	T 8900	Hose Clamp Pliers	To remove and install fuel hose clamps
3E - REED VALVE ASSEMBLY	T 8983	Sealant - RTV	

GENERAL

The fuel system, as defined by this manual, includes all the fuel components which are common to the system of the motor. The components included in the system are the Fuel tank, Fuel pump, Carburetor and Reed valve.

Troubleshooting the fuel system and a brief discription of the operation of the system is discussed in this subsection.

OPERATION

The fuel tank is non-pressurized and suction operated. A diaphragm-displacement type fuel pump on the motor draws fuel from the tank and furnishes it to the carburetor bowl. The upstroke of the piston in the cylinder creates a suction which draws air through the throat of the carburetor. A restriction in the throat, called a venturi, has the effect of reducing air pressure at this point (increasing air velocity.)

The reduction of air pressure causes the fuel to be pushed into and mix with the incoming air stream to form a combustible air/fuel mixture.

The air/fuel mixture is admitted to the crankcase of the motor by reed type inlet valves. The reed valve operates automatically, opening when the pressure in the crankcase is low enough so the outside pressure can overcome the reed tension. Figure 1.

TROUBLESHOOTING

General. When a motor will not start because of a problem in the fuel system, it is very easy to run through an organized procedure in order to pinpoint the cause of the trouble. Obviously the fuel in the tank must reach the combustion chamber. Any interruption of this flow will halt the operation of the motor. Go through the following suggested check list to determine the exact cause of the trouble.

Checking Fuel Flow. First make sure that there is a

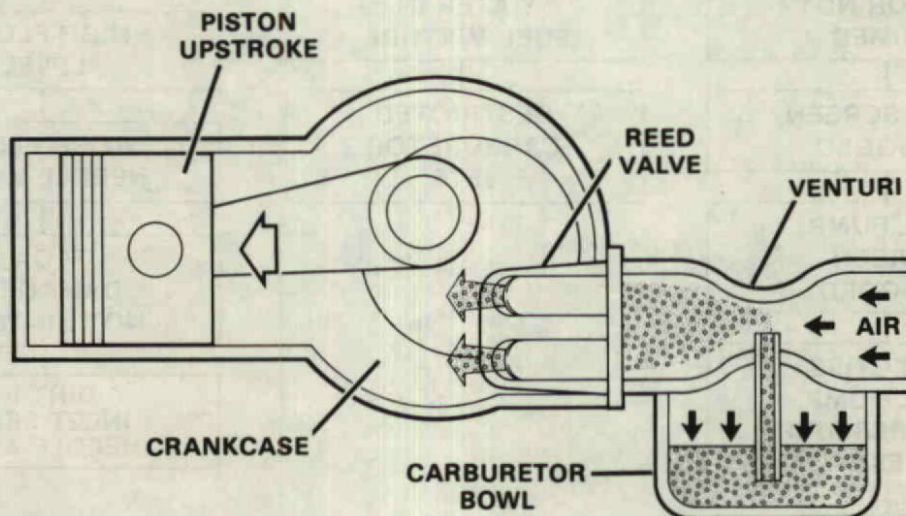


Figure 1. Operation of Fuel System.

fresh supply of properly mixed fuel in the tank. Open the vent of the fuel tank cap and prime the motor by squeezing the prime bulb. When the carburetor bowl is full of fuel, pressure will be felt on the priming bulb.

No Fuel To Carburetor Bowl. If the carburetor bowl is dry, check the line for obstruction. Disconnect the fuel line from the motor quick-disconnect coupling, and then depress the check valve (poppet) in the fuel line coupling. Squeeze the bulb and fuel should come out of the line, if it is not obstructed.

If the fuel line is clear, the trouble is somewhere between the connector on the support plate and the carburetor. Disconnect the fuel line at the carburetor inlet and check fuel flow by squeezing the priming bulb and directing fuel into a suitable container.

No fuel indicates an obstruction at the fuel pump, usually the fuel pump filter.

If squeezing the priming bulb produces fuel flow, then the trouble is in the carburetor, probably a stuck float valve or binding float.

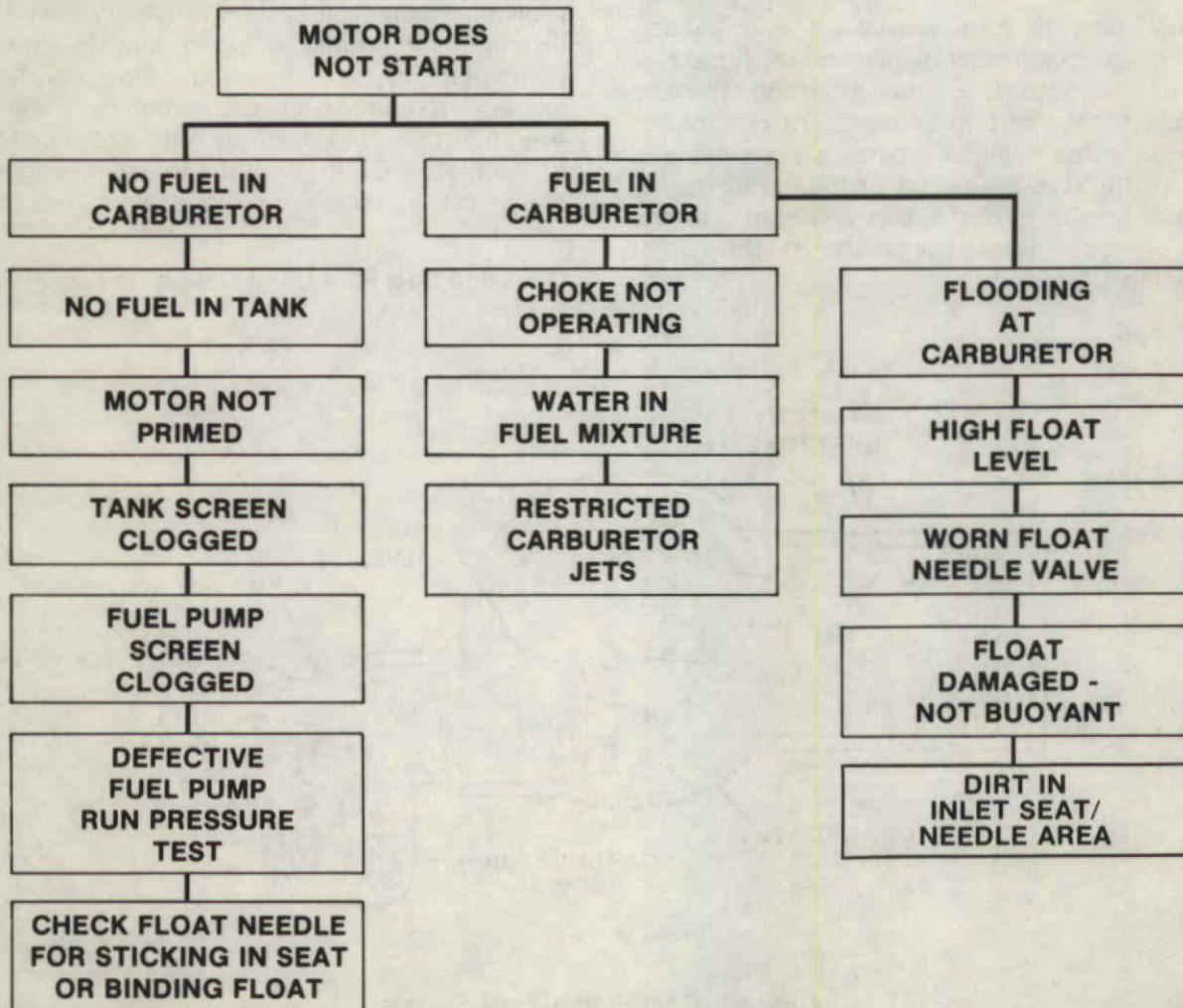
No Fuel To Combustion Chamber. Remove a spark plug and check its condition. A dry plug means that no fuel is reaching the combustion chamber. If the carburetor fuel bowl is known to be full, but the spark plug is dry, then the carburetor jets may be plugged.

Flooding. A wet spark plug means that the motor has been over-choked. Go through the procedure for starting a flooded motor. Disconnect the fuel supply line from the motor, remove both spark plugs and then spin the flywheel several times to remove the excess fuel from the combustion chambers. Reconnect the fuel line, replace and dry the spark plugs and then start the motor in the normal manner.

NOTE

A wet plug could also indicate the recirculating system is not functioning or the fuel pump diaphragm has ruptured.

Check the fuel in the carburetor to see if water has gotten into it. Water will appear as small beads or bubbles.



FUEL TANK AND COMPONENTS

GENERAL

The information in this subsection is concerned with cleaning and replacement of the fuel tank components.

FUEL TANK

Description. The fuel tank is of simple yet rugged construction, with a fuel mixture capacity of 6 gallons, (23 litres). It includes a carrying handle which also acts as a bracket to hold the fuel line when not in use.

The fuel tank is a non-pressurized, suction operated tank. Priming is achieved by squeezing the primer bulb (part of the fuel line) several times or until pressure required to squeeze the bulb increases. Quick disconnect couplers attached to the fuel line, shut off fuel flow when the line is disconnected from the tank or motor.

Cleaning. To prevent petroleum gum and varnish, which precipitate from a stale fuel mixture, the fuel tank should be drained and flushed once a year. Clean the tank by flushing with clean gasoline or solvent.

GAUGE CAP

Description. A fuel indicator is incorporated into the design of the fuel cap. The fuel indicator consists of a float which rides up and down on a spiral shaft. The end of the shaft is bent 90° and pointed to serve as a dial type indicator. As the fuel is consumed the float drops making the spiral shaft and pointer revolve.

Cleaning And Inspection. Check float for free movement on the spiral shaft. Inspect the two float support shafts for bends which could interfere with the float travel. Check that the float itself is not damaged or oil-soaked. Clean assembly with a suitable solvent.

FUEL TANK ADAPTER

Description. The fuel tank adapter acts as the fuel pick-up. It threads into the top of the tank and extends to the bottom. Clamped to the pick up end of the adapter is a screen by which fuel sediment is blocked from reaching the fuel system. On the outside end of the adapter is a connector. This connector is sealed until the fuel line is attached.

Cleaning And Inspection. Remove the fuel tank adapter and inspect for damage to the hose and screen. Remove hose clamp securing screen. Remove screen and clean with a suitable solvent and force air through the plastic collar. Figure 2.

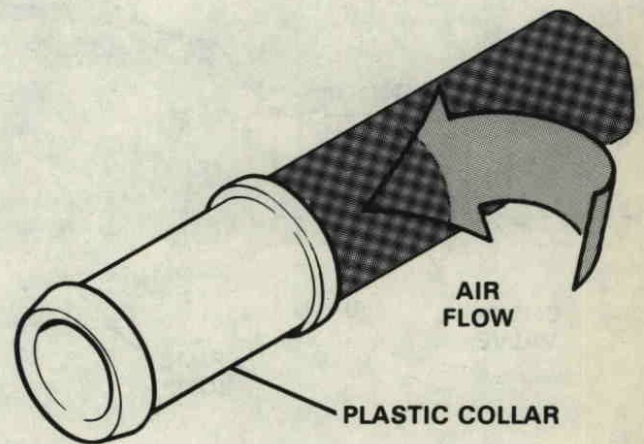


Figure 2. Cleaning Fuel Screen.

PRIME BULB

Description. The prime bulb is part of the fuel line. Rubber hoses are attached to both ends of the bulb and secured by ferrules. The tank side of the bulb contains a check valve which prevents fuel from running back into the tank. Figure 3.

Disassembly. To disassemble the prime bulb proceed as follows:

1. Place prime bulb in hot water (180° to 200° F [82° to 93° C] until hose becomes soft and pliable.
2. Pull hose and ferrule from each end of bulb.
3. Pull check valve assembly from prime bulb.
4. Remove valve check ball retainer and allow ball to roll out.

Cleaning And Inspection. Inspect all parts for damage and clean in a suitable solvent. Damage to check valve will require replacement of prime bulb as an assembly.

Reassembly. To reassemble the prime bulb proceed as follows:

1. Drop ball into check valve and reinstall retainer.
2. Slide check valve assembly into prime bulb.
3. Place ferrules or ends of hoses in hot water until they are soft and pliable. Push on to prime bulb.
4. Flush hose assembly with clean fuel prior to connecting it to motor.

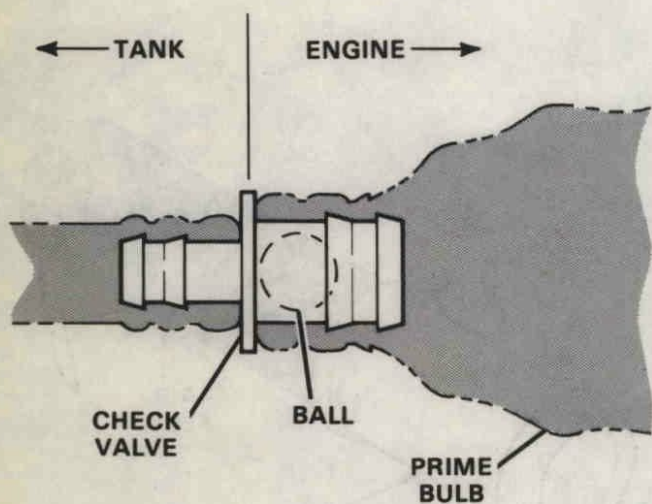


Figure 3. Assembly of Check Valve in Prime Bulb.

FUEL LINE COUPLERS

Description. The couplers on the fuel supply line prevent fuel flow when disconnected. Each coupler contains two o-ring seals, a poppet, and a poppet spring. The fuel is sealed at the point where the poppet contacts the bottom o-ring. When coupler is connected to motor or tank the poppet is pushed in separating it from the o-ring and allowing fuel to pass through. The top o-ring serves to seal the fuel

flow between the coupler and the bushing it is connected to (either on the tank or support plate of motor). Figure 4.

Disassembly. The o-ring seals can be obtained as replacement parts. The poppet and poppet spring however, are not replaceable and must be serviced as an assembly by obtaining a new coupler.

To disassemble the coupler proceed as follows:

1. Remove top o-ring seal by hooking it with a suitable instrument.

NOTE

A suitable instrument could be a piece of 16 gauge (1/16" diameter) steel wire. Form a small hook on the end using a needle nose pliers.

2. Remove bottom o-ring in the same manner.
3. Remove the poppet and poppet spring by shaking them out of coupler.

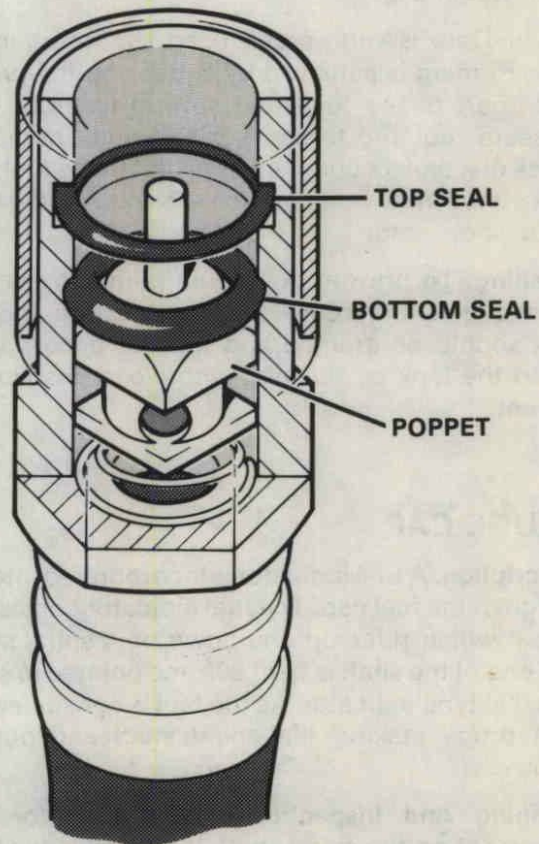


Figure 4. Components of Quick Disconnect Coupling.

Cleaning And Inspection. Inspect poppet and spring for obvious signs of damage. Inspect all parts for petroleum gum and varnish and clean with suitable solvent.

Reassembly. To reassemble to coupler proceed as follows:

1. Insert the poppet spring making sure the large end of spring is seated properly in the bottom of the coupler.
2. Insert the poppet (square end first) on top of spring.
3. Place a drop or two of oil on new bottom o-ring

and install it in its groove using a suitable tool (hooked piece of wire).

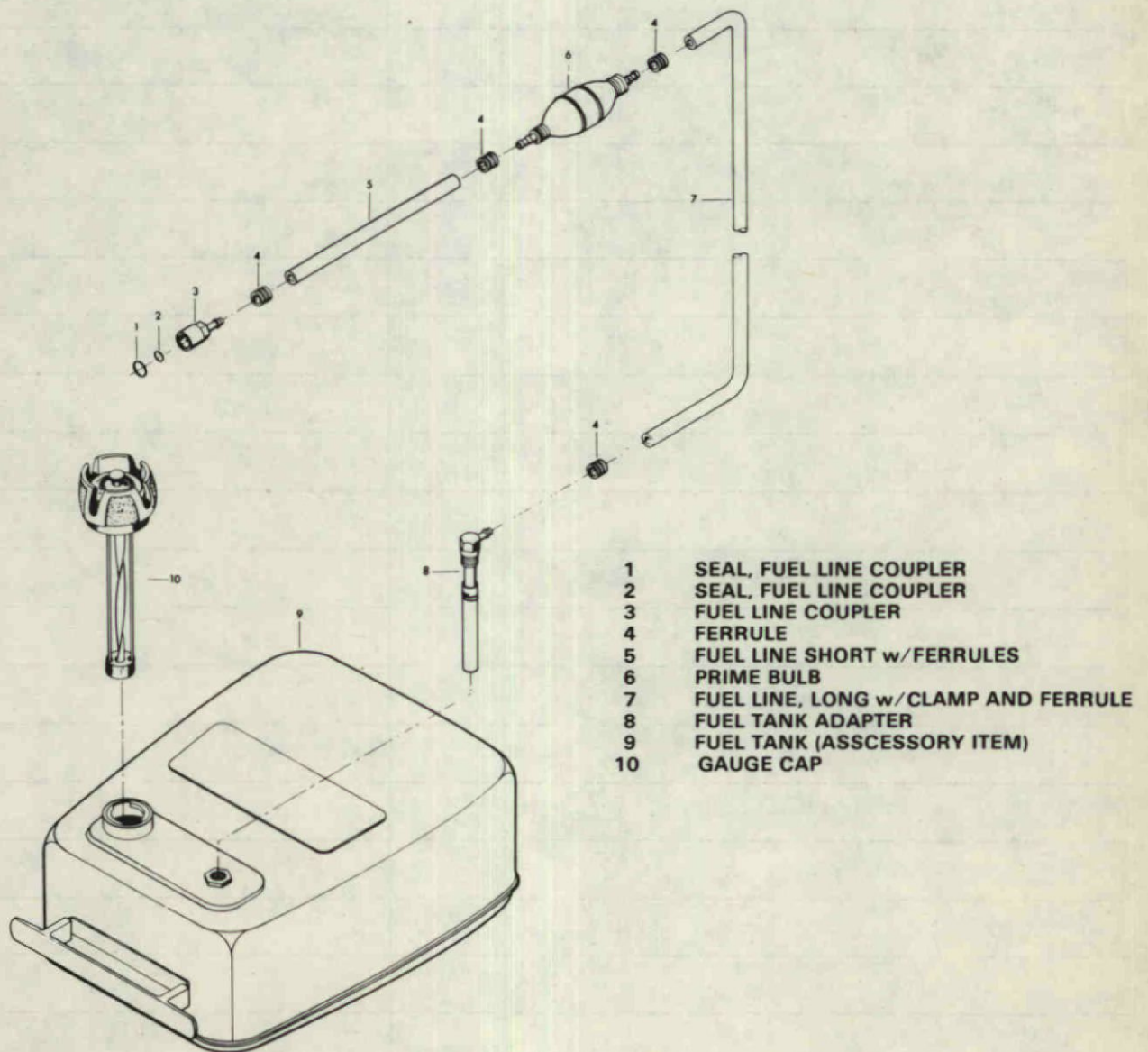
CAUTION

Be sure working end of wire is rounded off to prevent damage to new o-ring.

NOTE

To facilitate installation it may be necessary to use a second piece of wire to push poppet down while positioning o-ring. When properly installed the poppet will seat against the bottom o-ring providing a seal.

4. Place a drop or two of oil on new top o-ring and position it in the remaining groove of the coupler.



- 1 SEAL, FUEL LINE COUPLER
- 2 SEAL, FUEL LINE COUPLER
- 3 FUEL LINE COUPLER
- 4 FERRULE
- 5 FUEL LINE SHORT w/FERRULES
- 6 PRIME BULB
- 7 FUEL LINE, LONG w/CLAMP AND FERRULE
- 8 FUEL TANK ADAPTER
- 9 FUEL TANK (ASSCESSORY ITEM)
- 10 GAUGE CAP

Figure 5. Fuel Tank and Components.

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FUEL PUMP

GENERAL

The information in this subsection concerns the removal, repair, and installation of the fuel pump.

DESCRIPTION

A single stage diaphragm-displacement fuel pump is used to lift the fuel from the tank and direct it into the carburetor fuel bowl. The diaphragm in the

pump flexes back and forth with changes in the crankcase pressure of the No. 1 piston. This pressure is transmitted to two reeds, an inlet reed and an outlet reed, mounted on a plate inside the fuel pump. When the diaphragm flexes inward it opens the inlet reed, allowing fuel from the fuel tank to enter the pump. Fuel is drawn through a fine mesh screen filter before entering the pump. Figure 6. When the diaphragm flexes outward it closes the inlet reed and pushes the fuel through the outlet reed and out of the pump to the carburetor.

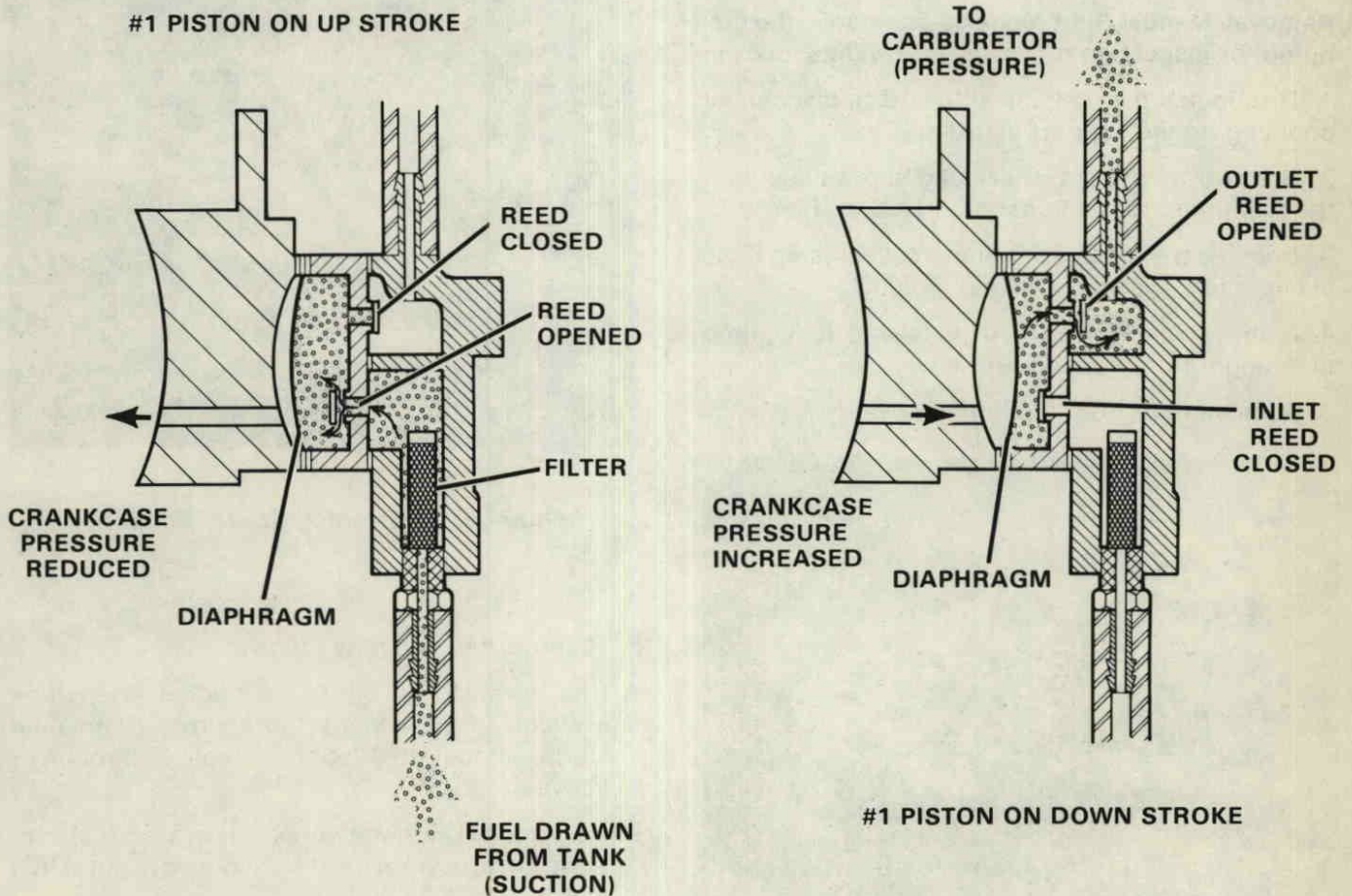


Figure 6. Operation of Fuel Pump.

TESTING

Conduct this test with the motor in a test tank or on the boat. Proceed as follows:

1. Remove fuel pump hose from carburetor.
2. Connect a fuel pressure gauge between the carburetor and fuel pump.

NOTE

Before testing, loosen fuel tank vent on cap to release any pressure that may have built up. Fuel tank should not be more than 24 inches (61 cm) below fuel pump.

3. Start motor and observe the gauge. Pump pressure should read as outlined in Table 1.

	R.P.M.	
600	2500-3000	4500
1 PSI	1.5 PSI	2.5 PSI
(7kPa)	(10kPa)	(17kPa)

Table 1. Fuel Pump Pressure Readings.

SERVICING

Removal. Manual Start Models. To remove the fuel pump for inspection or repair, proceed as follows:

1. Disconnect the fuel line at the quick disconnect coupling on the support plate.
2. Remove three (3) filister head screws securing the fuel pump to the transfer port cover. Figure 7.
3. Remove fuel lines from pump cover, using hose clamp pliers (Special Tool No. T 8900).
4. Remove fuel pump reed plate and fuel pump diaphragm from transfer port cover.
5. Remove filter from fuel pump cover.

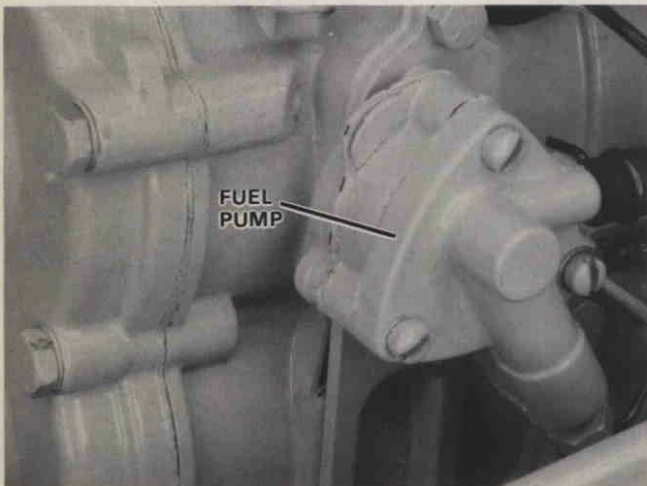


Figure 7. Removing Fuel Pump.

Removal. C-D Model.

1. Disconnect battery leads from battery terminals.
2. Remove four (4) screws securing coils to starter support.
3. Remove two (2) screws securing starter to starter support plate. Lay starter in support plate.
4. Remove four (4) screws securing starter support to starter support bracket on power head. Figure 8.

CAUTION

Be careful not to damage wiring when positioning starter support to gain access to fuel pump.



Figure 8. Unfastening Starter Support.

5. Remove fuel pump as follows:
 - A. If a screwdriver bit for a ratchet wrench is available, follow steps for removal of manual starter model fuel pump (steps 2 through 5 above).
 - B. If a standard screw driver only is available, starter switch with bracket must be removed to get at fuel pump. Figure 9.
 - C. Then follow steps for removal of manual starter model (steps 2 through 5 above).

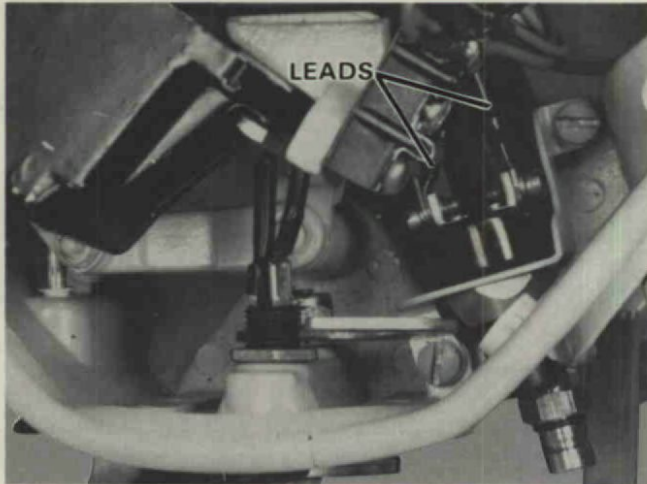



Figure 9. Removing Starter Switch.

Inspection and Repair. After the fuel pump has been disassembled, wash all the metal parts in cleaning solvent and inspect and repair the following:

 **WARNING**

Wear safety glasses while working with compressed air.

1. Visually inspect fuel filter for damage.

CAUTION

Do not wipe dry. Lint from cloth may clog filter.

2. Diaphragm. Because of the relatively small volume displaced by the flexing of the diaphragm, there must be no leaks in the fuel system. Check diaphragm for holes, breaks or excessive stretching. Hold up to light, observe for pin hole leaks.

3. Reed Plate. Reeds must lie flat when placed on the reed plate so when secured with screw and washer they do not have tension, which would restrict fuel flow, or stand open, which would allow fuel to flow unchecked. Figure 10.

REED MUST NOT SHOW SIGNS OF WARPAGE



REED MUST NOT HAVE TENSION



REED MUST NOT CURL UP ON END



Figure 10. Inspecting Fuel Pump Reeds.

Installation. Manual Start Models. To reinstall fuel pump, proceed as follows:

1. Use new gaskets. Place diaphragm between gaskets, be sure diaphragm is not wrinkled and that it extends beyond the gaskets all the way around. **DO NOT USE GASKET CEMENT.**
2. Place reed plate assembly, cover gasket and cover on diaphragm. Position on transfer port cover and secure with screws.
3. Connect fuel lines.

Installation. C-D Model.

1. Reassemble and install fuel pump, (steps 1 through 3 above).
2. Secure starter support to powerhead and starter support bracket with four (4) screws.
3. Install two (2) screws securing starter to starter support plate.
4. Secure coils to starter support with four (4) screws.
5. Reconnect battery leads.

GENERAL

This subsection describes the disassembly, repair, and reassembly of the carburetor.

DESCRIPTION

The carburetor is a single-barrel, float feed type. Fuel enters the carburetor through the fuel inlet connection and flows past the inlet needle and seat into the carburetor bowl. As the bowl fills with fuel, the float rises and through the action of the float lever, the inlet needle is closed against the seat shutting off the flow of fuel at a level determined by the buoyancy of the float and the adjustment of the float lever.

While filling the fuel bowl, fuel also flows through the main fuel jet into the main nozzle well area and into the idle and main nozzle tubes filling to the level determined by the float setting.

As fuel is used the float drops and the inlet needle opens allowing more fuel to flow into the carburetor. Opening and closing the inlet needle maintains a nearly constant fuel level.

In order to vary the speed of the motor, a valve is installed between the fuel nozzle and motor which limits the volume of fuel/air mixture available to the combustion chamber. When less mixture is available, the result is less RPM and less power. The type of throttle valve used on the Chrysler outboard is the disc (butterfly) valve.

Starting Choke Operation. When starting a cold engine, place the choke shutter in the closed position and throttle shutter in a partly open position. As the engine is cranked, suction will be transmitted to the idle and main nozzle tubes lifting and delivering fuel to the engine through the idle and main nozzle discharge ports.

Fuel enrichment is controlled by calibration of the choke shutter plate. The shutter plate may contain

areas open to atmosphere or the top half may be spring hinged to open during heavy vacuum. Either method can raise or lower the suction at the discharge ports increasing or reducing fuel delivered depending on open areas or hinge spring tension. Figure 11.

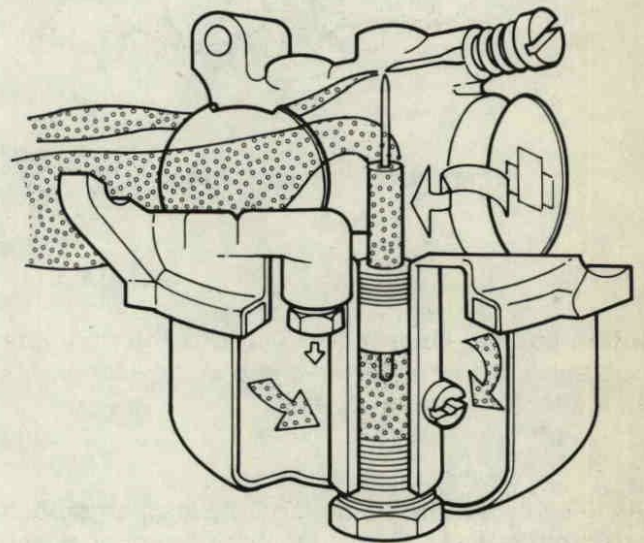


Figure 11. Starting Choke Operation.

Idle Operation. Idle fuel is dependent on the engine suction transmitted to the fuel in the idle fuel tube. The amount of idle fuel delivered is determined by the force of the engine suction and the setting of the idle fuel adjustment screw. As fuel is lifted from the idle fuel tube, air is introduced through the idle air bleed passage that atomizes the fuel which then passes through the idle adjustment orifice into the by-pass chamber mixing with additional air

supplied through the secondary idle ports discharging into the throttle bore through the primary idle discharge port. Figure 12.

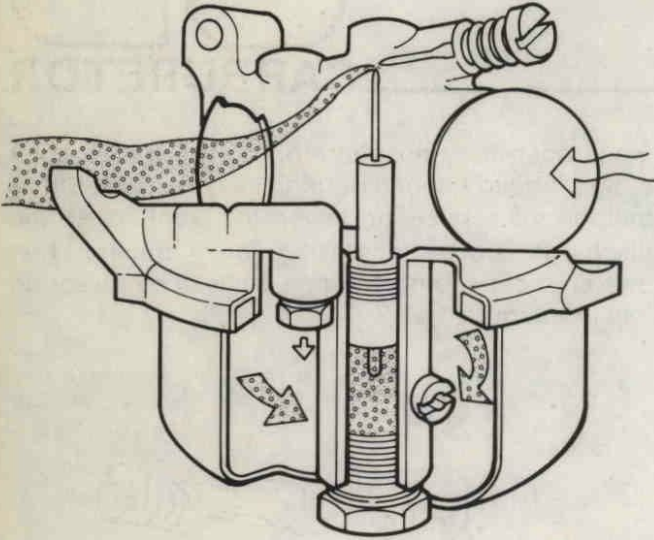


Figure 12. Idle Operation.

Intermediate Operation. During intermediate operation, the engine speed and air flow increases as the throttle shutter opens.

As this occurs, the secondary idle discharge ports are progressively exposed to engine suction which withdraws fuel from the main nozzle well through the idle tube into the by-pass chamber and discharging into the engine.

Continued throttle opening increases the carburetor air flow and suction in the main nozzle which also lifts fuel from the nozzle well into the air stream.

The open position of the throttle determines the quantity of intermediate fuel being delivered from the main nozzle which mixes downstream with the existing intermediate and idle fuel already flowing in the system. Figure 13.

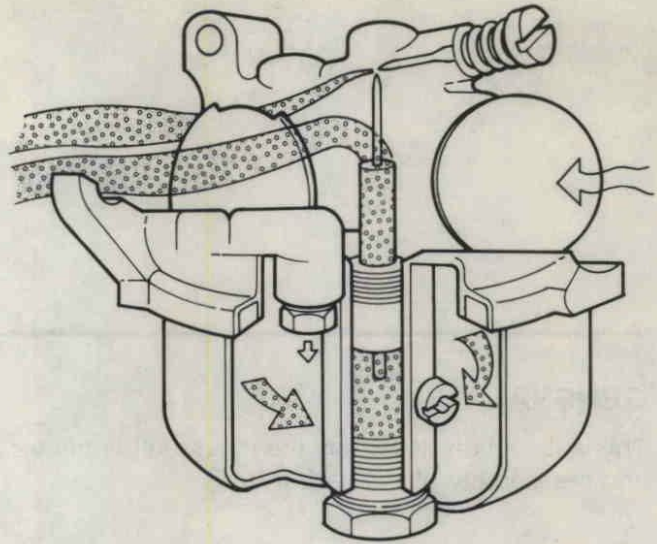


Figure 13. Intermediate Operation.

High Speed Operation. As the throttle opening is increased to obtain high speed operation, suction at the main nozzle also increases, lifting greater quantities of fuel from the nozzle well. As this occurs, the fuel level within the nozzle well tends to lower. As the fuel continues to lower in the fuel well, you will note that the bottom end of the idle tube will eventually become exposed to incoming carburetor air through the main nozzle air bleed located in the choke bore. When this level is reached, the idle tube is no longer in solid fuel, and the intermediate fuel being delivered through the idle system lessens. At this time the throttle would be at wide open or near wide open position during maximum or near maximum fuel delivery to the engine. High speed fuel then flows from the fuel bowl through the main fuel jet, through the nozzle well area, through the main nozzle and into the engine.

It is to be understood that the fuel level in the nozzle well is dependent on the fuel being consumed by the engine, and this in turn dependent upon the throttle opening. Figure 14.

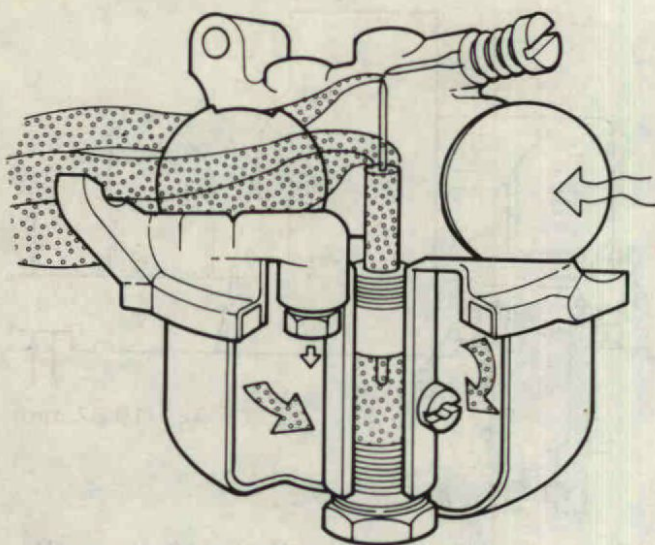


Figure 14. High Speed Operation.

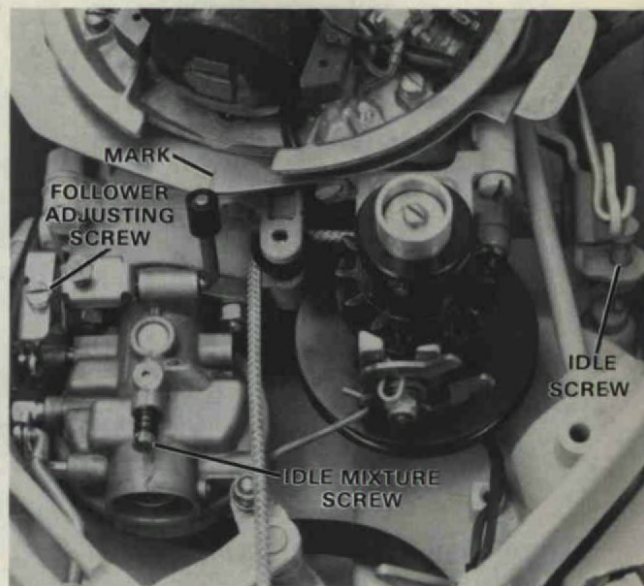


Figure 15. Adjusting Pick-Up Point.

CARBURETOR ADJUSTMENTS

Throttle Adjustment. Proper adjustment of the throttle cam follower on the stator ring cam is important for obtaining good overall running qualities together with the best possible fuel economy. Proceed with adjusting throttle as follows:

NOTE

If throttle does not close, either the throttle return spring is too weak and should be replaced or the throttle disc or linkage is binding.

1. Turn idle speed screw counterclockwise until throttle pick-up mark on throttle cam is on starboard side of roller on carburetor follower, Figure 15.

2. Advance throttle until throttle cam contacts roller. Slowly advance throttle until throttle shaft begins to move. Check roller to cam mark relationship. Mark on cam must be in center of roller or within 1/32" (0.79 mm). Turn adjusting screw on carburetor follower to obtain proper adjustment.

Idle Adjustment. To adjust the idle mixture, proceed as follows:

CAUTION

When adjusting the idle needle, turn carefully and gently. Do not force needle into seat.

1. Turn idle needle clockwise until it seats in the carburetor.
2. Open idle needle 1-1/4 turn counterclockwise.
3. Start motor and allow to warm up to operating temperature. Turn throttle to "SHIFT" position. Shift motor into "FORWARD" gear and close throttle (turn clockwise) to the lowest reliable throttle setting.

NOTE

Engine must be warmed up and left idling for minimum of (1) minute to allow recirculating system to function.

4. Slowly turn idle needle counterclockwise until motor speed decreases and operation becomes rough due to overrich mixture (Note adjustment position.)
5. Slowly turn idle needle clockwise, motor operation will become smooth and speed will increase. Continue turning adjustment clockwise until motor speed slows or misfires from the too lean mixture.
6. Turn idle screw to mid point between settings noted in steps 4 and 5.



Figure 16. Idle Mixture Adjustment Screw.

Idle Speed Adjustment. Adjust setting of idle speed screw as necessary until engine idles at 700 R.P.M. in FORWARD gear. Figure 17.

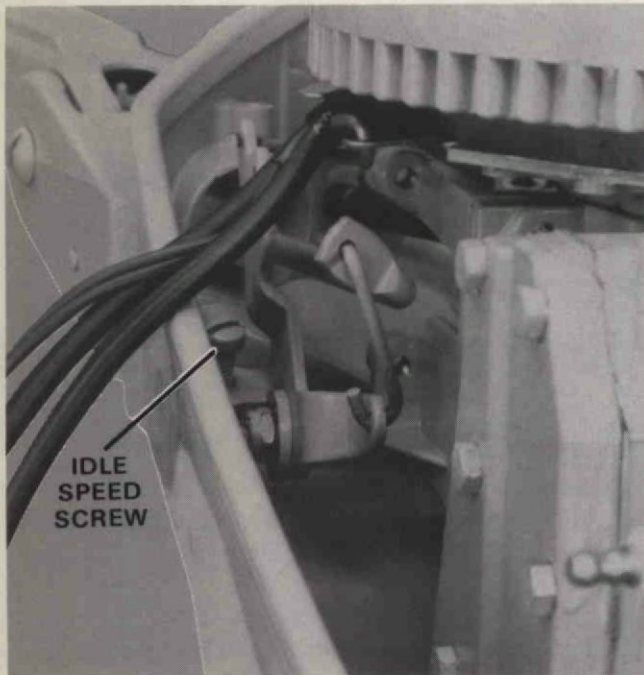


Figure 17. Idle Speed Adjustment Screw.

Float Adjustment. To adjust the float proceed as follows:

1. Adjust fuel level as follows:

A. Hold carburetor upside down so float weight closes needle valve. Figure 18.

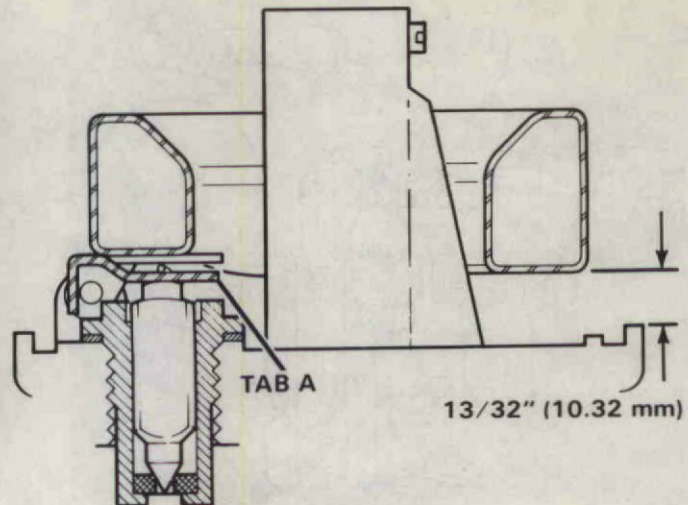


Figure 18. Adjusting Float Height (Fuel Level).

B. To obtain the correct fuel level, bend tab A that comes in contact with needle. Dimension must be $13/32''$ (10.32 mm).

CAUTION

Do not press down on float, damage to needle and/or float will result.

2. Adjust float drop as follows:

A. Hold carburetor up-right. Distance between bottom of float and fixed fuel jet to be $1/16''$ - $1/32''$ (1.6 mm - .8 mm). Figure 19.

B. Adjust by bending tab B.

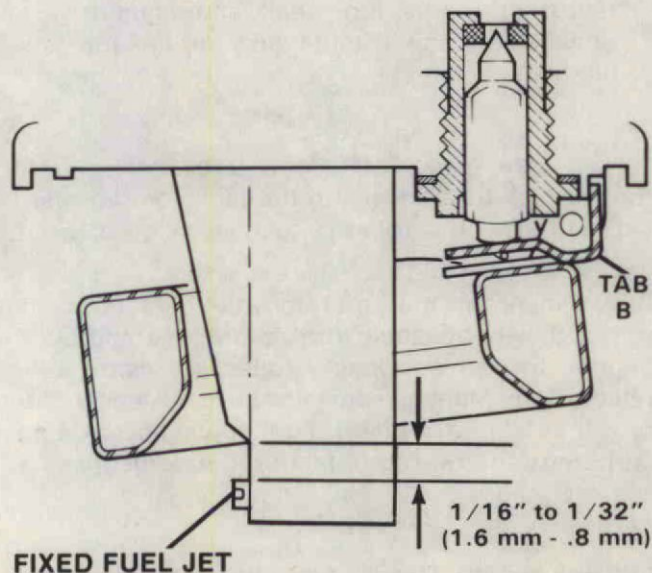


Figure 19. Adjusting Float Drop.

OVERHAUL

General. A repair kit is available and includes the inlet needle float valve assembly, jet assembly, idle needle, gasket kit, and float shaft. A gasket kit which contains all carburetor gaskets is also available separately. All other parts of the carburetor should be replaced as inspection dictates, or the entire carburetor should be replaced.

Removal, Carburetor. Manual Start Models.

1. Remove choke rod retaining clip from choke rod. Disconnect choke rod, Figure 20.

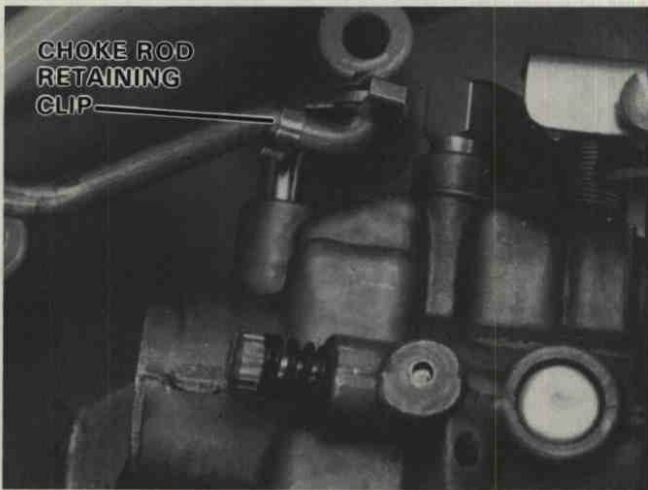


Figure 20. Removing Carburetor.

2. Loosen hex screw securing throttle cam follower arm to follower. Slide follower out and disconnect follower arm from carburetor.

WARNING

Do not allow fuel to come in contact with hot motor parts when removing carburetor.

3. Remove two (2) nuts securing carburetor to adapter plate, slide carburetor off of studs.
4. Using hose clamp pliers (Special Tool No. T 8900) slide fuel line clamp away from carburetor. Pull carburetor free from fuel line.

Removal, Carburetor. C-D Models.

1. Disconnect battery leads from battery terminals.
2. Remove four (4) screws securing coil to starter support.
3. Remove (2) screws securing starter to starter support plate. Lay starter in support plate.
4. Remove four (4) screws securing starter support to starter support bracket on power head. Figure 21.

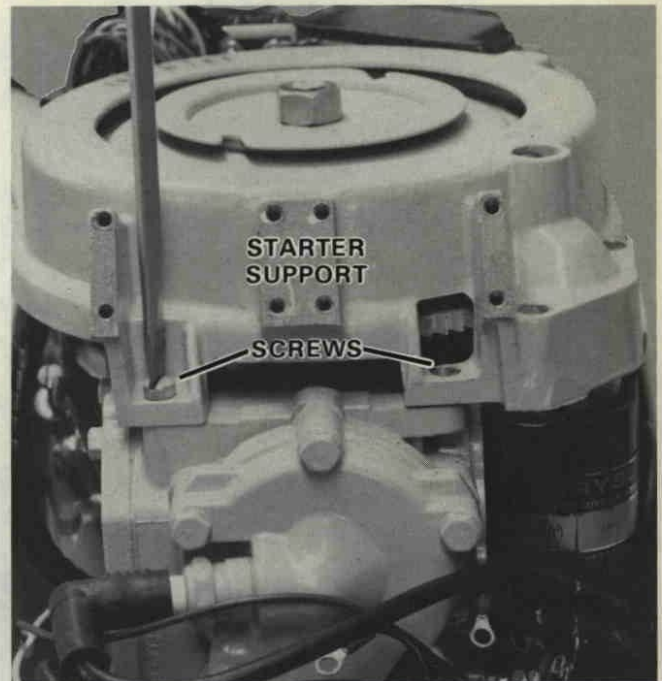


Figure 21. Removing Starter Support.

CAUTION

Be careful not to damage wiring when positioning starter support.

5. Disconnect neutral interlock switch.
6. Remove carburetor. Follow steps for manual start models.

Disassembly and Inspection. Inspect each part of carburetor as it is disassembled. Proceed as follows:

1. Remove idle needle and idle needle spring. Inspect for damage, especially the needle point which should have no rings or grooves on the seat point surface. Figure 22.

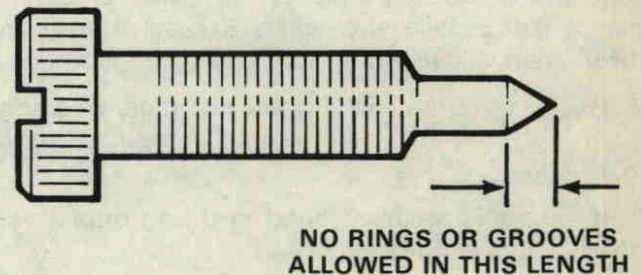


Figure 22. Inspecting Idle Needle.

2. Remove fuel bowl and fuel bowl gasket by removing the bowl retaining screw and gasket. Discard gaskets.

NOTE

Do not pass drills or wires through jets or passages. Doing so may enlarge orifices and affect carburetor calibration.

NOTE

Pin is knurled on one end. Push out from other end.

3. Remove float by pushing float shaft out. Inspect as follows:

- A. Inspect float for damage, wear.
- B. Inspect needle valve face for grooves or rings. Figure 23.

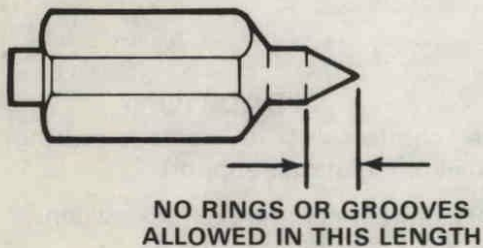


Figure 23. Inspecting Float Needle.

4. Remove needle valve seat. Inspect for dirt and wear. Discard gasket.

NOTE

Further disassembly of carburetor for cleaning is not necessary. However, further inspection is recommended.

5. Examine throttle and choke assemblies for damage and excessive wear. Excessive wear in these areas allows noticeable shaft movement.

6. Clean carburetor in a good commercial grade cleaning solution. Follow the manufacturer's instruction.

7. If excessive wear is found in the throttle area, disassemble as follows:

- A. Note position of throttle valve. Figure 24.
- B. Remove screw retaining throttle valve and remove throttle valve.

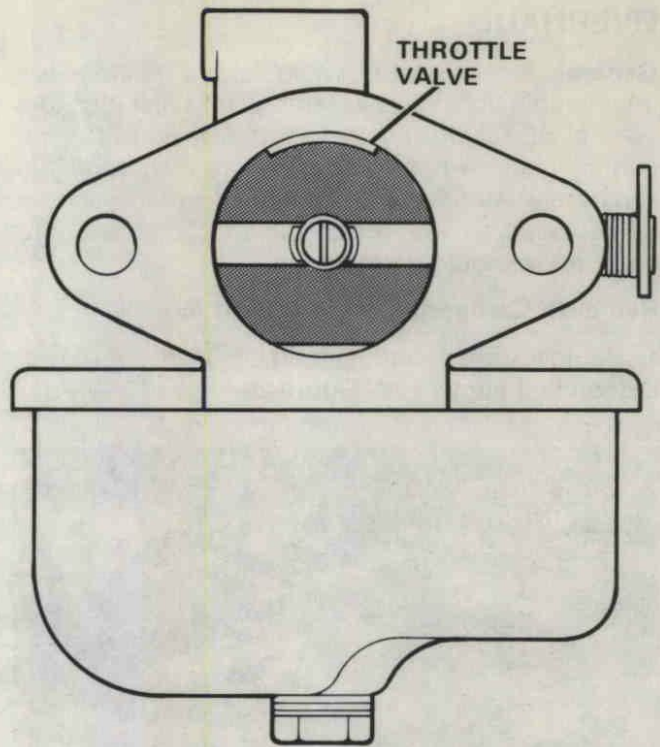


Figure 24. Position of Throttle Valve.

C. Note position of throttle return spring. Figure 25.

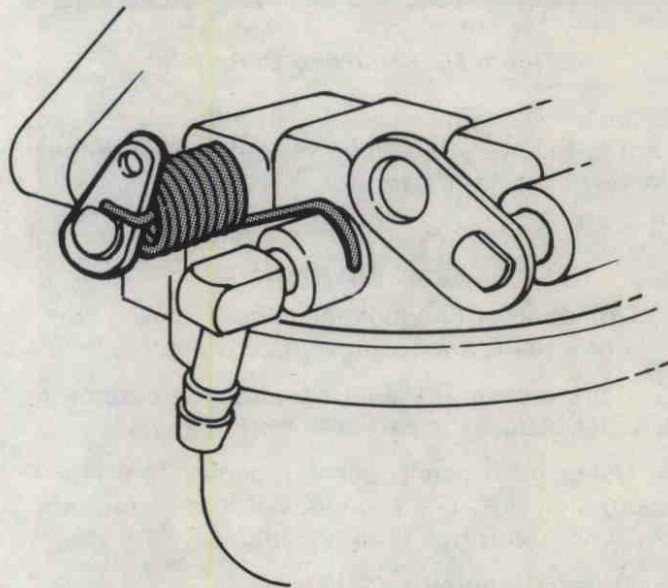


Figure 25. Throttle Return Spring.

8. Inspect body and throttle shaft for wear. Shaft is replaceable. If body is worn, carburetor must be replaced.

9. If excessive wear is found in the choke area, disassemble as follows:

- A. Note position of choke valve. Figure 26.

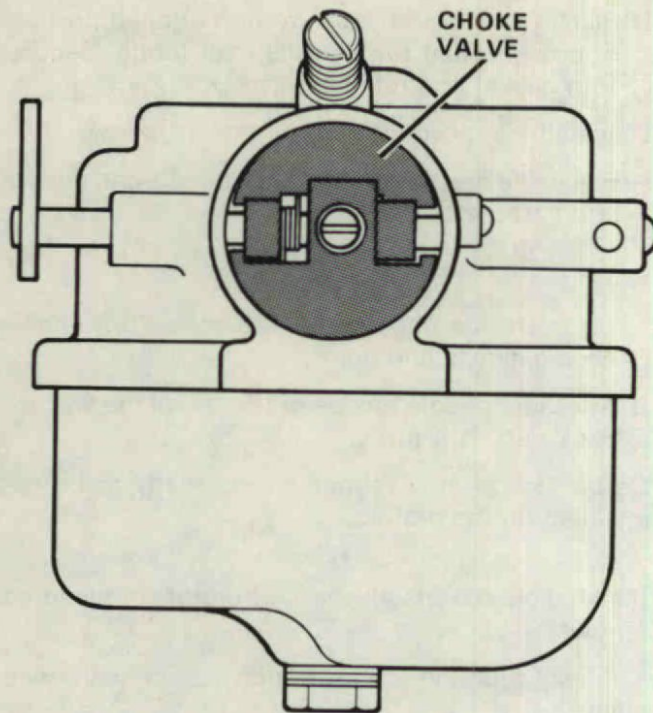


Figure 26. Position of Choke Valve.

- B. Remove screw, retaining choke valve to choke shaft, remove bottom half of valve.
- C. Pull choke shaft from carburetor.

NOTE

Dentent ball and spring will drop from carburetor body when choke shaft is removed.

- 10. Inspect body and choke shaft for wear. Shaft is replaceable. If body is worn, carburetor must be replaced.
- 11. After carburetor has been inspected for wear, clean in good commercial grade cleaning solution. Follow cleaning manufacturer's instructions.

Reassembly. Make certain all parts are clean and dry prior to reassembly. Use compressed air to dry internal passages of carburetor body. Proceed with reassembly as follows:

WARNING

Wear safety glasses while working with compressed air.

- 1. Assemble throttle assembly to carburetor as follows:
 - A. Place throttle spring on throttle shaft and insert in carburetor body. Figure 27.

- B. Assemble throttle valve to shaft, leave screw loose.
- C. Open and close throttle several times to locate disc in body bore. Tighten screw.

CAUTION

Throttle plate is beveled and can only be assembled one way. See enlarged section in Figure 27.

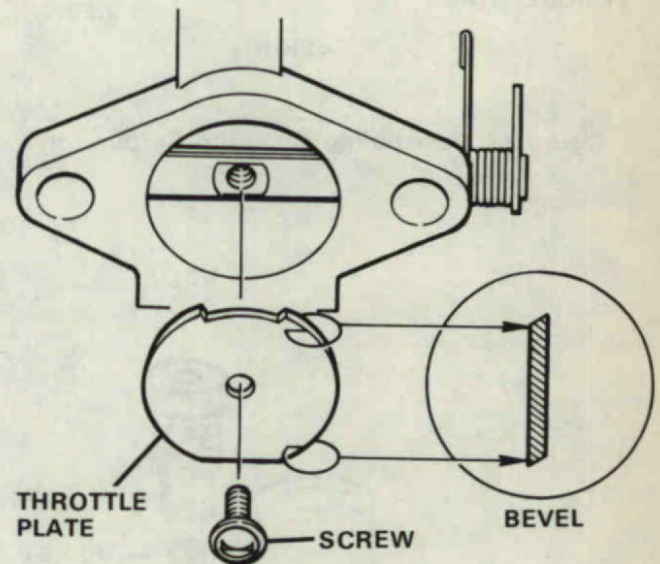


Figure 27. Assembling Throttle Valve to Shaft.

- 2. Assemble choke to carburetor as follows:
 - A. Slide choke shaft into carburetor until end of shaft extends into throat.
 - B. Position top half of choke plate in throat and slide choke shaft through one side. Allow choke plate half to hang down.

NOTE

Open ends of choke plate pivots are to front of carburetor.

- C. Place spring on end of choke shaft, ends straddling choke plate half.
- D. Install detent spring and ball in body.
- E. Depress ball and spring and slide choke shaft through.
- F. Place bottom choke plate half on choke shaft, end of spring under, secure with screw. Figure 28.
- 3. Place gasket on needle valve seat and install.

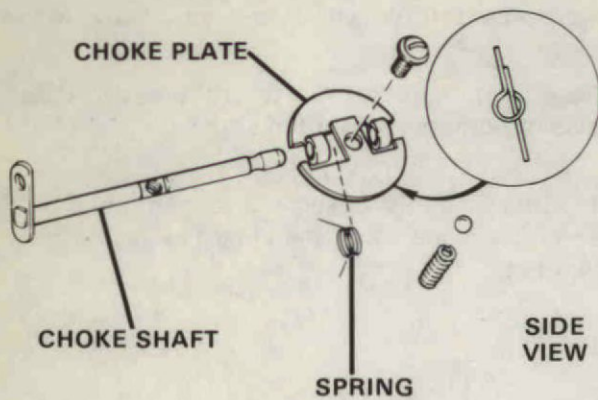


Figure 28. Assembling Choke to Carburetor.

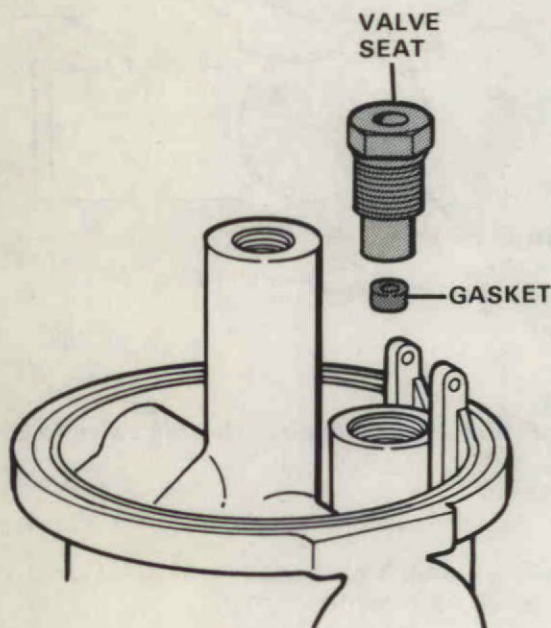


Figure 29. Assembling Float Valve Seat.

4. Assemble needle and float assembly as follows:
 - A. Drop needle in seat.
 - B. Place float in position.
 - C. Slide float shaft in place.
5. Adjust float height and float drop.
6. Assemble fuel bowl to carburetor as follows:
 - A. Install fuel bowl gasket.

B. Place fuel bowl on carburetor, flattened portion of bowl bottom toward fuel inlet fitting. Secure with gasket and retaining screw.

7. Install idle needle to carburetor as follows:

A. Place idle needle spring on idle needle and thread into carburetor body.

CAUTION

Do not force idle needle into seat. Turn idle needle slowly and gently.

B. After idle needle has been turned all the way in, back out 1-1/4 turns.

Carburetor is now rebuilt and is ready to be re-installed on the motor.

Installation. To install the carburetor, proceed as follows:

1. Install fuel line to carburetor, secure with hose clamp.
2. Place new carburetor gasket over studs.
3. Slide carburetor on mounting studs. Secure with nuts.
4. Place choke link on choke shaft, install washer and retaining ring.
5. Install fuel line to fuel pump carb. Secure with hose clamp.
6. Reinstall throttle linkage as follows:
 - A. Adjust follower arm adjustment screw so that inside dimension of follower arm is 9/16" (14.2 mm). Figure 30.

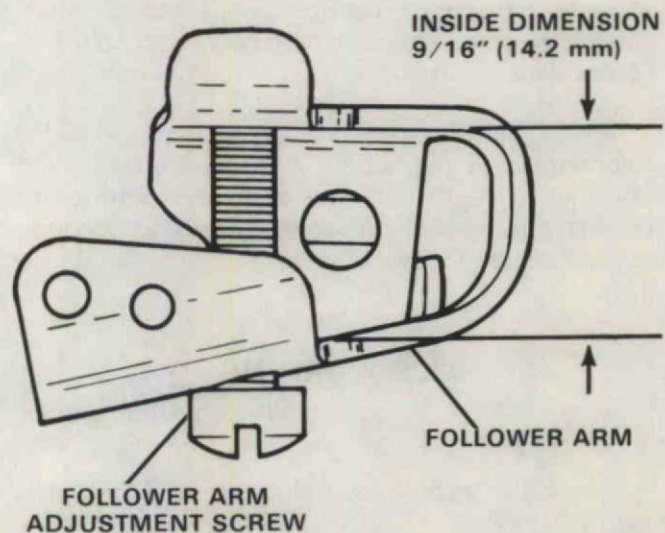


Figure 30. Setting Inside Dimension of Follower Arm.

B. Install throttle cam follower with roller through port side of boss on carburetor. Figure 31.

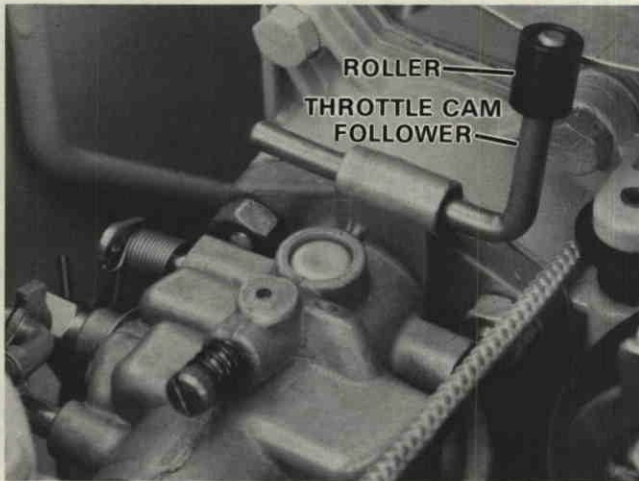


Figure 31. Installing Throttle Cam Follower and Roller.

C. Install brass throttle link in hole of throttle shaft arm and in outer hole of follower arm and make sure link ends face out. Then slide follower arm onto cam follower. Figure 32.

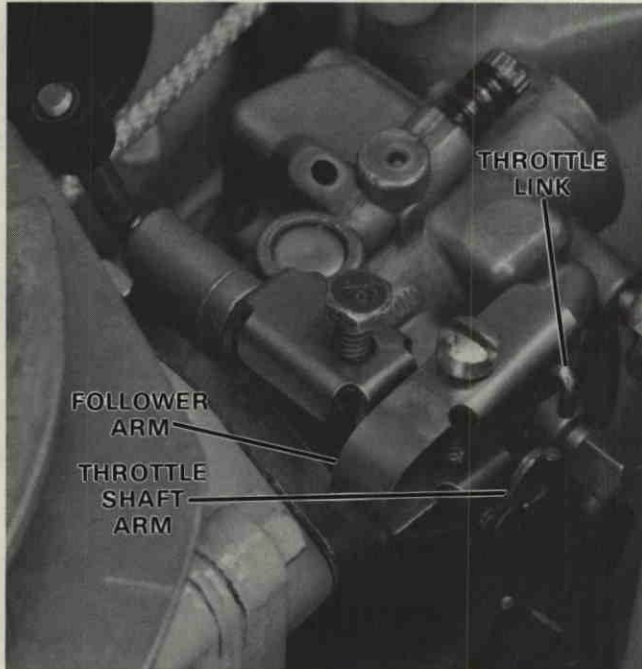


Figure 32. Installing Follower Arm to Cam Follower.

D. Position throttle cam with pick-up point mark on cam about 1/4" (6.4 mm) to the left of follower roller (when facing aft); by adjusting idle speed

screw. Press roller against cam at that point and tighten retaining screw of follower arm 1/16 turn beyond "finger tight".

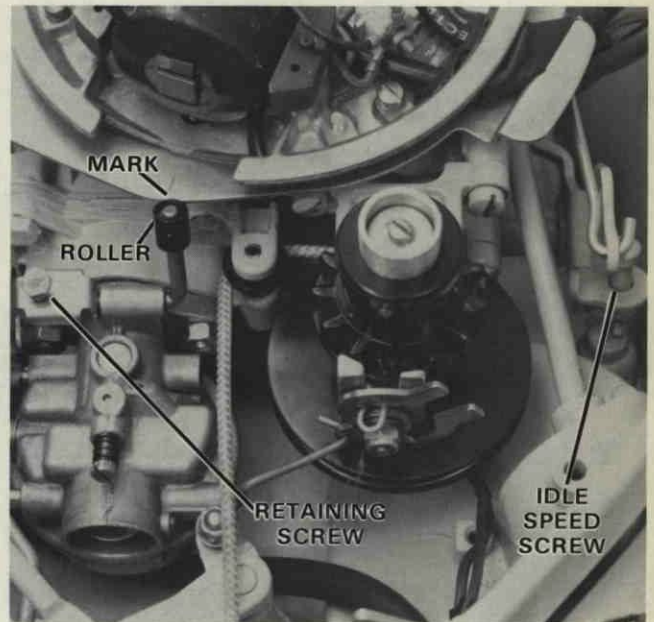


Figure 33. Positioning Throttle Cam Pick-Up Point and Roller.

E. Slowly advance throttle until throttle shaft begins to move. Check relation of roller to cam mark. Mark on cam must be in center of roller or within 1/32" (0.79 mm). Turn adjusting screw on follower arm to make adjustment. Figure 34.

7. Adjust throttle and idle settings.

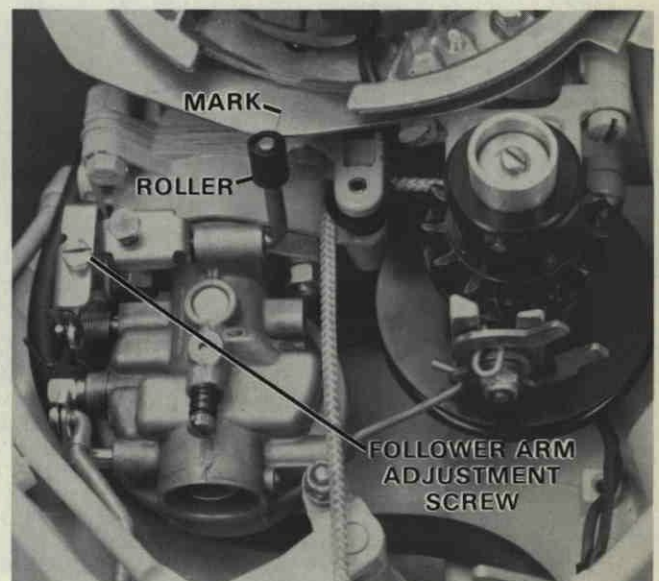


Figure 34. Checking Throttle Cam Mark and Roller.

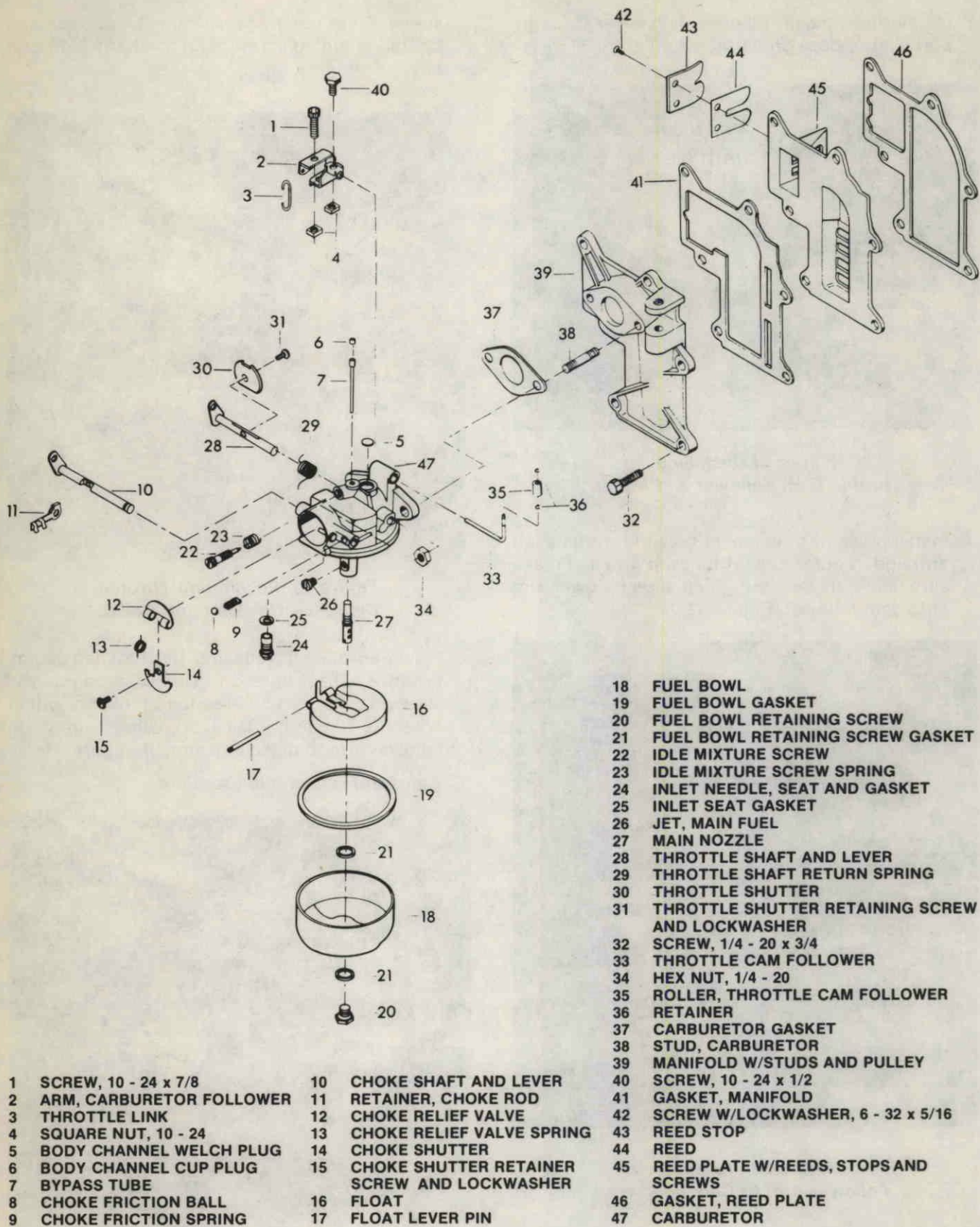


Figure 30. Carburetor and Manifold Assembly. Exploded View.

REED VALVE ASSEMBLY**GENERAL**

This subsection deals with removal, disassembly, repair and installation of the reed valve.

DESCRIPTION

The reed valve is between the carburetor and the crankcase of the motor. The reed valve times the injection of the fuel-air mixture from the carburetor into the crankcase by opening only when pressure in the crankcase drops to a predetermined point on the compression stroke. The reeds are designed to keep contact with the reed plate until pressure changes in the crankcase. Reed travel away from the plate is limited by the reed stop. When crankcase pressure increases, built in spring action of the reeds returns them and holds them against the plate.

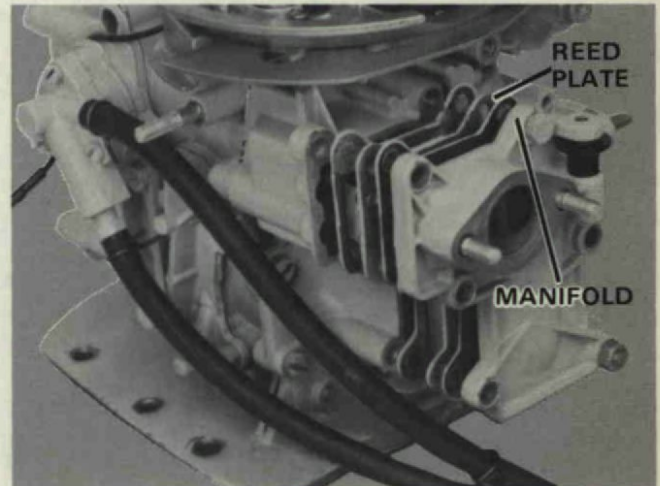


Figure 31. Removing Manifold and Reed Valve Assembly.

SERVICING**Removal. Reed Valve with Manifold****NOTE**

Steps to remove power head and carburetor are covered in their respective sections.

1. Remove power head.
2. Remove carburetor.
3. Remove six (6) screws securing manifold and reed plate to crankcase cover. Figure 31.
4. Remove reed plate with manifold gasket and reed plate gasket.
5. Remove manifold gasket and reed plate gasket from reed plate.

Disassembly. Reed Plate.

1. Remove screws securing two (2) reed stops and two (2) reeds on "V" part of reed plate (for top cylinder).
2. Remove screws securing remaining two (2) reed stops and two (2) reeds (for bottom cylinder).

Disassembly and Inspection. Inspect reeds. Reeds must lie flat on reed plate without tension (preload), which would restrict air flow, or stand open more than .012" (0.305 mm), which would allow air to be expelled through the carburetor. Figure 32.

Reeds not passing these inspections or displaying obvious damage, such as cracks or pieces broken from them, must be replaced.

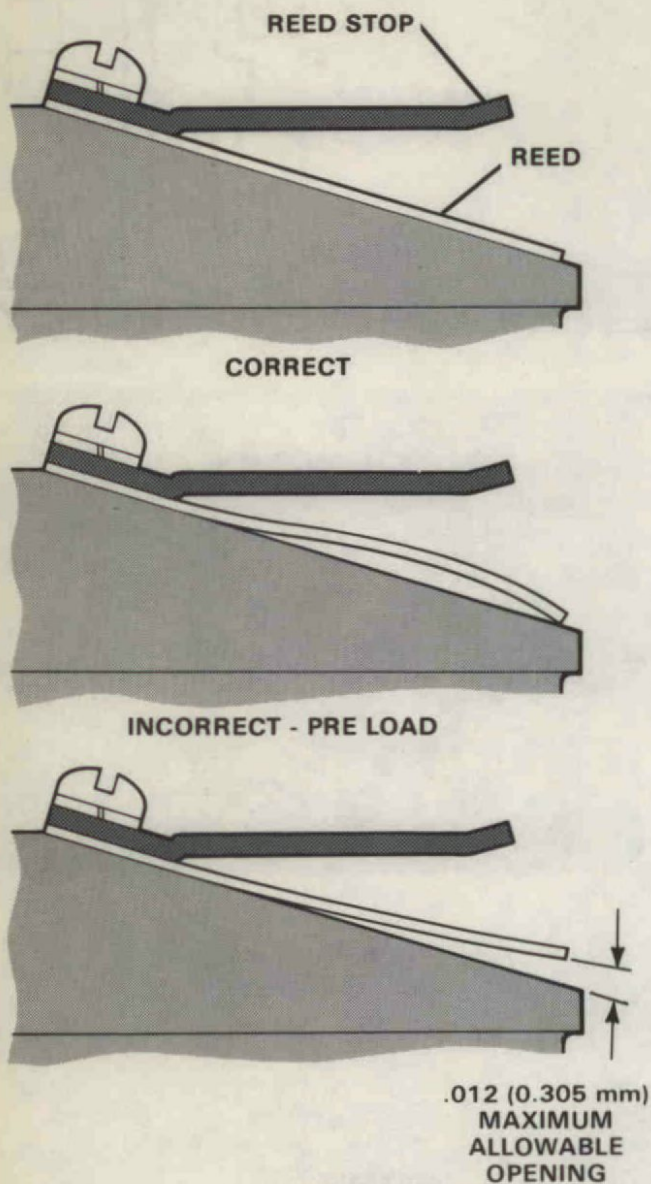


Figure 32. Inspecting Reeds.

Disassemble, inspect and, if necessary, replace the following:

1. Disassemble reed plate assembly as follows:

A. Remove screws and lockwashers securing reed stop and reeds.

B. Lay new reed on reed plate to check for flatness.
 C. Carefully locate reed over openings in reed plate. A minimum of .030" (0.76 mm) overlap is required. Figure 33.

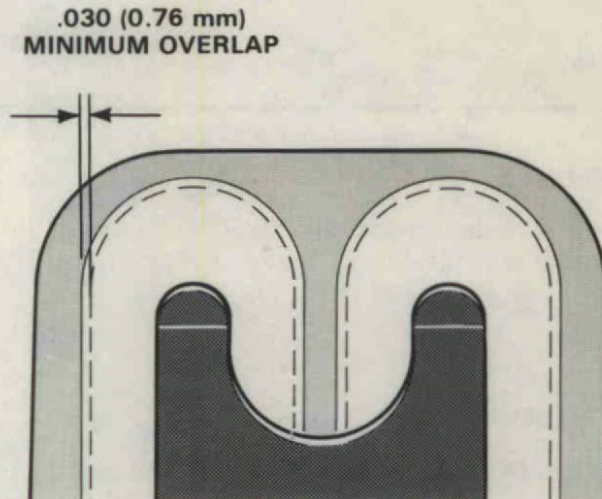


Figure 33. Measuring Reed Overlap.

D. Replace reed stop. Secure with screws and lockwashers.

Installation. To reinstall reed plate assembly, proceed as follows:

1. Apply a small bead of sealant (Special Tool No. T 8983) around reed plate opening of power head.
2. Place a new gasket on reed side of reed plate.
3. Place intake manifold with gasket in position on reed plate assembly. Install six (6) screws and tighten.
4. Install carburetor.
5. Install power head.

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SPECIAL TOOLS

Section	Part No.	Description	Use
4B - C-D IGNITION SYSTEM	T 8953	C-D Tester	To test stator output and secondary voltage
	T 8996	Ignition Tester	To test trigger output
4C - GENERATING SYSTEM	T 2938-1	Test Light	To make continuity tests
4D - MAGNETO IGNITION SYSTEM	T 2909	Knock-Off Nut	To remove flywheel
	T 2989	Flywheel Wedge	To remove flywheel
	T 2961	Lubricant - Rykon #2EP	
4E - ELECTRICAL STARTING SYSTEM	T 2951	Circuit Tracer	To troubleshoot 12 volt circuits

ELECTRICAL SYSTEM

GENERAL

The 9.9, 12 and 15 horse power outboard motors are available with either magneto ignition; manual start or C-D ignition; electric start. In addition, the C-D ignition has an alternator stator. The 250 and 280 Sailor models are offered with C-D ignition only.

OPERATION

Magneto Ignition. The rotation of the generating magnets in the flywheel creates a rotating magnetic field which cuts through the primary windings of the coil, generating voltage. While the ignition points are closed a complete circuit allows this current to flow through the primary coil winding building a very strong magnetic field in the secondary winding

of the coil. When the cam opens the ignition points, the magnetic field collapses. A very high voltage (approximately 18,000 volts) is induced in the secondary winding, and is routed to the spark plug via the high tension lead. When the ignition points are open, a self induced voltage remains in the primary windings. This voltage has no place to go except the condenser which is connected in the primary circuit. The condenser absorbs all the voltage creating an unbalanced condition in the system. In an attempt to distribute itself evenly the voltage races back and forth between the primary coil winding and the condenser. The oscillations "pump" the current from the secondary coil windings to the spark plug. Depressing the stop switch grounds the primary ignition circuit and stops the motor.

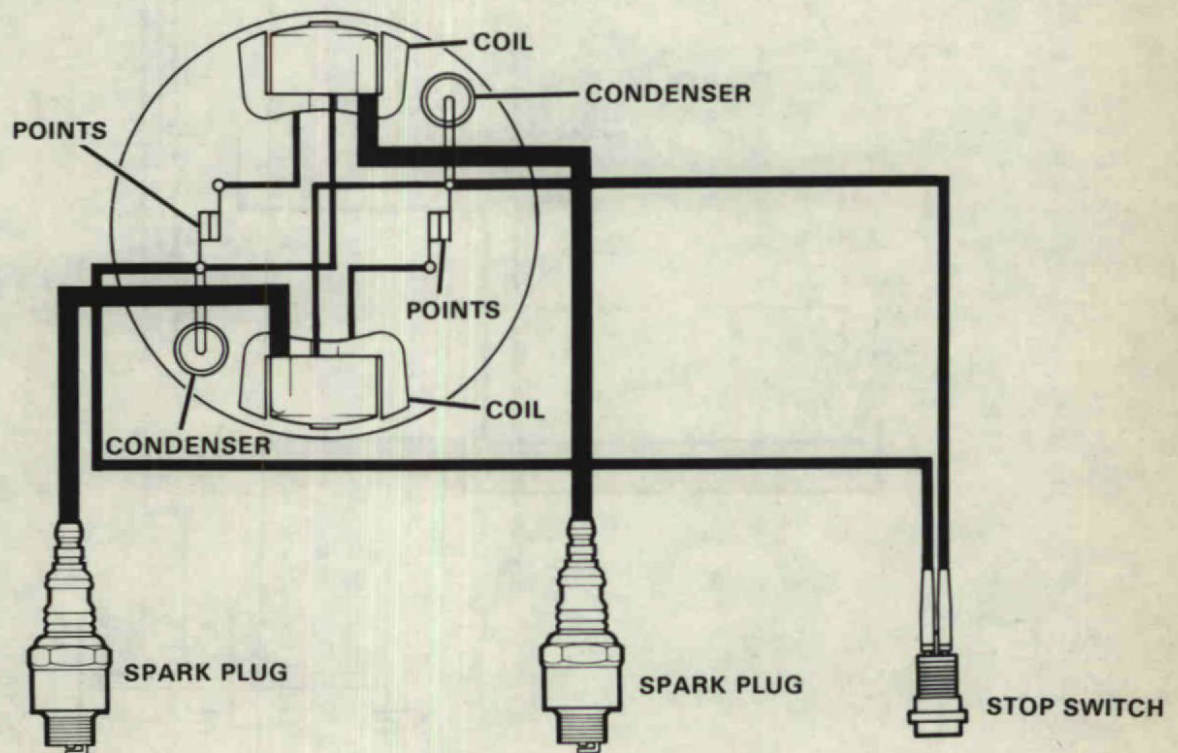


Figure 1. Magneto Ignition.

C-D Ignition System. The rotation of the generating magnets (located in the flywheel) creates a rotating magnetic field which cuts through the windings of the C-D stator and generates 225 volts AC. This voltage is fed to the C-D module, where it is converted to 225 volts D.C. by the full wave rectifier. The 225 volts D.C. is then placed on the storage capacitor. As the timing magnets rotate, they build up a magnetic field at the trigger coil for the No. 1 cylinder. When the flywheel reaches the proper position, the magnetic field collapses and induces a 2 volt maximum pulse in the No. 1 trigger coil. This 2 volt pulse causes the electronic switch to close which, in turn, allows the 225 volts on the capacitor to discharge into the ignition coil. The coil steps up the 225 volts to approximately 25,000 to 32,000 volts.

This voltage is fed to the spark plug where it ignites the fuel charge. Depressing the stop switch (to stop engine) shorts the C-D module to ground. Figure 2.

Generating System. In this system a 12 volt battery is used to provide starting illumination (boat lighting or navigational aids). In order to maintain a charge, the battery requires direct current.

The rotation of the generating magnets (located in the flywheel) creates a rotating magnetic field which cuts through the windings of the alternator stator and generates 12 volts A.C. This voltage is fed to a rectifier where it is converted to D.C. voltage and is directed to the battery .

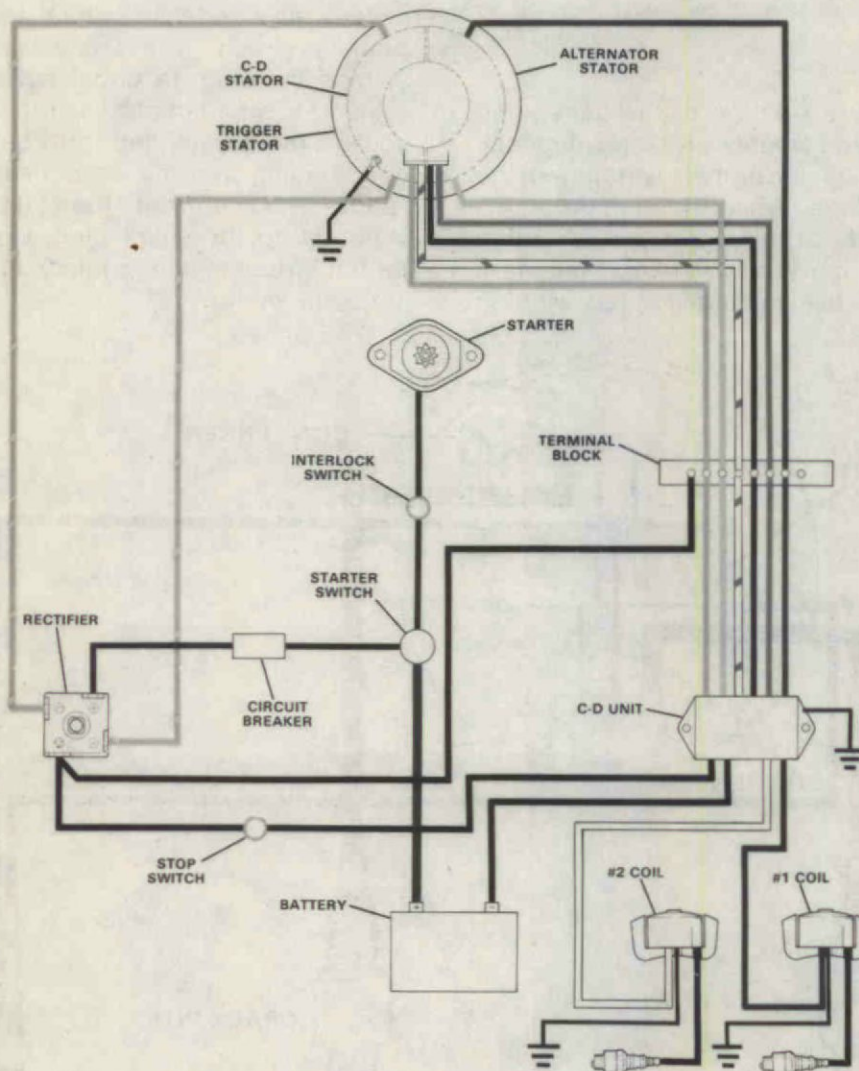


Figure 2. C-D Ignition.
(Color Schematic On Inside Back Cover.)

C-D IGNITION SYSTEM

GENERAL

The information in this subsection is concerned with troubleshooting the ignition system and replacement of the electrical components.

DESCRIPTION

The magneto capacitor discharge (C-D) ignition system consists of eight (8) major components: flywheel, C-D stator, trigger stator, stator ring, throttle cam, C-D module, coil (2 required), and spark plug, (2 required).

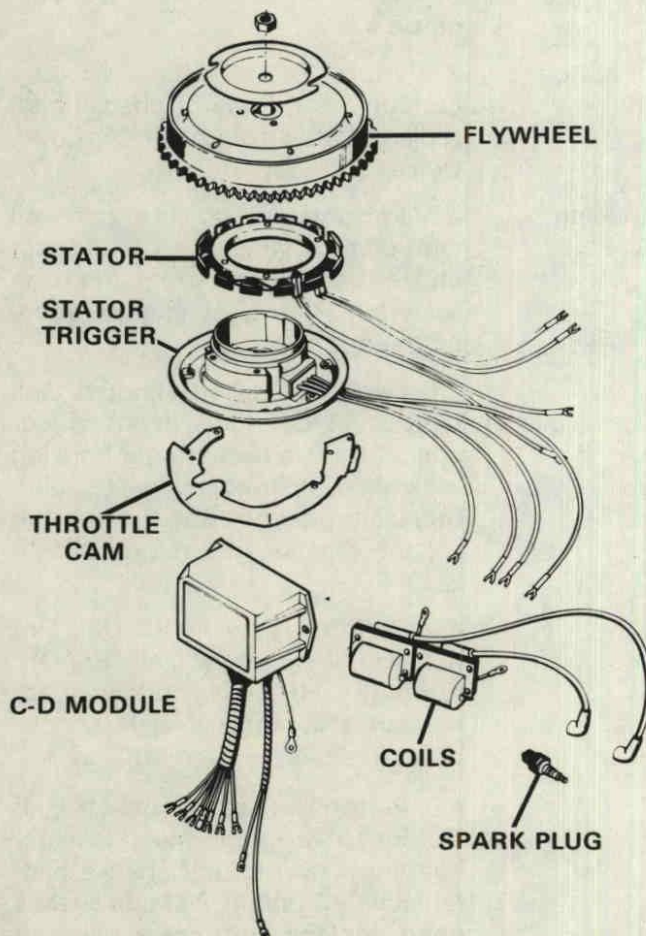


Figure 3. C-D Ignition System Components.

TROUBLESHOOTING

General. A malfunction in the C-D ignition will result in engine missing, surging or not running at all. These same symptoms can also be the result of insufficient, contaminated or excessive fuel. First determine that the cause of the problem is not the fuel system. See the Troubleshooting Guide for the fuel system.

Test Equipment. Troubleshooting the C-D ignition system involves the use of special test equipment. Figure 4.

! WARNING

To avoid possible shock hazards, do not handle C-D modules or tester lead wires during tests.

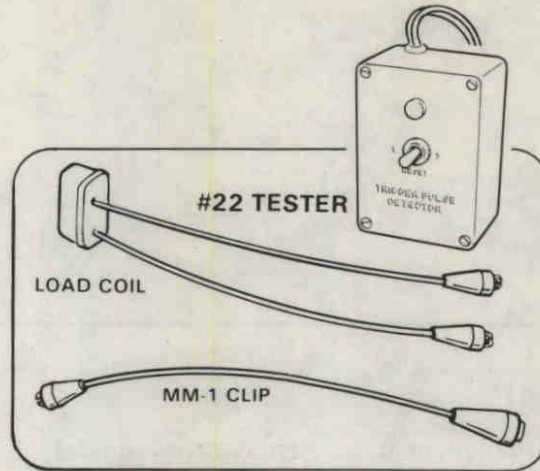
Preliminary Test. The preliminary test will determine if there is enough voltage present in the secondary wires to the spark plugs and if the plugs themselves are firing. Proceed with test as follows:

1. Clamp MM-1 clip over #1 spark plug wire and slide it down as close as possible to spark plug boot. (Spark plug wire remains connected to spark plug.)
2. With T8953 C-D tester, connect coil N lead to lead coming from MM-1 clip. Connect coil P lead to ground wire screw on terminal block.
3. Set tester dial on 75- crank engine: If tester lamp lights, cylinder is firing normally.
4. Repeat test on remaining cylinder. Merely unclip MM-1 clip from #1 lead and install on #2 and push reset button to put light out on C-D tester if it came on in previous check.
5. If light does not come on one or both of the cylinders, refer to the appropriate section for either a failure on one or both cylinders.

Determining The Problem. A problem in the C-D ignition system can be determined by following the systematic test procedures which follow.



T 8953 C-D TESTER



T 8996 IGNITION TESTER

Figure 4. Equipment Required to Perform Tests.

Problem	Possible Cause	Test Procedure
Engine does not fire on either cylinder (no spark at the plugs).	1. Shorted stop switch.	1. Remove one wire from stop switch. If both cylinders now fire, replace stop switch. If this is not the problem, proceed with possible cause #2.
	2. Defective alternator stator assembly. (Charge Coil)	2. Perform Test #1 (Stator Winding Output Test). If stator checks bad, replace stator. If stator checks good, proceed to Step 3A.
	3. Defective trigger housing (both triggers defective).	3.A Perform Test #2 (Trigger Coil Output #1 Cylinder). If #1 trigger checks bad, replace trigger housing assembly. If trigger checks good, proceed to Step 3B. 3.B Perform Test #3 (Trigger Coil Output #2 Cylinder). If #2 trigger checks bad, replace trigger housing assembly. If trigger checks bad, replace trigger housing assembly. If trigger checks good, proceed to Step 4.
	4. Defective C-D box.	4.A Perform Test #4 (C-D Unit Output to #1 Ignition Coil Primary Winding). If unit checks bad, replace C-D unit. If unit checks good, proceed to Step 4B. 4.B Perform Test #5 (C-D Unit Output to #2 Ignition Coil Primary Winding). If C-D unit checks bad, replace C-D unit. If C-D unit checks good, replace both spark plugs. If engine still does not fire, replace both ignition coils.

NOTE

Ignition coil continuity can also be checked as follows:

Primary Continuity - with ohmmeter on R x 1 scale, attach positive lead to terminal post and negative lead to ground - D.C. resistance in ohms should be .03 - .05.

Secondary Continuity - With ohmmeter on R x 1 scale, attach positive lead to terminal post and

negative lead to end of secondary wire (in sparkie boot). D.C. resistance in ohms should be 230 - 260.

NOTE

If a part is replaced in items 1 thru 4 above, and now one cylinder is firing normally, continue thru the sequence until the remaining cylinder failure is located.

Problem	Possible Cause	Test Procedure
Engine fires on #1 cylinder but does not fire on #2 cylinder (no spark at #2 plug).	<ol style="list-style-type: none">1. Defective spark plug.2. Defective C-D unit.3. Defective trigger housing assembly.4. Defective ignition coil on #2 cylinder.	<ol style="list-style-type: none">1. Replace spark plug on #2 cylinder. If engine does not fire on #2 cylinder, proceed to Step 2.2. Perform Test #5 (C-D Unit Output to #2 Ignition Coil Primary Winding). If C-D unit tests good, replace the ignition coil. If the C-D unit tests bad, proceed to Step #3.3. Perform Test #3 (Trigger Coil Output #2 Cylinder). If trigger tests good, replace the C-D unit. If trigger tests bad, replace the trigger housing assembly.4. Verify coil failure by continuity test - see above.
Engine fires on #2 cylinder but does not fire on #1 cylinder (no spark at #1 plug).	<ol style="list-style-type: none">1. Defective spark plug.2. Defective C-D unit.3. Defective trigger housing assembly.4. Defective ignition coil on #1 cylinder.	<ol style="list-style-type: none">1. Replace spark plug on #1 cylinder. If engine still does not fire on #1 cylinder, proceed to Step #2.2. Perform Test #4 (C-D Unit Output to #1 Ignition Coil Primary Winding). If C-D unit tests good, replace the #1 ignition coil. If C-D unit tests bad, proceed to Step #3.3. Perform Test #2 (Trigger Coil Output #1 Cylinder). If trigger tests good, replace the C-D unit. If trigger tests bad, replace the trigger housing assembly.4. Verify coil failure by continuity test - see previous page.

TROUBLESHOOTING TESTS

Test #1 — Stator Winding (Charge Coil) Output

Equipment: #22 Tester, T8953 Tester.

A. Low Voltage Output

1. Disconnect blue wire from stator at terminal block.
2. Disconnect yellow wire from stator at terminal block and connect it to the ground terminal on the terminal block, Figure 5.

3. Connect "P" lead (red) of #22 Tester to blue wire, Figure 5.
4. Connect "N" lead (yellow) of #22 Tester to Ground terminal, Figure 5.
5. Place switch of #22 Tester in #2 position.
6. Crank engine:
 - A. Tester lamp lights - stator low voltage winding is OK.
7. Reconnect blue wire to terminal block.
8. Proceed to second part of test on next page.

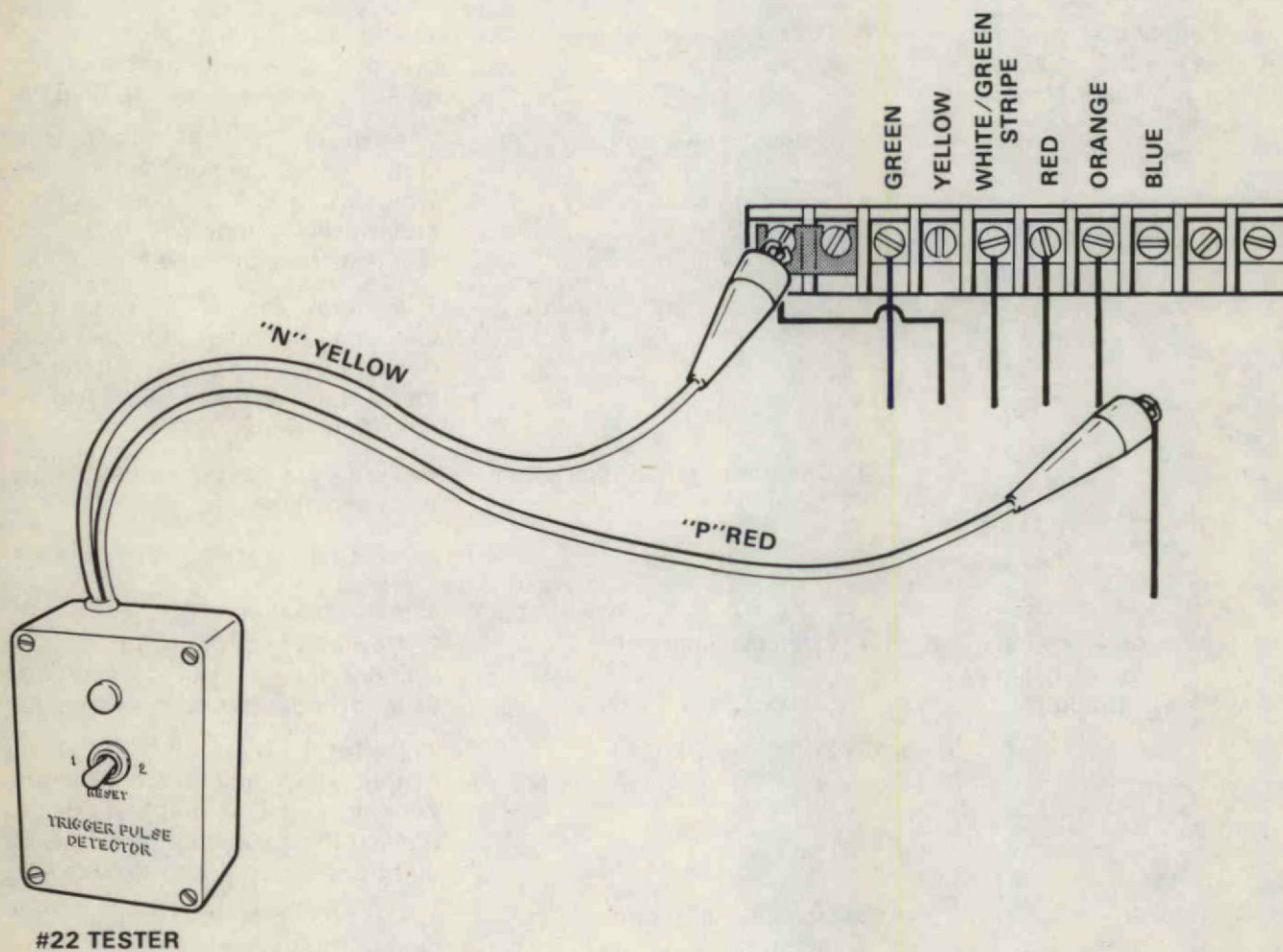


Figure 5

B. High Voltage Output

1. Disconnect yellow wire from ground (Step 2 on previous page). Resecure ground terminal.
2. Connect "P" lead (red) of T 8953 Tester to yellow wire, Figure 6.
3. Connect "N" lead (yellow) of T8953 to ground

terminal, Figure 6.

4. Set Tester dial to #10.

5. Crank engine:

A. Tester lamp lights - stator high voltage winding is OK.

6. Reconnect yellow wire to terminal block.

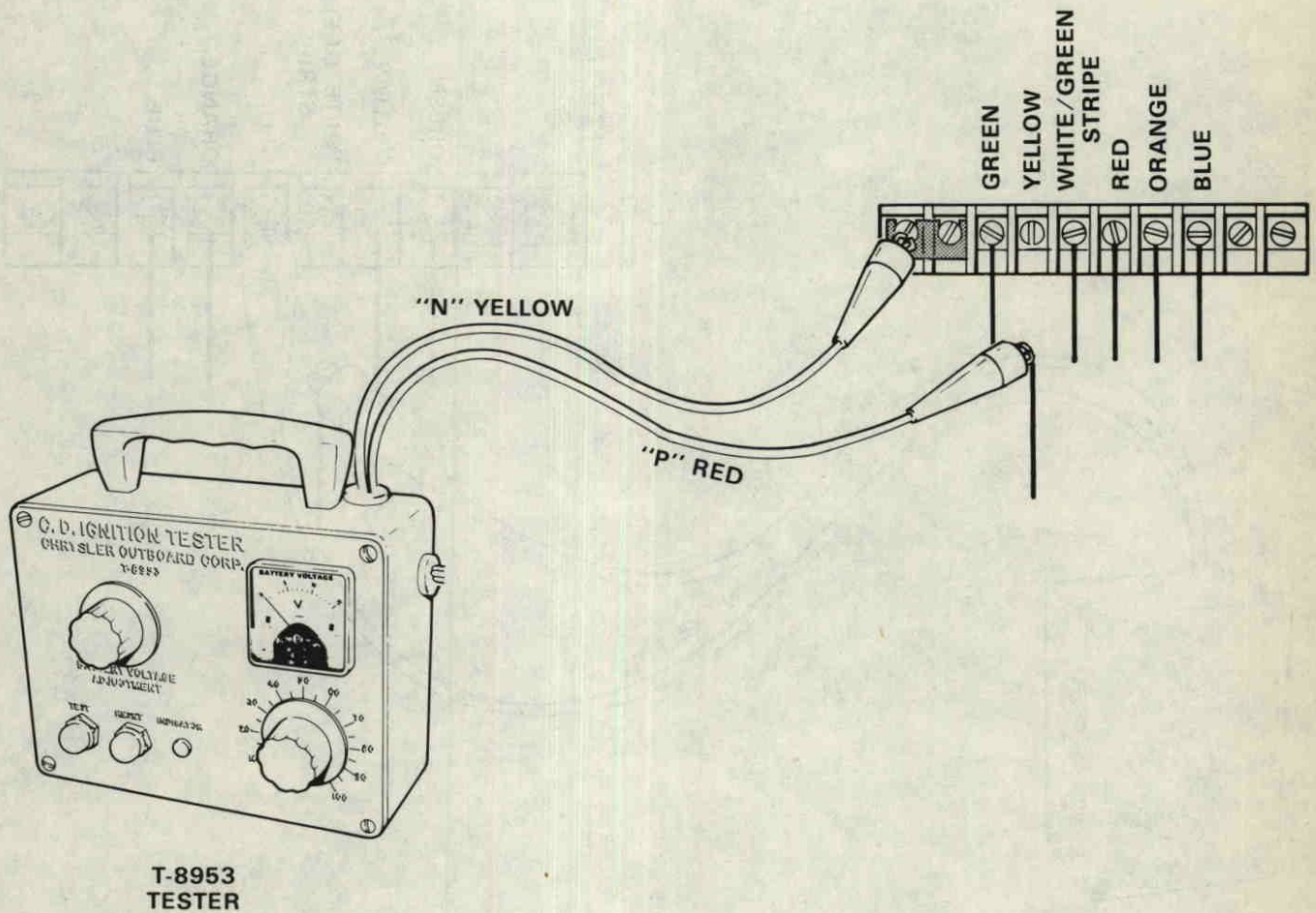


Figure 6

Test #2 — Trigger Coil Output #1 Cylinder

Equipment: #22 Tester

1. Disconnect white/green wire from trigger housing at terminal block.
2. Connect "P" lead (red) of #22 Tester to white/green wire, Figure 7.

3. Connect "N" lead (yellow) of #22 Tester to red wire terminal on terminal block, Figure 7.
4. Place switch of #22 Tester in #1 position.
5. Crank engine:
 - A. Tester lamp lights - trigger coil output is OK.
6. Reconnect white/green wire.

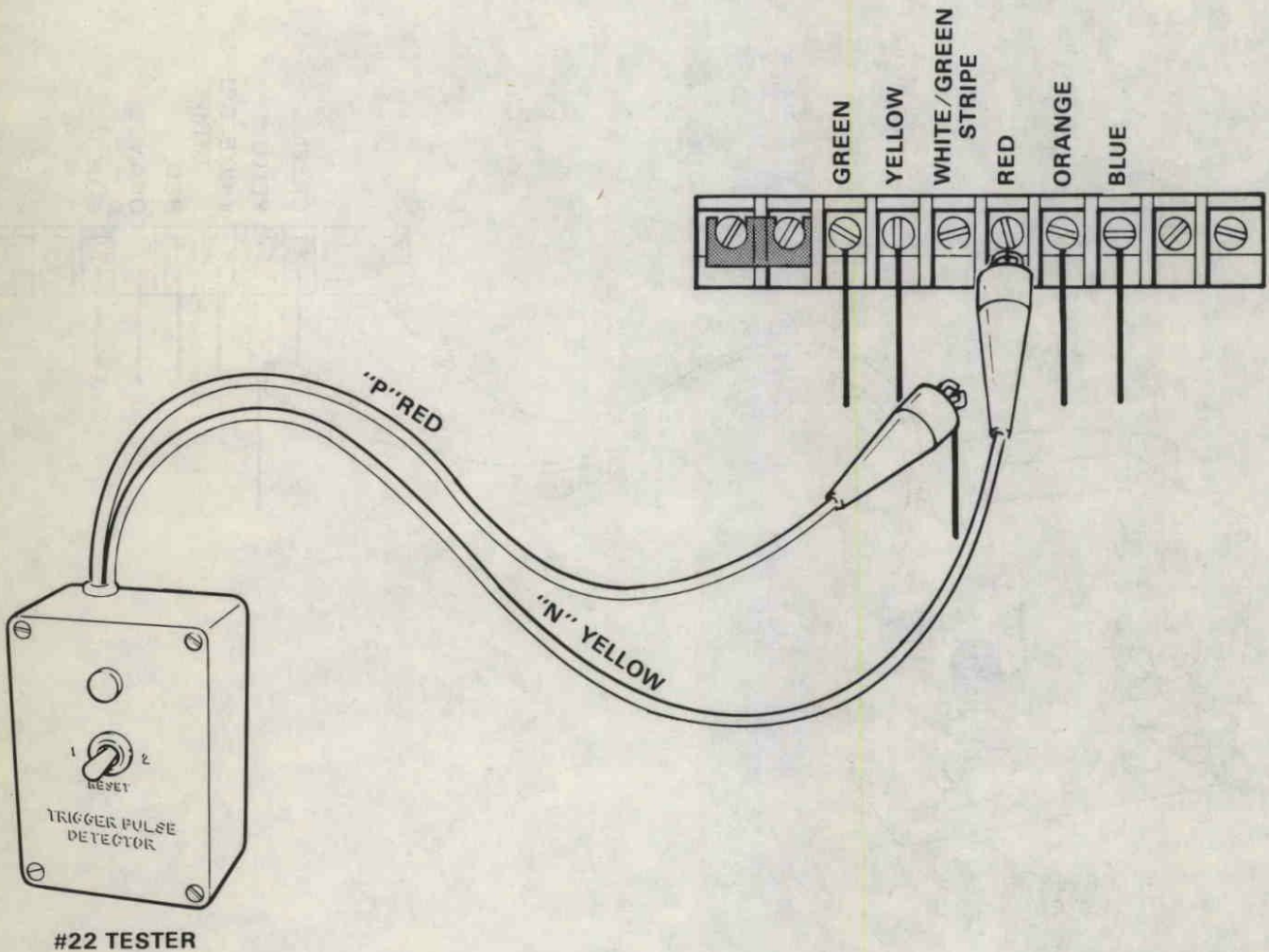


Figure 7

TEST #3 — Trigger Coil Output #2 Cylinder

Equipment: #22 Tester

1. Disconnect orange wire from trigger housing at terminal block.
2. Connect "P" lead (red) of #22 Tester to orange wire, Figure 8.

3. Connect "N" lead (yellow) of #22 Tester to green wire terminal on terminal block, Figure 8.
4. Place switch of #22 Tester in #1 position.
5. Crank engine:
 - A. Tester lamp lights - trigger coil output is OK.
6. Reconnect orange wire to terminal block.

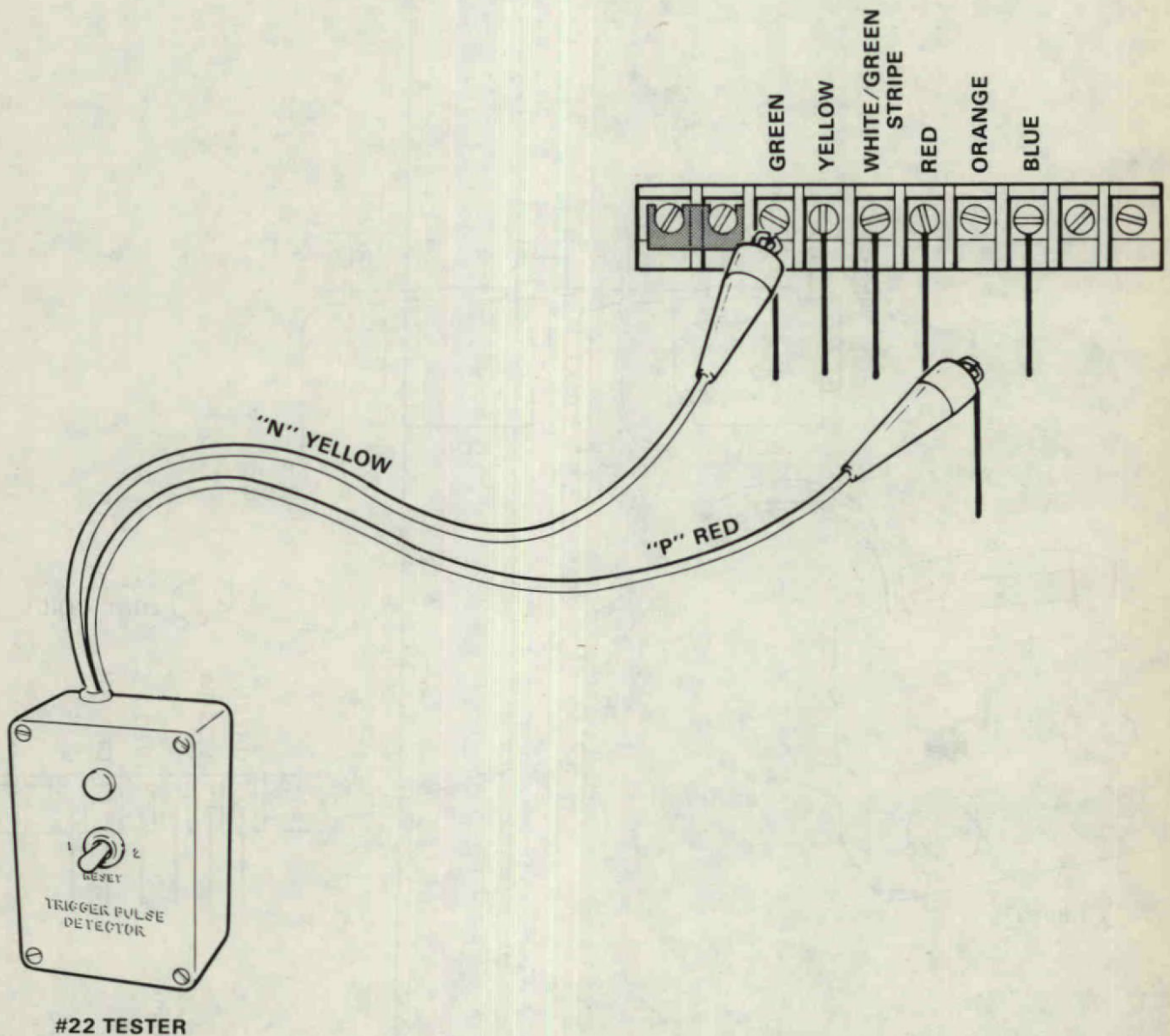


Figure 8

TEST #4 — C-D Unit Output to #1 Ignition Coil Primary Winding

Equipment: T8953 Tester, Load Coil.

1. Disconnect brown wire from C-D unit at #1 ignition coil.
2. Clip one lead of load coil to brown wire from C-D unit. Clip other load coil lead to ground terminal at terminal block, Figure 9.
3. Connect Tester "P" lead (red) to brown wire from

C-D unit (same wire as load coil in Step #2), Figure 9.

4. Connect Tester "N" lead (yellow) to ground terminal, Figure 9.
5. Set Tester dial to #50.
6. Crank engine:
 - A. Tester lamp lights - C-D unit is OK.
7. Reconnect brown wire to #1 ignition coil.

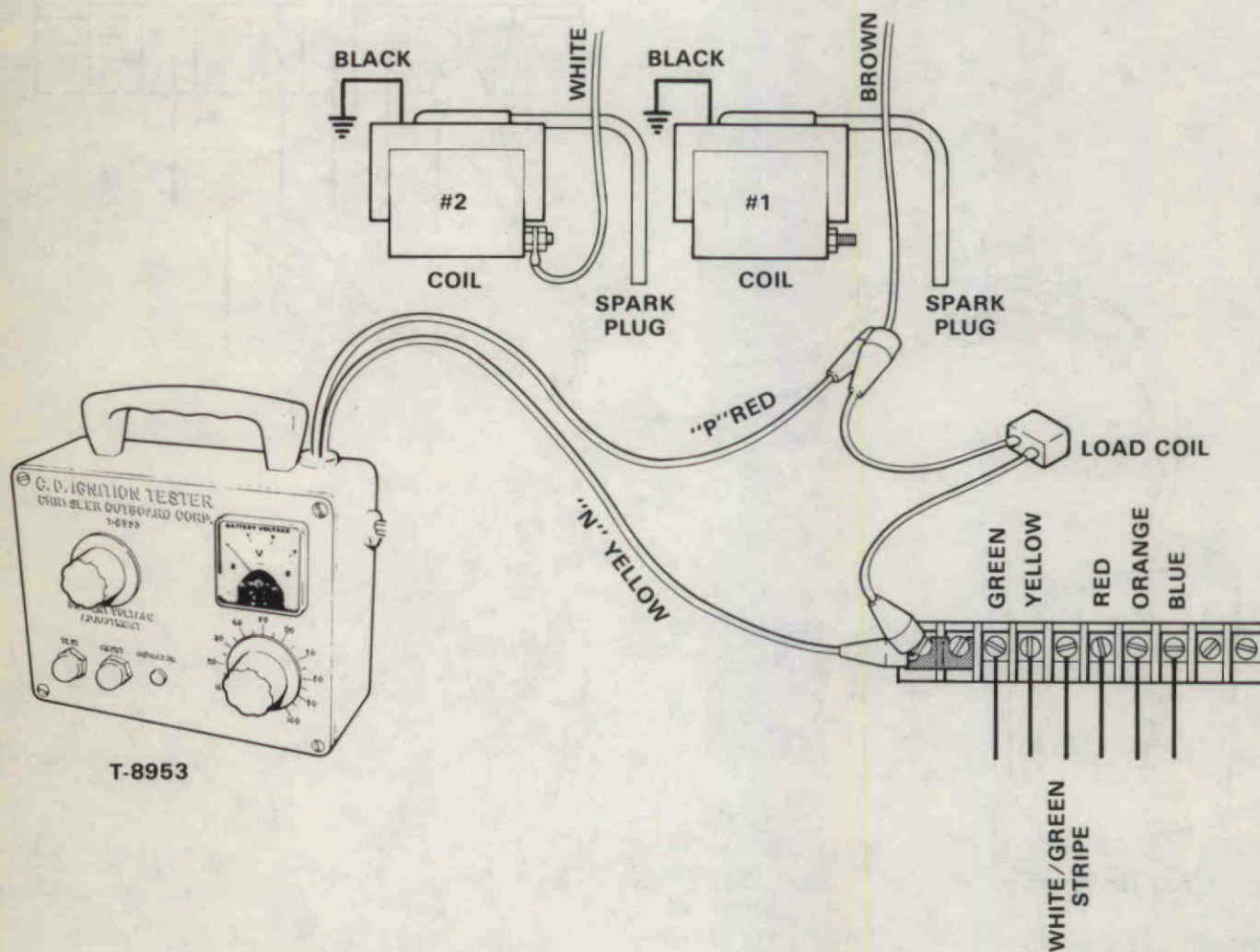


Figure 9

Test #5 — C-D Unit Output to #2 Ignition Coil Primary Winding

Equipment T8953 Tester, Load Coil.

1. Disconnect white wire from C-D unit at #2 ignition coil.
2. Clip one lead of load coil to white wire from C-D unit. Clip other load coil lead to ground terminal at terminal block, Figure 10.
3. Connect Tester "P" lead (red) to white wire from

C-D unit (same wire as load coil in Step #2), Figure 10.

4. Connect Tester "N" lead (yellow) to ground terminal, Figure 10.
5. Set Tester dial to #50.
6. Crank engine:
 - A. Tester lamp lights - C-D unit is OK.
7. Reconnect white wire to #2 ignition coil.

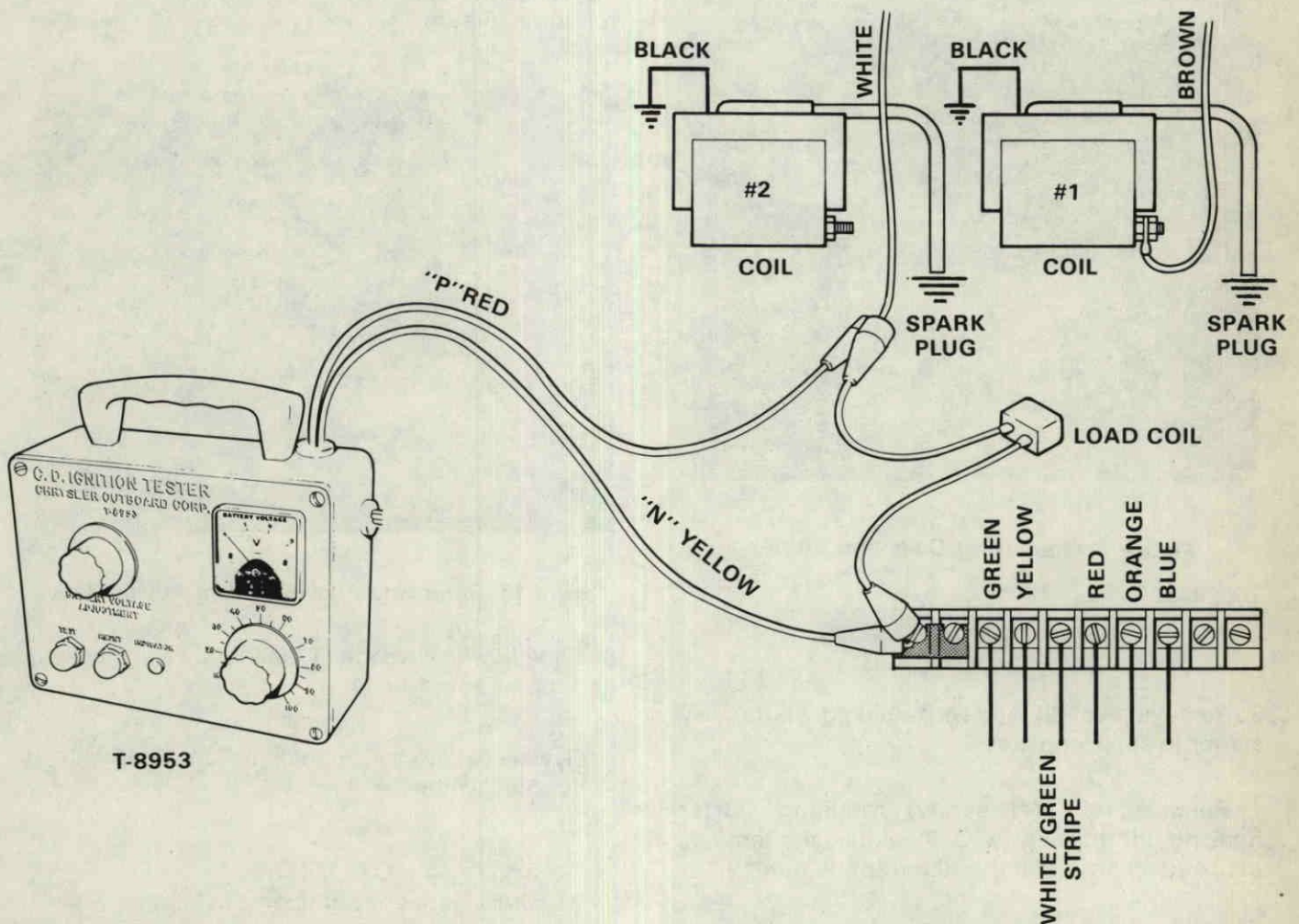


Figure 10

FLYWHEEL

Description. The flywheel contains two (2) sets of magnetic rings. The generating magnets are located around the outer circumference of the flywheel. The timing magnets are located at the hub of the flywheel.

Removal. To remove flywheel for inspection or replacement, proceed as follows.

1. Disconnect battery.
2. Remove coils, lay in support plate, Figure 11.

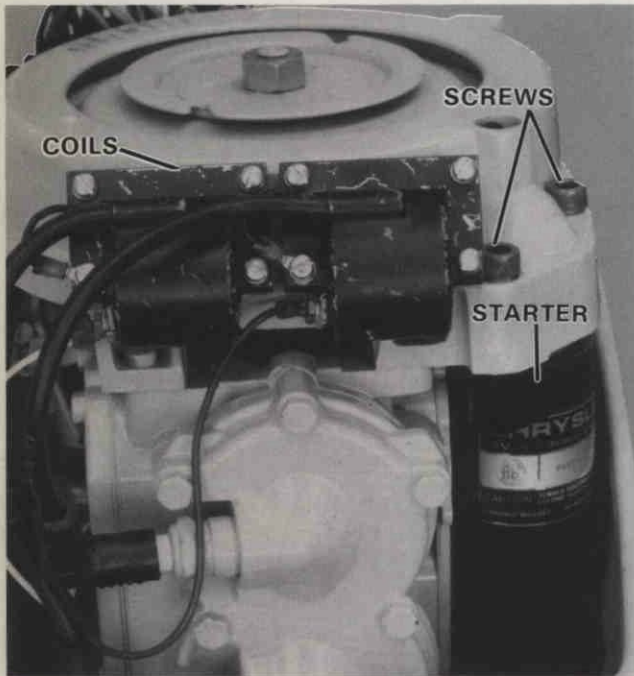


Figure 11. Removing Coils and Starter.

3. Remove two (2) screws retaining starter, lay starter in support plate.
4. Remove four (4) screws retaining starter housing, lift housing (w/C-D module and terminal block attached) up and to the front, Figure 12.
5. Remove nut securing flywheel to crankshaft.
6. Remove emergency starter collar from flywheel.



Figure 12. Removing Starter Housing.

7. Thread knock off nut (Special Tool No. T 2909) on crankshaft as far as it will go then back nut off two full turns. Figure 13.

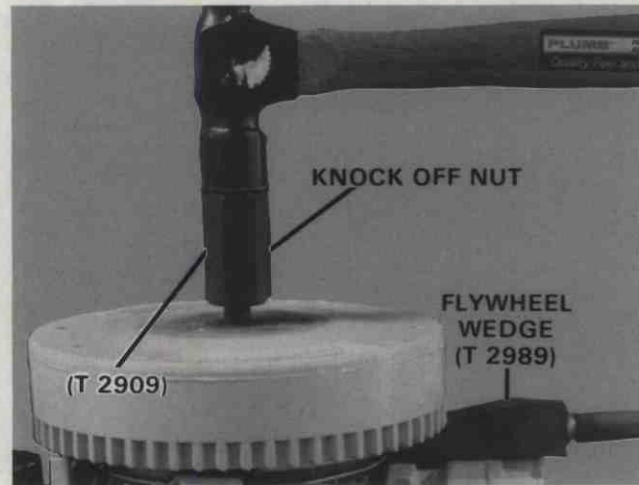


Figure 13. Removing Flywheel from Power Head.

8. Slide flywheel wedge (T 2989) between flywheel and top of power head.

NOTE

Flywheel keyway should be in line with flywheel wedge.

CAUTION

Be sure wedge does not come in contact with stator.

9. Pry up on flywheel with wedge and sharply tap knock-off nut with 16 oz. hammer.

CAUTION

Do not strike nut with excessive force as this can damage crankshaft and crankshaft bearings.

10. Remove knock-off nut and lift flywheel from crankshaft.

Inspection And Repair. The magnetic rings are permanently assembled to the flywheel and cannot be ordered or serviced as a separate item. If the magnets are badly damaged, a new flywheel complete with new magnets will be required. Carefully inspect flywheel for cracks and breaks.



WARNING

Cracked or chipped flywheels must be replaced. At high engine RPM a damaged flywheel can fly apart, throwing shrapnel over a large area.

Inspect crankshaft and flywheel tapers for fretting and working. If there is evidence of this condition or if engine has had 25 or more hours of operation, the flywheel bore must be lapped. To lap flywheel, proceed as follows:

1. Remove flywheel key from crankshaft.
2. Apply a light coating of valve grinding compound to tapered portion of crankshaft.
3. Install flywheel on crankshaft and rotate flywheel gently back and forth about 1/4 turn. Do not spin flywheel completely around crankshaft.
4. Rotate flywheel 90° and repeat above operation.
5. Remove flywheel, wipe compound off crankshaft and flywheel. Taper in bore of flywheel should have a minimum of 90% surface contact with taper on crankshaft.
6. If above condition is met, then thoroughly clean compound from flywheel, crankshaft and keyways.

Installation. Check crankshaft and flywheel tapers for traces of oil. This assembly must be perfectly dry. Swab tapered surfaces with solvent and blow dry with compressed air.



WARNING

Wear safety glasses when working with compressed air.

To install the flywheel, proceed as follows:

1. If flywheel key has been removed, reassemble key to crankshaft with outer edge of key parallel to center line of crankshaft, Figure 14.

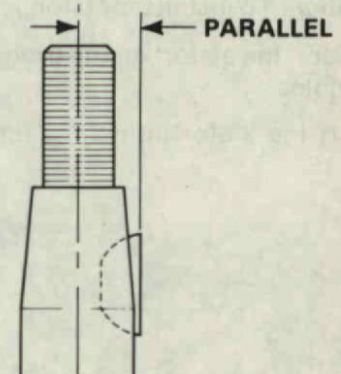


Figure 14. Position of Flywheel Key Prior to Assembly.

2. Install flywheel and emergency starter collar over crankshaft and thread on nut.

NOTE

Emergency collar **must** index into holes on top side of flywheel to prevent rotation!

Torque nut to 45 foot pounds (6.21 kg/m).

STATOR

Description. The C-D stator is simply a long wire wound around pole pieces. Three poles are devoted to the ignition system, nine to the generating system. Both have their own set of leads. It is mounted under the flywheel where the generating magnets rotate around the poles.

Removal. To remove the stator for inspection or replacement, proceed as follows:

1. Remove flywheel, see "Flywheel - Removal".
2. Disconnect the stator leads at the connectors..
3. Remove the four screws retaining the stator to the trigger stator.
4. Remove stator.

Cleaning And Inspection. Use a brush or compressed air to clean the stator windings, poles and laminations. Clean dirty pole laminations with No. 400 or finer sand paper. Inspect for loose connections or burnt insulation at the point where the lead wires connect to poles.



WARNING

Wear safety glasses when working with compressed air.

Installation. To install the stator, proceed as follows:

1. Position the stator, on the trigger stator; aligning screw holes.
2. Insert the stator mounting screws and tighten. Figure 15.

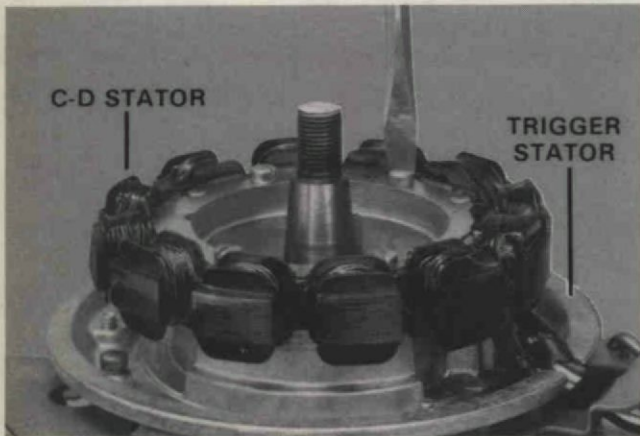


Figure 15. Assembling C-D Stator to Trigger Stator.

3. Attach the stator lead wires to the connectors.
4. Install flywheel, see "Flywheel - Installation".

TRIGGER STATOR

Description. The trigger stator is mounted under the flywheel. It contains two trigger coils, located 180° apart. One trigger coil controls the No. 1 cylinder and the other controls the No. 2 cylinder. The timing magnets (located in the hub of the flywheel) rotate inside the trigger stator adjacent to the trigger coils. Figure 16.

Removal. To remove the trigger stator for inspection or replacement, proceed as follows:

1. Remove flywheel, see "Flywheel - Removal".
2. Remove C-D stator, see "Stator - Removal".
3. Disconnect the trigger stator lead wires at the terminal block and ground wire from power head.
4. Remove the trigger stator mounting screws.
5. Lift off trigger stator, unhook throttle cam link.

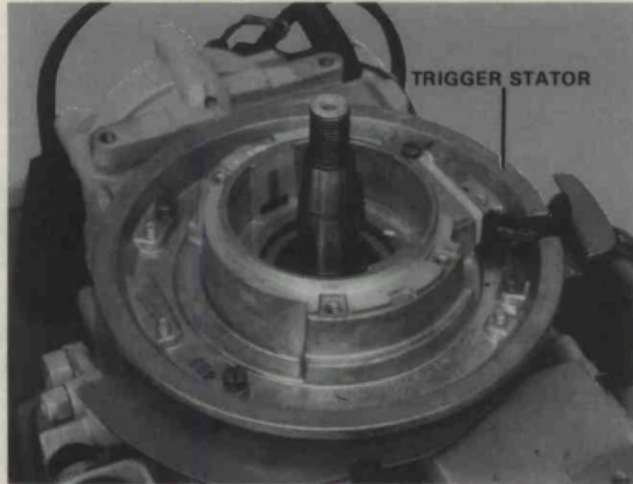


Figure 16. Removing Trigger Stator from Power Head.

Cleaning And Inspection. Clean the trigger stator with a brush or compressed air. Clean trigger coils with No. 400 or fine sand paper. Inspect the four lead wires for cracked or worn insulation. Inspect and clean ground wire terminal and mounting surface to insure good electrical contact.



WARNING

Wear safety glasses when working with compressed air.

Installation. To install the trigger stator, proceed as follows:

1. Hook throttle cam link to cam. Position trigger stator over crankshaft and align holes with stator ring.
2. Fasten trigger stator to stator ring.
3. Connect trigger stator leads and connect ground wire to power head.

C-D MODULE

Description. The C-D module is a sealed unit. It contains a full wave rectifier, storage capacitor and S.C.R. (silicon controlled rectifier) - which is an electronic switch.

The module is mounted to the starter housing. Figure 17.

Removal. To remove the C-D module, proceed as follows:



Figure 17. Removing C-D Module from Power Head.

1. Disconnect battery.
2. Disconnect module lead wires at the terminal block.
3. Disconnect lead wire at stop switch.
4. Disconnect brown and white lead wires at coils.
5. Remove the two module mounting screws; remove module.

Cleaning And Inspection. Clean module case with a dry rag. Inspect case for cracks. Inspect all lead wires for worn or cracked insulation.

Installation. To install C-D module, proceed as follows:

1. Route long white wire and brown wire down above carburetor toward port side of engine under fuel pump and boss for magneto control lever. Connect brown wire to terminal on starboard coil (#1) and white wire to terminal on port coil (#2).
2. Connect black lead (from C-D module) with slide terminal to starboard terminal on stop switch.
3. Place C-D module on starter support. Install starboard mounting screw with ground lead from C-D module under head of screw and tighten securely. Install port mounting screw with black end of battery cable under head of screw and tighten securely.

4. Route remaining lead wires up behind terminal block and connect to terminal block as follows: #2 green, #3 yellow, #4 white/green stripe, #5 red, #6 orange, #7 blue, Figure 18.

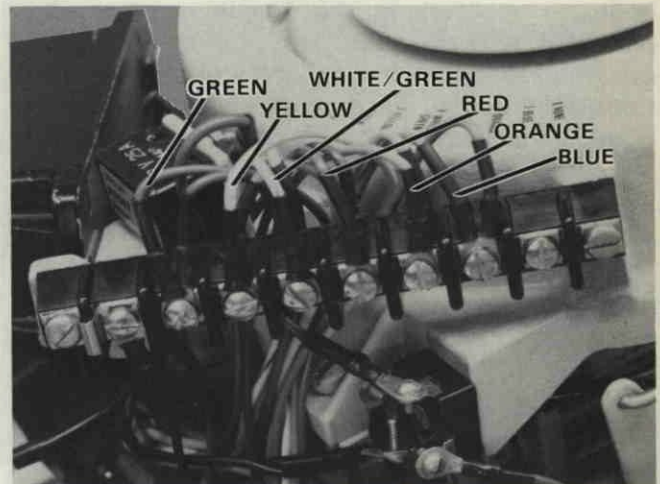


Figure 18. Connecting C-D Leads to Terminal Block.

5. Connect battery leads to battery terminals.

SPARK PLUGS

Description. A spark plug consists of two electrodes separated from each other by an air gap. The side electrode is connected to the shell of the spark plug. The center electrode is completely insulated from the shell.

The high voltage, produced in the secondary coil winding (located in the C-D module), is applied to the center electrode and causes a spark to jump the gap to the side electrode. This spark ignites the fuel-air mixture and starts the combustion process in the cylinder.

The gap between electrodes is critical because it affects the entire range of engine performance — starting, idling, accelerating, power and top speed.

Removal. Use a 13/16" deep well socket with rubber insert to protect spark plug insulation.

Inspection. In nearly every case of spark plug failure, the cause must be corrected before new or reconditioned spark plugs are installed. Otherwise, servicing will be needed again in a short time.

Engine misfire or generally poor operation is often caused by spark plugs in poor condition or with improper gap setting. The first thing to do after removing a spark plug is to carefully note its condition as this is often an indicator of the ignition trouble. Plugs fail for various reasons. Often the porcelain insulator cracks or becomes coated with oil, carbon or other deposits. This can cause the high voltage ignition impulse to pass from the center electrode to ground without jumping the spark gap. As an engine operates, the electrodes are gradually burned or worn away. In time, the gap becomes so wide that the available ignition voltage cannot jump the gap and the engine misfires.

Servicing. Every 100 hours remove plug, check condition and reset gap. Good operating conditions are indicated if plug has light coating of gray or tan deposit. A dead white, blistered coating could indicate overheating. A black (carbon) coating can indicate an "overrich" fuel mixture caused by improper carburetor adjustment or faulty recirculation system.

NOTE

DO NOT sandblast, wire brush, scrape or otherwise service plug in poor condition — best results are obtained with new plug. Set spark gap to .030" (0.76 mm).

Installation. Reinstall plug and torque to 120 to 180 inch pounds (140 - 205 kg/cm).

GENERATING SYSTEM**GENERAL**

The information in this subsection concerns troubleshooting and replacing the parts of the generating system.

DESCRIPTION

The generating system has 5 parts: flywheel, stator, rectifier, circuit breaker and battery.

TROUBLESHOOTING

When diagnosing a failure in the generating system, care must be taken to think of the system as a whole. Poor electrical connections in boat wiring, worn or cracked insulation of wires, corroded battery terminals, system overloading or a neglected, improperly serviced battery often give false impressions that a problem exists within the motor when it does not. A careful, visual inspection of the wiring should be made before resorting to meter testing.

Problem	Possible Cause	Test Procedure/Remedy
Battery power insufficient to start engine.	1. Battery terminals corroded.	1. Clean terminals and cables. Reconnect battery. If this is not problem, proceed with possible cause #2.
	2. Battery defective.	2. Test battery. See Battery Testing procedure (Section 4E). If battery checks good proceed with possible cause #3.
	3. Boat wiring defective.	3. Test boat wiring for short or damage. Perform Test #1. If wiring is not the problem, proceed with possible cause 4.
	4. Insufficient voltage produced to charge battery.	4A. Electrical system overloaded with too many electrical accessories. Perform Test #2. If accessory amperage draw is less than 4 amps, proceed to 4B. 4B. Generating system producing insufficient current, perform Test #3. If stator output is good proceed with possible cause 5.
	5. Rectifier defective.	5. Test rectifier, perform Test #4.
	6. Circuit breaker defective.	6. Test circuit breaker for continuity, perform Test #5.

Problem	Possible Cause	Test Procedure/Remedy
	7. Running engine at low speed (below stator cut-in RPM - 1000 RPM).	7. Turn off accessories and run engine at high speed or charge battery manually.
Problem	Possible Cause	Test Procedure/Remedy
Battery overcharged.	1. Sustained high speed operation.	1. Turn on accessories when running at high speed.

Testing.

Test #1. To test boat wiring for continuity use Special Tool No. T 2938-1 circuit continuity tester. Do tests systematically as follows:



WARNING

Disconnect battery prior to testing.

NOTE

Do not hook tester in series with any lights. Current drawn by the light will drain tester batteries.

1. Connect tester at each end of wire being tested.
2. Failure of test lamp to light anywhere along the circuit indicates a problem in that particular section. Replace section of wire and continue test. A dim light indicates excessive current draw or a short.

Test #2. Determining accessory current draw. Equipment: 10 amp or more, full scale ammeter.

1. Connect ammeter between the positive battery terminal and the accessory feed wire.

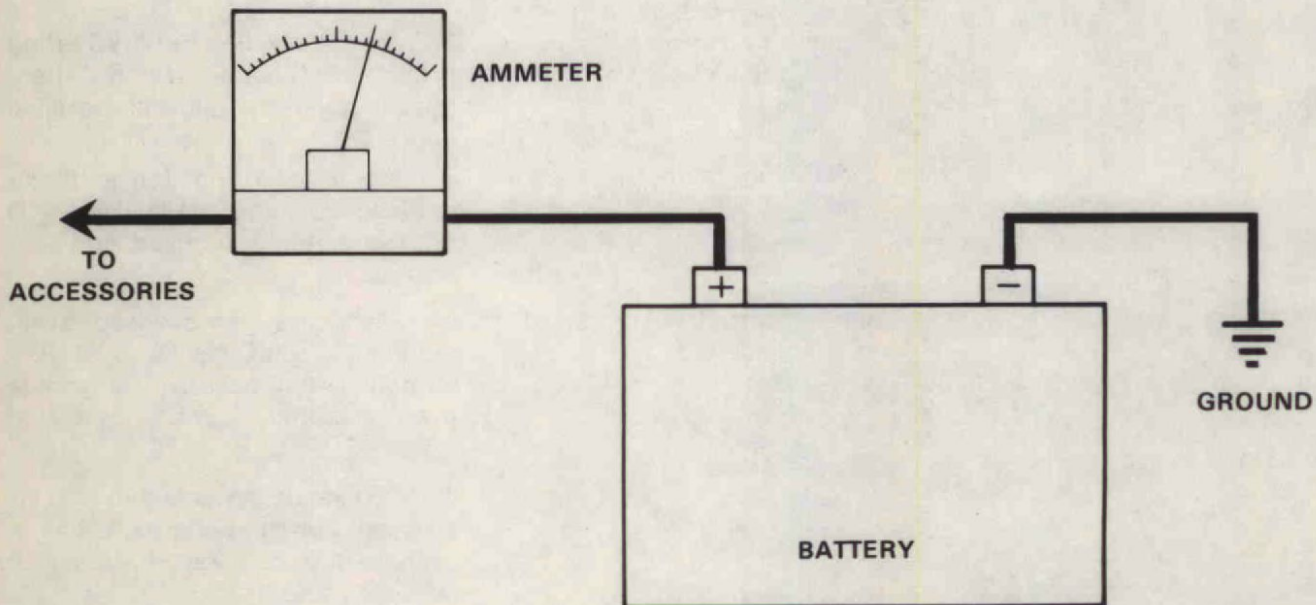


Figure 19. Test #2.

2. Start motor and turn on accessories. Total accessory current draw must not be greater than 4 amps.

Test #3. Testing stator. Equipment: 10 amp or more, full scale ammeter; volt-ohm meter or T 2938-1

continuity tester.

1. **With engine running** connect ammeter between positive (+) battery cable and positive (+) battery terminal.

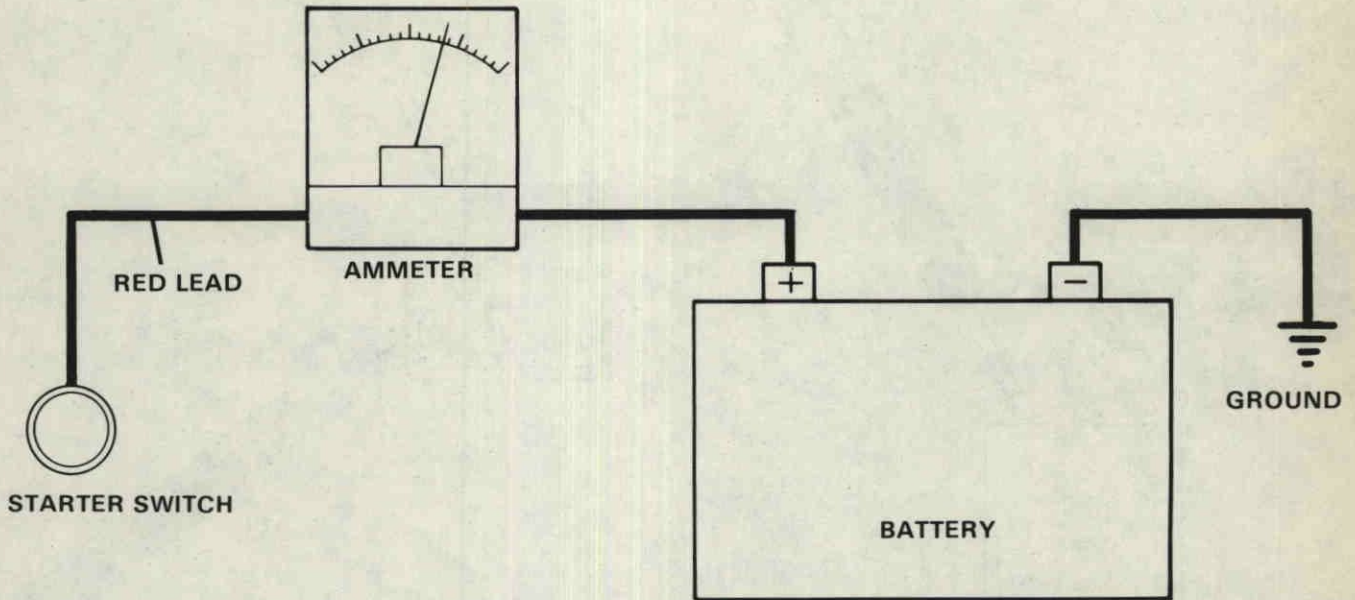


Figure 20. Test #3.

2. Reading should be 3.5 amps (minimum) @ 4000 R.P.M. cut-in R.P.M. is 1000 R.P.M., 1 amp minimum, should be seen at 2000 R.P.M.

3. **With engine not running**, disconnect stator leads (green/yellow stripe) from rectifier, connect ohm meter, low ohms scale or T 2938-1 continuity tester in series with stator. If tester lights or ohm reading is $1.5 \pm .5$ ohms stator is good.

Test #4. Testing rectifier. Equipment: ohm-meter or T 2938-1 continuity tester.

1. Disconnect all leads to rectifier.
2. Set ohm meter to RX1K or 10 K scale.
3. Connect red tester lead to negative (∇) terminal, black tester lead to one "AC" (\sim) terminal. Figure 21.
 - A. Tester should indicate low resistance.
 - B. Move black tester to other "AC" (\sim) terminal, resistance reading should be the same as Step A.

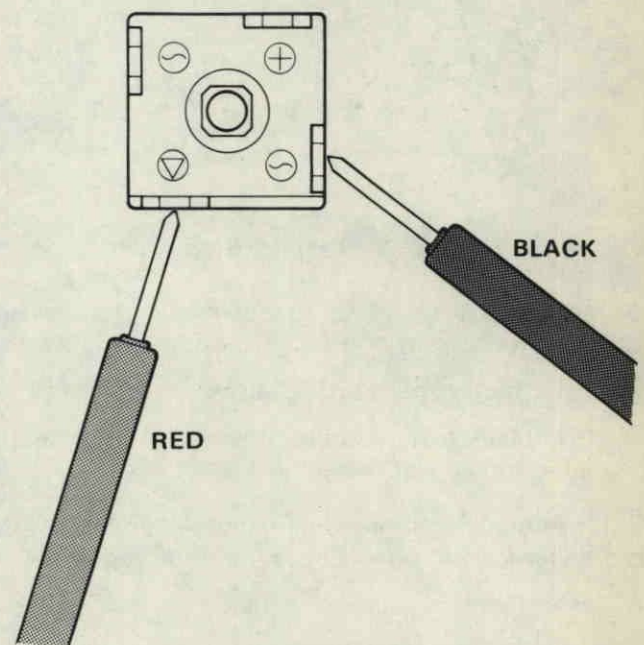


Figure 21. Test #4. Step 3.

4. With red tester lead on negative (∇) terminal, move black tester lead to positive (+) terminal. Figure 22.

A. Tester should indicate 2X reading found at AC (\sim) terminals.

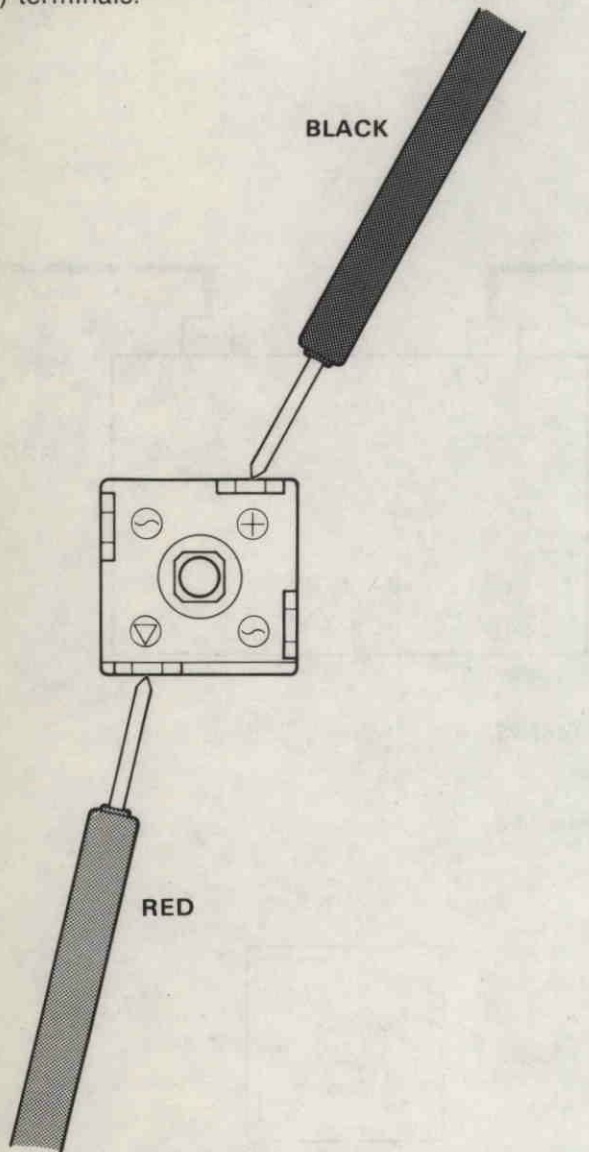


Figure 22. Test #4. Step 4.

5. Move red tester lead to positive (+) terminal, black tester lead to one AC (\sim) terminal. Figure 23.

A. Tester meter should not deflect.

B. Move black tester lead to other AC (\sim) terminal, meter should not deflect.

6. Move black tester lead to negative (∇) terminal, red tester lead to one AC (\sim) terminal. Figure 24.

A. Tester meter should not deflect.

B. Move red tester lead to other AC (\sim) terminal, meter should not deflect.

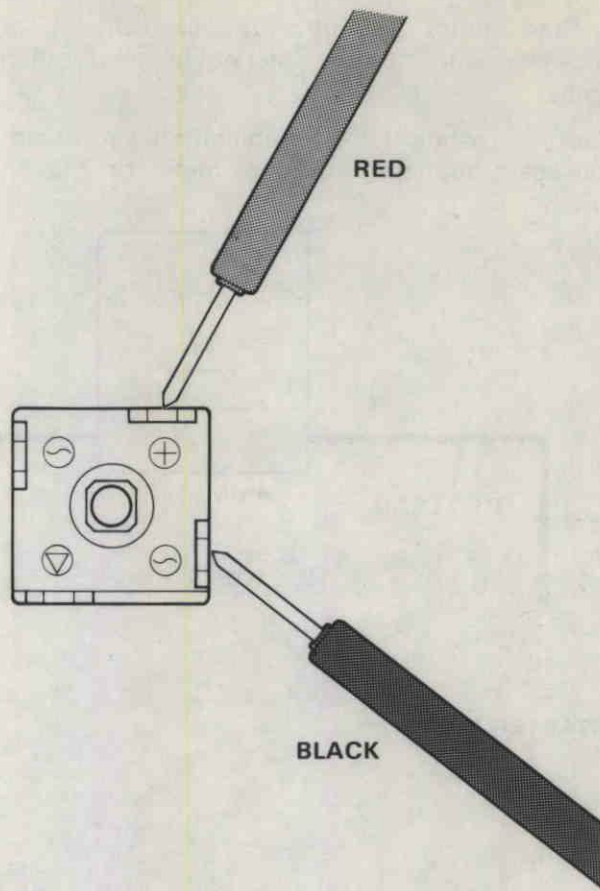


Figure 23. Test #4. Step 5.

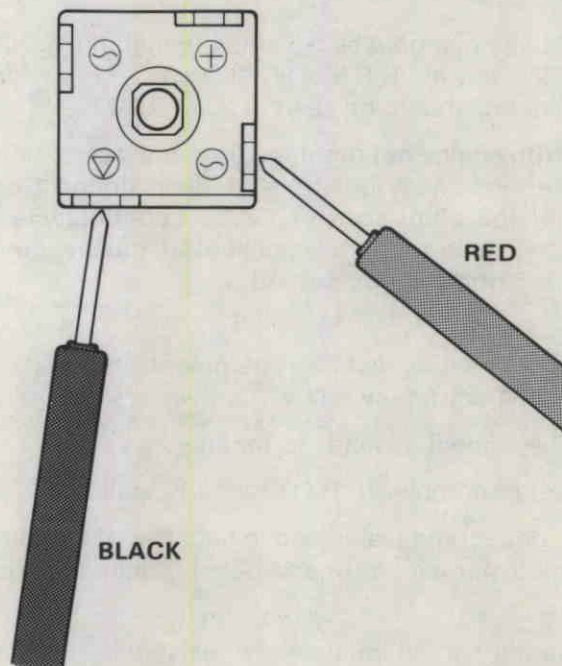


Figure 24. Test #4. Step 6.

When performing test #4 with T 2938-1 continuity tester, follow Steps 1-6, the following results are required.

Step 3. Bright light.

Step 4. Dim light.

Step 5. No light.

Step 6. No light.

Test #5. Checking circuit breaker. Equipment: T 2938-1 continuity tester.

1. Reset circuit breaker.
2. Connect one lead to each terminal, light should come on.

RECTIFIER

Removal. To remove the rectifier proceed as follows:

1. Disconnect battery.
2. Remove one screw securing rectifier to starter support. Figure 26.
3. Disconnect four (4) lead wires.

Cleaning and Inspection. Visually inspect bakelite body for cracks. Check terminals for looseness and corrosion. Remove corrosion with a file or emery cloth.

Installation.

1. Connect lead wires to rectifier. Figure 25.

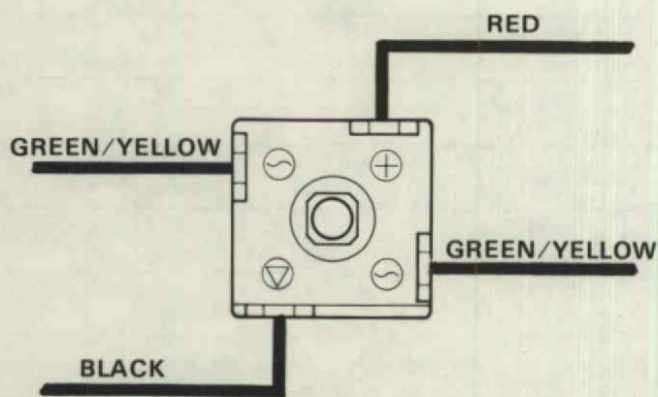


Figure 25. Installing Rectifier.

2. Place rectifier on starter support with negative (▽) terminal in bottom left hand corner, secure with screw.

CIRCUIT BREAKER

Removal.

1. Disconnect battery.
2. Remove nuts and lead wires from circuit breaker terminals. Figure 26.

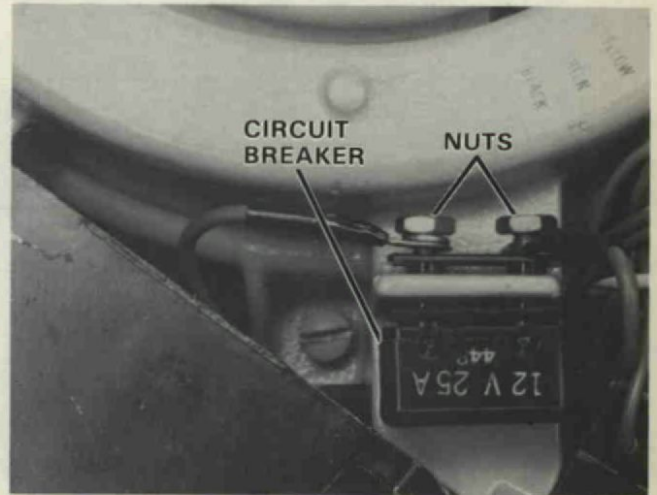


Figure 26. Removing Circuit Breaker.

NOTE

Loosen C-D mounting screws to allow removal of circuit breaker.

3. Remove circuit breaker and two insulators.

Cleaning and Inspection. Visually inspect bakelite body for cracks. Check terminals for looseness and corrosion. Remove corrosion with a wire brush.

Installation.

1. Place circuit breaker with insulators on mounting boss with reset button to port.
2. Connect lead wires. Figure 27.

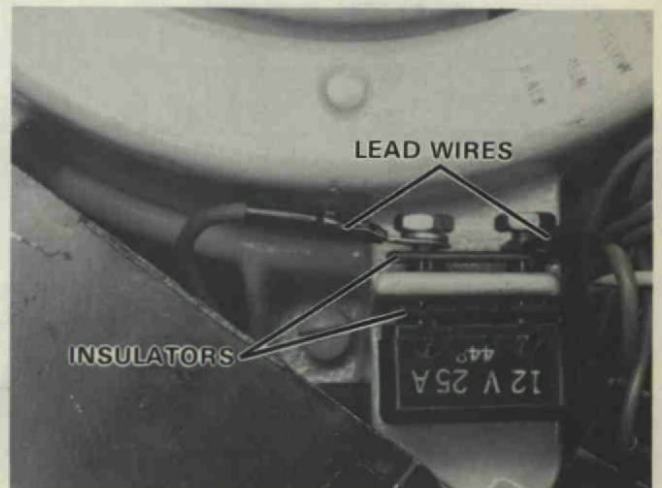


Figure 27. Installing Circuit Breaker.

Notes: _____



MAGNETO IGNITION SYSTEM

GENERAL

The information in this subsection deals with troubleshooting the ignition system and replacement of the electrical components

DESCRIPTION

The magneto ignition system consists of seven (7) major components: flywheel, stator plate, throttle cam, breaker points, condenser, coils (two required), and spark plugs (two required).

TROUBLESHOOTING

General. A malfunction in the magneto ignition system will result in the engine missing, surging or not running at all. Table 1. These same symptoms can also be the result of insufficient, contaminated, or excessive fuel. First determine that the cause of the problem is not the fuel system. See the Troubleshooting Guide for the fuel system.

Preliminary Tests.

1. Check spark as follows:
 - A. Remove spark plug, attach lead wire and ground plug against cylinder.
 - B. Crank engine to determine if there is sufficient spark to jump gap on plug.

NOTE

A bright blue spark should be evident. A weak, yellowish or red spark indicates insufficient spark voltage.

2. If there is insufficient spark voltage check the following possible causes:

- A. Poor grounds. Check grounds.
- B. Damaged or worn high tension lead. Replace.
- C. Malfunctioning stop switch. Disconnect leads from stop switch and repeat test. If defective, replace.
- D. Points not adjusted properly. Points gapped too wide allow insufficient time for coil primary winding to develop maximum voltage. Too small a gap, insufficient time to discharge. Adjust points.
- E. Points pitted or burned. Replace and adjust.

3. Check point condition as follows:

- A. Points oily or greasy. A smudge line on the stator plate directly beneath the contacts indicates excess lubrication of cam wick, or contamination due to defective top crankshaft seal.
- B. Points eroded on negative (stationary) side, built up on positive (movable) side indicates weak or defective condenser. Test or replace.

	Wiring and Connections	Spark Plugs	Breaker Points	Condenser	Coil	Timing
Engine hard to start	X	X	X	X	X	X
Engine misfires	X	X	X	X	X	X
Engine backfires	X	X				X
Engine knocks or pings		X				X
Engine pre-ignition		X				X
Engine loses power		X	X	X	X	
Engine overheating						X

C. Points built up on negative (stationary) side, eroded on positive (movable) side indicates incorrect condenser. Replace with proper part.

4. Check for poorly grounded or defective coil. Test or replace coil.

Test Equipment. To accurately determine the condition of components of the ignition system, an ignition tester should be used. Without the use of test equipment, components may be replaced needlessly.

A wide variety of ignition testers are available from various manufacturers. In addition, some automotive testers having the proper specifications can be used. The use of ignition testers is particularly recommended, since these units have provisions for checking all functions of the ignition system.

The following tests are made with the Merc-O-Tronic analyzer.

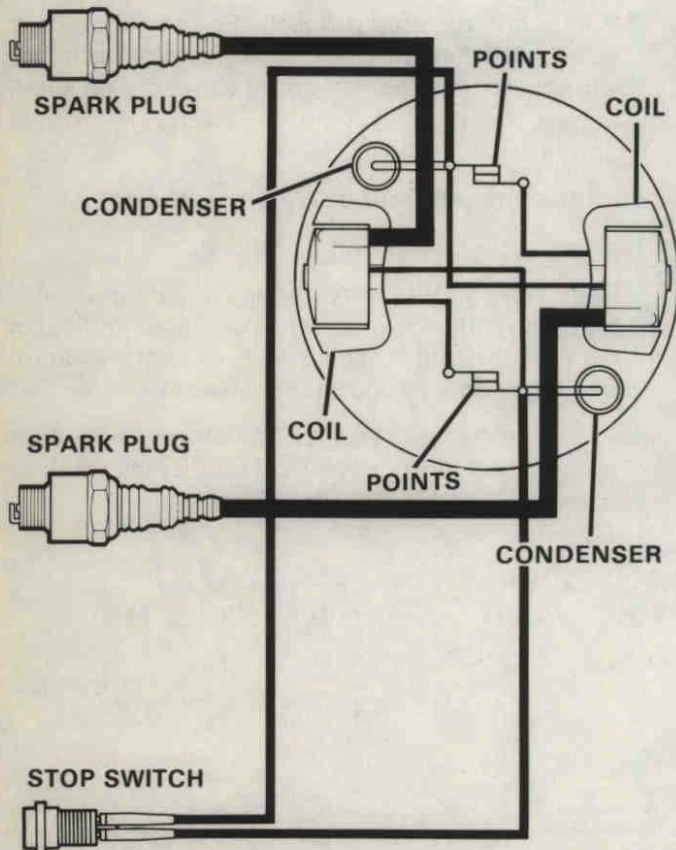


Figure 28. Magneto Ignition System. Electrical Schematic

FLYWHEEL

Removal. To remove the flywheel from the crankshaft, proceed as follows:

1. Remove nut securing flywheel to crankshaft. Thread knock-off nut (T 2909) on crankshaft until it bottoms on flywheel, back nut off two full turns.
2. Drive flywheel wedge (T 2989) between flywheel and top of power head and in approximately 1/8 inch from initial contact point with flywheel.

NOTE

Flywheel keyway should be in line with flywheel wedge.

CAUTION

Angle wedge to avoid contact with stator ring.

Pry up on flywheel with wedge and sharply tap knock-off nut with 16 oz. hammer as shown in Figure 29.

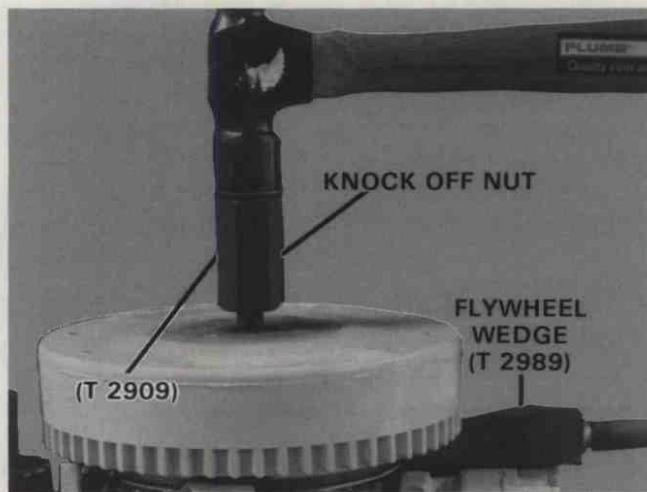



Figure 29. Removing Flywheel.

CAUTION

Do not strike nut with excessive force as this may damage crankshaft and crankshaft bearings.

3. Remove knock-off nut and lift flywheel and emergency starter collar from crankshaft.

Inspection. Visually inspect flywheel for cracks and breaks.

 **WARNING**

Cracked or chipped flywheels must be replaced. At high engine RPM, a damaged flywheel may fly apart throwing shrapnel over a large area.

Inspect taper in bore of flywheel as follows:

1. Remove flywheel key from crankshaft.
2. Apply light coating of valve grinding compound to tapered portion of crankshaft.
3. Install flywheel on crankshaft and rotate flywheel gently back and forth about 1/4 turn — do not spin flywheel completely around crankshaft.
4. Rotate flywheel 90° and repeat above operation.
5. Remove flywheel, wipe compound off crankshaft and flywheel. Taper in bore of flywheel should have a minimum of 90% surface contact with taper on crankshaft.
6. If above condition is met, then thoroughly clean compound from flywheel, crankshaft, and keyways.

Installation. To install the flywheel, proceed as follows:

1. If flywheel key has been removed, reassemble key to crankshaft with outer edge of key parallel to center line of crankshaft, Figure 14.
2. Install flywheel and emergency starter collar over crankshaft and thread on nut.

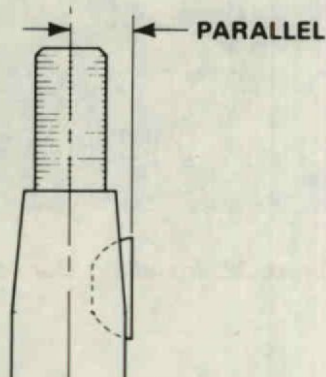


Figure 29A. Position of Flywheel Key Prior to Assembly.

NOTE

Emergency collar **must** index into holes on top side of flywheel to prevent rotation!

Torque nut to 45 ft. lbs. (6.21 kg/m).

CONDENSER

General. When the magnetic field in the coil collapses, voltage much higher than the original voltage is induced into the primary winding. As the breaker points open, the current tends to continue flowing across the points. The resulting arc would damage the points in a short time.

The condenser, by absorbing the surge of high-voltage, dampens the tendency of current to arc across the points. The condenser also allows the magnetic field to collapse rapidly, which contributes to high-voltage being induced into the secondary windings.

Removal. To remove the condenser for testing or replacement, proceed as follows:

1. Remove flywheel.
2. Remove condenser lead from breaker point terminal block.
3. Remove screw retaining condenser to stator plate as shown in Figure 30.
4. Remove condenser from stator plate.

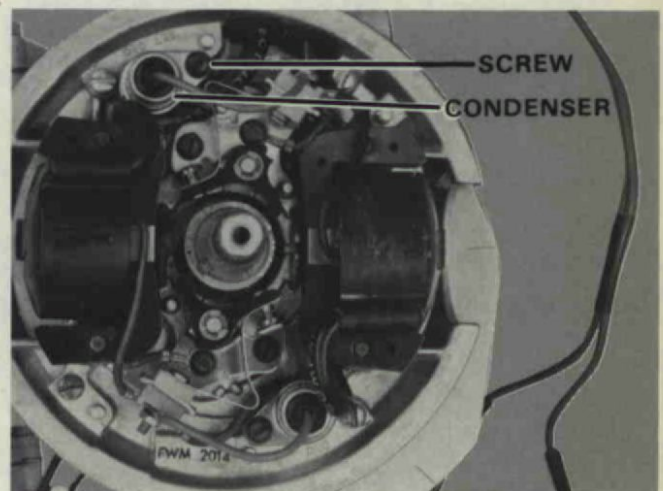


Figure 30. Removing Condenser.

Test Condenser Capacity.

To perform this test, proceed as follows:

1. Plug tester into a 115-volt, 60 cycle "AC" outlet.
2. Turn selector knob to "CONDENSER CAPACITY" position. Figure 32.

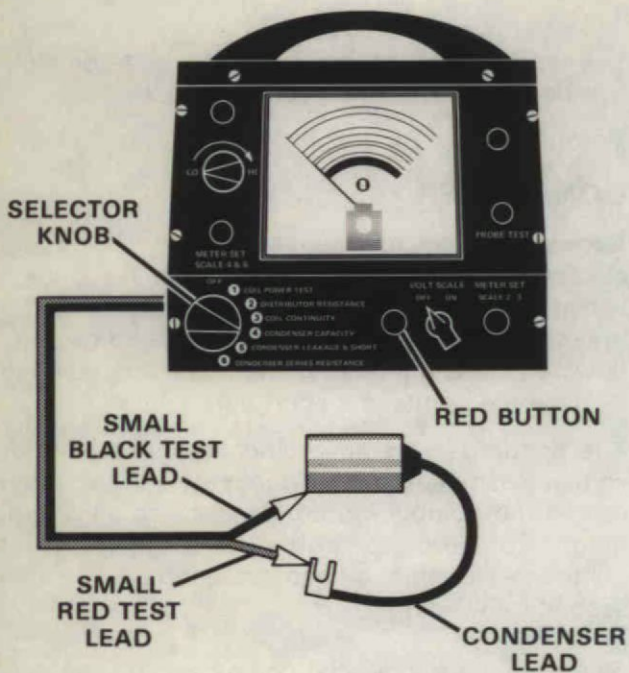


Figure 31. Testing Condenser.

3. Clip test leads together. Press red button and turn meter set knob until meter point lines up with set scales on right-hand side of meter. Release red button and disconnect leads. This sets the meter.
4. Connect small red test lead to condenser lead.
5. Connect small black test lead to body of condenser.
6. Press the red button and observe meter pointer on the "CONDENSER CAPACITY" scale.
7. Condenser capacity should be 16 minimum to 20 maximum. If not, replace the condenser.
8. Turn selector knob to "OFF" and test condenser for leakage or short.

Test Condenser for Leakage and Short. To perform this test, proceed as follows:

NOTE

Leave test leads connected as shown. Figure 31.

1. Turn selector knob to "CONDENSER LEAKAGE AND SHORT" position.
2. Press red button and observe meter pointer for at least 15 seconds. Pointer should move to the right and return all the way to the left on the "CONDENSER LEAKAGE OR SHORT" scale. If pointer does not return, replace condenser.
3. Turn selector knob to "OFF", remove tester leads and test condenser series resistance.

Test Condenser Series Resistance. To perform this test, proceed as follows:

1. Place selector knob in "CONDENSER SERIES RESISTANCE" position.
2. Clip the small black test lead and the small red test lead together. Turn meter set knob until meter pointer lines up with set scales on right-hand side of meter. Disconnect leads. This will set the meter.
3. Connect small red test lead to condenser lead.
4. Connect small black test lead to condenser body.
5. Meter must remain in the green area on the right-hand side of the "CONDENSER SERIES RESISTANCE" scale.
6. If meter pointer moves to the red area, series resistance is poor. Replace condenser.
7. Disconnect tester leads and unplug the tester.

Installation. To install condenser, proceed as follows:

1. Install condenser on stator plate and secure with screw as shown in Figure 32.
2. Connect condenser lead wire to terminal block of breaker point.
3. Install flywheel.

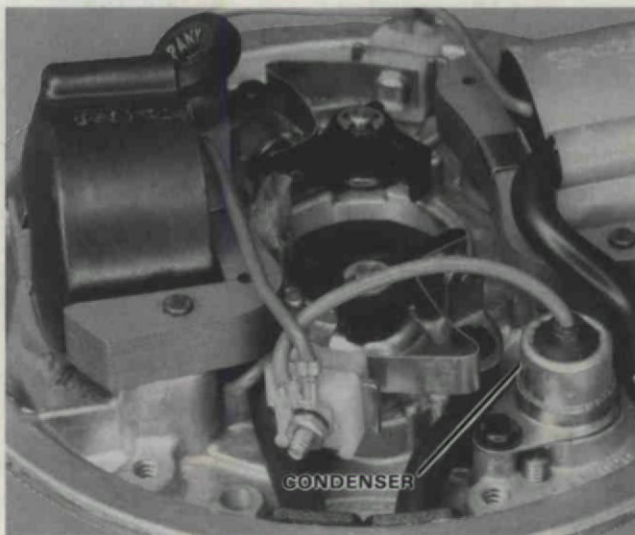


Figure 32. Installing Condenser.

COILS

General. The ignition coils do not require servicing on a regular basis, however, the coil should be kept in clean condition and the terminals and connections must be tight to provide good electrical contact.

Removal. To remove coils from stator plate, proceed as follows:

1. Remove flywheel.
2. Remove stator plate.
3. Disconnect coil lead wire from terminal block at breaker point. Figure 33.

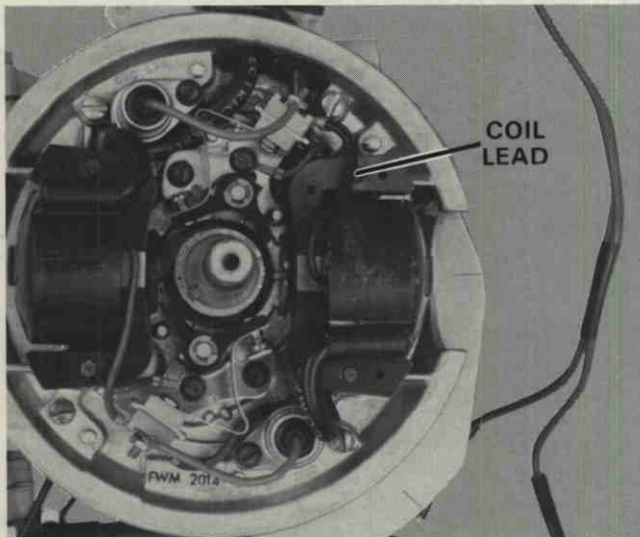


Figure 33. Removing Coil Leads.

4. Disconnect coil lead wire which connects to coil laminations or ground.
5. Straighten coil lamination retaining coil as shown in Figure 34.

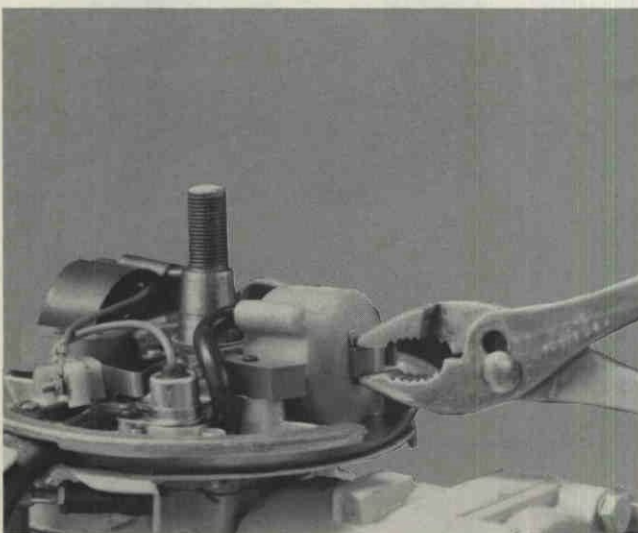


Figure 34. Straightening Coil Laminations.

6. Pry lip of coil wedge spring up from coil laminations as shown in Figure 35.

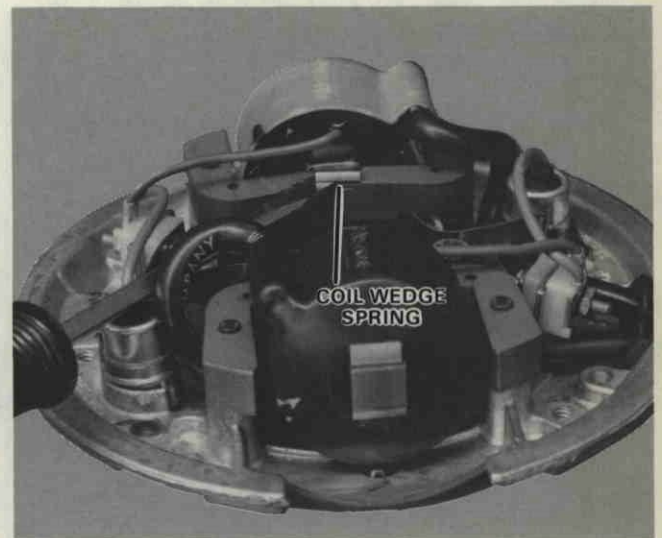


Figure 35. Removing Coils.

7. Pull coil from laminations. Note routing of spark plug lead wire for reference when installing new coil.
8. Remove sparkie cover and sparkie spring from end of lead wire. Figure 36.
9. Pull spark plug lead wire through stator plate and remove coil assembly.

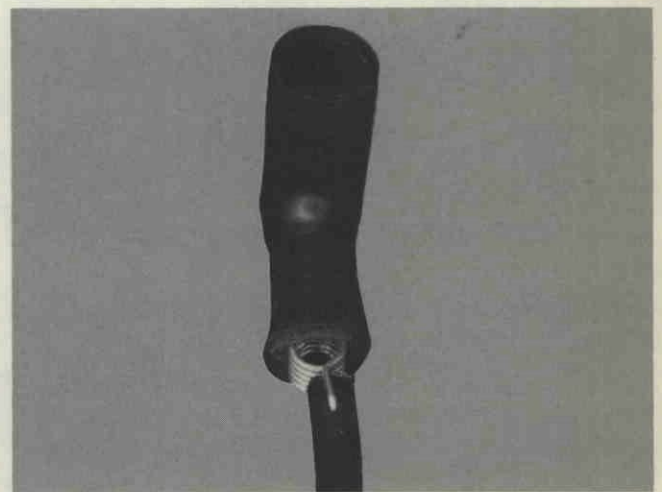


Figure 36. Sparkie Cover and Spring

Coil Power Test. Connect analyzer to coil as follows:

WARNING

Perform all tests to the coil on a wooden or insulated bench top to prevent leakage or shock hazards.

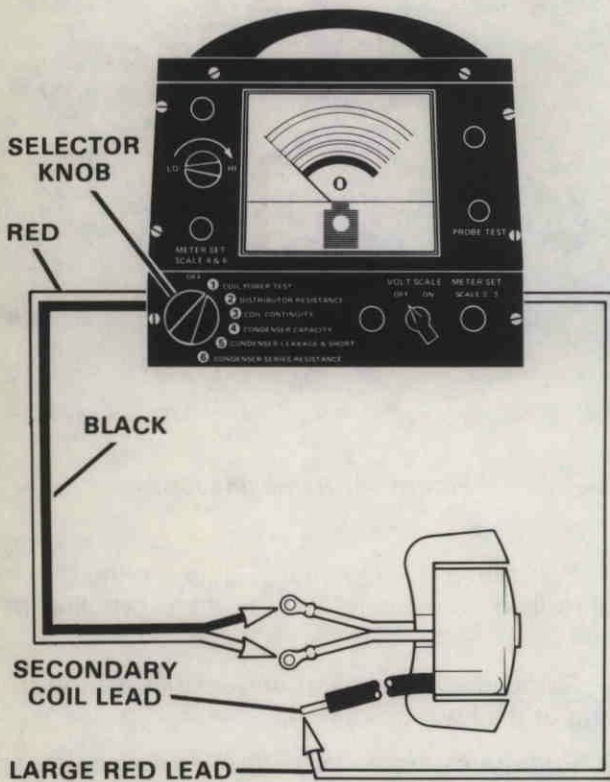


Figure 37. Coil Power Test.

1. Connect analyzer large red lead to the secondary coil lead.
2. Connect analyzer red test lead to either primary coil terminal.
3. Connect analyzer black test lead to remaining primary coil terminal.
4. Make sure current control knob is on "LO", and turn selector knob to "COIL POWER TEST" position.
5. Slowly turn current control knob clockwise until meter pointer shows 1.5 on the "COIL POWER TEST" scale. At this time, the spark gap should be firing steadily.
6. Return the current control knob to "LO" and turn selector knob to "OFF".

If spark gap was firing steadily, the coil is good. Leave the tester connected and test the coil highspeed. If spark gap was not firing steadily, replace the coil.

Testing Coil High-Speed. Leave analyzer and coil connected as shown. Figure 37.

IMPORTANT

Complete this test as quickly as possible. Return the current control knob to "LO" and selector knob to "OFF" immediately after test.

1. Turn selector knob to "COIL POWER TEST" position.
2. Turn current control knob to "HI" or until meter reaches full scale. Observe spark gap and turn current control knob to "LO" and selector knob to "OFF".
3. If spark gap fired steadily, the coil is good at high-speed. If spark gap did not fire steadily, replace the coil.
4. Remove the large red analyzer lead from from coil and proceed to next test.

Testing Coil Surface Insulation. To perform this test, proceed as follows:

1. Plug test probe into jack in front of analyzer. Figure 38.

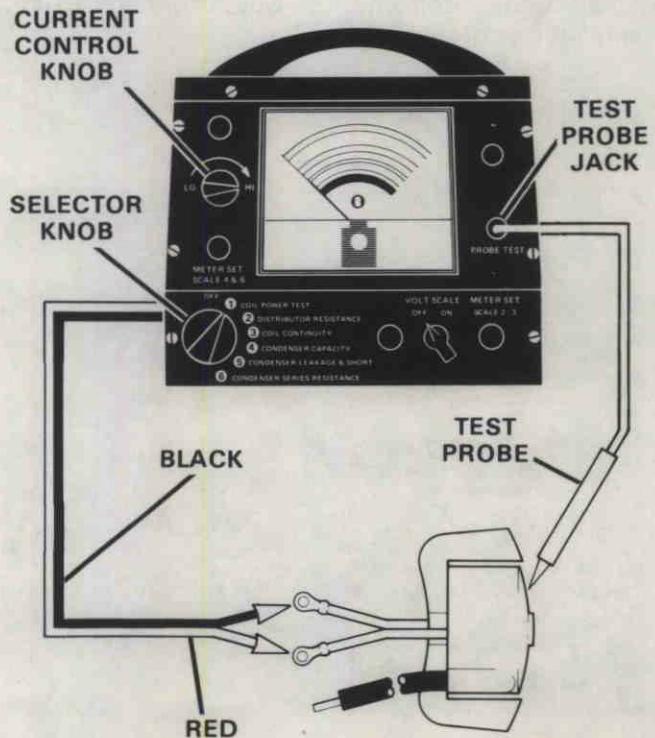


Figure 38. Testing Coil Surface Insulation.

- Turn selector knob to "COIL POWER TEST" position.
- Turn current control knob to "HI" or until meter reaches full scale.
- Move test probe over entire insulated surfaces of coil and spark plug lead(s).

IMPORTANT

Do not hold test probe at one point too long. Complete test as rapidly as possible.

NOTE

A faint spark may occur around coil. A strong spark indicates a leak.

- Return current control knob to "LO" and selector knob to "OFF".
- Remove all connections and test coil continuity.

Testing Coil Continuity. To perform this test, proceed as follows:

- Turn selector knob to "DISTRIBUTOR RESISTANCE" position. With test leads apart, turn meter set knob until meter pointer lines up with set mark on right side of meter.
- Connect small red test lead to either primary terminal. Connect small black test lead to remaining primary terminal. Figure 39.

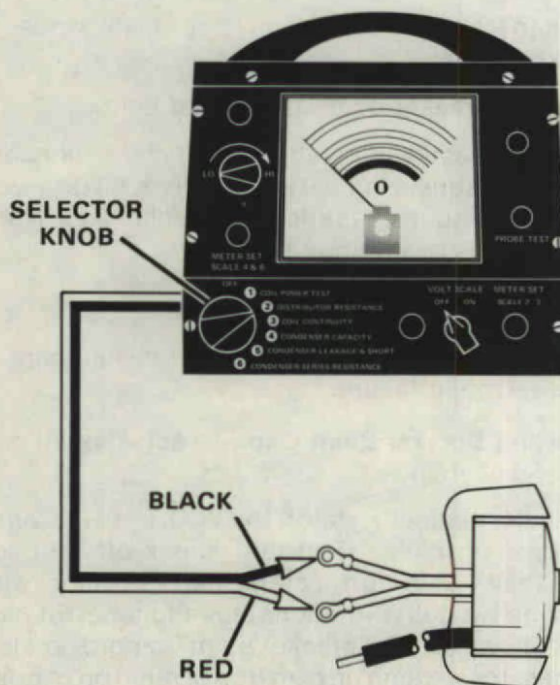


Figure 39. Testing Coil Continuity. Test #1.

- Meter resistance reading should be .48 - .54 ohms.
- If readings are high or low, replace the coil. Turn selector knob to "OFF". Remove test leads and test secondary continuity.
- Turn selector knob to "COIL CONTINUITY" position. Figure 40.
- Clip the small red test lead and the small black test lead together. Turn meter set knob until meter pointer lines up with set scale on right-hand side of meter. This sets the meter.
- Connect small red test to the spark plug lead.
- Connect small black test lead to either primary terminal.
- Test meter should read 6900-7800 ohms for part No. A12345 (WICO FWM - 1038), 13,500 - 16,500 ohms for part No. 12370 (WICO FWM - 2531A0) on the top of the "COIL CONTINUITY" scale. If readings are high or low, replace the coil.
- Remove the test leads from coil and turn selector knob to "OFF".

Installation. To reinstall the coils to the stator plate, proceed as follows:

- Position new coil at coil lamination of stator plate so that spark plug lead wire extends from upper left — inside (note position of spark plug lead wire in Figure 41).

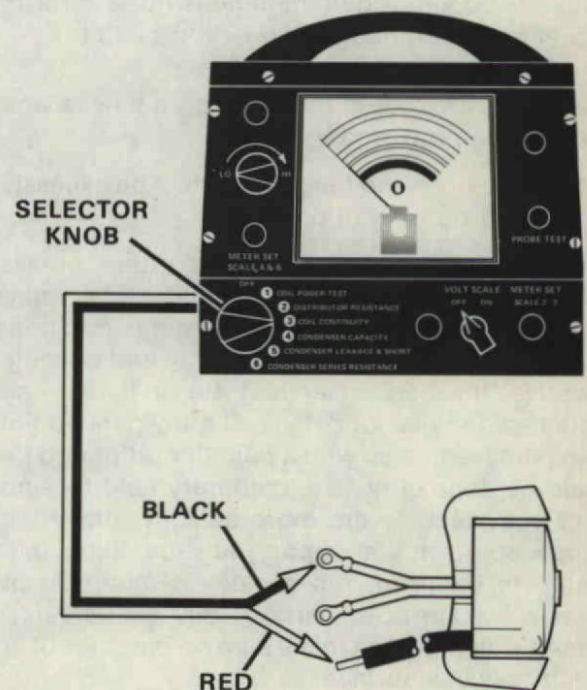


Figure 40. Testing Coil Continuity. Test #2.

2. Place coil wedge spring in coil so that small lip of spring is facing down and toward crankshaft.
3. Install coil with wedge spring onto laminations approximately half way. Then route spark plug lead wire as routed with original coil.
4. Push coil remainder of way on laminations until coil wedge spring snaps into place at rear of laminations. Large lip on coil wedge spring must be positioned over front coil surface. Bend bottom coil lamination to retain coil. Figure 34.
5. Connect coil ground lead wire from bottom of coil to lamination as shown in Figure 33.
6. Connect lead wire from top of coil to insulated terminal on breaker point as shown in Figure 32.
7. Reinstall sparkie spring and cover at end of spark plug lead wire. Be sure sparkie spring is making contact with wire inside insulation. (Refer to Figure 36.)
8. Install stator plate.
9. Reinstall flywheel.

1. Remove flywheel.
2. Remove two screws holding breaker point to stator plate as shown in Figure 41.

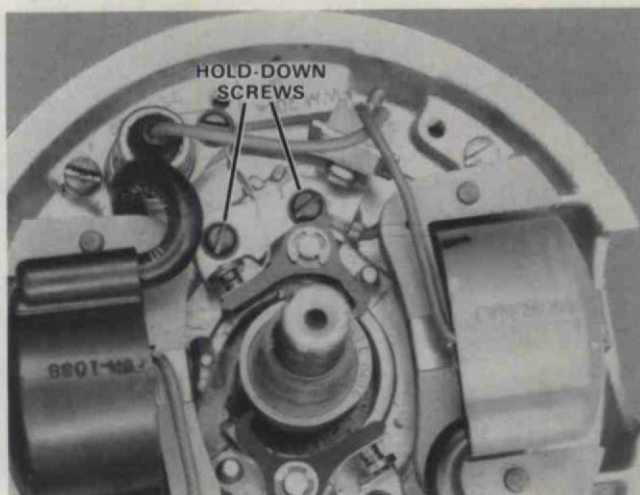


Figure 41. Location of Breaker Point Hold-Down Screws.

BREAKER POINTS

General. Engine operation is greatly affected by breaker point condition and adjustment of the gap. If points are burned or badly oxidized, little or no current will pass, and as a result, the engine may not operate at all. If it does run, it is likely to miss at full throttle. Adjusting the gap determines how long the points stay open. A definite time is needed for the magnetic field in the ignition coil to build up.

If the points are closed for too short a time, a weak spark will be produced by the coil.

If points are open too long, there may be excessive arching and burning of points.

Always replace badly burned or pitted breaker points. A certain amount of build up or metal transfer occurs under normal operating conditions; however if this occurs too frequently and becomes excessive, the condenser may be at fault — see Condenser Service for details. Slightly pitted points can be dressed down with a point file, although this should be done only as a temporary field fix since points may tend to arc more steadily after filing. Replace points at first opportunity after filing. If the points are oxidized, rub a piece of coarse cloth between the surfaces. Dirty or oily points can be cleaned with cloth but make sure no particles of lint are left between surface.

Removal. To remove the breaker points from the stator plate, proceed as follows:

3. Disconnect lead wires from coil and condenser from breaker point.
4. Remove breaker point from stator.

Installation. To install breaker points to stator plate, proceed as follows:

1. Position breaker point on stator plate. Do not tighten mounting screws at this time.
2. Connect condenser and coil lead wires to breaker point.
3. Adjust breaker point as outlined below.
4. Check cam wiper felt for sufficient lubricant. (Check by squeezing between fingers.) If dry, work a small amount of lubricant (Special Tool No. T 2961) into felt with fingers.

CAUTION

Do not over lubricate felt. Excessive lubricant causes point failure.

Adjusting Breaker Point Gap. To adjust point gap, proceed as follows:

1. Rotate magneto stator to, W.O.T. (wide open throttle) position. Reinstall knock-off nut on crankshaft and turn crankshaft in clockwise direction two full revolutions plus additional rotation until follower arm of breaker point is approximately 10° past top of ramp on cam (top of ramp on cam is a point at which further crankshaft or cam rotation produces no greater breaker point opening). Once

correct adjustment point is found, mark that spot on cam for adjusting other breaker point.

2. Adjust breaker point opening to .020 and tighten hold down screw. Repeat above procedure for other breaker point set.

3. Rotate engine after setting points and recheck breaker point gaps.

4. Check breaker point spring tension. Tension must be 16 to 32 oz. measured at right angles to surface at center of contact, Figure 42. A breaker point with too little tension will bounce and cause ignition advance to vary and thus cause premature power head failure. A breaker point with too much tension will cause premature point follower wear which leads to poor performance.

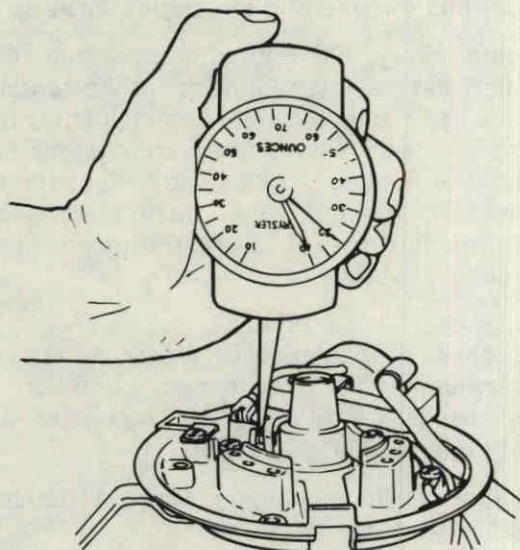


Figure 42. Checking Spring Tension.

STATOR PLATE

Removal. To remove the stator plate from the powerhead, proceed as follows:

1. Remove flywheel.
2. Remove screw holding ground lead from fuel pump on rear starboard side of engine.
3. Disconnect spark plug lead wires from spark plugs and from lead wire clip on exhaust port cover.
4. Remove four (4) screws holding magneto stator plate to stator ring. Figure 43.
5. Lift stator plate up and to port side to free stator from throttle cam link.
6. Turn stator plate over and remove screws holding throttle cam.



Figure 43. Stator Hold-Down Screw Locations.

Installation. To reinstall the stator plate to the powerhead, proceed as follows:

1. Position throttle cam on stator plate.
2. Secure throttle cam to stator plate with screws. Magneto ground wire is attached to rear starboard screw as shown in Figure 44.
3. Hook throttle cam link in hole of throttle cam on port side.
4. Install stator plate over crankshaft and attach to magneto stator ring with four screws. Before

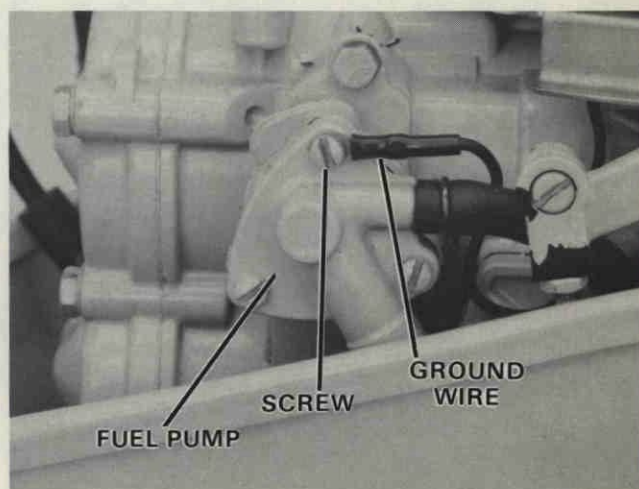


Figure 44. Assembling Throttle Cam and Ground Wire.

tightening screws, check follower roller to see that it is not under throttle cam or stator will not draw down properly.

5. Attach magneto ground wire to top screw of fuel pump.
6. Dress spark plug lead wires along power head and place lead wires in clip on exhaust port cover. Lead wire with sleeve that indicates top is for top cylinder spark plug. Attach leads to spark plugs.
8. Adjust throttle pick-up.
9. Reinstall flywheel.

SPARK PLUGS

Description. A spark plug consists of two electrodes separated from each other by an air gap. The side electrode is connected to the shell of the spark plug. The center electrode is completely insulated from the shell.

The high voltage, produced in the secondary coil winding is applied to the center electrode and causes a spark to jump the gap to the side electrode. This spark ignites the fuel/air mixture and starts the combustion process in the cylinder.

The gap between electrodes is critical because it affects the entire range of engine performance — starting, idling, accelerating, power and top speed.

Removal. Use a 13/16" deep well socket with rubber insert to protect spark plug insulation.

Inspection. In nearly every case of spark plug failure, the cause must be corrected before new or reconditioned spark plugs are installed. Otherwise, servicing will be needed again in a short time.

Engine misfire or generally poor operation is often caused by spark plugs in poor condition or with improper gap setting. The first thing to do after removing a spark plug is to carefully note its condition as this is often an indicator of the ignition trouble. Plugs fail for various reasons. Often the porcelain insulator cracks or becomes coated with oil, carbon or other deposits. This can cause the high voltage ignition impulse to pass from the center electrode to ground without jumping the spark gap. As an engine operates, the electrodes are gradually burned or worn away. In time, the gap becomes so wide that the available ignition voltage cannot jump the gap and the engine misfires.

Servicing. Every 100 hours remove plug, check condition and reset gap. Good operating conditions are indicated if plug has light coating of gray or tan deposit. A dead white, blistered coating could indicate overheating. A black (carbon) coating can indicate an "overrich" fuel mixture caused by improper carburetor adjustment or faulty recirculating system.

NOTE

DO NOT sandblast, wire brush, scrape or otherwise service plug in poor condition — best results are obtained with new plug. Set spark gap to .030" (0.76 mm).

Installation. Reinstall plug and torque to 120 to 180 inch lbs. (140 - 205 kg/cm).

ELECTRICAL STARTING SYSTEM

GENERAL

The starting circuit begins at the starter switch. Pushing in on the switch completes the circuit between the battery and the starter motor. The starter motor armature rotates, engaging the starter pinion with the engine flywheel ring gear.

As the engine fires and speeds up, the starter armature is overrun, causing the pinion to disengage. The starter switch is then released, opening the circuit between the battery and the starter motor. The interlock switch, which is located

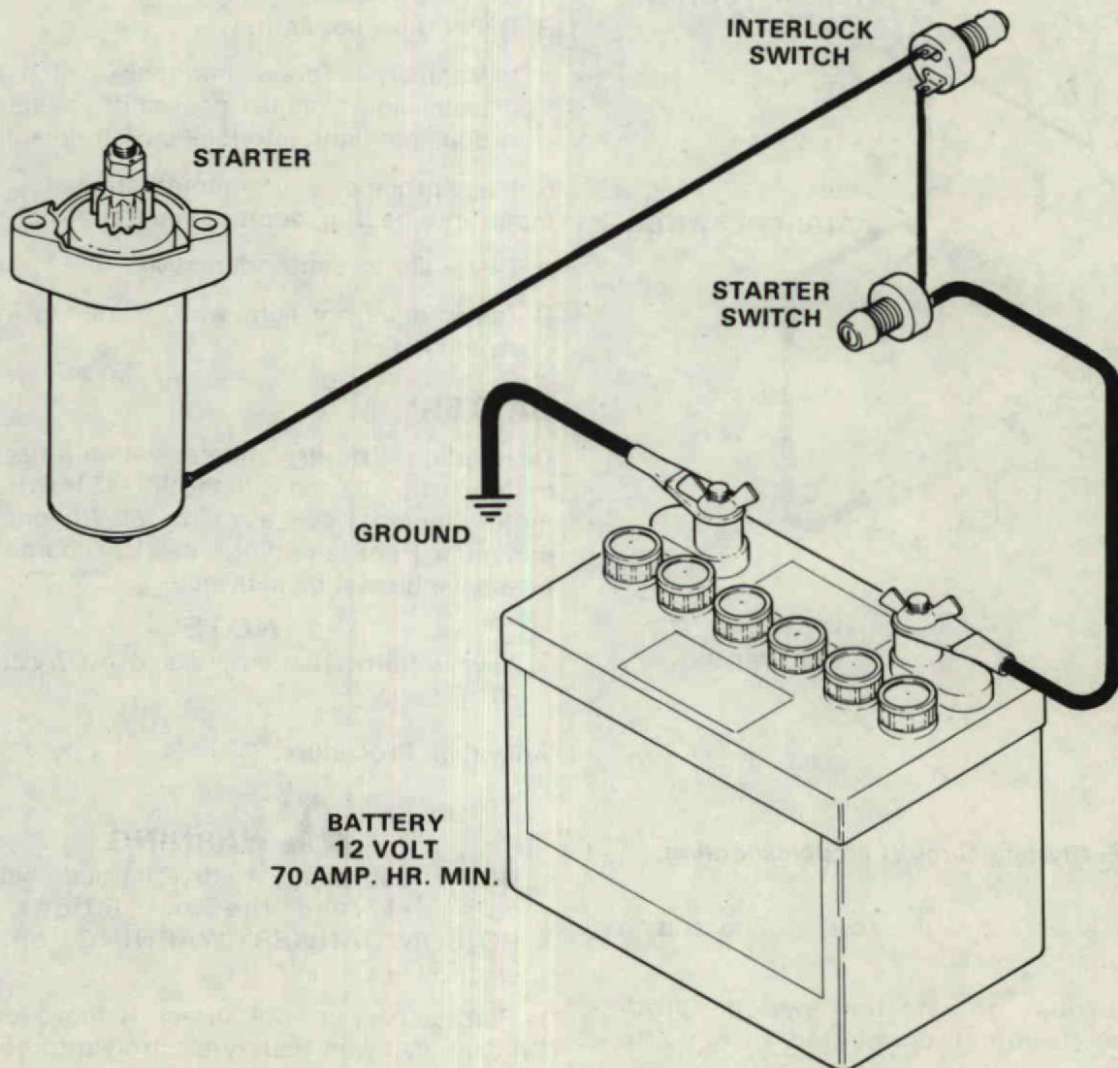


Figure 45. Starting System.

between the starter switch and the starter, is a safety feature that prevents the starter from functioning if the engine is not in the neutral shift position. The shift lever has a raised boss which depresses the interlock switch button. This causes the switch to have continuity and allows battery voltage to activate the starter motor.

TROUBLESHOOTING

Starting Circuit. Troubleshooting of the starter circuit is a systematic check beginning with the battery. Once the battery has been checked and tested, use Special Tool No. T 2951. Circuit Tester to trace the starting circuit.

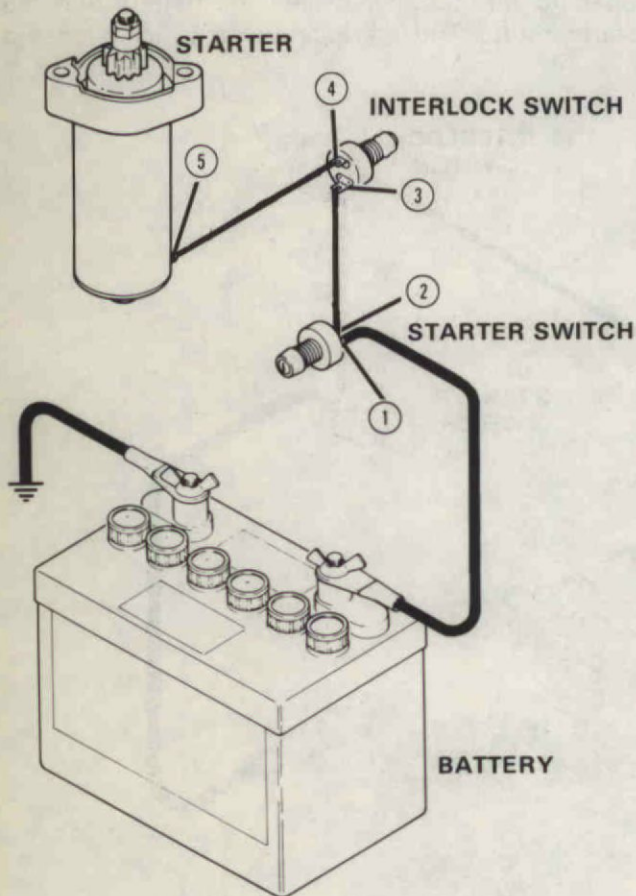


Figure 46. Starting Circuit. Troubleshooting.

1. Connect T 2951 circuit tracer ground clip to engine ground.
2. Place probe on starter switch "hot" terminal ① (terminal connected directly to battery).
 - A. Tester lights, proceed to Step #3.

- B. Tester does not light, or is dim:
 1. Poor engine ground
 2. Faulty lead wire, battery to switch.
3. Place probe on secondary terminal ② of starter switch. Depress starter switch button:
 - A. Tester lights, proceed to Step #4.
 - B. Tester does not light, switch defective.
4. Place probe on "hot" terminal of interlock switch. ③ (Terminal connected to starter switch). Depress starter switch button:
 - A. Tester lights, proceed to Step 5.
 - B. Tester does not light, wire defective.
5. Place probe on secondary terminal ④ of interlock switch. Shift motor into neutral. Depress starter switch button.
 - A. Tester lights, proceed to Step 6.
 - B. Tester does not light:
 1. Manually depress interlock switch button, tester lights, adjust gear shift linkage, tester does not light, interlock switch defective.
6. Place probe on starter motor terminal ⑤. Shift motor into neutral, depress starter switch button:
 - A. Tester lights, starter defective.
 - B. Tester does not light wire, starter to interlock switch defective.

BATTERY

Description. The dry charge (without electrolyte) battery to be for used with the 9.9 - 15 H.P. outboard motor should have a rating of 70 amp hours minimum. Prior to putting a new dry charge battery in service it must be activated.

NOTE

Always store batteries and acid in a dry area at 60° F to 90° F.

Activation Procedure.

WARNING

Before activating a dry-charged battery, carefully read the instructions and POISON/DANGER WARNING on the electrolyte carton.

1. Place battery on level surface. Remove vent caps. Fill each cell with battery electrolyte to bottom of vent well, observing handling precautions listed on electrolyte carton.

2. After cells are filled, tilt battery from side to side to release air bubbles.
3. Recheck electrolyte level in each cell and add as necessary.

NOTE

Uneven filling of cells will affect the battery capacity and service life.

4. Install vent caps supplied with battery.
5. Check battery case for leakage to make sure no damage occurred in handling.
6. Slow charge battery until fully charged. Battery temperature should not exceed 125° F.
7. Install battery.

NOTE

Since the level of charge of the battery as read by a hydrometer is depressed after the first few starting cycles, load testing is the only valid test at the time of activation. (See Load Test). Hydrometer testing may be used after the battery has been cycled in service.

The specific gravity of a newly installed battery will be approximately 1.225.

The specific gravity will normally rise to 1.250 to 1.265 after a few days in service.

NOTE

Electrolyte is made up of sulfuric acid and pure water. Approximately 35 percent by weight or 24 percent by volume is acid.



WARNING

Never add pure sulfuric acid to a battery.

Slow Charge. Slow charging is the preferred method of charging a battery. The slow charge method may be safely used, regardless of charge condition of the battery, provided the electrolyte is at the proper level in all cells and is not frozen.



WARNING

Do not attempt to charge or use a booster on battery with frozen electrolyte as it can cause the frozen battery to explode.

The normal charging rate for a battery is one amp per positive plate per cell. A minimum period of 24 hours is required when using this method.

A battery is in a maximum charged condition when all cells are gassing freely and three corrected specific gravity readings, taken at hourly intervals, indicate no increase in specific gravity.



WARNING

Always disconnect the battery cables before using a fast charger.

Fast Charge. A battery may be charged at any rate which does not cause the electrolyte temperature of any cell to exceed 125° F (51.7C) and which does not cause loss of the electrolyte.

A fast charger cannot be expected to fully charge a battery within an hour but will charge the battery sufficiently so that it may be returned to service. The battery can then be fully charged by the outboard charging system, provided the outboard is operated a sufficient length of time.

Testing.

NOTE

A complete battery test includes cleaning the top of the battery case, cleaning terminals and cable clamps, and performing hydrometer and heavy load tests.

General. The condition of a battery may be determined from the results of two tests: state of charge (hydrometer test) and ability to deliver current (heavy load test).

The hydrometer test should be performed first. If specific gravity indicates less than 1.225, the battery must be charged before further testing can be done. A battery which does not accept a charge is defective and no further testing is required.

Hydrometer Test. Prior to testing, inspect the battery for any damage (broken container, cover, loose post, etc.) that would make the battery unserviceable. To read the hydrometer correctly, position the top surface of the electrolyte in the hydrometer at eye level Figure 47. Disregard the curvature of the liquid where the surface rises against the float due to surface tension. Draw in only enough electrolyte to keep the float off the bottom of the hydrometer barrel with the bulb released. The

hydrometer must be kept in a vertical position while drawing in liquid and taking the reading.

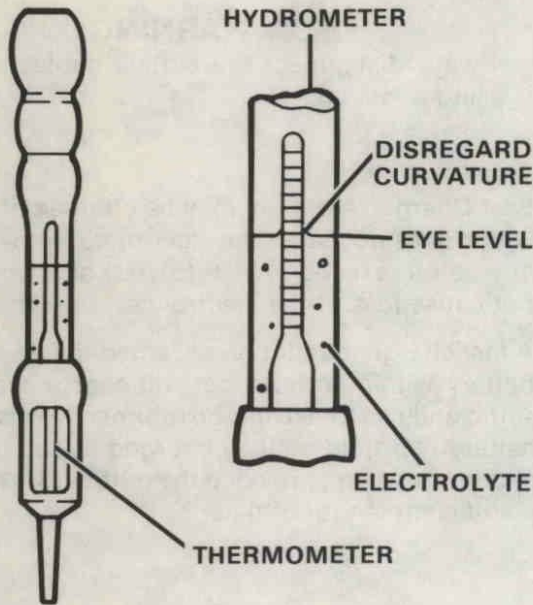


Figure 47. Reading Specific Gravity with a Float-Type Hydrometer.

CAUTION

Care should be taken when inserting the tip of the hydrometer into the cell to avoid damage to separators. Broken separators could result in premature battery failure.

Hydrometer floats are generally calibrated to read correctly at 80° F. When taking a reading at any other temperature, a correction factor must be used. The correction factor is approximately 0.004 specific gravity, referred to as 4 points of gravity. For each 10° F below 80° F, subtract 4 points. Always correct the readings for temperature variation. Test the specific gravity of the electrolyte **in each battery cell**.

Example. A battery is tested at 10° F and has a specific gravity of 1.240. The actual specific gravity is found as follows:

Number of degrees above or below 80° F equals 70° (80° - 10°).

70 divided by 10 (each 10° difference) equals 7.

7 x 0.004 (temperature correction factor) equals 0.028.

Temperature is below 80° so temperature correction is subtracted.

Temperatures corrected specific gravity is 1.212 (1.240 minus 0.028).

A fully charged battery should have a specific gravity of 1.250 to 1.265.

Specific Gravity	
State of Charge	Specific Gravity (Cold and Temperate Climates)
Fully Charged	1.265
75% Charged	1.225
50% Charged	1.190
25% Charged	1.155
Discharged	1.120

If the specific gravity of all cells is above 1.235, but the variation between cells is more than 50 points (0.050), it is an indication of an unserviceable battery. The unit should be removed for further testing.

If the specific gravity of one or more cells is less than 1.235, recharge the battery at approximately 5 amperes until 3 consecutive hourly readings are constant.

At the end of the charge period, if the cell variation is more than 50 points (0.050), replace the battery.

When the specific gravity of all cells is above 1.235 and variation between cells is less than 50 points, the battery can be tested under load.

Heavy Load Test. This test is performed to make sure the battery can deliver current under load. Proceed as follows:

1. Connect battery tester to the battery, and follow the manufacturer's instructions.
2. Discharge the battery under a fixed load, at three times the ampere-hour rating for approximately 15 seconds, then read the terminal voltage.
3. If the battery is in satisfactory condition, the terminal voltage reading should remain above 9 volts.
4. If the terminal voltage falls below this value, the battery is either defective or it is not fully charged.

NOTE

To be sure of the battery condition, carefully charge it and repeat the test.

5. Replace the battery if it is defective.

Battery Storage. All wet batteries discharge slowly when stored. Batteries discharge faster when warm than when cold. For example, at 100° F (37.8 C), a normal self-discharge of 0.0025 specific gravity per day could be expected. At 50° F (10 C), a discharge of 0.0003 specific gravity would be normal. Refer to Self-Discharge Rate chart.

Before storage, clean the battery case with a baking soda solution and wipe the case dry. When storing a battery, charge fully (no change in specific gravity after three readings taken one hour apart) and then store in as cool and dry a place as possible.

Freezing Temperature Chart

Specific Gravity (Corrected to 80 F)	Freezing Temperature
1.270	-84 F
1.250	-62 F
1.200	-16 F
1.150	+05 F
1.100	+19 F

Fully charge a stored battery before putting it into service.

Self-Discharge Rate Chart

Temperature	Approximate Allowable Self-Discharge Per Day For First Ten Days (Specific Gravity)
100 F (37.8 C)	0.0025 points
80 F (26.7 C)	0.0010 points
50 F (10.0 C)	0.0003 points

STARTER MOTOR

Description. The starter has two major parts — a stationary field magnet and a rotating armature.

The stationary field is made up of two permanent magnets which are affixed to the inner walls of the motor body. Figure 48.

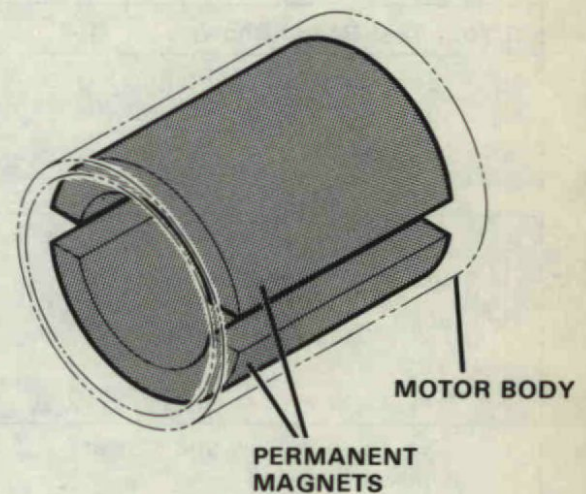


Figure 48. Permanent Magnets Located in Starter

The armature is made from conductor loops or windings wrapped around a laminated soft iron core which is, in turn, mounted on a shaft. The shaft is supported in plain bearings in the end caps. There is a small clearance between the armature and field to maximize the effects of the magnetic forces. Bearing wear can allow the armature to rub against the field magnets causing drag that will reduce armature speed, increase the amperage draw and reduce the available starting torque.

Two brushes are held in a brush holder in the commutator end cap — one brush is insulated, the other grounded. Springs hold the brushes under tension against the armature's commutator.

STARTER MOTOR TROUBLESHOOTING CHART

If the starter motor is not functioning normally, proceed with the steps listed as follows:

1. Remove spark plug lead wires from plugs. Place

engine in neutral gear.

2. Connect ammeter (should be 100 amp or higher scale) between cable and battery terminal.

3. Operate starter and observe current draws, cranking rpm and voltage drop at battery as shown.

**CURRENT DRAW
(NORMAL RANGE)**

40 — 70

**CRANKING R.P.M.
(NORMAL RANGE)**

350 — 550

VOLTAGE MINIMUM

10.0

If Your Test Result Shows:	The Probable Cause Could Be:
1. Low cranking speed and higher than normal current draw	A. Loose pole shoes B. Grounded armature C. Shorted armature D. Shorted field
2. Very high current draw and no armature rotation	A. Direct ground at starter switch B. Direct ground at starter brushes C. Direct ground on field connections
3. No current draw and starter fails to operate	A. Starter switch B. Broken or loose wire connections C. Interlock switch (defective) D. Remote controls improperly adjusted E. Dirty brushes or commutator
4. Low cranking speed and lower than normal current draw	High resistance in starter - look for: A. Dirty or loose connections B. Dirty brushes C. Dirty commutator or brush spring
5. Higher than normal cranking speed and higher than normal current draw	A. Shorted field

NOTE

Low cranking R.P.M. also indicates possible mechanical resistance in engine such as the following:

- A. Bearings
- B. Pistons
- C. Flywheel/stator
- D. Water pump

Removal. To remove the starter motor, proceed as follows:

1. Disconnect battery.
2. Disconnect cable from starter motor terminal.
3. Remove the two capscrews and remove starter motor from starter support housing. Figure 49.

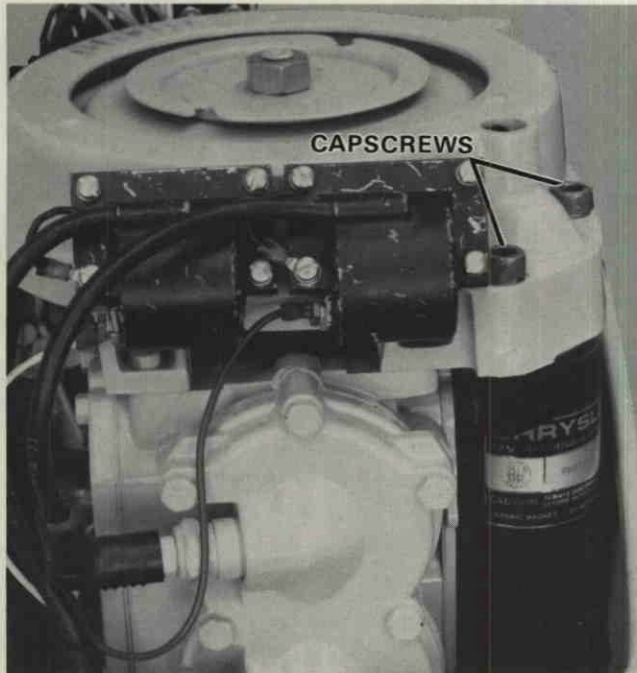


Figure 49. Removing Starter.

Testing Starter Drive (Starter Off Engine). To test, proceed as follows:



WARNING

Explosive hydrogen gases are present within battery at all times. Keep a safe distance between starter motor and battery when performing this test. A spark may cause battery to explode.

1. Connect a jumper cable between the positive terminal on a battery and the starter motor terminal nut.
2. Connect another jumper cable to the negative terminal of the battery.
3. Touch negative jumper cable to the frame of the starter motor and remove it.
4. Pinion should move freely up and down the clutch when the negative jumper cable is on and off the starter frame.
5. If the pinion does not move freely, disassemble the starter motor drive and inspect it for dirt or damage.

Testing Starter Armature Rotation. Rotate starter armature by hand. If armature does not rotate freely, a bent armature or badly worn bearing may be causing it to bind. Disassemble starter and inspect it for wear or damage.

Disassembly. To disassemble starter motor, proceed as follows:

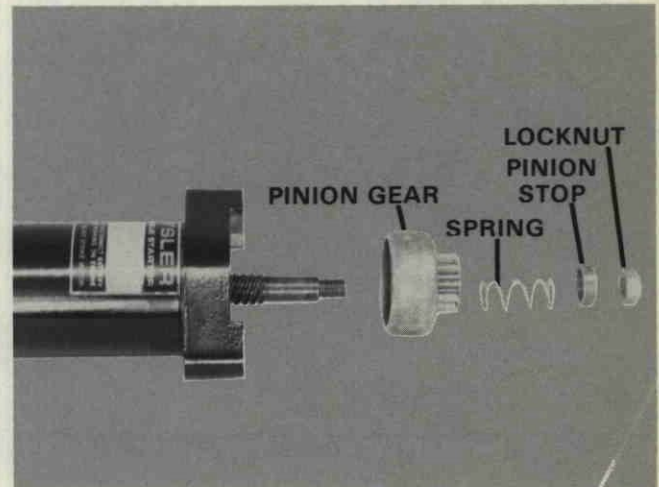


Figure 50. Disassembling Starter Motor.

CAUTION

Do not strike motor. Motor contains ceramic magnets which can break.

1. Remove locknut, pinion stop, spring and pinion gear, Figure 50.
2. Discard locknut (a new locknut will be required for assembly).
3. Remove the two thru bolts and lockwashers from starter motor.

4. Remove commutator end cap carefully so that brush springs will not be lost.
5. Tap and remove drive end cap and thrust washer.
6. Remove armature from body.

Testing Armature. If inspection does not reveal the cause of failure, test the armature for shorts, grounds and balance. Follow the test equipment manufacturer's procedure or use the following:

1. Armature short test.

- A. Place armature in growler jaws and turn power switch to GROWLER position.
- B. Hold a steel band parallel with and touching armature core. Turn armature slowly in growler jaws. If steel blade vibrates at any area of the core, area is shorted and armature must be replaced. Figure 51.

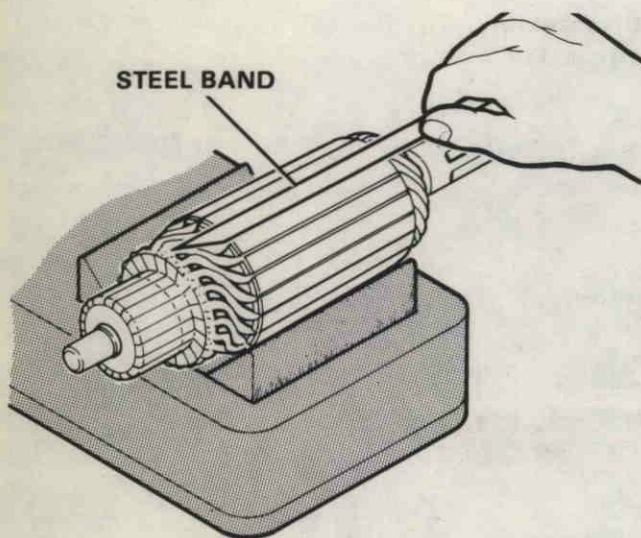


Figure 51. Testing Armature for Short.

2. Armature ground test.

- A. Place armature in growler jaws and turn power switch to TEST position. Figure 52.
- B. Touch one test lead to armature core, touch other lead to each commutator bar one at a time. If test light glows on any bar, armature is grounded and must be replaced.

NOTE

This test could also be performed with an ohmmeter. Attach one lead to core or shaft and other to commutator segments. Meter should show infinity or very high resistance.

3. Armature balance test.
 - A. Place armature in growler jaws and turn power switch to GROWLER position. Figure 53.
 - B. Place contact fingers of meter test cable across any two commutator bars at side of commutator.
 - C. Adjust voltage control until needle hits highest reading.
 - D. Test each commutator bar with the bar next to it until all bars have been checked. A zero reading shows an open circuit in a pair of bars.

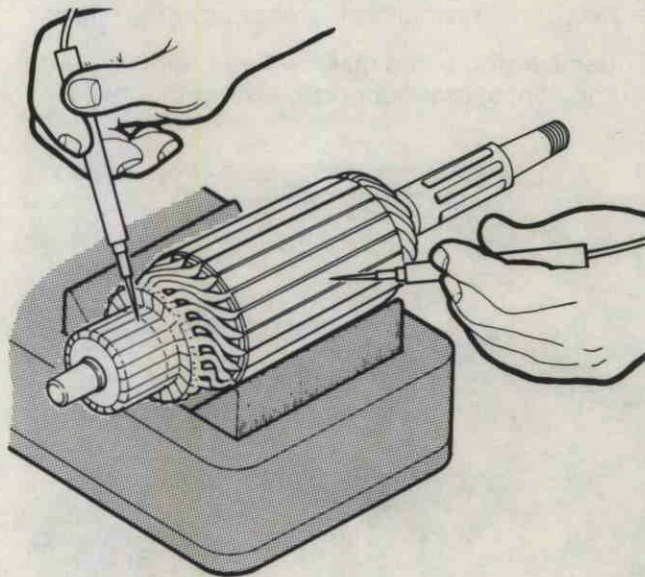


Figure 52. Testing Armature for Ground.

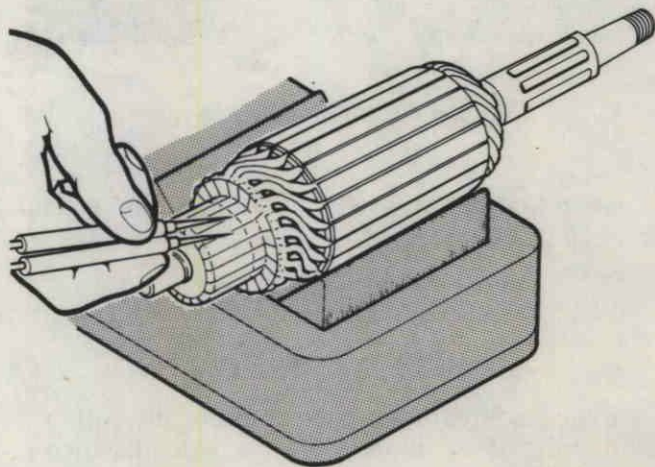


Figure 53. Armature Balance Test.

Brushes. Replace brushes if any are half worn, damaged or cracked. To replace brushes, the commutator end cap assembly must be replaced. Figure 54.

1. Check brush spring tension. Replace springs if tension is less than 40 ounces maximum.

Field Winding Ground Test.

1. Inspect insulated brush assembly for shorts with ohmmeter.
2. Perform ground brush test with ohmmeter; and check results as follows:
 - A. Ohmmeter should show very low resistance with leads attached to each end.
 - B. Meter should show infinity with one lead attached to brush terminal, other lead to case.
 - C. Meter should show very low resistance with one lead to ground brush, the other to frame where brush is attached.

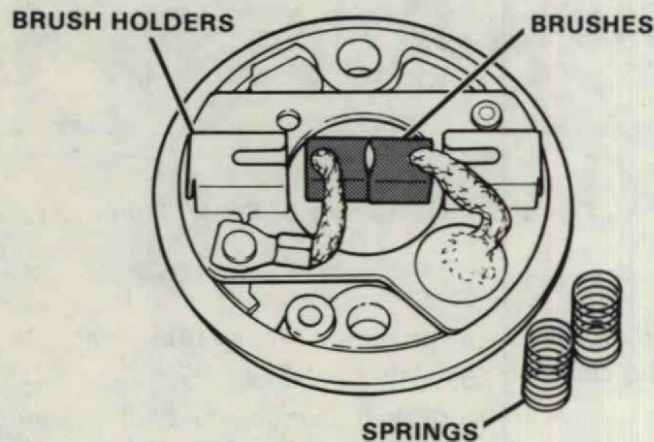


Figure 54. Starter Motor Brush Assembly.

Bearings. Inspect bearings in commutator end cap and drive end cap, for wear or damage. Figure 55.

Replace end cap(s) if necessary. Bearings are not serviceable and must be replaced as an assembly.

Cleaning and Inspection. After disassembly, all parts should be carefully inspected. Replace any questionable parts to insure maximum life of rebuilt unit.

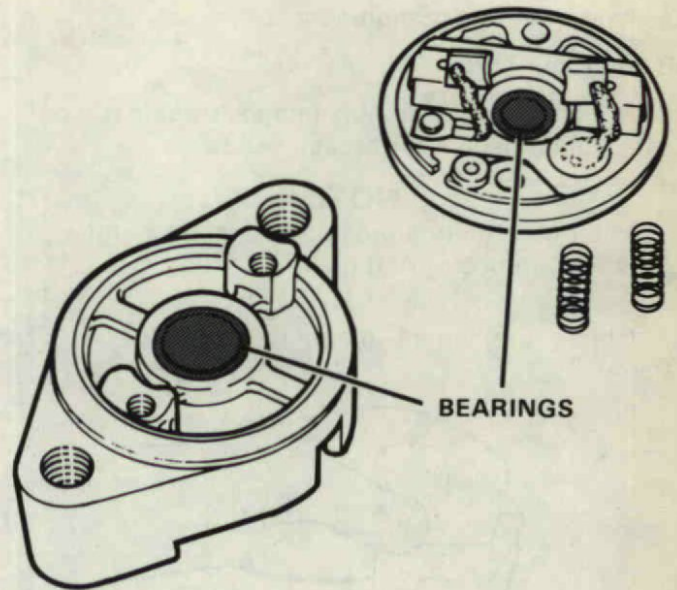


Figure 55. Starter Motor Bearing Location.

! WARNING

Wear safety glasses when using compressed air.

1. Clean starter frame, armature, drive assembly and end caps with brush or compressed air.
2. Inspect armature for loose connections at the point where armature windings are attached to commutator bars. Resolder any poor connections.

NOTE

Poor connections cause arcing and burning of commutator.

3. Clean dirty commutator with No. 400 or finer sandpaper.

CAUTION

Never use emery cloth to clean commutator.

4. Turn armature down on lathe if it is worn or out of round more than 0.005 inch.
5. Inspect armature shaft and end cap bearings for scoring and excessive wear.
6. Inspect drive assembly pinion gear for damage. An engine that has repeated starter motor pinion failures should be inspected for:

- A. Proper ring gear alignment.
- B. Improper parts.
- C. Wobbling ring gear. Maximum allowable run out is 0.030. Inspect for broken welds.

NOTE

When gear teeth are damaged, inspect entire circumference of ring gear.

- 7. Check permanent magnets in starter motor frame.

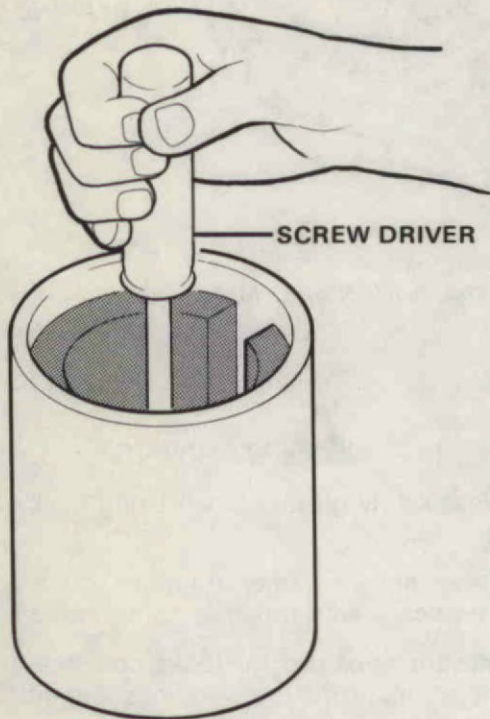


Figure 56. Testing Permanent Magnets in Starter Housing.

CAUTION

Make the following test carefully. Do not allow screwdriver to strike magnets. This can cause damage.

- 1. Hold screwdriver inside housing. Magnets should attract screwdriver strongly. Figure 56.

Reassembly. to reassemble starter motor, proceed as follows:

- 1. Lubricate the armature shaft with one drop of SAE No. 10 oil. Lubricate pinion gear helix on armature shaft.
- 2. Assemble thrust washer, drive end cap, pinion gear, spring, pinion stop, and new locknut on

armature shaft. Torque locknut to 160 in. lbs. (183 kg/cm).

- 3. Assemble armature to body. Align the mark on the body to the mark on the drive end cap. Figure 57.

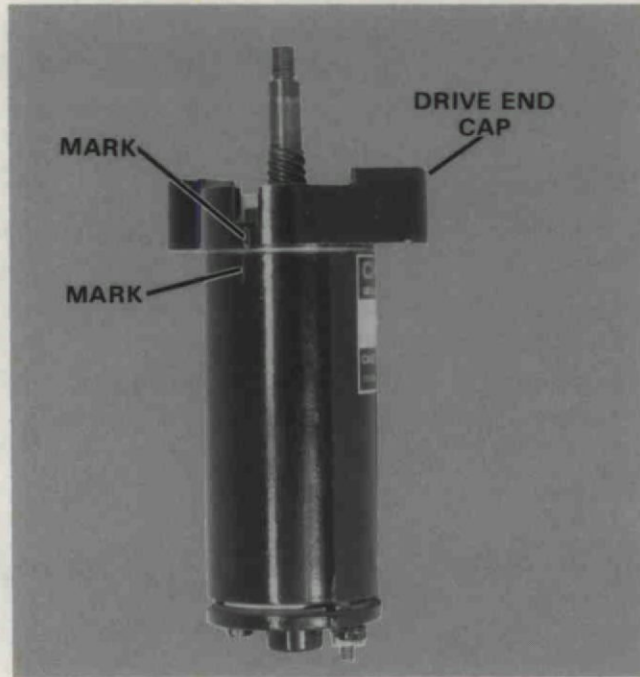


Figure 57. Reassembly of Starter Motor.

- 4. Install brush spring and ground brush lead into holder. Insert insulated brush in holder.
- 5. Insert armature shaft (commutator end) into end cap bearing. Figure 58.
- 6. Align notch on motor body with notch in commutator end cap and remove tool.
- 7. Insert thru bolts and torque to 95-100 in. lbs.
- 8. Check starter for operation.

Installation. To install starter motor, proceed as follows:

- 1. Place starter in position against engine and attach the two capscrews.
- 2. Reconnect starter cable.
- 3. Reconnect both battery cables to battery.

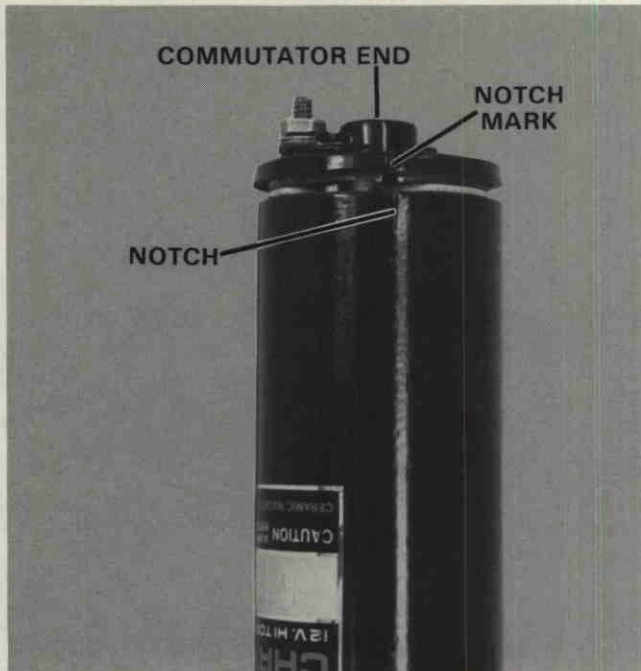


Figure 58. Installing Commutator End Cap to Motor Body.

STARTER SWITCH

Removal. Starter Switch.

1. Disconnect battery leads from battery terminals.
2. Remove two screws securing starter switch bracket to support plate and lift switch with bracket up far enough so that lead wires can be removed from switch terminals.
3. Remove lead wires from terminals on starter switch and remove switch with bracket.
4. Remove nut securing starter switch to bracket and remove switch.

Installation. Starter Switch.

1. Place switch in bracket, install nut with chamfer on nut facing forward and tighten securely.
2. Connect red battery cable lead and red lead from circuit breaker to starboard terminal on starter switch. Connect red lead from neutral interlock switch to port terminal on starter switch. Figure 59.
3. Place switch with bracket in position on support plate, install two screws and tighten securely.

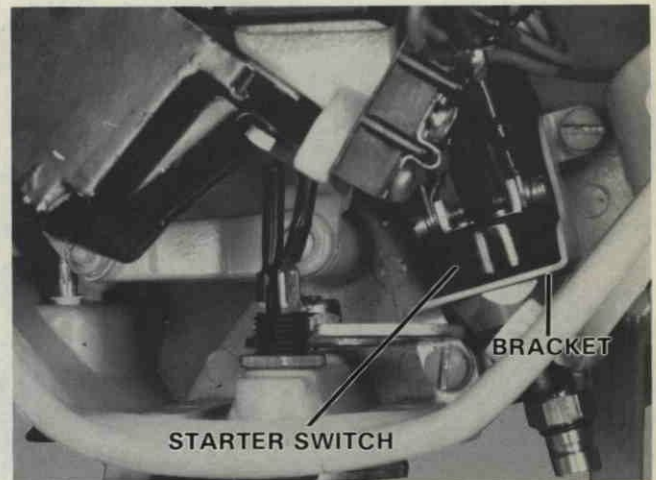


Figure 59. Connecting Leads to Starter Switch.

4. Connect battery leads to battery terminals.

INTERLOCK SWITCH

Removal. Interlock Switch.

1. Disconnect battery leads from battery terminals.
2. Remove nut securing interlock switch to interlock switch bracket and remove switch.
3. Remove two screws, lockwashers and lead wires from terminals on interlock switch.

Installation. Interlock Switch.

1. Connect red lead from starter switch to top terminal on interlock switch and secure with lockwasher and screw. Figure 60. Connect red lead

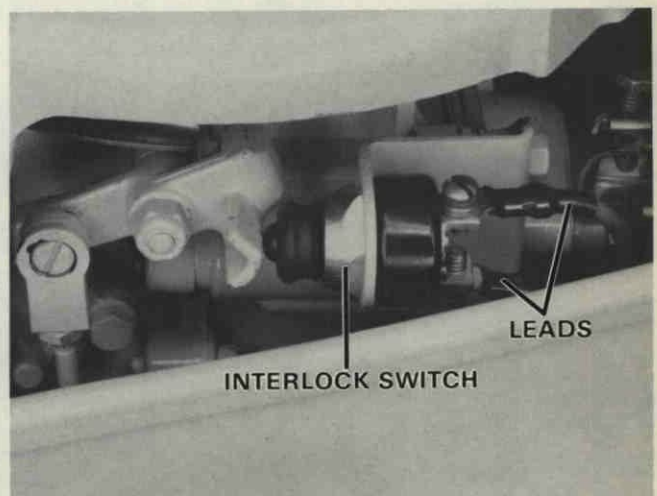


Figure 60. Connecting Leads to Interlock Switch.

from starter motor to bottom terminal on interlock switch and secure with lockwasher and screw.

2. Place switch in mounting bracket with plunger facing toward rear of engine and secure with hex nut.

3. Shift motor into neutral, interlock lever must depress switch. Adjust by removing screw securing interlock rod to lever. Loosen jam nut and turn bearing on or off until correctly adjusted. Figure 61.

4. Connect battery leads to battery terminals.

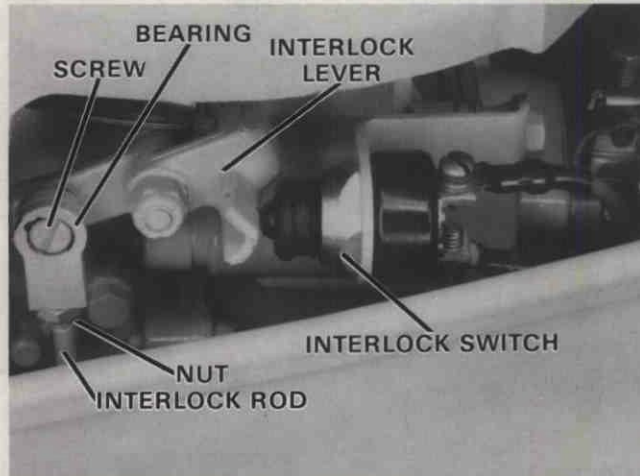


Figure 61. Correct Position: Interlock Switch & Interlock Lever.

STEERING HANDLE ASSEMBLY

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SPECIAL TOOLS

Section	Part No.	Description	Use
5 - STEERING HANDLE ASSEMBLY	T 2963-1	Sealant - 2 oz. Loctite D, Hardening Grade	

STEERING HANDLE ASSEMBLY

GENERAL

This section deals with removal, repair and installation of the steering handle assembly.

DESCRIPTION

The steering handle assembly controls the throttle, as well as steering components. The twist grip is mechanically connected to the throttle cam by the "magneto control system", which is included in this section.

Removal and Disassembly. Steering Handle Assembly.

1. Disconnect magneto control shaft and remove magneto control lever with links as follows:
 - A. Remove stop nut and washer from magneto control lever. Figure 1.

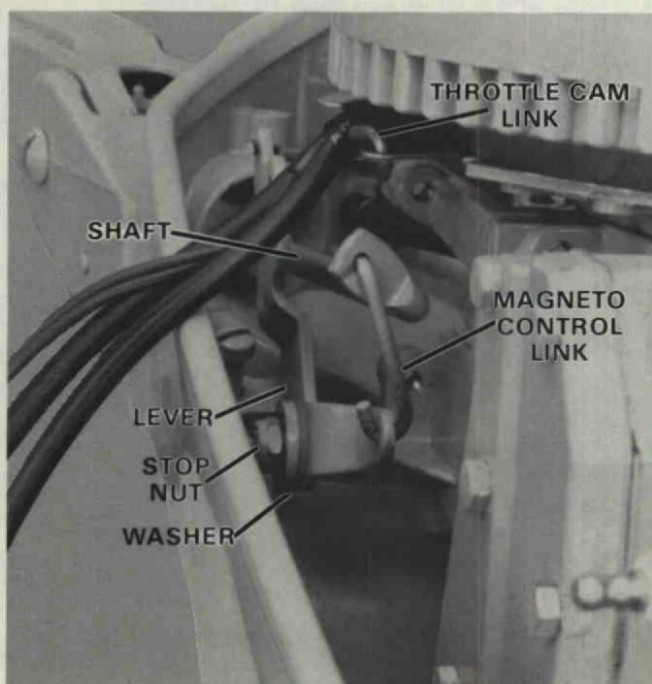


Figure 1. Disconnecting Magneto Control Shaft.

- B. Set throttle to fast.
 - C. Pull magneto control lever off pivot stud.
2. Disassemble magneto control lever assembly as follows:
 - A. Disconnect magneto control shaft link from magneto control shaft.
 - B. Pull magneto control lever out of support plate and detach both magneto control link and throttle cam link from lever.

NOTE

Shorter link is "magneto control shaft link".

3. Remove steering handle grip as follows:
 - A. Drive out spring pin securing grip to steering handle shaft. Figure 2.

CAUTION

Support grip or serious damage to steering components may result.

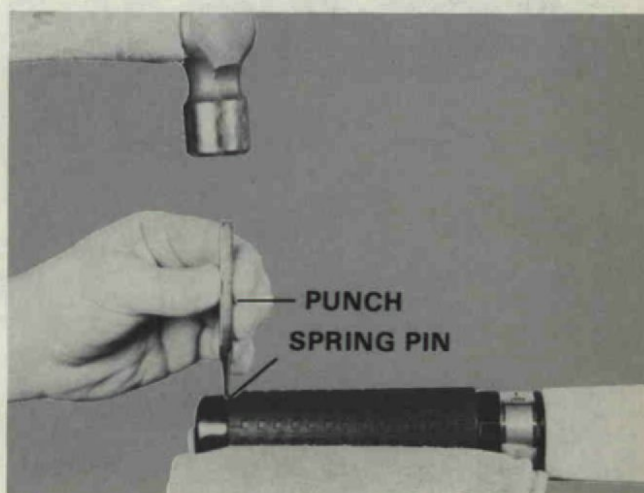


Figure 2. Removing Steering Handle Grip.

- B. Slide steering handle grip off steering handle and shaft.

NOTE

Sleeve and/or speed control indicator can be removed.

4. Remove steering handle from bracket as follows:
 - A. Remove pivot screw on port side of steering handle bracket.
 - B. Unthread truss head screw on starboard side of steering handle bracket about 1/8".
 - C. Position steering handle shaft gears to allow steering handle pivot insert to move toward gears.
 - D. Tap head of screw to drive insert far enough toward gears to remove steering handle from bracket. Figure 3.

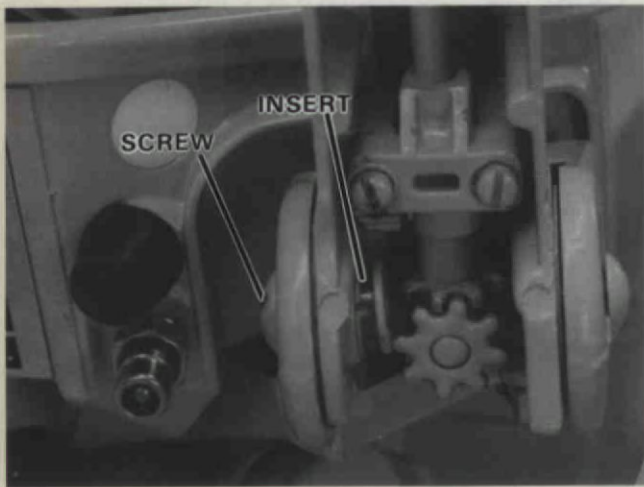


Figure 3. Tapping Insert to Free Handle.

- E. Remove screw and pull steering handle from bracket.

5. Disassemble steering handle as follows:

- A. Loosen set screw on steering handle shaft retainer. Figure 4.
 - B. Remove two (2) screws and lockwashers securing steering handle bearing and wedge. Remove bearing and wedge.
 - C. Slide shaft with gear and shaft bearing from steering handle.

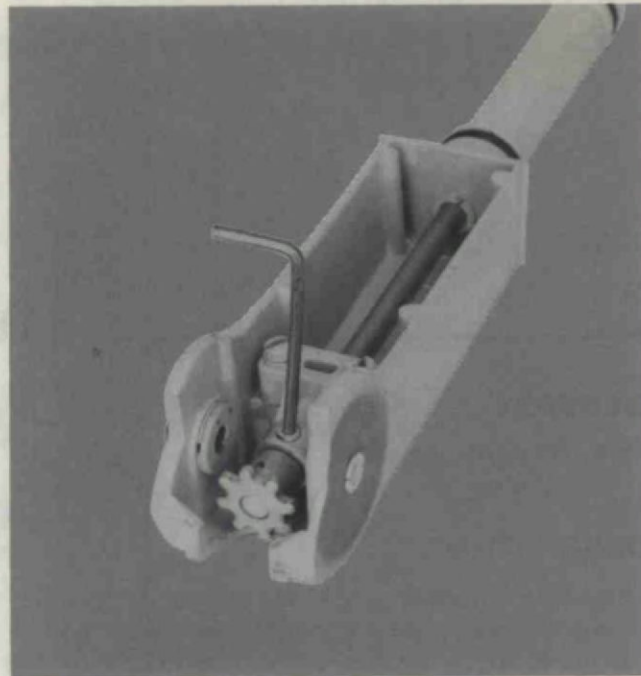


Figure 4. Loosening Set Screw.

- D. Remove insert and two (2) nylon bearings from steering handle. Figure 5.

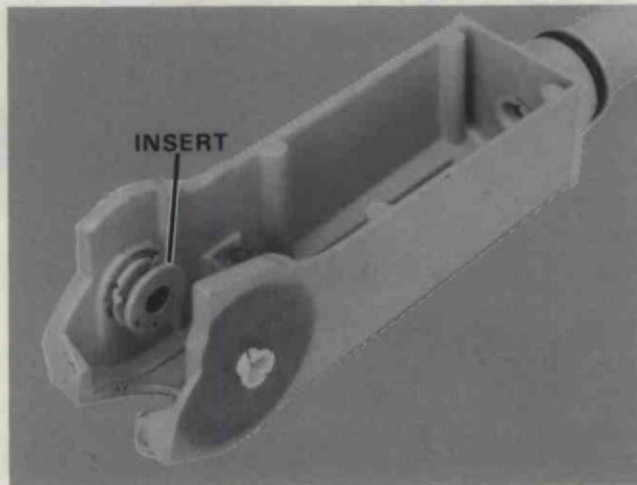


Figure 5. Removing Insert.

- E. Remove two (2) large nylon washers from pivot joints.
 6. Drive out spring pin to remove steering handle gear from shaft.

7. Remove two (2) screws and lockwashers securing steering handle bracket to steering arm bracket, and remove two (2) nylon bearings from bore of bracket.
8. Loosen set screw on magneto control shaft retainer.
9. Remove magneto control shaft gear as follows:
 - A. Pull gear away from boss on bracket.
 - B. Drive out spring pin that secures gear to shaft. Remove gear.
10. Remove magneto control shaft.
11. Remove steering handle stop and spring as follows:
 - A. Drive out steering handle pivot pin. Figure 6.

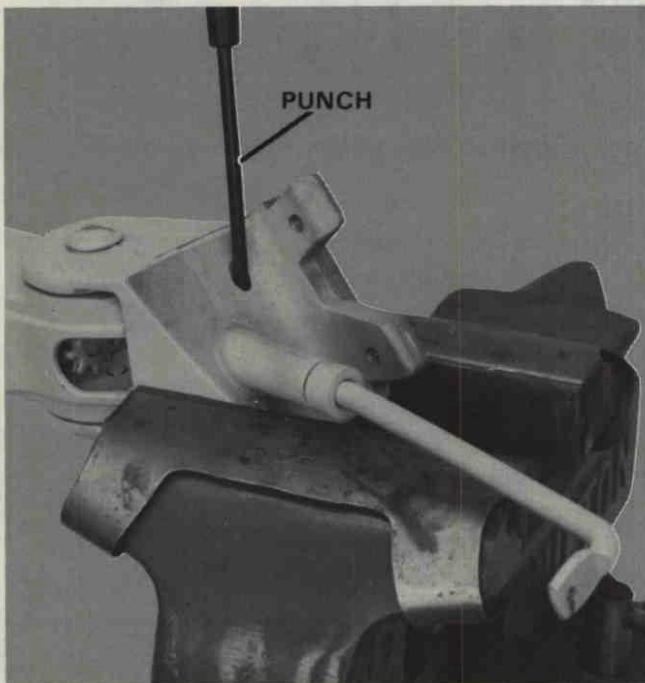


Figure 6. Removing Pivot Pin.

- B. Remove steering handle stop with bearings, and spring, from bracket.
- C. Remove two (2) nylon bearings from stop.

Inspection and Repair. Steering Handle Assembly.

1. Replace magneto control lever link and/or throttle cam link, if bent.
2. Repair steering handle grip.
 - A. Replace spring pin, if bent.
 - B. Replace sleeve and/or speed control indicator, if needed.

3. Repair steering handle.
 - A. Inspect bearing and wedge. Replace if badly worn or cracked.
 - B. Replace insert bearing, if badly worn.
 - C. Remove and replace seal (steering handle grip dampener); and forward seal on handle.
 - D. Replace steering handle shaft gear, if teeth are badly worn or broken.
 - E. Replace steering handle shaft spring pin, if bent.
 - F. Replace large nylon washers, if necessary.
4. Magneto control shaft and gear.
 - A. Replace magneto control shaft gear, if teeth are badly worn or broken.
 - B. Replace magneto control shaft gear spring pin, if bent.
5. Steering handle stop.
 - A. Replace two (2) steering handle stop bearings, if worn.
 - B. Replace steering handle pivot pin, if bent.
6. Check grease fitting on steering handle bracket.

Reassembly and Installation. Steering Handle Assembly.

1. Install steering handle stop and spring in bracket as follows:
 - A. Place two (2) bearings in bore of steering handle stop.
 - B. Install stop and spring. Figure 7.

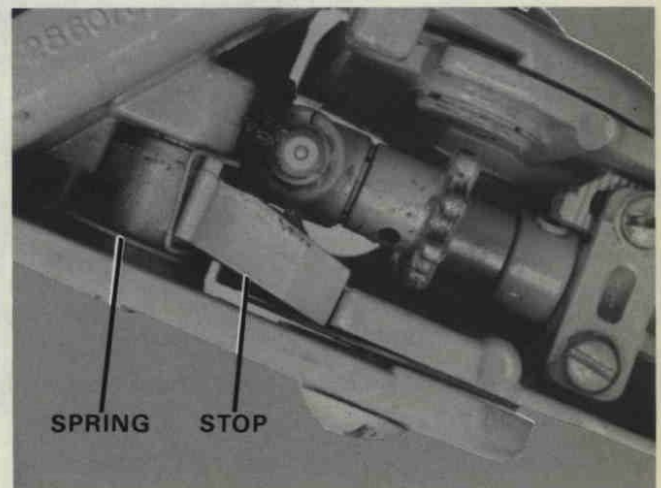


Figure 7. Installing Stop and Spring on Bracket.

2. Install magneto control shaft and gear in bracket as follows:

- A. Install two (2) nylon bearings on shaft bore in bracket.
- B. Place retainer on shaft.
- C. Install magneto control shaft with retainer in bracket.
- D. Place gear on shaft and secure with spring pin. Figure 8.

CAUTION

Be careful not to damage parts when tapping.

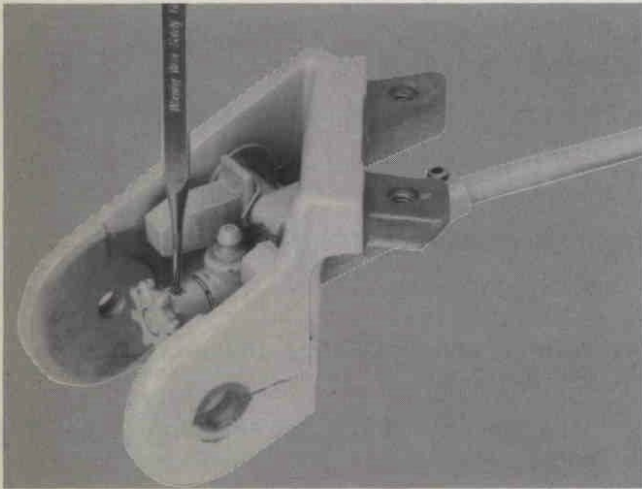


Figure 8. Securing Magneto Control Shaft Gear.

E. Hold gear firmly against boss on bracket and hold retainer firmly against boss on other side of bracket. Torque set screw in retainer to 45 in. lbs. (51kg/cm).

NOTE

Shaft end float must not exceed .005 or magneto control system will not work correctly.

- 3. Reassemble steering handle as follows:
 - A. Install insert and bearing on starboard side; and bearing on port side. Figure 5.
 - B. Install bearing in bore of steering handle.
 - C. Slide shaft assembly (shaft, steering handle bearing, retainer, gear) into handle. Figure 9.

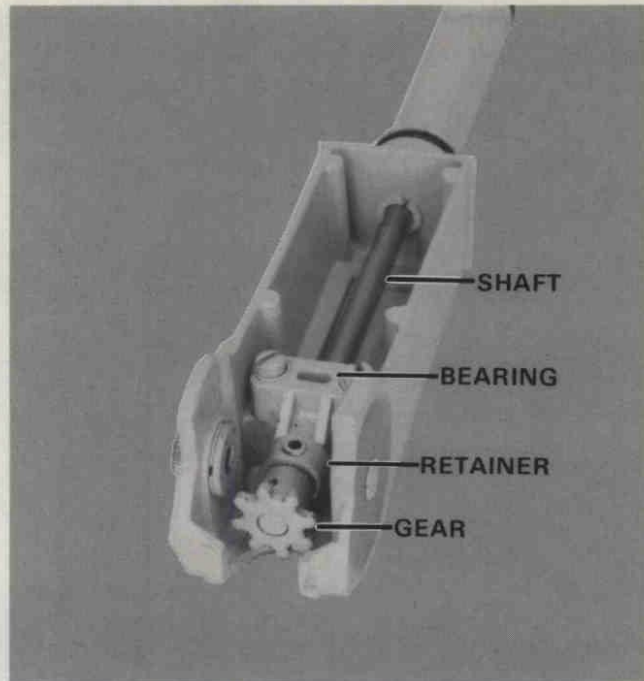


Figure 9. Assembling Steering Handle.

- D. Install wedge under bearing and install screws just tight enough to hold bearing and wedge.
- E. Install large nylon washers on both sides of steering handle at pivot joints.
- F. Slide shaft with gear away from bearing and place steering handle on bracket.
- 4. Install steering handle to bracket as follows:
 - A. Install pivot screw on port side of bracket.
 - B. Install screw (on starboard side) through insert.
- 5. Install steering handle grip as follows:
 - A. Line up spring pin holes in steering handle shaft and steering handle grip.
 - B. Drive spring pin through grip and shaft.
- 6. Install bracket to arm with two (2) screws.
- 7. Connect magneto control lever to magneto control shaft with magneto control link; and to throttle cam with throttle cam link (longer link). Secure with stop nut.

NOTE

Make sure links are installed correctly. Figure 10.

- 8. Adjust steering handle as follows:
 - A. Pull steering handle grip so steering handle gear

fits against bearing and meshes with magneto control shaft gear.

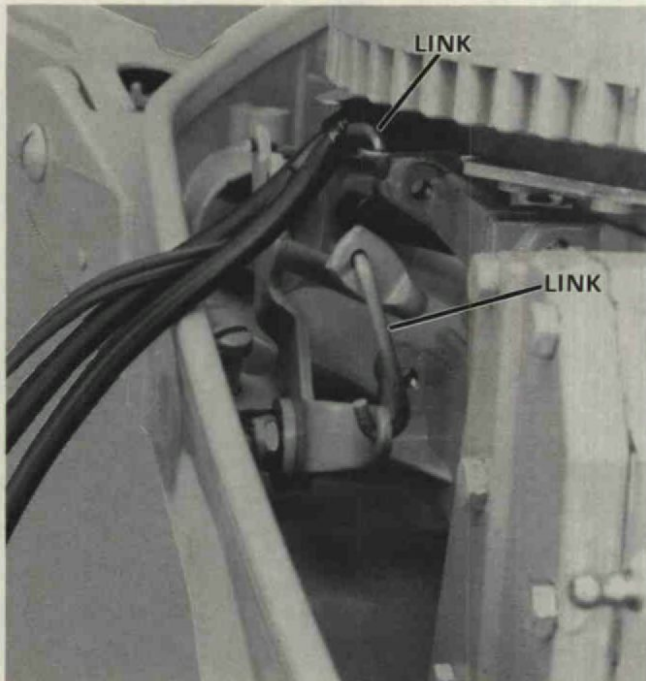


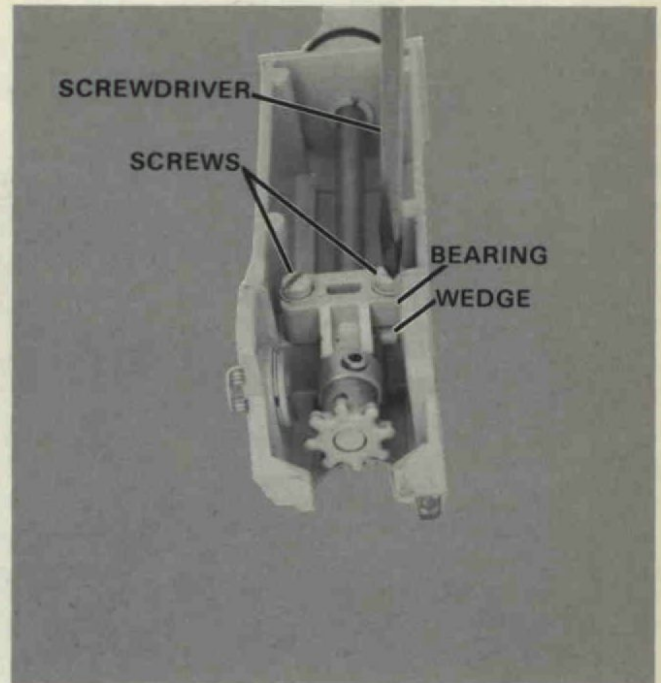
Figure 10. Installing Magneto Control Lever.

- B. Set magneto control lever at wide open throttle position.
- C. Slide steering handle shaft retainer against steering handle bearing and torque set screw in retainer to 45 in. lbs.

NOTE

Shaft end float can not exceed .005 or magneto control system will not work correctly.

- D. Adjust gear mesh, by loosening steering handle bearing screws and moving wedge fore and aft so that gear teeth touch firmly without binding or radial clearance. Figure 11.
- E. When gear mesh is correct, remove and Loctite bearing screw one at a time. Special Tool No. T 2963-1. Then tighten.



**Figure 11. Adjusting Gear Mesh.
(Shown apart for clarity)**

- F. Adjust steering handle friction by loosening or tightening screw on starboard side of steering handle bracket. Figure 12.

NOTE

A definite drag should be felt when tilting handle up or down.

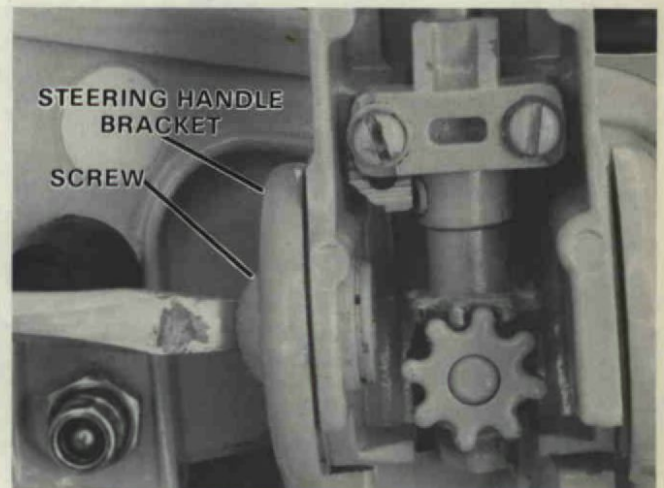
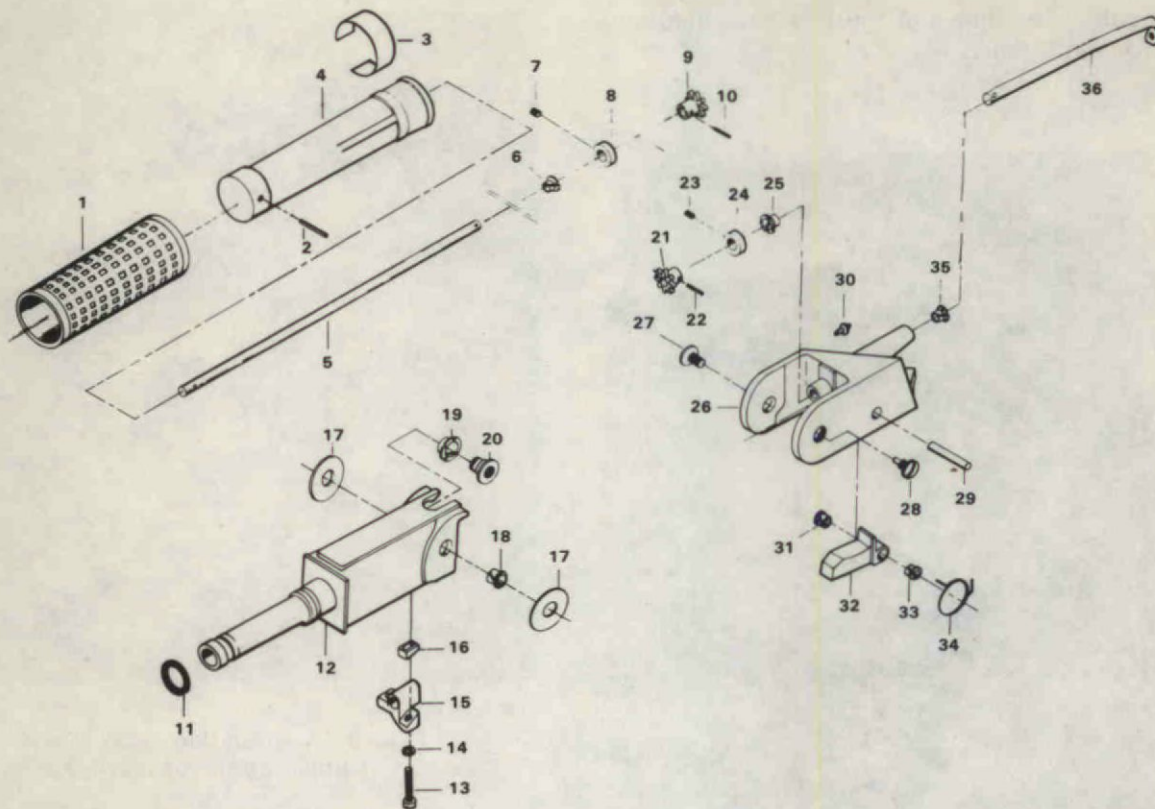


Figure 12. Adjusting Steering Handle Friction.



- | | | | |
|----|-------------------------------------|----|---|
| 1 | SLEEVE | 20 | INSERT, STEERING HANDLE PIVOT |
| 2 | SPRING PIN | 21 | GEAR, MAGNETO CONTROL SHAFT |
| 3 | SPEED CONTROL INDICATOR | 22 | SPRING PIN |
| 4 | GRIP, STEERING HANDLE W/SLEEVE | 23 | SET SCREW |
| 5 | SHAFT, STEERING HANDLE | 24 | RETAINER |
| 6 | BEARING | 25 | BEARING |
| 7 | SET SCREW | 26 | STEERING HANDLE BRACKET
W/GREASE FITTING |
| 8 | RETAINER | 27 | TRUSS HD SCREW, 5/16 - 18 x 5/8 |
| 9 | GEAR, STEERING HANDLE SHAFT | 28 | SCREW, STEERING HANDLE PIVOT |
| 10 | SPRING PIN | 29 | GROOVE PIN |
| 11 | SEAL, STEERING HANDLE GRIP DAMPENER | 30 | GREASE FITTING |
| 12 | STEERING HANDLE | 31 | BEARING, STEERING HANDLE STOP |
| 13 | SCREW, 10 - 24 x 7/8 | 32 | STEERING HANDLE STOP |
| 14 | INTERNAL TOOTH LOCKWASHER | 33 | BEARING, STEERING HANDLE STOP |
| 15 | BEARING, STEERING HANDLE | 34 | SPRING, STEERING HANDLE STOP |
| 16 | WEDGE, STEERING HANDLE | 35 | BEARING |
| 17 | WASHER, STEERING HANDLE | 36 | MAGNETO CONTROL SHAFT |
| 18 | BEARING | | |
| 19 | BEARING | | |

Figure 13. Steering Handle Assembly, Partial Exploded View.

Section

6

MANUAL STARTER

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SPECIAL TOOLS

Section	Part No.	Description	Use
6 - MANUAL STARTER	T 2985	Rewind Key	To remove and install starter
	T 2961	Lubricant - Rykon #2EP	

MANUAL STARTER

GENERAL

This section deals with removal, disassembly; inspection and repair; and installation of the manual starter.

DESCRIPTION

The manual starter consists of two (2) systems: the starter and the interlock system.

1. **Starter.** The starter is located on the front of the power head. It is held to the power head by two brackets. The starter rope is wound around a spring loaded spool, which has a pinion pinned to its top. The spring serves as the rewind force.

2. **Neutral Interlock.** The neutral interlock is in front of the starter bracket. It consists of a bracket

and connecting link. The interlock and a spring attached to the pinion gear function to prevent the motor from starting in gear.

OPERATION

With the motor in neutral, pulling on the starter rope turns the spool counterclockwise. A pre-loaded rewind spring inside the spool is held stationary at the bottom while the top turns with the spool building further spring pressure to return the rope when released. The pinion, at the top of the spool, is retained by a pin. There are cam shaped slots on both sides of the pinion, which allow the spool to turn as the pinion rises to engage the flywheel. Figure 1.

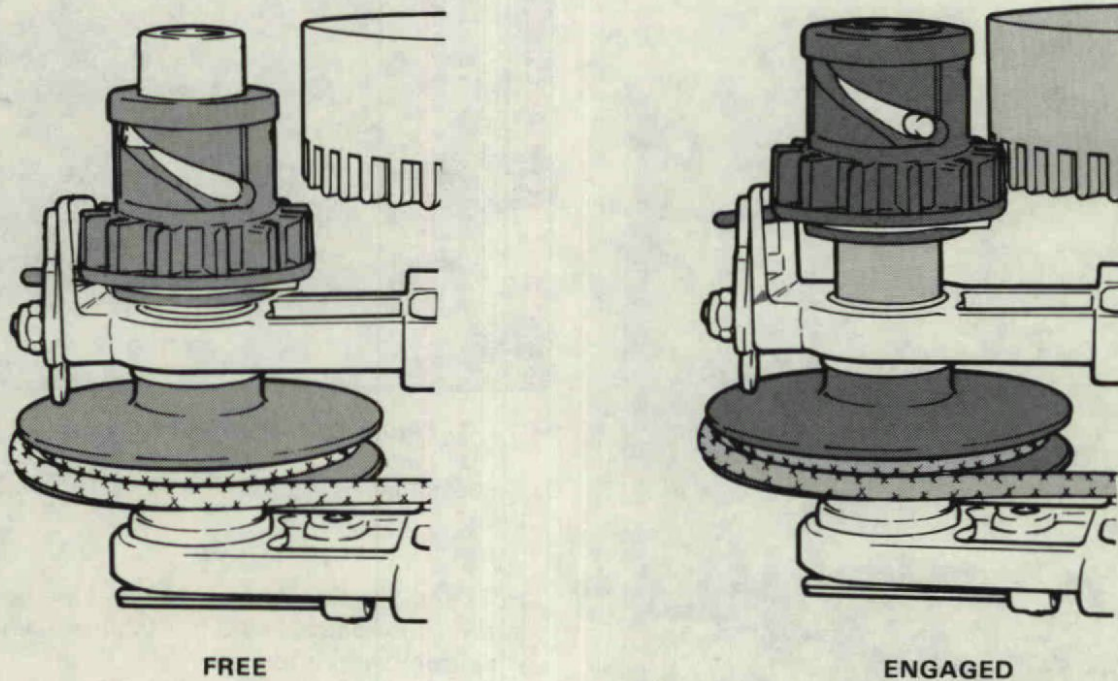


Figure 1. Operation of Starter Pinion Gear.

Removal. Manual Starter

1. Remove flywheel.
2. Remove screw on top of arbor (long shaft with groove) as follows:
 - A. Keep shaft from turning by holding a punch against pinion pin. Figure 2.

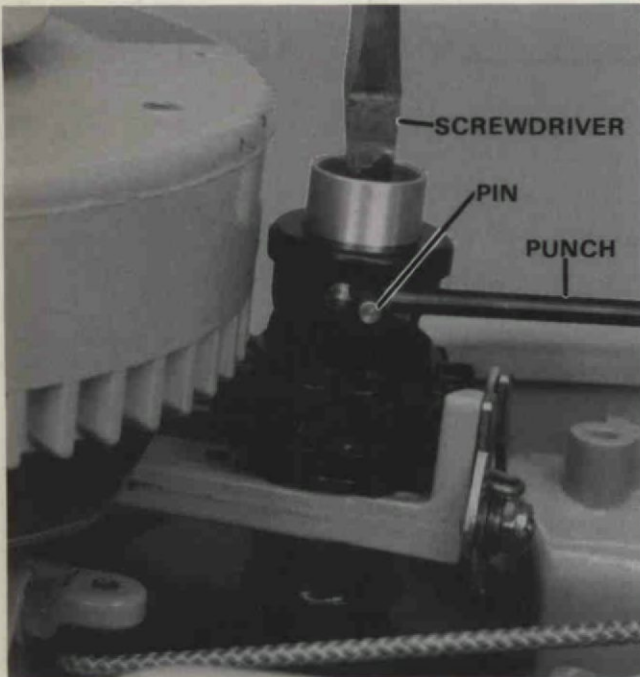


Figure 2. Removing Screw.

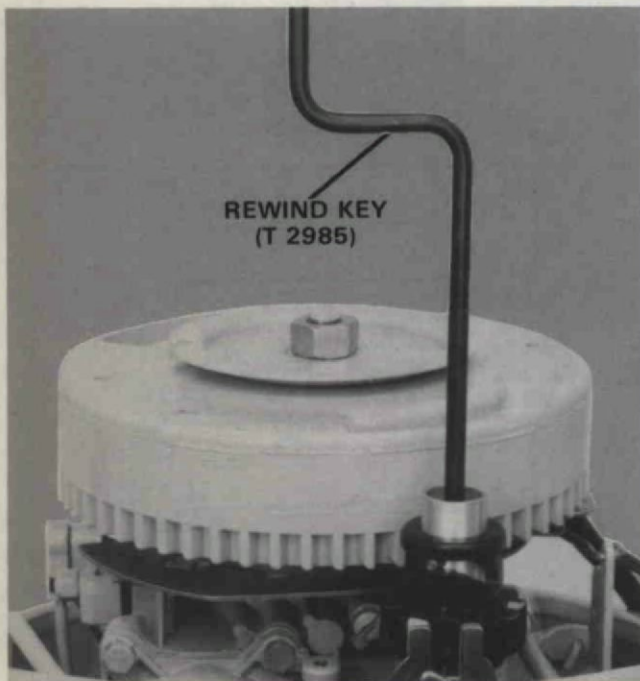


Figure 3. Installing Rewind Key.

- B. Take off screw.
 - C. Push pin half way out.
3. Install rewind key in place of screw just removed. Special Tool No. T 2985. Figure 3. Hold pin and securely tighten rewind tool.
 4. Remove pin from slot of pinion gear completely as follows:

CAUTION

Hold rewind key to keep starter spring from unwinding fast.

- A. Remove pin from slot. Allow spring to unwind slowly.
5. Remove rewind key with arbor and remove pinion gear; then remove rewind key from arbor.
 6. Take starter pinion spring off pinion gear.
 7. Remove starter rewind spring with retainer and end.
 8. Remove two (2) hex screws securing upper bracket. Remove stop nut, washer, and two (2) O rings securing interlock connecting link to gear shift shaft lever. Remove upper bracket with remainder of interlock assembly. Figure 4.

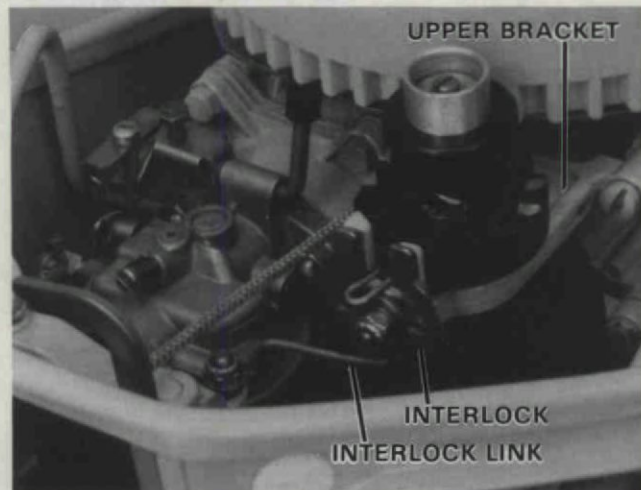


Figure 4. Removing Interlock.

9. Disassemble rest of interlock assembly as follows:

NOTE

Hold end of bracket upright so that the two (2) interlock detent balls do not fall from bracket when removing interlock.

- A. Unfasten stop nut and remove rest of interlock assembly (interlock, two (2) washers; interlock link; and two (2) interlock detent balls, and two (2) springs in bracket).

10. Remove starter rope from spool as follows:
 - A. Remove insert from starter rope handle.
 - B. Remove rope from insert and unwind rope from spool.
11. Remove two (2) screws securing lower bracket to crankcase cover and remove lower bracket with spring pin.

Inspection and Repair.

1. Wash all parts in solvent.
2. Inspect and repair as follows:
 - A. Inspect spool for wear. Check top of spool for burrs that could restrict pinion movement.
 - B. Check teeth of pinion gear for wear or breakage.
 - C. Measure pinion gear from inside edge of slots. Original dimension is .821 (20.85 mm).
 - D. Check rewind spring for wear and length. Original free length is 2-3/4" (70 mm). Figure 5.

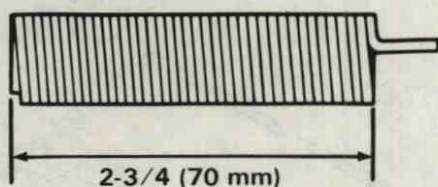


Figure 5. Checking Rewind Spring.

3. Measure pinion spring in middle. Original diameter is .778 (19.76 mm).
4. Replace two (2) O ring seals in interlock assembly.
5. Check spring pin in lower bracket. Spring pin must be in center of spool bore of bracket and parallel with under side of bracket. Straighten if necessary.

Installation. Manual Starter.

1. Install lower bracket.
 - A. Secure bracket (spring pin side down) to crankcase cover with two (2) screws.
2. Install starter rope and spool as follows:
 - A. Wind rope into spool counterclockwise as seen from top.
 - B. Apply light coat of grease to spool bore and place spool with rope in lower bracket.
 - C. Route rope around starter rope pulley on manifold and through support plate.

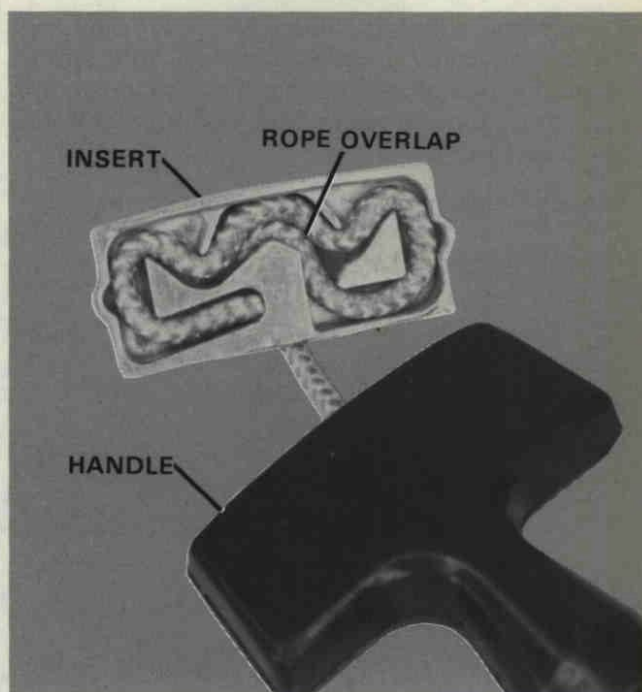


Figure 6. Placing Starter Rope in Insert.

- D. Feed rope through handle and into insert. Fold end over, so that there is an overlap of rope at midpoint of retainer. Figure 6.
- E. Pull insert into handle and wind rope into spool.
3. Place upper bracket on spool shaft, seat and install with two (2) screws.
4. Reassemble and install interlock assembly.
5. Install starter spring and pinion gear as follows:
 - A. Apply grease generously to both inside and outside of spring. Special Tool No. T 2961.
 - B. Install arbor (long shaft with groove) in spring so groove catches spring end.
 - C. Place arbor with spring in spool shaft. Line up notch of spring end with pin in lower bracket.
 - D. Apply grease lightly to groove and inner bore of pinion gear.
 - E. Replace pinion spring in groove of pinion gear.
 - F. Install pinion gear assembly on spool shaft with closed end of pinion spring through slot in bracket.
 - G. Install rewind key in tapped hole of arbor.
 - H. Line up holes in spool shaft and arbor. Insert pinion pin part way through slot in pinion gear and two holes. Hold end of pin and tighten key. Remove pin.

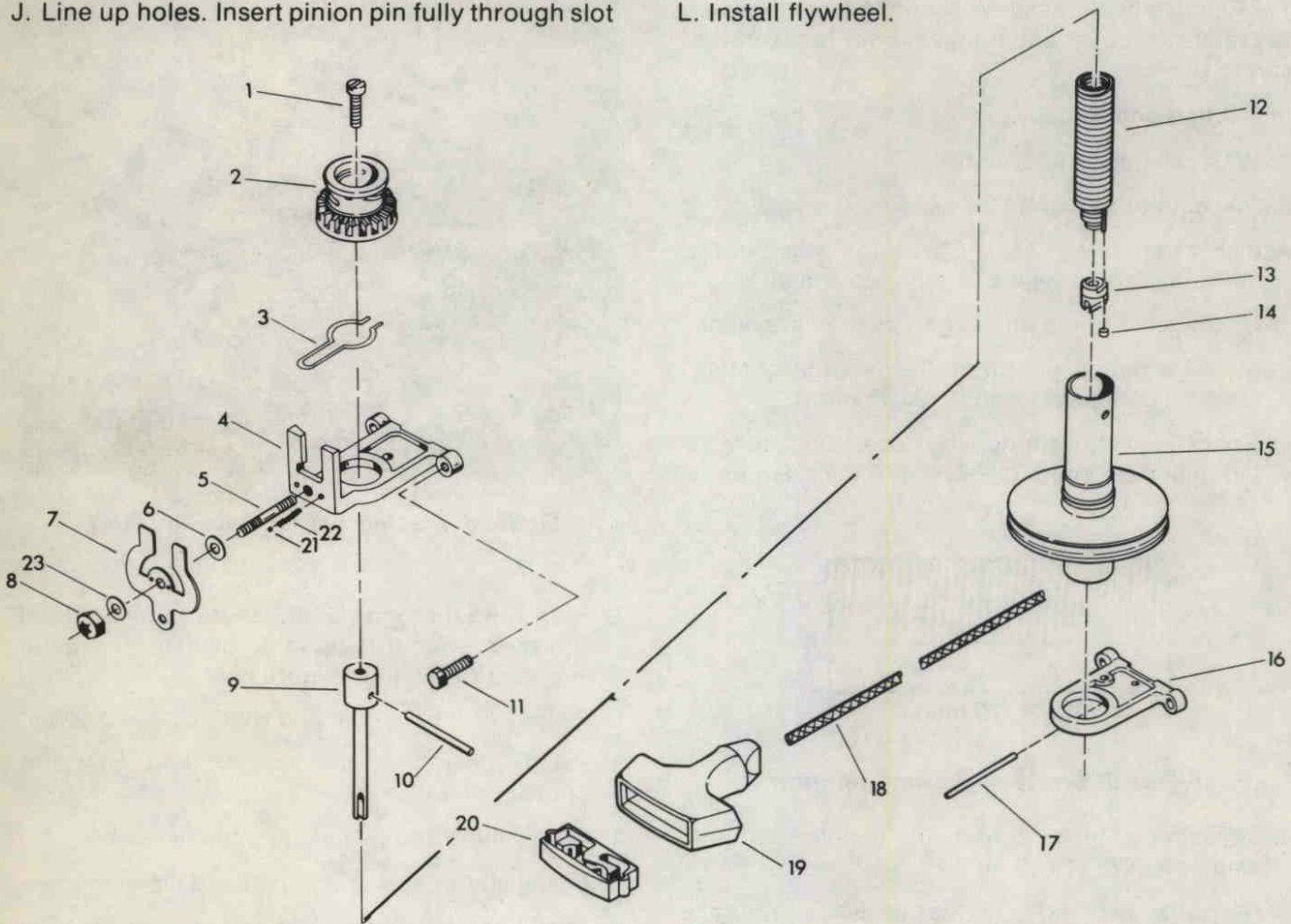
I. Turn starter spool to remove all slack from rope. Turn rewind key counterclockwise until spring tension just begins to be felt, then rewind starter spring by turning rewind key counterclockwise 3-1/2 to 4 turns.

in pinion gear and through spool shaft and arbor. Hold top of gear firmly and remove key.

K. Install screw in top of arbor.

J. Line up holes. Insert pinion pin fully through slot

L. Install flywheel.



- 1 SCREW, 10 - 24 x 9/16
- 2 GEAR, STARTER PINION
- 3 STARTER PINION SPRING
- 4 BRACKET, STARTER UPPER
- 5 STUD
- 6 PLAIN WASHER
- 7 STARTER INTERLOCK
- 8 STOP NUT
- 9 ARBOR, STARTER SPRING
- 10 STARTER PINION PIN
- 11 SCREW, 1/4 - 20 x 3/4
- 12 STARTER REWIND SPRING W/END AND RETAINER

- 13 RETAINER, STARTER REWIND SPRING
- 14 END, STARTER SPRING
- 15 STARTER SPOOL W/SHAFT
- 16 BRACKET, STARTER LOWER W/SPRING PIN
- 17 SPRING PIN, STARTER BRACKET
- 18 STARTER ROPE
- 19 HANDLE, STARTER ROPE
- 20 RETAINER, STARTER ROPE HANDLE
- 21 BALL, INTERLOCK DETENT
- 22 SPRING, INTERLOCK DETENT
- 23 PLAIN WASHER

Figure 7. Manual Starter Assembly. Exploded View.

Section

7

POWER HEAD

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Description.....	113
Principle of Operation	113
Troubleshooting	115
Overhaul	116

SPECIAL TOOLS

Section	Part No.	Description	Use
7 - POWER HEAD	T 2908	Seal Sleeve	To install upper crankshaft bearing cage seal
	T 8929	Adapter and Hex Bit	To torque connecting rod screws
	T 8949	Seal Installer	To install lower crankshaft seal
	T 2997	Ring Compressor	To install pistons
	T 8926	Ring Expander	To install rings on pistons
	T 3012	Seal Installer	To remove and install crankshaft bearing cage seal
	T 2998	Torque Wrench (0-100 lbs/ft)	To properly torque fasteners
	T 2999	Torque Wrench (0-600 lbs/ft)	To properly torque fasteners
	T 8993	Torque Wrench Adapter	To properly torque lower cylinder head bolts
	T 2991	Carbon Brush	To remove carbon from inside power head
	T 8900	Hose Clamp Pliers	To remove and install fuel hose clamps
	T 1749	Snap Ring Pliers	To remove and install piston pin retaining rings
	T 8919	Spring Pin Punch	To remove locating pins
	T 2990	Piston Pin Tool	To remove and install piston pin
	T 2947	Spark Plug Tap	To remove carbon from threads of cylinder head
	T 2961	Lubricant - Rykon #2EP	
	T 8983	Sealant - RTV	
T 2987-1	Lubricant - Anti-seize		

7

POWER HEAD

GENERAL

An engine needs three basic ingredients to run: proper fuel/air mixture, compression, and a spark at the right time. The information in this section is concerned with compression, and the parts of the power head that develop compression.

DESCRIPTION

The power head consists of the cylinder, pistons, rods, crankshaft, and the crankcase. The power head is a two-cycle engine with two horizontally mounted cylinders. The firing order is alternate so that each cylinder delivers one power impulse per crankshaft revolution.

The power head incorporates a **cross scavenged** system. As the pistons uncover the intake ports on the downstroke, fuel/air mixture enters the combustion chamber from the crankcase. The intake ports are opposite the exhaust ports. A baffle at the top of the pistons directs the fuel/air mixture up and around the cylinder, then down, forcing the exhaust gases out the exhaust ports.

PRINCIPLE OF OPERATION

The piston in a two-cycle engine acts as an inlet valve, exhaust valve, and air pump. When a two-cycle engine starts, the crankshaft turns and the piston rises. With the piston approaching Top Dead Center (combustion chamber filled with a compressed mixture of air and fuel) the spark plug

ignites the compressed mixture. The resulting explosion forces the piston down which in turn rotates the crankshaft. Figure 1A.

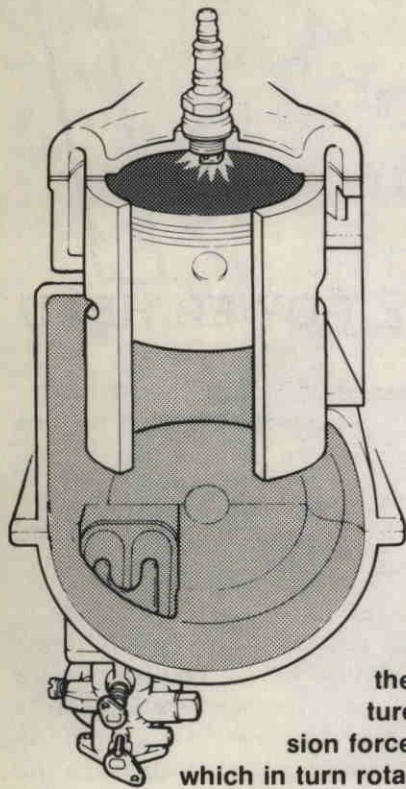
As the piston moves down, it first uncovers the exhaust ports. The exhaust escapes through the ports and the combustion chamber pressure falls.

Meanwhile, a fresh supply of air/fuel mixture is being compressed in the crankcase by the down stroke of the piston. Figure 1B. As the piston nears the bottom of this stroke, it uncovers the inlet ports and this fresh air/fuel mixture rushes into the combustion chamber in an effort to equalize the pressure between the crankcase and combustion chamber. The flow pattern of the fresh air/fuel mixture pushes the burned exhaust gases from the cylinder. Figure 1C.

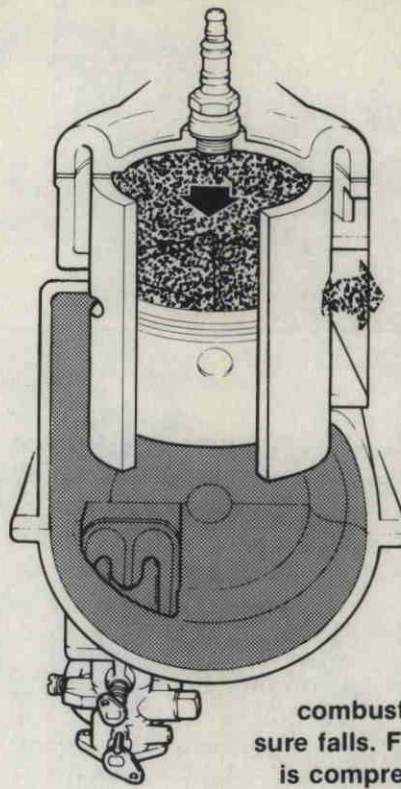
Now the compression stroke begins; the intake ports and exhaust ports are covered by the rising piston. As pressure increases in the combustion chamber, it decreases in the crankcase. This decrease in pressure permits a new air/fuel mixture from the carburetor to enter through the reed valve, thus preparing the next cylinder charge. Figure 1D.

The recirculating passages built into the cylinder block are designed to transfer any unburned fuel in one cylinder to the intake area of the other cylinder. Figure 2.

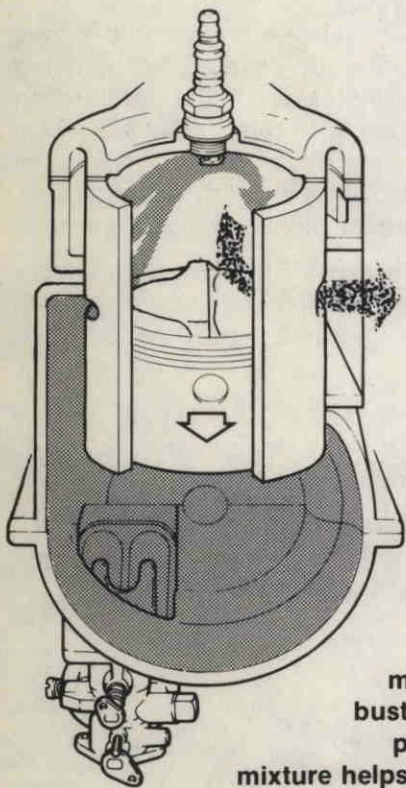
In this manner, all fuel is consumed in the combustion chamber rather than being allowed to vent overboard into the water.



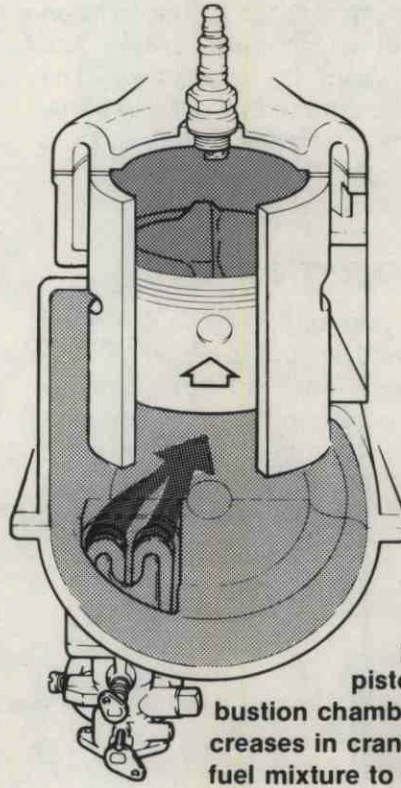
A. COMBUSTION
Spark plug ignites the compressed mixture. Resulting explosion forces the piston down which in turn rotates the crankshaft.



B. EXHAUST
Exhaust escapes through port and combustion chamber pressure falls. Fresh supply of fuel is compressed in crankcase.



C. INTAKE
Inlet port is uncovered, fuel mixture enters combustion chamber. Flow pattern of fresh fuel mixture helps push out exhaust.

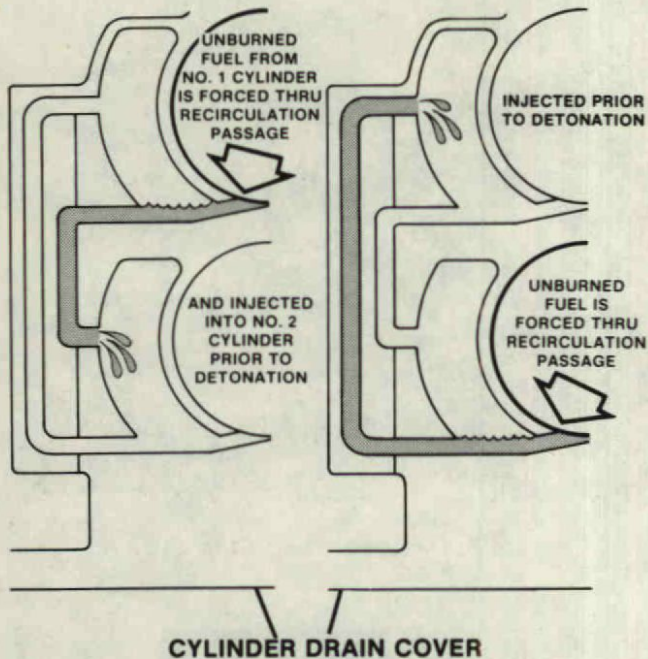


D. COMPRESSION
Intake and exhaust ports are covered by piston. Pressure in combustion chamber increases and decreases in crankcase allowing fresh fuel mixture to enter through reeds.

Figure 1. Operation of the 2-Cycle Motor.

UNBURNED FUEL IN NO. 1 CYLINDER

UNBURNED FUEL IN NO. 2 CYLINDER



**Figure 2. Fuel Transfer
within Recirculating Passages.**

TROUBLESHOOTING

Poor engine performance and/or hard starting may be signs of a compression problem. Other signs include excessively smoky exhaust, badly fouled plugs, power surging or extreme power loss. All can indicate engine compression problems. Therefore, when internal damage or wear is suspected as the cause of an engine problem, a compression test should be done first.

Compression Test. To perform a compression test, proceed as follows:

1. Remove both spark plugs from the power head.
2. Insert the tip of the compression tester into the spark plug hole of the cylinder being tested. Set throttle to wide open position. Figure 3.
3. Crank the engine over with the recoil starter several times to make sure that each cylinder comes up for the compression portion of its stroke several times.

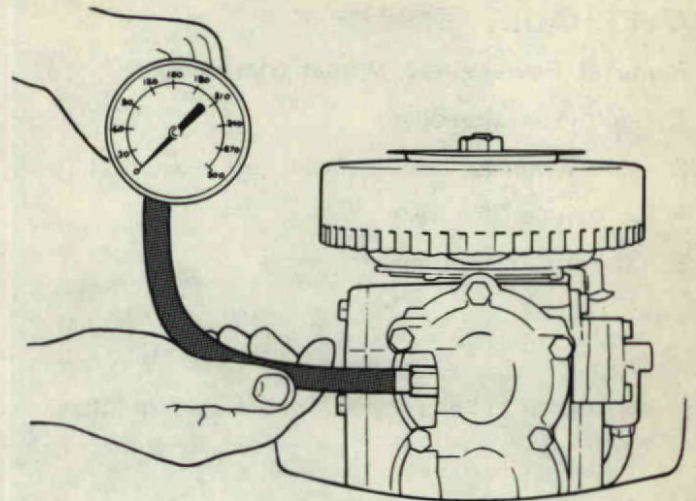


Figure 3. Compression Gauge Installed.

4. Note the reading on the gauge. A reading between 115-125 p.s.i. (9.9), 125-135 p.s.i. (12 & 15) indicates good compression. If the reading is lower, then there is a compression leak. Figure 4.

NOTE

Both cylinders should be within 10 p.s.i. of each other. If a greater variation is experienced the cylinder head should be removed and an inspection made to find the problem (failed head gasket, scored cylinder etc.).

NOTE

Sometimes simply tightening the head bolts to the proper torque will cure a leaky head gasket.

GOOD COMPRESSION RANGE (12 & 15 H.P. SHOWN)

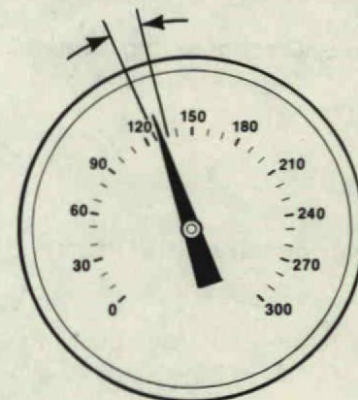


Figure 4. Compression Range.

Motor Noises. Learning to recognize certain sounds made by a running motor can help troubleshoot internal problems. These sounds can be traced down to their exact location using a mechanics stethoscope.

OVERHAUL

Removal. Power Head, Manual Start Model.

1. Remove engine cover.
2. Remove starter handle and insert as follows:
 - A. Pry handle off insert.
 - B. Take rope out of insert.

NOTE

Make knot to keep rope from winding up into spool.

3. Disconnect choke link from carburetor. Figure 5.

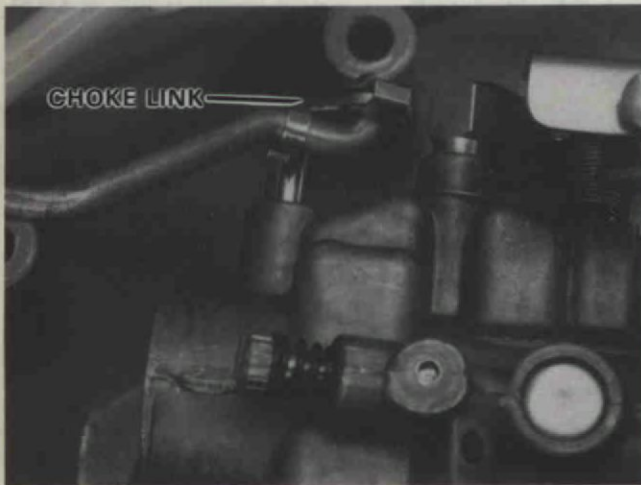


Figure 5. Disconnecting Choke Link from Carburetor.

4. Disconnect primary wires from stop switch. Figure 6.
5. Disconnect fuel line from bushing as follows: Figure 7.
 - A. Remove hose clamp with pliers. Special Tool No. T 8900.

CAUTION

Do not use pliers to pull hose, or hose may be damaged.

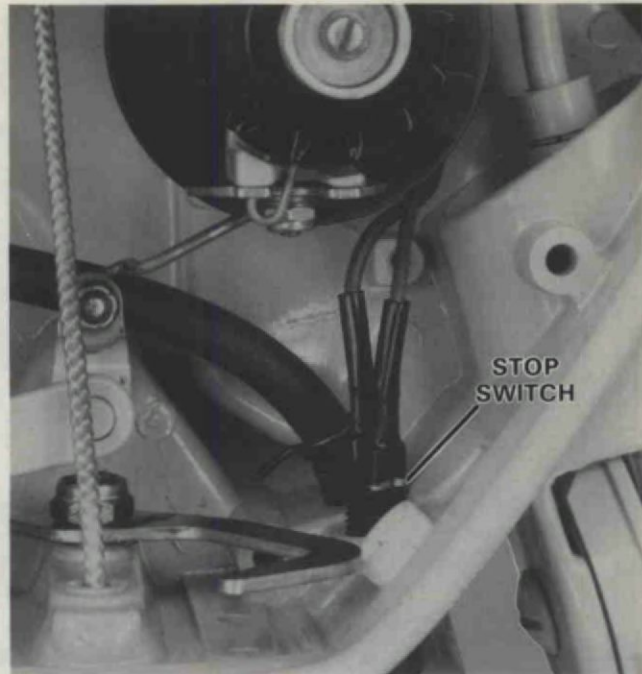


Figure 6. Disconnecting Stop Switch.

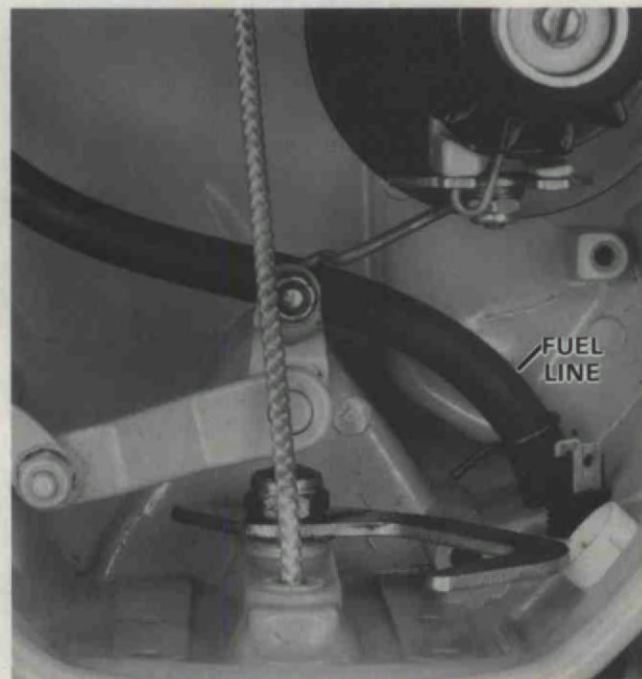


Figure 7. Disconnecting Fuel Line.

6. Disconnect magneto control lever. Figure 8.
7. Disconnect interlock from power head as follows:
 - A. Remove swivel screw securing interlock link bearing to interlock lever. Figure 9.

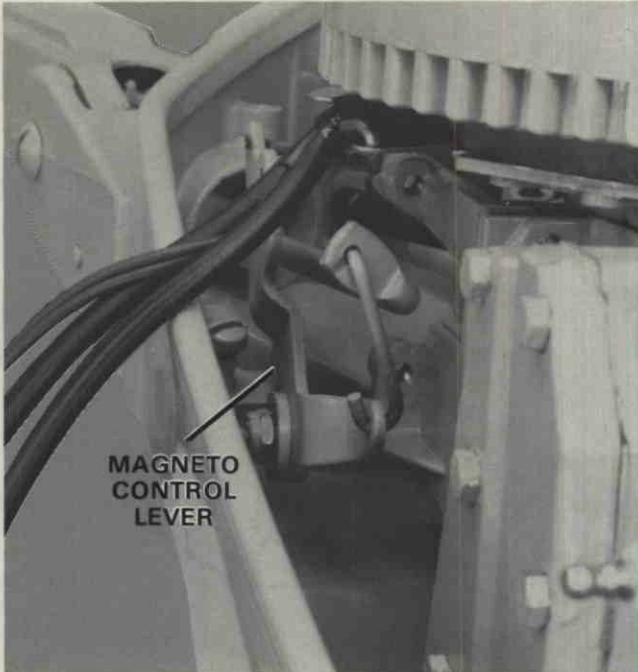


Figure 8. Magneto Control System.

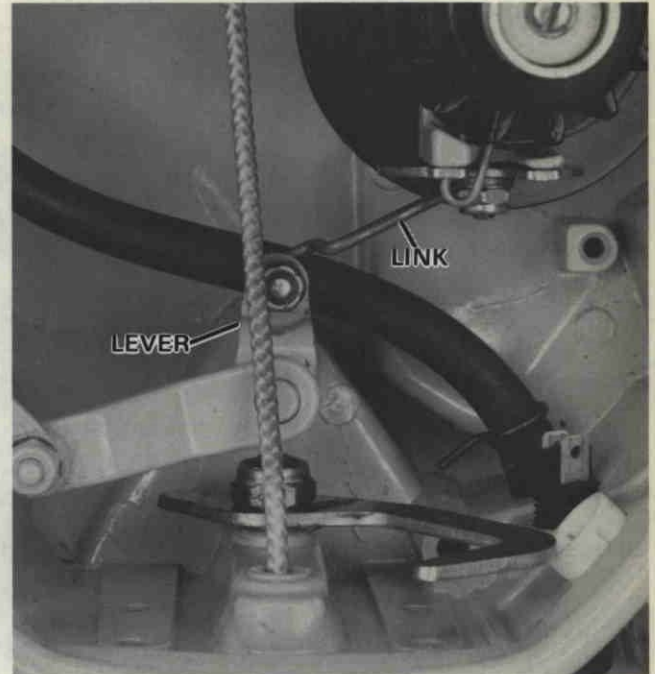


Figure 10. Disconnecting Interlock Link from Gear Shift Shaft Lever.

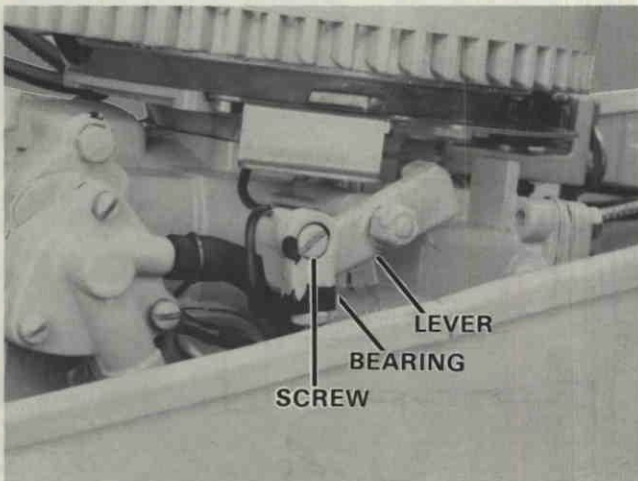


Figure 9. Disconnecting Interlock Lever.

B. Remove stop nut, two (2) washers and two (2) O rings securing interlock link to gear shift shaft lever. Figure 10.

8. Remove six (6) hex screws at base of cylinder and pull power head from support plate. Figure 11.

NOTE

Use swivel socket extension or remove fuel pump to get at forward and middle screws on starboard side.

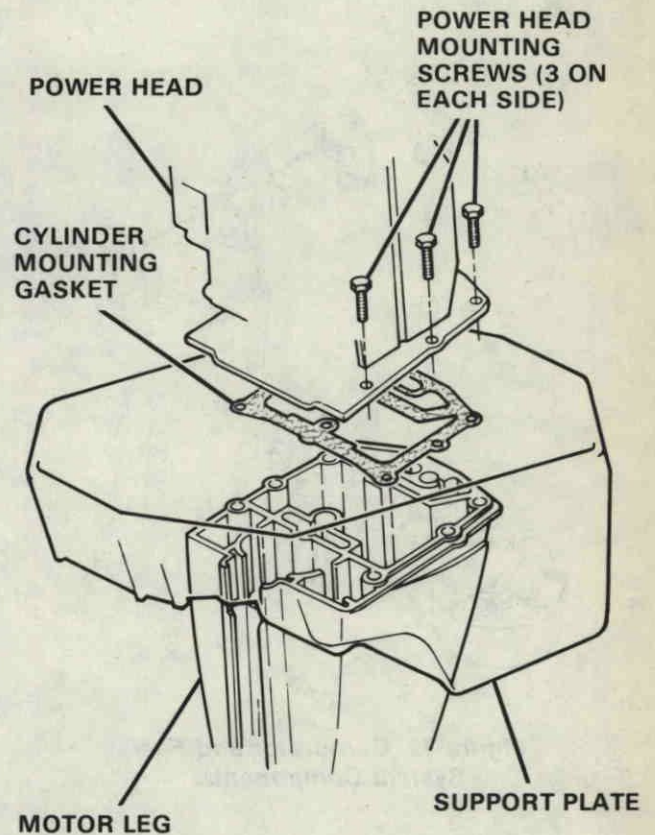


Figure 11. Removing Power Head from Support Plate.

Removal. C-D Models

1. Remove engine cover.
2. Remove starter support.
3. Disconnect choke link.
4. Disconnect stop switch.
5. Disconnect starter interlock switch.
6. Disconnect fuel lines from fuel pump.

Disassembly. C-D Models.

1. Follow steps for disassembly of Manual Start Models.

Disassembly. Manual Start Models.

NOTE

Figures 12, 13, 14 below show Manual Start Models. For C-D Models. See other sections.

1. Remove carburetor and fuel system components. Figure 12.

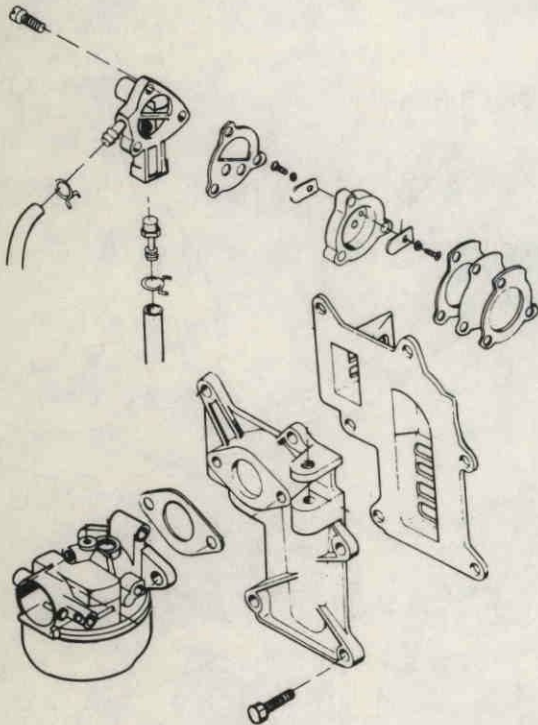


Figure 12. Carburetor and Fuel System Components.

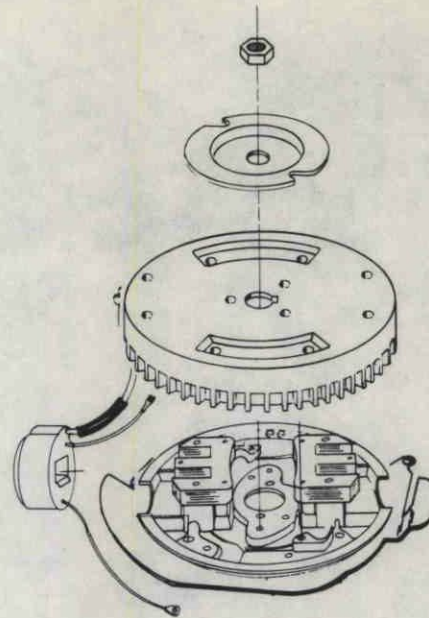


Figure 13. Flywheel and Ignition Components.

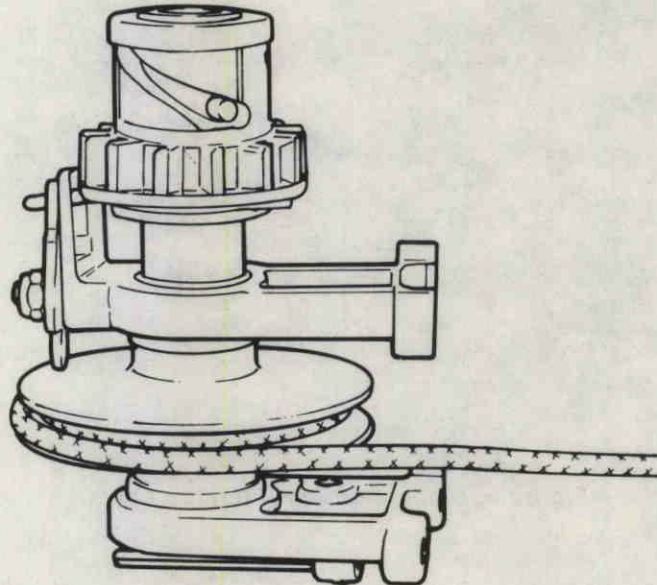


Figure 14. Manual Starter.

2. Remove flywheel and ignition components. Figure 13.

3. Remove manual starter. Figure 14.

4. Remove four (4) fill head screws securing bearing cage with seal, and stator ring to power head. Remove bearing cage with seal and stator ring. Figure 15.

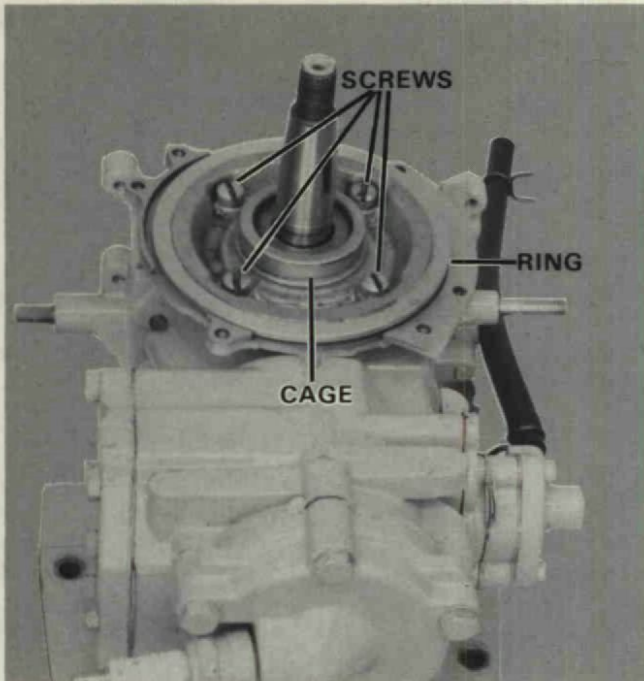


Figure 15. Removing Bearing Cage and Stator Ring.

5. Remove crankshaft bearing cage seal from cage with seal installer. Special Tool No. T 3012.
6. Remove bearing cage gasket and discard.
7. Remove eight (8) hex head screws securing exhaust cover to power head. Remove exhaust cover, plate, and two (2) gaskets. Figure 16. Discard gaskets.

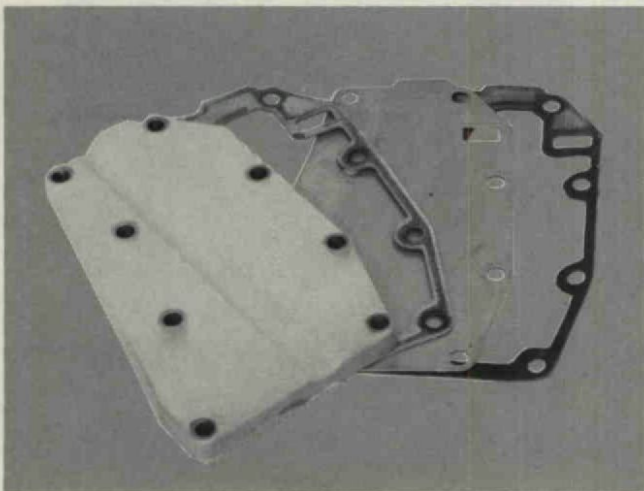


Figure 16. Removing Exhaust Cover.

8. Remove three (3) taptite, washer head screws securing exhaust tube to cylinder.

9. Remove driveshaft spline seal from (splined) bore of crankshaft. Discard seal.

10. Remove four (4) hex head screws that secure cylinder drain cover to cylinder. Remove cylinder drain cover and gasket.

11. Remove eight (8) bolts with washers that secure cylinder head to cylinder; remove cylinder head and gasket.

12. Remove three (3) screws that secure transfer port cover to cylinder. Remove transfer port cover and gasket.

13. Remove crankcase cover from cylinder as follows:

- A. Remove eight (8) 1/4" dia. screws and four (4) 5/16" dia. screws that secure crankcase cover to cylinder. Figure 17.
- B. Drive out two (2) locating pins. Special Tool No. T 8919. Figure 18.

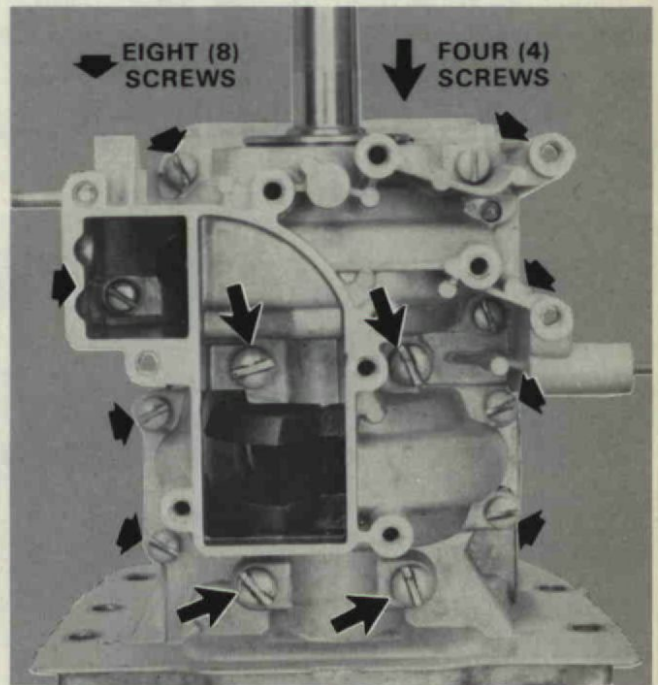


Figure 17. Removing Crankcase Cover Screws.

- C. Pry crankcase cover from cylinder. Use screwdriver at pry points. Figure 19.

NOTE

Top half of main bearing liner may come off during this step. Use swab with grease to retrieve any rollers (main bearing roller set) in cylinder.

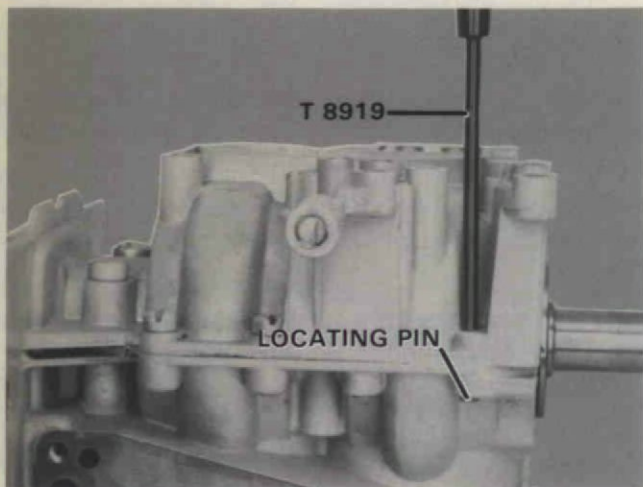


Figure 18. Removing Locating Pins.

CAUTION

Do not use magnet. Rollers may become magnetized, attract shavings, leading to damage. Magnetized rollers also create frictional heat.

14. Mark connecting rod and cap of top cylinder with "T"; connecting rod and cap of bottom cylinder with "B".

CAUTION

Mixing up rod caps will cause rod failure when engine is run.

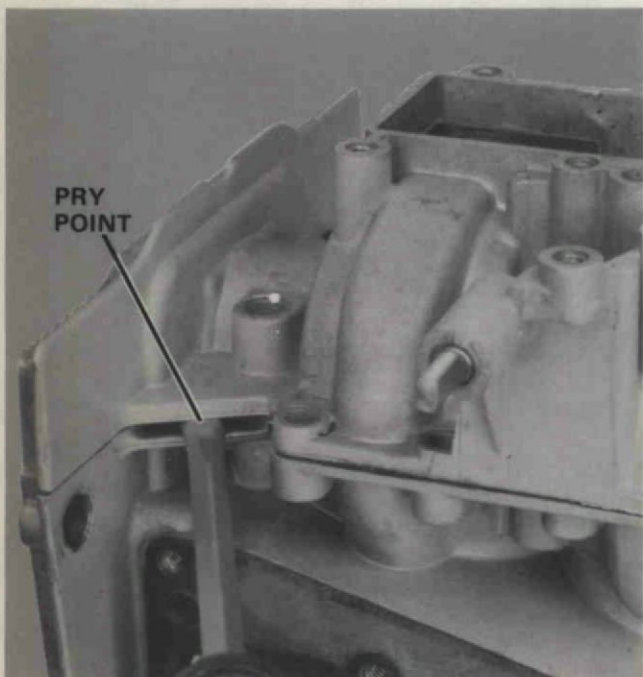


Figure 19. Prying off Crankcase Cover.

15. Remove connecting rod screws. Special Tool No. T 8929. Figure 20.

16. Remove connecting rod cap on top cylinder. Remove connecting rod bearing rollers and cage half.

NOTE

Place finger and thumb where cap joins connecting rod to keep rollers from falling into cylinder. Use swab with grease to retrieve any rollers that fall into cylinder. There are 16 rollers in each connecting rod roller set.

CAUTION

Do not use magnet. Rollers may be magnetized, attract shavings, leading to damage. Magnetized rollers also create frictional heat.

17. Follow step 16 for bottom cylinder connecting rod cap.

18. Remove center main bearing liner (exposed half of liner) and remove all exposed rollers.

19. Lift crankshaft from cylinder and remove remaining rollers. There are 26 rollers.

NOTE

Group rod caps, cages and rollers; center main bearing liners and rollers.

20. Remove seal and lower main bearing from crankshaft.

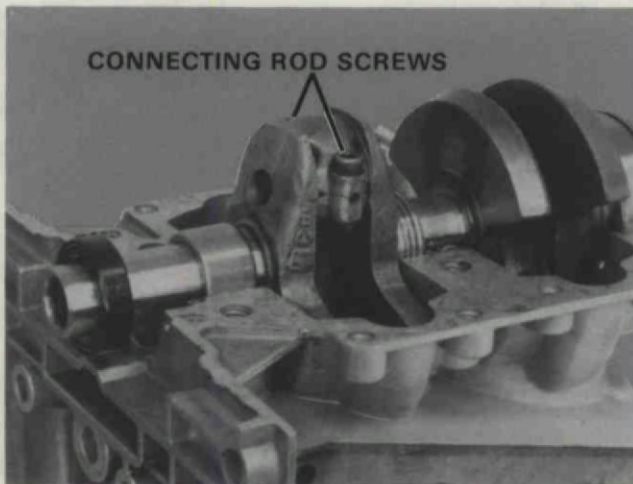


Figure 20. Removing Connecting Rod Screws.

21. Remove and disassemble piston assembly and connecting rod as follows:

A. Remove piston rings. Special Tool No. T 8926. Figure 21.



Figure 21. Removing Piston Rings.

B. Remove piston pin retaining rings. Special Tool No. T 1749.

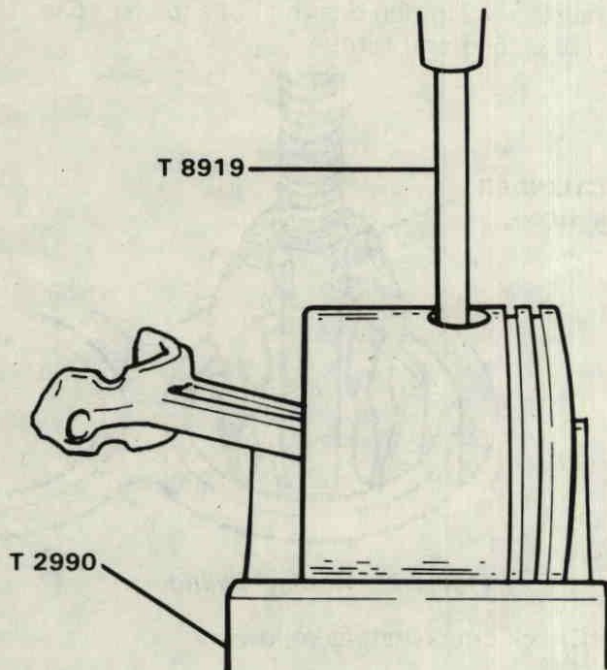


Figure 21A. Removing Piston Pin.

C. Drive piston pin out, using pin punch (Special Tool No. T 8919). Piston should be resting on smooth surface when driving pin out. Use pillow block (Special Tool No. T 2990).

NOTE

Group piston, piston pin, rings and connecting rod for each cylinder. Loosely reassemble rod caps to rods until reassembly of engine.

Inspection and Repair. Power Head.

NOTE

Refer to specifications for dimensions.

1. Remove carbon from exhaust ports and all exhaust passages, using cleaning solution or rotary brush. Special Tool No. T 2991.

NOTE

Carbon build up restricts exhaust gases and greatly reduces engine performance.

2. Clean all dried cement off gasket surfaces with lacquer thinner.



WARNING

Wear safety glasses when working with compressed air.

3. Wash all parts in solvent. Dry with compressed air.

4. Inspect crankshaft bearings and seals as follows:

A. Check upper and lower bearings for rust, cracks or wear.

B. Check upper and lower crankshaft seals for nicks, tears, or wear.

C. Remove metal around lower main seal bore (peened over to retain seal).

5. Inspect and repair cylinder head as follows:

A. Clean carbon from spark plug threads in cylinder head with a spark plug tap. Special Tool No. T 2947.

B. Check flatness of cylinder head by laying gasket surface on a piece of plate glass or surface plate. Measure at different points between head and glass with feeler gauge. Figure 22.

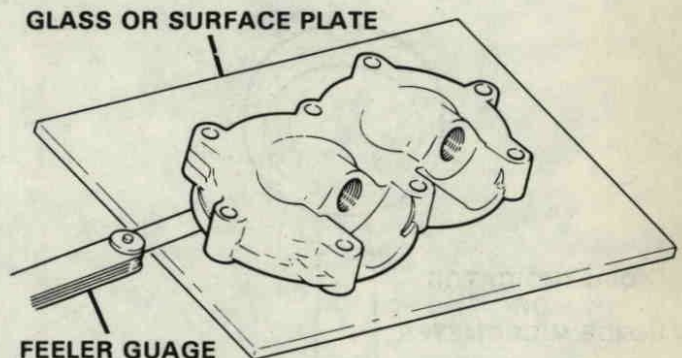


Figure 22. Checking Flatness of Cylinder Head.

C. Resurface cylinder head, if it is only slightly warped: lay a sheet of No. 120 emery cloth on the glass and slide head around in a figure 8 motion, exerting light and even pressure. Examine gasket surface area: high spots will be dull, low spots

unchanged. Continue until entire gasket surface has dull finish. Finish off with No. 180 emery cloth. Figure 23.

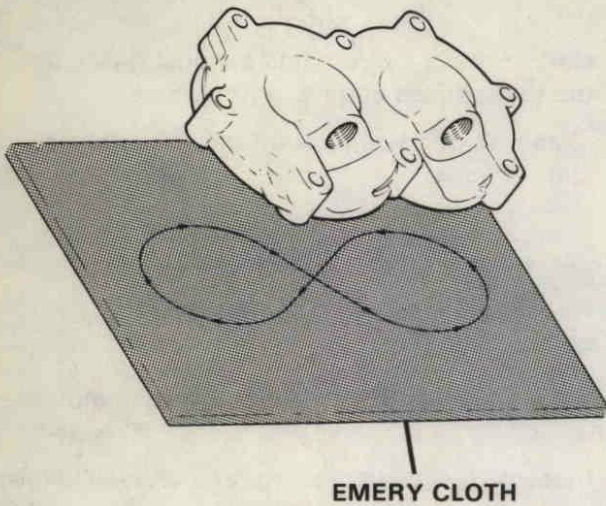


Figure 23. Resurfacing Cylinder Head.

6. Inspect and repair cylinder block and crankcase as follows:

A. Measure the I.D. of cylinder bores at three points with an inside micrometer or dial indicator. Measure 1/4" (6.35 mm) down from top, 1/4" (6.35 mm) up from exhaust port and about 3/16" (4.76 mm) down from lower edge of intake port. Measurements are also taken 90° from first set.

NOTE

The taper, or difference between the largest and smallest measurements, must not be more than .002" (0.05 mm). Figure 24.

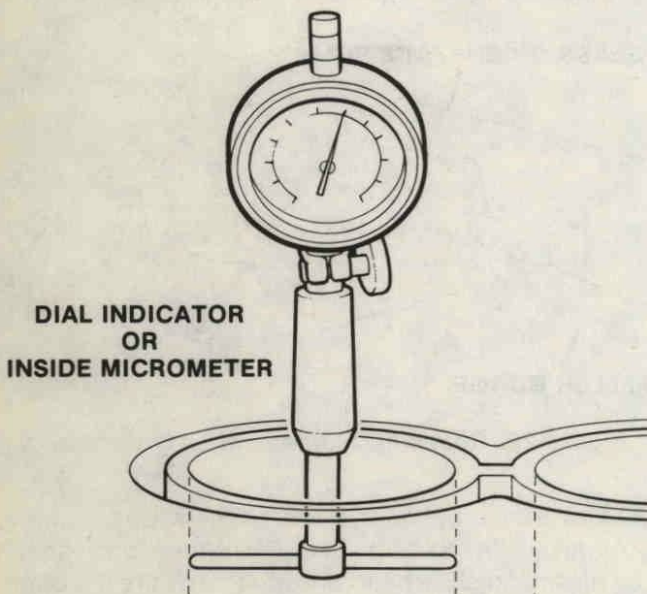


Figure 24. Measuring Cylinders.

B. Replace cylinder block if wear is more than .002" (0.05 mm) or if cylinder is out of round.

C. If cylinder is within wear tolerance, but slightly scored, hone with a fine stone cylinder hone. Figure 25.

NOTE

Use a low rpm drill with rapid up and down motion to obtain good cross hatch pattern for oil retention.

D. If cylinder walls are glazed, break the glaze by honing with a medium stone, 220 grit.

NOTE

Glaze reduces the effectiveness of the seal between the piston rings and cylinder walls.

E. Check bearing surfaces inside crankcase. Temporarily install crankcase cover on cylinder block to measure wear on crankshaft bearing surfaces. Tighten bearing bolts to 160 ± 5 in. lbs. (183 ± 5kg/cm) torque.

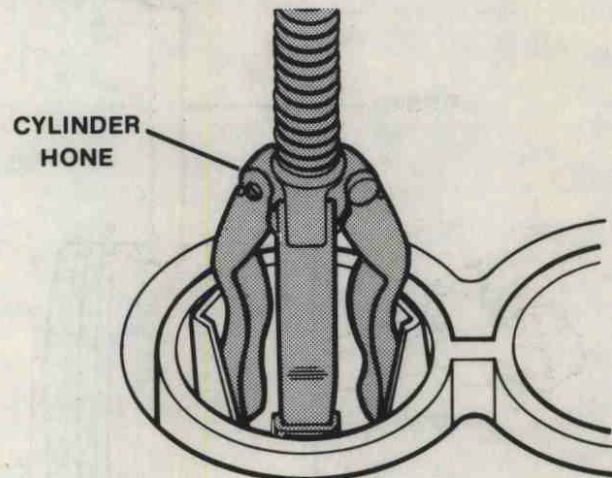


Figure 25. Honing Cylinders.

7. Check crankshaft as follows:

A. Check threads on end of crankshaft for damage. Repair with 1/2" - 20 die.

B. Inspect keyway and tapered ends of shaft for scoring, wear.

C. Check ball bearing for restricted movement, cracks and wear.

D. Measure crankshaft.

8. Check connecting rods as follows:

A. Measure both ends of connecting rods with inside micrometer.

NOTE

Assemble caps on rods, torque to specifications to establish proper diameter.

9. Check pistons as follows:

A. Closely inspect pistons for lack of roundness, wear and scoring.

NOTE

The type of damage helps determine the cause: diagonal wear is not normal - new pistons can be damaged quickly in the same way. Scoring can be caused by overheating, incorrect ignition timing, incorrect clearances between piston and cylinder and/or improper break-in procedure.

B. Measure piston at right angle to piston pin. Check for wear at top land and skirt.

C. Measure piston pin bore with an inside micrometer.

10. Measure piston ring gap as follows:

A. Insert new piston ring in cylinder just above exhaust port and intake ports. Figure 26.

NOTE

Use one of the pistons to slide ring in.

B. Measure ring gap with feeler gauge. Figure 26.

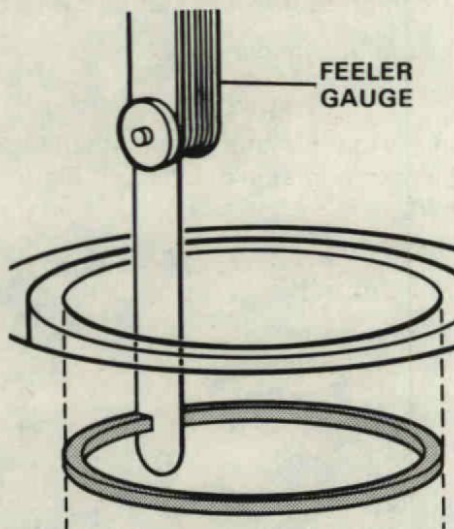


Figure 26. Measuring Piston Ring Gap.

NOTE

If gap is too tight, it can be opened with a file.

Reassembly. Power Head.

GENERAL NOTES:

1. Internal parts have close tolerance, so it is most important that all parts, the work area, and your hands are clean.

2. With new or rehone cylinders, the bores should be thoroughly scrubbed with warm soapy water

using a round bore brush. Dry thoroughly.

3. Follow torque values closely when tightening screws. Threads in aluminum castings are often damaged by over tightening.

4. When heat is called for in assembling press fit parts, a heat gun is advised. Open flame destroys protective coatings and paint.

5. Coat cylinder walls with oil.

6. Use only specified gaskets.

1. Assemble piston to connecting rod as follows:

CAUTION

The relation of these two parts is critical. Insert connecting rod with match marks or "V" slot to your left and with staking pins in piston grooves facing up. Figure 27.

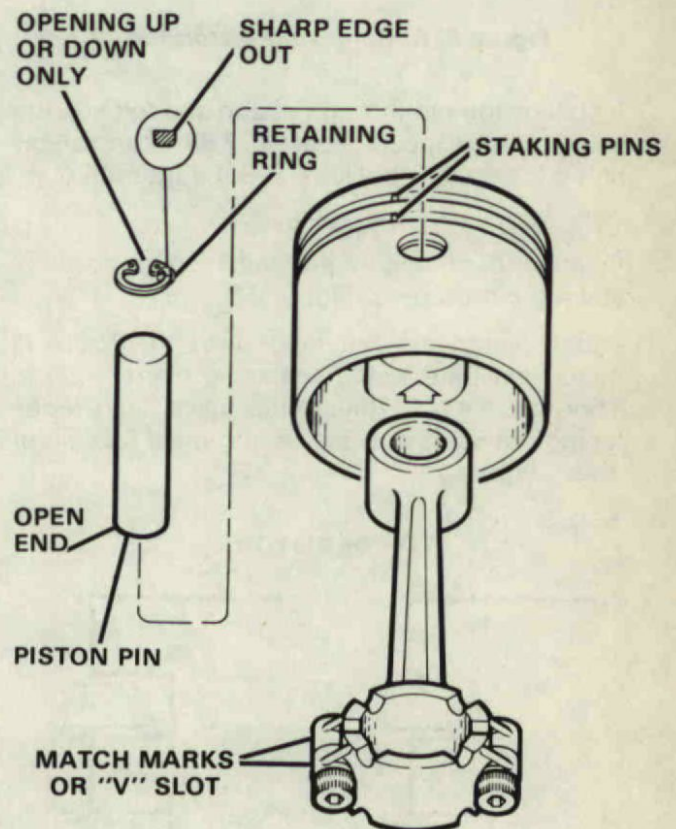


Figure 27. Assembling Piston to Connecting Rod.

A. Coat piston pin with oil. Apply a few drops of oil to both piston pin holes in piston and to bearing in connecting rod.

B. Heat piston to expand pin holes and ease installation of pin.

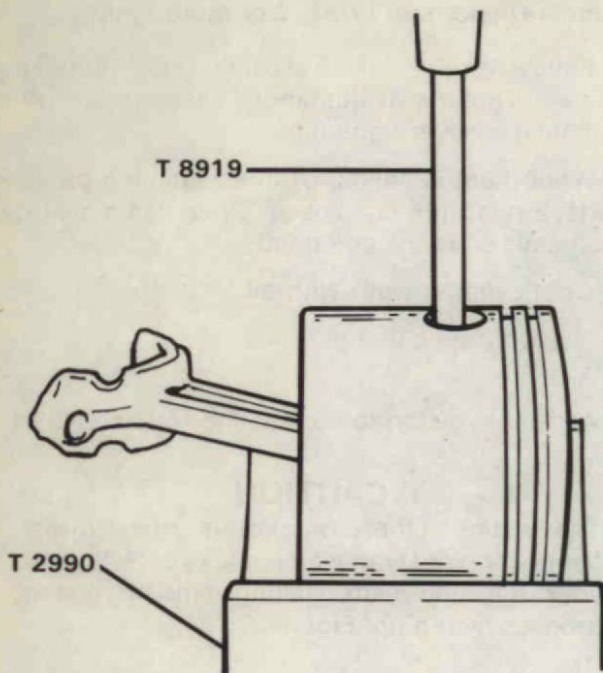


Figure 27A. Removing Piston Pin.

C. Install piston pin through piston and rod bearing using punch (Special Tool No. T 8919) and pillow block (Special Tool No. T 2990). Figure 27A.

NOTE

Open end of piston pin must be opposite staking pin grooves. Figure 27.

D. Install piston pin retaining rings in groove in piston pin bore, using snap ring pliers. Special Tool No. T 1749. Rings must have sharp edge facing outward, opening in ring must face up or down, Figure 27.

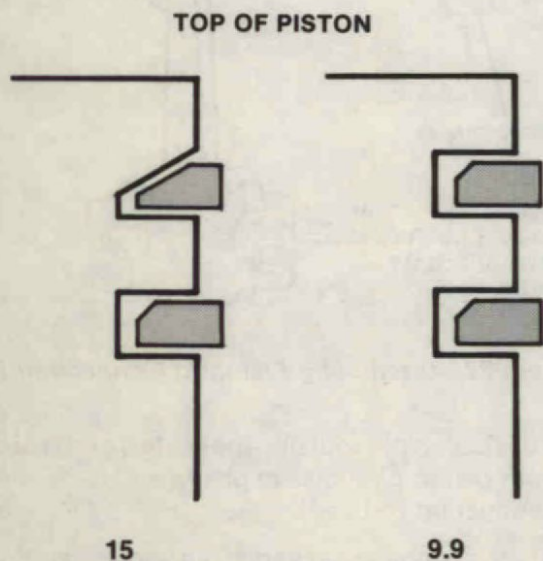


Figure 28. Installing Piston Rings.

E. Install piston rings on piston, using ring expander. Special Tool No. T 8926.

CAUTION

Install piston rings with bevel on inner edge facing up toward top of piston. Figure 28.

2. Install piston in cylinder bore as follows:

A. Coat pistons, piston rings and cylinder bore with SAE #30 oil.

NOTE

Be sure to install piston to cylinder bore it was removed from.

B. Install piston in ring compressor. Special Tool No. T 2997.

CAUTION

Staking pins must be in ring gaps and rings must be sealed in grooves or damage can result. Tap top edges of compressor making it uniform.

NOTE

There are indentations at one end of compressor. Place these on top of cylinder to prevent compressor from entering cylinder.

C. Insert piston in cylinder bore.

NOTE

Position piston so that intake baffle faces toward intake port side of cylinder. Figure 29.

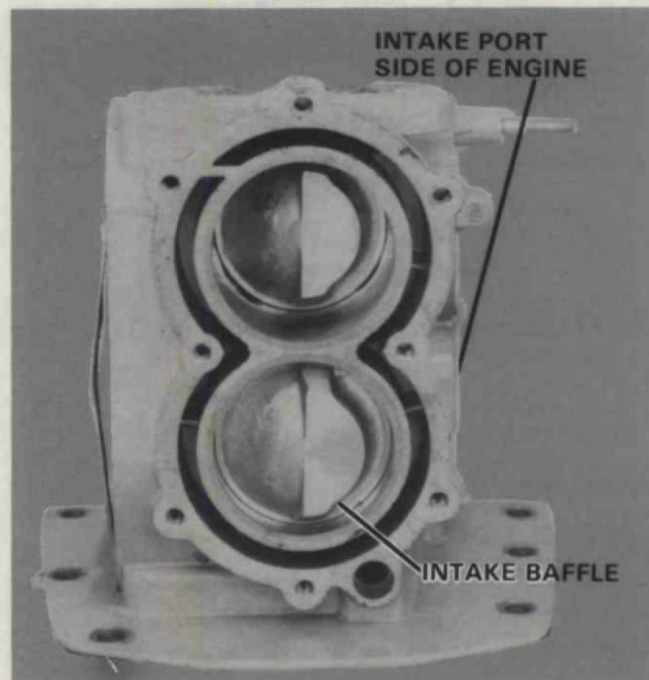


Figure 29. Inserting Piston in Cylinder.

- D. Tighten ring compressor until piston and rings can enter cylinder bore. Push piston into bore with thumb pressure.

CAUTION

Insufficient ring compression can cause damage to piston. Inset, Figure 30.

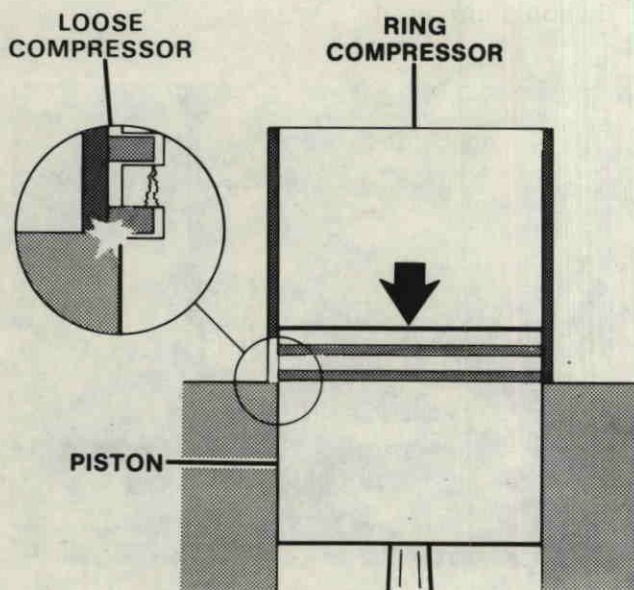


Figure 30. Installing Piston Assembly in Cylinder.

3. Assemble and install crankshaft as follows:

- A. Position cylinder block with connecting rods up.

NOTE

Check position of connecting rods. Match marks should face transfer port side of cylinder block.

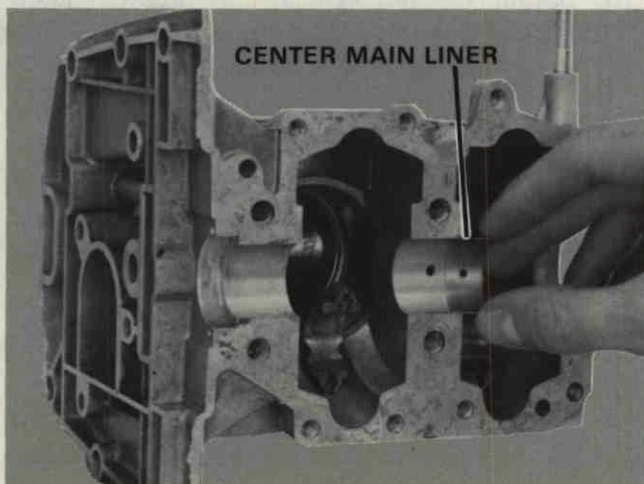


Figure 31. Installing Center Main Liner.

- B. Place main bearing liner in cylinder, lining up hole in liner with hole in cylinder. Figure 31.

- C. Apply a small amount of grease to liner (Special Tool No. T 2961), and place 12 rollers on liner.

- D. Clean and degrease outside casing of lower main bearing. Lubricate rollers with SAE #30 oil.

- E. Slide lower main bearing on to crankshaft with lettered side out.

- F. Lay crankshaft in cylinder, connecting rod throws over open end of connecting rods. Position lower main bearing. Figure 32.

- G. Grease center bearing throw lightly. Install remaining 14 rollers and liner.

4. Assemble connecting rods to crankshaft, one at a time, as follows:

- A. Apply grease to roller bearing cage, install cage and 7 rollers in connecting rod.

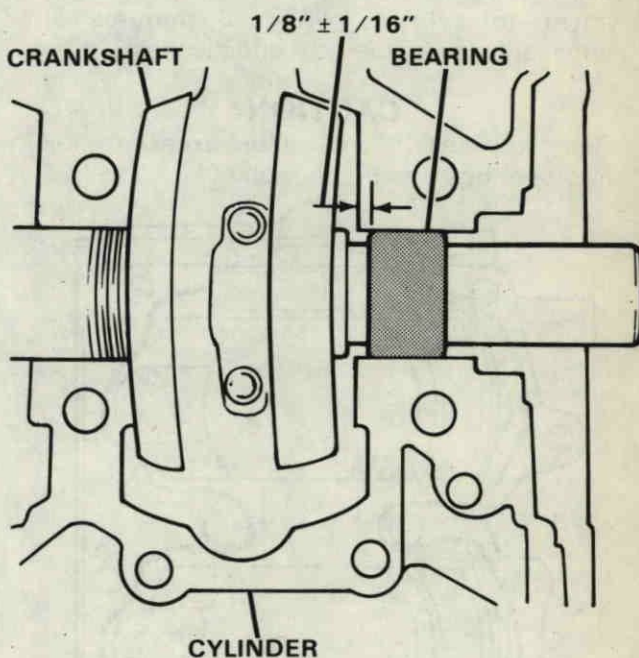


Figure 32. Positioning Lower Main Bearing.

- B. Move connecting rod with rollers under and up to crankpin.

- C. Grease exposed part of crankpin lightly, install cage and remaining 9 rollers.

- D. Place cap over crankpin.

CAUTION

Check for match marks on both connecting rod and cap.

- E. Apply sealant (Special Tool No. T 2963-1) to threads of connecting rod screws, install screws, and torque to 80 in. lbs. (91 kg/cm), using torque wrench (Special Tool No. T 2999) and connecting rod tool (Special Tool No. T 8929).

NOTE

Before torquing screws, check for cap offset with a sharp pencil at sanded area of both screw bosses. If offset is present, reposition cap and torque screws.

5. Install crankcase cover to cylinder as follows:

- A. Degrease parting line surfaces of both crankcase and cylinder.
- B. Apply a bead of fresh sealant, (Special Tool No. T 8983), to parting line surface of cylinder. Cover evenly and completely and make sure sealant reaches lower main seal case and upper main bearing race. Figure 33. Assemble crankcase cover to cylinder within 3 minutes after application to insure seal effectiveness.

CAUTION

Remove excess. Do not allow excess to flow into bearings and crankcase.

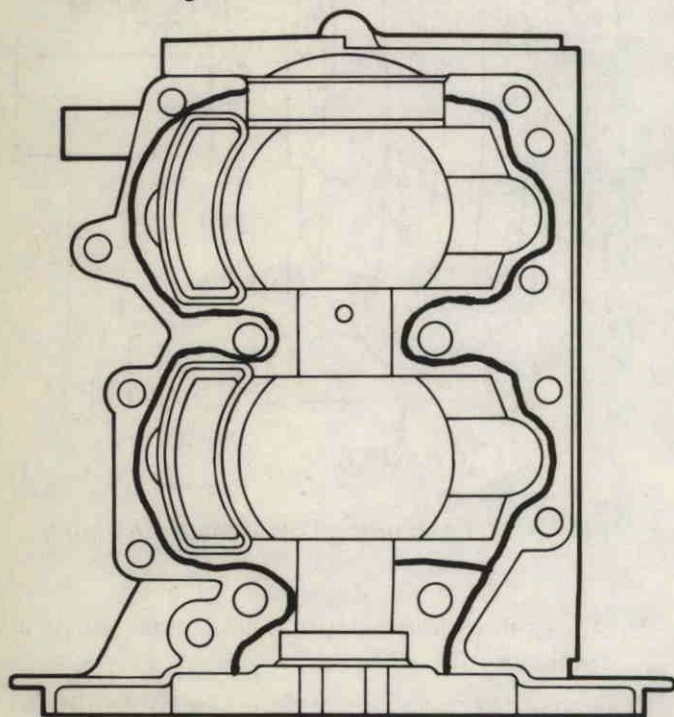


Figure 33. Applying Sealant to Parting Line.

- C. Place crankcase cover on cylinder. Position crankcase by driving in two (2) locating pins, using Special Tool No. T 8919, Figure 34.
- D. Apply sealant (Special Tool No. T 8983) to

threads of four (4) 5/16" diameter screws, install, and torque to 160 ± 5 in. lbs. (183 ± 5 kg/cm).

- E. Apply sealant (Special Tool No. T 8983) to threads of eight (8) 1/4" diameter screws, install, and torque to 70 in. lbs. (80 kg/cm).

NOTE

Turn crankshaft by hand to check for binding. It should turn easily.

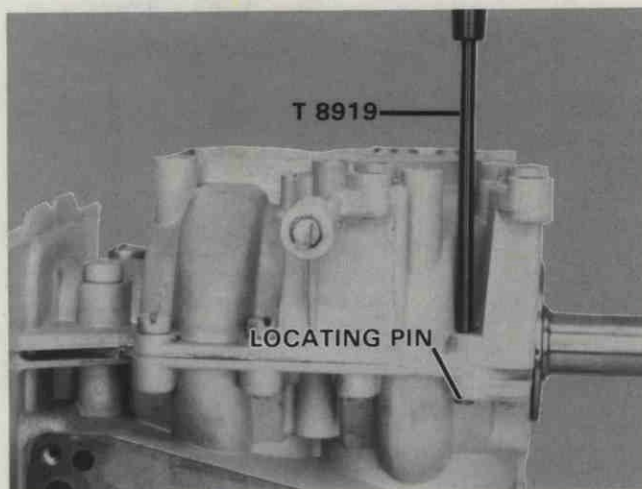


Figure 34. Installing Locating Pins.

6. Apply grease between lip of lower crankshaft seal and install on end of crankshaft. Make sure seal opening is face "up" (spring facing out). Finish installation of lower main bearing seal as follows:

- A. Drive seal into bore with seal installer. Special Tool No. T 8949.
- B. When seal is fully sealed, center punch two places at bottom of cylinder assembly, approximately 180° apart and 1/16" (1.58 mm) from edge of seal bore. Old punch marks should be removed by using a bearing scraper or some other sharp tool.

NOTE

Impressions should be a minimum of 1/8" (3.17 mm) from cylinder to crankcase cover parting line and be deep enough to force material over outer edge of seal case a minimum of .005 inches. Figure 35.

7. Install drive shaft spline seal. Figure 36.
8. Coat driveshaft splines liberally with anti-seize lubricant (Special Tool No. T 2987-1) to prevent corrosion, frozen driveshaft and difficult removal in the future.

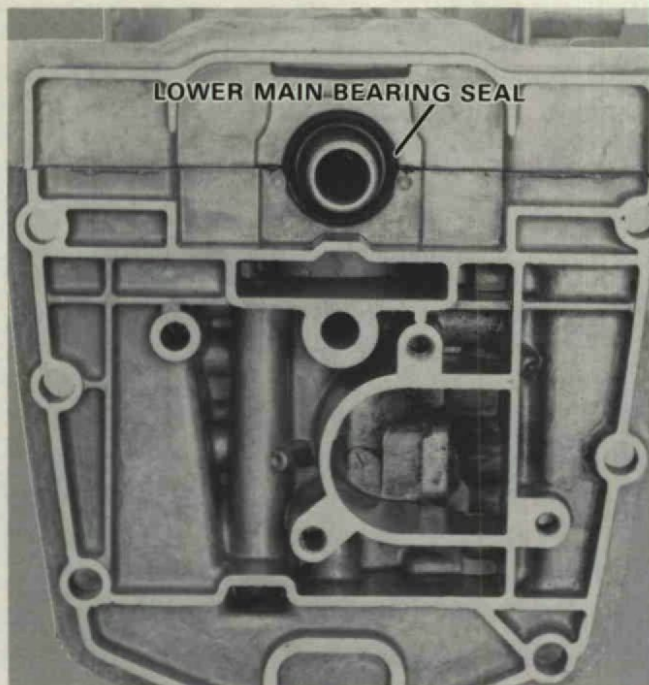


Figure 35. Securing Lower Main Bearing Seal.

9. Install cylinder head as follows:
 - A. Install cylinder head gasket on cylinder head, matching bolt holes and water passage bridgings.
 - B. Install cylinder head and gasket on cylinder, secure with eight (8) head bolts.

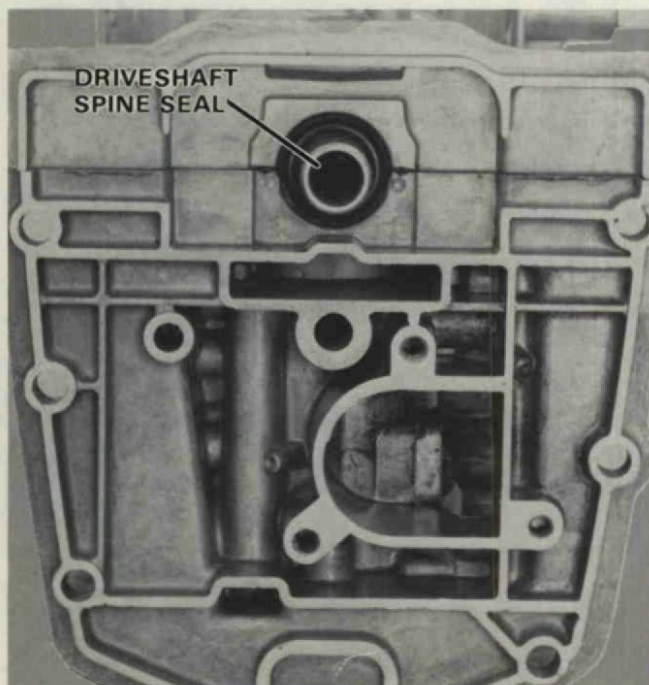


Figure 36. Installing Driveshaft Spine Seal.

NOTE

Torque bolts in sequence, first to 75 in. lbs. (86 kg/cm), then increase in increments of 25 in. lbs. (27 kg/cm), until 130 in. lbs. (149 kg/cm) is reached--to avoid warping cylinder head. Figure 37.

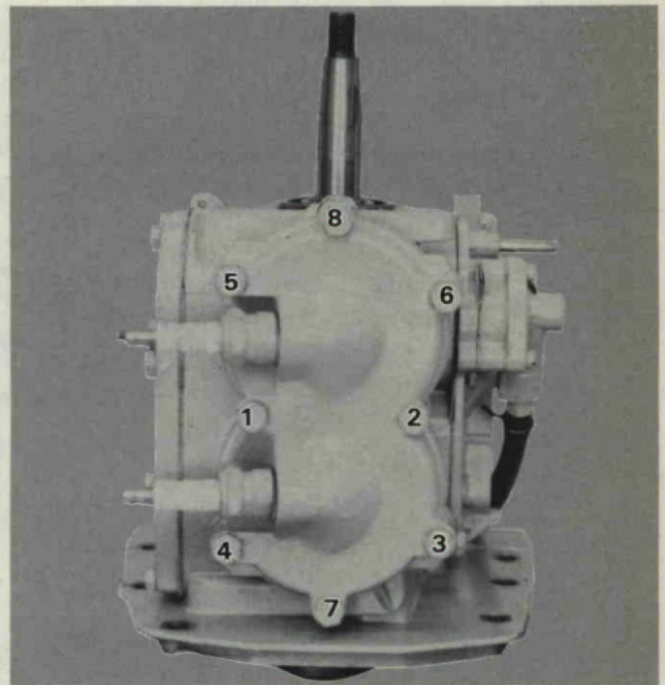


Figure 37. Torquing Sequence for Cylinder Head.

- C. Retorque cylinder head after running engine for at least 15 minutes and again after approximately 10 hours.
10. Install transfer port gasket and transfer port cover to cylinder, with three (3) screws. Torque to 90 in. lbs. (103 kg/cm).
11. Install cylinder drain cover and cylinder drain cover gasket as follows:
 - A. Install gasket on drain cover so that contours match, and place gasket and cover on cylinder.

CAUTION

Make sure that screens cover check valves in cover. Screens prevent deposits from entering check valves and possibly causing them to fail.

- B. Attach hose clamp with screw at top right hand corner of cover, install this screw and three (3) remaining hex head screws. Torque to 70 in. lbs. (80 kg/cm).

12. Install exhaust cover assembly in following order: exhaust cover gasket, exhaust plate, (second) exhaust cover gasket, exhaust cover, install eight (8) hex head screws and lead wire clip. Torque to 90 in. lbs. (103 kg/cm). Figure 38.

13. Install crankshaft bearing cage with seal, and stator ring as follows:

NOTE

Install upper crankshaft seal in crankshaft bearing cage with seal installer (Special Tool No. T 3012). Part number must face outward and sealing lips must face toward inside of cylinder. Bottom of seal case must be .060 (1.5 mm) to .090 (2.3 mm) from bottom of seal bore.

A. Install new bearing cage gasket on power head.

B. Apply grease to lips of seal.

C. Install seal sleeve (Special Tool No. T 2908) in bore of crankshaft bearing cage seal to protect seal when installing.

D. Install bearing cage with seal, seal sleeve, in counter bore of stator ring and slide this assembly onto gasket on cylinder assembly.

E. Line up holes in bearing cage, and gasket to holes in power head. Apply sealant (Special Tool No. T 8983), to screw threads, install four (4) fill head screws. Torque to 70 in. lbs. (80 kg/cm).

14. Install stator plate assembly as follows:

A. Place stator plate upside down and place throttle cam on stator plate. Slip spark plug lead wires into groove of cam.

B. Attach magneto ground lead wire to rear starboard screw and install four (4) screws, securing throttle cam to stator plate.

C. Hook magneto control link in hole of throttle cam on port side.

NOTE

During next step, be sure follower roller is not under throttle cam.

D. Place stator plate assembly on crankshaft and secure to magneto stator ring with four (4) screws.

15. Secure exhaust tube to cylinder block with three (3) taptite washer head screws.

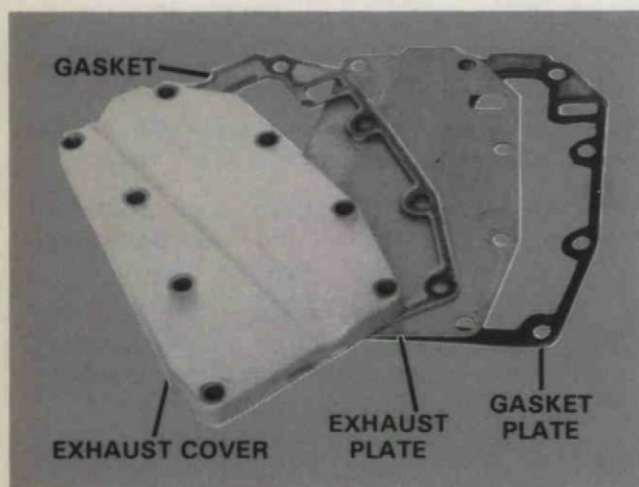


Figure 38. Positioning Exhaust Cover, Gaskets, Plate.

Installation. Power Head, Manual Start Models.

1. Place cylinder mounting gasket on motor leg.

2. Place power head in support plate and line up crankshaft with driveshaft splines.

3. Engage splines by either rotating flywheel or propeller shaft with unit in forward or reverse.

4. Ease power head down on motor leg.

NOTE

Be careful not to fold over rubber seal of support plate.

5. Secure cylinder to motor leg with six (6) hex head screws. Torque to 160 ± 5 in. lbs. (183 kg/cm).

NOTE

The following steps (6-10) are detailed in their respective sections.

6. Install neutral interlock swivel to interlock lever and bearing.
7. Install magneto control lever and linkages.
8. Install starter.
9. Install carburetor and fuel system components.
- A. Readjust throttle pick-up and linkage.

10. Install flywheel and ignition components.

Installation. C-D Models

1. Connect fuel lines to fuel pump.
2. Connect starter interlock switch.
3. Connect stop switch.
4. Connect choke link.
5. Install starter support.

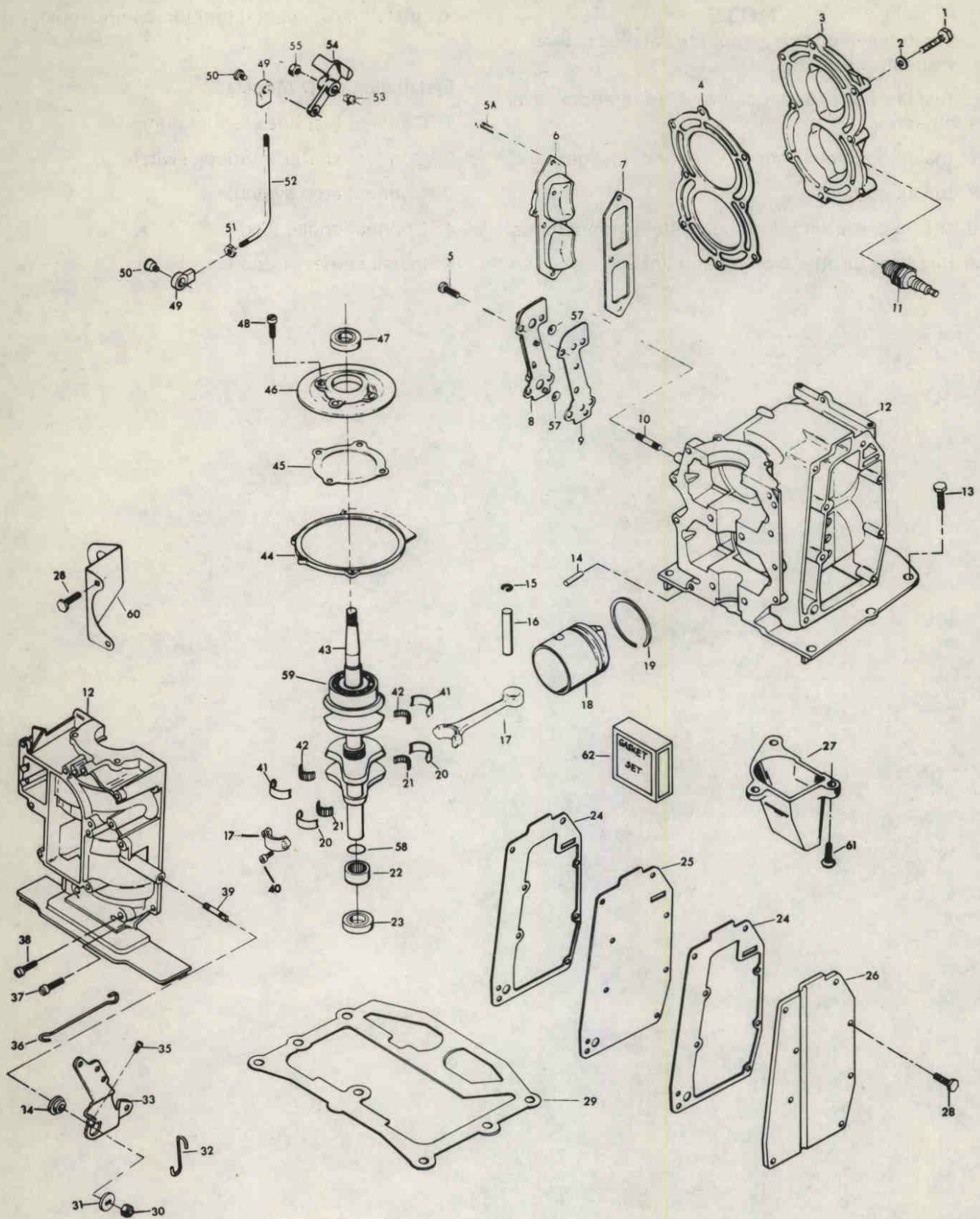
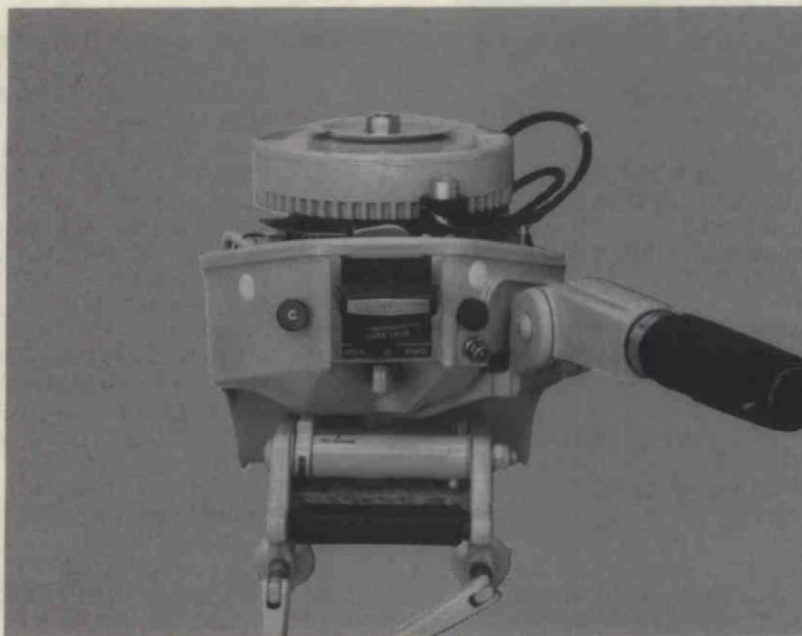
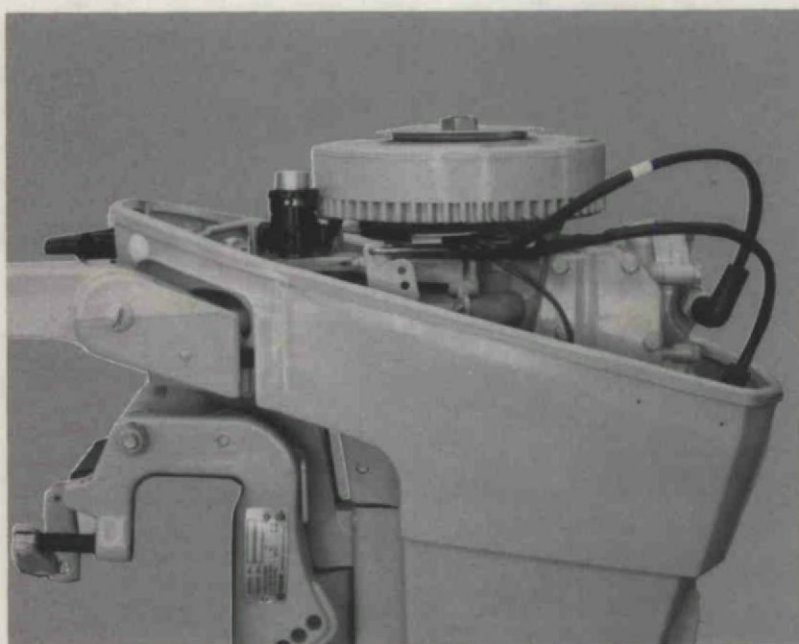


Figure 39. Powerhead Assembly. Exploded View.

- | | | | |
|----|--|----|---|
| 1 | SCREW, CYLINDER HEAD | 31 | WASHER |
| 2 | PLAIN WASHER | 32 | LINK, MAGNETO SHAFT |
| 3 | HEAD, CYLINDER | 33 | LEVER, MAGNETO CONTROL |
| 4 | GASKET, CYLINDER HEAD | 34 | BEARING, MAGNETO CONTROL LEVER |
| 5 | SCREW, 1/4 - 20 x 5/8 | 35 | SCREW, 1/4 - 20 x 1-1/4 |
| 6 | COVER, TRANSFER PORT | 36 | LINK, THROTTLE CAM |
| 7 | GASKET, TRANSFER PORT COVER | 37 | SCREW, 1/4 - 20 x 3/4 |
| 8 | COVER, CYLINDER DRAIN W/CHECK VALVES AND SCREWS | 38 | SCREW, 5/16 - 18 x 1-1/4 |
| 9 | GASKET, CYLINDER DRAIN COVER | 39 | STUD, MAGNETO CONTROL LEVER |
| 10 | STUD, INTERLOCK LEVER | 40 | SCREW, CONNECTING ROD |
| 11 | PLUG, SPARK | 41 | MAIN BEARING LINER SET |
| 12 | CYLINDER W/CRANKCASE COVER, DOWEL PINS, SCREWS AND STUDS | 42 | ROLLER SET, MAIN BEARING |
| 13 | SCREW, 5/16 - 18 x 1 | 43 | CRANKSHAFT W/UPPER MAIN BEARING |
| 14 | DOWEL PIN | 44 | RING, MAGNETO STATOR |
| 15 | RETAINING RING, PISTON PIN | 45 | GASKET, CRANKSHAFT BEARING CAGE |
| 16 | PIN, PISTON | 46 | CAGE, CRANKSHAFT BEARING W/SEAL |
| 17 | ROD, CONNECTING W/CAP AND SCREWS | 47 | SEAL, CRANKSHAFT UPPER |
| 18 | PISTON | 48 | SCREW, 1/4 - 20 x 7/8 |
| 19 | PISTON RING SET | 49 | BEARING, INTERLOCK ROD |
| 20 | CRANKPIN ROLLER BEARING CAGE | 50 | SWIVEL, INTERLOCK ROD BEARING |
| 21 | ROLLER SET, CONNECTING ROD | 51 | NUT, 10 - 24 |
| 22 | BEARING, CRANKSHAFT LOWER MAIN | 52 | ROD, INTERLOCK |
| 23 | SEAL, CRANKSHAFT LOWER | 53 | BEARING, INTERLOCK LEVER |
| 24 | GASKET, EXHAUST COVER | 54 | LEVER, INTERLOCK |
| 25 | PLATE, EXHAUST | 55 | NUT, 1/4 - 20 |
| 26 | COVER, EXHAUST | 57 | SCREEN |
| 27 | EXHAUST TUBE | 58 | SEAL, DRIVESHAFT SPLINE |
| 28 | SCREW, 1/4 - 20 x 7/8 | 59 | BEARING, CRANKSHAFT UPPER MAIN |
| 29 | GASKET, CYLINDER MOUNTING | 60 | BRACKET, INTERLOCK SWITCH |
| 30 | NUT, 5/16 - 24 | 61 | TAPTITE HEX WASHER HD SCREW, 1/4 - 20-5/8 |
| | | 62 | GASKET SET |

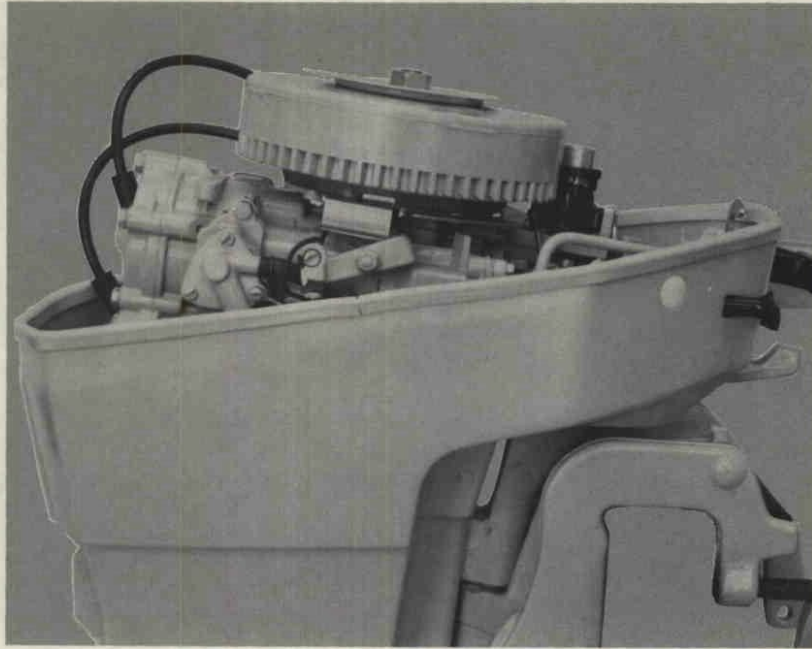


FORWARD

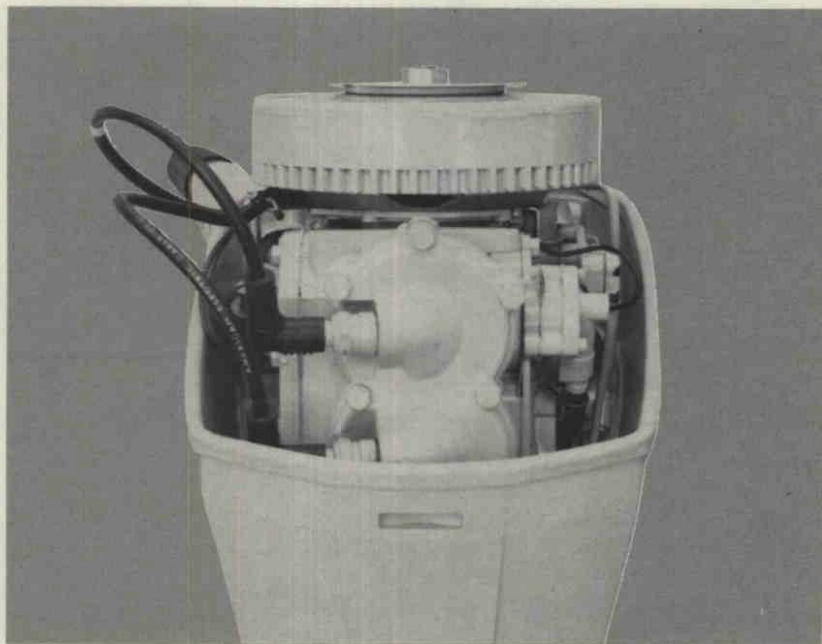


PORT

Figure 40. Forward and Port Side Views. Manual Start Models.

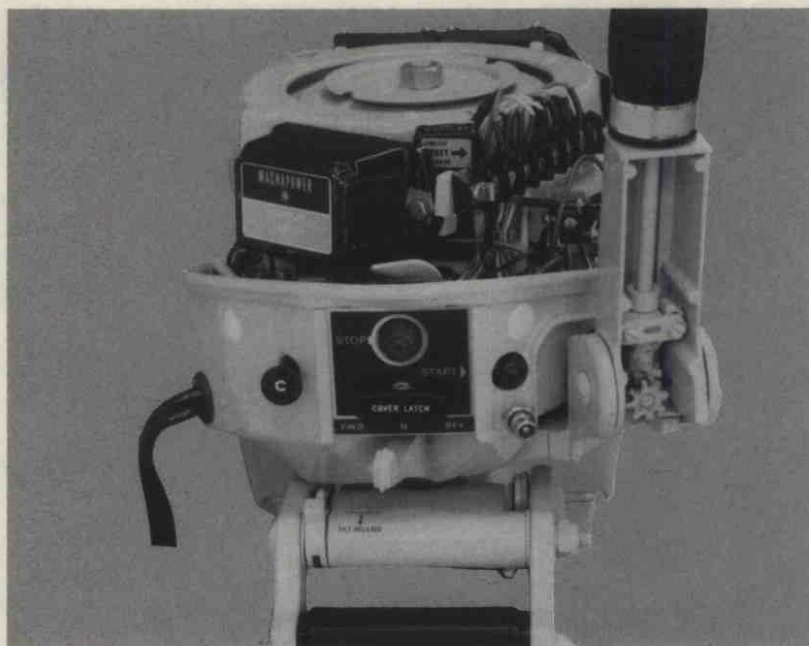


STARBOARD

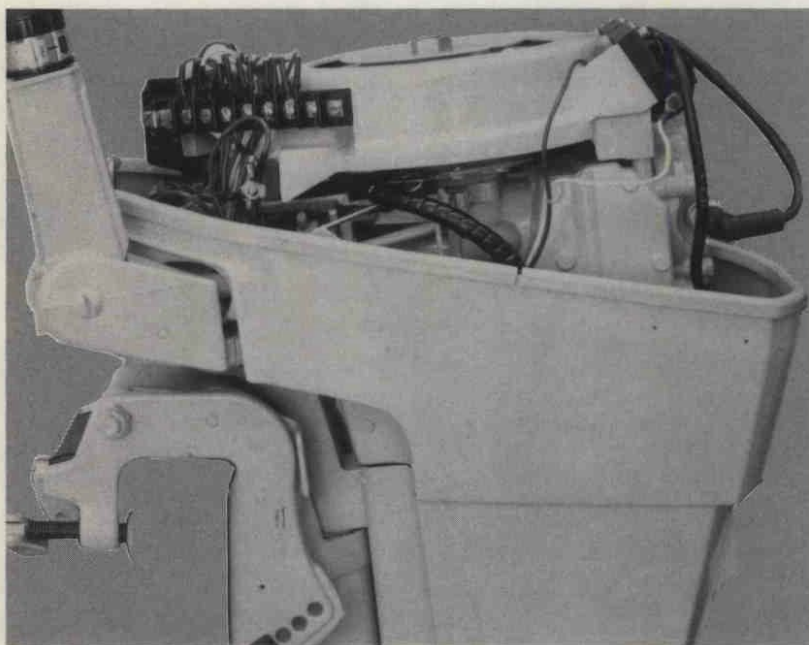


AFT

Figure 41. Starboard and Aft. Views. Manual Start Models.

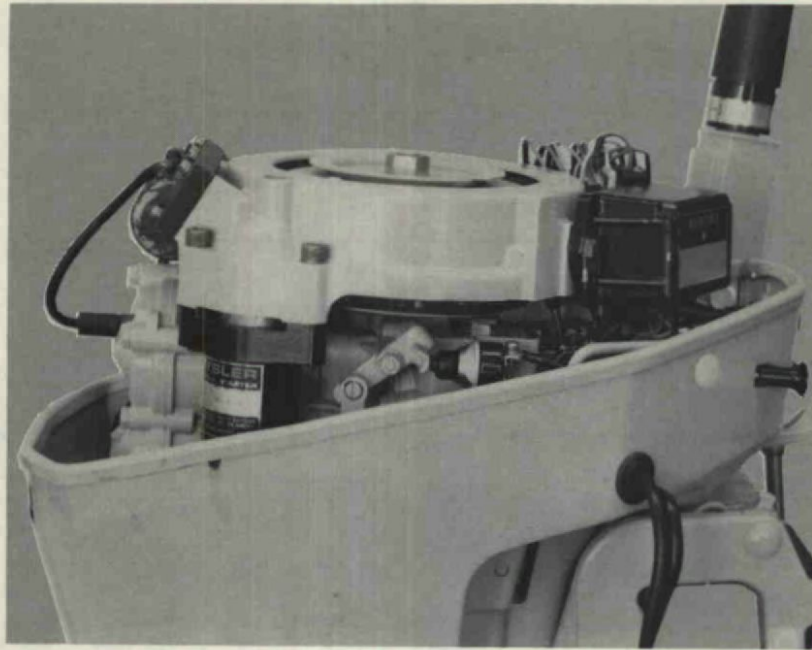


FORWARD



PORT

Figure 42. Forward and Port Side Views. Electric Start Models.



STARBOARD



AFT

Figure 43. Starboard and Aft Views. Electric Start Models.

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General	159
Water Pump	159
Gear Train	161

SPECIAL TOOLS

Section	Part No.	Description	Use
8A - MOTOR LEG AND SWIVEL BRACKET ASSEMBLY	T 2987-1	Lubricant - Anti-seize	To install driveshaft seal
	T 2907	Seal Installer	
8B - GEAR HOUSING	T 8919	Spring Pin Punch	To remove clutch pin
	T 2907	Seal Installer	To install driveshaft seal - water pump and gear housing
	T 8948-1	Puller	To remove propeller shaft bearing cage
	T 8953	Seal Installer	To install shift rod seal
	T 8950	Leakage Tester	To test gear housing seals for leaks
	T 2961	Lubricant - Rykon #2EP	
	T 2987-1	Lubricant - Anti-seize	
	T 8983	Sealant - RTV	
8C - GEAR HOUSING	T 8904	Forward Cup Installer	To install forward bearing cup
	T 8907	Driver Handle	To install forward bearing cup
	T 8921	Cup Remover	To remove forward bearing cup
	T 8918	Bearing Guide Set	To remove forward bearing cup
	T 3431	Seal Installer	To install propeller shaft seal
	T 8919	Spring Pin Punch	To remove clutch pin
	T 2907	Seal Installer	To install driveshaft seal - water pump and gear housing
	T 8948-1	Puller	To remove propeller shaft bearing cage
	T 8957	Seal Installer	To install shift rod seal
	T 8920	Bearing Installer	To install propeller shaft bearing
	T 8924-1	Checking Gauge	To shim lower unit
	T 8982	Shim Adapter	To use with checking gauge (T 8924-1)
	T 8995	Shim Spacer	To use with checking gauge (T 8924-1)
	T 8901	Indicator Holder	To use with checking gauge (T 8924-1)
	T 8902	Dial Indicator	To use with checking gauge (T 8924-1)
	T 8950	Leakage Tester	To test gear housing seals for leaks
	T 2961	Lubricant - Rykon #2EP	
	T 2987-1	Lubricant - Anti-seize	
T 8983	Sealant - RTV		

MOTOR LEG AND SWIVEL BRACKET ASSEMBLY**GENERAL**

This subsection deals with removal of the motor leg; and the disassembly, reassembly, and installation of the swivel bracket assembly.

DESCRIPTION

The swivel bracket assembly is attached to the motor leg and has four main functions: It secures the motor to the boat; it swivels, which allows the boat to be steered; it provides trim adjustment for better boat performance; and it allows the motor to be tilted up for transport.

SHOCK MOUNTS**GENERAL NOTE**

Vibration of the motor is partially absorbed by three rubber mounts. In time, these rubber mounts can dry out, crack, or otherwise lose their ability to dampen motor vibration.

Removal.

1. Place motor in normal operating position on motor stand.

2. Remove gear housing from motor leg as follows:

A. Remove four (4) screws securing gear housing to motor leg.

B. Shift engine into forward gear.

CAUTION

Turn flywheel or propeller shaft when shifting to avoid damage to dogs on clutch and gears.

C. Pull gear housing down to expose screw connecting upper and lower gear shift rods.

CAUTION

Hold gear housing so it does not bend shift rods or damage shift rod seal.

D. Remove screw and pull gear housing from motor leg. Figure 1.

3. Remove power head with support plate from motor leg as follows:

A. Remove two (2) cap screws and lockwashers securing steering handle bracket to steering arm. Figure 2.

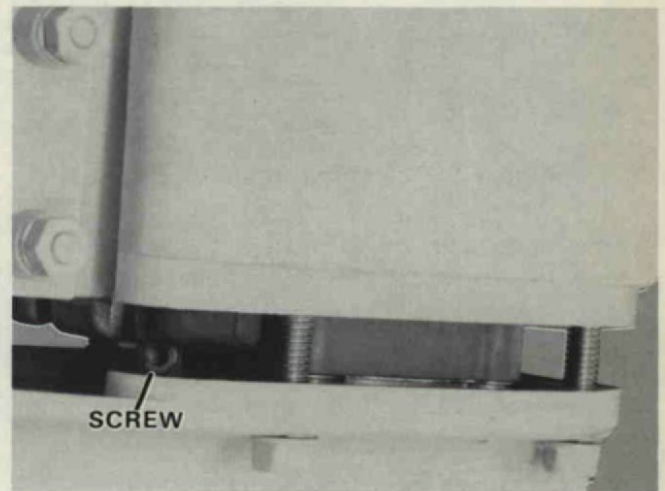


Figure 1. Removing Gear Housing from Motor Leg.

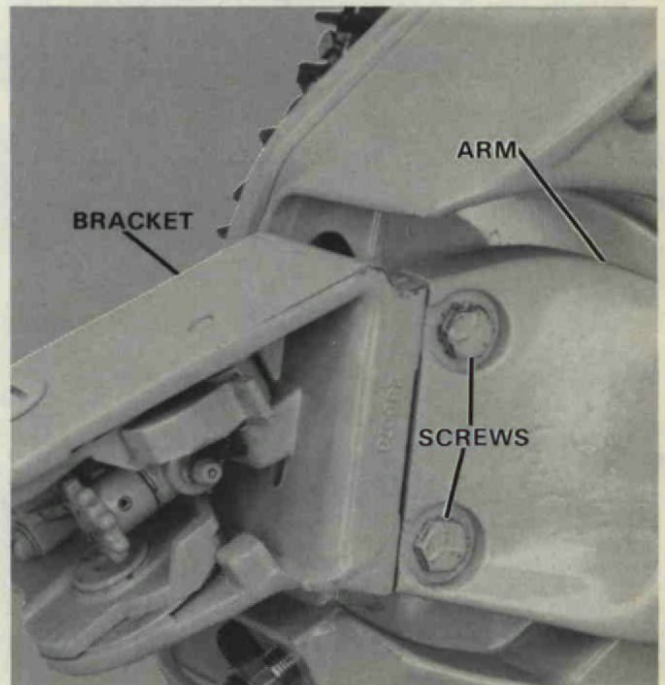


Figure 2. Disconnecting Steering Arm from Bracket.

B. Remove starter.

C. Detach interlock rod by removing screw (interlock rod bearing swivel.) Figure 3.

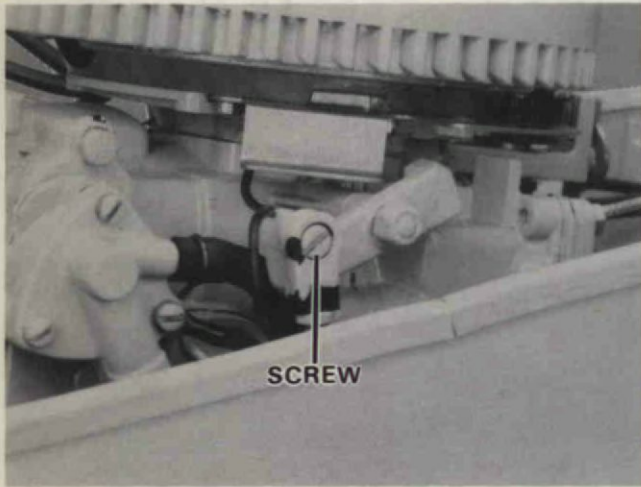


Figure 3. Detaching Interlock Rod.

D. Move interlock rod forward to allow access to forward cap screw, starboard side.

E. Remove six (6) cap screws securing power head and support plate to motor leg.

F. Lift power head with support plate from motor leg.

4. Remove lower shock mount as follows:

A. Remove two (2) hex bolts, lockwashers and nuts securing lower shock mounting bracket. Figure 4.

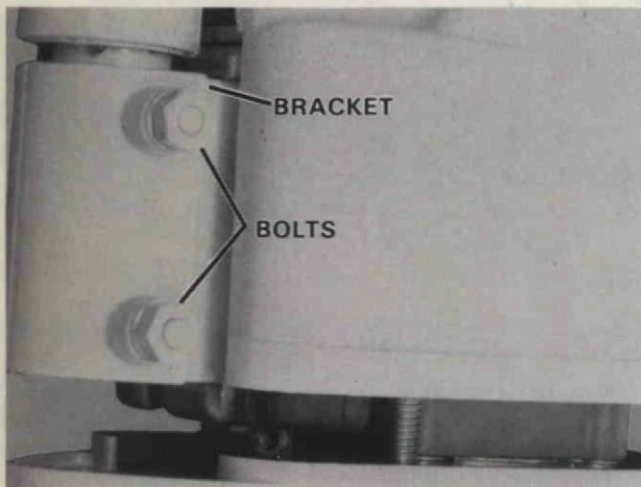


Figure 4. Removing Lower Shock Mount.

B. Remove bracket (two [2] halves) and lower shock mounts.

5. Remove two (2) upper shock mounts.

Installation. Shock Mounts.

1. Position new upper shock mounts in motor leg. Push in until they are seated properly. Figure 5.



Figure 5. Upper Shock Mounts Installed.

2. Insert lower shock mount in bracket and place on motor leg.

3. Secure bracket and mount with two (2) hex bolts, lockwashers, nuts.

4. Install power head and support plate on motor leg with six (6) screws.

NOTE

Make sure support plate is properly secured to rubber mount.

5. Install capscrew securing interlock rod to interlock lever.

6. Connect starter.

7. Install two (2) cap screws and lockwashers securing steering arm to steering arm bracket.

8. Secure lower unit to motor leg as follows:

A. Shift into forward gear by pulling up on lower gear shift rod to position hole in rod for assembly to upper gear shift rod.

CAUTION

Turn propeller shaft when shifting to avoid damage to dogs on clutch and gears.

B. Apply anti-seize compound (Special Tool No. T 2987-1) to splined area of driveshaft.

- C. Install gear housing to motor leg; engaging driveshaft splines in crankshaft; and aligning waterline in seal of water pump.
- D. Position gear housing so that gear shift rods are lined up as in Figure 6.

CAUTION

Gear shift rod seal will be damaged if gear shift rods are not assembled right.

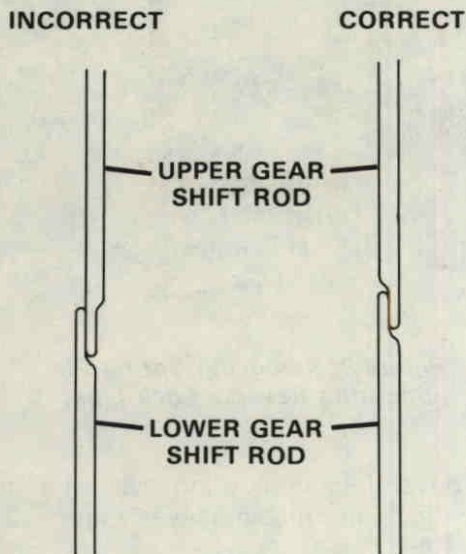


Figure 6. Proper Assembly of Gear Shift Rods.

- E. Connect rods with screw.
- F. Check again to see that waterline is seated in seal of water pump body.
- G. Secure gear housing to motor leg with four (4) hex screws.

SWIVEL BRACKET ASSEMBLY

Removal. Swivel bracket assembly (with motor leg):

1. Follow steps detailed in removal of shock mounts.
2. Loosen steering friction screw and slide steering arm assembly with king pin from swivel bracket assembly. Removal swivel bracket bearing and washer.

Disassembly.

NOTE

The following steps cover the complete disassembly of the swivel bracket. For some tasks, this may not be necessary. Check steps ahead before proceeding.

1. Disassemble steering arm as follows:
 - A. Remove bumper from starboard side of steering arm.
 - B. Remove spring pin holding king pin to steering arm.
 - C. Remove king pin. Figure 7.

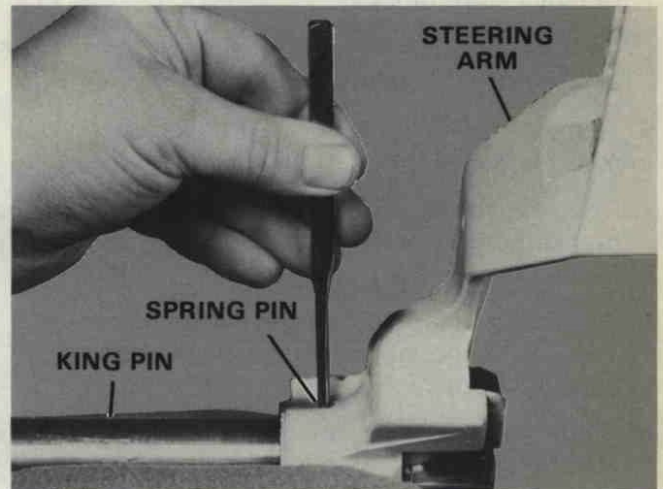


Figure 7. Removing King Pin from Steering Arm.

2. Remove both swivel bracket bearings from king pin bore.
3. Remove friction clamp, nut, screw from swivel bracket.
4. Disassemble motor leg as follows:
 - A. Press out driveshaft seal from bottom end of motor leg.
 - B. Press out water line from top of motor leg using tool with same diameter as waterline. Remove sleeve.
 - C. Remove waterline spring from top of motor leg.
5. Remove lock bar by squeezing handle.
6. Disassemble lock bar as follows:
 - A. Remove spring from handle.
 - B. Drive out spring pin securing lock bar handle to bar.
 - C. Remove handle.
7. Remove tilt lock as follows:
 - A. Remove tilt lock pivot and spacer from swivel bracket.
 - B. Remove tilt lock pivot from stern bracket.

C. Remove tilt lock, tilt stop spring, nylon spacer and wavy washer.

8. Remove stern brackets as follows:

A. Remove pivot bolt with stop nut and washer, and two (2) plain washers.

NOTE

Bolt is knurled under head.

B. Remove stern brackets.

C. Remove carrying handle by spreading brackets and removing locating pins.

9. Remove shallow water drive bracket and reverse lock assembly as follows:

A. Drive out groove pin securing shallow water drive bracket and reverse lock assembly.

CAUTION

Groove pin is tapered. Larger end has grooves. Tap out far enough to check and drive out from other end only.

B. *Single wire linkage:* unhook link (reverse lock lever link) from reverse lock.

Double wire linkage: loosen set screw in retainer swivel on reverse lock, and remove retainer with swivel from lock.

C. Remove reverse lock, reverse lock spacers and spring.

D. Drive out spring pin securing reverse lock release lever to reverse lock intermediate lever. Figure 8.

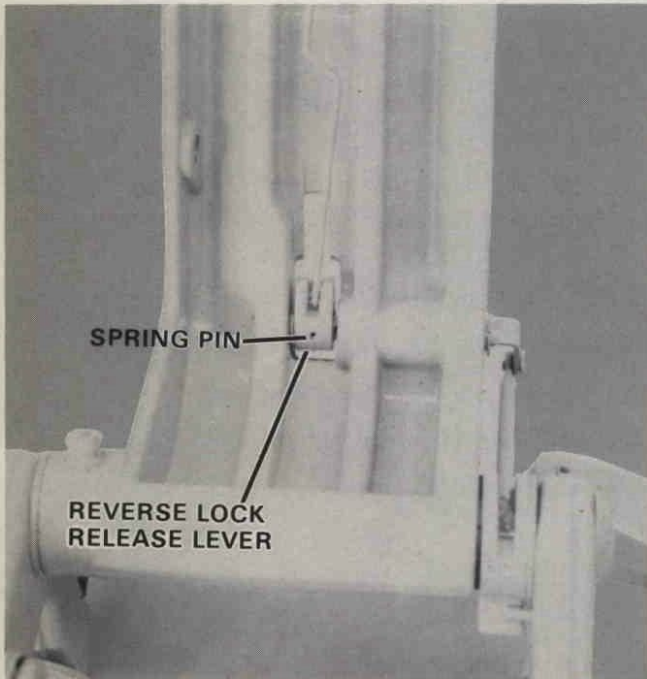


Figure 8. Removing Spring Pin in Reverse Lock Release Lever.

E. Slide out intermediate lever with two (2) bearings.

F. Drive out spring pin securing link to reverse lock release lever. Figure 9.

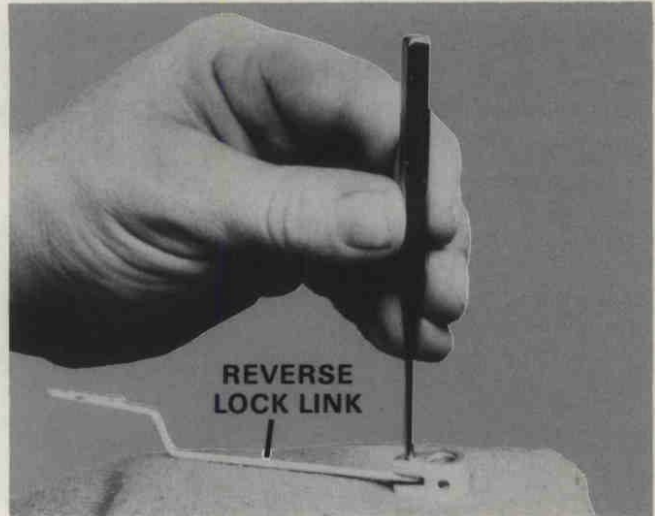


Figure 9. Removing Spring Pin Securing Reverse Lock Link.

G. Drive out spring pin securing reverse lock lever to reverse lock intermediate lever. Figure 10.

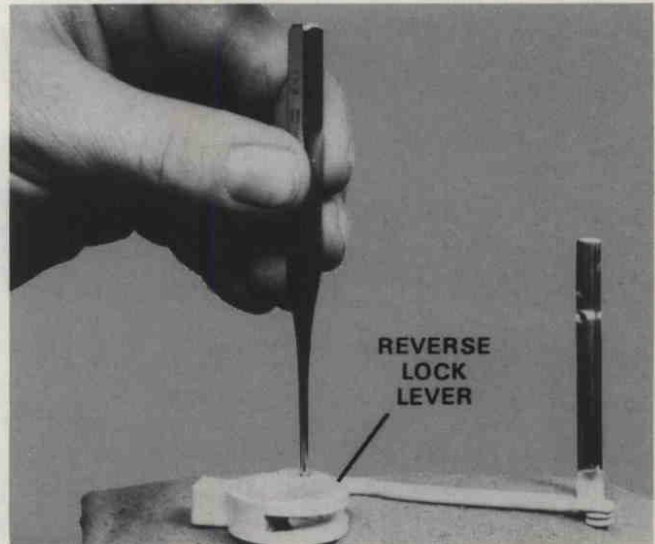


Figure 10. Removing Spring Pin in Reverse Lock Lever.

10. Remove clamp screw assembly as follows:

A. Saw through clamp screw between stern bracket and foot. Figure 11.

B. Unthread clamp screw from bracket.

C. Drive out spring pin securing clamp screw handle to clamp screw. Remove handle.

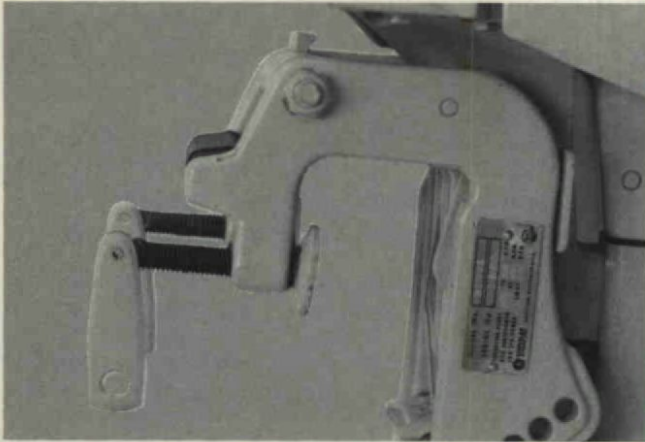


Figure 11. Replacing Clamp Screws.

Inspection and Repair.

1. Wash all parts in solvent. Wipe dry.
2. Check for worn or bent parts.
3. Check all bearings.

Reassembly and Installation. Swivel Bracket Assembly and Motor Leg.

1. Reassemble reverse lock assembly and shallow water drive bracket to swivel bracket as follows:

Single Link System:

- A. Secure end of link with small hook to reverse lock release lever, with spring pin.
- B. Hook other end (large hook) of link into hole in reverse lock lever.
- C. Assemble reverse lock, spring, spacers and shallow water drive bracket by driving groove pin into swivel bracket. Figure 12.

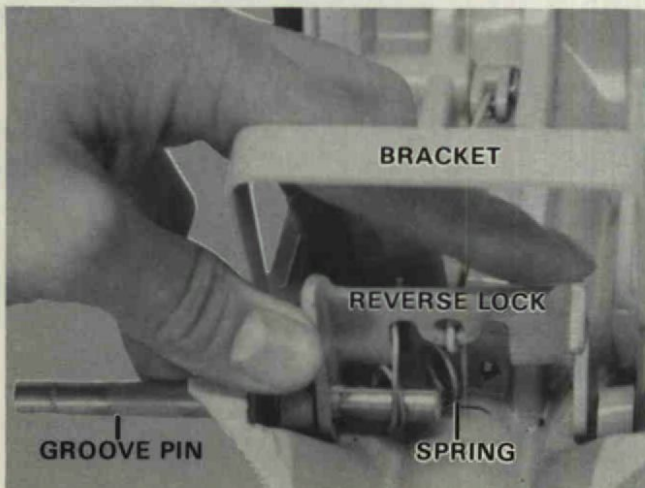


Figure 12. Installing Reverse Lock.

CAUTION

Make sure all parts are in the right position.

- D. Go to Step E. (Double Link System)

Double Link System:

- A. Install retainer with swivel on reverse lock. Install reverse lock, spring, and shallow water drive bracket with groove pin.
 - B. Hook end of link in swivel.
 - C. Go to Step E.
 - E. Place one bearing in reverse lock release lever and one bearing on end of reverse lock intermediate lever.
 - F. Slide end of reverse lock intermediate lever through swivel bracket and through reverse lock intermediate lever.
 - G. Secure with spring pin.
 - H. Secure end of reverse lock intermediate lever to reverse lock lever with spring pin.
 - I. Assemble reverse lock lever and two washers by inserting pivot bolt (stern bracket pivot bolt) through stern brackets and securing it with washer and nut. Do not fully tighten.
2. Install carrying handle with two locating pins and torque nut on end of pivot bolt to 125 ± 10 in. lbs. (142 ± 11 kg/cm).
 3. Install clamp screw assembly as follows:
 - A. Place clamp screw handle on clamp screw and secure with spring pin.
 - B. Thread clamp screw into stern bracket.
 - C. Place foot and stud in clamp screw and secure stud with spring pin.
 4. Install tilt lock assembly as follows: Figure 13.
 - A. Place pivot screw with wavy washer through pivot hole in tilt lock.
 - B. Place nylon spacer on screw.
 - C. Place spring on screw with hooked end of spring over tilt lock.
 - D. Thread and tighten pivot screw.
 - E. Pivot tilt lock until slot is over hole in swivel bracket.
 - F. Place nylon spacer between lock and bracket and secure with pivot screw.
 5. Install lock bar as follows:
 - A. Secure handle to bar with spring pin.

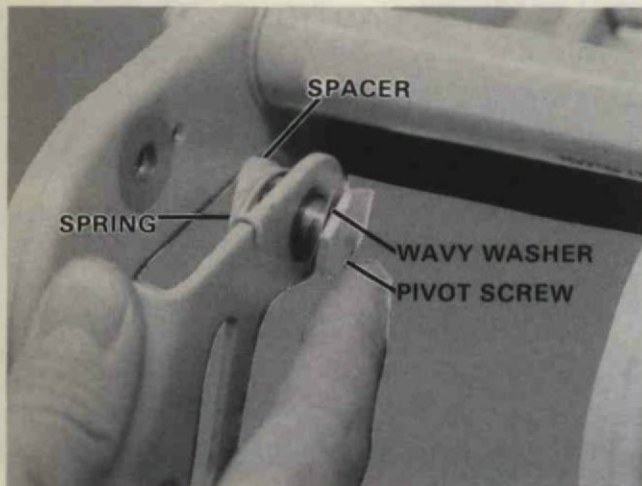


Figure 13. Installing Tilt Lock Assembly.

- B. Install spring in handle.
- C. Insert lock bar assembly through holes in stern bracket.
- 6. Adjust reverse lock as follows:
 - A. Adjust reverse lock so that there is a $.15 \pm .03$ " (3.81 ± 0.76 mm) clearance between top of lock bar and bottom edge of reverse lock.

- B. Set reverse lock release lever in "tilt release" position.

NOTE

Reverse lock must allow engine to tilt up and must cam over lock bar when engine is tilted down.

- 7. Adjust link if needed, as follows:

NOTE

There should be a $5/32$ " (3.97 mm) clearance between reverse lock and lock bar.

- A. Bend link in middle with pliers so that bends are $3/8$ " to $1/2$ " (9.53 mm to 12.70 mm) apart.

NOTE

Do not pull link up away from swivel bracket while bending.

- 8. Recheck reverse lock system. It should work as follows:

- A. Link must not touch swivel bracket.
- B. Reverse lock must lift up high enough to allow engine to tilt ("release" position).
- C. Release lever must snap back to lock position when engine is tilted up.
- D. Reverse lock must cam over lock bar when engine is tilted down in "running" position.

- 9. Reassemble motor leg as follows:
 - A. Install waterline spring in water inlet opening of motor leg.
 - B. Press waterline into plastic sleeve in motor leg from bottom of motor leg, until waterline is fully inside motor leg with bottom of waterline $1-1/8$ " (28.56 mm) from bottom edge of motor leg.
 - C. Press seal in bore of motor leg, using seal installer. Special Tool No. T 2907.
- 10. Install friction clamp in bore of swivel bracket. Secure with screw and square nut but do not tighten at this time.
- 11. Install swivel bracket bearings in king pin bore of swivel bracket.

NOTE

Make sure slits in bearing face to port side to avoid possible damage to king pin. Figure 14.

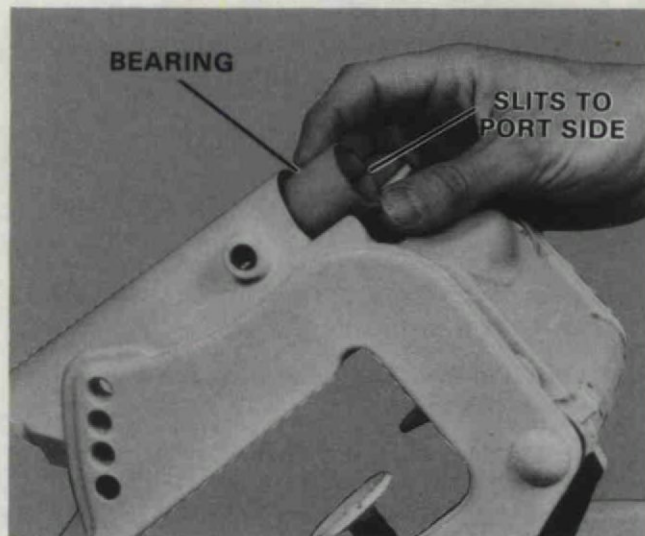


Figure 14. Installing Swivel Bracket Bearings.

- 12. Assemble steering arm as follows:
 - A. Install king pin in steering arm and secure with spring pin.
 - B. Install rubber bumper on starboard side of steering arm.
- 13. Install steering arm to motor leg.
- 14. Install swivel bracket with stern bracket to steering arm as follows:
 - A. Slide swivel bracket onto king pin.
 - B. Tighten friction screw until steering friction is correct.
- 15. Finish installation as detailed in Installation, Shock Mounts.

- | | | | | | |
|----|--|----|----------------------------------|----|--------------------------------------|
| 1 | HANDLE, CLAMP SCREW | 40 | REVERSE LOCK RELEASE LEVER | 69 | SPRING, LEG WATER BRACKET |
| 2 | CLAMP SCREW W/FOOT AND STUD | 41 | WASHER | 70 | SHOCK MOUNT UPPER |
| 3 | SPRING PIN | 42 | WASHER | 71 | SPRING PIN |
| 4 | SPRING PIN | 43 | LEVER, REVERSE LOCK INTERMEDIATE | 72 | STEERING ARM W/SPRING PIN AND BUMPER |
| 5 | STUD CLAMP SCREW | 44 | BEARING | 73 | SCREW, 1/4 - 20 x 5/8 |
| 6 | CLAMP SCREW FOOT | 45 | SPRING PIN | 74 | EXTERNAL TOOTH LOCKWASHER |
| 7 | NUT, 3/8 - 16 | 46 | LEVER, REVERSE LOCK | 75 | BUMPER |
| 8 | LOCK BAR W/HANDLE AND SPRING | 47 | BEARING | | |
| 9 | SPRING PIN | 48 | SPRING PIN | | |
| 10 | SPRING, LOCK BAR HANDLE | 49 | WASHER, SWIVEL BRACKET | | |
| 11 | LOCK BAR HANDLE | 50 | BEARING, SWIVEL BRACKET | | |
| 12 | STERN BRACKET PIVOT BOLT | 51 | CLAMP, STEERING HANDLE | | |
| 13 | WASHER | 52 | SQUARE NUT, 1/4 - 20 | | |
| 14 | STERN BRACKET STARBOARD W/CLAMP SCREW AND FOOT | 53 | SCREW, 1/4 - 20 x 1-3/8 | | |
| 15 | SPRING PIN | 54 | SWIVEL BRACKET W/GREASE FITTING | | |
| 16 | LOCK NUT | 55 | GREASE FITTING | | |
| 17 | TIE BAR | 56 | SPACER, TILT LOCK | | |
| 18 | LOCK NUT | 57 | TILT LOCK PIVOT | | |
| 19 | WASHER | 58 | BEARING, SWIVEL | | |
| 20 | HEX SLOTTED HD SCREW, 1/4 - 20 x 3-3/16 | 59 | KING PIN | | |
| 21 | CARRYING HANDLE | 60 | NUT, 1/4 - 20 | | |
| 22 | TILT LOCK PIVOT | 61 | BRACKET, SHOCK MOUNT LOWER | | |
| 23 | BOWED SPRING WASHER | 62 | SPRING LOCKWASHER | | |
| 24 | TILT LOCK | 63 | HEX BOLT, 1/4 - 20 x 2-3/8 | | |
| 25 | SPACER, TILT LOCK | 64 | SHOCK MOUNT LOWER | | |
| 26 | SPRING, TILT STOP | 65 | WATER LINE | | |
| 27 | STERN BRACKET PORT W/CLAMP SCREW AND FOOT | 66 | SLEEVE WATER LINE | | |
| 28 | BRACKET, LOCK STEERING | 67 | MOTOR LEG | | |
| 29 | NUT, STEERING LOCK BRACKET | 68 | SEAL, DRIVESHAFT | | |
| 30 | SCREW, STEERING LOCK BRACKET | | | | |
| 31 | WASHER, STERN BRACKET | | | | |
| 32 | GROOVE PIN | | | | |
| 33 | BRACKET SHALLOW WATER DRIVE | | | | |
| 34 | REVERSE LOCK | | | | |
| 35 | SPRING, REVERSE LOCK | | | | |
| 36 | SPACER, REVERSE LOCK | | | | |
| 37 | LINK, REVERSE LOCK LEVER | | | | |
| 38 | DECAL, TILT RELEASE | | | | |
| 39 | SPRING PIN | | | | |

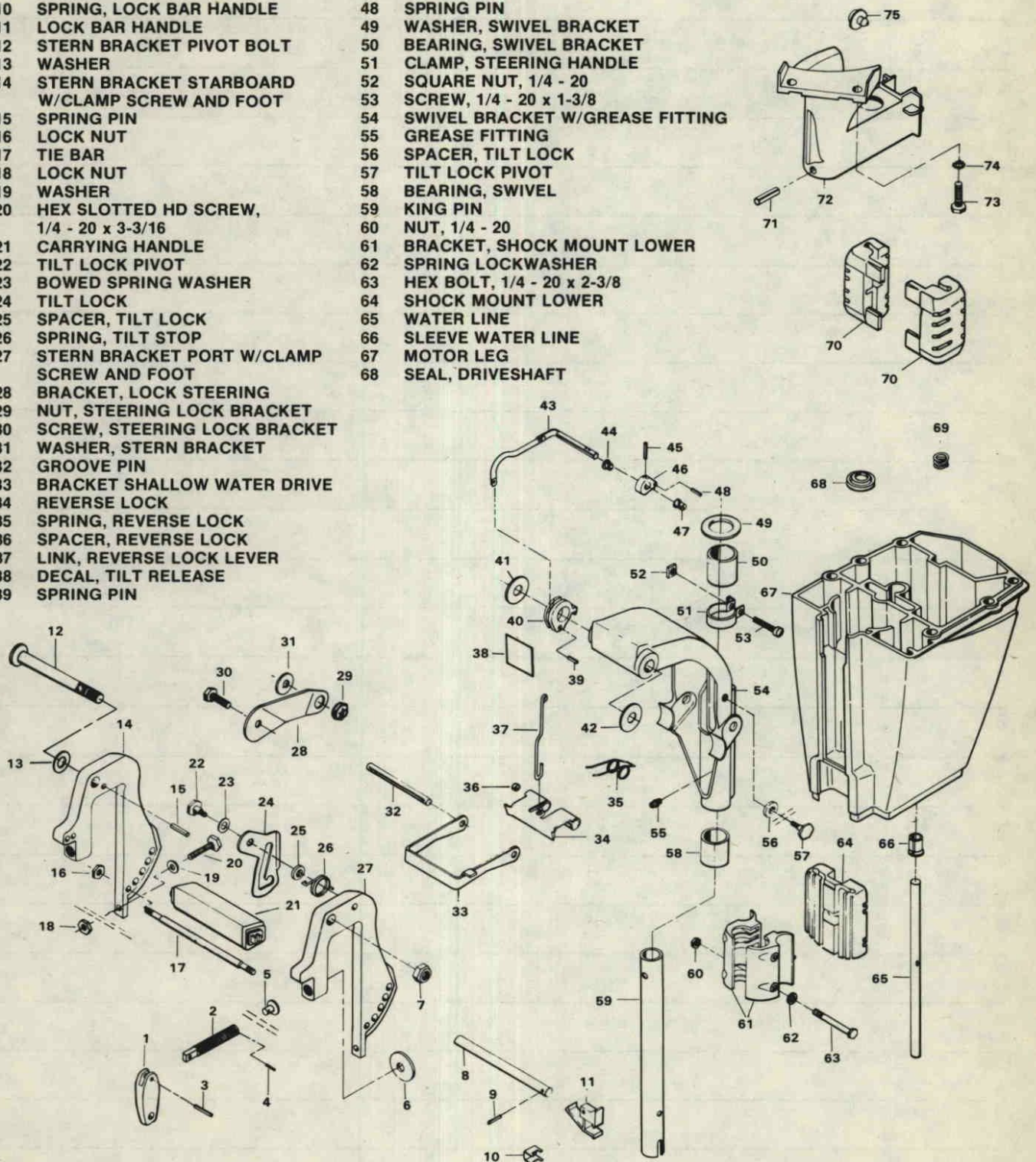


Figure 15. Swivel Bracket and Motor Leg Assembly.
Exploded View.

GENERAL

This section deals with the removal, repair and installation of the water pump, gear train and shift mechanism of the gear housing.

WATER PUMP

Description. The water pump is found on the top of the gear housing. An impeller inside the pump body is attached to the driveshaft and is propelled directly by the engine.

The center of the pump housing is offset, causing the impeller vanes to flex as they rotate. Figure 16. The impeller is sandwiched between the water pump body and water pump backplate, creating a seal. At slow speed the impeller vanes push tightly against the outside of the pump body forming a seal there as well. The volume (displacement) between any two vanes is least as they pass the outlet. As they rotate and the volume (displacement) increases, pressure will drop, forming a vacuum.

When the volume (displacement) is greatest, the vacuum highest and the leading vane goes past the inlet, the vacuum will draw cooling water into the body and carry it to the outlet where it is pumped through the motor cooling system.

At low speeds, the pump is a displacement pump. As motor speed increases, water resistance causes the vanes to flex in and it becomes a centrifugal pump.

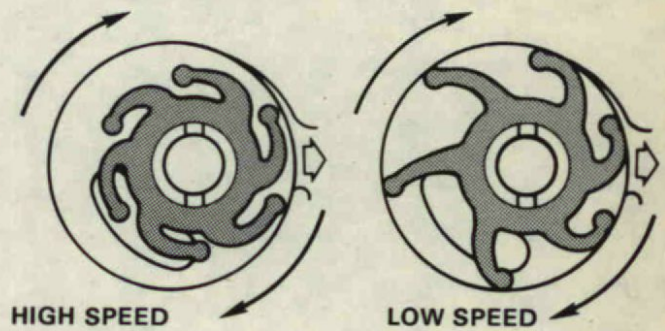


Figure 16. Operation of Water Pump.

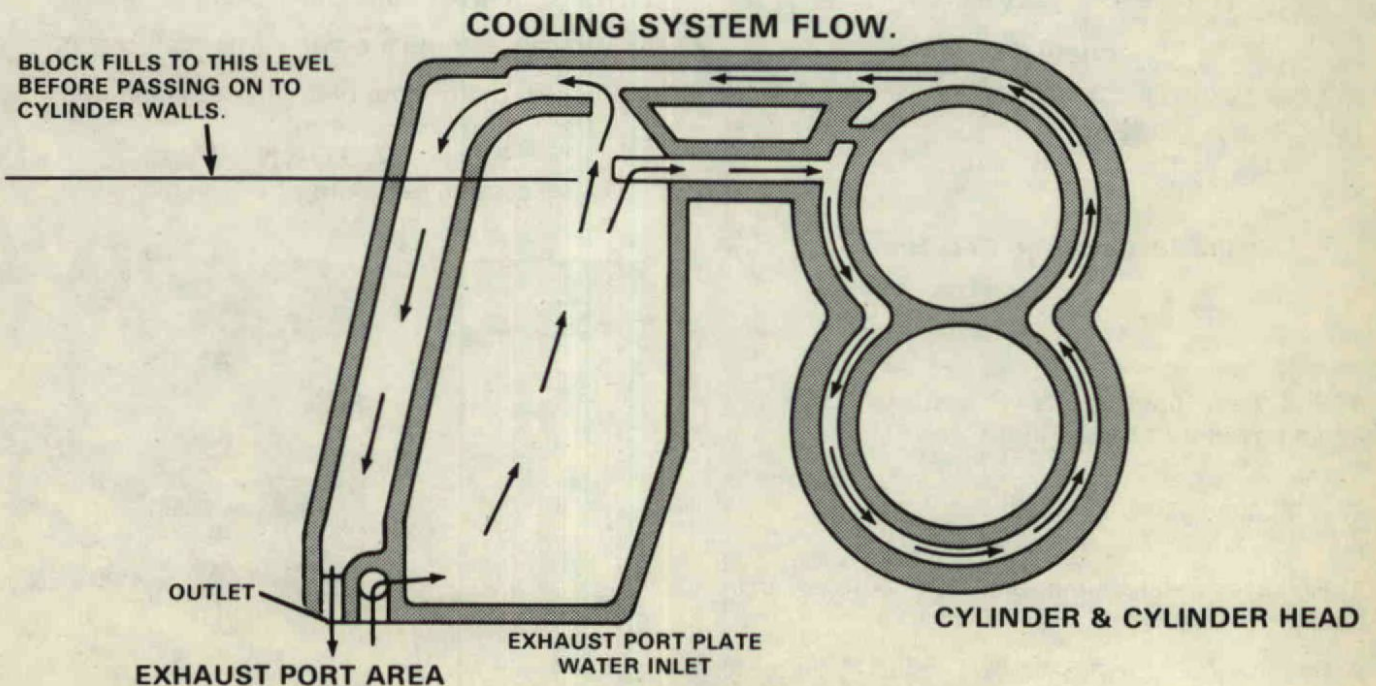


Figure 17. Cooling System.

Removal. To remove water pump from engine, proceed as follows:

WARNING

Disconnect spark plug leads to prevent accidental starting of motor.

1. Remove four (4) hex screws securing upper gear housing to motor leg.
2. Shift engine into forward gear.

NOTE

When shifting, rotate flywheel or propeller to avoid damaging clutch dogs and gears.

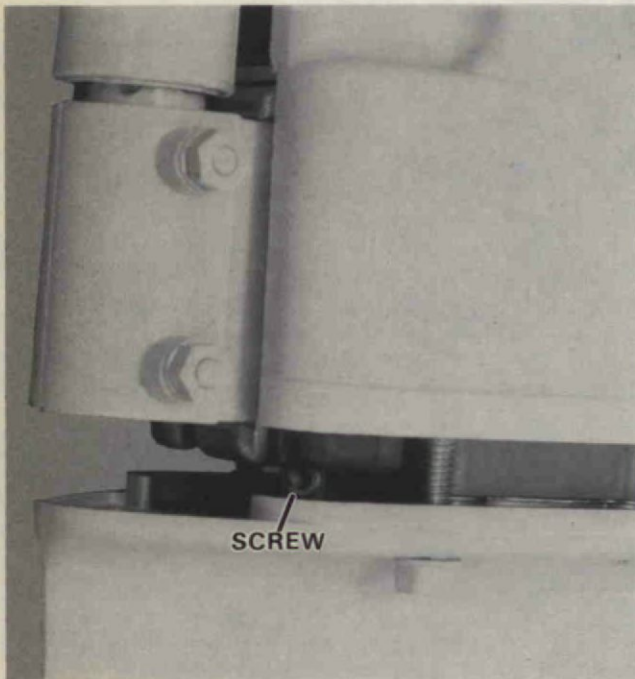


Figure 18. Removing Gear Housing.

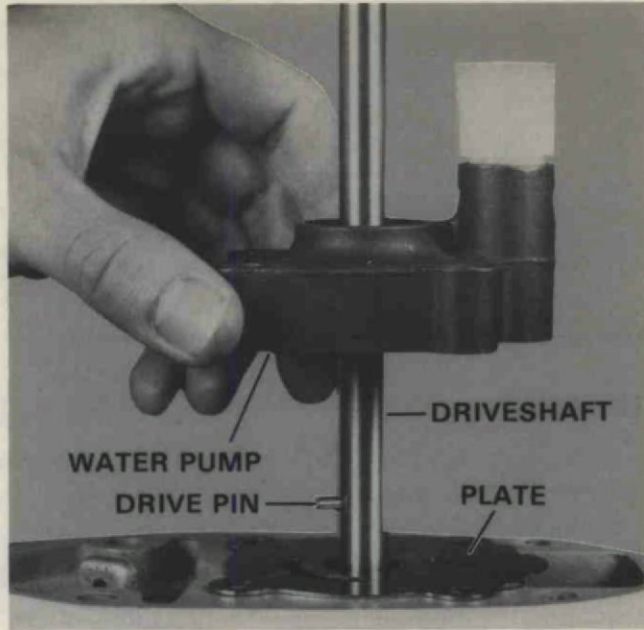


Figure 19. Removing Water Pump.

- B. Remove water pump with impeller from driveshaft.

NOTE

Grip driveshaft when removing water pump to prevent driveshaft from being removed.

6. Remove water pump impeller from water pump body.
 7. Remove water pump impeller drive pin from driveshaft and lift water pump plate off driveshaft.
 8. Remove water pump body driveshaft seal.
- A. Pry seal out of bore of pump body. Figure 20.

CAUTION

Do not scratch seal bore when removing seal.

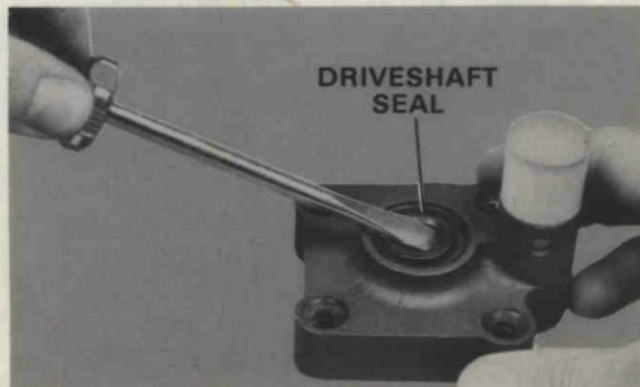


Figure 20. Removing Driveshaft Seal.

3. Pull gear housing down and remove screw joining gear shift rods. Figure 18.

4. Pull gear housing from motor leg.

5. Remove water pump body from upper gear housing as follows:

- A. Remove four (4) hex screws securing pump to upper gear housing. Figure 19.

Inspection and Repair. Replacement parts for the water pump are available individually or in kit form. The water pump kit includes a new body, seals, impeller, pin and backplate. Inspect and repair the following:

1. Inspect water pump impeller, replace if vanes are damaged or worn.
2. Clean pump body and backplate in solvent.
3. Inspect pump body and water pump backplate for wear or pitting, replace if excessive.

Reassembly. Reassemble water pump as follows: if water pump kit was used, proceed to Step 2.

1. Replace water pump body driveshaft seal as follows:
 - A. Apply grease, to sealing lips of seal (Special Tool No. T 2961).
 - B. Place new seal, spring end up, on top of seal bore. Use Special Tool No. T 2907 seal installer to press seal in. Figure 21.

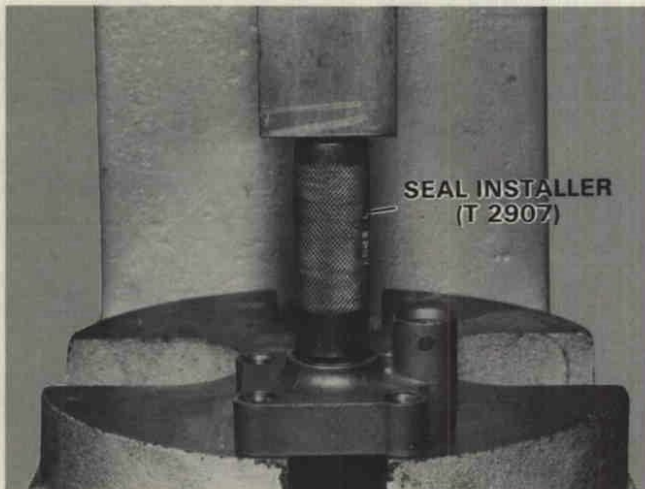


Figure 21. Installing Driveshaft Seal.

2. Install impeller (Rotate Impeller counterclockwise into pump body. Groove for drive pin should be open when viewed from bottom. Figure 6.

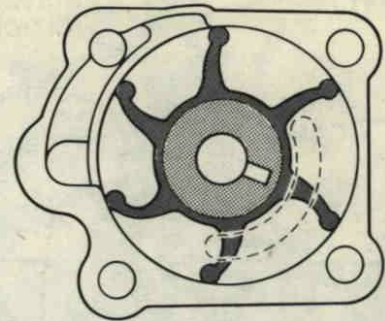


Figure 22. Installing Impeller.

Installation. To reinstall water pump, proceed as follows:

1. Place water pump backplate on gear housing. Make sure all holes line up.
2. Slide pump drive pin in hole of driveshaft.
3. Apply liberal amount of grease to end of driveshaft (Special Tool No. T 2961). Carefully guide driveshaft through impeller and driveshaft seal until pump drive pin engages slot in impeller.
4. Apply sealant to threads of cap screws (Special Tool No. T 8983). Secure pump.

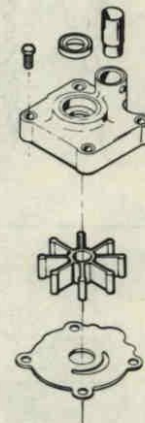


Figure 23. Water Pump. Exploded View.

GEAR TRAIN

Description. The gear train redirects vertical engine rotation to the propeller which is on a horizontal plane when the engine is running. Propeller rotation (forward or reverse) is controlled by the shifting mechanism of the gear train.

The driveshaft is splined to the pinion gear which meshes with forward and reverse gear. The propeller shaft engages the gears by means of the shift clutch.

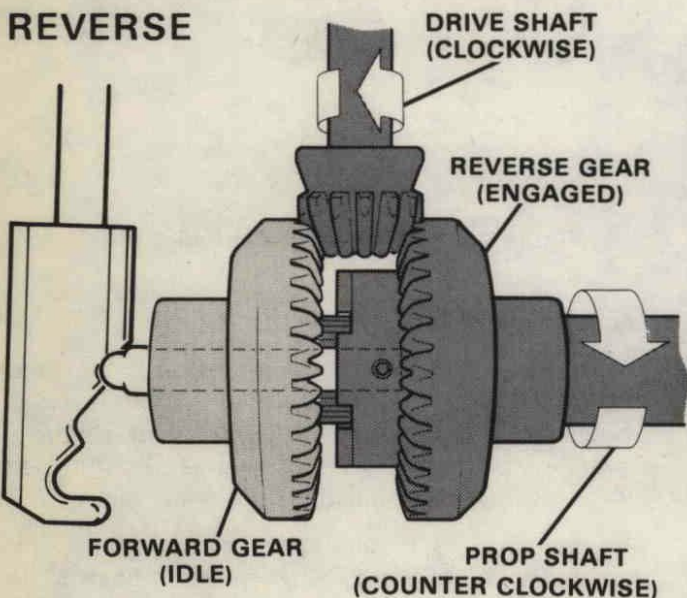
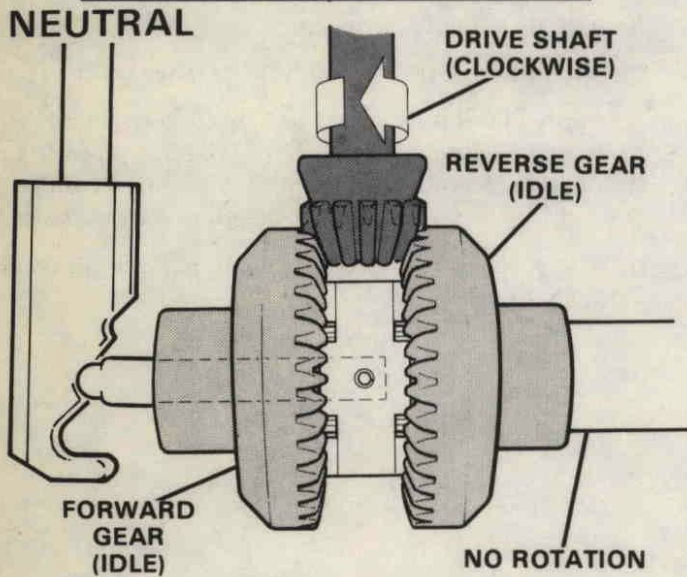
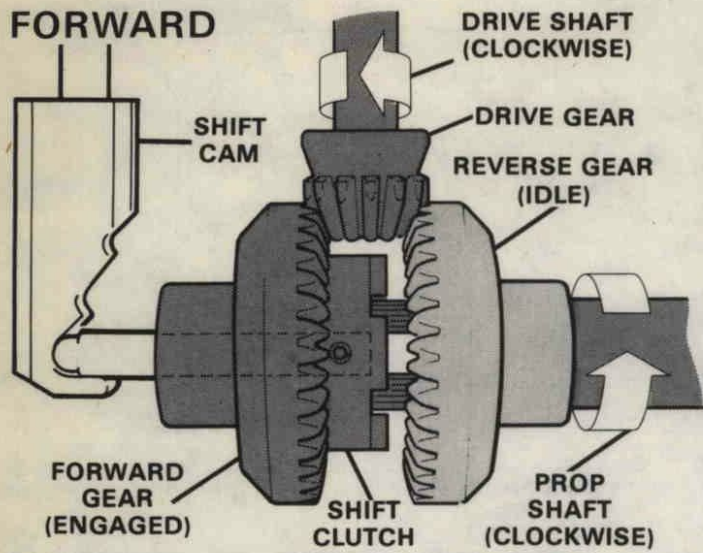


Figure 24. Operating of Gear Train.

The shift clutch moves back and forth by following the clutch shift cam on the end of the shift rod.

When shifted into neutral, the shift clutch centers itself between forward and reverse gear and does not contact either one. Figure 24 (Middle).

When the motor is shifted into forward gear the shift clutch engages forward gear, turning the propeller clockwise. Figure 24 (Top).

With the shift lever in reverse, the shift clutch engages reverse gear, turning the propeller counterclockwise. Figure 24 (Bottom).

Removal. To disassemble gear housing, proceed as follows:

! WARNING

Disconnect spark plug leads to prevent accidental starting of motor.

1. Remove water pump.
2. Drain gear housing as follows:
 - A. Drain gear housing grease by removing both "fill" and "vent" screws.
 - B. Probe drained gear lube with magnet. Steel shavings mean possible abnormal wear in gears or shifting mechanism.
3. Remove bearing cage as follows:
 - A. Remove two (2) fillhead screws securing bearing cage assembly to lower gear housing.
 - B. Install puller (Special Tool No. T 8948-1). Remove bearing cage assembly. Figure 25.

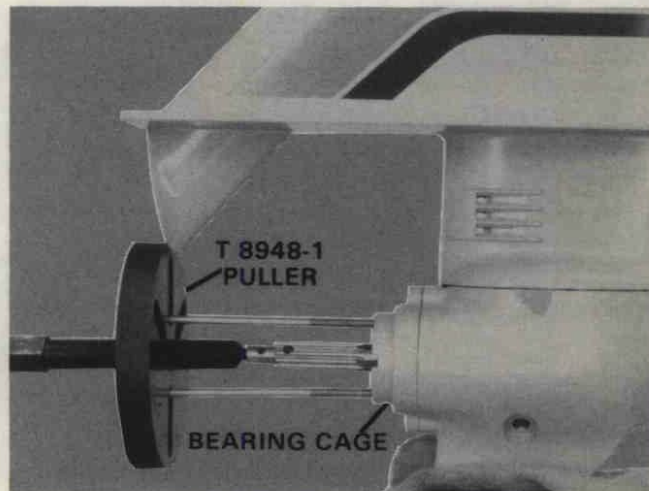


Figure 25. Removing Bearing Cage.

4. Remove long, hex bolt in front of water pump cavity.

- A. Remove lower gear shift rod by turning counterclockwise until it unthreads from shift cam.

CAUTION

Do this slowly to avoid cutting shift rod seal.

5. Remove nut and lockwasher inside gear housing.
6. Separate lower gear housing from upper gear housing.
7. Remove gear housing gasket from parting line of upper to lower gear housing.
8. Pull propeller shaft assembly from lower gear housing.
9. Slide rear bevel gear (reverse) and thrust washer off propeller shaft.
10. Remove bevel pinion, (drive gear).
11. Remove shift cam detent spring.
12. Slide cam out of slot in lower gear housing.
13. Slide front bevel gear (forward gear) out of bore in lower gear housing.
14. Remove propeller shaft thrust bearing and race.
15. Remove clutch as follows:
 - A. Remove shift pin from shaft.
 - B. Slide clutch against spring and install a 1/8" diameter drift punch through clutch slot in propeller shaft.

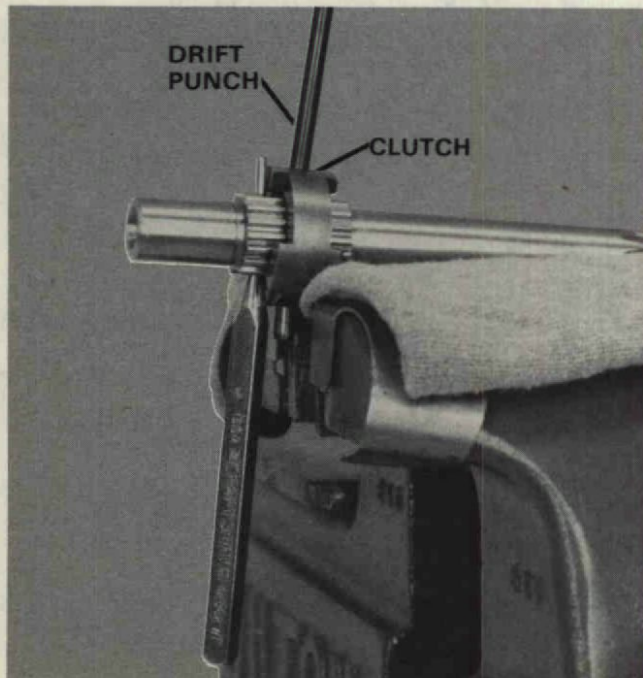


Figure 26. Removing Clutch.

NOTE

This procedure prevents damage to ends of clutch slots when removing spring pin from clutch. Figure 26.

- C. Place propeller shaft in vise.

CAUTION

Cover jaws to prevent scratching machined surfaces.

- D. Drive spring pin from clutch using pin remover. Special Tool No. T 8919. Figure 26.

Inspection and Repair. Lower Gear Housing.

NOTE

Replacement parts are available individually.

1. Thoroughly clean all gear housings parts in solvent. Dry with compressed air.



WARNING

Wear safety glasses when working with compressed air.

1. Thoroughly clean all gear housing parts in solvent. Dry with compressed air.



WARNING

Wear safety glasses when working with compressed air.

2. Inspect propeller shaft for obvious wear or distortion around clutch slot and propeller pin hole. Remove sharp burrs or nicks with a fine file or emery cloth. Check spline for cracks.

NOTE

Do not remove excessive metal from shaft.

3. Inspect thrust bearing and race for wear.
 4. Inspect clutch for wear. Replace if worn. Pay particular attention to clutch dogs.
- A. Check free length of clutch spring. Check straightness by rolling on flat surface. Figure 27.

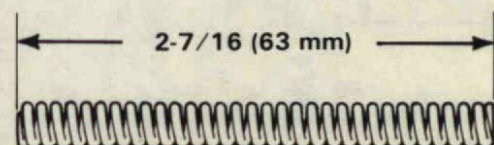


Figure 27. Measuring Clutch Spring Length.

B. Clutch is hardened. Look for cracks at shear points.

5. Check shift pin and shift cam for wear. Shift cam will wear on face. Excessive wear on crests may allow motor to drop out of gear. Check shift pin by measuring length. Overall length should be $1.709 \pm .003$ ($43.40 \pm .07$ mm).

6. Inspect propeller shaft bearing cage.

A. Check casting for cracks or corrosion.

B. Measure I.D. of bearing. Bearing can not be replaced except as an assembly. Figure 28.

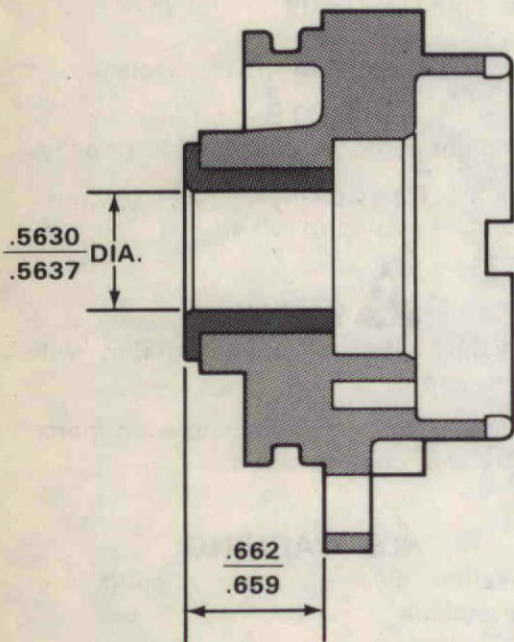


Figure 28. Propeller Shaft Bearing Cage Bearing I.D.

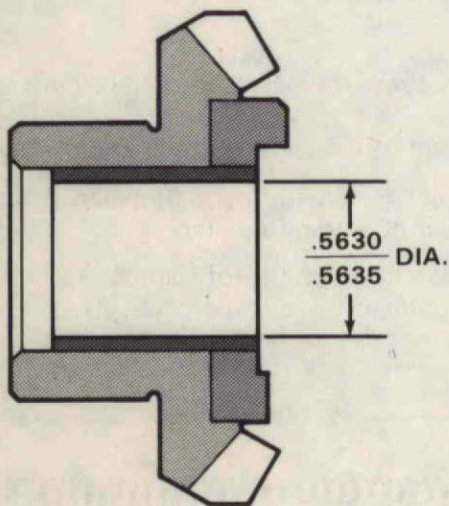


Figure 29. Rear Bevel Gear Bearing I.D.

7. Check gears for wear. Wear pattern will be noticeable. Gears should look as if each tooth was polished evenly.

8. Inspect rear bevel gear with bearing. Measure I.D. of bearing. Bearing can not be replaced except as an assembly. Figure 29.

9. Inspect pinion gear with bearing. Bearing can be replaced individually. If necessary, press off old bearing. Press on new bearing.

10. Inspect front bevel gear with bearing. Measure I.D. of bearing. Bearing can not be replaced except as an assembly. Figure 30.

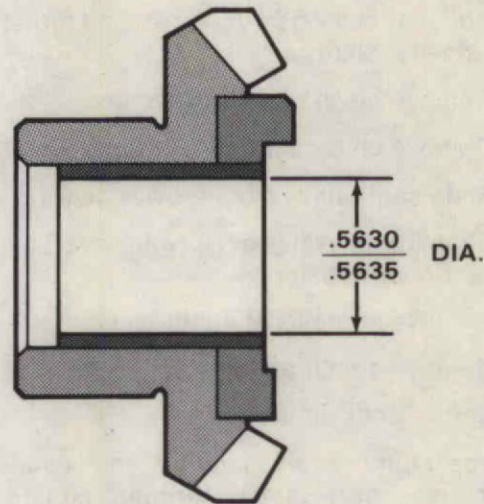


Figure 30 Front Bevel Gear Bearing I.D.

11. Carefully check lower gear housing bore for cracks, corrosion and burrs. Remove burrs, superficial corrosion may be permissible if not on sealing surface. Cracked housings must be replaced.

12. Remove gear housing gasket.

A. Remove old sealant and gasket pieces from both upper and lower gear housing.

B. Clean gasket surfaces of housings with solvent.

Inspection and Repair. Upper Gear Housing.

NOTE

Bearing below upper driveshaft seal can not be replaced individually.

1. Inspect housing for deterioration.

2. Clean water inlets.

3. Inspect housing for cracks or other damage.

Inspection and Repair. Remove and Replace Seals.

NOTE

All seals are available individually or in kit form. (Kit does not include waterline seal).

1. Inspect waterline seal for cracks.
2. Remove and replace shift rod seal as follows:
 - A. Thread 5/16" dia. lag screw into seal and insert 1/4" dia. rod from opposite side.
 - B. Press both seal and lag screw out of seal bore. Figure 31.

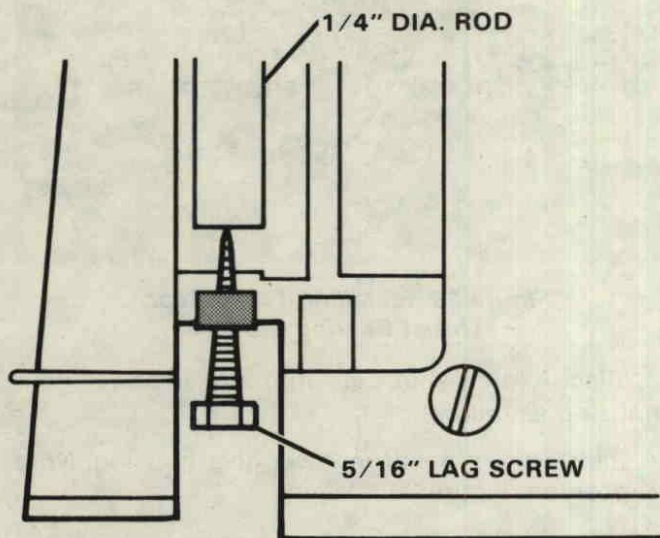


Figure 31. Removing Shift Rod Seal.

- C. Position new seal at seal bore so raised head around shift rod hole in seal is toward motor leg.
 - D. With seal installer, Special Tool No. T 8953, drive seal in until top is flush with bottom of seal bore chamfer.
3. Remove and replace driveshaft seal from upper gear housing bore as follows:
 - A. Pry seal out of bore with screwdriver.

CAUTION

Be very careful not to scratch bore.

- B. Apply grease to sealing lips of new seal.
- C. Place seal on installation tool so that major sealing lip with garter spring is against shoulder of tool. Special Tool No. T 2907.

- D. Position seal and tool in bore of upper gear housing. Press seal in until it reaches bottom of bore. Figure 32.

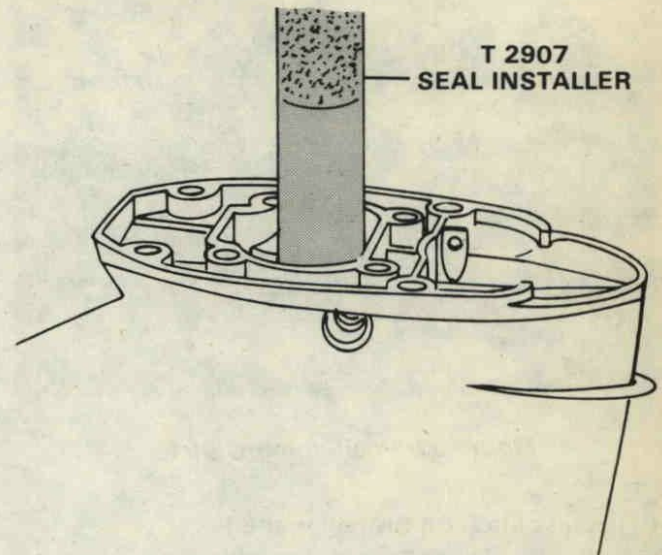


Figure 32. Installing Driveshaft Seal in Upper Gear Housing.

4. Remove and replace propeller shaft seal as follows:
 - A. Drive seal away from bearing in cage with a punch.

NOTE

Be careful not to damage cage.

- B. Press new seal in bore of bearing cage assembly using seal installer. Special Tool No. T 2907.

NOTE

Two different types of seals can be used:

1. Metal cased seal, which is installed with garter spring "in" toward gears of lower gear housing.
2. Rubber cased seal, which is installed with garter spring "out" towards propeller.

5. Remove and replace propeller shaft bearing cage seal (O ring).

Reassembly and Installation. Proceed as follows:

1. Reassemble clutch.
 - A. Drive spring pin part way into clutch.

CAUTION

Position clutch so that clutch dogs with chamfered edges are facing toward propeller end of propeller shaft. Figure 33.

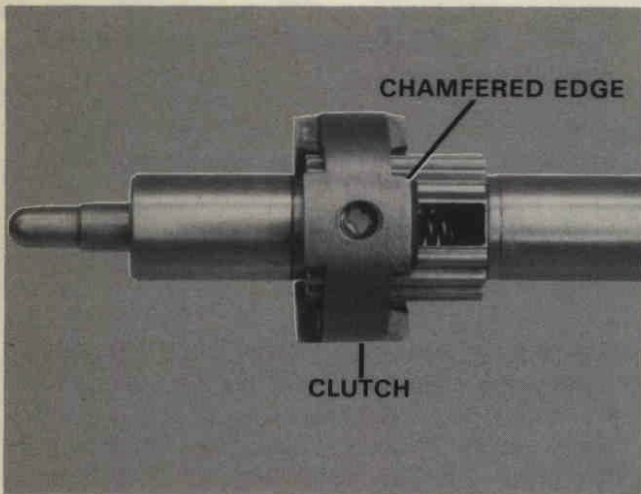


Figure 33. Positioning Clutch.

- B. Install clutch on propeller shaft.
- C. Clamp propeller shaft in vise. Protect surfaces with shop cloth.
- D. Compress clutch spring. Center clutch on splined part of shaft. Figure 34.
- E. Remove pin remover. Drive spring pin in until flush. Figure 34.
- F. Install shift pin in bore of propeller shaft with flat end of pin against spring pin of clutch.

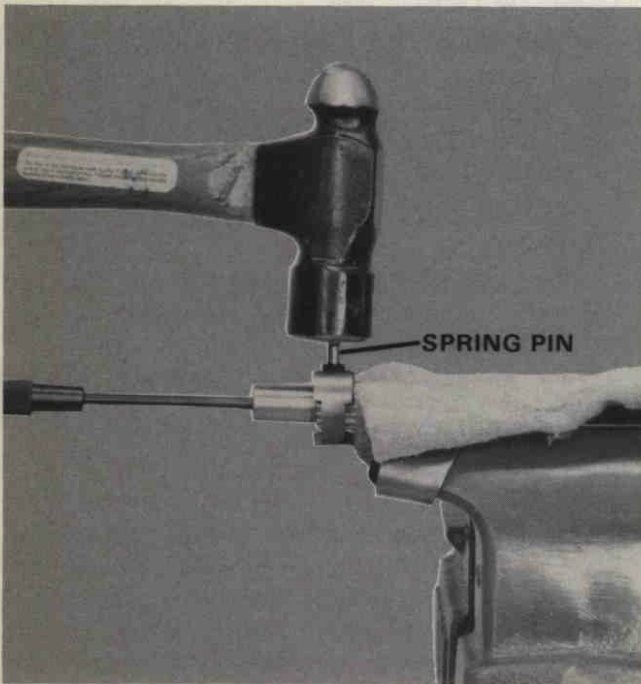


Figure 34. Installing Clutch.

2. Reassemble front gear as follows:

- A. Install thrust bearing, then race on front bevel gear. Figure 35.

NOTE

Thrust bearing must always be between front bevel gear and bearing race.

- B. Install thrust washer on front gear.

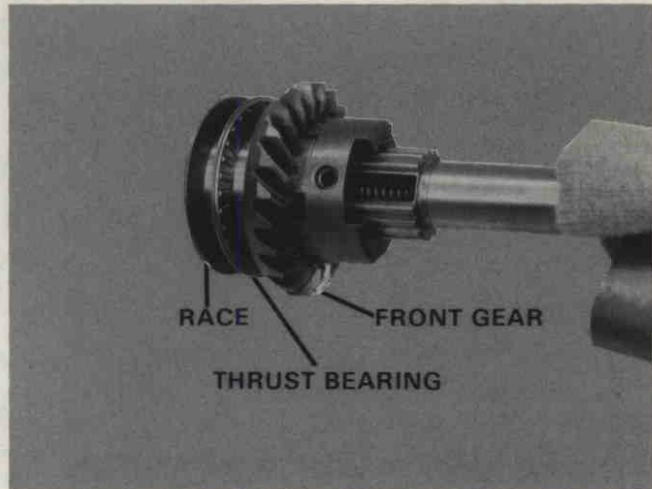


Figure 35. Installing Front Gear, Thrust Bearing, Race.

3. Place clutch shift cam into slot in lower gear housing as follows:

- A. Slide cam into slot in lower gear housing. Note position, Figure 36.

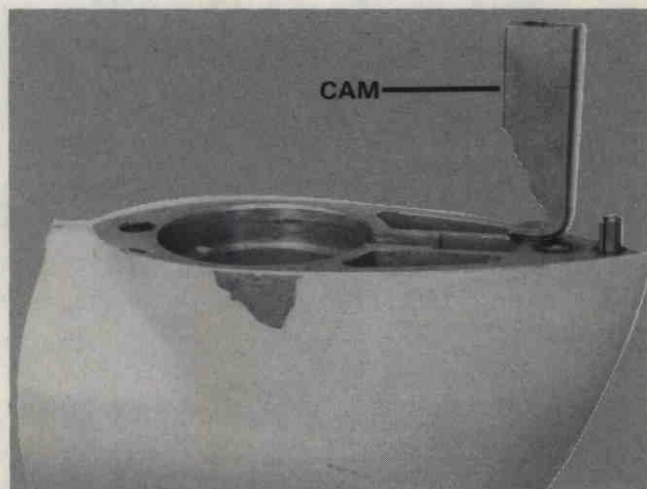


Figure 36. Installing Cam.

NOTE

During next step hold top of cam out of housing approximately 3/16" (4.76 mm), so forward gear position engages the shift pin.

4. Install front bevel gear assembly on propeller

shaft and place in bore of gear housing.

5. Install bevel pinion (drive) gear.
6. Place thrust washer on rear bevel gear (reverse) and slide gear onto propeller shaft.
7. Install shift cam detent spring in hole in front of bevel pinion. Figure 37.

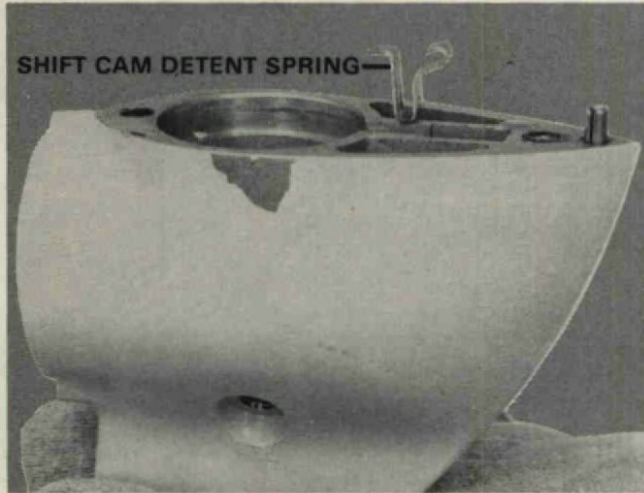


Figure 37. Installing Shift Cam Detent Spring.

8. Install gear housing gasket as follows:
 - A. Apply sealant on both sides of new gasket. Special Tool No. T 8983.
 - B. Install on lower gear housing.
9. Install upper gear housing on lower gear housing as follows:
 - A. Align spring pin in front of lower gear housing with bore of upper gear housing. Figure 38.

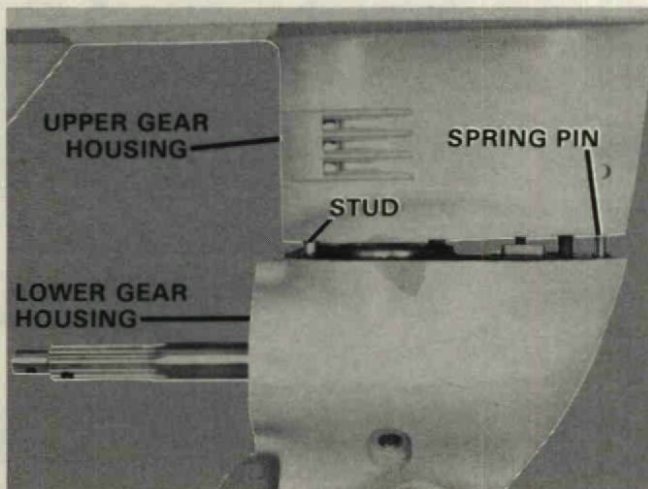


Figure 38. Installing Lower Gear Housing to Upper Gear Housing.

10. Place hex nut and spring lockwasher inside lower gear housing on stud of upper gear housing and tighten securely.

11. Apply sealant under head of 1/4 x 20 hex bolt (long bolt). Special Tool No. T 8983. Place bolt in upper gear housing. Torque to 125 ± 5 in. lbs. (142 ± 5 kg/cm).

12. Install bearing cage as follows:

- A. Apply grease to bearing cage seal and between lips of propeller shaft seal.
- B. Slide bearing cage assembly on propeller shaft. Press bearing cage into lower gear housing.
- C. Attach with two (2) fill head screws.
- D. Torque screws to 70 in. lbs. (80 kg/cm).

13. Install gear shift rod lower as follows:

- A. Push rod through seal and thread all the way into shift cam.
14. Install water pump.

Installation. Gear Housing.

1. Adjust lower gear shift rod as follows:

- A. Shift into neutral.
- B. Measure from middle of hole in rod to top mounting surface of upper gear housing. Hole should be 3/16" ± 3/64" (4.75 mm ± 1.19 mm) below surface. Figure 39. Flared indented end should face rear starboard hole of upper gear housing.

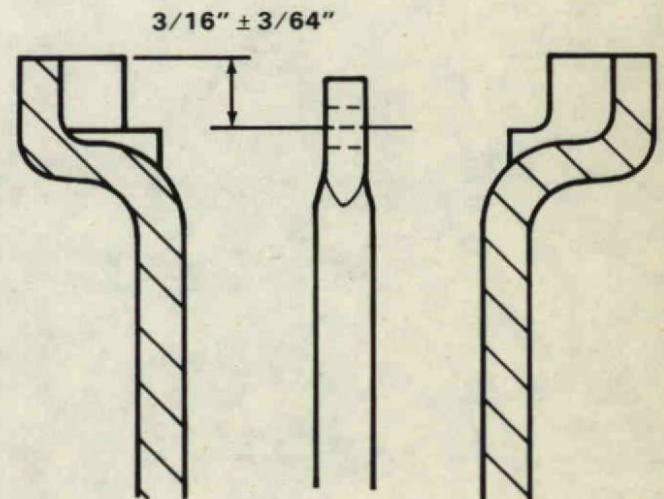


Figure 39. Gear Shift Rod Adjustment.

C. Shift lower unit into forward gear by pulling up on lower gear shift rod to position hold in rod for assembly to upper gear shift rod.

CAUTION

Turn propeller shaft when shifting to avoid damage to dogs on clutch and gears.

- D. Apply anti-seize compound to splined area of driveshaft. Special Tool No. T 2987. Install gear housing to motor leg.
 - E. Engage driveshaft splines in crankshaft and align waterline in seal of water pump.
 - F. Position lower unit, aligning lower gear shift rod to upper rod. Shift rods must be positioned correctly or leakage and damage to gear shift rod seal will occur. Connect rods with screw. Figure 40.
 - G. Check that waterline is seated in seal of water pump body.
 - H. Secure gear housing to motor leg with four (4) hex head screws.
 - I. Refill with gear lube.
2. Pressure test gear housing as follows:
 - A. Remove vent plug from lower, starboard side of gear housing.
 - B. Thread adapter of pressure tester into vent hole on gear housing and tighten securely. Special Tool No. T 8950.
 - C. Pressurize housing to 10 p.s.i. and observe gauge for five minutes. If pressure drops, immerse housing in water and repressurize (10 p.s.i.).

INCORRECT

CORRECT

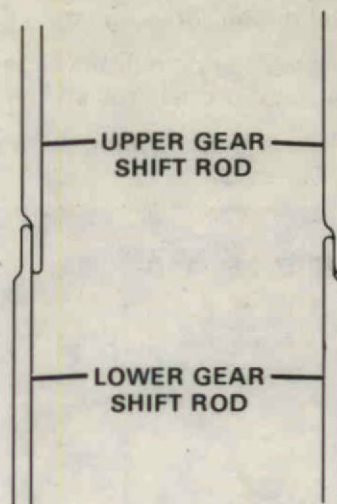


Figure 40. Connecting Gear Shift Rods.

Replace seals wherever oil leaks or air bubbles appear, then retest.

CAUTION

Seals may be damaged if pressure exceeds 10 p.s.i.

- D. Remove tester, install vent plug and tighten securely.
3. Install propeller pin, propeller and propeller nut with cotter pin.

- 1 SEAL, INLET WATER LINE
- 2 SCREW, 1/4 - 20 x 1-1/4
- 3 WATER PUMP BODY
- 4 SEAL, WATER PUMP
- 5 WATER PUMP IMPELLER

- 6 WATER PUMP BACK PLATE
- 7 SEAL DRIVESHAFT
- 8 DRIVESHAFT
- 9 WATER PUMP IMPELLER DRIVE PIN
- 10 GEAR SHIFT ROD UPPER
- 11 SCREW W/LOCKWASHER, 10 - 24 x 12

- 12 GEAR SHIFT ROD LOWER
- 13 SEAL, GEAR SHIFT ROD LOWER
- 14 HEX BOLT, 1/4 - 20 x 7
- 15 SCREW, 1/4 - 20 x 1
- 16 NYLITE WASHER
- 17 GEAR HOUSING PLUG
- 18 GEAR HOUSING UPPER W/BEARING
- 19 STUD, GEAR HOUSING REAR
- 20 GASKET, GEAR HOUSING
- 21 BALL BEARING
- 22 SPRING, CAM DETENT
- 23 GEAR, BEVEL PINION W/ITEM 16
- 24 CLUTCH, SHIFT CAM
- 25 SPRING PIN
- 26 NYLITE WASHER
- 27 GEAR HOUSING PLUG
- 28 SPRING LOCKWASHER
- 29 NUT, 1/4 - 20
- 30 GEAR HOUSING LOWER W/BEARING, PLUG AND SPRING PIN
- 31 RACE, PROPELLER SHAFT BEARING
- 32 BEARING, RADIAL, PROPELLER SHAFT
- 33 BEVEL GEAR FRONT W/BEARING
- 34 THRUST WASHER
- 35 CLUTCH SHIFT PIN
- 36 CLUTCH SPRING
- 37 CLUTCH
- 38 SPRING PIN
- 39 PROPELLER SHAFT
- 40 PROPELLER PIN
- 41 THRUST WASHER
- 42 BEVEL GEAR REAR W/BEARING
- 43 SEAL PROP SHAFT BEARING CAGE
- 44 PROPELLER SHAFT BEARING CAGE W/BEARING
- 45 SEAL, PROPELLER SHAFT
- 46 SCREW, 1/4 - 20 x 9/16
- 47 PROPELLER (ACCESSORY ITEM)
- 48 PROPELLER NUT W/COTTER PIN
- 49 COTTER PIN

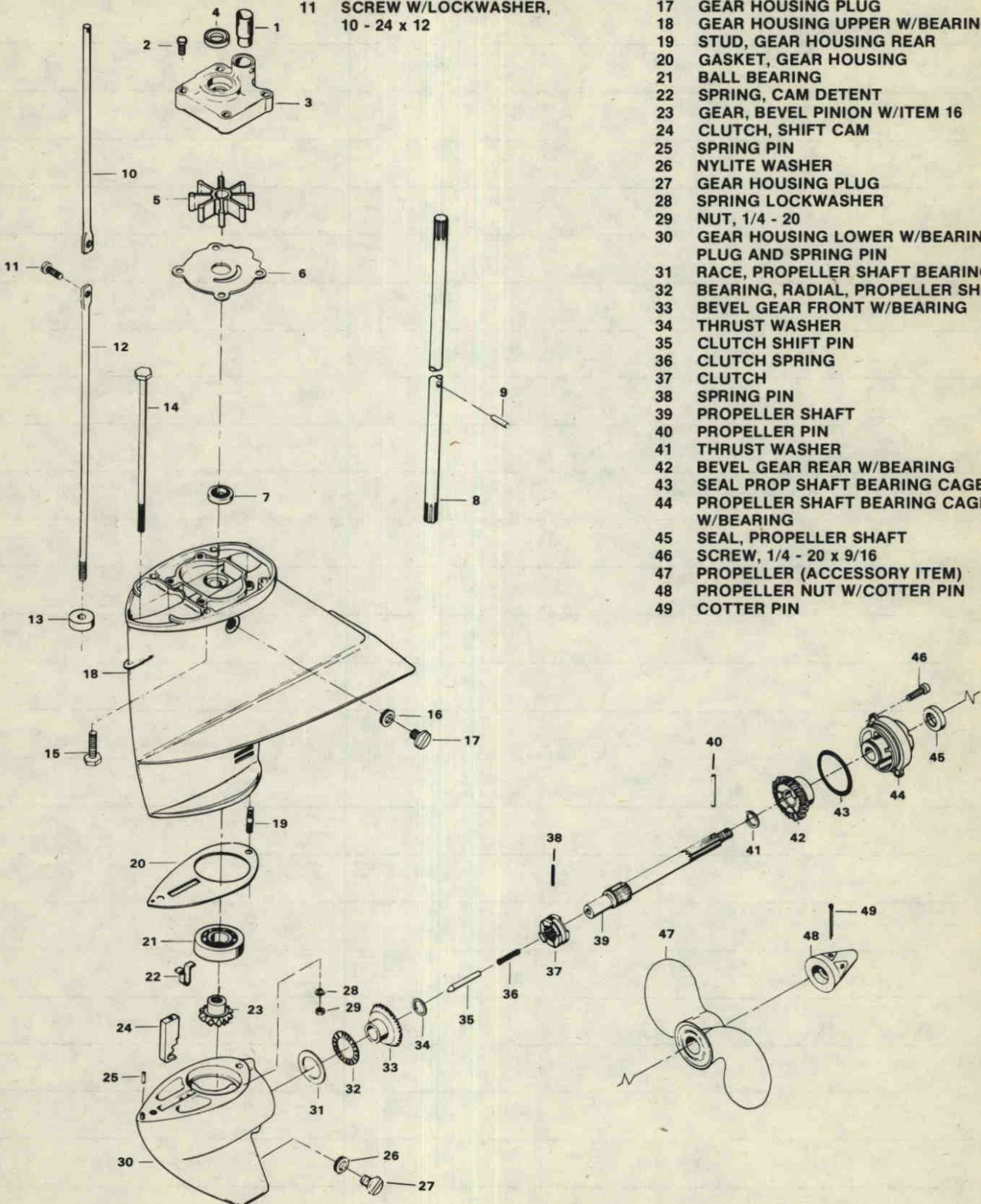


Figure 41. Gear Housing. Exploded View.

GEAR HOUSING (SAILOR)

GENERAL

The information in this subsection deals with removal, repair, and installation of the water pump, gear train, and shift mechanism of the gear housing.

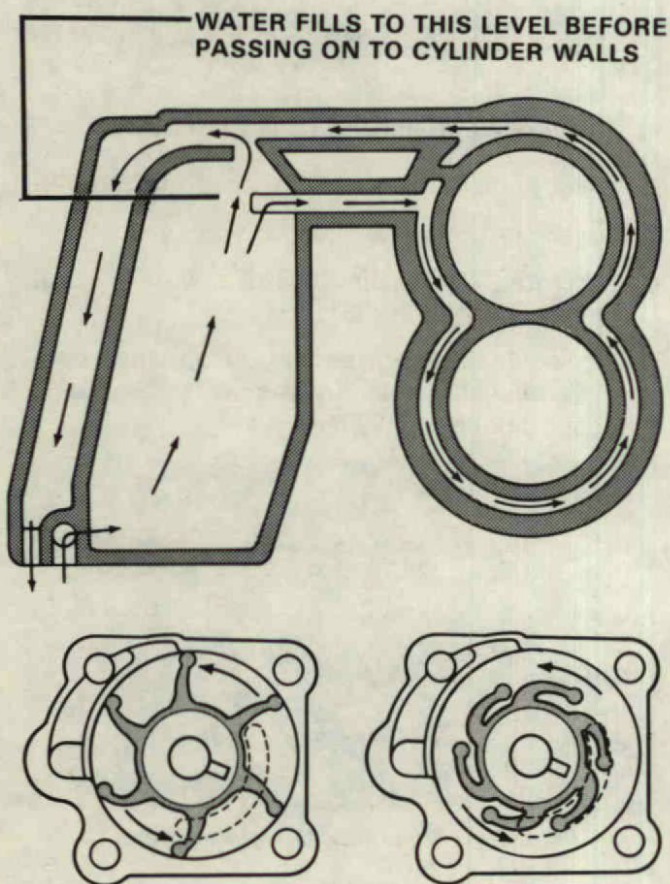


Figure 43. Operation of Cooling System and Water Pump.

WATER PUMP

Description. The water pump is located on top of the gear housing. An impeller inside the pump body is attached to the driveshaft and is propelled directly by the engine.

The center of the pump housing is offset, causing the impeller vanes to flex as they rotate. The impeller is sandwiched between the water pump body and water pump backplate creating a seal. At slow speed, the impeller vanes push tightly against the outside circumference of the pump body forming a seal there as well. The volume (displacement) between any two vanes is least as they pass the outlet. As they rotate and the volume (displacement) increases, pressure will drop forming a vacuum. When the volume (displacement) is greatest and the vacuum highest, and the leading vane goes past the inlet, the vacuum will draw cooling water into the body and carry it to the outlet where it is pumped through the motor cooling system.

At low speeds, the pump is a displacement pump. As motor speed increases, water resistance causes the vanes to flex in and it becomes a centrifugal pump.

Removal. To remove the water pump from the gear housing proceed as follows:



WARNING

Disconnect spark plug leads to prevent accidental starting of motor.

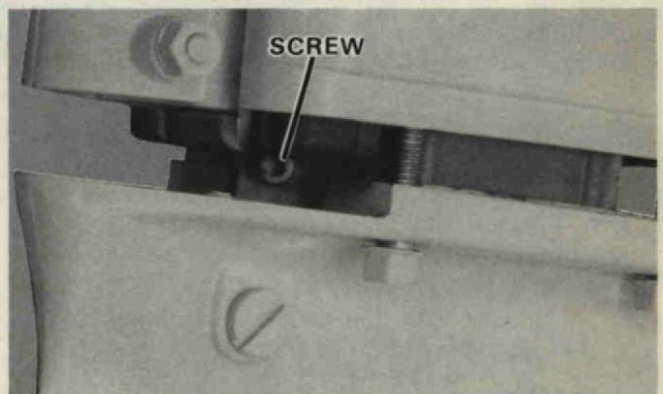


Figure 44. Removing Gear Shift Rod Screw.

1. Remove four (4) screws securing upper gear housing to motor leg.

- Shift engine into forward gear.

CAUTION

When shifting, turn propeller or flywheel to avoid damage to clutch or gears.

- Pull lower unit down and remove screw joining gear shift rods. Figure 44.
- Pull lower unit from motor leg.
- Remove water pump body as follows:

- Remove four (4) cap screws, securing pump to upper gear housing. Figure 45.
- Slide water pump body with impeller up and off driveshaft

NOTE

Hold on to driveshaft when removing water pump to prevent driveshaft from being removed with water pump.

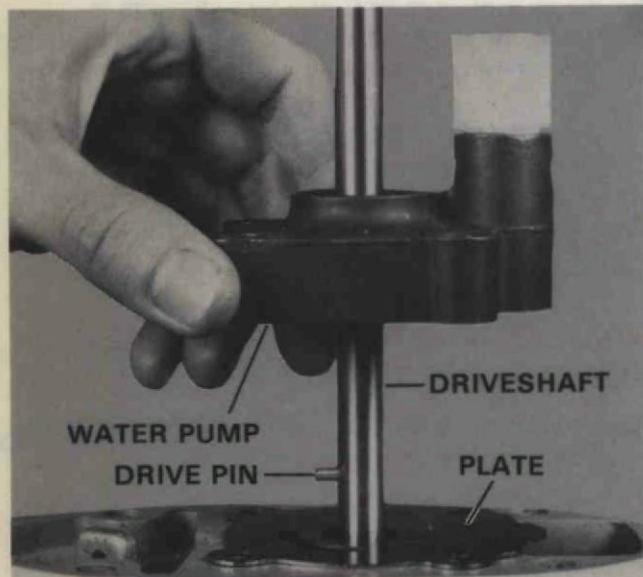


Figure 45. Removing Water Pump.

- Remove water pump impeller drive pin from driveshaft and lift water pump plate up and off driveshaft.
- Remove water pump impeller from water pump body.

Inspection and Repair. Replacement parts for the water pump are available individually or in kit form. The water pump kit includes a new body assembly (including new seals), impeller, pin and backplate. Inspect and repair the following:

- Inspect water pump impeller, replace if vanes are damaged or worn.
- Clean pump body and backplate in solvent.
- Inspect pump body and water pump backplate

for wear and/or pitting, replace if excessive.

- Remove driveshaft seal. Figure 46.

CAUTION

Do not scratch seal bore when removing seal.

- Remove inlet waterline seal. Inspect. If replacing, apply soapy solution to base of new seal. Install.

Reassembly. To reassemble water pump, proceed as follows:

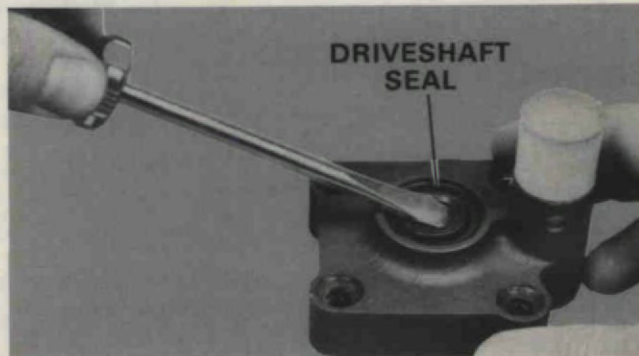


Figure 46. Removing Driveshaft Seal.

If a water pump kit was used, proceed to Step 2.

- Replace driveshaft seal as follows:

- Apply grease to sealing lips of drive shaft seal. Special Tool No. T 2961.
- Place new seal, spring end up, on top of seal bore. Use seal installer to press seal in. Figure 47. Special Tool No. T 2907.



Figure 47. Installing Driveshaft Seal.

- Install impeller. Grooves for drive pin should be open when viewed from the bottom. Figure 48.

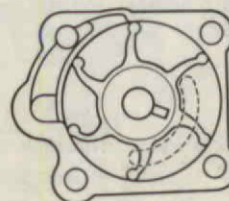


Figure 48. Position of Impeller Pin Groove.

Installation. To install water pump to lower unit, proceed as follows:

1. Place water pump backplate on gear housing. Make sure holes all line up properly or plate is not installed properly.
2. Slide pump drive pin in hole of driveshaft.
3. Apply grease (Special Tool No. T 2961) to end of driveshaft. Guide it carefully through impeller and driveshaft seal until pump drive pin engages slot in impeller.
4. Apply sealant (Special Tool No. T 8983 to threads of cap screws. Secure pump.

GEAR TRAIN

Description. The gear train redirects vertical engine rotation to the propeller which is on a horizontal plane. The propeller rotation (forward or reverse) is controlled by the shifting mechanism of the gear train.

The driveshaft is splined to the pinion gear which meshes with both forward and reverse gears. The propeller shaft engages with one or the other of these two gears by means of the shift clutch.

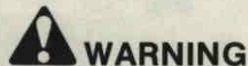
The gear shift arm is attached inside the gear housing by a pivot screw. When the shift rod is activated it enables the shift arm to push or pull the clutch between the two gears.

When shifted into neutral, the shift clutch centers itself between the forward and reverse gear and makes contact with neither one. Figure 49.

When the motor is shifted into forward gear the shift clutch engages with the forward gear, turning the propeller in a clockwise direction. Figure 49.

With the shift lever in reverse, the shift clutch engages with the reverse gear, turning the propeller in a counterclockwise direction. Figure 49.

Disassembly. Gear Housing.



WARNING

Disconnect spark plug leads to prevent accidental starting of motor.

1. Remove gear housing and water pump.
2. Drain gear housing as follows:
 - A. Drain gear housing grease by removing both "fill" and "vent" screws.

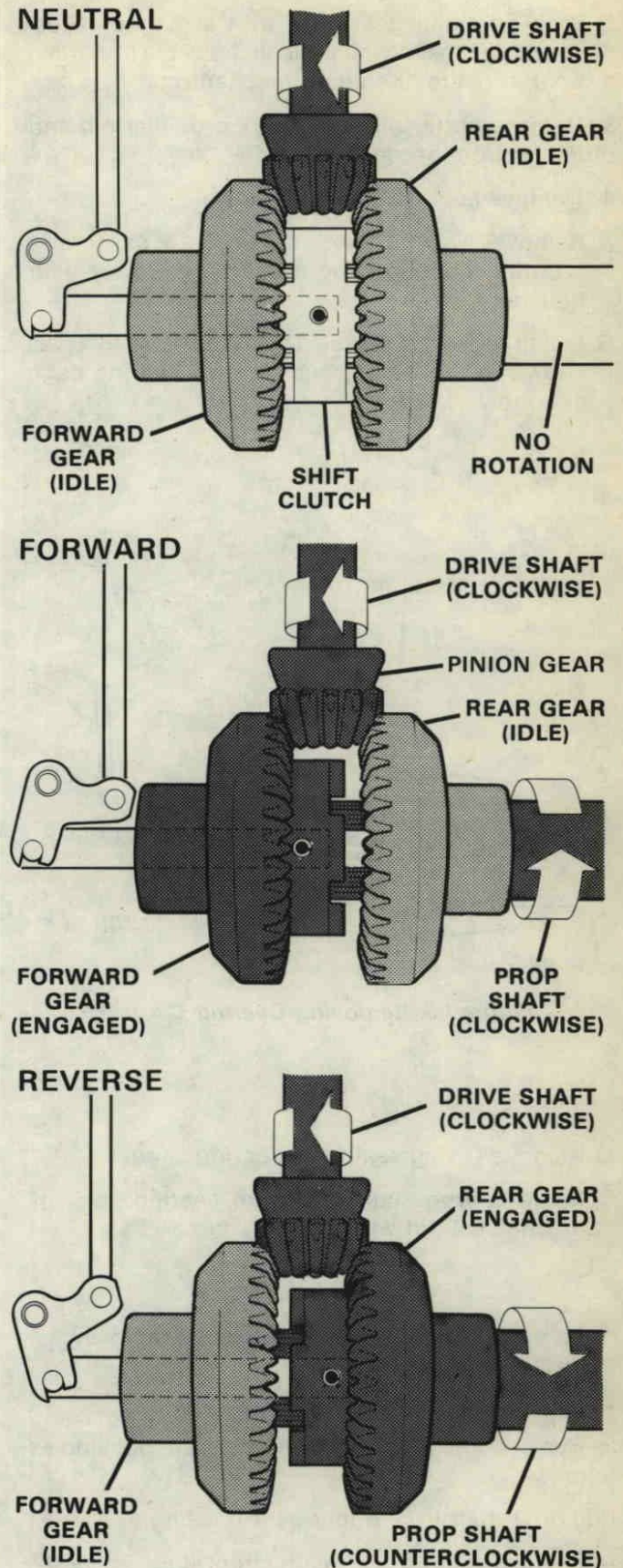


Figure 49. Operation of Gear Train and Shift Mechanism.

- B. Probe drained gear lube with a magnet. Steel shavings present will indicate possible abnormal wear in gears or shifting mechanism.
- 3. Remove cotter pin, prop. nut, propeller pin and propeller from propeller shaft.
- 4. Remove bearing cage as follows:
 - A. Remove two (2) hex socket head capscrews securing bearing cage assembly to lower gear housing.
 - B. Install puller (Special Tool No. T 8948-1) as shown in Figure 50, and remove bearing cage assembly.

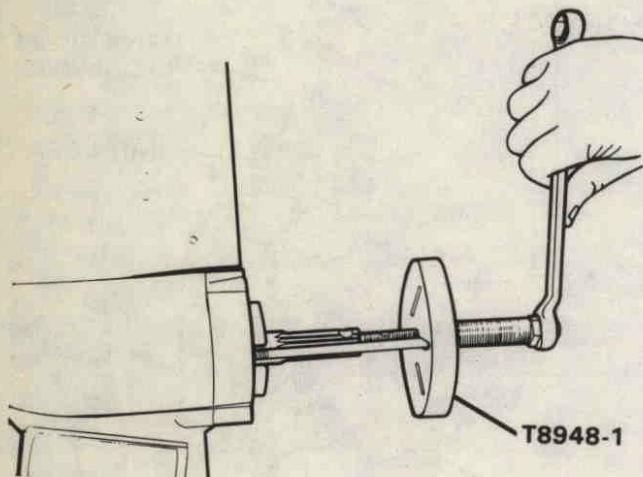


Figure 50. Removing Bearing Cage.

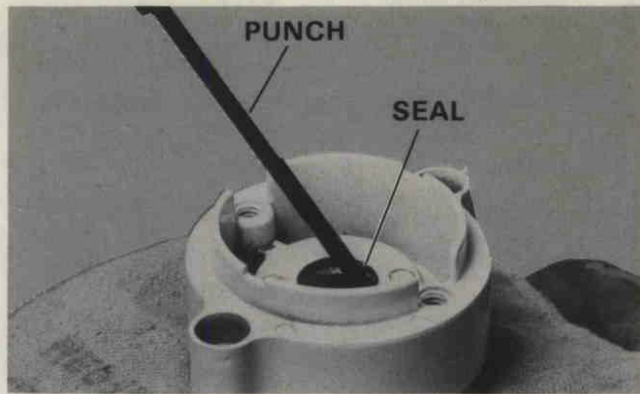


Figure 51. Removing Propeller Shaft Seal.

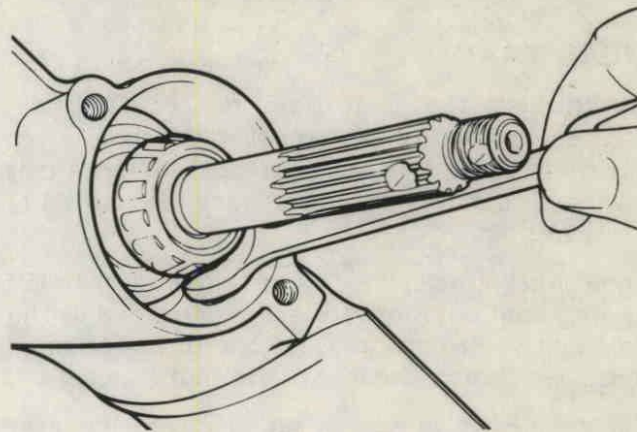


Figure 52. Removing Nut and Lockwasher from Stud.

- C. Remove plug, shift detent spring and shift detent guide from upper gear housing. Figure 53.

- C. Remove O ring seal from bearing cage.
- D. Remove prop shaft seal from bearing cage by driving seal out with a punch. Figure 51.

CAUTION

Do not damage bearing cage when removing seal.

- 5. Remove and disassemble upper gear housing as follows:
 - Pull driveshaft from upper gear housing.
 - A. Remove nut and lockwasher from stud. Figure 52.
 - B. Remove nut and lockwasher from forward gear housing stud.

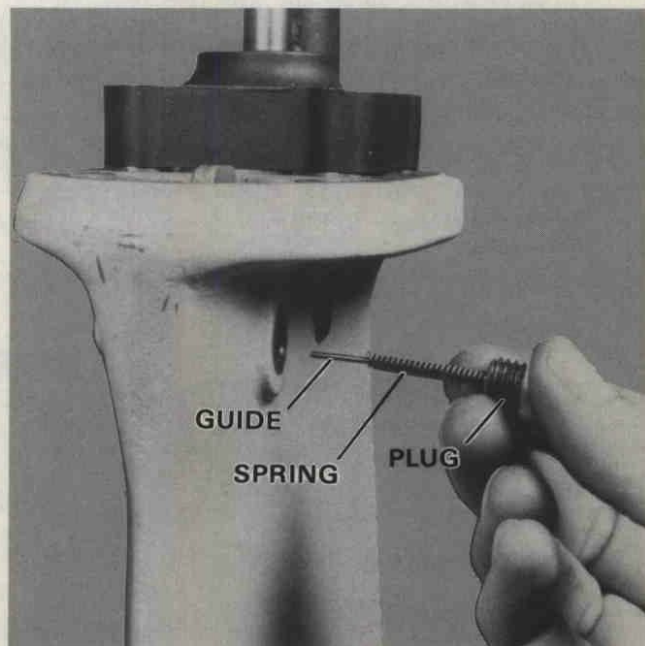


Figure 53. Removing Shift Detent Assembly.

- D. Turn lower shift rod counterclockwise until it unthreads from shift arm. Pull shift rod from gear housing.
- E. Lift upper gear housing from lower gear housing.
- F. Remove O ring from groove in lower gear housing.
- G. Pry seal out of bore in upper gear housing with screwdriver. Figure 54.

CAUTION

Be very careful not to scratch seal bore with screwdriver when removing seal.

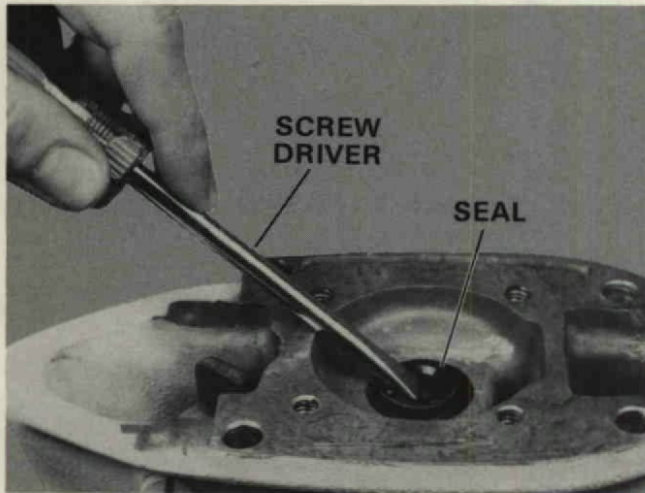


Figure 54. Removing Driveshaft Seal.

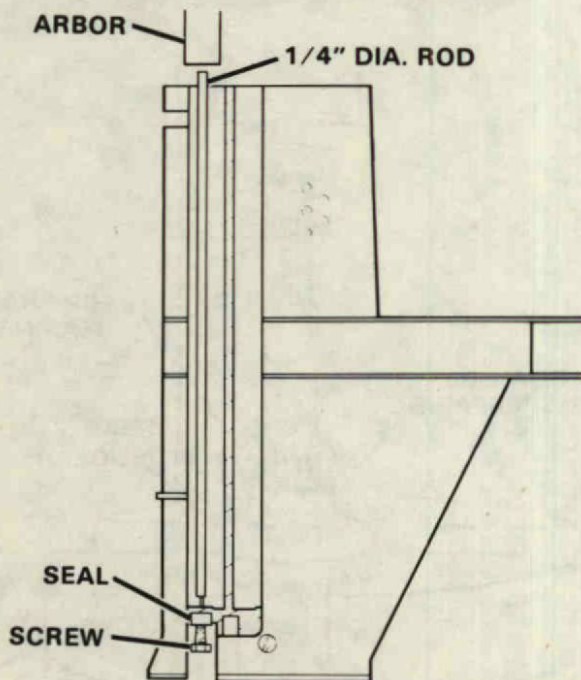


Figure 55. Removing Gear Shift Rod Seal.

- H. Remove gear shift rod seal from upper gear housing by threading a 5/16" diameter screw

through shift rod seal. Press seal from gear housing. Figure 55.

- I. Drive out spring pin securing gear shift rod coupling to gear shift rod and remove coupling. Figure 56.



Figure 56. Removing Coupling.

- 6. Remove pinion shaft as follows:
 - A. Remove coupler from end of pinion shaft. Figure 57.

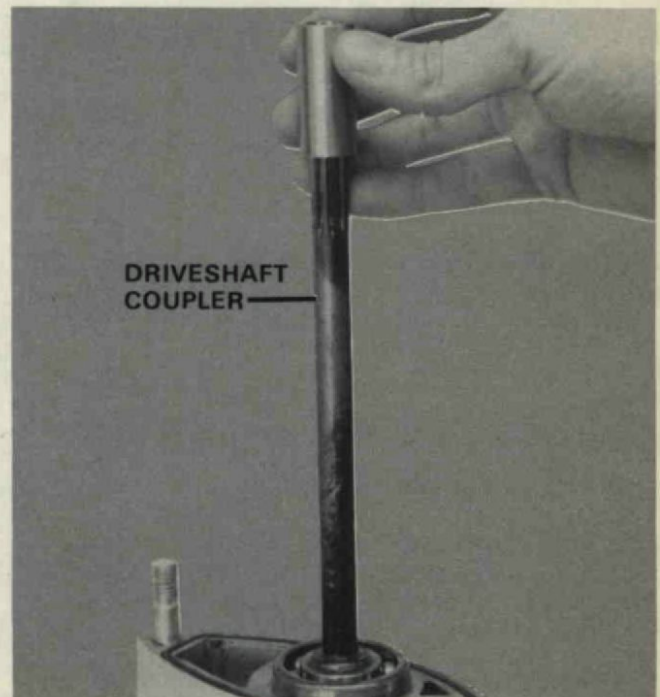


Figure 57. Removing Coupler.

B. Remove pinion assembly.

NOTE

Bearing is not available as an individual service item. Bearing is a slip fit in gear housing bore and is removable by hand.

7. Remove propeller shaft as follows:

A. Pull propeller shaft assembly from lower gear housing.

8. Remove gear shift arm as follows:

A. Remove gear shift arm pin. Figure 58.

B. Remove shift arm.

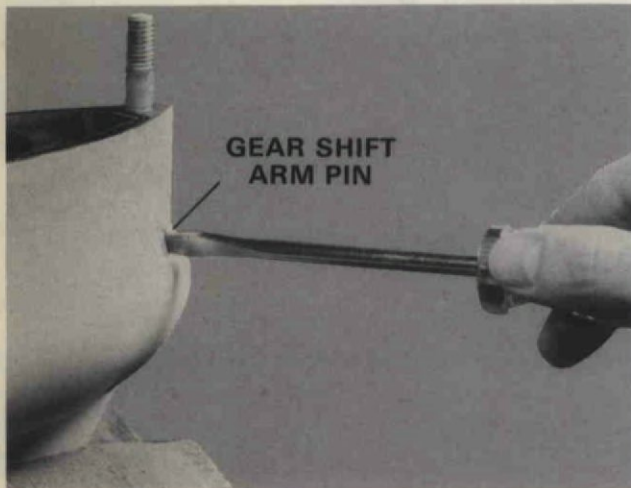


Figure 58. Removing Gear Shift Arm Pin.

Prior to further disassembly, close inspection should be made of bearings and gears.

Disassembly. To disassemble the propeller shaft, proceed as follows:

1. Remove shift yoke from shift pin.

2. Slide forward gear with bearing from shaft.

3. Remove spacer from shaft.

4. Remove clutch as follows:

A. Drive out spring pin securing clutch to shift pin. Use punch (Special Tool No. T 8919). Figure 59.

B. Remove clutch and shift pin.

5. Remove rear gear and bearing as follows:

A. Place propeller shaft in an arbor press. Figure 60.

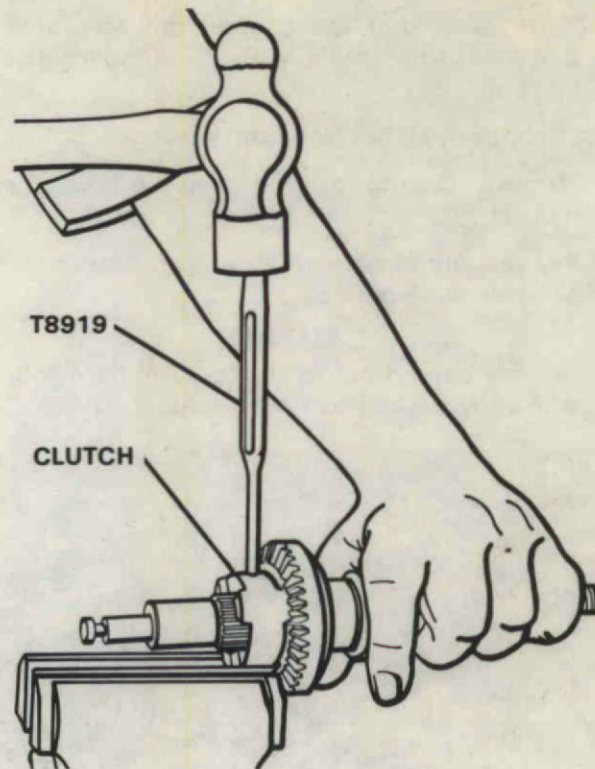


Figure 59. Removing Clutch and Shift Pin.

B. Remove propeller shaft bearing rear, shims, reverse gear (bronze) bearing, reverse gear and reverse gear thrust washer from prop shaft.

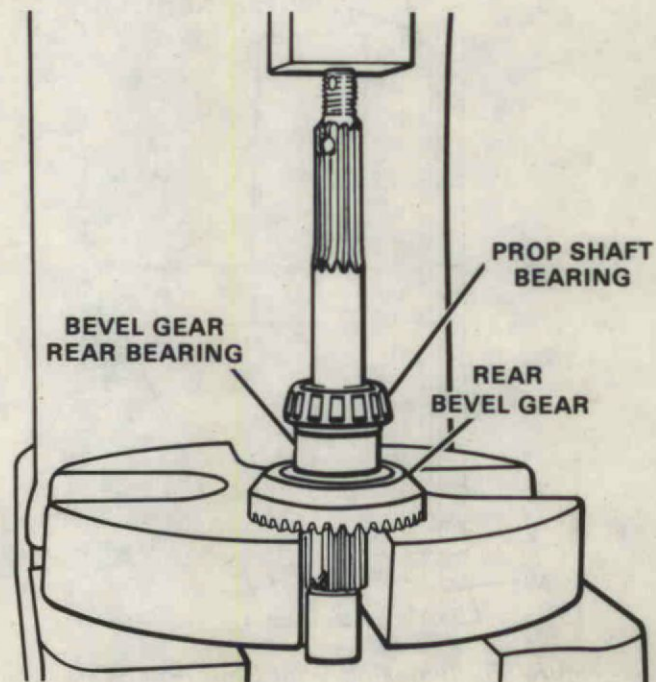
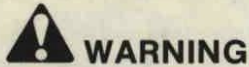


Figure 60. Removing Propeller Shaft Components.

Inspection and Repair (Lower Gear Housing).
Thoroughly clean all gear housing components in solvent. Dry with compressed air.



WARNING

Wear safety glasses when working with compressed air.



WARNING

DO NOT spin bearing cones with compressed air. The cage will explode, causing injury.

1. Inspect propeller shaft for obvious wear or distortion around clutch slot and propeller pin hole. Remove sharp burrs or nicks with a fine file or emery cloth. Check spline for cracks.

NOTE

Do not remove excessive metal from shaft.

2. Inspect front bearing for wear. If wear is noted, bearing cup must be removed from housing. Remove cup as follows:

- A. Use cup remover (Special Tool No. T 8921) and bearing guide set (Special Tool No. T 8918) to remove bearing cup from lower gear housing. Figure 61.

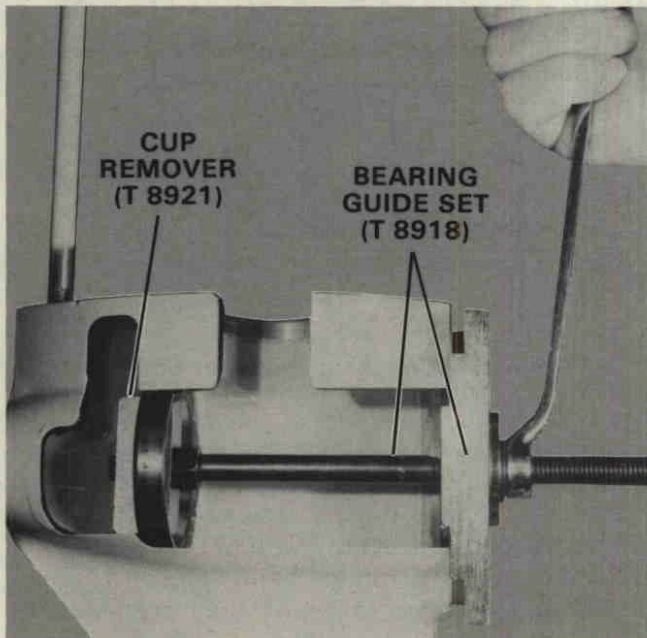


Figure 61. Removing Bearing Cup from Gear Housing.

- B. Press bearing cup in lower gear housing using cup installer (Special Tool No. T 8904) with driver handle (Special Tool No. T 8907) and guide plate (Special Tool No. T 8918) as shown in Figure 62.

- C. Bearing cone is replaced as part of forward gear assembly only.

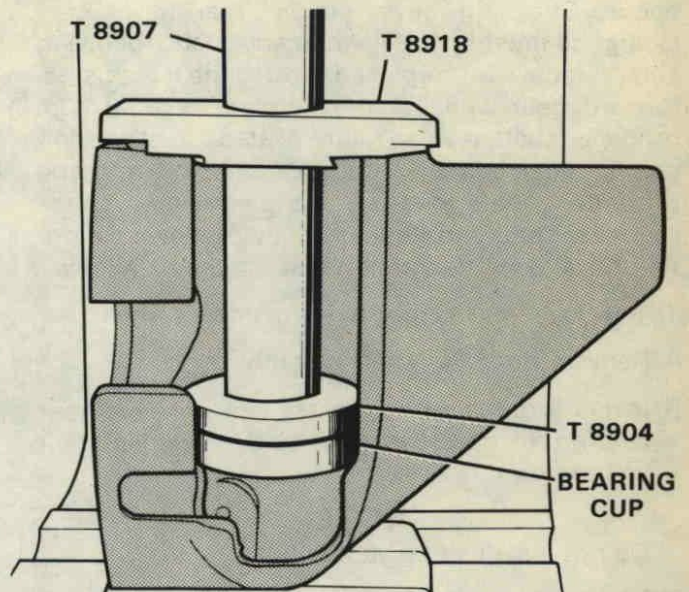


Figure 62. Installing Bearing Cup in Gear Housing.

3. Inspect clutch for wear. Replace if worn. Pay particular attention to clutch dogs.
4. Check shift pin and yoke for wear.
5. Check gears for wear, replace if necessary.
6. Inspect propeller shaft bearing cage.
7. Inspect rear bevel gear bearing.
8. Inspect pinion shaft with bearing.
 - A. Check bearing for wear.
 - B. Check splines for cracking or twisting.

NOTE

Bearing is not available individually, only as an assembly.

9. Carefully check inside of gear housing for cracks, corrosion and burrs. Remove burrs. Superficial corrosion may be permissible if not on sealing surface. Cracked housings must be replaced.

Inspection and Repair (Upper Gear Housing).

Remove anti-corrosion anode from side of housing. Inspect for deterioration. Zinc alloy sacrificial anode protects engine against corrosion from water or bad wiring in boat or boat moored nearby. Replace if badly corroded or metal is missing; and find source of trouble. Clean water inlets. Inspect housing for cracks or other damage.

Reassembly (Lower Gear Housing).

The lower gear housing uses variable thickness shims and spacers to establish proper engagement between gears. If

this relationship is not held within tolerance, premature gear wear and/or bearing failure may occur. Checking bevel pinion/ rear bevel gear clearance must be done when any of the following components are replaced: lower gear housing, forward gear with bearing, forward bearing cup, propeller shaft, reverse gear, reverse thrust washer, reverse gear bearing, propeller shaft bearing and propeller shaft bearing cage. Always check propeller shaft end float after setting bevel pinion/ rear bevel gear clearance. Reassemble as follows:

1. Set bevel pinion/rear bevel gear clearance:

A. Remove propeller shaft assembly.

B. Install thrust washer, reverse gear, reverse gear bearing (bronze bearing) and propeller shaft bearing on propeller shaft.

NOTE

Do not install shims at this time.

C. Place prop shaft with components on arbor press. Slip bearing installer (Special Tool No. T 8920) over end of prop shaft and press components on prop shaft until bearing bottoms out. Figure 63.

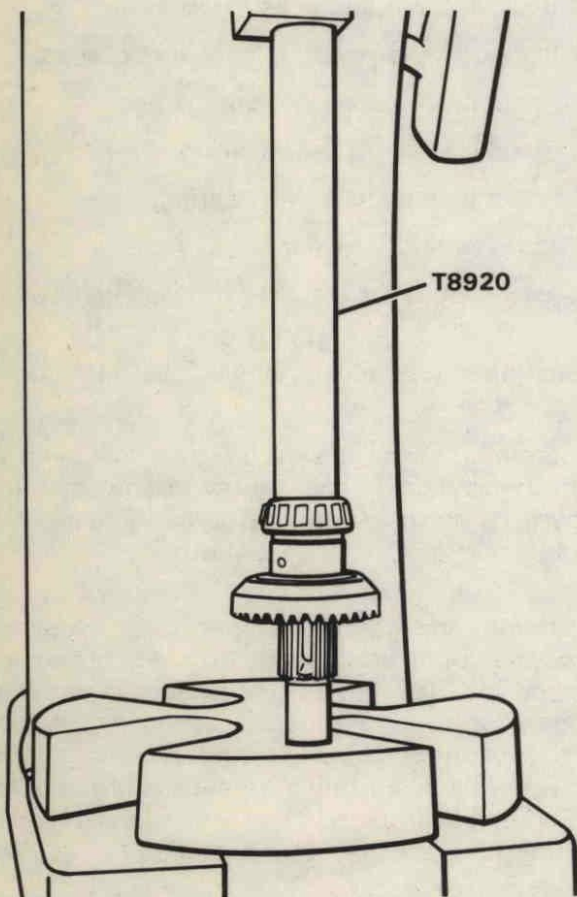


Figure 63. Installing Propeller Shaft Components.

CAUTION

The installer must be centered on the inner race of the bearing to prevent damage to the bearing.

D. Clamp checking guage (Special Tool No. T 8924-1) in vise. Install Special Tool No. T 8982 on checking gauge and secure with two hex socket head screws. Place Special Tool No. T 8982A (barrel) in bore at bottom of T 8924-1 checking gauge. Set propeller shaft with components in place on shimming fixture. Figure 64.

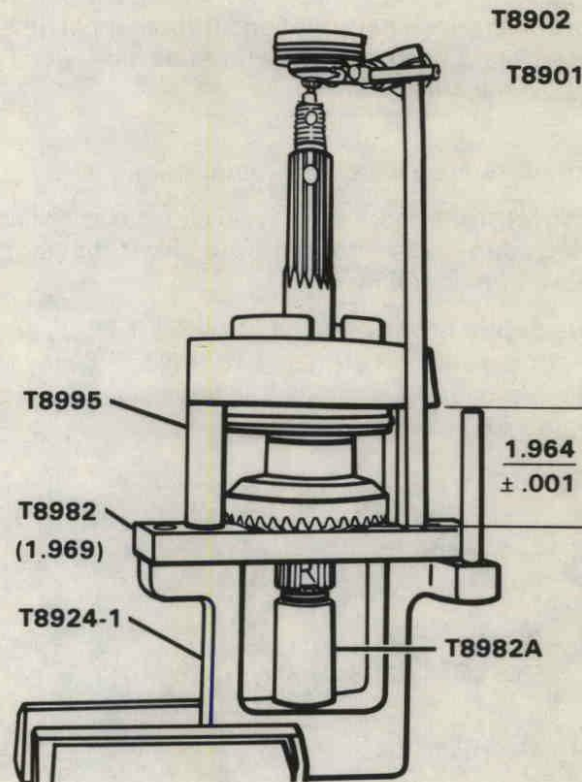


Figure 64. Checking Propeller Shaft.

E. Remove the O ring seal from propeller shaft bearing cage. Install the bearing cage on propeller shaft. Figure 48. Install two (2) T 8995 shim spacers and secure with two (2) hex socket head screws. Rotate shim spacers while tightening screws to insure they are standing straight, then torque screws to 25 in. lbs.

F. Install dial indicator holder (Special Tool No. T 8901) and dial indicator (Special Tool No. T 8902) on the post of T 8982 shim adapter. Figure 48. Set the foot of the dial indicator on the flat milled surface of the prop shaft. In the initial step of shimming you are determining the distance from the bottom face of the reverse gear

to the mounting surface of the bearing cage. This distance must be $1.964 \pm .001$ ". Figure 64.

The T 8995 spacers are ground to a dimension of 1.969"; therefore, when the gear is properly shimmed, you will get a dial indicator reading of $.005 \pm .001$ " (0.13 ± 0.03 mm).

G. Push down on prop shaft to seat the gear against the surface of T 8982. Set the dial indicator to "O".

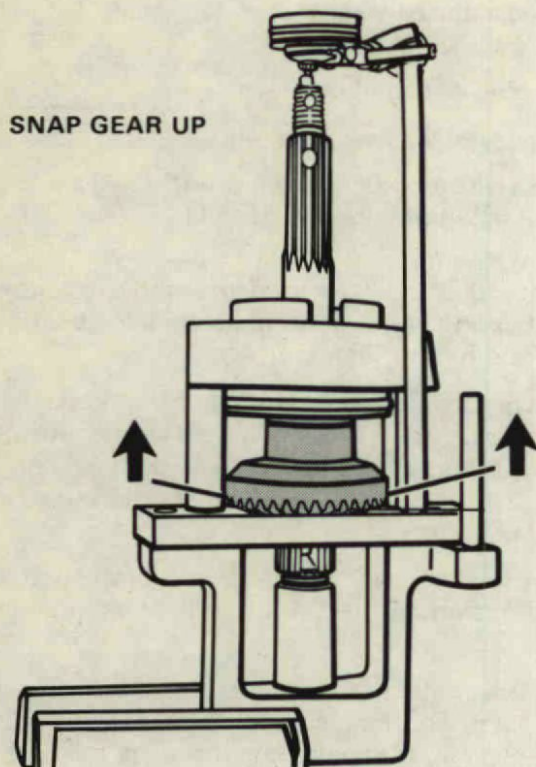


Figure 64A. Checking Space: Rear Gear to Cage.

H. Grasp gear and pull up with a quick snap using equal pressure on opposite sides of gear and without rotating. Note amount of movement of pointer on dial indicator. Allow gear to drop back down, pointer on dial indicator should go back to "O". Repeat above procedure to verify reading. Readings should be consistent. If they are not, check the mounting and zero adjustment of the dial indicator.

I. Compute thickness of shims required as shown in Example A.

NOTE

In some cases a combination of shims may be required to achieve the allowable dimension.

EXAMPLE

If dial indicator reading from Step H is	.011
Minus the spacer overage	-.005
Thickness of shims required is	.006

NOTE

There are three shim thicknesses available. They are:

Part No.	Size	Color
2052	.005	Silver
2053	.006	Copper
2054	.008	Black

J. After determining proper shims required, remove dial indicator and holder from shim adapter. Remove two (2) screws securing bearing cage to shim adapter and remove bearing cage. Remove T 8995 shim spacers and remove propeller shaft from checking gauge.

K. Place propeller shaft in arbor press and remove prop shaft bearing from prop shaft as shown in Figure 60.

L. Install proper shim(s) as determined in Step I. (above).

NOTE

Shims are placed between reverse gear bearing (bronze) and prop shaft bearing.

M. Install prop shaft bearing as outlined in Step C.

N. Repeat Steps D through H. You **must** have a reading of $.005 \pm .001$ " (0.13 ± 0.03 mm).

O. Remove prop shaft assembly from checking gun.

2. Check propeller shaft end float as follows:

A. Clamp lower gear housing in a vise with prop shaft end of housing horizontal.

B. Install clutch and shift pin on propeller shaft and secure with spring pin.

C. Install thinnest forward thrust washer available on forward end of prop shaft, part number 2087, which is .056" (1.42 mm) thick.

NOTE

The correct end float is $.005 \pm .001$ " (0.13 ± 0.03 mm). The end float is controlled by the thickness of the forward thrust washer. There are eleven (11) different thicknesses of washers available. Refer to the parts book for part numbers and sizes available.

- D. Install forward gear assembly on propeller shaft.
- E. Install propeller shaft assembly in gear housing, making sure gear shift lever does not interfere with gear shift pin.
- F. Install prop shaft bearing cage assembly in gear housing.

NOTE

Leave the O ring seal off of bearing cage. This eases installation and removal of bearing cage during shimming.

- G. Install dial indicator post (Special Tool No. T 8982C) in upper bearing cage screw hole and one (1) prop shaft bearing cage screw in lower hole. Tighten until snug.
- H. Rotate gear housing so that prop shaft is vertical. Install dial indicator holder (Special Tool No. T 8901) and dial indicator (Special Tool No. T 8902) on dial indicator post T 8982C. Set foot of dial indicator so that it contacts machined surface at end of prop shaft. Figure 65.
- I. Apply a downward force on prop shaft and rotate back and forth 90° to seat forward bearing in bearing cup.
- J. Set dial indicator to "0".
- K. Pull up on prop shaft with as much force as possible. Note and record dial indicator reading. Repeat this procedure several times.
- L. Determine thickness of thrust washer required as shown below:

EXAMPLE

If dial indicator reading noted in Step K is	.012
Minus the desired end float	<u>-.005</u>
Result	.007

M. Add this result to the thickness of the thrust washer installed on the prop shaft in Step C. This will determine the thickness of washer required for .005" (0.13 mm) prop shaft end float.

EXAMPLE

Thickness thrust washer installed in Step C	.056
Plus result of example above	<u>+.007</u>
Thickness of washer required	.062

Select a washer which is within .001" (0.03 mm) of final result obtained in Step M.

- N. Remove dial indicator and dial indicator post from bearing cage. Remove screw from bearing cage and remove bearing cage.
 - O. Remove forward gear assembly from prop shaft and remove .056" (1.42 mm) thrust washer. Install correct thrust washer, which will give you .005 ± .001" (0.13 ± 0.03 mm) end float as determined in Step M.
 - P. Install forward gear assembly and prop shaft in gear housing and recheck end float as outlined above.
3. After completing shimming procedures, remove bearing cage and install O ring seal in groove in bearing cage and propeller shaft seal as follows:

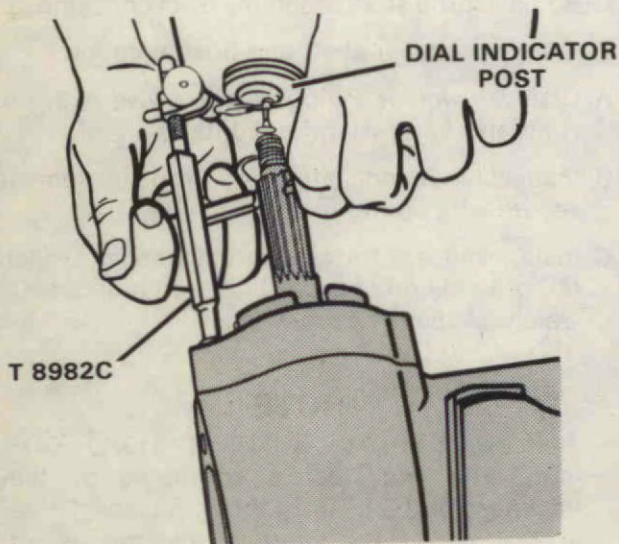


Figure 65. Checking Propeller End Float

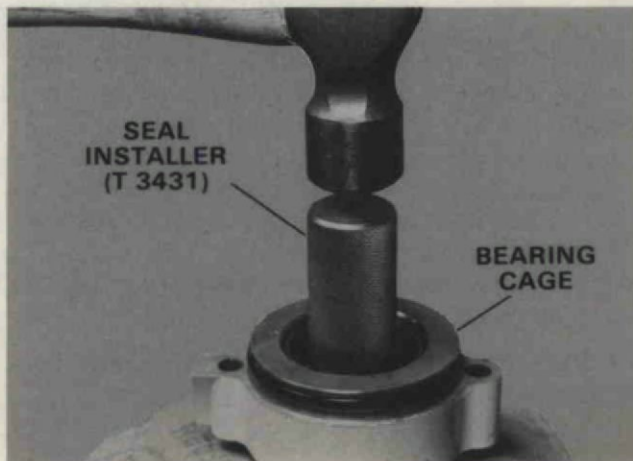


Figure 66. Installing Seal in Bearing Cage.

- A. Apply grease (Special Tool No. T 2961) between lips of propeller shaft seal. Use seal installer (Special Tool No. T 3431) to press seal into bearing cage. Figure 66. Garter spring should face out toward rear of prop shaft and seal should bottom in bore.
- B. Place O ring seal in groove in bearing cage.
- C. Apply light coat of grease (Special Tool No. T 2961) to "O" ring seal.
4. Remove propeller shaft assembly.

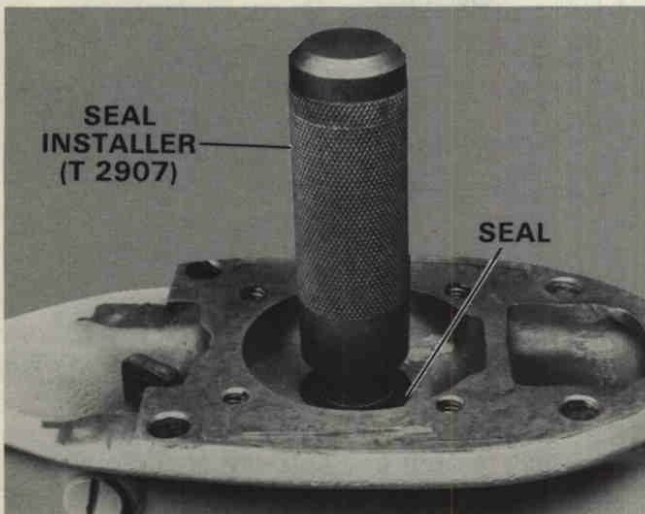


Figure 67. Installing Driveshaft Seal.

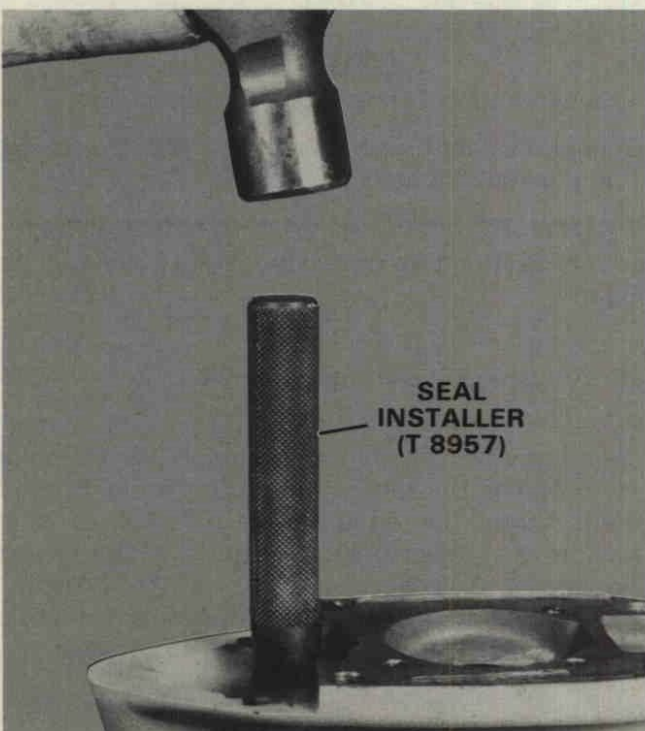


Figure 68. Installing Shift Rod Seal.

5. Install driveshaft seal in upper gear housing as follows:

- A. Apply grease to lips of seal. Place seal on Special Tool No. T 2907 so that major sealing lip with garter spring is against shoulder of tool.
- B. Position seal and tool in bore of upper gear housing as shown in Figure 67 and press seal in until it contacts bottom of bore.

6. Install shift rod seal in upper gear housing as follows:

- A. Install shift rod seal using Special Tool No. T 8957. Install with raised bead on seal facing up. Seat in bore by driving down until seal is flush to .010" (0.26 mm) depressed below cavity surface. Figure 68.

7. Install upper gear housing to lower gear housing as follows:

- A. Place O ring seal in groove of lower gear housing.
- B. Place bevel pinion shaft with bearing in lower gear housing. **DO NOT SEAT BEARING AT THIS TIME.** Install driveshaft coupler to top of pinion gear shaft.
- C. Place upper housing on lower housing, do not secure.
- D. Install shift rod (with coupler) in upper gear housing. Use care not to damage shift rod seal.

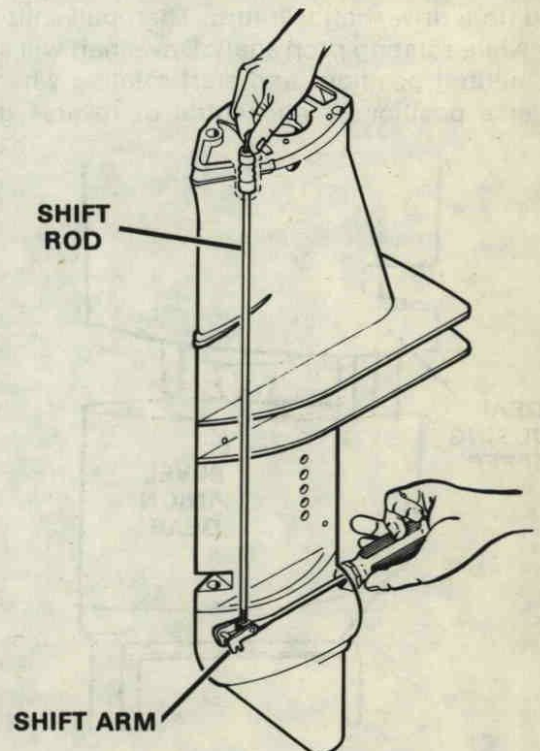


Figure 69. Assembling Shift Arm to Shift Rod.

E. Use a screwdriver to hold the swivel on the shift arm in a horizontal position and thread the shift rod into the swivel 2 turns. Figure 69.

F. Lift upper housing up from lower housing as far as it will go. Reach inside lower housing and push pinion shaft up out of bore. Figure 70. Set upper housing over to one side of lower gear housing. Bottom of pinion gear should be resting on parting line surface of lower gear housing.

G. Slide propeller shaft assembly into lower gear housing until ears on shift yoke engage with forks on shift arm. Set upper housing and pinion shaft in place on lower housing. Figure 71.

NOTE

Keep forward pressure on propshaft while doing this or ears of yoke will disengage from shift fork.

NOTE

Apply a small amount of grease to shift yoke to hold it in position when installing.

H. Install driveshaft in gear housing. Thread shift rod into coupler as far as it will go. Check to see that shift yoke has engaged with shift arm by pushing in on prop shaft and rotating it. At the same time push gear shift rod completely down and note driveshaft will turn. Then pull shift rod up while rotating prop shaft. Driveshaft will stop (at neutral position) and start rotating when in reverse position. If no neutral or reverse gear

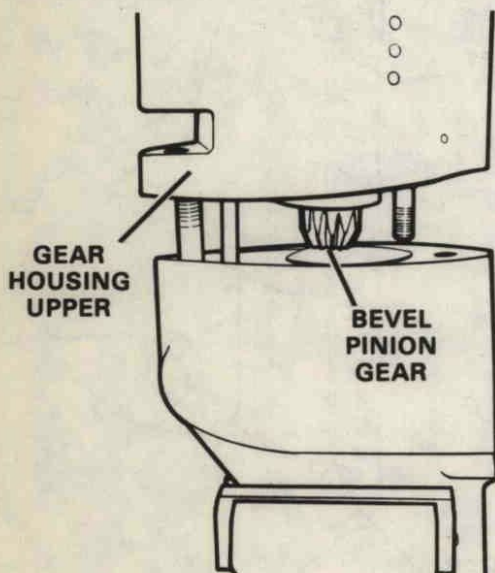


Figure 70. Positioning Upper Housing to Side.

position is present, this indicates that shift yoke is not engaged in shift arm. Repeat Step F and G if this occurs.

I. Install lockwasher and nut on rear stud of gear housing and lockwasher and nut on forward gear housing stud, tighten securely.

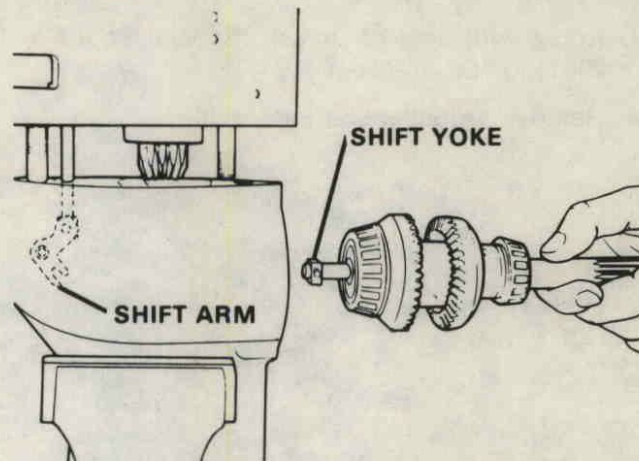


Figure 71. Installing Propeller Shaft Assembly.

NOTE

Use painted nut and lockwasher on forward stud.

8. Install propeller shaft bearing cage as follows:

A. Carefully guide cage on propeller shaft and seat in housing.

CAUTION

Avoid cutting O ring when installing cage.

B. Apply sealant (Special Tool No. T 8983) to screws and install. Tighten securely.

9. Install shift detent spring and detent pin in upper gear housing and secure with spring holding plug. Figure 72.

10. Adjust lower shift rod as follows:

Place shift rod coupler in neutral position (center detent position on shift rod coupler). At this point the prop shaft should rotate freely. From this point there should be equal travel distance to both forward and reverse gear position. If this is not present, rotate the gear shift coupler counterclockwise one full turn at a time until there is equal distance from both neutral to forward and reverse.

11. Install water pump.

SPECIAL TOOLS

The following is a listing of basic special tools required to service the 9.9, 15 & 250 Sailor Horsepower Chrysler Outboard Motors. Refer to the "Parts Price List" for prices and ordering instructions.

Part No.	Part Name	Use	Selected Use
TUNE-UP			
T 2989	Flywheel Wedge	To remove flywheel	
T 2909	Knock-Off Nut	To remove flywheel	
T 8930-1	Feeler Gauge	To adjust breaker points	9.9 & 15 H.P. only
MANUAL STARTER			
T 2985	Starter Rewind Key	To rewind starter spring	9.9 & 15 H.P. only
POWER HEAD			
T 2998	Torque Wrench (0 - 100 lbs./ft.)	To properly secure fasteners	
T 2999	Torque Wrench (0 - 600 lbs./in.)	To properly secure fasteners	
T 2991	Carbon Brush	To remove carbon from inside of power head	
T 8900	Hose Clamp Pliers	To remove and install fuel hose clamps	
T 11202	Seal Installer	To install crankshaft seals	
T 3012	Seal Installer	To install upper crankshaft bearing cage seal	
T 8949	Seal Installer	To install lower crankshaft seal	9.9 H.P. Sailor only
T 2908	Seal Sleeve	To install upper crankshaft bearing cage seal	
T 8929	Adapter and Hex Bit	To torque connecting rod screws	
T 1749	Snap Ring Pliers	To remove and install piston pin retaining rings	
T 2997	Ring Compressor	To install pistons	
T 8926	Ring Expander	To install piston rings	
T 8993	Torque Wrench Adapter	To torque lower cylinder head bolts	
T 2990	Piston Pin Tool	To remove and install piston pin	
T 2947	Spark Plug Tap	To remove carbon from cylinder head threads	
LOWER UNIT			
T 8948-1	Puller	To remove propeller shaft bearing cage	
T 8957	Seal Installer	To install shift rod seal	
T 2907	Seal Installer	To install driveshaft seal in upper gear housing propeller shaft seal and water pump seal	
T 8904	Forward Cup Installer	To install forward bearing cup	9.9 H.P. Sailor only
T 8907	Driver Handle	To install forward bearing cup	9.9 H.P. Sailor only
T 8921	Cup Remover	To remove forward bearing cup	9.9 H.P. Sailor only
T 8918	Bearing Guide Set	To remove forward bearing cup	9.9 H.P. Sailor only
T 3431	Seal Installer	To install propeller shaft seal	9.9 H.P. Sailor only
T 8919	Spring Pin Punch	To remove clutch pin	9.9 H.P. Sailor only
T 8985	Seal Installer	To install propeller shaft seal	9.9 H.P. Sailor only
T 8920	Bearing Installer	To install propeller shaft bearing	9.9 H.P. Sailor only
T 8924-1	Checking Gauge	To shim lower unit	9.9 H.P. Sailor only
T 8982	Shim Adapter	To use with checking gauge (T 8924-1)	9.9 H.P. Sailor only
T 8995	Shim Spacer	To use with checking gauge (T 8924-1)	9.9 H.P. Sailor only
T 8901	Indicator Holder	To use with checking gauge (T 8924-1)	9.9 H.P. Sailor only
T 8902	Dial Indicator	To use with checking gauge (T 8924-1)	9.9 H.P. Sailor only
TEST EQUIPMENT			
T 2938-1	Battery Powered Test Light	To test for continuity in wires	
T 8342	Test Wheel	To test motor in test tank	9.9 H.P. only
T 8352	Test Wheel	To test motor in test tank	15 H.P. only
T 2955A	Test Wheel	To test motor in test tank	9.9 H.P. Sailor only
T 8950	Leakage Tester	To test gear housing seals for leaks	
T 8996	Ignition Tester	To test trigger output	9.9 & 9.9 H.P. Sailor only
T 8953	C-D Tester	To test stator output and secondary voltage	9.9 & 9.9 H.P. Sailor only
T 2951	Circuit Tracer	To test 12 volt circuits for continuity	
LUBRICANTS AND SEALANTS			
T 2961	Lubricant - Rykon #2EP		
T 2987-1	Lubricant - Anti-seize		
T 8969	Lubricant - 7 oz. 2 LSI Lubricant		
T 8983	Sealant - RTV		
T 8936-1	Sealant - 2 cc Loctite Retaining Compound #75		
T 2962-1	Sealant - 50 cc Loctite H, Non-hardening Grade		
T 2963-1	Sealant - 2 oz. Loctite D, Hardening Grade		
T 8935	Sealant Primer - 6 oz		

ACCESSORIES

Part No.	Part Name	Use	Selected Use
5H041	Battery Terminal Kit	Fits standard positive and negative battery posts	9.9 & 9.9 H.P. Sailor
5H051	Battery	74 amp hour rating	9.9 & 9.9 H.P. Sailor
5H021	Battery Extension Cable 6-1/2 Ft.	Adapts to engine's battery cable	9.9 & 9.9 H.P. Sailor
5H081	Battery Cable - 15 Ft.	Provides disconnect plug at engine	9.9 H.P. only
5H027	Steel, 6 Gallon Fuel Tank	Auxiliary tank	9.9 & 15 H.P.
5H026	Steel, 6 Gallon Fuel Tank	Auxiliary Tank	9.9 H.P. Sailor
5H040	Steel, 12 Gallon Fuel Tank	Auxiliary tank	
5H029	Fuel Tank Anchor	Secures tote tank to boat floor	
476	Fuel Line Adaption Kit	Adapts model 5H027 tank for disconnect at tank	9.9 & 15 H.P.
588	Flushing Adapter	Permits fresh water flushing of water passages with standard garden hose	9.9 & 15 H.P.
5H013	Flushing Adapter	Permits fresh water flushing of water passages with standard garden hose	9.9 H.P. Sailor
5H025	Anti-corrosion Anode	Protects engine from electrolysis corrosion - mounts on cavitation plate	9.9 & 15 H.P.
5H062	Water Pump Kit	Heavy duty water pump recommended for continued operation in sandy or salt water	
137	Steering Connector	Wire form with latch	9.9 & 15 H.P.
167	Ignition Cut-Off Kit	Permits stopping of engine from operator's seat	9.9 & 15 H.P.
K1019-1	5" Long Leg Conversion Kit	Converts 15" standard shaft model to 20" long shaft model	9.9 & 15 H.P.
5H057	15" Long Leg Conversion Kit	Converts 15" standard shaft or 20" long shaft model to 30" long shaft model	9.9 & 15 H.P.
5H088	Remote Control Conversion Kit	Permits remote control of throttle and gear shift from front of boat	
5H090	Remote Electric Start Kit	Provides remote electric start and choke	9.9 & 9.9 H.P. Sailor
195-6	Remote Control Cables	Connects remote control box to throttle and gear shift on motor.	
thru 195-40		Available in 6 through 40 foot lengths	
5H142	Sailboat Remote Control	Provides recessed panel installation	9.9 H.P. Sailor
5H130	Synchro-Drive Control Box (Single Lever)	Permits remote control of throttle and gear shift from starboard side of boat	
866	Duo-Drive Control (Twin Lever)	Permits remote control of throttle and gear shift. May be mounted on port or starboard side of boat	9.9 & 15 H.P.
5H131	Port Side Decal Kit	Converts 5H130 control box to port side mounting	9.9 & 15 H.P.
5H054	Remote Steering Bracket	Mounts in place of steering handle	9.9 & 15 H.P.
72H03	Carrying Bag	Canvas bag for transporting and storing engine	9.9 & 15 H.P.
5H134	Boat White Lacquer	Engine touch-up paint in 12 3/4 oz. spray bombs (6 cans per case)	
596	Chrysler Outboard Oil	Chrysler Outboard Oil is compounded from selected high quality heat resistant base oil and a non-metallic additive to lubricate and maintain cleanliness of Chrysler Outboard motors. Chrysler Outboard Oil is available in pint cans, six-pack cartons (6 pints) and cases (24 pints).	
597	Chrysler Outboard Gear Lube	Chrysler Outboard Gear Lube is an extreme pressure lubricant formulated to handle the high gear loads present in an outboard lower unit. Chrysler Outboard Gear Lube prevents rust and corrosion of the lower unit working parts, allows the lower unit to work more efficiently and last longer. Chrysler Outboard Gear Lube is available in 8 ounce plastic tubes and 12 tube cases.	
5H059	Chrysler Outboard Multi-Purpose Grease	Lubricates bearings and other moving parts. Available in 8 oz. tubes and 12 tube cases.	
5H060	Chrysler Outboard Grease Gun	Used with Chrysler Outboard Multi-Purpose Grease tubes for pressure fittings.	
OB3609	Owner's Guide		
OB3642	Service Manual		

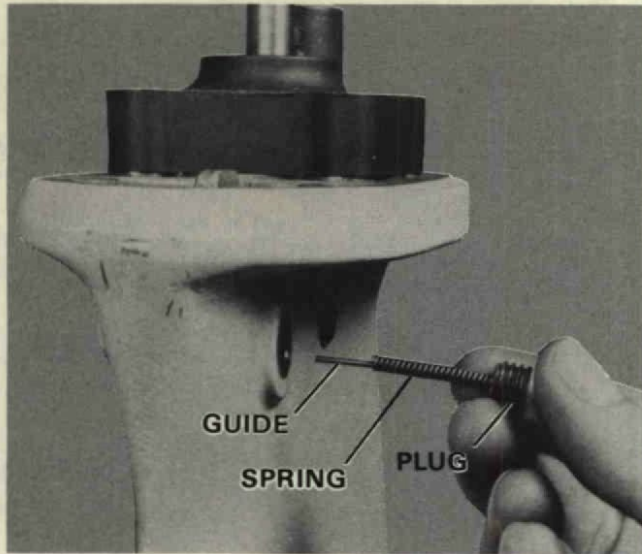


Figure 72. Installing Shift Detent Assembly.

12. Pressure test gear housing assembly as follows:

- A. Refill lower unit with gear lube.
- B. Remove "vent" plug from upper gear housing.
- C. Thread adapter of pressure tester (Special Tool No. T 8950) in vent hole of gear housing and tighten securely.
- D. Pressurize housing to 10 p.s.i. and observe gauge for five minutes. If pressure drops, immerse housing in water and repressurize to 10 p.s.i. Observe for air bubbles. Replace any seals seen to be leaking and retest.

CAUTION

Do not pressurize gear housing beyond 10 p.s.i. or seals may be damaged.

- E. Remove tester, install "vent" plug.

13. Install lower unit as follows:

- A. Shift lower unit into forward gear by pulling up on gear shift rod lower to position hole in coupling for assembly to gear shift rod upper.

- B. Apply a bead of sealant (Special Tool No. T 8983) at inside edge of entire motor leg flange and around and in four tapped holes in motor leg.
- C. Apply anti-seize (Special Tool No. T 2987-1) to splined area of driveshaft. Position gear housing on motor leg. Engage driveshaft splines with crankshaft splines and align waterline in seal in water pump.
- D. Align gear shift rod lower coupler to shift rod upper as shown in Figure 73. Shift rods must be positioned exactly as shown or engine will not shift properly. Install screw securing lower shift rod to upper shift rod.
- E. Check to see that waterline is seated in seal of water pump body.
- F. Secure gear housing to motor leg with four screws.

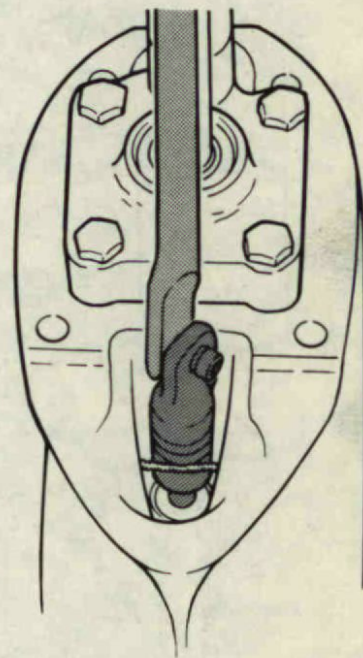


Figure 73. Aligning Gear Shift Rods.

- 1 SPRING PIN
- 2 GEAR SHIFT ROD UPPER
- 3 SCREW, 1/4 - 20 x 1-1/4
- 4 SEAL
- 5 SEAL, INLET WATERLINE

- 6 WATER PUMP BODY W/WATER PUMP SEAL
- 7 DRIVESHAFT
- 8 WATER PUMP IMPELLER DRIVE PIN
- 9 WATER PUMP IMPELLER
- 10 WATER PUMP BACK PLATE
- 11 SCREW W/WASHER, 10 - 24 x 1/2
- 12 COUPLING SHIFT ROD
- 13 SPRING PIN
- 14 GEAR SHIFT ROD LOWER
- 15 SCREW, 5/16 - 18 x 1-1/4
- 16 GEARHOUSING UPPER W/BEARING, SEALS, WASHER AND PLUG
- 17 NYLTITE WASHER
- 18 GEAR HOUSING PLUG
- 19 GUIDE, SPRING DETENT
- 20 SPRING, SHIFT DETENT
- 21 PLUG, SPRING HOLDING
- 22 SEAL, SHIFT ROD LOWER
- 23 NUT, S.S., 3/8 - 16
- 24 LOCKWASHER
- 25 SEAL, GEAR HOUSING LOWER
- 26 COUPLING, DRIVESHAFT
- 27 YOKE
- 28 STUD
- 29 PINION SHAFT W/BEARING
- 30 GEAR SHIFT ARM
- 31 GEAR SHIFT ARM PIN
- 32 SEAL "O"RING
- 33 GEAR HOUSING LOWER W/PLUG, WASHER AND BEARING CUP
- 34 BEARING CUP
- 35 BEVEL GEAR FORWARD W/BEARING
- 36 SPACER, BEVEL GEAR FRONT .056, .059, .062, .065, .068, .071, .074, .077, .080, .083, .086.
- 37 CLUTCH
- 38 SPRING CLUTCH
- 39 GEAR SHIFT ARM PIN
- 40 PROPELLER SHAFT
- 41 THRUST WASHER BEVEL GEAR
- 42 GEAR, BEVEL REAR
- 43 BEARING, BEVEL GEAR REAR
- 44 SHIM PROPELLER SHAFT BEARING .005 (SILVER)
- 45 SHIM PROPELLER SHAFT BEARING .006 (RED)
- 46 SHIM PROPELLER SHAFT BEARING .008 (BLACK)
- 47 BEARING, PROPELLER SHAFT REVERSE THRUST
- 48 SEAL, PROPELLER SHAFT
- 49 SEAL, PROPELLER SHAFT BEARING CAGE
- 50 CAP SCREW, 5/16 - 18 x 1
- 51 PROPELLER SHAFT BEARING CAGE W/SEALS AND BEARING CUP
- 52 PROPELLER NUT W/SEAL & COTTER PIN
- 53 PROPELLER NUT W/SEAL & COTTER PIN
- 54 COTTER PIN
- 55 SEAL, PROPELLER NUT
- 56 PROPELLER PIN (PACK OF 6 W/COTTER PIN)
- 57 ANTICORROSION ANODE
- 58 SCREW 10 - 24 x 9/16
- 59 GEAR HOUSING SEAL KIT
- 60 WATER PUMP KIT

